Guidelines and Specifications
for
Flood Hazard Mapping Partners

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FEMA's Flood Hazard Mapping Program

Guidelines and Specifications *for* Flood Hazard Mapping Partners

Executive Summary

FEDERAL EMERGENCY MANAGEMENT AGENCY

www.fema.gov/mit/tsd/dl_cgs.htm

FINAL

February 2002

Executive Summary

This summary provides background information on the purpose and scope of these *Guidelines and Specifications for Flood Hazard Mapping Partners* (hereinafter referred to as "these Guidelines"). These Guidelines define the technical requirements, coordination and documentation activities, and product specifications for Flood Hazard Maps and related products. The guidelines and specifications documented herein are to be followed by Federal Emergency Management Agency (FEMA) Regional and Headquarters Office staff and the staff of other Flood Hazard Mapping Partners involved in producing and maintaining Flood Hazard Maps and related products under the National Flood Insurance Program (NFIP).

For decades, the national response to flood disasters was generally limited to constructing flood-control works, such as dams, levees, and seawalls, and to providing disaster relief to flood victims. This approach did not reduce all monetary flood losses, nor did it discourage unwise floodplain development. To compound the problem, the public could not buy flood coverage from insurance companies, and building techniques to reduce flood damage were often overlooked.

In the face of mounting flood losses and escalating costs to the general taxpayer for disaster relief, the U.S. Congress created the NFIP with the passage of the National Flood Insurance Act of 1968. The U.S. Congress broadened and modified the NFIP with the passage of the Flood Disaster Protection Act of 1973, the National Flood Insurance Reform Act of 1994, and other legislative measures. In enacting each piece of legislation, the U.S. Congress focused on reducing future flood damage and providing an insurance mechanism that allows a premium to be paid for protection by those most in need of the protection.

To meet the community participation and flood hazard assessment objectives of the NFIP, the U.S. Congress initially assigned the following responsibilities to the Secretary of the U.S. Department of Housing and Urban Development:

> (1) identify and publish information with respect to all flood plain areas, including coastal areas located in the United States, which have special flood hazards, within five years following the date of the enactment of this Act, and (2) establish flood-risk zones in all such areas, and make estimates with respect to the rates of probable flood-caused loss for the various flood-risk zones for each of these areas, within fifteen years following each date.

Those responsibilities are now assigned to the Director of FEMA.

For more than two decades as the agency responsible for administration of the NFIP, FEMA has been engaged in a massive and unprecedented effort to identify and assess flood hazards and present flood hazard information on community-based mapping. To date, FEMA has produced over 100,000 Flood Hazard Map panels for approximately 19,000 communities representing approximately 150,000 square miles of floodplain. The net effect of this work is that it has protected citizens' lives, properties, and personal finances by providing an insurance mechanism

for those at risk and flood hazard data to minimize the flood risk for new and existing development.

In the enabling legislation that created and amended the NFIP, FEMA has been authorized to consult with, receive information from, and enter into agreements or other arrangements with the head of any State, regional, or local agency in order to identify floodplain areas. Therefore, FEMA has encouraged strong Federal, State, regional, and local partnerships for the purposes of reducing flood losses and disaster assistance.

Over the years, FEMA has established and implemented initiatives to build on Federal, State, regional, and local partnerships and, where appropriate, formalize the partnerships. Through these initiatives, FEMA and its Federal, State, regional, and local public- and private-sector partners have formalized improved cooperation in the flood hazard identification and mapping processes. Building on these partnerships, FEMA has envisioned implementing a new "optimized" process for producing new and revised Flood Hazard Maps that will take advantage of Flood Hazard Mapping Partners' contributions.

Recognizing that the contributions of FEMA and the Flood Hazard Mapping Partners may evolve as the optimized process is implemented, these Guidelines do not emphasize the traditional roles of the various Flood Hazard Mapping Partners. Instead, these Guidelines specify the requirements that the Flood Hazard Mapping Partner that agrees to complete a specific mapping-related task must meet to ensure consistent and accurate flood hazard information is provided to U.S. citizens nationwide.

To provide a sound basis for floodplain management and insurance rating, the Flood Hazard Maps must present flood hazard information that is accurate and up to date. However, current funding levels for flood hazard mapping are not sufficient for FEMA to update the entire inventory of Flood Hazard Maps.

As a result, over 60 percent of the 100,000-map panel inventory is over 10 years old. FEMA estimates that an additional $750 million above current funding levels would be required to update the nation's Flood Hazard Maps in 7 years. Therefore, today, perhaps more than ever before, FEMA relies on the combined contributions of FEMA staff and the following Flood Hazard Mapping Partners to obtain and maintain accurate, up-to-date flood hazard information:

- Community officials;
- Regional agency officials;
- State agency officials;
- Communities, regional agencies, and State agencies participating in the FEMA Cooperating Technical Partners initiative;
- Other Federal agencies;
- FEMA Contractors;

- Contractors for communities, regional agencies, and State agencies;
- Community residents and property owners; and
- Other program constituents, including U.S. Congress, insurance, lending, real estate, and land development industries; and
- Federal, State, and local disaster and emergency response officials.

These *Guidelines* combine FEMA technical, programmatic, and administrative procedure publications, guidance documents (listed below), and memorandums regarding Flood Hazard Mapping . These *Guidelines* also reflect recent changes to processes and products associated with the implementation of the FEMA Map Modernization Program, including the Cooperating Technical Partners initiative and the new Flood Map Project Scoping procedures.

Unless specifically indicated otherwise by FEMA for a particular contract/agreement, these Guidelines supersede previous FEMA guidelines and specifications documents regarding the preparation of Flood Hazard Maps, including, but not limited to, the following:

- Flood Insurance Study Guidelines and Specifications for Study Contractors (FEMA 37, January 1995*)* and any previous versions thereof*;*
- "Airborne Light Detection and Ranging Systems" (Appendix 4B to FEMA 37, May 2000);
- Guidelines and Specifications for Flood Map Production Coordination Contractors (Final Draft, February 17, 1999*);*
- Guide for Preparing Technical Support Data Notebook (January 1990*);*
- Guidelines for Determining Flood Hazards on Alluvial Fans (February 23, 2000*);*
- Guidance for Scoping Flood Mapping Projects (January 12, 2001*);*
- Guidelines and Specifications for Wave Elevation Determination and V Zone Mapping (March 1995);
- *Guidelines and Specifications for Wave Elevation Determination and V Zone Mapping – Great Lakes* (October 1994);
- "Procedures for Collecting Depositing, and Reporting Fees Under Part 72 of the NFIP Procedures" (undated);
- "Procedures for the Administration of FEMA's Fee-Charge System" (undated);
- "DFIRM Graphic Specifications" (November 2000);

- "DFIRM Base Map Standards" (November 1998); and
- "Standard DFIRM Database Guidelines and Specifications" (May 2001).

These Guidelines are organized into three volumes and 13 appendices as described below.

Volume 1 explains the activities involved in the completion of Flood Map Projects and provides guidelines for performing those activities in the following phases:

- Mapping Needs Assessment;
- Project Scoping;
- Topographic and Flood Hazard Data Development;
- Map and Report Production; and
- Preliminary/Post-Preliminary Processing.

Additional information on the types of Flood Map Projects undertaken by FEMA and Flood Hazard Mapping Partners nationwide, the products generated as a result of the Flood Map Projects, and the processes that must be followed to generate those products is provided in the Introduction to these Guidelines, in Subsections INT.6 and INT.7.

Volume 2 provides guidelines for the processing of revisions and amendments to Flood Hazard Maps initiated by communities and other Flood Hazard Mapping Partners, including the following:

- Letters of Map Amendment;
- Letters of Map Revision Based on Fill;
- Letters of Map Revision; and
- Physical Map Revisions.

Additional information on the products generated as a result of these revisions and amendments and the processes that must be followed to generate those products is provided in the Introduction to these Guidelines, in Subsections INT.6 and INT.7.

Volume 3 provides guidelines and specifications for support activities performed for FEMA by various Mapping Partners in the following general categories: program coordination, special technical and program support, public outreach activities, special correspondence support, and other program support.

Appendices A through M provide additional guidelines and specifications for the processes and products covered in Volumes 1, 2, and 3. These appendices cover the following topics:

- Aerial mapping and surveying, including airborne LIght Detection and Ranging Systems;
- Datum conversions;
- Hazard analyses and mapping of coastal, shallow, ice-jam, and alluvial fan flooding (four separate appendices);
- Evaluation and mapping of flood protection systems;
- Scoping for Flood Map Projects;
- Flood Insurance Study report format guidelines and specifications;
- Flood Hazard Map format guidelines and specifications;
- Digital Flood Hazard Map database guidelines and specifications; and
- Technical and administrative support data preparation and processing requirements.

For the convenience of all Mapping Partners, a **List of Frequently Encountered Acronyms and Abbreviations** and a **Glossary of Frequently Encountered Terms** also have been included in these Guidelines.

These Guidelines are a "living" document that will be updated whenever FEMA determines that changes to the product and processing requirements documented herein are appropriate. A new version of these Guidelines will be posted each October as a collection of PDF files that mirror the structure of the three volumes and 13 appendices. Additional information on the update process is provided below.

FEMA Regional and Headquarters Office staff will notify Mapping Partners when changes are made. Such changes may be frequent as FEMA proceeds with implementation of the Map Modernization Program. Therefore, FEMA encourages all Mapping Partners to remain familiar with, and cognizant of, FEMA's progress in implementing the Map Modernization Program. Details on FEMA's implementation activities may be found on the FEMA Flood Hazard Mapping website at http://www.fema.gov/mit/tsd/MM_main.htm.

To ensure Mapping Partners are provided with a controlled and current version of these Guidelines for Flood Hazard Mapping activities, the following document control procedures have been implemented:

- A header on each page identifies the document source.
- A footer on each page provides the page number, major section number (e.g., 1.1, 1.2), and version date (e.g., February 2002).
- A date (month and year) reflecting the last time the section or subsection was revised appears at the end of each numbered section and subsection.

Mapping Partners will also be able to keep up to date on changes to these Guidelines through a website with the following features (currently under development):

- An "Overview Paragraph," which explains the functionality of the site and which provides the yearly update schedule;
- An "Update Queue," which contains new specifications and/or guidance issued by FEMA that supersede specifications and/or guidance presented in specific portions of these Guidelines;
- A "Summary of Changes," which describes all changes made to these Guidelines since they were last revised; and
- An "Archive," which contains previous versions of these Guidelines.

Because these Guidelines are a living document, new technologies and methodologies deemed applicable to Flood Map Projects in the preparation of Flood Hazard Studies for FEMA can be included in future updates. Therefore, FEMA encourages Mapping Partners to submit ideas for improving these Guidelines. Written comments may be submitted electronically by sending an e-mail message to FEMACG&S@floodmaps.net. Alternatively, they may be sent to the following address or transmitted by facsimile to the number provided:

Federal Emergency Management Agency

Federal Insurance and Mitigation Administration

Hazard Mapping Division

500 C Street, SW

Washington, DC 20472

Facsimile: 202-646-4596

Attention: Allyson Lichtenfels, FEMA G&S Coordinator

FEMA welcomes the contributions of its many and varied Flood Hazard Mapping Partners and looks forward to the mutually beneficial efforts that will further promote FEMA's mission—to reduce loss of life and property and protect our Nation's critical infrastructure from all types of hazards through a comprehensive, risk-based, emergency management program of mitigation, preparedness, response, and recovery.

Map MODERNIZATION

Federal Emergency Management Agency

FEMA's Flood Hazard Mapping Program

Guidelines and Specifications *for* Flood Hazard Mapping Partners

Table of Contents

FEDERAL EMERGENCY MANAGEMENT AGENCY

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FINAL

February 2002

Guidelines and Specifications for Flood Hazard Mapping Partners

		Source
INTRODUCTION		
INT.1	Purpose and Scope of Document	FMPCC G&S Introduction
INT.2	Organization of Document	
INT.3	General Performance Requirements	FMPCC G&S Introduction
INT.4	Planned Updates	
INT.5	Overview of Flood Hazard Mapping Program	*A Cost-Effective Plan for Flood Studies Maintenance* and *Modernizing FEMA's Flood Hazard Mapping Program: A Progress Report*
INT.6	Overview of Flood Hazard Mapping Products	FMPCC G&S and *A Cost-Effective Plan for Flood Studies Maintenance*
INT.7	Overview of Flood Hazard Mapping Processes	*A Cost-Effective Plan for Flood Studies Maintenance*
INT.8	Overview of Mapping Formats	*A Cost-Effective Plan for Flood Studies Maintenance* and FMPCC G&S
INT.9	Overview of Mapping Partners	*Modernizing FEMA's Flood Hazard Mapping Program: A Progress Report*
INT.10	Guidelines for Mapping Partners in Perspective	
VOLUME 1 - FLOOD STUDIES AND MAPPING		
1.1	Overview of the Flood Map Project Process	
1.2	Mapping Needs Assessment	
1.3	Project Scoping	Scoping Manual Jan 2001, FEMA 37 Project scoping plus new material
1.4	Data Development/Report and Map Production	FEMA 37, FMPCC G&S, and current Optimized Study Process practice
1.5	Preliminary/Post-Preliminary Processing	Portions from FEMA 37 and FMPCCG&S
1.6	References	
VOLUME 2 - MAP REVISIONS AND AMENDMENTS		
2.1	Physical Map Revisions	FMPCC G&S
2.2	Coastal Barrier Resources System Revisions	"
2.3	Notice-to-User Revisions	Formally documented for inclusion into these G&S
2.4	Letter of Map Change Processing	FMPCC G&S and Procedure Memo 22
2.5	Revalidation Letters	FMPCC G&S
2.6	Corporate Limit Changes	"
2.7	Program Implementation	"
2.8	Fee-Collection System Responsibilities	"
2.9	Special Conversion Processing Procedures	"
2.10	References	
VOLUME 3 - PROGRAM SUPPORT		
3.1	Introduction	
3.2	Program Coordination and Reporting	Portion from FMPCC G&S
3.3	Library and Archive Support	"
3.4	Procedure, Guidance, and Policy Development and Implementation Assistance	"
3.5	Technical Assistance	"
3.6	Map Assistance Center Support	"
3.7	Flood Hazard Mapping Website Maintenance and Enhancement Support	FHM Website Protocols
3.8	Support for Mapping Needs Assessment Program	NFIRA, Section 575
3.9	Special Correspondence	Portion from FMPCC G&S
3.10	Letters of Determination Review	"
3.11	Engineering Study Data Package Facility Support	"
3.12	Map Service Center Support and Coordination	"
3.13	Training Support	
3.14	Post-Flood Hazard Verification/Recovery Tools	
3.15	Hazard Identification and Mapping Activities	Portion from FMPCC G&S
3.16	Risk Assessment Activities	"
3.17	Fee-Charge System Maintenance	Fee Charge System Procedures s for Part 72 and Fee Charge Systems Procedures for External Data Requests
3.18	Cooperating Technical Partners Initiative Support	
3.19	Support for Other Map Modernization Objectives	*Modernizing FEMA's Flood Hazard Mapping Program, A Progress Report*
3.20	Q3 Flood Data Maintenance	Portion from FMPCC G&S
3.21	Support for Conversion/Compliance Process	FEMA *Document Control Procedures Manual*
3.22	Other Program Support	
3.23	References	
APPENDIX A - GUIDANCE FOR AERIAL MAPPING AND SURVEYING		
A.1	Introduction	FEMA 37, Appendix 4A. Aerial Mapping and Surveying Spec's and 4B
A.2	Industry Geospatial Standards	NSSDA (FGDC 195f) and NGS-5f (NOAA, 1997)
A.3	Accuracy Guidelines	FEMA 37 Appx 4 updated to NSSDA
A.4	Data Requirements	FEMA 37 rewritten to NDEP recommendations
A.5	Ground Control	FEMA 37 rewritten FGDC network accuretly

		Source
A.6	Ground Surveys	FEMA 37 rewritten to NGS-58
A.7	Photogrammetric Surveys	FEMA 37 Appx 4
A.8	Airborne Light Detection and Ranging Surveys	FEMA 37 Appx 4B rewritten to NDEP recommedations
A.9	References	Updated from FEMA 37
APPENDIX B CONVERTING TO THE NORTH AMERICAN VERTICAL DATUM OF 1988		
B.1	Background	FEMA 37; FMPCC G&S App. D with updated information
B.2	Data Collection	"
B.3	Conversion Criteria	"
B.4	Conversion of Unrevised Flood Elevations	"
B.5	Conversion from NAVD88 to NGVD29	"
B.6	Paragraphs for Flood Insurance Study Report	"
APPENDIX C GUIDANCE FOR RIVERINE FLOODING ANALYSES		
C.1	Detailed Hydrologic Analysis	FEMA 37, current policies and practices
C.2	Hydrologic Review	White Paper on Hydrology Review
C.3	Detailed Hydraulic Analyses	FEMA 37, current policies and practices
C.4	Approximate Analyses	FEMA 37, FEMA 265, NC CTP Issue Paper #11 (*Hydraulic Analyses of Structures in Zone A Areas*)
C.5	Hydraulic Review	White Paper on Hydraulic Review
C.6	Floodplain Mapping	FEMA 37, FMPCC G&S, and current practice
C.7	Hydrologic and Hydraulic Analyses of Lake Levels for Closed Basins	Current policies and practices
C.8	Future-Conditions Flood Mapping	Final Rule Published in *Federal Register* on 11-27-01
C.9	References	
APPENDIX D GUIDANCE FOR COASTAL FLOODING ANALYSES AND MAPPING		
D.1	General Guidance	FEMA 37 - Appendix 1
D.2	Wave Elevation Determination and V Zone Mapping: Gulf of Mexico and Atlantic Ocean	Guidelines and Specifications for Wave Elevation Determination and V-Zone Mapping (Final Draft March 1995)
D.3	Wave Elevation Determination and V Zone Mapping: Great Lakes	Guidelines and Specifications for Wave Elevation Determination and V-Zone Mapping - Great Lakes (Draft August 1996)
D.4	Wave Elevation Determination and V Zone Mapping: Pacific Ocean	
D.5	Erosion Hazard Study, Identification, and Mapping	
D.6	References	
APPENDIX E GUIDANCE FOR SHALLOW FLOODING ANALYSES AND MAPPING		
E.1	Introduction	FEMA 37, Appendix 2
E.2	Study Scope	"
E.3	Applicable Flood Hazard Zones	"
E.4	Shallow Flooding Classifications and Descriptions	"
E.5	Study Procedures	"
APPENDIX F GUIDANCE FOR ICE JAM ANALYSES AND MAPPING		
F.1	Introduction	FMPCC G&S, Appendix I and FEMA 37, Appendix 3
F.2	Ice Jam Types	"
F.3	Reconnaissance	"
F.4	Analysis Approaches	"
F.5	Presentation of Results	"
F.6	References	"
APPENDIX G GUIDANCE FOR ALLUVIAL FAN FLOODING ANALYSES AND MAPPING		
G.1	Introduction	NRC 1996 Report on Alluvial Fan Flooding, Alluvial Fan Guidelines
G.2	Analysis Approach	"
G.3	Additional Information on Sediment Transport	"
G.4	References	"
APPENDIX H GUIDANCE FOR MAPPING OF AREAS PROTECTED BY LEVEE SYSTEMS		
H.1	Introduction	FEMA 37; Section 65.10 of NFIP Regulations
H.2	Levee System Components and Terminology	"
H.3	Levee System Evaluation Criteria	"
H.4	Criteria for Crediting Levee Systems on FIRMs	"
H.5	Review Responsibilities	FMPCC G&S
H.6	Floodplain Mapping and Flood Profiles	FEMA 37 and Section 65.10 of NFIP Regulations
H.7	Flood Control Restoration Zones	Section 65.14 of NFIP Regulations
APPENDIX I SCOPING GUIDANCE AND TOOLS		

		Source
I.1	Pre-Scoping Meeting Activities	Scoping Manual Jan 2001
I.2	Scoping Meeting Activities	"
I.3	Post-Scoping Meeting Activities	"

APPENDIX J FORMAT AND SPECIFICATIONS FOR FLOOD INSURANCE STUDY REPORTS

J.1	Submittal Content for Flood Insurance Study Reports	FEMA 37, Chapter 9 and FMPCC G&S, Appendix C
J.2	Preparation of Flood Insurance Study Reports	"
J.3	Volume Printing	"
J.4	Sample Flood Insurance Study Report	"

APPENDIX K SPECIFICATIONS AND FORMAT FOR FLOOD INSURANCE RATE MAPS

K.1	Mapping Methods and Formats	FMPCC G&S and Procedure Memos 3, 4, 11, 14, 15. 22, and 25
K.2	Map Frames	"
K.3	Map Index	"
K.4	Map Body	"
K.5	Map Legend	"
K.6	Map Title Block	"
K.7	Map Locator Diagram	"
K.8	Notes to Users	"
K.8	Preliminary Flood Insurance Rate Map Deliverables	"
K.9	Deliverables to Map Service Center	"

APPENDIX L GUIDANCE FOR PREPARING DIGITAL FIRM DATABASE

L.1	Digital Flood Insurance Rate Map Database Overview	Map Modernization DFIRM Database Work Group, Draft DFIRM Specifications, FEMA 37 Appendix 7
L.2	Preparation of Draft Digital Data	"
L.3	Preparation of Preliminary and Final Digital Flood Insurance Rate Map Databases	"
L.4	Database Table Structure Requirements for Draft Digital Data	"
L.5	Federal Emergency Management Agency Digital Mapping Information Checklist	"
L.6	Metadata Example for Draft Digital Data	"
L.7	Database Table Structure Requirements for Preliminary and Final Digital Flood Insurance Rate Map Databases	"
L.8	Metadata Example for Preliminary and Final Digital Flood Insurance Rate Map Databases	"

APPENDIX M GUIDANCE FOR PREPARING AND MAINTAINING TECHNICAL AND ADMINISTRATIVE SUPPORT DATA

M.1	Background	FEMA 37, FMPCCG&S, *Guide for Preparing Technical Support Data Notebook*
M.2	Preparation and Submittal Requirements	"
M.3	Processing and Maintenance Requirements	"

GLOSSARY OF FLOOD HAZARD MAPPING TERMS

LIST OF ACRONYMS AND ABBREVIATIONS

Map MODERNIZATION

Federal Emergency Management Agency

FEMA's Flood Hazard Mapping Program

Guidelines and Specifications *for* Flood Hazard Mapping Partners

Introduction

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FINAL

February 2002

Introduction

INT.1 Purpose and Scope of Document

The Federal Emergency Management Agency (FEMA), as the agency responsible for administration of the National Flood Insurance Program (NFIP), conducts flood hazard studies and prepares Flood Hazard Maps and related products. These *Guidelines and Specifications for Flood Hazard Mapping Partners* (hereinafter referred to as "these Guidelines") define technical requirements, product specifications for Flood Hazard Maps and related National Flood Insurance Program (NFIP) products, and associated coordination and documentation activities. These Guidelines are to be followed by FEMA Regional Office and Headquarters staff and the staff of other Flood Hazard Mapping Partners involved in producing and maintaining Flood Hazard Maps and related products of the NFIP. Information on the Flood Hazard Mapping Partners (hereinafter referred to as "Mapping Partners") involved in the Flood Hazard Mapping Program is provided in Section INT.9.

These *Guidelines* combine FEMA technical, programmatic, and administrative procedure publications, guidance documents (listed below), and memorandums regarding Flood Hazard Mapping . These *Guidelines* also reflect recent changes to processes and products associated with the implementation of the FEMA Map Modernization Program, including the Cooperating Technical Partners initiative and the new Flood Map Project Scoping procedures.

Unless specifically indicated otherwise by FEMA for a particular contract/agreement, these Guidelines supersede previous FEMA guidelines and specifications documents regarding the preparation of Flood Hazard Maps, including, but not limited to, the following:

- Flood Insurance Study Guidelines and Specifications for Study Contractors (FEMA 37, January 1995) and any previous versions thereof;
- "Airborne Light Detection and Ranging Systems" (Appendix 4B to FEMA 37, May 2000);
- Guidelines and Specifications for Flood Map Production Coordination Contractors (Final Draft, February 17, 1999);
- Guide for Preparing Technical Support Data Notebook (January 1990);
- Guidelines for Determining Flood Hazards on Alluvial Fans (February 23, 2000);
- Guidance for Scoping Flood Mapping Projects (January 12, 2001);
- Guidelines and Specifications for Wave Elevation Determination and V Zone Mapping (March 1995);

- *Guidelines and Specifications for Wave Elevation Determination and V Zone Mapping – Great Lakes* (October 1994);
- "Procedures for Collecting Depositing, and Reporting Fees Under Part 72 of the NFIP Procedures" (undated);
- "Procedures for the Administration of FEMA's Fee-Charge System" (undated);
- "DFIRM Graphic Specifications" (November 2000);
- "DFIRM Base Map Standards" (November 1998); and
- "Standard DFIRM Database Guidelines and Specifications" (May 2001).

[February 2002]

INT.2 Organization of Document

These Guidelines have been organized into three volumes and 13 appendices as described in Subsections INT.2.1 through INT.2.4. For the convenience of all Mapping Partners, a **List of Frequently Encountered Acronyms and Abbreviations** and a **Glossary of Frequently Encountered Terms** also have been included in these Guidelines.

[February 2002]

INT.2.1 Volume 1

Volume 1 explains the activities involved in the completion of Flood Map Projects and provides guidelines for performing those activities in the following phases:

- Mapping Needs Assessment;
- Project Scoping;
- Topographic and Flood Hazard Data Development;
- Map and Report Production; and
- Preliminary/Post-Preliminary Processing.

Additional information on the products generated as a result of Flood Map Projects and the processes required to generate the products is provided in Sections INT.6 and INT.7.

[February 2002]

INT.2.2 Volume 2

Volume 2 provides guidelines for revisions and amendments to Flood Hazard Maps initiated by communities and other Flood Hazard Mapping Partners, including the following:

- Letters of Map Amendment;
- Letters of Map Revision Based on Fill;
- Letters of Map Revision; and
- Physical Map Revisions.

Additional information on the products generated as a result of these revisions and amendments and the processes that must be followed to generate those products is provided in the Introduction to these Guidelines, in Sections INT.6 and INT.7.

[February 2002]

INT.2.3 Volume 3

Volume 3 provides guidelines and specifications for support activities performed for FEMA by various Mapping Partners in the following general categories:

- Program coordination, including development and maintenance of FEMA databases and Management Information Systems, courier service, library archiving and maintenance, distribution of archived mapping-related materials;

- Special technical and program support, including meeting and conference support, hazard identification and mapping activities, risk assessment activities, post flood hazard verification and mapping activities, and policy development and implementation assistance;

- Public outreach activities, including Map Assistance Center support, website content development and maintenance activities , training assistance, Cooperating Technical Partners initiative support, and Mapping Needs Assessment activities;

- Special correspondence support, including Congressional Responses, Director Responses, Mapping Responses, Freedom of Information Act Responses, and Letters of Determination Review ; and

- Other program support, including Map Service Center assistance, Q3 Flood Data maintenance, fee-charge system maintenance, Map Modernization Program support, and Engineering Study Data Package Facility maintenance.

[February 2002]

INT.2.4 Appendices

Additional guidelines and specifications for the processes and products covered in Volumes 1, 2, and 3 are presented in 13 appendices covering the following topics:

- Aerial mapping and surveying, including airborne LIght Detection and Ranging Systems;
- Datum conversions;
- Hazard analyses and mapping of riverine flooding;
- Coastal flooding;
- Shallow flooding;
- Ice-jam flooding;

- Alluvial fan flooding;
- Evaluation and mapping of flood protection systems;
- Scoping for Flood Map Projects;
- Flood Insurance Study report format guidelines and specifications;
- Flood Hazard Map format guidelines and specifications;
- Digital Flood Hazard Map database guidelines and specifications; and
- Technical and administrative support data preparation and processing requirements.

[February 2002]

INT.3 General Performance Requirements

Although they are printed separately, these Guidelines are considered to be a part of any Contract Statement of Work (SOW) or other agreement signed by a Mapping Partner with FEMA to perform work in support of the NFIP and will be incorporated in said contract SOW or other agreement. Performance in accordance with these Guidelines is required, unless otherwise specified in the Contract SOW or other agreement.

Mapping Partners shall provide all data and other materials necessary to prepare and process new and revised Flood Hazard Maps, reports, and related supporting documents in accordance with the requirements detailed in these Guidelines. Selected Mapping Partners also shall provide program support services and products in accordance with the requirements detailed in these Guidelines when so tasked by FEMA. Specific performance requirements, most notably especially with respect to deliverable items, also will be detailed in the Contract SOW or other agreement.

[February 2002]

INT.3.1 Resolution of Inconsistencies in Contract Documents

In the event of inconsistencies between the requirements detailed in these Guidelines and Contract SOWs or other agreements with FEMA, Mapping Partners shall resolve the inconsistencies through consultation with the FEMA Regional Project Officer (RPO), FEMA Regional Assistance Officer (AO), Project Officer (PO) at FEMA Headquarters, and/or Contracting Officer (CO) at FEMA Headquarters. In most cases, inconsistencies shall be resolved in the following priority order:

1. Formal exceptions by the RPO, AO, PO, or CO documented and made a part of the case file for the mapping activity undertaken;
2. Contract SOW or other agreement schedule;
3. Special terms and conditions of the contract or other agreement;
4. General provisions of the contract or other agreement;
5. Other provisions of the contract SOW or other agreement, whether incorporated by reference or otherwise; and
6. These Guidelines.

The FEMA RPO and/or PO shall ensure that Mapping Partners achieve the technical requirements of the contract or agreement. To accomplish this, the FEMA RPO or PO shall provide direction on technical and programmatic issues, monitor the progress of work, and evaluate performance. The FEMA RPO and/or PO may issue written or verbal instructions to expand on the details of the Contract SOW or agreement, or these Guidelines. The FEMA RPO and/or PO also shall make recommendations to the AO or CO whenever the Contract SOW or

other agreement, period of performance, or other technical provisions of the contract SOW or other agreement should be amended to accomplish the objectives of the contract or agreement.

The FEMA RPO and/or PO shall not direct a Mapping Partner to undertake any activity that will affect the price, period of performance, scope, or administrative provisions of the contract SOW or other agreement. If required, these activities shall be authorized by the FEMA AO and/or CO at the recommendation of the FEMA RPO and/or PO.

In the event of inconsistencies between the requirements documented in these Guidelines and any FEMA operating policies or procedures, the inconsistencies shall be resolved in the following priority order:

1. Statutes governing the NFIP;
2. NFIP regulations;
3. Issuance of memorandums of policy or procedure, criteria, or guidelines that post-date these Guidelines;
4. Written guidance provided by the FEMA RPO and/or PO; and
5. These Guidelines.

[February 2002]

INT.3.2 Documentation of Exceptions

The responsible Mapping Partner and/or FEMA shall document all exceptions to standard procedures and specifications contained herein in the case file for the specific mapping activity. At the request of the FEMA RPO or PO, the responsible Mapping Partner also shall document exceptions in periodic Monitoring reports, discussed in Volume 3, Subsections 3.2.1 and 3.2.6 of these Guidelines, which should contain a description of the issue and resolution as appropriate for all such exceptions.

[February 2002]

INT.3.3 Engineering, Mapping, and Report Standards

The engineering, mapping, and report standards documented in these Guidelines reflect current policy and procedures. The flood hazard information presented on the maps and in the related reports and other products of the Flood Hazard Mapping Program forms the technical basis for the administration of the NFIP locally and nationally. Therefore, FEMA and its Mapping Partners must adhere to the rigorous standards documented herein, both in performing the initial flood hazard analyses for a community or flooding source within a community and preparing the initial Flood Hazard Map, report, and other supporting products, and in performing a revised analysis of flood hazards and preparing a revised Flood Hazard Map and related products.

[February 2002]

INT.4 Planned Updates

These Guidelines are a "living" document that will be updated whenever FEMA determines that changes to the product and processing requirements documented herein are appropriate. A new version of these Guidelines will be posted each October as a collection of PDF files that mirror the structure of the three volumes and 13 appendices. Additional information on the update process is provided below.

FEMA Regional and Headquarters Office staff will notify Mapping Partners when changes are made. Such changes may be frequent as FEMA proceeds with implementation of the Map Modernization Program. Therefore, FEMA encourages all Mapping Partners to remain familiar with, and cognizant of, FEMA's progress in implementing the Map Modernization Program. Details on FEMA's implementation activities may be found on the FEMA Flood Hazard Mapping website at http://www.fema.gov/mit/tsd/mm_main.htm.

To ensure Mapping Partners are provided with a controlled and current version of these Guidelines for Flood Hazard Mapping activities, the following document control procedures have been implemented:

- A header on each page identifies the document source.
- A footer on each page provides the page number, major section number (e.g., 1.1, 1.2), and version date (e.g., February 2002).
- A date (month and year) reflecting the last time the section or subsection was revised appears at the end of each numbered section and subsection.

Mapping Partners will also be able to keep up to date on changes to these Guidelines through a website with the following features (currently under development):

- An "Overview Paragraph," which explains the functionality of the site and which provides the yearly update schedule;
- An "Update Queue," which contains new specifications and/or guidance issued by FEMA that supersede specifications and/or guidance presented in specific portions of these Guidelines;
- A "Summary of Changes," which describes all changes made to these Guidelines since they were last revised; and
- An "Archive," which contains previous versions of these Guidelines.

Because these Guidelines are a living document, new technologies and methodologies deemed applicable to Flood Map Projects in the preparation of Flood Hazard Studies for FEMA can be included in future updates. Therefore, FEMA encourages Mapping Partners to submit ideas for improving these Guidelines. Written comments may be submitted electronically by sending an e-

mail message to FEMACG&S@floodmaps.net. Alternatively, they may be sent to the following address or transmitted by facsimile to the number provided:

Federal Emergency Management Agency

Federal Insurance and Mitigation Administration

Hazard Mapping Division

500 C Street, SW.

Washington, DC 20472

Facsimile: 202-646-4596

Attention: Allyson Lichtenfels, FEMA G&S Coordinator

[February 2002]

INT.5 Overview of Flood Hazard Mapping Program

For decades, the national response to flood disasters was generally limited to constructing flood-control works, such as dams, levees, and seawalls, and to providing disaster relief to flood victims. This approach did not reduce all monetary flood losses, nor did it discourage unwise development in the floodplain. To compound the problem, the public could not buy flood coverage from insurance companies, and building techniques to reduce flood damage were often overlooked.

Thus, it was in the face of mounting flood losses and escalating costs to the general taxpayer for disaster relief that the U.S. Congress created the NFIP with the passage of the National Flood Insurance Act of 1968. The NFIP was broadened and modified with the passage of the Flood Disaster Protection Act of 1973, the National Flood Insurance Reform Act of 1994, and other legislative measures, with the intent being to reduce future flood damage and provide an insurance mechanism that allows a premium to be paid for protection by those most in need of the protection.

The NFIP enables property owners in communities that choose to participate in the NFIP to insure structures against flood losses. The 1973 Act's mandatory flood insurance purchase requirements, which were expanded and strengthened in the 1994 Act, protect the financial interests of the lender, the borrower, and the taxpayer. Insurance coverage reduces reliance on Federal disaster assistance and also reduces the number of income tax write-offs for uninsured loans.

By employing sound floodplain management practices, officials and residents of a participating community can minimize the extent of the area requiring the mandatory purchase of flood insurance and protect homes and businesses from much of the devastating financial losses resulting from future flood disasters. More careful local management of floodplain development results in construction practices that can reduce flood losses and reduce the high costs associated with flood disasters.

To meet the community participation and flood hazard assessment objectives of the NFIP, the U.S. Congress assigned the following responsibilities to the Secretary of the U.S. Department of Housing and Urban Development:

> ...(1) identify and publish information with respect to all flood plain areas, including coastal areas located in the United States, which have special flood hazards, within five years following the date of the enactment of this Act, and (2) establish flood-risk zones in all such areas, and make estimates with respect to the rates of probable flood-caused loss for the various flood-risk zones for each of these areas, within fifteen years following each date.

Those responsibilities are now assigned to the Director of FEMA. For more than two decades as the administrator of the NFIP, FEMA has been engaged in a massive and unprecedented effort to identify and assess flood hazards and present flood hazard information on community-based mapping. The results to date have been impressive. FEMA has produced over 100,000 Flood

Hazard Map panels for approximately 19,000 communities representing approximately 150,000 square miles of floodplain. The net effect of this work is that it has protected citizens' lives, properties, and personal finances by providing an insurance mechanism for those at risk and flood hazard data to minimize the flood risk for new and existing development.

The Flood Hazard Maps are referred to for each of the 15 million mortgage transactions each year and every time a community issues a building permit. Although originally developed to support the flood insurance and floodplain management activities associated with the NFIP, the Flood Hazard Maps are currently used by no fewer than nine distinct constituencies for a variety of applications, including disaster preparedness, response, and recovery; risk assessment; and diverse mitigation activities.

The Flood Hazard Mapping Program continues to be funded almost exclusively by flood insurance policyholders. The Flood Hazard Maps are used daily by the following:

- **State and local floodplain managers, planners, and other officials** to establish and enforce minimum land-use and construction ordinances that comply with minimum NFIP standards;
- **Engineers** to consider the flood hazard when designing flood mitigation projects, such as structure elevations and relocations, buyouts, and culvert replacements;
- **Insurance companies and agents** to determine actuarial rates for flood insurance policies;
- **Lenders** to determine the flood hazard status of mortgaged properties at loan origination and throughout the life of the mortgages;
- **Real estate professionals and property owners** to determine the flood hazard status of properties;
- **Flood map determination firms** to specify the location of properties relative to the flood hazard area as well as provide other interpretive services for lenders;
- **Land development industry** to aid in designing developments that will be safe from flood hazards;
- **Surveyors** to prepare elevation certificates for structures; and
- **Federal, State, and local disaster and emergency response officials** to prepare for flooding disasters and issue warnings to those in danger of flooding and, after a flood has occurred, to implement emergency response activities and to aid in the rebuild and reconstruction process.

As the uses and applications have grown over the years, the Flood Hazard Maps have evolved in response to user needs and improved technologies; however, production of new and revised maps has always taken place within real-world fiscal constraints. Newer digital mapping

techniques are often more cost effective, in both the short- and long-term, than the old manual techniques. However, FEMA's conversion of over 100,000 existing map panels to a digital format has been, by design, deliberate and methodical. Because of funding constraints, the conversion generally has occurred only when new or updated flood hazard information has required an update to a Flood Hazard Map for a community or in support of some disaster response activities. FEMA estimates that an additional $750 million above current mapping funding levels would be needed to update the current national map inventory in 7 years.

As mapping technologies, applications, and uses for the Flood Hazard Maps evolve, and the NFIP map users become increasingly sophisticated, the Flood Hazard Maps, as well as associated NFIP products, must also continue to evolve. Accordingly, these Guidelines will continue to evolve to reflect current practices and technologies.

[February 2002]

INT.6 Overview of Flood Hazard Mapping Products

The NFIP objectives of flood hazard assessment and community participation have been achieved in two phases. The initial phase of community participation in the NFIP is referred to as the Emergency Phase; the Emergency Phase also may be referred to as the Emergency Program in some FEMA documents. The second phase of community participation is referred to as the Regular Phase; the Regular Phase also may be referred to as the Regular Program in some FEMA documents.

Information on the products that are produced and distributed by FEMA, its contractors, and other Mapping Partners during the Emergency and Regular Phases of the NFIP is provided in Subsections INT.6.1 and INT.6.2, respectively.

[February 2002]

INT.6.1 Mapping Products Generated During Emergency Phase

The Emergency Phase was designed to provide participating communities with a limited amount of insurance at federally subsidized rates until a detailed evaluation of the flood hazard could be performed. During the Emergency Phase, a community usually is provided with a Flood Hazard Boundary Map (FHBM). The FHBM presents an approximate delineation of the Special Flood Hazard Areas (SFHAs) in a community. The SFHAs are the areas that would be inundated by the flood having a 1-percent chance of being equaled or exceeded in any given year. The 1-percent-annual-chance flood is also referred to as the "base flood" or "100-year flood."

If a community chooses to participate in the Emergency Phase of the NFIP, the community must adopt the FHBM and require permits for construction or other development in the SFHAs as shown on the FHBM.

[February 2002]

INT.6.2 Mapping Products Generated During Regular Phase

During the second phase of community participation in the NFIP—the Regular Phase—FEMA imposes more comprehensive floodplain management requirements on participating communities in exchange for higher amounts of insurance. Also, insurance for new and substantially improved structures is rated on an actuarial, or actual risk, basis. The insurance is based on flood insurance risk zones and elevations as determined by a detailed assessment of flood hazards and risk for the community.

The results of the initial detailed assessment, termed a Flood Insurance Study (FIS), are presented on a Flood Insurance Rate Map, or "FIRM," and, for some communities, on a Flood Boundary and Floodway Map, or "FBFM." The results also are presented in a collateral report, referred to as an "FIS report," which provides supporting documentation for information presented on the FIRM and FBFM.

During the first decade of the NFIP, the FIRM and FBFM were prepared using traditional manual cartographic techniques. However, as the technology developed, FEMA has gradually transitioned to a digital environment. The mapping product that is produced using digital production techniques is referred to as a Digital Flood Insurance Rate Map, or "DFIRM." The data associated with the DFIRM are maintained in a Geographic Information System (GIS) or spatial database, which is referred to as the "DFIRM Database."

In addition to the DFIRM products, FEMA is also creating Raster FIRMs. These Raster FIRMs are either created by scanning the manually produced FIRMs or as a by-product of the creation of DFIRMs.

Once the flood hazard data are generated, they are subject to various dynamic factors that affect their accuracy and, thus, their value as a tool for assessing flood risks for insurance and floodplain management purposes. These factors are as follows:

- Changes in development trends;
- Changes in hydrologic conditions;
- Changes in topographic conditions;
- Changes in flood hazard and risk assessment technologies and available data; and
- Discoveries of errors in existing analyses.

Therefore, since the early years of the NFIP, FEMA has performed restudies of hazards and coordinated with communities to revise or amend maps, reports, and other products in response to the dynamic factors listed above. Depending on the extent and impact of the revised flood hazard information, FEMA has physically revised and reissued the mapping products or has issued an alternative product, referred to as a Letter of Map Change, or "LOMC."

The LOMC has the same effect as a physical map update in that it documents a change to the effective FIRM, FBFM, and/or FIS report. However, because these products are not physically revised and republished, LOMCs generally take less time to process and are significantly less expensive for FEMA to complete.

Additional information on the mapping products discussed above is presented in Subsections INT.6.2.1 through INT.6.2.6.

[February 2002]

INT.6.2.1 Flood Insurance Rate Map

The FIRM is the insurance and floodplain management map produced by FEMA that identifies, based on detailed or approximate analyses, the areas subject to flooding during a 1-percent-annual-chance flood event in a community. Flood insurance risk zones, which are used to compute actuarial flood insurance rates, also are shown. In areas studied by detailed analyses, the FIRM shows Base Flood Elevations (BFEs) to reflect the elevations of the 1-percent-annual-chance flood. For many communities, when detailed analyses are performed, the FIRM also may show areas inundated by 0.2-percent-annual-chance, or "500-year," flood and regulatory floodway areas. Specific information on how the detailed analyses are to be performed, how floodplain and regulatory floodway boundaries are to be delineated, and how the BFEs and regulatory floodway are to be computed is provided in Volume 1 of these Guidelines.

[February 2002]

INT.6.2.2 Flood Boundary and Floodway Map

The FBFM is the floodplain management map issued by FEMA that depicts, based on detailed flood hazard analyses, the boundaries of the 1-percent-annual-chance (100-year) and the 0.2-percent-annual (500-year) floodplains and, when appropriate, the regulatory floodway. The FBFM does not show flood insurance risk zones or BFEs. Specific information on how the detailed flood hazard analyses are to be performed, how floodplain and regulatory floodway boundaries are to be delineated, and how the regulatory floodway is to be computed is provided in Volume 1 of these Guidelines. (Note: Since the mid-1980s, FEMA has been incorporating information related to the regulatory floodway into the FIRM; however, numerous communities still have separately published FBFMs.)

[February 2002]

INT.6.2.3 Flood Insurance Study Report

The FIS report is a document, prepared and issued by FEMA, that documents the results of the detailed flood hazard assessment performed for a community. The primary components of the FIS report are text, data tables, photographs, and Flood Profiles. Specific information on the contents of the FIS report and how it is to be produced is provided in Appendix J of these Guidelines.

[February 2002]

INT.6.2.4 Digital Flood Insurance Rate Map

The DFIRM is a FIRM containing the information described in Subsection INT.6.2.1, prepared as a digital product. Creation of the DFIRM product may involve converting the existing manually produced FIRM to digital format. DFIRM products also may be created from new digital data sources using a GIS environment. The DFIRM product allows for the creation of interactive, multi-hazard digital maps. Linkages are built into an associated database to allow users options to access the engineering backup material used to develop the DFIRM, such as hydrologic and hydraulic models, Flood Profiles, data tables, Digital Elevation Models, and structure-specific data, such as digital elevation certificates and digital photographs of bridges and culverts.

[February 2002]

INT.6.2.5 Digital Flood Insurance Rate Map Spatial Database

The objective of the DFIRM spatial database is to facilitate the collection, storage, processing, and distribution of data developed by FEMA. The DFIRM spatial database enables Mapping Partners to share the data necessary for the DFIRM production and conversion process. In addition, the database enables rapid map updates/revisions in the future. Where possible, all mapping and engineering data elements are linked to physical geographic features and georeferenced. The use of a GIS as a component of the DFIRM spatial database provides the ability to georeference and overlay the mapping and engineering data. This allows the database to support a wide variety of existing and visionary FEMA engineering and mapping products.

[February 2002]

INT.6.2.6 Raster Flood Maps

The creation of raster FIRMs and FBFMs will allow FEMA and its map users to access the flood hazard information shown on the FIRM from electronic media, such as CD-ROMs, or via the Internet instead of printed and folded hardcopy (paper) maps. The raster FIRMs and FBFMs present the identical information shown on the printed maps in a more convenient format for computer users.

[February 2002]

INT.6.2.7 Letters of Map Change

A LOMC is a letter, prepared and issued by FEMA, that officially amends or revises an effective FHBM, FIRM, FBFM, FIS report, or DFIRM. LOMCs are issued in three forms: Letter of Map Revision Based on Fill, or "LOMR-F"; Letter of Map Revision based on conditions other than fill, or "LOMR"; and Letter of Map Amendment, or "LOMA."

A LOMR-F is an official revision of the effective NFIP map for a community. The LOMR-F provides FEMA's determination as to whether a property (i.e., legally defined parcel of land or structure) has been elevated on fill above the BFE and is therefore outside the SFHA.

A LOMR also is an official revision, by letter, of an effective NFIP map. The LOMR product is issued by FEMA to change flood elevations, floodplain and regulatory floodway boundaries, and planimetric features.

A LOMA is an official amendment of the effective NFIP map for a community. The LOMA provides FEMA's determination as to whether a property that is on natural ground has been inadvertently included in the SFHA shown on the map. The LOMA establishes the property's location in relation to the SFHA.

Additional information on LOMC processes and related products is provided in Subsection INT.7.2 and Volume 2 of these Guidelines.

[February 2002]

INT.6.2.8 Revalidation Letters

To assist communities in maintaining the FIRM, FEMA developed a process for revalidating LOMCs automatically when a revised FIRM becomes effective, thereby superseding the LOMCs. The result of this process is a revalidation letter, termed a "LOMC-VALID letter." FEMA generally issues the LOMC-VALID letter approximately 2 weeks before the effective date of the revised FIRM, and the LOMC-VALID letter becomes effective 1 day after the effective date of the revised FIRM. The LOMC-VALID letter provides a list of all LOMCs on the revised FIRM panels that are revalidated, meaning that those LOMCs are still in effect for NFIP purposes.

[February 2002]

INT.6.2.9 Letters of Determination Review

As mandated by the National Flood Insurance Reform Act of 1994, FEMA developed a Standard Flood Hazard Determination Form that is to be used by all regulated lenders and Federal agency lenders that make flood hazard determinations for improved property used to secure loans. When a borrower disagrees with the Standard Flood Hazard Determination made by the borrower and the borrower and lender cannot reach an agreement, the borrower and lender may request a determination from FEMA. The FEMA response to such requests is a Letter of Determination Review, or "LODR."

If sufficient information is provided, the written response from FEMA will indicate FEMA's concurrence or disagreement with the lender's determination and whether the subject building is in the SFHA shown on the effective NFIP map. If sufficient information is not provided, the submitted information will be returned with a written response detailing the additional information FEMA would need to make a determination.

INT.6.2.10 Special Conversion Products

The conversion of a community to the Regular Phase of the NFIP is usually accomplished through the publication of a FIRM for the community. However, for some newly identified communities and communities that are participating in the Emergency Phase of the NFIP, FEMA may take an alternative approach and use specially designed "Special Conversion" procedures. Under these Special Conversion procedures, FEMA may convert a community to the Regular Phase of the NFIP without performing a detailed flood hazard analysis and preparing a FIRM with detailed flood risk zones. Under these procedures, a community is converted, based on the recommendation of the FEMA Regional Office, through either non-floodprone or minimally floodprone conversion procedures.

The products for non-floodprone and minimally floodprone communities are discussed below. An explanation of the terms "non-floodprone" and "minimally floodprone" and additional information on Special Conversion procedures is provided in Subsection INT.7.1.4 and in Volume 1 of these Guidelines.

Conversion Products for Non-Floodprone Communities

Once a community has been approved for a non-floodprone conversion, FEMA sends the community a letter to effect the conversion. The content of the letter for a particular community will vary, depending on the community's status in the NFIP and the existence of an FHBM.

Conversion Products for Minimally Floodprone Communities

If no changes are required within the SFHA shown on the effective FHBM, FEMA converts the community to the Regular Phase of the NFIP with a letter only. The letter informs the community that the FHBM is now a FIRM.

If the SFHA shown on the existing FHBM for a community must be revised, FEMA converts the community with a FIRM that is an updated version of the FHBM. Depending on the flooding situation in the community, FEMA prepares and prints one of the following:

- A FIRM that shows all SFHAs as Zone A;
- A FIRM Index that notes that all areas in the community are Zone D (used in cases where the FIRM is the community's initial map and all areas are considered remote and uninhabited); or
- A FIRM (one or more panels printed) that shows Zones A and X (unshaded)) for the community's most populated areas and notes on the map Index that all unprinted panels are Zone D.

FEMA transmits Preliminary copies of the required map products to the community along with a transmittal letter that documents the floodprone status of the community.

INT.6.3 Other Flood Hazard Mapping Products

FEMA issues a variety of other products related to the creation and distribution of the products discussed in Subsections INT.6.1, INT.6.2, and INT.6.3 (e.g., Summaries of Map Actions, BFE notices, appeal resolution letters). These products are discussed in detail in Volumes 1 and 2 and in the appendices in these Guidelines. In addition, FEMA and its Mapping Partners produce and distribute a variety of products to support the administration of the NFIP in general and the Flood Hazard Mapping Program in particular. These products, and the processes followed in preparing and distributing them, are discussed in Volume 3 of these Guidelines.

[February 2002]

INT.7 Overview of Flood Hazard Mapping Processes

INT.7.1 FEMA-Funded Flood Map Projects and Update Activities

To fulfill its mandate to identify floodprone areas, FEMA has an ongoing program to (1) develop new FIRMs for floodprone communities that do not have them and (2) to produce updated FIRMs for communities with existing FIRMs. Detailed information on the processes, guidelines, and specifications by which FEMA develops and updates FIRMs are provided in Volume 1 of these Guidelines.

For the purposes of these Guidelines, all activities related to the flood hazard analyses performed for new or revised FIRMs are referred to as "Flood Map Projects." However, these activities have until recently been categorized as one of the following:

- Flood Insurance Study;
- Flood Insurance Restudy;
- Limited Map Maintenance Program Revision;
- Existing Data Study;
- Existing Data Restudy;
- Special Conversion;
- Coastal Barrier Resource System Revision; or
- Notice-to-User Revision.

A more detailed description of each category of activities, as well as the revalidation process, is provided in Subsections INT.7.1.1 through INT.7.1.7.

[February 2002]

INT.7.1.1 Flood Insurance Studies and Restudies

A "Flood Insurance Study (FIS)" is the initial study of flood hazards performed for a community that does not have an effective Flood Insurance Rate Map (FIRM). An FIS also may be referred to as a "Type 15 FIS" or a "Type 15 study."

A "Flood Insurance Restudy (RFIS)" is a revised study of flood hazards performed for a community that already has an effective FIRM (and, in some cases, FBFM). An RFIS also may be referred to as a "Type 19 RFIS" or a "Type 19 restudy."

FISs and RFISs have traditionally been performed by FEMA Study Contractors. However, these types of Flood Map Projects also may be performed by communities, regional agencies, and States that are participating in the Cooperating Technical Partners (CTP) initiative.

[February 2002]

INT.7.1.2 Limited Map Maintenance Program Project Revisions

A "Limited Map Maintenance Program project revision," or "LMMP," is a limited-scope restudy of flood hazards that generally involves a single community and one watercourse. The data submitted to FEMA for an LMMP are similar in format and level of detail to those submitted for an RFIS.

[February 2002]

INT.7.1.3 Existing Data Studies and Restudies

FEMA also may prepare an "Existing Data Study," or "XDS," for a community that does not have a FIRM using previously published flood hazard information. This flood hazard information comes from one of the following sources:

1. Reports prepared by Federal agencies for purposes other than the NFIP, such as Flood Hazard Analyses Reports (FHARs) and Floodplain Information reports (FPIs);
2. Other engineering reports prepared by Federal, State, or local agencies; or
3. FIS reports, FIRMs, and FBFMs issued by FEMA for adjacent communities (especially previously unincorporated areas of a county).

If FEMA uses previously published information to prepare an initial or revised FIRM and FIS report for a community that is already participating in the Regular Phase of the NFIP without a FIRM, the product produced is referred to as an "Existing Data Restudy," or "RXDS."

[February 2002]

INT.7.1.4 Special Conversions

As mentioned earlier in this Introduction, FEMA may convert a community to the Regular Phase of the NFIP without preparing a FIRM with detailed flood risk zones. The exact process that is followed depends on whether FEMA determines the community is "non-floodprone" or "minimally floodprone."

Non-floodprone communities are those communities that are determined by FEMA to not be subject to inundation by the 1-percent-annual-chance (100-year) flood. The FEMA guidelines employed for determining whether a community is designated as non-floodprone are that all of its SFHAs are less than 200 feet wide and all drain less than 1 square mile, or physiographic features that preclude floodplain development exist in the community.

Minimally floodprone communities are those communities subject to inundation by the base flood, but for which existing conditions indicate that the area is unlikely to be developed in the foreseeable future. The criteria used by FEMA to evaluate a community's development potential are as follows:

- Floodplains are publicly owned and designed for open space or preservation.
- Zoning laws, sanitary codes, subdivision regulations, shore land regulations, or community regulations effectively prohibit floodplain development.
- Surrounding land use or topography effectively limits the development potential.
- Population is decreasing or stable, and there is no foreseeable pressure for floodplain development.
- Floodplains are remote and uninhabited, and future development is unlikely.

Other indicators may be used in addition to these criteria to assess the development potential. One important indicator is the size of the undeveloped floodplain relative to the size of the entire community. The larger the proportion, the more the floodplain is likely to be subject to pressure for development.

[February 2002]

INT.7.1.5 Coastal Barrier Resource System Revisions

In cooperation with the U.S. Department of the Interior, FEMA transfers Coastal Barrier Resource System (CBRS) boundaries to FIRMs using congressionally adopted source maps. FIRMs clearly depict the unique CBRS areas and their effective dates with special map notes and symbology. An important distinction to make in CBRS revisions and other types of map revisions is the community review component. Although FEMA shows CBRS areas on FIRMs, the U.S. Congress is the only entity that may authorize a revision to CBRS boundaries, therefore any requests for revisions to CBRS boundaries shown on FIRMs must be addressed by the US Fish and Wildlife Service and/or Congress.

The revised CBRS boundaries are not a component of flood hazard analyses, and are not determined by FEMA. Additional information on CBRS revisions is provided in Volume 2, Section 2.2 of these Guidelines.

[February 2002]

INT.7.1.6 Notice-To-User Revisions

The intent of a "Notice-To-User" revision is to quickly and inexpensively correct a non-technical problem with a published FIS report, FIRM, or FBFM. These types of revisions are intended solely to correct a noted defect with the product and cannot be used to establish new or revised flood hazard information. The corrected components are sent to all individuals that previously

received a copy of the product that contained the error or omission. A Notice-To-User letter signed by the FEMA PO is sent with the corrected FIS report, FIRM, and/or FBFM to provide a brief explanation of the revision. Additional information on Notice-To-User Revisions is provided in Volume 2, Section 2.3 of these Guidelines.

[February 2002]

INT.7.1.7 Revalidations

When a revised FIRM panel becomes effective, all previous LOMCs issued for that panel are superseded. Therefore, each time a FIRM panel is physically revised and republished, the panel must be updated to include the changes in flood hazard information resulting from previously issued map update actions, including LOMCs. Frequently, the results of a LOMC cannot be shown on a revised FIRM panel due to the limited size of the change contained in the LOMC or because the change is structure-specific.

The changes made to the effective FIRM via the LOMC process become effective without the affected panel(s) being physically revised and republished. Therefore, FEMA maintains records of these modifications so they may be incorporated into the next physical update of the affected FIRM panel(s), if mappable. To assist communities in maintaining the FIRM, FEMA developed a process for revalidating LOMCs automatically when a revised FIRM becomes effective. The result of this process is the issuance of a revalidation letter, termed a "LOMC-VALID letter."

The LOMC-VALID letter is considered legally binding, in the same manner as the original LOMC, provided it is accompanied by a copy of the original LOMC. If required by the requester, FEMA forwards a copy of the original LOMC with the LOMC-VALID letter. No fee is to be assessed for such requests.

Detailed information on processing procedures and requirements for revalidation letters is provided in Volume 2, Section 2.5 of these Guidelines.

[February 2002]

INT.7.2 Community and Property Owner-Initiated Map Revisions

Requests for map revisions may be submitted to FEMA by community officials or by individuals through their community officials in accordance with Part 65 of the NFIP regulations. These map revision requests generally involve changes to one or more of the following: (1) flood elevations, (2) flood risk zones, (3) floodplain boundaries, (4) regulatory floodway boundaries, and (5) corporate limits. These changes usually result from one or more of the following:

- Natural or manmade changes in the watershed or floodplain that affect flood hazards;
- Availability of new or more detailed topographic or flood information;
- Community annexations of floodprone areas; or
- Errors or discrepancies uncovered in the effective FIS report or map(s).

As discussed earlier in this Introduction, in response to such requests, FEMA may physically revise and reissue the FIS report and map(s). This action is referred to as a "Physical Map Revision," or "PMR."

FEMA also may revise the FIS report and maps by issuing a letter documenting the changes to the FIS report and/or map(s). This action is referred to as either a LOMR-F if the change is based solely on the placement of earthen fill and BFEs are not modified, or a LOMR if the change is based on conditions other than the placement of earthen fill. Additional information on PMRs, LOMRs, and LOMR-Fs is provided in Subsections INT.7.2.1 and INT.7.2.2.

[February 2002]

INT.7.2.1 Physical Map Revisions

FEMA generally will initiate a PMR when:

- Changes resulting from the requested revision are extensive, affecting significant portions of a FIRM panel or multiple FIRM panels;
- Revision will add significant SFHAs to the effective FIRM; or
- Revision will result in an increase in the BFEs and/or regulatory floodway.

FEMA also may prepare a revised FIS report and/or FBFM, depending on the nature of the revision. Detailed information on PMRs is provided in Volume 2, Section 2.1 of these Guidelines.

[February 2002]

INT.7.2.2 Letters of Map Revision

The FIRM can be revised by a LOMR-F when it is determined by FEMA that a legally defined parcel of land or structure has been elevated above the BFE based on the placement of earthen fill after the date of the first NFIP map. The LOMR-F request must be routed through the community Chief Executive Officer (CEO), or an official designated by the CEO, and the supporting data and documentation must satisfy the criteria described in Section 65.5 of the NFIP regulations. The issuance of a LOMR-F may revise the effective FHBM or FIRM by removing the parcel of land or structure from the SFHA; however, LOMR-Fs should not be confused with LOMRs that make changes in BFEs, floodplain and floodway boundary delineations, and coastal high hazard areas.

Requests for LOMR-Fs may involve one or more properties (lots) or structures. Final determinations based on as-built data may be made for undeveloped lots totally filled above the BFE, portions of lots defined by metes and bounds and filled above the BFE, or for existing structure(s) on ground elevated by fill above the BFE.

Detailed information on processing procedures and requirements for LOMR-Fs is provided in Volume 2, Subsection 2.4.4 of these Guidelines.

FEMA may issue a LOMR to revise SFHAs, BFEs, or regulatory floodways on an effective FIRM, FBFM, and/or FIS report when the extent of the changes resulting from the requested revision are limited or when the request must be addressed quickly. However, FEMA typically does not issue a LOMR to add SFHAs to an effective FIRM and FBFM or to increase BFEs. If the width of an SFHA increases, and the increase is contained entirely on the requester's property, FEMA may issue a LOMR.

FEMA prepares the LOMR using a standard format and provides a general description of the changes resulting from the requested revision. For most LOMRs, FEMA prepares and includes annotated copies of the affected Flood Profile, FIRM, and FBFM panels; Summary of Discharges Table; and Floodway Data Table, as appropriate. Although a revision accomplished by LOMR usually becomes effective on the date of the LOMR, the effective date may vary.

Detailed information on the processing procedures for LOMRs is provided in Volume 2, Subsection 2.2.1 of these Guidelines.

[February 2002]

INT.7.3 Conditional Map Revisions

Conditional Map Revisions are those based on proposed alterations to the floodplain conditions within a community.

A requester may choose to submit documentation that satisfies the criteria of Section 65.8 of the NFIP regulations and request that FEMA review and comment on the effect that a proposed project involving the placement of earthen fill within the SFHA will have on the SFHA designation for one or more legally defined parcels of land or one or more proposed structures.

Conditional determinations also provide FEMA's comments as to whether or not the proposed project meets the minimum NFIP floodplain management criteria. Those FEMA reviews usually result in the issuance of a Conditional Letter of Map Revision Based on Fill, or "CLOMR-F." Detailed information on processing procedures and requirements for CLOMR-Fs is provided in Volume 2, Subsection 2.4.3 of these Guidelines.

A community or individual may request that FEMA review and comment on the effect of a proposed project on the flood hazards depicted on the effective FIRM and/or FBFM for a community. In these cases, FEMA reviews the proposed project based on proposed construction drawings instead of as-built plans. These reviews usually result in the issuance of a Conditional Letter of Map Revision, or "CLOMR." The CLOMR describes the effect of the project, if constructed as proposed, on the effective FIRM and/or FBFM. A CLOMR often contains detailed information on conditions that must be met by a requester before FEMA will issue a final determination regarding revising the FIS report, FIRM, and/or FBFM. Detailed information on processing procedures and requirements for CLOMRs is provided in Volume 2, Subsection 2.4.5 of these Guidelines.

[February 2002]

INT.7.4 Map Amendments

Under the provisions of Part 70 of the NFIP regulations, a requester who believes that his or her property has been inadvertently included in an SFHA is allowed to substantiate this claim by requesting a LOMA. As mentioned earlier in this Introduction, a LOMA is an official determination by FEMA that a property has been inadvertently included in an SFHA as shown on an effective FHBM or FIRM and is not subject to inundation by the 1-percent-annual-chance flood. Generally, the property is located on natural high ground at or above the BFE or on fill placed prior to the effective date of the first NFIP map designating the property as within an SFHA. Limitations of map scale and development of topographic data more accurately reflecting the existing ground elevations at the time the maps were prepared are the two most common bases for LOMA requests.

The result of such a request, if warranted, is an amendment to the currently effective FHBM or FIRM. Requests for such determinations generally are submitted by the owners of the affected property or others having an insurable interest in properties that may have been included in the SFHA. LOMAs eliminate the Federal requirement for the purchase of flood insurance. It remains the lending institution's prerogative, however, to require or waive the insurance purchase requirement.

LOMA requests may involve one or more properties (lots) and one or more structures. Final determinations, based on existing conditions, may be made for undeveloped lots or for existing structures.

Detailed information on processing procedures and requirements for LOMAs is provided in Volume 2, Subsection 2.4.2 of these Guidelines.

[February 2002]

INT.7.5 Conditional Map Amendments

Under Part 70 of the NFIP regulations, a requester who believes his or her structure, when constructed on natural ground at or above the BFE, will be outside the SFHA, may request a conditional determination from FEMA. FEMA's response is usually a "Conditional Letter of Map Amendment," or "CLOMA." CLOMAs provide FEMA's comment on whether the structure, if built as proposed, would be in the SFHA. CLOMAs may not be issued for unimproved or undeveloped property. Detailed information on processing procedures and requirements for CLOMAs is provided in Volume 2, Subsection 2.4.1 of these Guidelines.

[February 2002]

INT.7.6 Annexation Requests

FEMA receives a considerable number of requests from communities to have their NFIP maps updated to reflect recent annexations or de-annexations. To accommodate these requests, FEMA developed a standard procedure for processing these requests. Using this procedure, processing decisions are made based on the following factors: (1) status of map for annexing community, (2) existence of flood hazard information for annexed area, (3) source of flood hazard information, and (4) effect of annexation on community participation in the NFIP.

Depending on the decision made, FEMA will take one of the following actions:

- Send a letter to the annexing community indicating the revision will not be made at this time because the flood hazard information has not changed.
- Issue one or more LOMRs to revise the affected map panel(s) for both the annexing and de-annexing communities.
- Physically update and re-issue affected FIRM panel(s) for both the annexing and de-annexing communities.
- Create new FIRMs for communities that do not have FIRMs when necessary to meet NFIP regulations.
- Send a memorandum to the FEMA RO staff requesting additional guidance and coordination with the community (when the annexed area is covered by an effective or rescinded FHBM or by a rescinded FIRM).

Detailed information on processing procedures and requirements for annexation requests is provided in Volume 2, Section 2.6 of these Guidelines.

[February 2002]

INT.7.7 Letters of Determination Review

When a borrower disagrees with the Standard Flood Hazard Determination made by the borrower and the borrower and lender cannot reach an agreement, the borrower and lender may request a determination from FEMA. The FEMA response to such requests is a LODR.

If sufficient information is provided, the written response from FEMA will indicate FEMA's concurrence or disagreement with the lender's determination and whether the subject building is in the SFHA shown on the effective NFIP map. If sufficient information is not provided, FEMA will return the submitted information with a written response indicating the additional information to be submitted.

Detailed information on processing procedures and requirements for LODR requests is provided in Volume 3, Section 3.10 of these Guidelines.

[February 2002]

INT.8 Overview of Mapping Formats

FEMA uses two basic formats in preparing FHBMs, FIRMs, and FBFMs—Flat Map and Z-Fold Map. Although they are discussed separately below, the Standard, Map Initiatives, and Countywide Formats are subsets of the Flat Map and Z-Fold Map Formats. Graphic representations of Flood Hazard Maps prepared in these formats are provided in Appendix K of these Guidelines.

[February 2002]

INT.8.1 Flat Map Format

For the Flat Map Format, the panels are produced as 11" x 17" pages that are formatted and printed in a booklet form. If more than one panel is required to cover a community, FEMA prepares a cover sheet that includes an index and legend. FEMA used the Flat Map Format primarily to prepare FHBMs; however, FEMA also prepared some FIRMs in this format. FEMA has not, and will not, prepare FBFMs or DFIRMs in this format. FEMA has, for the most part, discontinued the Flat Map Format for new Flood Hazard Maps and plans to convert the remaining inventory to Z-Fold Format on a community-by-community basis.

[February 2002]

INT.8.2 Z-Fold Map Format

For the Z-Fold Map Format, FEMA produces one or more map panels in a folded format similar to that used for road maps. FEMA shows a Legend on each printed panel. If more than one panel is required to cover a community, FEMA prepares an index, either in Z-Fold Format or as an accompanying 8.5" x 11" document. (See Appendix K of these Guidelines for further details.) FEMA has historically used the Z-Fold Map format to produce many FHBMs; most FIRMs; all FBFMs; and, most recently, all DFIRMs.

[February 2002]

INT.8.3 Standard Format

Until 1985, FEMA produced and published separate FIRMs and FBFMs. This is referred to as the Standard Format for FEMA maps. Generally speaking, FEMA only produced separate FBFMs if (1) regulatory floodways were computed, so they had to be shown on the map, or (2) if separate FBFMs were required by State regulations even if FEMA did not compute or delineate a regulatory floodway.

[February 2002]

INT.8.4 Map Initiatives Format

Starting in 1986, FEMA began preparing FIRMs in its Map Initiatives Format. For FIRMs prepared in the Map Initiatives Format, FEMA combined all essential information previously shown on the separately published FIRM and FBFM into a FIRM. At this same time, FEMA instituted some additional format changes to make the FIRM more user-friendly and useable. These changes included simplifying the flood insurance rate zone designations for SFHAs developed based on detailed flood hazard assessments and providing a new cross-hatching feature to identify regulatory floodway areas.

[February 2002]

INT.8.5 Countywide Format

At about this same time, FEMA instituted its Countywide Format, to enable seamless flood hazard coverage at the county level. For FIRMs prepared in the Countywide Format, FEMA compiles the effective flood hazard information for all jurisdictions within the subject county (both unincorporated and incorporated areas) and produces one FIRM and one FIS report. For FIRMs prepared in Countywide Format, FEMA included all essential information that previously appeared on the effective FIRMs and FBFMs for the individual communities, unless that information had been superseded by a restudy or map revision.

[February 2002]

INT.9 Overview of Mapping Partners

To provide a sound basis for floodplain management and insurance rating, the Flood Hazard Maps must present flood hazard information that is correct and up to date. Maintaining correct and up-to-date flood hazard information requires the combined contributions of many Mapping Partners.

The following are the primary Mapping Partners involved in the development and maintenance of the Flood Hazard Maps and other flood hazard and risk information used for NFIP purposes:

- FEMA Regional Office staff;
- FEMA Headquarters Office staff;
- Community officials;
- Regional agency officials;
- State agency officials;
- Communities, regional agencies, and State agencies participating in the CTP initiative;
- Other Federal agencies;
- FEMA Contractors;
- Contractors for communities, regional agencies, and State agencies; and
- Community residents and property owners.

Brief descriptions of each of the primary groups of Mapping Partners as well as other constituent groups that have an interest in the accuracy of the flood hazard information are provided in Subsections INT.9.1 through INT.9.9.

[February 2002]

INT.9.1 FEMA Regional Offices

FEMA has offices in each of 10 Regions. The locations of these offices and the States, Commonwealths, and Territories that they cover are presented below.

- **Region I**, located in Boston, oversees flood hazard mapping and floodplain management activities in Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont.
- **Region II**, located in New York City, oversees flood hazard mapping and floodplain management activities in New Jersey, New York, Puerto Rico, and the U.S. Virgin Islands.

- **Region III**, located in Philadelphia, oversees flood hazard mapping and floodplain management activities in Delaware, District of Columbia, Maryland, Pennsylvania, Virginia, and West Virginia.

- **Region IV**, located in Atlanta, oversees flood hazard mapping and floodplain management activities in Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, and Tennessee.

- **Region V**, located in Chicago, oversees flood hazard mapping and floodplain management activities in Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin.

- **Region VI**, located in Denton, Texas, oversees flood hazard mapping and floodplain management activities in Arkansas, Louisiana, New Mexico, Oklahoma, and Texas.

- **Region VII**, located in Kansas City, oversees flood hazard mapping and floodplain management activities in Iowa, Kansas, Missouri, and Nebraska.

- **Region VIII**, located in Denver, oversees flood hazard mapping and floodplain management activities in Colorado, Montana, North Dakota, South Dakota, Utah, and Wyoming.

- **Region IX**, located in San Francisco, oversees flood hazard mapping and floodplain management activities in Arizona, California, Hawaii, Nevada, Guam, American Samoa, and the Northern Mariana Islands.

- **Region X**, located in Bothell, Washington, oversees flood hazard mapping and floodplain management activities in Alaska, Idaho, Oregon, and Washington.

[February 2002]

INT.9.2 FEMA Headquarters Office

The FEMA Headquarters, or National, Office is located in Washington, DC. The Federal Insurance and Mitigation Administration is the office within FEMA that oversees flood hazard mapping and floodplain management activities nationwide.

[February 2002]

INT.9.3 Community Officials

Many community officials have active roles in the process of creating and maintaining Flood Hazard Maps, implementing floodplain management ordinances, and ensuring wise floodplain development. The community officials who work most closely with FEMA and other Mapping Partners are the Chief Executive Officer, floodplain managers, and community planners.

[February 2002]

INT.9.4 Regional Agency Officials

The regional agencies that have active roles in the process of creating and maintaining Flood Hazard Maps, implementing floodplain management ordinances, and ensuring wise floodplain development are watershed management districts, flood control districts, regional planning councils, councils of governments, and regional offices of State agencies.

[February 2002]

INT.9.5 State, Commonwealth, and Territory Officials

Many State, Commonwealth, and Territory agencies are actively involved in creating and maintaining Flood Hazard Maps, implementing floodplain management ordinances, and ensuring wise floodplain development. The most active agency in each is referred to as the "State NFIP Coordinator," or "State Coordinating Agency" for that state, commonwealth, or territory.

The State NFIP Coordinators in each FEMA Region are listed below.

Region I

Connecticut Department of Environmental Protection
Maine State Planning Office
Massachusetts Department of Flood Hazard Management Programs
New Hampshire Office of Emergency Management
Rhode Island Emergency Management Agency
Vermont Department of Environmental Conservation

Region II

New Jersey Department of Environmental Protection
New York State Department of Environmental Conservation
Puerto Rico Planning Board
U.S. Virgin Islands Department of Planning and Natural Resources

Region III

Delaware Department of Natural Resources
District of Columbia Environmental Health Administration
Maryland Emergency Management Agency
Pennsylvania Department of Community and Economic Development
Virginia Department of Conservation
West Virginia Office of Emergency Services

Region IV

Alabama Emergency Management Agency
Florida Division of Emergency Management
Georgia Department of Natural Resources
Kentucky Division of Water Resources
Mississippi Emergency Management Agency
North Carolina Division of Emergency Management
South Carolina Department of Natural Resources
Tennessee Department of Economic and Community Development

Region V

Illinois Department of Natural Resources
Indiana Department of Natural Resources
Michigan Department of Environmental Quality
Minnesota Department of Natural Resources
Ohio Department of Natural Resources
Wisconsin Department of Natural Resources

Region VI

Arkansas Soil and Water Conservation Commission
Louisiana Department of Transportation and Development
New Mexico Department of Public Safety
Oklahoma Water Resource Board
Texas Natural Resources and Conservation Commission

Region VII

Iowa Department of Natural Resources
Kansas Department of Agriculture, Division of Natural Resources
Missouri Emergency Management Agency
Nebraska Natural Resources Commission

Region VIII

Colorado Water Conservation Board
Montana Department of Natural Resources and Conservation
North Dakota State Water Commission
South Dakota Division of Emergency Management
Utah Division of Comprehensive Emergency Management
Wyoming Emergency Management Agency

Region IX

Arizona Department of Water Resources
California Department of Water Resources
Hawaii Department of Land and natural Resources
Nevada Division of Water Planning
Guam Department of Public Works
American Samoa Economic Development Planning Office
Northern Mariana Islands Building Safety Division

Region X

Alaska Department of Community and Economic Development
Idaho Department of Water Resources
Oregon Department of Land Conservation and Development
Washington State Department of Ecology

[February 2002]

INT.9.6 Participants in Cooperating Technical Partners Initiative

One of the key objectives of the FEMA Map Modernization Program is to increase local involvement in, and ownership of, the flood mapping process. To meet this objective, FEMA developed and implemented the Cooperating Technical Partners, or "CTP," initiative. FEMA has identified the following beneficial reasons for partnering with State, local, and regional organizations to produce NFIP maps:

- The data used for local permitting and planning will also be the basis for the NFIP map, facilitating more efficient floodplain management.
- The CTP initiative provides the opportunity to modify a national program to interject a tailored, local focus where unique conditions may exist that necessitate special approaches to flood hazard identification.
- The partnership mechanism provides the opportunity to pool resources and extend the productivity of limited public funds.

In support of the CTP initiative, FEMA has committed to the following:

- To recognize the contributions made by FEMA's State, regional, and local community Partners by providing timely and accurate flood hazard information;
- To maximize the use of Partners' contributions as a means of leveraging limited public funds to the fullest extent possible while maintaining essential NFIP standards;
- To fully integrate contributing Partners into the flood hazard data development process, with the corresponding authorities and responsibilities;

- To provide training and technical assistance to Partners when appropriate; and
- To facilitate mentoring to increase capabilities of both existing and potential Partners.

The CTP initiative allows communities as well as regional agencies and State, Commonwealth, and Territory agencies that have the interest and capability to become active partners in the FEMA Flood Hazard Mapping Program. FEMA and its Partners administer activities under the CTP initiative through close and frequent coordination and through formal agreements.

More detailed information on these agreements and eligible CTP activities is provided in Volume 3, Section 3.18 of these Guidelines.

[February 2002]

INT.9.7 Other Federal Agencies

Five Federal agencies have been actively involved in the NFIP since its inception, and have worked closely with FEMA in performing flood hazard studies and preparing Flood Hazard Maps. These agencies are the U.S. Army Corps of Engineers, U.S. Geological Survey, Natural Resources Conservation Service, U.S. Bureau of Reclamation, Tennessee Valley Authority. These agencies also often provide FEMA with copies of reports (e.g., Floodplain Information Reports, Flood Hazard Analyses Reports) and other information that was developed for purposes other than the NFIP for FEMA use in updating the Flood Hazard Maps for affected communities.

In accordance with Paragraph 65.10(e) of the NFIP regulations, a Federal agency with responsibility for levee design may certify that a levee has been adequately designed and constructed to provide protection from the 1-percent-annual-chance flood. Therefore, the U.S. Army Corps of Engineers and other Federal agencies may be involved in a flood hazard study/restudy or map revision even when they are not contracted with FEMA to perform the hydrologic and hydraulic analyses.

FEMA works closely with the National Geodetic Survey, the part of the National Oceanic and Atmospheric Administration that maintains a network of more than 750,000 precisely located monumented reference points nationwide. The NGS national reference network and Global Positioning System photogrammetry provide a universal set of coordinates across community, county, and State lines. FEMA requires such a foundation of accurate coordinates for the Flood Hazard Maps.

FEMA works closely with, and provides technical assistance to, the U.S. Fish and Wildlife Service to improve the mapping of Coastal Barrier Resource System Areas. Specifically, FEMA assists the U.S. Fish and Wildlife Service in producing digital, vector mapping that is suitable for direct incorporation as a thematic layer in Digital FIRMs and potential posting on a website. As requested by the U.S. Congress, FEMA uses the mapping developed by the Service to present Coastal Barrier Resource System areas and related information of the Flood Hazard Maps for affected communities. Additional information on Coastal Barrier Resource System revisions is presented in Subsection INT.7.1.5 and in Volume 2, Section 2.2 of these Guidelines.

FEMA has established a partnership with the U.S. Geological Survey through the National Digital Orthophoto Partnership Program. Through this Program, the U.S. Geological Survey will produce Digital Orthophoto Quadrangle Maps, or "DOQs," for those communities where no community base map that meets FEMA base map specifications exists. FEMA will then use the information to update the Flood Hazard Maps.

FEMA is an active participant in the National Digital Elevation Program, which was established to promote the exchange of digital elevation data and technology among government, private-sector, and academic communities and establish standards and guidance that will benefit all agencies and users.

FEMA also is working cooperatively with 16 other Federal agencies participating on the Federal Geographic Data Committee, or "FGDC." The Committee is developing the National Spatial Data Infrastructure, which encompasses policies, standards, and procedures for organizations to cooperatively produce and share geographic data. The goals of this Infrastructure are to (1) reduce duplication of effort among agencies; (2) improve quality and reduce costs related to geographic information; (3) make geographic data more accessible to the public; (4) increase the benefits of using available data; and (5) establish key partnerships with States, counties, cities, tribal nations, academia, and the private sector to increase data availability.

Representatives of the U.S. Army Corps of Engineers, U.S. Geological Survey, and National Aeronautics and Space Administration participated in the development of guidelines and specifications for the use of airborne LIght Detection and Ranging Systems, or "LIDAR" systems. That information now appears in Appendix A, Section A.8 of these Guidelines.

[February 2002]

INT.9.8 FEMA Contractors

The primary FEMA contractors that assist FEMA and the other Mapping Partners in creating and maintaining Flood Hazard Maps and implementing floodplain management ordinances and their traditional roles and responsibilities are summarized in Subsections INT.9.8.1 through INT.9.8.3.

[February 2002]

INT.9.8.1 Study Contractors

The Study Contractors, or "SCs," are the private-sector architectural/engineering firms and Federal agencies that perform flood hazard studies and restudies under contract to, or through Interagency Agreement (Federal agencies) with FEMA. The Federal agencies that have performed flood hazard studies and restudies for FEMA are the U.S. Army Corps of Engineers, U.S. Geological Survey, Natural Resources and Conservation Service (formerly U.S. Soil Conservation Service), U.S. Bureau of Reclamation, and Tennessee Valley Authority.

[February 2002]

INT.9.8.2 Flood Map Production Coordination Contractors

The Flood Map Production Coordination Contractors, or "MCCs," are the private-sector architectural/engineering firms that: (1) review and process flood hazard studies and restudies; (2) review and process revisions and amendments to NFIP maps and related products; (3) prepare Preliminary copies and final reproduction materials for Flood Hazard Maps, reports, and related products; (4) provide program development and implementation support to FEMA and other Mapping Partners; and (5) maintain Region-based archives of flood hazard data.

[February 2002]

INT.9.8.3 Map Service Center Contractor

The Map Service Center Contractor is a private-sector firm that maintains the FEMA Flood Hazard Mapping inventory and related products, distributes printed copies of Flood Hazard Maps and related products, and provides customer service support to FEMA and other Mapping Partners.

[February 2002]

INT.9.9 Contractors for Communities and Regional Agencies

To expand their resources or to complete a specific short- or long-term mapping-related project, communities and regional agencies may hire contractors to provide a variety of engineering and mapping services. These contractors may be private-sector firms or public-sector agencies (Federal, State, and regional) with specific experience, knowledge, or capability.

[February 2002]

INT.9.10 Contractors for State/Commonwealth/Territory Agencies

To expand their resources or to complete a specific short- or long-term mapping-related project, State, Commonwealth, and Territory agencies may hire contractors to provide a variety of engineering and mapping services. These contractors may be private-sector firms or public-sector agencies (Federal, State, and regional) with specific experience, knowledge, or capability.Community Residents and Property Owners

Community residents and property owners play an active role in creating and maintaining Flood Hazard Maps by providing community officials, FEMA, and their contractors with historical and property-specific information during the preparation of a new or revised Flood Hazard Map; by providing property- or area-specific technical support data to community officials and FEMA for use in revising or amending Flood Hazard Maps; and by notifying community officials and FEMA of potential violations of local floodplain management and development ordinances.

[February 2002]

INT.9.11 Other Program Constituents

Other Program constituents that may play lesser, but nonetheless important roles in the process of creating and maintaining Flood Hazard Maps, implementing floodplain management ordinances, and ensuring wise floodplain development and management are the following:

- U.S. Congress;
- Insurance companies and agents;
- Lenders;
- Real estate professionals;
- Flood map determination firms;
- Land development industry;
- Surveyors; and
- Federal, State, and local disaster and emergency response officials.

Several organizations that represent state and local officials, the nation's realtors, home builders, and surveyors, and those with a stake in floodplain management, development review, disaster mitigation, emergency response, land-use planning, and environmental protection, have formed a coalition. The coalition was formed to support the FEMA Map Modernization Program and take an active part in assuring that the Flood Hazard Maps are accurate. The following organizations are members of this coalition:

- American Congress of Surveying and Mapping;
- American Planning Association;
- American Public Works Association;
- American Society of Civil Engineers;
- Association of State Floodplain Managers;
- Association of State Wetland Managers;
- Coastal States Organization;
- National Association of Counties;
- National Association of Development Organizations;
- National Association of Flood and Stormwater Management Agencies;

- National Association of Home Builders;
- National Association of Realtors,
- National Emergency Management Association;
- National League of Cities;
- National Flood Determination Association; and
- National Lenders Insurance Council.

The National Wildlife Federation and the Western Governors Association also have publicly supported the FEMA Map Modernization Program.

[February 2002]

INT.10 Guidelines for Mapping Partners in Perspective

Since its inception, the Federal Government has had primary responsibility for administering the NFIP in general, with a special emphasis on the identification and mapping of the nation's floodplains. The Federal Government undertook the identification and mapping activities to create a broad-based awareness of flood hazards and to provide data necessary for community floodplain management programs and to actuarially rate flood insurance.

In the enabling legislation that created and amended the NFIP, FEMA has been authorized to consult with, receive information from, and enter into agreements or other arrangements with the head of any State, regional, or local agency in order to identify these floodplain areas. Therefore, FEMA has encouraged strong Federal, State, regional, and local partnerships for the purposes of reducing flood losses and disaster assistance.

Over the years, FEMA has established and implemented initiatives to build on Federal, State, regional, and local partnerships and, where appropriate, formalize the partnerships. Through these initiatives—including the recent Cooperating Technical Partners initiative—FEMA and its State, regional, and local partners have formalized improved cooperation in the flood hazard identification and mapping processes. Many communities and the agencies that serve them have developed considerable technical capabilities and resources that provide the opportunity to improve and expand the collection, development, and evaluation of flood hazard data.

Recognizing that the contributions of FEMA and all of its Mapping Partners may evolve over the next several years, these Guidelines have not emphasized the traditional roles of the various Mapping Partners. Instead, these Guidelines specify the requirements that the Mapping Partner performing a specific task must meet to ensure consistent and accurate flood hazard information is provided to U.S. citizens nationwide.

Map MODERNIZATION

Federal Emergency Management Agency

FEMA's Flood Hazard Mapping Program

Guidelines and Specifications *for* Flood Hazard Mapping Partners

Volume 1: Flood Studies and Mapping

FEDERAL EMERGENCY MANAGEMENT AGENCY

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FINAL

February 2002

Volume I

Flood Studies and Mapping

1.1 Overview of the Flood Map Project Process

The Federal Emergency Management Agency (FEMA) has specific mandates within the National Flood Insurance Act of 1968, as amended, to identify flood hazards nationwide and publish and update flood hazard information in support of the National Flood Insurance Program (NFIP). FEMA is required to consult with local officials in identifying floodprone areas, and specific procedures are described in the Act for establishing proposed flood elevations.

The NFIP regulations (found at Title 44 of the Code of Federal Regulations, Parts 59-77) were developed as the program evolved. They codify the requirements of the 1968 Act and identify the administrative procedures required to carry out the statutory mandates. Parts 65, 66, 67, 70, and 72 of the NFIP regulations refer to specific procedures to be followed in flood hazard mapping activities.

To fulfill its mandate to identify floodprone areas, FEMA has an ongoing program to (1) develop new Flood Insurance Rate Maps (FIRMs) for floodprone communities without maps and (2) to produce updated FIRMs for communities with maps. This Volume details the processes, guidelines, and specifications by which FEMA develops and updates FIRMs and collateral Flood Insurance Study (FIS) reports.

Activities for developing a new FIRM and/or updating an existing FIRM (both actions will be referred to hereinafter as "Flood Map Projects") are completed in four phases:

1. Mapping Needs Assessment;
2. Project Scoping;
3. Topographic and Flood Hazard Data Development/Report and Map Production; and
4. Preliminary/Post-Preliminary Processing.

Figure 1-1 depicts the phases of the process, which is applicable to all Flood Map Projects, including those that involve the following:

- Developing new or updated flood hazard data;
- Digitizing floodplain boundaries from the effective FIRMs and fitting them to a digital base map, thus converting the existing manually produced FIRMs to digitally produced FIRMs referred to as DFIRMs; and
- Combinations thereof.

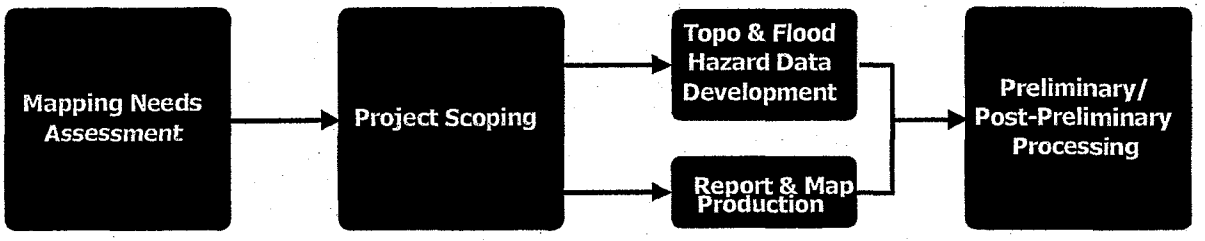


Figure 1-1. Phases of Flood Map Project Process

Subsections 1.1.1 through 1.1.4 summarize the four phases of the Flood Map Project process; greater detail is provided in Sections 1.2 through 1.5. Subsection 1.1.5 describes the roles of the various Mapping Partners in completing the tasks associated with any given Project, and Subsection 1.1.6 describes FEMA's oversight role.

[February 2002]

1.1.1 Mapping Needs Assessment

For communities with effective FIRMs, the purpose of the Mapping Needs Assessment is to evaluate whether the flood hazard data and other data shown on the FIRM are adequate. If the data on the FIRM are not adequate, the community will identify the specific data elements that need to be updated (e.g., flood hazard data for specific flooding sources, base map information). If a community has an effective Flood Boundary and Floodway Map (FBFM), the community also will evaluate the accuracy of the data on the FBFM.

For communities that do not have effective FIRMs or FBFMs, including those that have Flood Hazard Boundary Maps (FHBMs), the purpose of the Mapping Need Assessment is to determine whether the community is floodprone and whether a FIRM should be produced.

The Mapping Needs Assessment forms the basis for selecting and prioritizing Flood Map Projects to initiate and, for those selected, serves as the "building block" for the Project Scoping phase. The Mapping Needs Assessment process is discussed in detail in Section 1.2.

[February 2002]

1.1.2 Project Scoping

The Project Scoping phase begins after a community's mapping needs have been identified and FEMA and the community have decided to initiate a Flood Map Project to create or update the FIRM. Building on the Mapping Needs Assessment, Project Scoping entails the following:

- Conducting background research and community outreach;
- Determining what flood hazard data (e.g., those data shown in effective FIS reports and on effective FIRMs) can be used in the revised flood hazard analyses and/or transferred without change to the new FIS report and FIRM. That is, for some communities, it may be possible simply to transfer all flooding source data to the new FIS report and FIRM; in others, it may be that only the existing hydrologic data can be used and that new hydraulic analyses need to be performed; in still others, it may be that no existing data can be used);
- Identifying other data needed to complete the Flood Map Project and sources of those data (e.g., base map, topography, cross sections, transects);
- Establishing priority levels for flooding sources to be analyzed and mapped;
- Determining whether the FIRM format should be countywide or community-based, digital or manual, and what tiling scheme should be used;
- Developing schedules and cost estimates for the components of the Flood Map Project; and
- Assigning project tasks to Mapping Partners and developing appropriate contracts or agreements for completion of assigned work.

All Mapping Partners contributing to the Flood Map Project, including the affected communities, will participate in the Project Scoping phase. The Project Scoping process is discussed in detail in Section 1.3.

[February 2002]

1.1.3 Topographic and Flood Hazard Data Development/Report and Map Production

After the Project Scoping phase has been completed and all contractual orders to initiate work have been issued, the Topographic and Flood Hazard Data Development/Report and Map Production phase of the Flood Map Project begins. This phase may entail the following:

- Developing and/or obtaining topographic and cross-section data needed for engineering analyses and floodplain boundary delineations;
- Performing engineering analyses and delineating floodplain boundaries;
- Obtaining and preparing the base map for FIRM production;
- Digitizing directly from the effective FIRM those floodplain boundaries that are not being updated;
- "Merging" new or updated flood hazard data (for updated portions of flooding sources) with effective data (for non-revised portions of flooding sources) to produce the updated FIRM; and
- Producing or revising the FIS report, including the Flood Profiles and data tables (e.g., Summary of Discharges Table, Floodway Data Table).

To compress timeframes, many work elements will be completed concurrently and collaboratively by the assigned Mapping Partners. For example, FIRM production may begin with one Mapping Partner conducting engineering analyses for several flooding sources while another acquires base maps and digitizes floodplain boundaries and other flood hazard data that will not be revised as part of the Flood Map Project. Data development and map and report production are discussed in detail in Section 1.4.

[February 2002]

1.1.4 Post-Preliminary Report and Map Processing

Upon completion of the Topographic and Flood Hazard Data development/Report and Map Production phase, FEMA issues the new or updated FIS report and FIRM to officials of the affected communities in "Preliminary" form for review and for distribution to other interested parties in the communities. Through an informal comment period following the issuance of the Preliminary copies and through formal public meetings, FEMA provides the affected communities, their citizens, and other interested parties the opportunity to comment on the FIS report and FIRM. If the informal public review requires making significant changes in base map or flood hazard information, these changes are incorporated and "Revised Preliminary" copies of the FIS report and FIRM are issued.

When required, FEMA initiates a statutory 90-day appeal period to provide community officials and citizens a formal opportunity to "appeal" any new or modified 1-percent-annual-chance (100-year) flood elevations, also referred to as Base Flood Elevations (BFEs), or to "protest" other flood hazard data. FEMA will consider and evaluate all comments and data submitted during the 90-day appeal period and resolve all appeals and protests in consultation with the community. The following occurs during the remainder of the post-Preliminary process:

- Providing communities with a 6-month period to make any necessary changes in their floodplain management ordinances;
- Conducting final quality assurance/quality control (QA/QC) reviews to ensure the accuracy of the information presented in the FIS report and on the FIRM, and its compliance with these Guidelines;
- Printing activities performed by the U.S. Government Printing Office (GPO) in coordination with the FEMA Map Service Center (MSC), which is responsible for distribution of the printed copies of the FIS report and FIRM; and
- Printing and distributing the FIS report and FIRM.

[February 2002]

1.1.5 Mapping Partners

As discussed in the Introduction, Section INT.9 of these Guidelines, several Mapping Partners may be involved in a particular Flood Map Project. The Mapping Partners most frequently include FEMA Regional Office (RO) and Headquarters (HQ) staff; communities or regional agencies, including those participating in the FEMA Cooperating Technical Partners (CTP) initiative (hereinafter referred to as CTPs; Study Contractors (SCs) selected by FEMA or the community to perform certain portions of the work; contractors selected by a CTP to perform certain portions of the work; and FEMA's Flood Map Production Coordination Contractors (MCCs). The assignment of project tasks to communities, CTPs, SCs, CTP contractors, and MCCs may vary from project to project. These task assignments are made during the Project Scoping phase to allow FEMA and the Project team to achieve a "best value" for its mapping efforts based on the capabilities and resources of the various Mapping Partners.

The bar graphs in Figure 1-2 demonstrate the flexibility in the assignment of Flood Map Project tasks and illustrate how the assignment of responsibilities can vary.

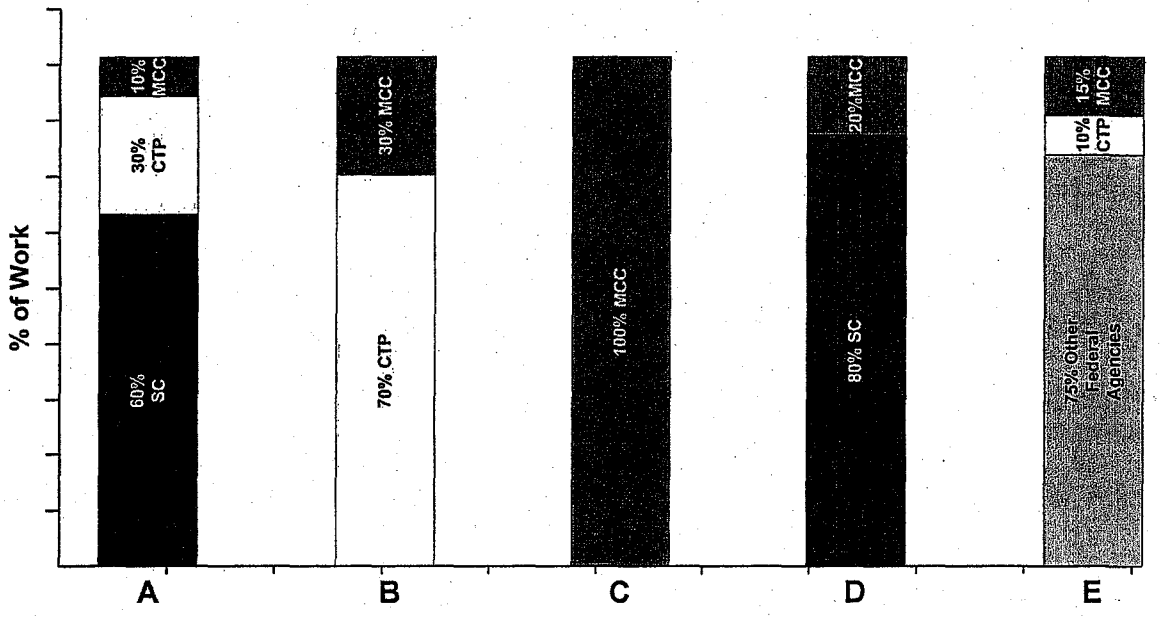


Figure 1-2. Possible Distribution of Task Assignments for Flood Map Projects

Column A depicts a map update that combines the efforts of the CTP and SC to complete the engineering analyses, floodplain mapping, and digital FIRM production, with support from the MCC for upfront research and post-Preliminary processing. The SC would perform independent QA/QC reviews of the CTP work.

Column B depicts a project with engineering analyses, floodplain mapping, and digital FIRM production by the CTP and upfront research, ongoing coordination, independent QA/QC reviews, and post-Preliminary processing by the MCC.

Column C depicts a digital FIRM conversion prepared by the MCC with no new flood hazard data.

Column D depicts a "traditional" FEMA-contracted study. The SC completes the engineering analyses and floodplain mapping and the MCC performs upfront research, ongoing coordination, independent QA/QC reviews, digital FIRM production, and post-Preliminary processing.

Column E depicts a Flood Map Project completed primarily by another Federal agency. The MCC performs upfront research, ongoing coordination, and post-Preliminary processing. For the Flood Map Project depicted in Column E, the community would be moderately involved, perhaps through sharing of base map data for the production of the digital FIRM.

[February 2002]

1.1.6 Oversight of Flood Map Projects

All Mapping Partners performing work under a contractual or cooperative agreement will perform work under the authority of FEMA Project Officers (POs) and Assistance Officers (AOs). The AOs and POs may not be the same people for different Mapping Partners. For CTPs and SCs, the PO is normally an engineer from the Flood Insurance and Mitigation Division of the appropriate FEMA RO and is referred to hereinafter as the Regional Project Officer (RPO). For MCCs, the PO is the appropriate Studies Team Leader from the Hazards Study Branch of the Hazard Mapping Division, Federal Insurance and Mitigation Administration, and is referred to hereinafter as the PO at FEMA HQ.

The AO for CTPs and SCs is a Contracting or Acquisitions Officer from the appropriate RO and is referred to hereinafter as the AO. For MCCs, the AO is a Contracting Officer (CO) from the Financial and Acquisition Management Division at FEMA HQ and is referred to hereinafter as the CO at FEMA HQ.

The RPO or PO at FEMA HQ is the Mapping Partner's primary contact at FEMA and is responsible for general oversight and coordination of activities performed under the Mapping Partner's contractual or cooperative agreement with FEMA. Responsibilities of the RPO and PO at FEMA HQ include:

- Facilitating contractual task orders for FEMA contractors;
- Facilitating Partnership Agreements, Mapping Activity Statements (MASs), and Cooperative Agreements with CTPs;
- Coordinating with other FEMA programs (e.g., Community Rating System); and
- Monitoring the Mapping Partner's activities and performance.

The AO or CO is responsible for contractual and financial aspects of contractual and cooperative agreements, including:

- Administering task orders, MASs, and Cooperative Agreements;
- Reviewing and approving technical and cost proposals;
- Overseeing financial reporting requirements;
- Dispersing payments to Mapping Partners; and
- Monitoring financial administration requirements.

Each Flood Map Project performed following the procedures described in this Volume will have a FEMA Lead assigned to manage the Project through its lifecycle, from Project Scoping through distribution of the printed FIS report and FIRM. The FEMA Lead, which will typically be an Engineer from FEMA HQ or the appropriate RO, will oversee the project's scope,

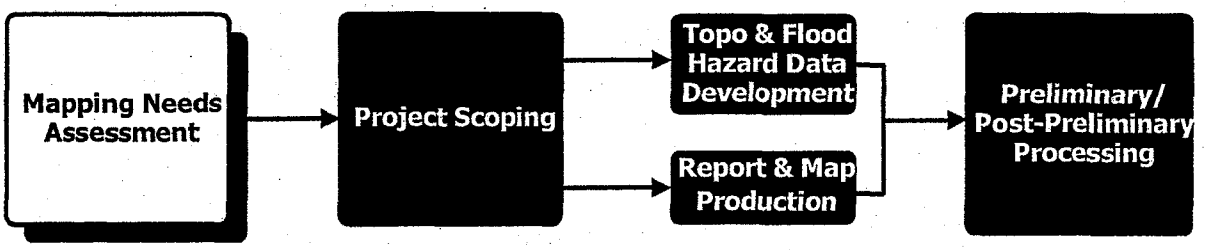
schedule, and budget on a day-to-day basis as well as coordinate the activities of the various Mapping Partners. In particular, the FEMA Lead's responsibilities include determining the scope of a Flood Map Project and assigning roles to the Mapping Partners involved in it.

In general, the FEMA Lead will provide direction to all Mapping Partners in the performance of the Flood Map Project. For Flood Map Projects that involve developing new or updated flood data, the FEMA Lead will typically be a FEMA Regional Engineer. For Flood Map Projects that involve digital conversions with no development of new or updated flood data, the FEMA Lead will either be a FEMA Regional Engineer or a Project Engineer from FEMA HQ. When the FEMA Lead is not the RPO or PO for the Mapping Partner, the FEMA Lead will coordinate with the RPO, PO, or his/her designee, as necessary, on matters related to the project's scope, schedule, budget, or technical issues.

All issues affecting cost or performance period will necessitate a modification of task orders, MASs, or Cooperative Agreements and will be coordinated by the FEMA Lead with the appropriate AO or CO.

[February 2002]

1.2 Mapping Needs Assessment



As discussed in Section 1.1, during the Mapping Needs Assessment phase, the community and FEMA will (1) evaluate of the adequacy of the published Flood Hazard Map and other data, if FEMA has published such a map, or evaluate whether an unmapped community is floodprone; and (2) determine whether a Flood Hazard Map (usually a FIRM) should be published.

The Mapping Needs Assessment forms the basis for selecting Flood Map Projects to initiate and, for those selected, serve as the "building block" for the Project Scoping phase. Further, Section 575 of the National Flood Insurance Reform Act of 1994 mandates that at least once every 5 years FEMA assess the need to revise and update all floodplain areas and flood risk zones identified, delineated, or established under Section 1360 of the National Flood Insurance Act, as amended. Accordingly, FEMA established the Mapping Needs Assessment process under which data on mapping needs are collected and then evaluated for the purpose of identifying and prioritizing potential Flood Map Projects.

FEMA considers two categories of mapping needs:

1. Flood Data Update Needs – Any need to update existing or develop new flood hazard data (BFEs, floodplain boundaries, and/or regulatory floodway boundaries); and

2. Map Maintenance Update Needs – Any need to change non-engineering reference features that are important for users to locate property on the FIRMs, such as street and road locations and names or corporate boundaries. Map maintenance needs do not require new, updated engineering analyses and do not affect the floodplain delineation.

Mapping Needs Assessment is an ongoing program activity, and FEMA uses a variety of sources for gathering needs data, including CTPs, community surveys, other Federal and State agencies, NFIP State Coordinators, Community Assistance Visits and Calls, and FEMA archives. The mapping needs identified by FEMA and its Mapping Partners are catalogued in the Mapping Needs Update Support System (MNUSS). MNUSS allows FEMA to document and evaluate the mapping needs of each community and assists in prioritizing Flood Map Projects comparatively based on the identified needs, thereby identifying the most cost-beneficial Flood Map Projects to be undertaken. Additional information concerning MNUSS is provided in Volume 3, Subsection 3.8.2 of these Guidelines.

The flowchart in Figure 1-3 shows the conceptual process for the Mapping Needs Assessment.

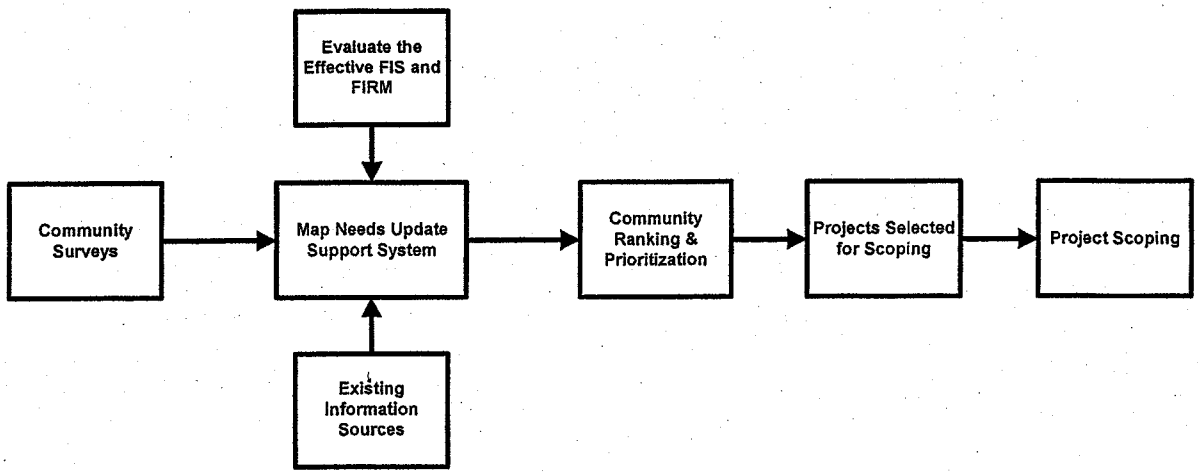


Figure 1-3. Mapping Needs Assessment Process

FEMA encourages each community to assess its mapping needs on an ongoing basis and to keep FEMA informed of any changes. A detailed Mapping Needs Assessment is essential to scope a Flood Map Project properly. Therefore, if a detailed Mapping Needs Assessment has not been completed before a Flood Map Project is initiated, that assessment should be done during the initial scoping phases of the project as discussed in Section 1.3.

FEMA will frequently assign a Mapping Partner to conduct the Mapping Needs Assessment for a particular community or a logical grouping of communities. This section provides guidance on conducting a detailed Mapping Needs Assessment. Some of the methods of compiling mapping needs data may not apply to every community or group of communities.

[February 2002]

1.2.1 Existing Information Sources

To conduct a thorough Mapping Needs Assessment, the Mapping Partner that performs the assessment shall consider all potential existing information sources, including:

- FEMA archives;
- Community Assistance Visits (CAVs);
- Community Assistance Calls (CACs);
- Planning reports prepared by other agencies;
- Community floodplain managers or administrators;
- State NFIP Coordinators; and
- NFIP Biennial Reports.

[February 2002]

1.2.1.1 FEMA Archives

The MCCs assist FEMA in reviewing and preparing FIS reports and FIRMs and maintaining archives for each community participating in the NFIP regarding production of these documents. Frequently, community mapping needs are maintained in these archives. The Mapping Partner that is performing the Mapping Needs Assessment may obtain information on how to obtain data from the FEMA archives through the FEMA Flood Hazard Mapping website (http://www.fema.gov/mit/tsd/st_order.htm).

Additionally, the Mapping Partner that is performing the Mapping Needs Assessment may find it useful to obtain and review a MNUSS Needs Summary report for the community. The summary report identifies the existing mapping needs information on file for the community and the source of the data. If a Mapping Partner is conducting a Mapping Needs Assessment and does not have access to MNUSS, a Needs Summary may be obtained through the FEMA Lead.

[February 2002]

1.2.1.2 Community Assistance Visits and Calls

FEMA created the Community Assistance Program (CAP) to provide outreach and technical support to communities participating in the NFIP. The CAP is an integral part of the administration of the NFIP at the regional, state, and local level.

Under the CAP, both Community Assistance Visits (CAVs) and Community Assistance Calls (CACs) are used to obtain input and share information. A CAV is a visit by FEMA regional staff or the State NFIP Coordinator to a community to assess whether the community's

floodplain management program meets NFIP participation requirements. Frequently, the RO will use a CAC, which is simply a telephone call to the community, to supplement or replace a CAV.

Although it is not the primary purpose of the CAV and CAC, the FEMA RO staff usually ask a community official about the overall satisfaction with the depiction of flood hazards on the Flood Hazard Map. Therefore, a review of CAV and CAC files may be a valuable source of information about the community's map update needs. These files are kept in the FEMA RO and/or State NFIP Coordinator's office.

[February 2002]

1.2.1.3 Planning Reports Prepared by Other Agencies

Some State and local floodplain management agencies and planning organizations are undertaking special efforts to identify mapping needs for areas with a history of recurring flooding. For example, the district offices of the U.S. Army Corps of Engineers (USACE) as well as other Federal, State and regional planning agencies have mandates to provide various forms of nonstructural and structural flood protection and floodplain management planning. Before undertaking such projects, these agencies typically prepare a planning or reconnaissance report, flood damage assessment, or some other type of pre-project planning report. A review of such reports on a regional or state-by-state basis may be helpful in identifying map update needs.

[February 2002]

1.2.1.4 Community Floodplain Manager or Administrator

One of the best sources of information regarding the community's map update needs is the floodplain manager or administrator for the community. Mapping Partners that perform a Mapping Needs Assessments shall consult with the community floodplain manager or administrator for information regarding map update needs.

[February 2002]

1.2.1.5 State Coordinators

State NFIP Coordinators may have valuable information regarding community map update needs. Specifically, they may be able to provide input on needs of multiple communities within a specific area or watershed and can be especially helpful when examining the needs of a large potential project area. Mapping Partners that perform Mapping Needs Assessments shall consult with the State NFIP Coordinator for information regarding map update needs.

[February 2002]

1.2.1.6 Biennial Reports

The NFIP Biennial Reports are prepared from information provided by community officials. Based on community responses to standard questionnaires, these reports include information about changes to flood hazards, projects that have been constructed, recent flooding events, and annexations that have been undertaken. These reports, which can be obtained through the FEMA Lead, may provide information that is useful for assessing map update needs.

[February 2002]

1.2.2 Community Surveys

A Mapping Partner may be tasked by FEMA to develop a community survey or questionnaire and/or to conduct such a survey or questionnaire to a specific NFIP community.

[February 2002]

1.2.3 Evaluating Effective Flood Insurance Study Report and Flood Insurance Rate Map

In addition to gathering information from the sources of mapping needs identified in Subsection 1.2.1, it is crucial that the Mapping Partner performing the Mapping Needs Assessment evaluate the effective FIS report and FIRM to obtain a complete picture of all the map update needs for a given community. One significant factor affecting the need for updating the FIS report and FIRM for the community is the nature of the natural or manmade changes that have occurred in the community and surrounding areas since these documents were prepared, and the extent to which these changes affect potential flooding. Another factor affecting the need to update an FIS report and FIRM is the level of detail and quality of the existing data and underlying analyses.

The recommended approach to evaluating the FIS report and FIRM to determine whether the information contained in these documents is accurate and up to date is discussed in Subsection 1.2.3.1 for flood data update needs and in Subsection 1.2.3.2 for map maintenance update needs.

[February 2002]

1.2.3.1 Flood Data Update Needs

A flood data update need is simply any need to update flood hazard data (e.g., discharges, BFEs, floodplain boundaries, or regulatory floodway boundaries). The FIS report and FIRM are based on riverine and/or coastal hazard analyses. To assess the community's flood data update needs, Mapping Partners that perform Mapping Needs Assessments shall evaluate any changes in flooding conditions (e.g., changes to the discharges for a particular stream, changes to a beach profile in a coastal area) since previous analyses in support of FIS report and FIRM were performed.

[February 2002]

Determining Age of Analyses

A critical first step in the Mapping Needs Assessment process is to determine when the most recent riverine and coastal analyses were conducted. This information is generally specified in Section 3.0 of the FIS report (refer to Appendix J of these Guidelines for further information regarding FIS reports).

The dates of the effective FIS report and FIRM panels are generally not reliable indicators of when the riverine and coastal analyses were conducted because not all flooding sources, or all portions of particular flooding sources, are revised when an FIS report and FIRM are revised. In other words, a FIRM panel may be revised based on new analyses of only a single flooding source on that panel, while new analyses were not performed for all other flooding sources on that panel. For those unrevised flooding sources, the new effective date of the FIRM panel has no bearing on the date the underlying analyses were conducted. Similarly, not all components of the analysis of a particular flooding source are necessarily revised. For instance, flood elevations may be revised based on a new hydraulic analysis, even if the underlying hydrologic analysis was not revised.

The methodology of coastal analyses has changed substantially since the 1980s. For instance, wave heights were not properly considered until after a 1977 National Academy of Sciences report discussed them; neither were the effects of erosion on the beach and dune profiles properly considered prior to 1989. Mapping Partners that perform Mapping Needs Assessments shall review coastal analyses carefully to determine whether all factors that are currently considered in determining flood hazards have been considered.

Taking into account the multiple variables that can affect alluvial fans and their flooding characteristics—including climate, fan history, vegetation, and land use—FEMA recently developed an approach to identify and map flood hazards on alluvial fans that accounts for site-specific conditions. The approach, documented originally in *Guidelines for Determining Flood Hazards on Alluvial Fans* (FEMA, 1999) and detailed in Appendix G of these Guidelines, addresses recommendations in a 1996 report prepared by the National Research Council Committee on Alluvial Fan Flooding (National Research Council, 1996). For alluvial fan areas that were identified and mapped before FEMA issued *Guidelines for Determining Flood Hazards on Alluvial Fans,* Mapping Partners may want to consider an approach to evaluating alluvial fan hazards other than the one used for the effective FIRM.

[February 2002]

Comparing Recent Flooding Events to Effective Flood Insurance Rate Map

As part of determining flood data update needs, the Mapping Partner shall compare the flood hazards shown on the existing FIRM to any documented out-of-bank flooding that has been estimated by the community or a State or Federal agency to be approximately equal to the 1-percent-annual-chance flood. However, the Mapping Partner shall exercise care not to assume that a mapping error exists on the FIRM on the basis of historical flood events. The return frequency of flooding can vary greatly from stream to stream or from one part of a stream to

another, depending on the distribution of rainfall over the drainage basin(s). For example, if precipitation is localized, flooding on a small tributary may approach the 1-percent-annual-chance event, but the flooding on the larger receiving stream may be a much smaller magnitude event. Conversely, the main stream could be experiencing flooding from rainfall in the upper watershed that does not affect the lower tributaries, causing less severe flooding on the tributaries than the main stream.

The Mapping Partner may find that documentation of observed rainfall amounts and high-water marks, including any photographs of flooding events within the community, may be useful information to review. Anecdotal information on flooding is not considered reliable unless it is combined with surveyed high-water marks and includes the date and time of the high-water mark observation. The Mapping Partner also may find that information about the performance of bridges and culverts during the flood event is useful, particularly whether the carrying capacity of the bridge openings or culverts were adequate or were exceeded or whether any bridge openings or culverts were clogged with debris or ice. Photographs of bridges and culverts during flooding also may be useful.

[February 2002]

Assessing Factors that Affect Hydrologic Analyses

One of the primary components in riverine flooding analyses is the hydrologic analysis. The methodology for hydrologic analyses is discussed in Section 3.0 of the FIS report (refer to Appendix J of these Guidelines for further information regarding FIS reports). Floodplain and watershed conditions can change that would affect these analyses. Factors that affect the hydrologic conditions that should be considered in evaluating the community's need for a flood data update are discussed below.

Changes in Land Use in the Watershed

Significant development or other changes in land use in the watershed (both within the community and in any upstream communities) can significantly change the discharges. Often, the increase in impervious areas associated with urbanization causes an increase in the stream's peak discharge. The Mapping Partner can evaluate the amount of development in a community by reviewing a variety of information, including:

- Community Comprehensive Plan;
- Community zoning maps;
- Site plans for large projects;
- Storm water utility plans; and
- Letters of Map Change (LOMCs) issued by FEMA since the effective FIRM was published.

Mapping Partner should refer to Volume 2 of these Guidelines for more information on LOMCs issued by FEMA, which include Letters of Map Amendment (LOMAs), Letters of Map Revision Based on Fill (LOMR-Fs), and Letters of Map Revision (LOMRs).

[February 2002]

Publication of New Regional Regression Equations

The U.S. Geological Survey (USGS) is responsible for recording, studying, and publishing streamflow data, including the magnitude and frequency of flood peaks. From these data, the USGS develops or revises regional regression equations and publishes them in Water Resources Investigation Reports. If effective base (1-percent-annual-chance) flood discharges were estimated using regression equations and the analyses are more than 10 years old, there is a reasonable chance that the regional regression equations have been revised since those analyses were conducted. The Mapping Partner shall compare the effective base flood discharges to those computed using the most up-to-date regression equations. A significant difference would indicate a need for a flood data update. The Mapping Partner may obtain information on the most current regional regression equations for a particular area from the USGS district office. Although other agencies may publish regression equations for a region, only the USGS regression equations are typically used for NFIP purposes.

[February 2002]

Changes in Design Storm Data

If the effective hydrologic analyses were performed using a rainfall-runoff model (e.g., HEC-1, TR-20), changes in design storms may affect the base flood discharge. Currently, design storm data are obtained from two publications: National Weather Service Technical Paper No. 40, *Rainfall Frequency Atlas of the United States*, and National Oceanic and Atmospheric Administration Atlas 2, *Precipitation-Frequency Atlas of the Western United States*. The revised design storms may cause changes in discharge estimates.

Information on updating design storms can be found on the National Weather Service website at http://www.nws.noaa.gov/oh/hdsc/studies/prcpfreq.html.

[February 2002]

Increase in Length of Stream Gage Record

An increase in the length of a stream gage record may also affect the flood discharge estimate. If the effective discharge was estimated by conducting a frequency analysis of a relatively short record of stream gage data, the base flood discharge estimate may be changed if newly available data are added. If stream gage data with a relatively long record (50 years or more) were used in the effective analyses, however, a few additional years usually will not cause significant changes in the base flood discharge estimate, unless a large-magnitude event occurred since the analyses were conducted. All frequency analyses are to be performed in accordance with the methods specified in Bulletin 17B, *Guidelines for Determining Flood Flow Frequency* (Interagency

Advisory Committee on Water Data, 1982). The effective flood discharge shall be revised only if that discharge is outside the 90-percent confidence interval (higher than 95-percent confidence limit or lower than 5-percent confidence limits) of the newly computed flood discharge.

[February 2002]

Construction of Flood-Control Structures

Certain flood-control structures (e.g., reservoirs and detention ponds) are designed to reduce the peak flood discharges. Therefore, the Mapping Partner shall evaluate carefully any flood-control structures constructed since the effective hydrologic analyses were performed to determine whether the structures have a significant effect on the base flood discharge. However, not all reservoirs are designed to mitigate flooding. Therefore, the Mapping Partner must evaluate the function(s) of a reservoir to determine whether it affects discharges. Flood-control structures may be built by Federal agencies (e.g., the USACE, the Natural Resources Conservation Service (NRCS), or the U.S. Bureau of Reclamation) or local organizations (e.g., water management districts or irrigation districts). The agency or organization that built and/or administers the structure should have the necessary information available.

In addition to evaluating new flood-control structures, the Mapping Partner shall evaluate existing structures to determine whether they continue to operate in the same manner as they did when the hydrologic analyses were conducted. For example, changes in the operating flood stages of a reservoir may affect how flood-waters are routed through the reservoir. Any changes in operating procedures may affect how the structure is considered in future mapping efforts.

[February 2002]

Assessing Factors That Affect Hydraulic Analyses

Another primary component in riverine flooding analyses is the hydraulic analysis. The methodology for hydraulic analyses is discussed in Section 3.0 of the FIS report, detailed in Appendix J of these Guidelines. Floodplain conditions can change that would affect these analyses. Mapping Partners that perform Mapping Needs Assessments shall consider factors that affect the hydraulic conditions in evaluating the community's flood data update needs as discussed below.

[February 2002]

New Bridges and Culverts

If a discharge exceeds the capacity of a bridge opening or culvert, floodwaters can back up, thereby increasing flood levels upstream. Although most bridge openings and culverts are designed to allow stream flows associated with frequent storm events to pass without such backwater effects, they may not be designed to carry the 1-percent-annual-chance flood discharge. Therefore, the Mapping Partner shall evaluate any bridges or culverts that have been constructed since the effective FIS report and FIRM were completed to determine the potential effect of the bridges and culverts on the 1-percent-annual-chance flood and the associated

regulatory floodway. The Mapping Partner may obtain information regarding the date of construction and other details of roads, bridges, and culverts from the state Department of Transportation or local public works departments.

[February 2002]

Changes in Stream Morphology

Any significant change in the stream channel or floodplain geometry, particularly regrading or the placement of fill, can affect the 1-percent-annual-chance floodplain and the associated regulatory floodway. Another consideration is any change in the stream location, either through natural processes (e.g., stream migration, erosion, or deposition) or through manmade changes (e.g., channelization, stream widening, stream straightening, or dredging). Additionally, any significant change in the vegetation or structural encroachments in the floodplain may affect a stream's hydraulic characteristics. Aerial photographs are useful tools in evaluating changes in stream channels and floodplains. Mapping Partners that perform Mapping Needs Assessments shall evaluate all of these factors that may result in changes in stream morphology.

[February 2002]

Construction of Flood-Control Structures

Some flood-control structures (e.g., levees, diversion channels) are designed to protect certain areas from inundation or otherwise reduce flood elevations. Therefore, Mapping Partners that perform Mapping Needs Assessments shall evaluate carefully any flood-control structures constructed since the hydraulic analyses were performed to determine whether they have a significant effect on the floodplain boundary delineation and/or flood elevations. Levee systems and diversion channels are typically, but not always, built by the USACE. The agency or organization that built and/or administers the structure should have information about that structure. Specific procedures for evaluating and mapping levees are provided in Appendix H.

[February 2002]

Assessing Factors That Affect Stillwater Analyses

The analyses of coastal flood hazards can be broadly categorized into two components: analyses of the stillwater elevations and analyses of the effects of waves. When determining whether the stillwater conditions in a coastal area require restudy, Mapping Partners that perform Mapping Needs Assessments shall consider (1) whether any major storm events have occurred that may provide data; and (2) increased length of tide gage record.

[February 2002]

Occurrence of Major Storm Events

Surveys of high-water marks taken from the insides of structures can provide data on stillwater elevations for comparison to the stillwater elevations shown in the FIS report. An indicator of

map update needs is when a relatively minor storm event causes stillwater elevations well above those in the published FIS report.

[February 2002]

Increased Length of Tide Gage Record

An increase in the length of a tidal gage record may also affect the stillwater elevation estimate. If the effective stillwater elevation was estimated by conducting a frequency analysis of a relatively short record of tidal gage data, the stillwater elevation estimate may be sensitive to newly added data. If tidal gage data with a relatively long record were used in the effective analyses, however, a few additional years usually will not cause significant changes in the stillwater elevation estimation, unless a large-magnitude event occurred since the analyses were conducted.

[February 2002]

Assessing Factors That Affect Wave Height Analyses

The second broad category of analyses to be considered in coastal areas is the analyses of wave heights, which include the effects of erosion. When determining whether the stillwater conditions in a coastal area require new analyses, the Mapping Partner shall consider the following factors:

- When the previous wave height analyses were conducted (if they were included in the previous analysis);
- When the previous erosion analyses were conducted (if they were included in the previous analysis);
- Whether any seawalls or other structures have been constructed;
- Whether dunes have been built/rebuilt or otherwise enhanced;
- Whether any major storm events may have changed the beach profile,
- Whether any major storm events may provide data;
- Whether any significant beach or dune erosion has occurred; and
- Whether more detailed topographic data is available for coastal areas.

Each of these factors is discussed below.

[February 2002]

Age of Previous Wave Height Analyses

A critical first step in the Mapping Needs Assessment is to determine when the most recent coastal analyses were conducted. As mentioned in Subsection 1.2.3.1, the methodology for coastal analyses has changed substantially since the 1980s, requiring that the Mapping Partner determine whether all currently accepted methodologies and protocols have been applied.

[February 2002]

Age of Previous Erosion Analyses

The Mapping Partner shall determine when the most recent erosion analyses were conducted and whether the previous analysis is adequate to represent the existing beach profile.

[February 2002]

Construction of Seawalls or Other Structures

Some flood-control structures such as seawalls are designed to protect certain areas from inundation or otherwise reduce flood elevations. Therefore, the Mapping Partner shall evaluate carefully any new coastal flood-control structures determine whether they have a significant effect on the flood hazard delineation and/or flood elevations. The private entity, federal agency or local organization that built and/or administers the structure should have information about that structure.

[February 2002]

Effects of Major Storm Events on the Beach Profile

The Mapping Partner shall determine whether significant storm events have changed beach profiles enough to alter the flood hazard delineation along the shoreline. If a beach profile has changed, it may have an effect on BFEs and may move the inland limit of the floodplain.

[February 2002]

Availability of Data from Major Storm Events

Surveys of high-water marks taken from the outsides of structures can provide data on wave heights for comparison to the elevations shown in the FIS report and on the FIRM. Additionally, surveys of flood inundation limits in the storm impact area, which can be determined by water marks on structures and debris lines, can be compared to the flood zone delineations on the FIRM. An indicator of flood data update needs is when a relatively minor storm event causes flooding and damage well outside the identified flood insurance risk zone on the FIRM or well above the BFEs indicated on the effective FIRM.

[February 2002]

Significant Beach or Dune Erosion

After erosion has occurred, new survey and mapping of the beaches and dunes may indicate a significant lowering of the dune crest elevations, which would result in a greater landward extension of the hazard area than that is shown on the effective FIRM.

[February 2002]

Updated Topographic Data

Many of the coastal high hazard areas were mapped based on wave height studies that relied on USGS 7.5-minute series topographic quadrangle maps, typically with 5-foot contours. If more detailed and/or updated topographic information is available for the community, the better data may provide a refined assessment of the wave elevations, hazard zones, and the primary frontal dune location.

[February 2002]

Presence of Areas Not Studied or Studied by Approximate Methods

Not all floodprone areas in a community may have been studied using detailed methods as part of the effective flood analyses. Areas that were rural and had little development at the time the analyses were conducted may not have been studied or may have been studied using approximate methods and designated Zone A.

If development has occurred in such areas, detailed-study analyses may be warranted to determine the flood elevations and floodplain boundaries more precisely. Mapping Partners that perform Mapping Needs Assessments shall evaluate the amount of development near all flooding sources in the community that were not studied or were studied by approximate methods.

[February 2002]

1.2.3.2 Map Maintenance Update Needs

Map maintenance needs relate primarily to the non-engineering reference information found on the community base map. The base map, which covers the entire geographical area of the community, depicts certain features and their names (e.g., roads, railroads, streams, bench marks) as well as corporate limits and section lines.

The community base map is the preferred source for the features depicted on the FIRM. These features help map users locate properties relative to the flood insurance risk zones; thus, it is crucial that the features be placed and identified accurately.

To determine whether a map maintenance update is needed, Mapping Partners that perform Mapping Needs Assessments shall examine the features on the FIRM and consider the following questions: Have the corporate boundaries changed? Have new roads been built in or near the 1-percent-annual-chance floodplain?

Another reason for a map maintenance update is the availability of digital base mapping. Minimum criteria for locally produced base maps are provided in Section 1.4.

[February 2002]

1.2.4 Mapping Needs Assessment for Unmapped Communities

Mapping Partners may be tasked by FEMA to assess the mapping needs of communities for which FEMA has not published a Flood Hazard Map. The Mapping Needs Assessment for these "unmapped communities" shall include determining whether the community is floodprone and, if so, identifying whether flood data already exist that can be used to prepare an FIS report and FIRM or whether new flood data will have to be developed.

To determine whether a community is floodprone, Mapping Partners that perform Mapping Needs Assessments shall contact community officials to discuss whether the community has experienced recent or historical flooding problems, particularly focusing on areas of existing or anticipated development. In coordination with local officials, the Mapping Partner shall try to ascertain whether the community's flooding experiences relate to "general" conditions of flooding (as defined in Section 59.1 of the NFIP regulations) or to local storm water drainage problems.

Mapping Partners that perform Mapping Needs Assessments also shall review, at a minimum, the effective NFIP maps of the contiguous communities, including the county, to determine whether flooding sources with identified flood hazards may affect the subject community. The Mapping Partner shall review the USGS topographic maps covering the subject community to determine, based on contours and drainage patterns, whether flooding is likely to affect the community. As a general rule, FEMA is concerned primarily with flooding sources that have a drainage area of 1 square mile or more.

Mapping Partners that perform Mapping Needs Assessments shall contact other potential data sources such as the USACE, the NRCS, the USGS, and the State NFIP Coordinator to determine (1) whether they know of any historical flooding problems occurring within the community and (2) whether they are aware of existing studies or mapping (e.g., Floodplain Information Reports or Flood Hazard Analyses Reports) that provide flood data for the community.

Upon completion of the Mapping Needs Assessment for an unmapped community, the assigned Mapping Partner shall submit the following documentation to FEMA:

- Written recommendation as to whether the community should be considered floodprone, with a brief description and any calculations or mapping that support that determination;
- Communication records or meeting minutes documenting coordination with community officials, the State NFIP Coordinator, and other agencies contacted during the Mapping Needs Assessment;

- A list of flooding sources in the community that should be mapped if the community is to be considered floodprone;
- If the community is to be considered floodprone, a summary of existing flood studies or mapping that could be used to create a FIRM. Copies should be provided, or sufficient information should be provided on how FEMA can obtain the existing studies or mapping; and
- Any other pertinent data or information obtained during the needs assessment that may assist FEMA in determining whether to initiate a Flood Map Project for the community.

[February 2002]

1.2.5 Mapping Needs Update Support System

As discussed earlier, MNUSS is a web-based database that is used by FEMA to catalogue and inventory mapping needs. Upon completion of a Mapping Needs Assessment, FEMA may request that Mapping Partners that perform Mapping Needs Assessments enter information directly into the MNUSS or provide a summary of the information in a spreadsheet format for entry into MNUSS by another Mapping Partner.

If the first option is used, the Mapping Partner shall enter the data in accordance with FEMA guidance for collecting and inputting mapping needs into MNUSS." If the second option is used, the FEMA Lead will provide a spreadsheet template to be completed by the assigned Mapping Partner.

[February 2002]

1.2.6 Community Ranking and Prioritization

MNUSS includes a ranking mechanism and a project cost estimate for map updates. Once the MNUSS database is updated to include the latest needs assessment information, communities are ranked. FEMA uses the MNUSS ranking to help prioritize flood map update projects for funding allocation.

[February 2002]

1.2.7 Project Selected for Scoping

Flood Map Projects may be funded through a variety of mechanisms and combinations of mechanisms:

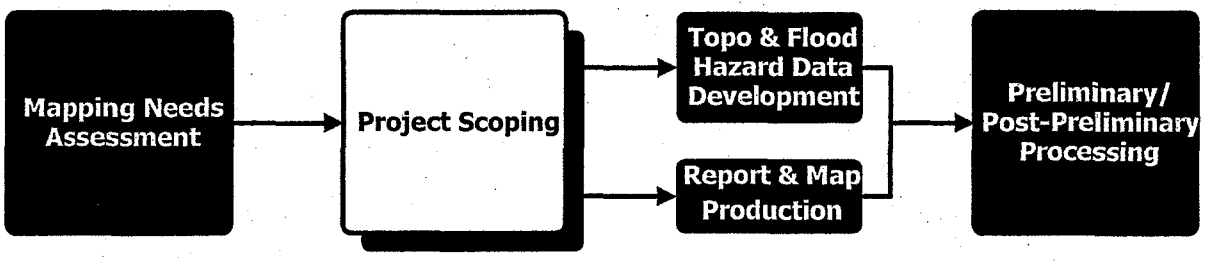
- FEMA's annual Flood Hazard Mapping Program budget;
- Disaster Relief Funding; and

- Cooperative Agreements under the CTP initiative.

Based on the Mapping Needs Assessment, subsequent ranking and prioritization, and available funding, FEMA will select Flood Map Projects for scoping. The Project Scoping phase is described in Section 1.3.

[February 2002]

1.3 Project Scoping



Once FEMA has decided to initiate a Flood Map Project, the following steps are undertaken during the Project Scoping phase:

- Conducting background research and community outreach;
- Determining what effective data can be used in the analyses and/or transferred to the new FIS report and FIRM;
- Identifying other data needed to complete the Flood Map Project and sources of those data (e.g., base map, topography, cross sections, or transects);
- Establishing priority levels for flooding sources to be analyzed and mapped;
- Making FIRM format decisions (e.g., countywide or community-based, digital or manual);
- Developing schedules and cost estimates of the components of the Flood Map Project; and
- Assigning project tasks to Mapping Partners and developing appropriate contracts or agreements for completion of assigned work.

As described in Subsection 1.1.6, each Flood Map Project will have a FEMA Lead assigned to manage the project through its entire lifecycle. The FEMA Lead will oversee the project's scope, schedule, and budget and coordinate the activities of the various Mapping Partners. In particular, the FEMA Lead's responsibilities include determining the scope of a Flood Map Project and assigning roles to the FEMA Mapping Partners involved in the project.

At the direction of the FEMA Lead, Mapping Partners will typically provide support in researching the information necessary to make scoping decisions, developing scoping documents, and managing the scoping process. For each project, the FEMA Lead will determine the specific level of participation for each Mapping Partner in the scoping process.

Through the CTP initiative, FEMA works cooperatively with communities that are able to participate actively in flood hazard mapping tasks within the community. The community's

interest in participating as a CTP should be determined before the detailed scoping phase so that the community's participation in the map update can be included in the project plan that is developed. CTPs work very closely with the FEMA Lead to make scoping decisions and share responsibilities for decision-making and management of the project. The specific role and responsibility of each CTP shall be determined individually in cooperation with the FEMA Lead.

If a CTP or other Mapping Partner wishes to deviate from the standards and requirements detailed in these Guidelines, they must negotiate these deviations during the Project Scoping phase. In addition, all deviations must be documented in the appropriate contracts or agreements for completion of assigned work.

The Project Scoping phase is intended to enable FEMA and its Mapping Partners to achieve a "best value" for completing any Flood Map Project by prioritizing and addressing a community's mapping needs and distributing the work based on the strengths and capabilities of all available Mapping Partners. Comprehensive Project Scoping ensures that the plan for a Flood Map Project considers all factors and takes advantage of each Mapping Partner's capabilities.

The guidance for the Project Scoping phase is applicable to different types of Flood Map Projects, including:

- Countywide, community-based, and watershed-based studies;
- Flood data updates involving field reconnaissance, new engineering analyses, more detailed topographic data, or floodplain mapping;
- Digital conversions; and
- Any combination thereof.

Project Scoping activities are grouped into Pre-Scoping Meeting, Scoping Meeting, and Post-Scoping Meeting activities. Many of the tasks within each group can take place concurrently and are not contingent on the completion of previous tasks. In addition, the FEMA Lead has the flexibility to tailor the scoping process to fit the needs of the project. For example, for smaller Flood Map Projects, the FEMA Lead may wish to combine, scale back, or eliminate certain activities.

Subsections 1.3.1, 1.3.2, and 1.3.3 provide guidance for completing the pre-Scoping Meeting, Scoping Meeting, and Post-Scoping Meeting activities, respectively. The plan for the Flood Map Project developed during Project Scoping phase must be compatible with the procedures and technical requirements for conducting any required engineering analyses and preparing the maps as described throughout these Guidelines. The FEMA Lead shall choose the specific scoping activities to undertake for each particular Flood Map Project. Appendix I of these Guidelines provide a "toolbox" with templates, tools, and forms for the scoping activities described herein.

[February 2002]

1.3.1 Pre-Scoping Meeting Activities

The following activities must be conducted before the Scoping Meeting:

- Form a Project Management Team;
- Make the initial contact with the community;
- Prepare the preliminary Project Management Plan;
- Hold an initial project teleconference call with the community;
- Form the Project Team;
- Perform required research;
- Identify potential obstacles;
- Draft a project scope;
- Identify other potential resources;
- Hold a teleconference call to discuss the draft of the project scope;
- Draft a revised scope of work; and
- Distribute background information.

[February 2002]

1.3.1.1 Formation of Project Management Team

FEMA RO and/or HQ staff will select the FEMA Lead depending on the type of Flood Map Project being undertaken. In general, the appropriate FEMA Regional Engineer will be the FEMA Lead for Flood Mapping Projects that will involve development of new or updated flood hazard data. For digital conversions with no new or updated flood hazard development, a FEMA HQ Project Engineer will be the FEMA Lead. If the community selected for update will participate as a CTP, the FEMA Lead will work in close cooperation with the community Project Manager.

The FEMA Lead will form a Project Management Team as soon as the community is selected by FEMA for a map update and the Flood Map Project is initiated. The Project Management Team will manage the project for its entire lifecycle.

The Project Management Team may be comprised of several Mapping Partners, including:

- FEMA RO Regional Engineer;
- AO;
- FEMA HQ Project Engineer;
- CO;
- Other FEMA team members;
- CTP or other community representative;
- MCC representative;
- SC representative (optional); and
- State NFIP Coordinator representative (optional).

The roles of each team member are discussed below.

[February 2002]

FEMA Lead

The FEMA Lead shall provide monitoring and oversight of the budget, schedules, and scope of the project.

[February 2002]

FEMA Assistance Officer

The FEMA AO or CO shall oversee and administer contract documents and agreements related to the project.

[February 2002]

Other FEMA Team Members

Other FEMA team members shall make decisions when the FEMA Lead is unavailable and provide technical and programmatic support, as needed.

[February 2002]

Flood Map Production Coordination Contractor Representative

The MCC representative shall assist in the resolution of technical issues and provide technical and Project Management support.

[February 2002]

Community Representative

The community representative, particularly a CTP, shall work closely with the FEMA Lead to manage the scoping process and define a Flood Map Project agreeable to FEMA and the community.

[February 2002]

Study Contractor and State Coordinator Representatives

The SC representative and the State NFIP Coordinator representative shall assist in the resolution of technical issues and provide technical support.

[February 2002]

1.3.1.2 Initial Community Contact

The FEMA Lead will call the community (or communities) as soon as possible after initiation of a Flood Map Project to provide notification that FEMA has selected the community for a possible map update and will be working with the community to develop the project scope. In the case of a CTP project, the community may already be coordinating with the FEMA Lead. For some projects, especially large countywide or basinwide studies, the FEMA Lead may choose to delegate the scope development (or a portion thereof).

The following topics will be covered during the initial telephone call:

- Purpose of the Flood Map Project (i.e., the update needs that have prompted the map update);
- The community's perception of its mapping needs;
- Target schedule for completing the project;
- Possibility of the community contributing as a CTP; and
- The community's engineering, planning, and Geographic Information System (GIS) capabilities (to determine how advanced its capabilities are and in which community department or agency these activities are undertaken).

A sample form for planning and recording this telephone call is provided in Appendix I as the Initial Community Contact—Record of Communication template.

Usually, the FEMA Lead and the community are the only participants in the initial call. If the FEMA Lead determines that the community has a significant interest in participating as a CTP, the scoping process may be delayed while FEMA and the community discuss potential CTP activities. It is desirable for FEMA and the community to agree on the general outline of the community's participation in the Flood Map Project and to sign a Partnership Agreement before proceeding with additional scoping activities.

[February 2002]

1.3.1.3 Preliminary Project Management Plan

The Project Management Team shall prepare a preliminary Project Management Plan. This plan establishes certain coordination protocols and management objectives for the entire Project. Each plan shall contain the following items:

- A description of the Flood Map Project;
- The Project Management Team members;
- A description of the Project Team (list of the primary Mapping Partners and their roles; discuss whether CTPs are an option; note that the Project Management Team is a subset of the Project Team);
- Communication protocols between Project Team members (e.g., Monitoring Information on Contracted Studies, e-mail, a Project-specific website);
- Major milestones and intermediate reporting requirements;
- An Outreach strategy (e.g., press releases, briefings for congressional staff, "Letters to the Editor" from FEMA Director, Project-specific updates on the FEMA website);
- Other ongoing activities and related projects;
- QA/QC review requirements;
- Retention and maintenance of records; and
- Project completion activities.

The Project Management Plan template is provided in Appendix I, Subsection I.1.2 of these Guidelines.

Once the Project Team is formed (see Subsection 1.3.1.5), each team member will be provided with a copy of the preliminary Project Management Plan. The Project Management Plan is a "living" document that may be updated as the Project progresses.

[February 2002]

1.3.1.4 Initial Project Team Conference Call

Once the preliminary Project Management Plan has been prepared, the FEMA Lead will arrange an initial Project Management Team conference call that includes all Project Management Team members and the appropriate community representative. If more than one community is involved in a Flood Map Project, the FEMA Lead will decide whether to conduct a separate call for each community or a combined conference call.

During the call, the following issues as well as any others identified by the Project Management Team, will be discussed with the community:

- Community's assessment of its flood mapping needs;
- Data available from other sources, such as digital base maps or ongoing studies;
- Involvement of other key players, such as regional or State agencies; and
- Community potential as a CTP (if the FEMA Lead is aware of local technical capabilities or the community otherwise indicates its interest in a CTP arrangement during the initial community contact).

The Initial Project Conference Call Agenda/Meeting Minutes form is provided in Appendix I, Subsection I.1.3 of these Guidelines.

[February 2002]

1.3.1.5 Project Team Formation

The FEMA Lead will determine which Mapping Partners will participate on the Project Team. If a CTP is involved, the CTP Lead will work closely with the FEMA Lead to identify the team members. The Project Team should include Mapping Partners and NFIP stakeholders whose collective capabilities provide all the necessary resources to complete the Flood Map Project. The Project Team will include:

- All members of the Project Management Team;
- Other contractor representatives (if not already a part of the Project Management Team);
- Community/CTP representative(s);
- State representative (the State NFIP Coordinator or a representative from an agency such as the State Department of Natural Resources); and
- Others, such as regional planning agencies and water management districts, as necessary.

The FEMA Lead will coordinate the formation of the Project Team based on the needs of the project. It is important to note that while various Mapping Partners will normally be included on the Project Team, they will not necessarily fill "traditional" or predetermined roles. Rather, each Mapping Partner's level and extent of involvement will be tailored by the FEMA Lead based on the needs of the specific project to allow FEMA to achieve a "best value."

Mapping Partners with task order-based contracts will be issued a scoping task order to participate in the project through completion of Project Scoping. Work assignments for the Map Production component of the project will be issued through follow-on task orders.

[February 2002]

1.3.1.6 Preliminary Research Activities

The FEMA Lead will assign preliminary research to Project Team members, usually FEMA contractors. These activities can be separated into two categories—researching effective information and researching available data for the Flood Map Project. The specific activities in each category are summarized below.

[February 2002]

Researching Effective Information

The assigned Mapping Partner shall complete the following tasks:

- Inventory the FEMA library for effective FIRM panels, FIS reports, and other flood hazard data or existing study data;
- Summarize the information in MNUSS;
- Summarize contiguous community agreement checks;
- Review CAV and CAC files;
- Conduct a thorough Map Needs Assessment (unless one has already been conducted) as described in Section 1.2; and
- Develop a "scoping map" and an overview of the results of the research.

An Effective FIRM Summary template is provided in Appendix I, Subsection I.1.4 of these Guidelines.

[February 2002]

Researching Available Data for the Mapping Project

The assigned Mapping Partner shall complete the following tasks:

- Identify available base map information;
- Identify available topographic data;
- Identify available flood hazard data; and
- Identify other available hydrologic and hydraulic information and data.

An Available Data Inventory template is provided in Appendix I, Subsection I.1.5 of these Guidelines.

The research phase of Project Scoping is critical to maximizing the value of the Flood Map Project and minimizing project costs. Topographic data acquisition and field surveys can constitute up to 50 percent of the cost of a map update when all new data must be obtained. If existing information is suitable for the planned update, it is critical that it is identified during this phase and used for the Flood Map Project.

Applicable data may be available from a variety of sources. If FEMA has previously studied the area, the FEMA archives may have detailed data from the previous study. Often, detailed topographic data, cross-section surveys, and dimensions of hydraulic structures may be partially or entirely applicable to the new Flood Map Project, thereby requiring surveys of new structures or updated topographic information for limited areas where changes have occurred. Moreover, an evaluation of the previous study may also provide a better understanding of the causes for the update need and could possibly assist the Project Management Team in determining that some of the existing work is still applicable.

Similarly, other agencies may also have performed studies that may be relevant to the planned project or have generated data that may be useful. The Mapping Partner performing the research shall also contact the following organizations to determine whether they have data that are suitable for the planned Flood Map Project:

- Federal agencies such as USACE, NRCS, USGS, or Tennessee Valley Authority;
- State and regional agencies (water resource agencies, natural resource agencies, State NFIP Coordinator, flood information repositories); and
- Agencies in the affected communities (city engineers, planning, permitting, and zoning).

If there are ongoing flood hazard studies in nearby communities, the assigned Mapping Partner also shall contact the entities performing the studies to determine whether they have identified data that are applicable to the planned Flood Map Project.

The assigned Mapping Partners shall use the Available Data Inventory template in Appendix I to document all research, including the agencies that were contacted, the date, the name of the person contacted, the telephone number, and the results of the research.

[February 2002]

1.3.1.7 Potential Obstacles

The Project Management Team will identify potential obstacles in an effort to learn of any issues that could delay or prohibit the Flood Map Project. Some examples of potential obstacles to completing the project in a timely fashion are:

- Inability to address mapping needs adequately with available funding;
- Difficulty coordinating community funding with FEMA funding;
- Lack of an available base map meeting FEMA minimum specifications (described in Appendix K of these Guidelines);
- Hydrologic and/or hydraulic issues;
- Community concerns;
- Reliance on other studies or data (e.g., topographic mapping) that will not be available within the project's scheduling constraints;
- Needs not being as high a priority as originally identified; and
- Other considerations (Federal/State/non-governmental organizations, programmatic, disaster-related, legal).

The Project Management Team will explore potential issues on an ongoing basis. If potential obstacles are identified that could halt or significantly hinder the completion of the project, the Project Management Team will evaluate all possible alternatives and develop an appropriate course of action as soon as practicable.

A Potential Obstacle to Project Completion Checklist template is provided in Appendix I, Subsection I.1.6 of these Guidelines. This checklist is a "living" document that should be updated as necessary throughout the lifecycle of the project.

[February 2002]

1.3.1.8 Draft Scope of Project

The draft Scope of Project shall be prepared under the direction of the FEMA Lead. The draft Scope of Project will be based on mapping needs determined during the Mapping Needs Assessment and/or the research portion of Project Scoping.

Developing the draft Scope of Project includes the following activities:

- Conducting background research and community outreach;
- Determining what effective FIS data can be used in the analyses and/or transferred to the new Flood Map Project (i.e., it may be that all data for a flooding source can simply be transferred to the new Flood Map Project, or it may be that only the existing hydrologic data can be used and new hydraulic analyses need to be performed, or it may be that no existing data can be used);
- Identifying other data needed to complete the Flood Map Project and sources of those data (e.g., base map, topography, cross sections, transects);
- Establishing priority levels for flooding sources to be analyzed and mapped;
- Making FIRM format decisions;
- Developing schedules and cost estimates of the components of the Flood Map Project; and
- Assigning project tasks to Mapping Partners and developing contract agreements.

The Draft Scope of Project form in Appendix I, Subsection I.1.7 of these Guidelines shall be used to document the draft Scope of Project. The draft Scope of Project is a "living" document that will be updated, when necessary.

[February 2002]

Determining Which Flood Data Should Be Used

In determining the flood data to use, the Project Management Team will consider the nature of the map update need and the cost versus benefit of using a particular method of obtaining and/or producing the flood data. The methods of obtaining/producing the flood data are as follows:

- Use of information from effective FIRM;
- Detailed study/analyses;
- Approximate study/analyses; and
- Redelineation of floodplain boundaries based on updated topographic information.

The Flood Map Project may use a combination of these methods. A detailed study is typically the preferred method, but also the most costly. The Flood Map Project may involve only digitizing effective FIRM information (digital conversion).

The selection of the most appropriate method for obtaining/producing the flood data for a specific flooding source is primarily a function of the following:

- The amount of existing or anticipated development potentially affected by the flooding source;
- The flood insurance risk zone designation of the subject area on the effective FIRM;
- The number of actual flooding events that confirm or contradict the mapped flood hazards on the effective FIRM; and
- The cost of performing the Flood Map Project.

Tables 1-1 and 1-2 provide guidance for selecting the method for riverine and coastal environs, respectively, based on the first three criteria listed above. The selected methods may then be changed by the FEMA Lead during the Project Scoping phase based on the cost (for example, a flooding source proposed for a detailed study may be changed to redelineation of floodplain boundaries using updated topographic data if available funding so dictates).

The following subsections briefly describe each of the methods listed in the table for obtaining and/or producing flood hazard data.

[February 2002]

Use Effective Information—Riverine

This is the least expensive method of updating data for riverine areas. No new analyses or floodplain mapping are required; rather, the effective NFIP data are used "as-is." Mapped flood hazard areas on the effective NFIP map that are not being updated through a detailed or approximate study or redelineation are "carried over" to the updated FIRM. For Flood Map Projects that entail converting a manually produced FIRM to a digital FIRM (i.e., digital conversion), the effective information must be digitized and fitted to the selected base map. In some instances, FEMA or the community may identify the need to create a digital FIRM for a jurisdiction where no study is ongoing. This may be to advance FEMA's goal of converting its entire flood map inventory to a digital format, to use a more accurate, up-to-date base map, or to provide the community with the increased capability of GIS digital FIRM data.

[February 2002]

Table 1-1. Selection of Technical Method—Riverine and Lacustrine

	Designation on Effective FIRM			
Technical Method	**Unmapped (Zones D, C, X if flood hazard is identified)**	**Approximate (Zone A)**	**Detailed without Floodway (Zones AE, A1-30, AO, AH)**	**Detailed with Floodway (Zones AE, A1-30)**
Approximate Study	• Areas of moderate development	• Areas of moderate or minimal development and • SFHA seems inaccurate (e.g., flooding losses in Zones B, C, or X; numerous LOMAs; comparison with accurate topographic data)	OPTION NOT AVAILABLE	OPTION NOT AVAILABLE
Redelineation	OPTION NOT AVAILABLE	OPTION NOT AVAILABLE	• Effective discharges and BFEs appear accurate, but SFHA seems inaccurate (e.g., flooding losses in Zones B, C, or X; numerous LOMAs; comparison with accurate topographic data)	• Effective discharges and BFEs appear accurate, but SFHA seems inaccurate (e.g., flooding losses in Zones B, C, or X; numerous LOMAs; comparison with accurate topographic data)
Detailed Study (Riverine)	• Areas of dense development	• Areas of dense development	• Flood experience indicates that discharges and BFEs are outdated (e.g., USGS gage information indicates discharges out of date); • watershed development has significantly altered discharges; floodplain projects (e.g., channelization, bridges, etc.) since FIS analysis; • flood control structures since FIS analysis; and/or • community wishes to add regulatory floodway	• Additional years of record available for stream gage analysis resulting in significantly different discharges • Hydrology and/or hydraulic methods outdated • Flood experience indicates that discharges and BFEs are outdated (e.g., USGS gage information indicates discharges out of date); • watershed development has significantly altered discharges; • floodplain projects (channelization, bridges, etc.) since FIS analysis; and/or • flood control structures since FIS analysis

Use Effective Information	• Areas of no or minimal development	• Effective SFHA appears accurate - area has not experienced flooding	• Effective BFEs and SFHA appear accurate based on past events • Additional years of record available for stream gage analysis that results in significantly different discharges • Hydrology and/or hydraulic methods outdated	• Effective BFEs and SFHA appear accurate based on past events

Table 1-2. Selection of Technical Method—Coastal

Level of New Study/Restudy	Unmapped (Zones C, X, D)	Approximate (Zone V)	Detailed (Zones A1-A30, AE, V1-V30, VE)
Redelineation	OPTION NOT AVAILABLE	OPTION NOT AVAILABLE	• Effective stillwater elevations and BFEs appear accurate based on past events, but • SFHA or V zone seems inaccurate (e.g., flooding losses in Zones B, C, or X; evidence of velocity flooding in A zones; numerous LOMAs);or • V zone does not extend to the inland limit of the primary frontal dune
Detailed Coastal	• Areas of moderate or dense development	• Areas of moderate or dense development	• Flood experience indicates that stillwater elevations and/or BFEs are outdated; • Significant changes have occurred to the shoreline and transect profile since effective FIS analysis; • Wave height and/or runup methods not used at all in effective FIS analysis; and/or • Outdated wave height and runup methodologies used for the effective FIS analysis
Use Effective Information	• Areas of minimal or no development	• Areas of minimal or no development	• Effective BFEs, SFHA, and V zones appear accurate based on past events

Use Effective Information—Coastal

This is the least expensive method of updating data for coastal areas. No new analyses or floodplain mapping are required; rather, the effective NFIP data are used "as-is." Mapped flood hazard areas on the effective NFIP map that are not being updated through a coastal re-analysis or redelineation are "carried over" to the updated FIRM. For Flood Map Projects that entail converting a manually produced FIRM to a digital FIRM, the effective information must be digitized and fitted to the selected base map.

[February 2002]

Detailed Study—Riverine

This data update method entails using topographic data, channel bathymetry, and bridge/culvert opening geometry to conduct detailed hydrologic and hydraulic analyses and floodplain mapping. Detailed-study methods involve the determination and publication of BFEs. Normally, a regulatory floodway will be determined if a flooding source is studied by detailed methods. If a regulatory floodway along a particular flooding source has been developed and is shown on the FIRM, and if the flooding source is being restudied, the new detailed study must include the regulatory floodway. Detailed-study methods may be used regardless of the current flood insurance risk zone designation. They may be used to update a previous detailed study, to upgrade the analysis of an area previously studied using approximate methods, or to map the SFHA in areas that were previously unmapped.

If these areas are experiencing or expected to experience moderate to dense development, then detailed studies are important to provide BFEs and regulatory floodways to regulate safe construction in these areas. This applies to residential, industrial, or commercial areas where growth is beginning and/or subdivision is underway, and where these trends are likely to continue. They include areas that are likely to be developed within 5 years following the completion of the study.

[February 2002]

Detailed Study—Coastal

This data update method entails using transects and offshore bathymetry to conduct detailed erosion, wave height, and wave runup analyses and prepare floodplain mapping. Detailed coastal methods involve the determination and publication of BFEs and designation of the coastal high hazard areas (V zones). As for detailed riverine study methods, detailed coastal study methods may be used regardless of the current flood insurance risk zone designation. Considerations for the use of detailed coastal study methods are similar to those for detailed riverine study methods.

[February 2002]

Approximate Study—Riverine or Lacustrine

This data update method entails using topographic data, typically without bathymetry or bridge/culvert opening geometry, to conduct approximate hydrologic and hydraulic analyses. An approximate analysis results in the delineation of a 1-percent-annual-chance floodplain but does not include the determination of BFEs or base flood depths. Generally, approximate-study methods are appropriate for areas where no flood hazards have been identified but which are thought to be floodprone. If these areas are experiencing light to moderate development and these trends are expected to continue, then approximate-study methods are appropriate. Likewise, approximate-study methods may be used for areas that were already mapped based on an approximate study and where development is minimal to moderate, but where experience indicates that the current SFHA delineation is inadequate.

[February 2002]

Redelineation—Riverine

This data update method involves no new analyses. This method uses effective information (Flood Profiles and data tables from the FIS report, BFEs from the FIRMs, and supporting engineering analyses) and new topographic data that are more up-to-date and/or detailed than those used to produce the effective FIRM to redelineate the floodplain boundaries. Redelineation of effective 1-percent-annual-chance floodplain boundaries that were based on a detailed study is appropriate when the discharges and BFEs determined by the existing study are appropriate, the delineation of the floodplain boundaries is inadequate, and updated topographic data are available. It is important to verify that the new topographic data source is superior to the existing data and that no changes in the hydraulic characteristics of the floodplain indicate that the existing study is no longer appropriate.

[February 2002]

Redelineation—Coastal

This data update method involves no new analyses. This method combines effective information from the FIS report and FIRM and the supporting engineering analyses with new, more detailed, or more up-to-date topographic data to redelineate coastal high hazard areas (V zones).

[February 2002]

Identifying Topographic Data Needs and Sources

Topographic data are required for three of the methods of updating flood data: detailed study, approximate study, and redelineation. Detailed study requires topographic mapping of floodplain areas and surveys of bathymetry and structures. Approximate study may or may not require bathymetry or structures. Redelineation requires only topographic mapping of floodplain areas.

Significant cost savings can be realized if existing topographic sources are used because 50 percent of the cost of a map update may be to acquire new topographic data. Possible sources of existing topographic data include local planning departments, GIS Coordinators for community/county, city engineers, Directors of Public Works, FEMA archives (particularly for cross-section data from effective hydrologic and hydraulic models), and State Departments of Transportation (e.g., bridge plans). The Available Data Inventory template provided in Appendix I should be used to summarize the existing topographic data that may be available to the Mapping Partners.

Detailed specifications for topographic data and field surveys are contained in Appendix A. In evaluating the suitability of existing topographic data, the Project Management Team will consider the following factors:

Contour Mapping or Digital Elevation Models

- Contour interval should be 4 feet or less (2 feet in flat terrain).
- Currency of data—whether significant changes (e.g., highways, subdivisions, and mining) have occurred since the data were developed. It may be possible to update only "pockets" of the data. If there is a question about the currency of the data, "spot checks" should be performed to verify the accuracy.

Bathymetric and Bridge/Structure Cross Sections Effective Study or Other Source

- Currency of data—whether significant changes (e.g., new bridges, culverts, geomorphologic changes) have occurred since the data were developed. If there is a question about the currency of the data, "spot checks" should be performed to verify the accuracy.
- Density of cross sections—whether an adequate number are located in the project area.
- It may be possible to supplement existing cross-section and structural data with additional and/or updated cross sections at selected locations.

The topographic data and the base map data used for the FIRM should be compatible. Like features in both data sources should align. If suitable existing topographic data are not available, it will be necessary to develop new topographic and/or survey data. Appendix A provides the requirements for developing new topographic data and performing cross-section and structure surveys.

[February 2002]

Making Map Product Decisions

FEMA's preference is to produce all new and updated FIRMs in digital format. In some rare instances, it may be cost-prohibitive to convert a manually produced FIRM to digital format. In such cases, the FEMA Lead may decide to produce the updated FIRM using manual cartographic

methods or create a "partial digital" FIRM whereby only the FIRM panels affected by new or updated flood data are produced digitally, leaving the other panels unrevised. The first decision, therefore, is to decide whether to produce an entire FIRM digitally, produce part of the FIRM digitally, or produce the FIRM manually.

[February 2002]

Base Map

All digital FIRM flood map update projects must have a suitable digital base map to compile the results of the study. This step is critical because of the expense involved in acquiring a suitable base map if none is available and because FEMA's primary mission does not include the production of base cartographic data. Lack of a suitable base map will likely prevent the publication of the revised flood data. The Available Data Inventory template provided in Appendix I, Subsection I.1.5 of these Guidelines shall be used to summarize existing base map data that may be available to the Mapping Partners.

If the FIRM will be produced digitally, a community-supplied base map that meets FEMA criteria is the first choice for base map. USGS Digital Orthophoto Quadrangles (DOQs) are the second choice and the default base map if suitable community data are not available. If neither suitable community base map data nor USGS DOQs are available for a FIRM scheduled to be produced digitally, FEMA will provide the community with information on base map sources, including information on partnering with USGS to initiate DOQ production for that community. DOQ production normally takes 12 to 14 months, so coordination with USGS shall be initiated with that timeframe and the new digital FIRM production schedule in mind. FEMA's criteria for base maps are discussed in Section 1.4. Detailed information on FEMA base map standards are provided in Subsection 1.4.3.1.

[February 2002]

Map Format

FIRMs may be prepared in the community-based (i.e., single-jurisdiction) or Countywide format. These formats are described in Appendix K of these Guidelines. FEMA's preferred FIRM format is Countywide. In some instances, such as when it will be cost-prohibitive to produce a Countywide FIRM (e.g., only a relatively small portion of the county is affected by new flood data, or when a suitable county base map is not available), the FEMA Lead, in consultation with the Project Management Team, may decide to produce the new or updated FIRM in community-based format.

[February 2002]

Graphics

FEMA graphics standards are to be used unless agreed upon with FEMA during the Project Scoping phase. Communities may have some flexibility in the presentation of flood hazard information on the FIRM, particularly with regard to the presentation of flood hazard data based on future-conditions analyses. General guidance regarding the inclusion of future-conditions

flood hazard data on the FIRM and in the FIS report is provided in Appendix C, Subsection C.8 of these Guidelines.

[February 2002]

Database

The FEMA standard digital FIRM spatial database should be produced. Any deviations should be agreed upon with FEMA during the Project Scoping phase. Also, during the Project Scoping phase, to the Project Management Team must decide on the options that will be included in the enhanced database.

The digital FIRM Database product that accompanies new digital FIRMs has the flexibility to incorporate additional data that are not necessarily shown on the FIRM. The enhanced digital FIRM Database provides the capability to add other data to the standard digital FIRM Database. For example, GIS data representing watersheds and sub-basins, stream reach hydrologic network structure, building footprints, land-use classifications, or soil types may be included. Other data sets such as model input and output files, digital elevation certificates, or digital photographs of hydraulic structures could also be included.

Detailed information on the standards for the digital FIRM Database is provided in Appendix L of these Guidelines.

[February 2002]

Map Scales

Map scales should be selected depending on the density of information, width of floodplains, type of study (i.e., detailed, approximate), and scale of the previously prepared FIRM(s). Subsection 1.4.2.2 describes the map scale selection process.

[February 2002]

Datum

FEMA would prefer to use North American Vertical Datum of 1988 (NAVD88) as the elevation datum, except in certain circumstances such as when a community does not plan to adopt NAVD88 for local vertical control or when the conversion of existing information referenced to another datum is cost prohibitive. Detailed information on the protocol for selecting the vertical datum is provided in Appendix B of these Guidelines.

[February 2002]

Map Layout

A standard coordinate system and horizontal datum for all FIRMs is desirable so that they can be easily referenced to one another. The preferred coordinate system is Universe Transverse Macerator referenced to the North American Datum of 1983. Details of coordinate systems and projections for published FIRMs are discussed in Appendix K.

Digital FIRMs are tiled using a paneling scheme that is based on USGS 7.5-minute series topographic quadrangles or subdivisions thereof, depending on the scale of the digital FIRM. Details of digital FIRM paneling are discussed in Subsection 1.4.3.2.

Coordination of the map layout and paneling scheme between Mapping Partners is important throughout the FIRM production process. A preliminary FIRM layout shall be determined during the Project Scoping phase and shall be used for the work maps and the final FIRM products.

[February 2002]

1.3.1.9 Identification of Other Potential Resources

Through the process of doing the preliminary research, identifying potential obstacles, developing the preliminary Project Management Plan, and drafting the Scope of Project, additional resources for the Flood Map Project may become evident. These could be local, State, or Federal agencies not originally included in the Project Team that may be able to contribute to the project. They may also include local organizations such as universities that have capabilities or resources that would benefit the project. If a recent flood has occurred, valuable data may be obtained from local Engineering or Public Works departments or residents.

The FEMA Lead will assign the appropriate Project Management Team member(s) to contact additional resources to investigate their possible contribution to the project. A concerted effort should be made during the Project Scoping phase to identify these other potential resources, because their contribution might significantly affect the Scope of Project.

[February 2002]

1.3.1.10 Draft Scope of Project Conference Call

The Project Management Team will hold a conference call once the research has been completed and the draft Scope of Project has been prepared. The FEMA Lead will arrange the call. If more than one community is involved in the Flood Map Project, the FEMA Lead will decide whether to conduct separate calls or a combined conference call; the FEMA Lead may also decide to divide the calls among the Project Management Team members. Before the conference call, the FEMA Lead or CTP Lead will distribute the draft Scope of Project. The purpose of the call is to discuss and refine the draft Scope of Project and to schedule the Scoping Meeting.

A Draft Scope of Project Conference Call Agenda/Meeting Minutes Form is provided in Appendix I, Subsection I.1.8 of these Guidelines.

[February 2002]

1.3.1.11 Revised Draft Scope of Project

Based on the results of the conference call, the Project Management Team will revise the draft Scope of Project for discussion at the Scoping Meeting.

[February 2002]

1.3.1.12 Distribution of Background Information

The FEMA Lead will prepare a detailed meeting agenda for the Scoping Meeting. A Scoping Meeting Agenda/Minutes Form template is provided in Appendix I, Subsection I.2.4 of these Guidelines. The FEMA Lead will distribute the Scoping Meeting agenda, the revised draft Scope of Project, and the preliminary Project Management Plan to all attendees before the Scoping Meeting.

A Document Transmittal Letter template is included in Appendix I, Subsection I.2.2 of these Guidelines. This letter can be used to distribute the background information to all meeting attendees. It also includes a checklist of information that the community should bring to the meeting.

[February 2002]

1.3.2 Scoping Meeting Activities

This subsection provides general guidance for topics to be discussed and agreed upon during the Scoping Meeting. In previous FEMA documentation, this meeting has been referred to as the "Time and Cost meeting" and/or "Initial Consultation Coordination Officer meeting." The structure of the meeting will vary depending on the anticipated scope. A Flood Map Project that involves an entire county may require more than one Scoping Meeting and coordination between many community officials to prioritize needs. The FEMA Lead will decide the best approach and structure for the Scoping Meeting.

The purpose of the Scoping Meeting is to bring all interested parties together to finalize the Scope of Project (including the areas to be studied) and the task assignments. The FEMA Lead will determine the attendees, which will include the following:

- FEMA Lead;
- Project Management Team members (as needed);
- Contractor representative(s);
- State representative(s); and
- Community representative(s).

The FEMA Lead also will invite those organizations or agencies that might have relevant information or can assist with the project (e.g., the USACE, the USGS, local surveyor) to attend the Scoping Meeting.

Before the Scoping Meeting, Project Team members may perform informal field reconnaissance (sometimes called a "windshield survey") to become familiar with possible study areas. This effort may be coordinated with local community officials and will facilitate discussion in the Scoping Meeting for those not familiar with the area.

A list of items to bring to the Scoping Meeting, known as the Scoping Meeting Item Checklist, is provided in Appendix I, Subsection I.2.1 of these Guidelines; a Scoping Meeting Attendance Sheet template is included in Appendix I, Subsection I.2.3. The Scoping Meeting Agenda/Minutes form template provides a mechanism for the Project Management Team to document the topics to be discussed during the meeting. The FEMA Lead will identify someone from the Project Management Team to complete the checklist, attendance sheet, and agenda/minutes form. The topics to be covered in the Scoping Meeting are discussed below.

[February 2002]

1.3.2.1 National Flood Insurance Program Overview

The FEMA Lead will briefly discuss the NFIP and FEMA's role and responsibilities. The community's floodplain administrator will briefly discuss the community's floodplain management ordinances. The FEMA Lead will then briefly describe the mapping process, with an approximate project timeline for the entire project, up through the distribution of effective FIS.

[February 2002]

1.3.2.2 Mapping Needs List Prioritization and Finalization

The FEMA Lead or CTP Lead will present and review the initial mapping needs list, present an overview of the initial research findings, and make initial selection of proposed methods for obtaining/producing flood data. Any additions or changes to the needs list will be discussed. All the listed needs will also be ranked in priority. The scoping maps (i.e., maps that define the scope, such as the effective FIRM or USGS maps) prepared during the pre-Scoping Meeting activities may be used to assist in discussing and ranking these needs.

As discussed previously, it may be that the costs of using the technical methods initially selected to obtain/produce flood data will exceed the available funding for the Flood Map Project. Thus, the update needs for each flooding source within the project area must be weighed against the update needs for other flooding sources within the project area. In such instances, the FEMA Lead, in consultation with the Project Management Team and the community, will prioritize the map update needs to ensure that the areas of greatest need can be addressed with the available funding. In general, highest priority will be given to the following areas:

- Areas of dense existing or anticipated development, including areas where new road crossings have been constructed over the subject stream(s);
- Areas affected by flood-control structures and/or channelization;
- Areas where natural physical changes in the floodplain have been significant (due to subsidence or extreme erosion, for example);
- Areas that were studied by approximate methods and unmapped areas, especially those with development pressure;

- Areas where the community has experienced flooding outside mapped floodplains, with severe damage to buildings and/or infrastructure;
- Areas where mapped flood hazards do not match those shown on contiguous FIRMs (unless those FIRMs are not considered to be accurate); and
- Areas where flood data (BFEs, floodplains, and regulatory floodways) are likely to be changed the most by a restudy.

[February 2002]

1.3.2.3 Refinements to Draft Scope of Project

The FEMA Lead will present the draft Scope of Project. Each section will be reviewed and refined during the meeting, as discussed below.

[February 2002]

Review and Refinement of Project Area

Based on the discussion of mapping needs, the Project Team will finalize the areas to be included in the project. Areas to be studied by detailed and approximate methods will be identified, including areas not previously studied that are known by community officials to be floodprone. The scoping maps can be helpful in these efforts.

[February 2002]

Review and Refinement of Flood Hazard Identification Methodologies

The Project Team will discuss the extent of riverine or coastal modeling required for the project. The research completed during the pre-Scoping Meeting phase will be reviewed to determine the extent and applicability of previous modeling. The community and others, when appropriate, will provide any models or computations they have prepared that could be used in the project. The technical methodologies presented in the draft Scope of Project will be reviewed. Issues to be discussed include the following:

- Models to be used from FEMA's approved models list;
- Requirements for tie-ins to adjacent NFIP maps;
- Areas where complex models might be required (to reflect shallow flooding, alluvial fan flooding, or ice-jam flooding); and
- Coordination on coastal issues.

[February 2002]

Review and Refinement of Data Collection Needs and Methods

The FEMA Lead will discuss the availability and accuracy of existing topographic data, which will be provided during the Scoping Meeting, if possible. The vertical and horizontal datums will be included in these discussions. If existing topographic data are not sufficient, options for aerial data collection will be discussed, including traditional aerial photogrammetry and new remote-sensing technologies, such as Light Detection and Ranging (LIDAR) systems.

Options for field survey efforts will also be discussed, including surveys of bridges, culverts, levees, dams, etc.; channel cross sections or lake/ocean transects surveys; and other data surveys, as needed.

The Project Team might also decide that further research of existing data is required. If so, a Project Team member will be assigned this task. The community will point out any major site developments or land use changes that could happen in the near future. These changes will be discussed with respect to timing any survey or data collection efforts for the project.

[February 2002]

Review of Proposed Paneling Scheme

The scoping map will be used to review the proposed paneling and scale scheme.

[February 2002]

Review and Refinement of Base and Topographic Map Sources

The FEMA Lead will discuss FEMA's base map specifications. The discussion will include the following topics:

- Base map source (i.e., locally developed data or DOQs meeting FEMA's minimum specifications) to be used for the project;
- Topographic and planimetric data sources;
- Coordination of countywide issues, if necessary;
- Horizontal and vertical datums; and
- Acquisition of the base map, if the Project Team does not already have the digital files.

[February 2002]

Finalization of Map Production and Database Options

The proposed FIRM format and optional features and data for the enhanced digital FIRM Database (e.g., GIS data for watershed boundaries, stream reach hydrologic network structure, land use data, soil data, digital elevation certificates, photographs of structures) from the draft Scope of Project will be reviewed, refined, and finalized.

[February 2002]

1.3.2.4 Assignment of Project Team Member Tasks

Based on the Scope of Project, the FEMA Lead will make preliminary task assignments to Project Team members. In addition to assigning tasks, timeframes will be established and recorded for each task. Also, the role of each Project Team member in providing quality control will be confirmed. Any particular tasks or responsibilities not already discussed as part of the previous agenda will be considered here. The objective is for Project Team members to come away from the meeting with a clear understanding of their roles and responsibilities for the project. Table 1-3 shows the available resources for completing Flood Map Projects.

Table 1-3. Available Resources for Completing Flood Map Projects

Project Element		CTP	MCC	SC
Field Surveys of Structures and Cross Sections		x	x	x
Elevation Data/Topographic Mapping		x	x	x
Detailed Riverine	Hydrologic Analyses	x	x	x
	Hydraulic Analyses	x	x	x
	Floodplain Mapping	x	x	x
Detailed Coastal	Engineering Analyses	x	x	x
	Floodplain Mapping	x	x	x
Detailed Alluvial Fan	Engineering Analyses	x	x	x
	Floodplain Mapping	x	x	x
Approximate Analyses		x	x	x
Redelineation of Floodplain Boundaries		x	x	x
Base Map Acquisition		x	x	x
Base Map Preparation		x	x	x
DFIRM Production		x	x	x
QA/QC Review of Topographic Data			x	
QA/QC review of Flood Hazard Data (Engineering Analyses and Mapping)			x	
QA/QC Review of Digital FIRM			x	
Preliminary/Post-Preliminary Processing			x	

Note: Shaded project elements are required for all CTP projects; non-shaded project elements are optional depending on the scope of the specific CTP project.

The Project Team members responsible for obtaining/developing topographic data and/or conducting field reconnaissance and surveys shall coordinate any subcontracting efforts. The responsibilities include determining several sources for scope and cost estimates and obtaining input from communities on local surveyors.

The Task Assignment and Scheduling Worksheet in Appendix I, Subsection I.2.5 can be used to make assignments and develop a schedule for the project. The Flood Mapping Project Process Flowchart, which is included in Appendix I, Subsection I.2.6 may also be useful.

[February 2002]

1.3.2.5 Community Partnership Agreements

If the community will not be participating in the project by contributing work, a Community Partner Memorandum of Agreement (MOA) will be signed by the community and FEMA to document the good faith efforts to collaboratively assess the community's needs, develop an appropriate Scope of Project, and develop and publish the resulting maps. If the community will be participating in the project by contributing work or base map data but has not yet completed an MOA under the CTP initiative, an MOA will be completed and signed by the community, FEMA, and the State, as necessary.

If these agreements cannot be signed at this meeting (for example, if they require city council approval), they are to be processed as soon as possible after the Scoping Meeting. MOA templates are provided in Appendix I, Subsections I.2.7 and I.2.8.

[February 2002]

1.3.3 Post-Scoping Meeting Activities

This section provides general guidance for scoping activities that will occur after the Scoping Meeting is held. These activities include documentation of the meeting itself, finalization of task assignments to the Project Team members, development of a Statement of Work (SOW) or Mapping Activity Statement (MAS), and preparation of time and cost estimates. If the community is participating as a CTP, the work will be covered by an MAS. An SOW will cover work performed by a FEMA contractor.

Additional guidance for the FEMA Lead is provided in FEMA Manual 7810.2, *Regional Project Officer Guidance for Flood Insurance Studies* (FEMA, 1990).

[February 2002]

1.3.3.1 Scoping Meeting Documentation

The Project Management Team shall prepare and distribute the meeting minutes, which shall include a list of all the participants and their respective assignments for the project, as well as the overall schedule for the project as discussed at the Scoping Meeting. The overall project schedule will establish the basis for each Project Team member's assignment(s). Project Team members shall review their task assignments and provide feedback or comments to the Project

Management Team. All changes to the proposed scope, schedule, and task assignments shall be coordinated with the FEMA Lead and, if necessary, communicated to the other team members.

[February 2002]

1.3.3.2 Statement of Work or Mapping Activity Statement Preparation

The FEMA Lead shall develop an SOW or, working with the CTP, shall develop an MAS based on task assignments made during the Scoping Meeting and any subsequent changes. The FEMA AO in the FEMA RO and/or the FEMA CO at FEMA HQ shall review and approve the SOW or MAS before the FEMA Lead distributes it to the Project Team members. A template SOW is provided in Appendix I, Subsection I.3.1 of these Guidelines. Whenever possible, the FEMA Lead shall ensure that one SOW will be prepared for the entire Flood Map Project with the Mapping Partner responsible for each task clearly identified. Similarly, the FEMA Lead shall ensure that a single MAS is prepared for each Flood Map Project whenever possible.

Once the SOW or MAS has been drafted, the FEMA Lead shall prepare a Government Estimate for the proposed work and submit it to the FEMA AO and/or CO for review and approval. If a contractor for a CTP is participating in the scoping, the CTP shall be responsible for developing, reviewing, and distributing time and cost estimates for an SOW for this contractor in conjunction with the CTP responsibilities outlined in the MAS.

[February 2002]

1.3.3.3 Distribution of Statement of Work and Mapping Activity Statements

The FEMA AO or CO shall distribute the draft SOW and/or MAS to the Project Team. This will confirm assignments to Project Team members and also will allow the community and others to have final input into the SOW and/or MAS.

[February 2002]

1.3.3.4 Time and Cost Estimate Preparation

Based on the SOW or MAS, each Mapping Partner participating in the Flood Map Project shall develop a time and cost estimate for assigned tasks. As part of these estimates, Project Team members also shall establish a schedule for their portion of the work within the schedule from the Scoping Meeting. The Project Team members shall submit their estimates to the AO and/or CO within a mutually agreed timeframe. A template for preparing time and cost estimates is provided in Appendix I, Subsection I.3.2 of these Guidelines.

[February 2002]

1.3.3.5 Evaluation of Time and Cost Estimates

The FEMA AO and/or CO, in consultation with the FEMA Lead, shall evaluate the time and cost estimates submitted by each Project Team member and shall compare the aggregate cost values to the budgeted funds for the Flood Map Project. For a CTP-funded project, the CTP shall work with FEMA to evaluate the costs. The Project Management Team also shall check the Project

Team members' schedules to ensure they are consistent with the overall project schedule agreed upon at the Scoping Meeting.

If the aggregate costs exceed the target project budget, the AO and/or CO shall determine whether to reduce the scope of the project, increase the project budget, or negotiate with Project Team members on certain elements of the project. The AO and/or CO and the FEMA Lead shall consult with community officials and the Project Management Team regarding any changes in the project scope.

Similarly, if the aggregate costs are significantly less than the target project budget, the AO and/or CO shall determine whether to expand the scope of the project, allocate the surplus budget for other projects, or hold the surplus budget in reserve for addressing potential problems if they arise. Again, the AO and/or CO and the FEMA Lead shall typically coordinate with the community and the Project Management Team regarding any expansion of the project scope.

[February 2002]

1.3.3.6 Negotiation of Final Time and Cost Figures

If the project scope changes as a result of the evaluation described in Subsection 1.3.3.5, the AO and/or CO, in consultation with the FEMA Lead, shall revise the SOW or MAS accordingly and redistribute it to Project Team members. The Project Team members shall develop and submit revised time and cost estimates in accordance with the revised SOW or MAS. The FEMA Lead also shall revise the Government Estimate, if necessary, and resubmit it to the AO and/or CO.

As a result of this evaluation, the AO and/or CO may negotiate with specific Project team members regarding certain elements of the time and cost estimates, even if the project scope is not changing. For example, the AO and/or CO may request changes regarding the time or labor categories planned for specific tasks. Additionally, the CTP may choose to do this as well with the contractors for which they are responsible.

The AO and/or CO, in consultation with the FEMA Lead (and possibly CTP), shall evaluate the revised time and cost estimates and negotiate with the Project Team members. This evaluation/negotiation process will be repeated until all parties agreed with the time and cost estimates and the SOW and/or MAS are finalized.

[February 2002]

1.3.3.7 Community Agreement Processing

As discussed previously, if the community is participating as a CTP, the FEMA Lead will work with community officials to sign both a CTP MOA and an MAS for the project. In most situations, the MOA will have already been processed before the Project Scoping phase of the project begins.

If the community will be receiving FEMA funding for the project, the FEMA Lead will coordinate with the FEMA Operations Support Division to provide the community with a Request for Application package so that the community may receive Cooperative Agreement

funding. The FEMA Lead and/or AO shall work with the community to complete the application forms, as needed. After review and acceptance of the application package, the AO shall make the allocation to the community and prepare the appropriate documentation and notification.

The community is encouraged to develop a CTP Agreement with FEMA even if the community is not directly assigned tasks in the SOW through a Community Partner MOA.

[February 2002]

1.3.3.8 Finalization of Project Management Plan

The FEMA Lead, in consultation with the FEMA AO and/or CO, shall incorporate the final SOW or MAS and establish intermediate project reporting and project close-out requirements in the Project Management Plan. The Plan will then be ready for finalization.

[February 2002]

1.3.3.9 Updates to Mapping Needs Update Support System Database

Once the SOW or MAS and the contract requirements are finalized, a Mapping Partner designated by FEMA shall update the MNUSS database to indicate that the needs included in the SOW or MAS are being included in an ongoing Flood Map Project. This ensures that needs being addressed by the project will not be considered during the prioritization of projects for future years. The designated Mapping Partner also shall update MNUSS to add any new needs identified during the scoping activities that will not be addressed by this mapping project, and/or to revise any existing needs to reflect information obtained during the scoping process. Additionally, the designated Mapping Partner shall flag the needs that could not be verified during the research and community coordination activities as "not verified."

[February 2002]

1.3.3.10 Distribution of Final Tasks and Notice to Proceed

The FEMA AO and/or CO shall distribute the final SOW or MAS to the Project Team members and notify them to proceed accordingly. A sample Notice to Proceed letter template is included in Appendix I, Subsection I.3.3 of these Guidelines. Because cost information is proprietary, the AO and/or CO shall distribute the time and cost estimates only to the Project Team members performing the work. The AO, CO, and/or FEMA Lead also shall arrange for an announcement to be published in a prominent local newspaper advising of the planned Flood Map Project and requesting that relevant facts and technical data be submitted for consideration.

[February 2002]

1.3.4 Outreach and Coordination

The outreach activities for a Flood Map Project can best be understood as a process that begins during the Project Scoping phase and continues through the Map Production and Post-preliminary phases. This section will address all but the post-Preliminary activities, which are

addressed in Section 1.5. A regulatory overview of required activities is followed by a description of tools that can be used in working with stakeholders to keep them informed and to solicit their input.

The overarching goal for conducting outreach is to create a climate of understanding and ownership of the mapping process at the State and local levels. Well-planned outreach activities can reduce political stress, confrontation in the media, and public controversy, which can arise from lack of information, misunderstanding, or misinformation. These outreach activities also can assist FEMA and other members of the Project Team in responding to congressional inquiries.

By proactively reaching out to all key stakeholders as early in the Flood Map Project as possible, the maps can be used to their full potential. The likelihood of appeals may also be reduced or eliminated. Specific outreach goals include:

- Establishing two-way communication to inform and obtain feedback from stakeholders;
- Ensuring compliance with due process requirements;
- Interacting with technical representatives to ensure production of accurate and up-to-date maps;
- Identifying and addressing the needs of all affected stakeholders;
- Enhancing ownership by communities; and
- Tracking, monitoring, and evaluating outreach activities and adjusting efforts according to ongoing feedback and evolving project needs.

[February 2002]

1.3.4.1 Consultation and Coordination

Outreach activities to educate stakeholders about a particular Flood Map Project and the mapping process in general must be planned, tracked, monitored, and evaluated. Outreach activities also must address the legal due-process requirements and other opportunities for public involvement, including the ways in which public input will be used in developing maps. Under Section 66.4 of the NFIP regulations, FEMA is required to designate a Federal employee as the Consultation Coordination Officer (CCO) for each community when an analysis is undertaken to establish or modify flood elevations. When FEMA appoints a CCO, that person becomes responsible for consultation and coordination activities. Mapping Partners involved in a Flood Map Project may be asked to assist the FEMA CCO in consultation and coordination efforts.

[February 2002]

1.3.4.2 Initial Coordination and Outreach

When a Flood Map Project is initiated, FEMA shall contact the local officials and the State NFIP Coordinator and inform them that their community has been selected for a possible study. FEMA shall work with local officials to inform the community and request information through meetings and other consultation activities. The regulations also require FEMA to encourage local dissemination of information and keep local officials apprised of progress. Contractors and other Project Team members may assist in providing this information and informing local officials.

[February 2002]

1.3.4.3 Establishing and Maintaining Community Case Files and Dockets

Other due process and regulatory requirements involve detailed record keeping and documentation requirements. For example, FEMA must establish legal files, referred to as "dockets," that must be maintained and made available to the public. When a community is initially considered for a Flood Map Project involving a new or revised flood hazard analysis, FEMA must establish a community case file.

As work on the Flood Map Project progresses, FEMA or a Mapping Partner designated by FEMA, shall include copies of correspondence, as well as documentation of all actions related to tentatively identifying a community, providing BFEs, and suspending or reinstating a community in the community case file. FEMA must maintain the community cases file even if an NFIP map is administratively rescinded or withdrawn after notice or the community successfully refutes its floodprone designation.

Designated Mapping Partners will assist FEMA in establishing and maintaining the community case files to ensure accuracy and completeness. These files must include copies of the following:

- All correspondence between FEMA and the community concerning the study, including reports of any meetings among FEMA representatives, property owners, the state NFIP coordinating agency, study contractors, or other stakeholders;
- Relevant publications;
- Completed flood elevation study; and
- Final determination. (See Section 1.5 for more information.)

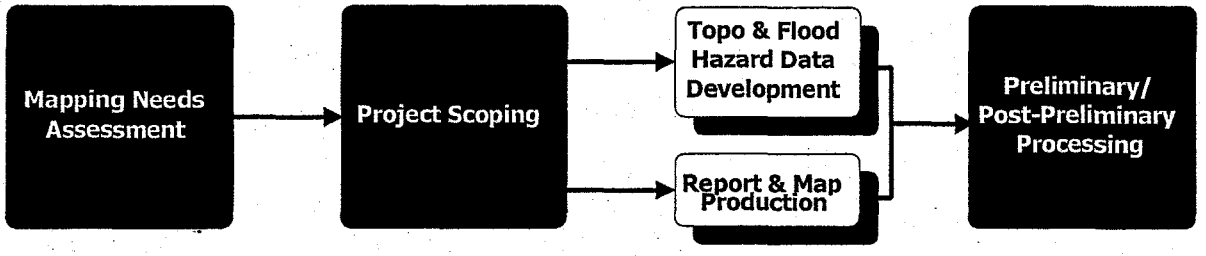
In accordance with Part 67 of the NFIP regulations, FEMA also must establish and maintain a Flood Elevation Determination Docket (FEDD). In the FEDD, discussed in more detail in Section 1.5, FEMA records all matters pertaining to flood elevation determinations, starting with the issuance of the Preliminary versions of the FIS report and FIRM to community officials.

While due process and documentation requirements mandate the minimum regulatory requirements that must be met, additional outreach may be beneficial to all parties involved to

maximize usefulness of the new or updated flood hazard data, to encourage State and local ownership of the maps, and to explain and provide incentives for best practices.

[February 2002]

1.4 Data Development/ Report and Map Production



After completion of the Project Scoping phase (covered in Section 1.3 and Appendix I of these Guidelines), including the issuance of the necessary Task Orders and/or MASs, the Data Development/Report and Map Production phase of the Flood Map Project begins. This section overviews the data development and FIRM production process. Note that this section primarily focuses on Flood Map Projects that will result in a new or updated FIRM, produced digitally. As noted in Section 1.3, FEMA will produce all new FIRMs digitally, and prefers to produce updated FIRMs digitally. However, the FEMA Lead may direct that an updated FIRM be produced using manual cartographic techniques when cost constraints or other factors so dictate. This decision will be made during Project Scoping.

A Special Problem Report, or equivalent document providing the same information, is required whenever a significant problem requiring FEMA resolution is encountered or when a significant change in scope, schedule, or budget is necessary. A Special Problem Report must be submitted to the FEMA Lead immediately following the identification of the issue.

Figure 1-4 shows the process for data development and production of the FIS report and FIRM. As shown, there are two parallel "paths" for completing the topographic and flood hazard data development and the production of the FIS report and FIRM. To complete a Flood Map Project in a timely and cost-effective manner, it is critical that activities be completed simultaneously where possible and that all Project Team members work collaboratively. Figure 1-4 shows that concurrent activities are the foundation of the Flood Map Project process.

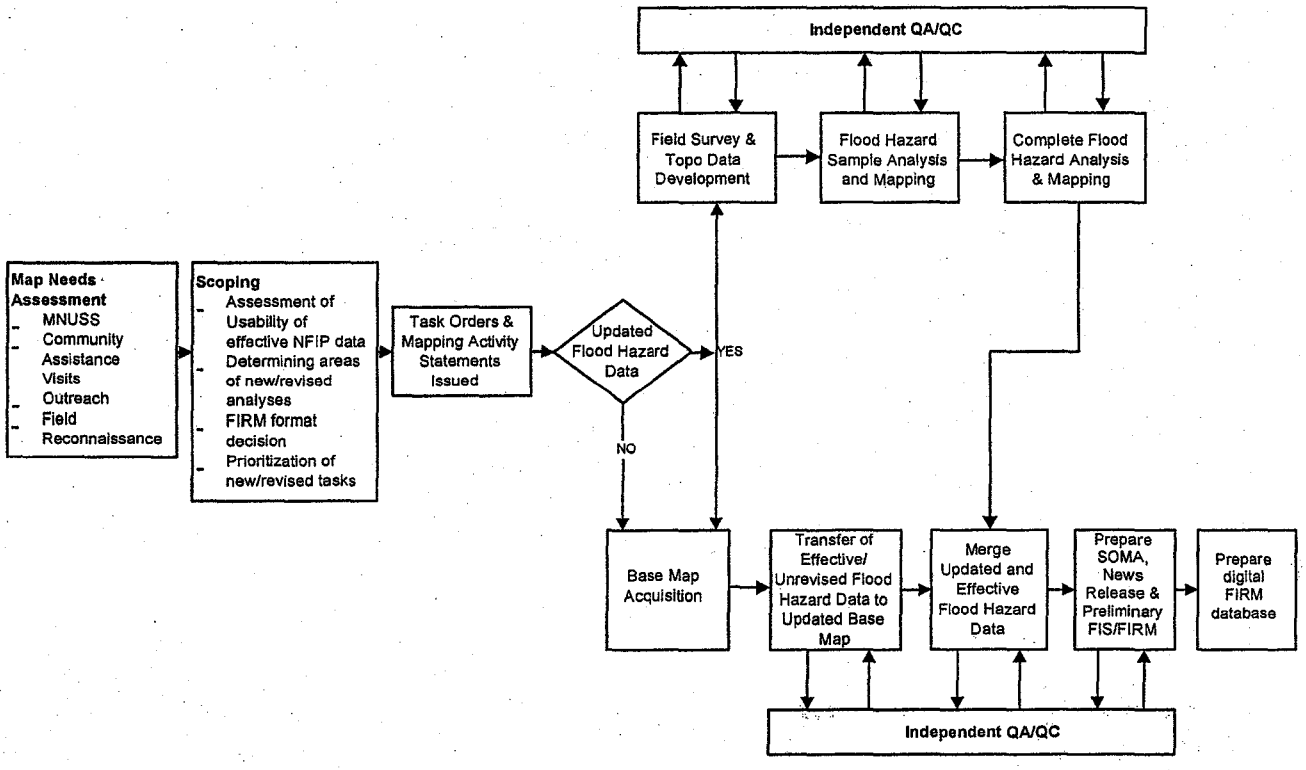


Figure 1-4. Data Development and Map Production Process

All Flood Map Projects will include a map production component; Flood Map Projects that incorporate new or updated flood hazard data also will include a topographic and flood hazard data development component as well as a provision for independent incremental reviews of these data by a qualified QA/QC reviewer.

[February 2002]

1.4.1 Independent Quality Assurance/Quality Control Review

Each Mapping Partner contributing to a Flood Map Project must ensure that its contributions to the project are in compliance with the standards in these Guidelines as well as any additional standards provided by FEMA in Project-related task orders or MASs. As shown in Figure 1-4, the flood hazard and topographic data development process requires interim reviews of analyses and products. The independent QA/QC review for each analysis and product must be conducted by an entity other than the Mapping Partner that performed the analysis or prepared the product.

An independent QA/QC review of topographic data also may be required, particularly for data collected using new or emerging technologies, such as LIDAR.

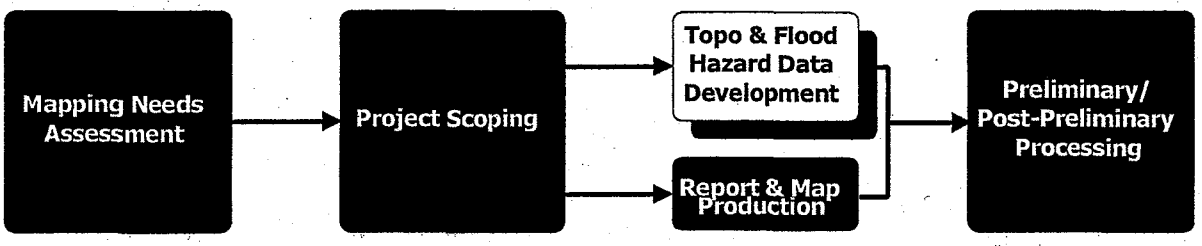
The Mapping Partner responsible for the preparation of the Preliminary FIS report and FIRM shall submit for an independent review, the merged flood hazard data and other ancillary products associated with the preparation of the Preliminary FIS report and FIRM.

The FEMA Lead, during Project Scoping, shall determine the scope, protocols and associated details of these independent reviews. The intent of these independent QA/QC reviews is to reasonably verify that the analyses and other activities that are performed and the products that are generated during a Flood Map Project meet the requirements in these Guidelines and in Project-related task orders and MASs. The independent QA/QC reviewer(s) shall provide a summary report to the FEMA Lead and the Mapping Partner that prepared the data, analyses, or mapping.

In addition, the Mapping Partner responsible for the preparation of the Preliminary FIS report and FIRM shall ensure, through an internal QA/QC process, that all components of the study are in compliance with these Guidelines.

[February 2002]

1.4.2 Topographic and Flood Hazard Data Development



The following activities are completed during the Topographic and Flood Hazard Data Development subphase for a Flood Map Project that will include new or updated flood hazard data:

- Field survey and topographic data development, including aerial topographic surveys, cross-section surveys, hydraulic structure surveys, and establishment of vertical control and location of qualifying bench marks;
- Flood hazard data development, including detailed flood hazard analyses, approximate flood hazard analyses, and redelineations of floodplain boundaries based on updated topographic data); and
- Creation and submittal of draft materials, including floodplain mapping (i.e., work maps), digital files for GIS-based applications, and FIS report components.

The Topographic and Flood Hazard Data Development subphase includes collecting or acquiring the necessary topographic and field data and conducting detailed and/or approximate analyses

and/or performing redelineation of floodplain boundaries using flood elevations from the effective FIS report and FIRM. Thus, this component is required only for Flood Map Project that will include new or updated flood hazard data.

The topographic and flood hazard data development path includes the steps summarized below.

1. Field survey and topographic data development, including:
   - Aerial topographic surveys;
   - Cross section surveys;
   - Hydraulic structure surveys; and
   - Establishment of vertical control and location of qualifying bench marks.
2. Flood hazard data development, including:
   - Generating updated flood hazard data;
   - Redelineation of effective floodplain boundaries based on updated topographic information;
   - Creation of work maps displaying the updated / revised floodplain mapping;
   - Creation of digital files for GIS applications; and
   - Creation of a draft FIS report containing supporting flood hazard data tables and Flood Profiles for flooding sources studied by detailed methods.

[February 2002]

1.4.2.1 Field Survey and Topographic Data Development

Accurate, up-to-date topographic data are needed for flooding sources to be updated through the performance of a detailed or approximate engineering analysis and when redelineating floodplain boundaries using effective flood elevations. Further, survey data for channel cross sections and hydraulic structures (e.g., bridges, culverts, or dams) are required for detailed flood hazard analyses and may be required for some approximate engineering analyses (if so determined during the Project Scoping phase of the Flood Map Project).

Significant cost savings may be realized if existing topographic and cross-section data sources can be used for a Flood Map Project. Accordingly, the Mapping Partner performing the flood hazard analyses shall conduct research to identify existing sources of topographic and field survey data and, if such sources are found, to assess the adequacy of the data for the Project. Section 1.3 of these Guidelines provides guidance on assessing the adequacy of existing topographic and survey data.

The topographic data and the base map data used in preparing the effective FIRM must be compatible; that is, like features in both data sources must align. If the Mapping Partner performing the flood hazard analyses determines that no data exist or that existing data are inadequate or need to be supplemented, then that Mapping Partner shall develop the necessary data following the guidance in Appendix A of these Guidelines"

[February 2002]

Bench Marks

Vertical control monuments (also referred to as bench marks) must be shown on the FIRM to assist map users in establishing vertical control for flood elevation determinations. Bench marks shown on the FIRM must meet a minimum qualifying standard; they must be First or Second Order Vertical and have a stability classification ranking of A, B, or C as defined by the National Geodetic Survey (NGS). All qualifying bench marks within a given jurisdiction that are cataloged by the NGS and entered in the National Spatial Reference System (NSRS) with the aforementioned qualifications shall be shown on the FIRM and identified by their NSRS Permanent Identifier (PID).

When local jurisdictions have established their own vertical monument network, these monuments also may be shown on the FIRM with the appropriate designations. Local monuments shall be placed on the FIRM only if the community has requested that they be included, and if the monuments meet the aforementioned inclusion criteria. Additional information on qualifying criteria is provided below.

Temporary vertical control monuments—formerly referred to as Elevation Reference Marks (ERMs) on FIRMs—that were established by FEMA study contractors during the performance of a study or restudy shall not be shown on the FIRM unless they meet specific qualifying criteria as indicated below. This standard applies to all FIRMs, regardless of whether they are being created for the first time or being revised. ERMs that appear on FIRM panels being revised must be removed and replaced with qualifying bench marks.

Descriptions of bench marks shall not appear on the FIRM. Map users will be provided with a phone number and an Internet address that allows them to access the NSRS to obtain the most up-to-date information on all vertical control monuments shown on the FIRM.

[February 2002]

Qualifying Criteria for Inclusion of Existing Bench Marks

Bench marks cataloged by the NGS and included in the NSRS vary widely in stability classification and level of precision relative to levels of confidence. The minimum criteria for inclusion of an NSRS bench mark on the FIRM are that the monument be Second Order Vertical and Stability Classification C, or better.

NGS Stability definitions are as follows:

- Stability A Monuments are monuments of the most reliable nature and are expected to hold position/elevation well (e.g., mounted in bedrock).
- Stability B Monuments are monuments that generally hold their position/elevation well (e.g., concrete bridge abutment).
- Stability C Monuments are monuments that may be affected by surface ground movements (e.g., concrete monument below frost line).
- Stability D Monuments are monuments of questionable or unknown stability (e.g., concrete monument above frost line, or steel witness post).

For digital FIRMs, the locations of temporary monuments (i.e., ERMs) shall be recorded in the associated spatial database. For all FIRMs, the Technical Support Data Notebook (TSDN) records the temporary monument elevation and description information.

[February 2002]

Qualifying Criteria for New Vertical Control Monuments

Vertical control monuments established by FEMA study contractors may be added to the FIRM provided they have been classified by, and entered into, the NSRS as indicated above and meet the following criteria:

- They must be surveyed per NGS-58 guidelines for Secondary Base 5-centimeter monuments relative to existing NSRS monuments.
- They must have stability classifications of A, B, or C.
- Global Positioning System (GPS) files and station descriptions must have been previously submitted and accepted by the NGS for inclusion in the NSRS.

[February 2002]

Portrayal of Bench Marks on Flood Insurance Rate Maps

Appendix K of these Guidelines provides the graphic specifications for the portrayal of bench marks on FIRMs. If the number of qualifying bench marks is small, the Mapping Partner may include bench marks that lie outside the jurisdiction boundaries, but within the neatlines of printed FIRM panels.

[February 2002]

1.4.2.2 Flood Hazard Data Development

As described in Section 1.3, the flood hazard data that shall be used for a Flood Map Project are determined as part of the Project Scoping phase. The basic methods for developing flood hazard data for a Flood Map Project are summarized below.

- Use of flood hazard information from the effective NFIP map without change;
- New or updated flood hazard data (using one or a combination of the following methods):
- Redelineation of effective floodplain boundaries based on updated topographic data
- Detailed coastal and riverine flood hazard analyses; and
- Approximate flood hazard analyses.

The method used for each flooding source identified as a flood hazard will be determined during the Project Scoping phase. (See Section 1.3 for a more detailed discussion of each of these methods.) For most Flood Map Projects, the Mapping Partners involved will use a combination of these methods to produce the new or updated FIRM.

[February 2002]

Use of Effective Flood Hazard Information

Flood hazard information on the effective NFIP map (i.e., FIRM, FBFM, or FHBM) that is not being updated through a separate flood hazard analysis or floodplain boundary redelineation shall be "carried over" to the new or updated FIRM unless information is available that indicates that this data is no longer deemed technically sound or valid.

[February 2002]

New or Updated Flood Hazard Data

The development of flood hazard data by one of the three methods indicated above shall be conducted as a two-step process to ensure an independent review of sample hydrologic and hydraulic analyses and/or floodplain mapping is performed before an entire project is completed. During the Project Scoping phase, the FEMA Lead will specify the scope and extent of analyses and mapping to be included in the sample and will specify the number of required interim review submittals (if any).

For example, for one Flood Map Project, the interim review submittal sample may include complete detailed hydrologic, hydraulic, and coastal analyses and floodplain mapping for a subset of all the flooding sources to be studied as part of the project. For another Flood Map Project, the Mapping Partner may be required to provide only the hydrologic analyses for one watershed, the hydraulic analyses for a portion of the flooding source, and the floodplain mapping in a third area. The FEMA Lead will specify during the Project Scoping phase what the review requirements shall be for interim and/or partial review submissions.

After the interim submittals of analyses and mapping have been independently reviewed and all comments and concerns have been addressed, the assigned Mapping Partner will complete the analyses and prepare updated floodplain mapping for all assigned flooding sources. The assigned Mapping Partner shall then submit the completed draft materials in the TSDN format described in Appendix M of these Guidelines. Additional information on the draft submittal requirements is provided in Subsection 1.4.2.3

[February 2002]

Generating and Updating Flood Hazard Data

As part of a Flood Map Project, a Mapping Partner may be required to perform detailed analyses, approximate analyses, or a combination of both for one or all of the following types of flood hazards:

- Riverine flooding;
- Coastal flooding;
- Shallow flooding;
- Ice-jam flooding; and
- Alluvial fan flooding.

In performing these analyses, the assigned Mapping Partner also may be required to evaluate levee systems and map the areas affected by those systems.

Table 1-4 summarizes the relevant appendices in these Guidelines that provide the requirements for conducting analyses of riverine, coastal, shallow, ice-jam, and alluvial fan flooding, for evaluating levee systems, and for mapping these hazards and systems. Unless otherwise directed by the FEMA Lead, the assigned Mapping Partner shall follow the guidelines in these appendices when generating or updating data for FEMA.

Table 1-4. Location of Guidance for Performing Flood Hazard Analyses

Type of Flood Hazard	Relevant Appendix
Riverine	Appendix C – Guidance for Riverine Flooding Analyses and Mapping
Coastal	Appendix D – Guidance for Coastal Flooding Analyses and Mapping
Shallow	Appendix E – Guidance for Shallow Flooding Analyses
Ice Jam	Appendix F – Guidance for Ice-Jam Analyses and Mapping
Alluvial Fan	Appendix G - Guidance for Alluvial Fan Flooding Analyses and Mapping
Areas Protected by Levees	Appendix H – Guidance for Evaluating Flood Protection Systems

[February 2002]

Redelineation of Effective Floodplain Boundaries

The other option for updating flood hazard data—redelineation of effective floodplain boundaries using more up to date and/or more detailed topographic mapping or data than that used to prepare the effective FIRM to redraw the floodplain boundaries based on the flood elevations using in preparing the effective FIRM—should primarily be limited to floodplains along flooding sources studied by detailed methods where BFEs or flood depths are designated on the effective FIRM. However, if elevation or depth data have been generated for a flooding source for which only approximate analyses were performed by FEMA, this option may be applied to redelineate the approximate floodplain boundaries as well.

Prior to redelineating effective floodplain boundaries, the assigned Mapping Partner shall perform the following activities to assess the appropriateness of this approach:

- Review the planimetric features surveyed during the topographic data development process to ensure that the horizontal accuracy of the planimetric features is compatible with the selected FIRM base map.

- Review the effective 1- and 0.2-percent-annual-chance flood elevations to ensure that they are valid and usable for the floodplain boundary redelineation process. If conditions have changed such that the Flood Profile included in the effective FIS report no longer represents existing conditions (for example, if bridge or culvert construction has occurred), the Mapping Partner may need to perform updated hydrologic and hydraulic analyses. The assigned Mapping Partner shall obtain the required approval from the FEMA Lead before proceeding with such analyses.

- Investigate changed planimetric or topographic conditions that indicate the need for updated analyses and may preclude the use of this method. Such situations include significant discrepancies in planimetric features or stream distance between Flood Profiles and topographic mapping. The assigned Mapping Partner shall bring these situations to the attention of the FEMA Lead.

If the redelineation option is chosen, the assigned Mapping Partner shall follow the guidelines in Appendix C, Section C.6 of these Guidelines in preparing the required floodplain mapping.

[February 2002]

1.4.2.3 Draft Materials Submittal

Upon completion of the Flood Map Project, the assigned Mapping Partner shall submit final draft materials, in TSDN format, to the FEMA Lead (or other Project Management Team member identified during the Project Scoping phase) for review and processing. These materials may be submitted by U.S. Mail, by Express Mail Service, or by Internet or other electronic means. The assigned Mapping shall retain copies of support data relating to those analyses.

If the FIRM will be prepared in the FEMA Countywide Format, the assigned Mapping Partner shall submit all date in one TSDN package. If the FIRM will NOT be prepared in the FEMA Countywide Format, the assigned Mapping Partner shall submit a separate TSDN package for

each community for which flood hazard data have been developed. If the flood hazard data developed pertain to more than one community, the assigned Mapping Partner shall submit duplicate copies of those data for the TSDN for each community or shall provide clear, detailed cross-referencing of those data in each TSDN.

[February 2002]

Floodplain Mapping

The assigned Mapping Partner shall provide, in draft format, a neatly compiled "work map" that contains the flood hazard data necessary to produce the Preliminary version of the FIRM. The work map is typically the topographic map used to delineate the updated floodplain boundaries and/or the base map to be used for FIRM production. The assigned Mapping Partner shall submit the work map in digital form unless otherwise approved by the FEMA Lead. The assigned Mapping Partner shall submit the compiled work map (original copy) and/or plots of the digital files as part of the TSDN.

When new photogrammetric mapping and surveying are included in a Flood Map Project, the assigned Mapping Partner shall also use surveying and mapping procedures, within floodplains and adjacent buffer zones, that meet or exceed the National Standard for Spatial Data Accuracy statistical and testing methodology for estimating the positional accuracy of points on maps and in geospatial data, with respect to georeferenced ground positions of higher accuracy, as specified in Appendix A of these Guidelines. The Flood Map Project Scoping process detailed in Section 1.3 and Appendix I of these Guidelines should be carefully reviewed and followed by any Mapping Partner that will be preparing a digital FIRM submission, to clarify the data format requirements and scope of work.

Whenever possible, the assigned Mapping Partner shall ensure that the work map, which shall be prepared in "FIRM-ready" format whenever possible, complies with the following guidelines:

- Use the same base map that FEMA will use for FIRM production for the base map.
- Use the proposed FIRM panel tiling and numbering scheme. (This tiling applies only to hard copy maps)
- Prepare individual work map panels at the same scale as the FIRM panels.
- Use labels, legends, and notes that are compatible with the FEMA FIRM graphic specifications provided in Appendix K of these Guidelines...
- Submit digital data in a seamless format. (See Appendix L of these Guidelines for details.)
- Where flood hazard data on the existing NFIP map will remain unchanged, the assigned Mapping Partner shall, depending on the assignments made in the Project Scoping document, either (1) incorporate the unrevised flood hazard information in the work map or (2) provide a copy of the effective NFIP map (in lieu of a work map) indicating the unchanged areas.

If the assigned Mapping Partner is not required to prepare the work map in a "FIRM-ready" format, the Mapping Partner may submit the work map as strip maps, covering the revised floodplain areas. At a minimum, the work map must cover all areas with updated flood hazard data. Additionally, planimetric features must be compatible with those shown on the base map to be used for FIRM production.

[February 2002]

Work Map Content

Mapping Partners that prepare work maps shall comply with the following minimum requirements:

- Floodplain and floodway boundaries, cross sections, BFEs, and flood insurance risk zones must be shown. Guidance for BFEs on work maps may be found in Appendix C, Section C.6.3 of these Guidelines. Guidance on developing cross-section data for use on work maps may be found in Appendix A, Section A.4.6 of these Guidelines.

- Planimetric features on the work map must be correctly located with respect to the same features on the base map to be used for FIRM production. The positional differences between the two maps must be within the accuracy specifications for base maps that appear in Subsection 1.4.2.1 and the accuracy specifications for topographic mapping that appear in Appendix A of these Guidelines.

Mapping Partners shall, at a minimum, show the following information in and near the floodplains on the work map:

- Cross sections used in the hydraulic model;

- Contours showing ground elevations at the contour interval specified in the Project Scoping document;

- Cultural features, such as railroads, airfields, streets, roads, highways, levees, dikes, seawalls, dams and other flood-control structures, and other prominent manmade features and landmarks;

- Up-to-date corporate limits, extraterritorial jurisdiction limits, and boundaries of excluded areas;

- Horizontal reference grid lines (State Plane or Universal Transverse Mercator [UTM]) with appropriate values annotated; and

- Public Land Survey System reference grid (also known as township and range) where present.

Mapping Partners may include, but are not required to show, the following information on the work map:

- Building outlines;
- Topographic spot elevations;
- Property lines; and
- Details of areas outside the corporate boundaries.

Mapping Partners shall ensure that areas shown on the work map that are excluded from the community under study are delineated by a solid line border and labeled "AREA NOT INCLUDED." The name of any excluded areas must also be provided within the appropriate map area. Mapping Partners shall also ensure that the work maps as well as aerial photographs, topographic maps, base maps, community maps, and any other source maps submitted, are properly identified with the following information:

- Title;
- Topographic certification;
- Index of submitted map sheets;
- Community name(s) and state for which the Flood Map Project was performed;
- Six-digit community identification number;
- Date map was prepared and/or published (day, month, year);
- Horizontal datum;
- Vertical datum;
- Control grid (e.g., State Plane or UTM);
- Map scale;
- North arrow;
- Mapping Partner name;
- Name(s) of applicable flooding source(s) covered;
- FIRM panels affected;
- Indication of whether map is one of several maps; and
- Any other relevant information that can assist users in identifying the data.

Because the work maps will be used to produce the FIRM and will be maintained for future use and reference, the assigned Mapping Partner shall ensure the clarity and durability of the maps.

Mapping Partners shall discard extraneous or duplicate maps; however, if copies are to be retained for record purposes, they must be clearly marked as "void" or "superseded by other material."

[February 2002]

Digital Files of Mapping Information

By structuring and storing its flood hazard data in an intelligent GIS format, FEMA expects to be able to increase the utility and value of these data. Therefore, the Mapping Partner responsible for performing the flood hazard analyses shall submit digital mapping information and supporting data to the FEMA Lead or other Project Team member identified by the FEMA Lead, such as the Mapping Partner responsible for preparing the Preliminary FIS report and FIRM. The draft digital FIS report and FIRM data will support the creation of the preliminary and final digital FIRM GIS database in conjunction with the creation of the Preliminary and final FIS report and FIRM.

To accommodate the large variety of mapping software used by Mapping Partners and the variety of Mapping Partners that draft FIS report and FIRM components, the requirements for producing draft digital FIRM data are flexible. Data may be submitted in a Computer Assisted Drafting and Design data structure or GIS data structure. In addition, a wide variety of data formats are acceptable. However, to facilitate the efficient exchange of digital flood hazard data between FEMA and its Mapping Partners, the submitting Mapping Partner shall ensure that the draft digital FIRM data conform to the specifications in Appendix L of these Guidelines.

[February 2002]

Flood Insurance Study Report

Depending on the agreed-upon scope of the Flood Map Project, the Mapping Partner that performs the flood hazard analyses shall prepare and submit a complete draft version of the FIS report reflecting the updated flood hazard data or revised components for inclusion in the existing FIS report. The Mapping Partner shall follow the guidelines provided in the FIS report Data Checklist provided in Appendix J, Section J.1 of these Guidelines. The Mapping Partner that prepares the Preliminary FIS report will use this information.

Material to be submitted shall include Flood Profiles, data tables, and descriptions of the flood hazard analysis methods employed. The draft FIS report submittal shall be prepared in accordance with the format and guidance provided in Appendix J. Flood Profiles are a critical component of the FIS Report; guidance on the production of Flood Profiles is provided in Appendix J, Subsection J.2.3.

[February 2002]

1.4.2.4 Engineering Standards

The following are core engineering standards to be used by all Mapping Partners:

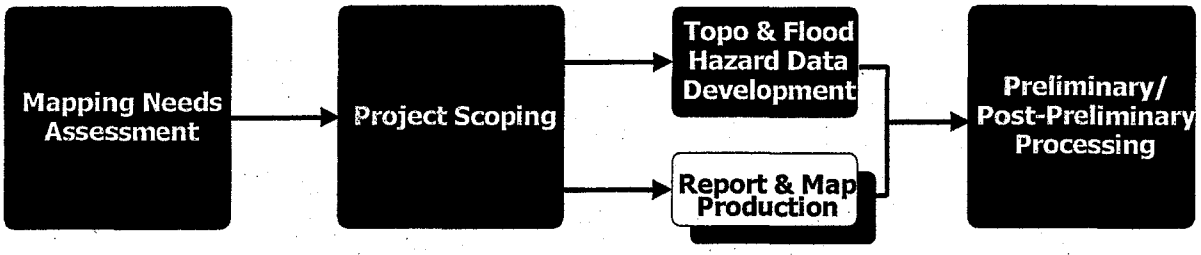
- The 1-percent-annual-chance flood shall be the primary flood event determined and the 1-percent-annual-chance floodplain shall be mapped on a FIRM.
- The flood hazard information shown on a FIRM and in an FIS report, and the hydrologic and hydraulic analyses performed to determine flood hazards, must be based on existing conditions. However, a community may **choose** to include flood hazard information that is based on future conditions on a FIRM and in an FIS report **in addition to** the existing-conditions information. (See Volume C, Section C.8 of these Guidelines for general guidance on the inclusion of future-conditions flood hazard information.)
- The 10-, 2-, and 0.2-percent-annual-chance flood intervals are customary accepted intervals for flood hazard assessments. The 0.2-percent-annual chance floodplain is usually mapped on a FIRM.
- Flood hazard studies must be performed using FEMA accepted computer models. FEMA has approved models for four categories—coastal models, hydrologic models, hydraulic models, and sediment transport models—for nationwide use. A listing of these nationally and locally accepted models is available on the FEMA website at http://www.fema.gov/mit/tsd/en_modl.htm.
- Locally developed models have been accepted for use within several specific jurisdictions (i.e., Denver's Urban Drainage and Flood Control District). Locally accepted models must meet the requirements of Subparagraph 65.6(a)(6) of the NFIP regulations before they are accepted by FEMA for NFIP purposes. A listing of these nationally and locally accepted models is available on the FEMA website at http://www.fema.gov/mit/tsd/en_modl.htm.
- Calculated discharges for a Flood Map Project (including those determined by regression equations and/or computer models) must be compared to available floodflow-frequency data.
- Regulatory floodways must be developed using standard methodologies.
- Unless otherwise stated during the Project Scoping phase of the mapping process, flood hazards will not be depicted at sites where the drainage area is less than 1 square mile.
- Models must be calibrated to measured profiles, estimated profiles, or reliable high-water marks from observed flood events whenever possible.

- Flood-control structures (e.g., seawalls, levees) must be certified to withstand the designated flood event before they can be credited on the FIRM as providing flood protection. All criteria specified in Section 65.10 of the NFIP regulations and Appendix H of these Guidelines must be satisfied before levees may be credited and mapped as providing protection from the 1-percent-annual-chance flood event.
- Cross sections and transects must be reasonably spaced to accurately define the study area.
- Backup material submitted n support of assumptions used in the engineering analyses must be provided with the analyses.

Many of these core standards are detailed throughout these Guidelines. Mapping Partners that wish to deviate from any of these standards and formats must obtain approval from the FEMA Lead.

[February 2002]

1.4.3 Report and Map Production



The following activities are accomplished during the Report and Map Production subphase of the Flood Map Project.

- Base map acquisition and preparation;
- FIRM compilation, which entails setting up the final FIRM format (scale, orientation, and panel scheme) and compiling existing flood hazard data (in manual or digital form) from the effective NFIP map and fitting it to the new or updated base map to meet current FIRM specifications;
- Merging of revised and effective flood hazard data into a seamless dataset;
- Research and summary regarding LOMCs issued previously for affected FIRM panels;
- Preparation of required news releases and legal notices;
- Preparation of new or revised FIS report, including Flood Profiles and supporting tables;

- Preparation of new or revised FIRM panel(s); and
- Development of digital FIRM database for digital FIRMs.

[February 2002]

1.4.3.1 Base Map Acquisition and Preparation

All Flood Map Projects that will result in a digital FIRM require a digital base map that reflects reference features (roads, streets, hydrographic features, political jurisdiction boundaries) needed by users to locate properties on FIRMs. The Project Scoping process will identify the base map to be used and assign the Mapping Partner responsible for obtaining the base map for use by FEMA for FIRM production.

Early coordination with all communities affected by a Flood Map Project is an important part of the Project Scoping Process described in Section 1.3 of these Guidelines. The Mapping Partner responsible for preparing the Preliminary FIRM shall send a letter to each affected community that:

- Describes the FIRM product;
- Requests pertinent information (pertinent information that is requested includes base map data; a current corporate limits map; elevation data [either electronic or hardcopy] and any engineering information that needs to be updated or added to the FIRM);
- Describes the minimum requirements for the submittal of data to be included in the new FIRM product, and
- Identifies the base map source that will be used if community data are not available or suitable.

[February 2002]

Base Map Choice Priorities

Base map data to be used in producing a digital FIRM are prioritized as follows:

1. Base map data that are supplied by communities or other non-Federal sources (e.g., State or regional agencies) and meet FEMA criteria are the first choice for digital FIRM production. These files may be in either vector or raster format. If both are available, vector data are preferable due to the ease of their use, their file size, and their lower printing cost. However, community preferences are taken into account when making this choice.
2. USGS DOQs are the second choice and the default base map if suitable community data are not available.

If neither suitable community base map data nor USGS DOQs are available for a county scheduled for digital FIRM production, FEMA will provide the community with information on base map sources, including information on partnering with USGS to initiate DOQ production for that county. DOQ production normally takes 12 to 14 months, so coordination with USGS must be initiated with that time frame and the digital FIRM production schedule in mind.

Digital FIRM road and railroad names are derived from community-supplied files or hardcopy sources, effective FIRM panels, and/or U.S. Bureau of the Census Topologically Integrated Geographic Encoding and Reference System (TIGER) files. Road names are needed regardless of which base map source is chosen for digital FIRM production.

[February 2002]

Minimum Standards for Community-Supplied Data

For FEMA to use community-supplied base map data instead of USGS DOQs for new digital FIRM production, minimum standards for resolution, horizontal accuracy, vertical accuracy, horizontal reference system, data sources, currency, coverage, availability, restrictions on use, required and optional contents, thematic separation of data, file format and transfer media, tiling, data structure, and metadata must be met. These minimum requirements are summarized below.

[February 2002]

Resolution

The minimum resolution requirement for raster data files is 1-meter ground distance. Higher resolution data are also acceptable.

[February 2002]

Horizontal Accuracy

The National Standard for Spatial Data Accuracy (NSSDA) is used to report the horizontal accuracy of the base map data used by FEMA to produce a FIRM. The NSSDA uses radial accuracy ($Accuracy_r$) to report the radius of a circle of uncertainty, such that the true or theoretical location of a point falls within that circle 95 percent of the time. The minimum horizontal positional accuracy for new FIRM base map data is that of the default base map – the USGS DOQs, which have an NSSDA radial accuracy of 38 feet. Data that meet higher accuracy standards are also acceptable. $Accuracy_z$ of 38 feet is the same as radial root mean square error (RMSEr) of 22 feet.

[February 2002]

Vertical Accuracy

For hilly terrain, where 4-foot contours are considered acceptable for hydraulic modeling, digital elevation data must have vertical accuracy ($Accuracy_z$) of 2.4 feet (i.e., vertical root mean square error (RMSEz) of 1.2 feet). In moderate to flat terrain, where 2-foot contours are required to

accurately determine 1-percent-annual-chance flood elevations and floodplain boundaries, the digital elevation data must have $Accuracy_z$ of 1.2 feet (i.e., RMSEz of 0.6 foot).

According to the NSSDA, which replaced the National Map Accuracy Standards of 1947 for digital mapping products, $Accuracy_z$ defines vertical accuracy at the 95-percent confidence level. This means that the true or theoretical location of a point falls within ± of that linear uncertainty value 95 percent of the time. $Accuracy_z = RMSE_z \times 1.9600$, where $RMSE_z$ is the square root of the mean of the squared errors in elevations of check points used to evaluate the vertical accuracy of a digital dataset.

[February 2002]

Horizontal Reference System

The files must be georeferenced to a known projection and datum and be accompanied by information that describes those parameters.

[February 2002]

Data Sources

Community-supplied data may be in the form of digital orthophotos or vector data files. Locally produced digital orthophotos may be at larger scales and higher resolution than USGS DOQs, but they must meet USGS DOQ standards at a minimum. Aerial images that are not ortho-rectified are not acceptable. Vector files may be photogrammetrically compiled or digitized from orthophotos. Unacceptable vector file sources include TIGER files or other files compiled at scales smaller than 1:20,000.

[February 2002]

Currency

The data must have been created or reviewed for update needs within the last 7 years.

[February 2002]

Coverage

Complete and integrated data for an entire county are preferred. If only portions of a county are available, FEMA may choose to use the default base map source (USGS DOQs) for the county.

[February 2002]

Availability

The data must be available at the time of the initial coordination contact and must be sent within 30 days of receipt of FEMA's request.

[February 2002]

Restrictions on Use

FEMA must be able to print and distribute an unlimited number of hardcopy maps using the data. FEMA must also be able to distribute the base map data and floodplain information freely to the public. Conversion of vector base map data to a raster format for distribution is an option if this satisfies community concerns over release of proprietary data.

[February 2002]

Required Contents

The files must contain all transportation features (e.g., roads, railroads, and airports) in the community. If DOQs are supplied, these features must be clearly visible. If vector files are supplied, they must also contain transportation features. Roads are considered to be those travelways intended and maintained for use by motorized vehicles. In vector format, roads may be portrayed as road centerlines or edges of pavement.

The USGS DOQs or community-supplied transportation features shall be augmented with the following vector data if available:

- Hydrographic features, including streams, rivers, lakes, and shorelines;
- Current political boundaries, including those that define the county, corporate limits, extraterritorial jurisdictional areas, military lands, and Native American lands;
- Parks or forest lands, if applicable;
- Range, township, and section lines, if applicable; and
- Feature names for all of the above features that have names. These may be provided as annotation/text features or as attributes.

[February 2002]

Optional Contents

The following features shall be included, if available:

- Bridges;
- Unimproved roads or trails (i.e., those travelways not intended for motorized vehicles or not usually used by motorized vehicles due to width or seasonal conditions);
- Flood-control structures (levees, dams, weirs, floodwalls, or jetties);
- Elevation data in the form of contours and spot elevations, DEM or DTM data, a Triangulated Irregular Network, or mass points and break lines;
- Building footprints;

- Parcel outlines or parcel centroids; and
- Mass points and break lines and the resulting data that are derived from them, if available.

[February 2002]

Thematic Separation of Data

Thematic data must be separated by level, layer, attribute, or file.

[February 2002]

File Format and Transfer Media

The file format and transfer media requirements provided in Appendix L of these Guidelines must be met.

[February 2002]

Tiling

One single file or a series of thematic files that cover the entire geographic area of the community are preferred to individual small tiles that cover limited geographic areas.

[February 2002]

Data Structure

Vector data files must meet the data structure requirements provided in Appendix L of these Guidelines.

[February 2002]

Metadata

The files must be accompanied by metadata that comply with the Federal Geographic Data Committee metadata standards.

[February 2002]

1.4.3.2 Flood Insurance Rate Map Compilation

The Mapping Partner responsible for the production of the Preliminary FIS report and FIRM shall normally conduct the FIRM compilation process. This process shall normally occur concurrently with the preparation of new or revised flood hazard analyses.

The compilation process includes determining FIRM scale, layout and paneling scheme, digitizing effective floodplain and regulatory floodway information, and fitting the effective floodplain regulatory floodway information to the new base map.

[February 2002]

Map Scale Selection

The scale to be used for the development of the Preliminary FIS should be coordinated during the Scoping Meeting with the FEMA Lead, FEMA's Mapping Partners, and the community/county prior to compilation of the maps.

Existing FIRM scales should be reviewed and, where appropriate, either the same map scales or a compatible map scale should be used for the Mapping Partner draft work maps. Existing small-scale FIRM panels are often remapped at larger scales to accommodate detailed floodplain mapping with narrow floodplains and/or floodways.

To accomplish this at a reasonable cost, FEMA will photo-enlarge the existing base map artwork to be used as-is for the revised FIRM. For example, one panel of an existing FIRM at a scale of 1" = 1,000' may need to be photo enlarged by the review Mapping Partner 200 percent to create four, 1" = 500' scale panels due to the narrowness of the new floodplain delineations. If the existing FIRM is at the scale of 1" = 1,000', the Mapping Partner should prepare the work maps at 1" = 1,000' (or 1" =5 00' if the floodplains are narrow). If a work map scale of 1" = 400' was used by the Mapping Partner, FEMA would either photo-reduce the work maps to match the existing FIRM base materials or redraft the entire FIRM to match the work map scale. Older, manually produced FIRMs may have been prepared with different map scales (e.g., 1" = 200', 1" = 400'. 1" = 800'). Manual revisions of those panels may retain their existing scales.

[February 2002]

Paneling/Tiling Scheme

During the Scoping Meeting for a Flood Map Project, the paneling scheme and scale of mapping used for data capture and work maps shall be determined. The FIRM paneling scheme shall follow that used by USGS for the 7.5-minute quadrangle series, or subdivisions thereof depending on the scale of the FIRM. Map panels shown at 1" = 2,000' are tiled using the same neatlines as the corresponding USGS 7.5-minute quadrangles. Map panels shown at 1" = 1,000' are tiled using neatlines that correspond to USGS DOQs or 3.75-minute quarter-quadrangles. Map panels shown at 1" = 500' are tiled using neatlines that correspond to USGS 1.875-minute quarter-quarter-quadrangles.

The quadrangle tiles shall generated using the horizontal datum of the base map. If the base map is in NAD83, the quad grid shall be generated in NAD83 and projected to match the coordinate system of the base map.

[February 2002]

Guidelines for Conversion to Quad Tiling for Small Communities

When small jurisdictions that were formerly shown on one or a few FIRM panels now fall on significantly more panels as a result of quad-based tiling, the paneling scheme can be modified from strictly quad-based. If conversion to a quad paneling layout would double the panel count,

or if the FIRM was formerly shown as an Only Panel Printed and the quad layout necessitates creation of a FIRM Index, a modified paneling scheme may be used.

[February 2002]

North Orientation

All digital FIRMs must be oriented so that grid north points to the top of the map sheet. Older manual FIRMs may have been prepared with a different north orientation. Manual revisions to those panels may retain their existing north orientation.

[February 2002]

Rotation

The FIRM data do not need to be rotated to align exactly to the map border. The slight tilt inherent in the data as the panels move farther away from the central meridian is acceptable.

[February 2002]

Coordinate System and Horizontal Datum

A standard coordinate system and horizontal datum for all FIRMs is preferred so that they can be easily referenced to each other. Additionally, FEMA's goal is to maintain nationwide FIRM datasets in a central online repository and maintenance of the digital FIRMs in a common coordinate system and horizontal datum facilitates this as well.

The preferred coordinate system for FIRMs is UTM referenced to NAD83. This coordinate system and horizontal datum are most commonly used by USGS for DOQs. FIRMs may be prepared in other coordinate systems and horizontal datums if necessary. This situation primarily applies to studies that use a raster base map supplied in a coordinate system other than UTM NAD83. Raster base map data are not reprojected if at all possible, since this operation is so time consuming. The FIRM vectors are projected to fit the raster base map data.

[February 2002]

Map Insets

All geographic areas shown on FIRMs must be created and maintained in real-world coordinates. Map insets a generally shall not be used in preparing FIRMs because of this requirement. Narrow, extensive areas around the perimeter of a jurisdiction may be added to existing, adjacent map sheets as overedge areas, if space permits. Larger areas may require a separate map panel.

[February 2002]

Panel Numbering

After the map scale(s) and layout for a community have been established, the map panels are numbered. FIRMs use a panel numbering sequence that relates panel number to map scale.

Panels shown at 1" = 500' use numbers divisible by 1; panels at 1" = 1,000' use numbers divisible by 5 (excluding those divisible by 25) and panels at 1" = 2,000' use numbers divisible by 25. Table 1-5 further illustrates the numbering sequence corresponding to the various map scales.

Table 1-5. Panel Numbering Sequence

Map Scale	Panel Numbers
1" = 500'	1, 2, 3, 4, 6, 7, 8, 9, 11, 12, 13, 14, 16, 17, 18, etc.
1" = 1,000'	5, 10, 15, 20, 30, 35, 40, 45, 55, 60, 65, 70, etc.
1" = 2,000'	25, 50, 75, 100, 125, 150, 175, 200, 225, 250, etc.

[February 2002]

Single-Scale Flood Insurance Rate Maps

Single-scale FIRMs are those in which all panels within the community or county are printed at the same scale. The panel numbering follows sequentially from left to right and from top to bottom according to the scale. Figure 1-5 contains an example of a FIRM with all panels shown at a scale of 1" = 500'.

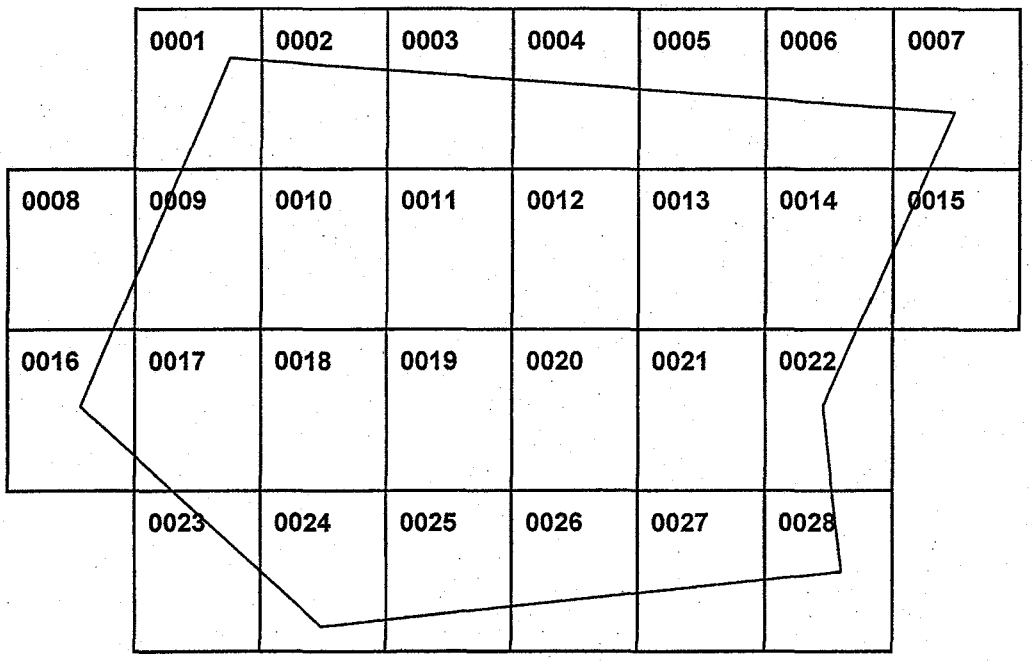


Figure 1-5. Single-Scale Panel Numbering Scheme (1" = 500')

[February 2002]

Multiple-Scale Flood Insurance Rate Maps

Multiple-scale FIRMs are to be numbered based on a logical breakdown of USGS 7.5-minute series quadrangle sheets. To accomplish this, the Mapping Partner may envision a USGS quadrangle as having 16 possible subdivisions, with the smallest block being a 1" = 500' scale segment and the largest block being the entire quadrangle at a scale of 1" = 2000'.

Beginning with the first small-scale map panel, the four large-scale map panels that lie within the grid layout of the larger "parent" panel are numbered sequentially from left to right and top to bottom. The associated small-scale map panel is numbered sequentially after the four large-scale panels the area of which it duplicates (i.e., panel 0025 covers the same geographical area as panels 0005, 0010, 0015, and 0020 combined). This numbering system is continued in a similar manner to the numbering system for single-scale maps; that is, the next number series would be 0030, 0035, 0040, and 0045 for the larger-scale panels, followed by 0050 for the smaller-scale panel. Figure 1-6 illustrates this system. Figure 1-7 contains an example of a FIRM with panels shown at different scales.

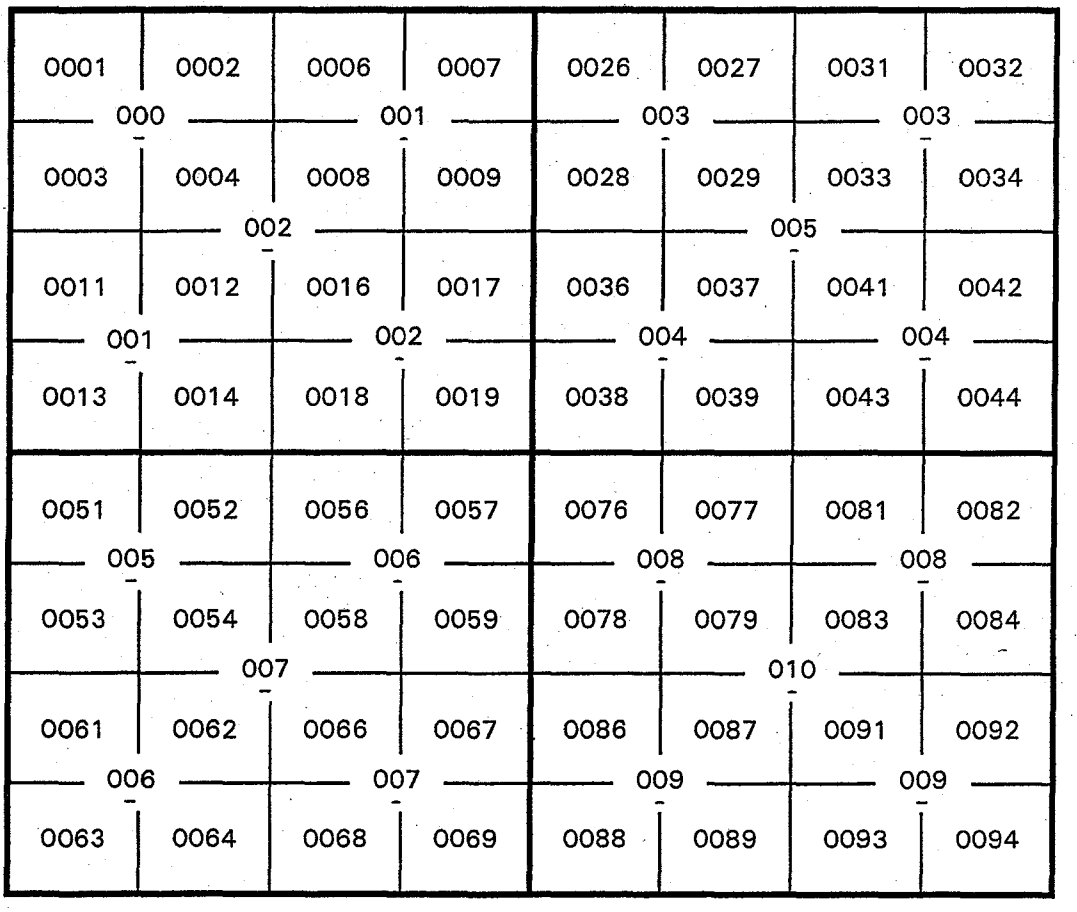


Figure 1-6. Multiple-Scale Panel Numbering Scheme

(Heavy lines indicate USGS 7.5-minute quadrangle neatlines)

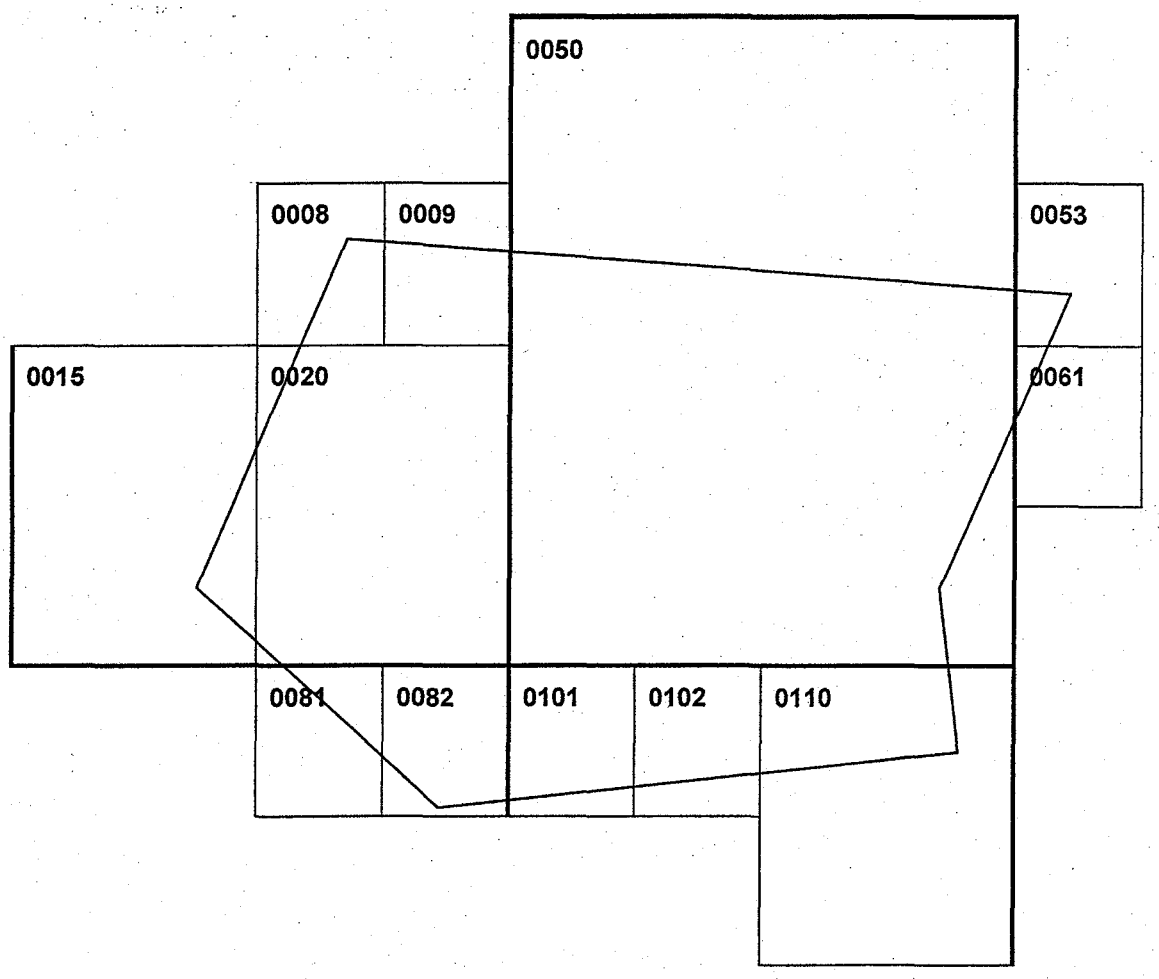


Figure 1-7. Multiple-Scale Panel Numbering Scheme

(Heavy lines indicate USGS 7.5-minute quadrangle neatlines)

[February 2002]

Digitization and/or Enhancement of Effective Floodplain Boundaries

This phase of the FIRM production process focuses on digitizing and/or enhancing the effective, unrevised flood hazard information to meet FEMA's mapping specifications. This stage in the development of the Preliminary FIRM is often where existing flood hazard information that is not being restudied is transferred from the effective FIRM (and, in some cases, FBFM) onto a newer and/or community base map. This process does not require new or updated flood hazard analyses or topographic information for the identified flooding sources on the effective FIRM. Appendix C, Subsection C.6.1 of these Guidelines provides details on the protocol for the transfer of effective flood hazard data onto a new or updated base map source.

[February 2002]

1.4.3.3 Merging Revised and Effective Flood Hazard Data

The focus of this stage of map production is to merge the revised flood hazard information together with the effective flood hazard information to construct the Preliminary FIRM. All supporting information in the effective FIS report also must be merged with the new/revised flood hazard data resulting from the Flood Map Project.

[February 2002]

Seamless Data

The designated Mapping Partner shall ensure that the effective and new or revised flood hazard data are compiled into a seamless data with no discontinuities. All inconsistencies between new/revised flood hazard data and unrevised/effective flood hazard data must be identified during the Project Scoping phase and resolved as appropriate in consultation with the FEMA Lead before work commences. The Mapping Partner responsible for the flood hazard data development shall ensure that revised flood hazard data ties in reasonably well to the effective floodplain data. The potential mismatches should have been identified during the scoping phase and addressed at that time. Any problematic residual tie-in issues shall be brought to the attention of the FEMA RPO and/or PO.

[February 2002]

Countywide Format Issues

During the initial creation of a countywide FIS report and FIRM, the Mapping Partner that creates the Preliminary FIS report and FIRM shall ensure that flood hazard data originating from formerly community-based FIRMs are properly merged. This will require the following:

- Flood Profiles for streams crossing corporate limits shall be combined into one seamless set. Any identified discontinuities shall be addressed and resolved. Accordingly, data tables in the FIS report shall reflect a continuous dataset for each detailed flooding source.
    - Cross sections shall be re-lettered as appropriate to ensure continuity from the downstream beginning of the detailed study to the upstream limit of detailed study.
    - Differences in stream names crossing through different communities shall be addressed and resolved.
    - Differences in flood hazard data across corporate limits of adjacent jurisdictions shall be identified and resolved.
    - Gaps or overlaps in aerial coverage shall be identified and resolved.

[February 2002]

Areas Not Included

The following is a brief summary of the protocol to follow when the designated Mapping Partner encounters an "Area Not Included" during the preparation of the Preliminary FIRM; additional guidance is provided in Appendix K of these Guidelines.

An Area Not Included is defined as an area excluded from the mapping of the subject community because (1) it is under the jurisdiction of another community and is mapped on the FIRM for that community, or (2) access to the area is limited due to security reasons (e.g., military installations). The assigned Mapping Partner shall submit any available flood information within these areas. The decision for depicting the information on the FIRM is the responsibility of the FEMA Lead.

Areas subject to Federal or State jurisdiction (e.g., parks, national forests, game reserves, certain military bases) shall normally be included on the FIRM. When the assigned Mapping Partner encounters an area such as these, the FEMA Lead shall be consulted for guidance. The Mapping Partner may be requested to assess and delineate SFHAs in these areas using available source maps, such as USGS floodprone area quads. Where existing SFHA delineations on an effective FIRM are terminated at the boundary of an improperly excluded area, the FEMA Lead may request that the Mapping Partner responsible for the flood hazard analyses use detailed topographic mapping to extrapolate floodplain boundaries through the subject area.

[February 2002]

1.4.3.4 Summary of Map Action Preparation

To assist communities in maintaining the NFIP maps, particularly the FIRM, the Mapping Partner responsible for preparing the Preliminary FIS report and FIRM shall prepare summaries of the LOMAs, LOMR-Fs, and LOMRs that will be superseded when the revised FIRM panels become effective. FEMA provides these Summaries of Map Actions (SOMAs) to the communities at significant milestones during the processing of a Flood Map Project that results in a physical update to the FIRM to make the affected communities aware of the effect the revised FIRM panels will have on previously issued LOMAs, LOMR-Fs, and LOMRs.

To ensure the modifications made by LOMAs, LOMR-Fs, and LOMRs are included in a physical map update, the assigned Mapping Partner shall perform searches for determinations at four stages: (1) before the Preliminary copies of the affected FIRM panel(s) are prepared and sent to the community for review and comment; (2) before Revised Preliminary copies of the affected FIRM panel(s) are prepared and sent to the community for review and comment; (3) before the Letter of Final Determination (LFD) letter is sent to the community; and (4) before the effective date of the revised FIRM panels.

At each stage, the assigned Mapping Partner shall sort the LOMAs, LOMR-Fs, and LOMRs into the following categories:

- Category 1 includes those LOMAs, LOMR-Fs, and LOMRs for which the results have been shown on the revised FIRM panel(s).

- Category 2 includes those LOMAs and LOMR-Fs for which the results could not be mapped and shown on the revised FIRM panel(s) because of scale limitations or because the affected areas were determined to be outside the SFHA as shown on the effective FIRM. These LOMAs and LOMR-Fs are automatically revalidated after the revised FIRM panel(s) become(s) effective.

- Category 3 includes those LOMAs, LOMR-Fs, and LOMRs for which the results have not been, and will not be, reflected on the revised FIRM panel(s) because the flood hazard information on which the original determinations were based is being superseded by new flood hazard information.

- Category 4 includes those LOMAs, LOMR-Fs, and LOMRs for which new determinations must be made. LOMAs and LOMR-Fs that were previously issued for multiple lots or structures where the determination for one or more of the lots or structures has changed as a result of the re-mapping cannot be revalidated through the revalidation process. The assigned Mapping Partner shall use the data submitted in support of the original LOMA or LOMR-F request to make a new determination after the revised FIRM becomes effective. A single new determination letter is issued for the subject properties.

During the preparation of the Preliminary copies of the FIRM (and FBFM, if required), the activities below shall be completed. Additional information on SOMA production procedures is provided in Section 10 of *Document Control Procedures Manual* (FEMA, 2000).

- The designated Mapping Partner shall produce a Preliminary SOMA by generating a report of LOMAs, LOMR-Fs, and LOMRs completed or pending for the community.

- The designated Mapping Partner shall review the in-house LOMA, LOMR-F, and LOMR case files, other community-based files, hard copies of LOMAs and LOMR-Fs completed by the ROs, and case files for LOMAs, LOMR-Fs, and LOMRs completed by the designated Mapping Partner to ensure all affected LOMAs, LOMR-Fs, and LOMRs are identified and listed on the SOMA. LOMAs, LOMR-Fs, and LOMRs that have already been superseded by a previous map (i.e., its determination date is prior to the current effective FIRM date) will not be investigated for inclusion on the SOMA.

- The designated Mapping Partner shall review each identified LOMA, LOMR-F, and LOMR to determine whether it has been affected by new flood hazard information and if it can be incorporated into the FIRM. Those LOMAs, LOMR-Fs, and LOMRs that are unaffected by the new flood hazard information and can be reflected on the FIRM are listed in Category 1 of the SOMA. Those LOMAs, LOMR-Fs, and LOMRs that cannot be reflected on the FIRM but are unaffected by the updated flood hazard information are listed in Category 2 of the SOMA.

- For the remaining LOMAs and LOMR-Fs, the designated Mapping Partner shall review the case files to determine whether the LOMA or LOMR-F can be revalidated.

To determine this, the designated Mapping Partner shall perform the following activities:

- Locate the LOMC site on the Preliminary FIRM;
- Determine the proposed BFE for the site; and
- Compare the Lowest Adjacent Grade (LAG), or the lowest ground elevation of undeveloped lot(s) to the proposed BFE at the site.
- If the LAG(s) or lowest ground elevation at the site is above the proposed BFE, the designated Mapping Partner shall include the LOMA or LOMR-F in Category 2 of the SOMA, because it may be eligible for revalidation once the proposed BFEs are finalized. LOMAs and LOMR-Fs issued for properties with a LAG(s), LFFE(s), or lowest ground elevations below the BFE may be superseded and therefore may be included in Category 3 of the SOMA.
- As noted above, LOMCs are revalidated by a single letter, the LOMC-Valid letter; therefore, the designated Mapping Partner shall include the LOMAs and LOMR-Fs issued for multiple structures or lots where the determinations for the lots/structures are no longer as they were for the original determination in Category 4 of the SOMA.
- The designated Mapping Partner shall distribute the draft SOMA with the transmittal letter that accompanies the Preliminary copies
- If no LOMAs, LOMR-Fs, and LOMRs have been issued since the affected FIRM panel(s) became effective, the designated Mapping Partner prepare a SOMA that indicates that there are no LOMCs involved with the subject Flood Map Project. In addition to this, an explanatory paragraph shall be included in the Preliminary transmittal letter to acknowledge this fact.

[February 2002]

1.4.3.5 Incorporation of Letters of Map Change

The Mapping Partner responsible for preparing the Preliminary FIS report and FIRM shall ensure that previously issued LOMAs, LOMR-Fs, and LOMRs are incorporated into the new FIS report and FIRM where new or revised flood hazard information do not supersede the determination made by the LOMC. The designated Mapping Partner shall include the outline of the areas covered by LOMCs with the submitted FIRM information. Guidance on the data formats and attributes for these features are provided in Appendix L of these Guidelines.

[February 2002]

1.4.3.6 News Release Notice Preparation

During the processing of a new or revised FIRM, a News Release notice is required for each community for the purpose of proposing new or revised 1-percent-annual-chance flood elevations. The News Release is critical in the initiation of the statutory 90-day appeals process.

The designated Mapping Partner must therefore prepare a News Release notice for publication that lists all new or revised BFEs appearing on the FIRM. The publication of the News Release Notice shall be in accordance with the specifications noted in Section 1.5 and the regulations found at Section 67.3 of the NFIP Regulations.

The News Release Notice is intended to:

- Provide the community information on proposed BFEs;
- Direct citizens to review the Preliminary FIS before the study becomes effective;
- Provide property owners awareness of proximity to detailed study 1-percent-annual-chance floodplains;
- Inform citizens where they can view or obtain copies of the preliminary and effective FIS report and FIRM; and
- Provide a complete list of studied and/or revised flooding sources and the proposed BFEs (lowest and highest) for each flooding source.

The following are guidelines that shall be used to prepare a News Release Notice:

- List the extreme BFEs (lowest and highest, rounded to the nearest whole foot) for new or revised flooding sources.
- List only one elevation for a given location.
- Never list a range of elevations for a given flooding source (i.e., 426 to 532 or 426-532).
- List the lowest (downstream) elevation and description of the location first, then the highest (upstream) and its location.
- Provide the latitude and longitude (if possible) for each referenced elevation.
- Use the Flood Profile to determine the proposed BFE whenever possible.
- For flooding sources not be represented by Flood Profiles, determine the flood elevations from supporting data tables in the FIS report or from the FIRM. For a coastal flooding source, the lowest BFE will likely be determined from a Zone AE area and the highest from a Zone VE area.

- For Zone AO (an area of shallow flooding with depths between 1 and 3 feet), show the depth as "#1", "#2", or "#3"

- For Zone AH, an area of shallow flooding with a BFE, shown the BFE as *(BFE number).

- For proposed BFE revisions, the location and elevation listed for the proposed revised elevation shall be at the point where there is only a one foot (rounded to the nearest whole foot) difference between the effective and the revised elevations. Exceptions are when the revision limits are at the corporate limits, Limit of Detailed Study, or stream confluence, or for any coastal flooding sources. For proposed revisions to existing BFEs, when determining the lowest and highest revised BFE value, it is important to note that the difference between effective and revised elevations may be as little as 0.1 foot. For example, an effective elevation of 55.4 (which rounds to 55) is revised to an elevation of 55.5 (which rounds to 56). Conversely, an effective elevation of 55.5 and revised elevation of 56.4 both round to 56; therefore this is not considered a changed elevation.

- If the Flood Profile for a detailed study tributary of a revised flooding source has been revised solely due to the backwater effects from that flooding source, entries for lowest and highest elevation change entries may be necessary on the News Release. The following guidelines shall be followed in this case.

- The tributary requires its own News Release entries if the effects of the backwater extend more than 500 feet upstream of the tributary's confluence with the flooding source.

- If the backwater effects are less than 500 feet, the entries for the flooding source will cover the backwater elevations of the tributary. No separate entries are necessary.

- Follow the guidance below for the listing of location reference points on a News Release Notice:

  - Points shall be reflected on the Flood Profile.

  - Avoid using arbitrary points or points with no definite name (i.e., Unnamed or Access Road).

  - "Limits of Detailed Study" may be used only if it is the nearest point on the Flood Profile for 2 or less miles and it can be referenced to a stable point such as the confluence with the main flooding source or a named structure.

  - Convert the measured distance to miles (rounded to the nearest 1/10 mile) when the measured distance exceeds 2,000 feet Avoid referencing points that are great distances (more than three miles) from the subject elevation.

  - Describe distances as "approximately (measured distance) upstream/downstream of."

- Describe locations in close proximity (less than 50 feet) to a structure as "upstream side of" or "downstream side of."

- Reference Zone AO or AH shallow flooding areas by the surrounding streets. For example: "Between Jones Road and Main Street" and "300 feet north of Jones Road and 500 feet west of Main Street."

- Relate the coastal elevation reference points to a point on the shoreline. Flooding areas affected by a single elevation such as with a lake can be referenced as the entire shoreline.

The Sample Base Flood Elevations Worksheet in Figure 1-8 is provided as a guide for the Mapping Partner preparing the News Release.

Flooding Source(s)	Location of Referenced Elevation	Latitude (optional)	Longitude (optional)	BFE (NGVD)	
				Effective	Proposed

Figure 1-8. Base Flood Elevations Worksheet

[February 2002]

1.4.3.7 Countywide News Release Notice

The Mapping Partner responsible for preparing the Preliminary FIS report and FIRM shall prepare a single News Release for communities covered by a FIRM prepared in the FEMA Countywide format. This News Release will then be published in the appropriate local newspaper(s) to initiate the 90-day appeal period for each community. The Countywide News Release will provide a listing for each stream that has proposed BFE changes at any location within the subject county, and will include a column to indicate the communities affected by the new or revised flood elevations.

There are four distinct situations that will necessitate a news release entry for a stream in a countywide format FIRM. These situations are as follows:

- The subject stream has either been restudied or is newly studied within the county.

- The subject stream was studied by detail methods in adjacent communities within the county, but the former community-based FIRMs do not exhibit a seamless match of BFEs across community boundaries. In this situation, one of the two mismatched datasets must be adjusted to agree with the one that is considered to be the most

recent and accurate. The revised BFEs shall be listed on the Countywide News Release and the affected jurisdictions will be noted appropriately.

- The subject stream has been studied by detail methods in one community but has either not been studied or has been studied by approximate methods in an adjacent community. The former Zone A floodplain must be converted to a detailed Zone AE with BFEs, thereby necessitating a News Release entry.

- The floodplain for a detailed-study stream has been extended into an adjacent community to achieve a seamless match across jurisdiction boundaries. This scenario may occur even if the subject stream does not physically lie in the affected jurisdiction, but its associated floodplain extends across jurisdiction boundaries.

- The sample Countywide Base Flood Elevations Worksheet in Figure 1-9 is provided as a guide for the Mapping Partner preparing the countywide format News Release.

Flooding Source(s)	Location of Referenced Elevation	Latitude (optional)	Longitude (optional)	BFE (NGVD)		Communities Affected by the Proposed BFEs
				Effective	New/ Revised	

Figure 1-9. Countywide Base Flood Elevations Worksheet

[February 2002]

1.4.3.8 Preparation of the Preliminary Flood Insurance Study Report

The Mapping Partner responsible for preparing the Preliminary FIS report shall incorporate any corrections resulting from the technical review, coordinating such revisions with the Mapping Partner responsible for performing the analyses, the FEMA Lead, and other Project Team members. When required, the designated Mapping Partner shall prepare the FIS report in final form in accordance with the requirements and specifications provided in Appendix J. Preliminary copies and, if necessary, Revised preliminary and proof copies of the FIS report shall be distributed to the affected community or communities at each of the processing stages.

During the preparation of the Preliminary FIS report, the designated Mapping Partner shall also develop and process the SOMc and the News Release of new and revised flood elevations.

[February 2002]

1.4.3.9 Preliminary Map Specifications and Standards

The designated Mapping Partner shall prepare the Preliminary FIRM in accordance with the specifications provided in Appendix K, Section K.1 of these Guidelines. The formats described in Appendix K include Digital, Map Initiatives, Partial Map Initiatives, Countywide, Single-Jurisdiction, FIRM and FIS Report Combinations, FIRM/FBFM (Standard), and Manual.

[February 2002]

Mapping and Flood Insurance Risk Zone Standards

While unique themes and presentation formats may be coordinated with FEMA on a case-by-case basis, there are specific core mapping standards and components that must be followed in preparing FIS reports and FIRMs.

Many of these standards are detailed throughout these Guidelines. Mapping Partners that wish to deviate from any of these core mapping standards and formats must coordinate an exception directly with the FEMA and the other Project Team members.

[February 2002]

Mapping Standards

A list of Core Mapping Standard components to be used by all Mapping Partners is as follows:

- The 1-percent-annual-chance floodplains (the national standard) will be mapped on the FIRM.
- Whole-foot BFEs will be shown within detailed-study floodplains; exceptions to this are made where BFEs are expressed in metric increments such as Puerto Rico.
- The 0.2-percent-annual-chance floodplains will be on the fringe of detailed-study 1-percent-annual-chance floodplains when available.
- Regulatory floodways will be mapped within the 1-percent-annual-chance floodplain and must meet the minimum standards outlined in Paragraph 60.3 (d) (3) of the NFIP regulations.
- Stream channel boundaries or centerlines must stay within the identified 1-percent-annual-chance floodplain; if a regulatory floodway is developed, the stream must stay within the regulatory floodway boundaries.
- For detailed-study streams, cross sections must be shown to represent the riverine hydraulic analysis.
- Transects must be shown to represent the coastal hydraulic analysis.
- Flood insurance risk zone labels must be present on the FIRM for each zone.
- "Flood Insurance Rate Map" will be the official name appearing on the FIRM, regardless of whether it is produced manually or digitally.
- "Flood Insurance Study" will be the official name appearing on the FIS report cover.
- "Flood Boundary and Floodway Map" will be the official name appearing on the FBFM, if one is produced.

- The FEMA logo will appear in the FIRM (and FBFM) title block and on the FIS report cover.
- The proper use of leaders to flood hazard zone and map features must be applied. (See Appendix K of these Guidelines.)
- Roads in and near identified Special Flood Hazard Areas must be labeled.
- Studied flooding sources must be labeled.
- FIRM legend and border notes specified in Appendix K of these Guidelines must be used.
- Procedures for mapping multiple-county communities must be followed as detailed in Appendix K, Subsection K.1.5.1 of these Guidelines.

During various phases of the Flood Map Project process, it is recognized that certain Mapping Partners will want to portray unique mapping formats and flood hazard themes on FIRMs. FEMA partners must recognize that certain core features must be present in order to facilitate the writing of flood insurance policies and to maintain consistent national floodplain management standards. Examples of deviations from these standards are the tiling of FIRM panels to a unique grid system; the portrayal of floodways reflecting future conditions; or a reference to a CTP or State seal to accompany the FEMA seal on the FIRM title block. All such exceptions must be coordinated and approved in advance with FEMA.

[February 2002]

Flood Insurance Risk Zone Standards

Flood insurance risk zones are defined in the Section 64.3 of the NFIP regulations and further described on the prototype FIRM Legend information provided in Appendix K, Section K.5 of these Guidelines.

In addition to the mapping standards listed above, the standards listed below for flood insurance risk zones shall be applied by all Mapping Partners participating in Flood Map Projects.

To assist the insurance agent in determining actuarial flood insurance rates for specific properties, each floodplain or special flood hazard area is divided into flood insurance rate zones that are based on the floodplain boundaries determined in an FIS. The Mapping Partner preparing the hydrologic and hydraulic analyses shall designate appropriate flood insurance risk zones on the submitted work map. Areas within the 1-percent-annual-chance floodplain boundary are termed Special Flood Hazard Areas; areas between the 1- and 0.2-percent-annual-chance floodplain boundaries are termed Areas of Moderate Flood Hazard; and remaining areas above the 0.2-percent-annual-chance floodplain are termed Areas of Minimal Flood Hazard. The areas are subdivided into flood insurance rate zones according to the criteria discussed below.

Zone A

Zone A is the flood insurance rate zone that corresponds to the 1-percent-annual-chance floodplains that are determined in the FIS by approximate methods. Because detailed hydraulic analyses are not performed for such areas, no BFEs or depths are shown within this zone.

Zone AE

Zone AE is the flood insurance risk zone that corresponds to the 1-percent-annual-chance floodplains that are determined in the FIS by detailed methods. In most instances, BFEs derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

Zone AH

Zone AH is the flood insurance risk zone that corresponds to the areas of 1-percent-annual-chance shallow flooding with a constant water-surface elevation (usually areas of ponding) where average depths are between 1 and 3 feet. The BFEs derived from the detailed hydraulic analyses are shown at selected intervals within this zone. A description of technical methods used to identify these areas is provided in Appendix E of these Guidelines.

Zone AO

Zone AO is the flood insurance risk zone that corresponds to the areas of 1-percent-annual-chance shallow flooding (usually sheet flow on sloping terrain) where average depths are between 1 and 3 feet. The depth should be averaged along the cross section and then along the direction of flow to determine the extent of the zone. Average depths derived from the detailed hydraulic analyses are shown within this zone. A description of technical methods used to identify these areas is provided in Appendix E of these Guidelines. In addition, alluvial fan flood hazards are shown as Zone AO on the FIRM. For a comprehensive description of alluvial fan studies, refer to Appendix G of these Guidelines.

Zone A99

Zone A99 is the flood insurance risk zone that corresponds to areas of the 1-percent-annual-chance floodplain that will be protected by a Federal flood protection system where construction has reached specified statutory milestones. No BFEs or depths are shown within this zone.

Zone AR

Zone AR is the flood insurance risk zone that corresponds to areas of special flood hazard that results from the decertification of a previously accredited flood protection system that is determined to be in the process of being restored to provide a 1-percent-annual-chance or greater level of flood protection.

Zone V

Zone V is the flood insurance risk zone that corresponds to the 1-percent-annual-chance coastal floodplains that have additional hazards associated with storm waves. Because approximate hydraulic analyses are performed for such areas, no BFEs are shown within this zone.

Zone VE

Zone VE is the flood insurance risk zone that corresponds to the 1-percent-annual-chance coastal floodplains that have additional hazards associated with storm waves. BFEs derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

Zone X

Zone X is the flood insurance risk zone that corresponds to areas outside the 1-percent-annual-chance floodplain, and areas of 1-percent-annual-chance sheet flow flooding where average depths are less than 1 foot, areas of 1-percent-annual-chance stream flooding where the contributing drainage area is less than 1 square mile, or areas protected from the 1-percent-annual-chance flood by levees. No BFEs or depths are shown within this zone.

Zone D

Zone D is the flood insurance risk zone that corresponds to unstudied areas where flood hazards are undetermined, but possible. Zone D designation may not be used in Flood Insurance Studies unless otherwise approved by the Regional Project Officer. It should be noted that the Mapping Partner is not required to perform a flood hazard factor analysis and subsequent Zone A1-A30 or AE determination even though this information may currently be reflected on a community's FIRM published in the non-map initiative format.

If community officials request that FEMA show future-conditions flood hazard information on the FIRM, the future-conditions flood insurance risk zone—Zone X (Future Base Flood)—shall be referenced on the FIRM and in the FIS report. Zone X (Future Base Flood) shall be defined in the FIRM legend and in the FIS report as follows:

> Zone X (Future Base Flood) is the flood insurance risk zone that corresponds to the 1-percent-annual-chance floodplains that are determined based on future-conditions hydrology. No BFEs or base flood depths are shown within this zone.

[February 2002]

1.4.3.10 Development of Spatial Database for Digital Maps

When developing new flood hazard data, FEMA's goal is to produce a version that can be used in the GIS environment. By structuring and storing its flood hazard data in a GIS format, FEMA expects to be able to increase the utility and value of these data. The Mapping Partner will be responsible for creating the finished digital FIRM GIS Database in conjunction with the creation of the finished FIS report and FIRM.

To facilitate community review of the Preliminary FIS produced by FEMA, the designated Mapping Partner must produce a Preliminary digital FIRM Database. The Preliminary digital FIRM Database shall be distributed for review with the hard-copy FIS report and FIRM.

The Preliminary digital FIRM Database shall also be sent to FEMA for the initial independent QA/QC review at this time. This QA/QC review will occur in parallel with the community review of the Preliminary FIS report, FIRM and digital FIRM Database.

To provide a consistent digital flood hazard data product, the Preliminary digital FIRM Database must meet the specifications in Appendix L of these guidelines. The requirements for the Preliminary digital FIRM Database are the same as for the Final digital FIRM Database with the exception of database field that contains the effective date of the current FIRM. These fields are left blank for the Preliminary digital FIRM Database.

The files must be accompanied by metadata that comply with the Federal Geographic Data Committee metadata standards. See Appendix L for details.

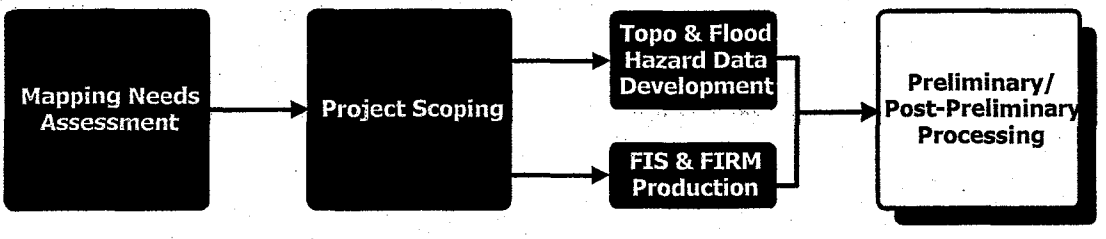
[February 2002]

1.4.4 Status Reporting

Specific reporting requirements for each Mapping Partner will be specified in the task order or MAS for the Flood Map Project. If so directed by the FEMA Lead, Mapping Partners shall use the FEMA Monitoring Information on Contracted Studies database for reporting purposes. Additional information on this database is provided in Volume 3 of these Guidelines.

[February 2002]

1.5 Preliminary and Post-Preliminary Processing



As shown in Figure 1-2, during the Project Scoping phase of the Flood Map Project, FEMA will assign Preliminary and post-Preliminary processing support tasks to the appropriate Mapping Partner. The designated Mapping Partner shall follow the required procedures for preparing and distributing new and revised FIS reports and FIRMs, standard correspondence, and enclosures as documented in Section 1 and Appendix A of the *Document Control Procedures Manual* (FEMA, 2000). FEMA will update the document processing procedures detailed in the *Document Control Procedures Manual* to incorporate FEMA policy and procedure changes. FEMA will notify the designated Mapping Partner of these policy and procedure changes through memorandums. FEMA also will notify all Mapping Partners of these changes by posting updates to the *Document Control Procedures Manual* and posting the policy and procedure memorandums themselves on the FEMA Flood Hazard Mapping website at http://www.fema.gov/mit/tsd/frm_docs.htm.

During the Preliminary processing phase, the designated Mapping Partner, with the approval of the FEMA RPO and the PO at FEMA HQ, shall prepare and distribute Preliminary copies of the new or revised FIS report and FIRM. During the phase following the issuance of the Preliminary FIS report and FIRM—referred to as the Post-Preliminary processing phase—community officials, residents, and other interested parties shall have several opportunities to review and comment on the FIS report and FIRM. During the Post-Preliminary processing phase, the following activities are likely to occur:

- The FEMA CCO will hold a public meeting with community officials, residents, and other interested parties to present and explain the new or revised FIS report and FIRM and review NFIP requirements with the affected communities.
- FEMA will, if new or modified BFEs result from the Flood Map Project, initiate a 90-day appeal period to allow community officials and other interested parties to submit scientific or technical data in an effort to refute the findings of the Flood Map Project.
- Community officials and interested parties will inform FEMA of their agreement with the project results or submit data in support of an appeal or protest them during the statutory 90-day appeal period.
- FEMA will consider and evaluate all comments received during the 90-day appeal period and resolve all appeals and protests in consultation with the communities.

- FEMA will provide communities with a compliance period to make any necessary changes to their floodplain management ordinances.
- The community will update its ordinances as appropriate and submit them to FEMA for approval.
- The designated Mapping Partner will perform final QA/QC checks on the FIS report and FIRM and will prepare the final versions of the new or revised FIS report and FIRM for publication.
- The Mapping Partner will submit the final versions of the new and revised FIS report and FIRM to the FEMA Map Service Center (MSC).
- The MSC will coordinate printing of the FIS report and FIRM with the U.S. Government Printing Office (GPO) and distribute the printed copies to the affected communities and other Mapping Partners identified by FEMA.

More detailed information on Preliminary and post-Preliminary processing requirements is provided in Subsections 1.5.1, 1.5.2, and 1.5.3.

[February 2002]

1.5.1 Preliminary Processing Requirements

The designated Mapping Partner shall distribute copies of the Preliminary FIS report and FIRM to community officials, the State NFIP Coordinator, the FEMA Regional Engineer, and other Mapping Partners identified by FEMA as appropriate. The exact distribution requirements will vary, depending on the production techniques used to produce the FIS report and FIRM and their format. However, the Mapping Partner also shall distribute copies of the Preliminary FIS report and FIRM to all Mapping Partners that contributed to the Flood Map Project, with formal documentation of changes that were agreed upon during the review and processing period that preceded production.

For new and revised FIRMs prepared in Countywide Format, the Mapping Partner shall distribute complete sets of panels to the appropriate county, State, and Federal agencies, as well as other interested agencies. However, the Mapping Partner shall distribute to the incorporated communities within the county only the FIRM Index(es) and those FIRM panels containing information affecting those particular communities. For FIS reports prepared in the Countywide format for the first time, the designated Mapping Partner shall distribute copies of the entire FIS report to each incorporated community and the county.

For Preliminary copies of revised FIS reports and FIRMs, the designated Mapping Partner may, under certain circumstances, distribute only the revised components of the FIS report. At the direction of the FEMA PO for cost containment purposes, the designated Mapping Partner may distribute only certain volumes of a multiple-volume FIS report, only the Flood Profiles revised as a result of the Flood Map Project, or only the pages of the Floodway Data Table that were revised as a result of the Flood Map Project. FEMA will discuss such decisions with the CTP Lead and other community officials on a project-by-project basis.

Format specifications for the Preliminary FIS report are provided in Subsection 1.4.2 and Appendix J of these Guidelines. Format specifications for the Preliminary FIRM are provided in Subsection 1.4.2 and Appendix K of these Guidelines.

To ensure the modifications made by LOMCs are included in the FIS report and on the FIRM, the designated Mapping Partner shall perform searches for LOMC determinations at four stages:

- Before the affected Preliminary FIRM panels are prepared and sent to the community for review and comment;
- Before the affected Revised Preliminary FIRM panels (if necessary) are prepared and sent to the community for review and comment;
- Before the Letter of Final Determination (LFD) is sent to the community; and
- before the effective date of the revised FIRM panels.

The results of this research are documented in the versions of the SOMA that accompaniy the Preliminary FIS report and FIRM, Revised Preliminary FIS report and FIRM. and LFD.

[February 2002]

1.5.2 Post-Preliminary Processing Requirements

After the designated Mapping Partner distributes the Preliminary copies of the new or revised FIS report and FIRM, FEMA and the Mapping Partners involved in the Flood Map Project shall follow the processing requirements documented below.

[February 2002]

1.5.2.1 Partner Coordination and Input

Following issuance of the Preliminary FIS report and FIRM, FEMA will provide a period (usually 30 days) for community officials, community residents, and other interested Mapping Partners to review the Preliminary FIS report and FIRM before proceeding with processing of the FIS report and FIRM. If the Mapping Partner that performed the engineering analyses and prepared the initial floodplain mapping or another Mapping Partner involved in the Flood Map Project determines that the Preliminary FIS report and FIRM do not accurately reflect the BFEs, 1- and 0.2-percent-annual-chance floodplain boundary delineations, and/or regulatory floodway boundary delineations, that Mapping Partner shall inform the FEMA Lead within 15 days of the receipt of the Preliminary FIS report and FIRM. The FEMA Lead, working in consultation with other Project Management Team members, shall determine which Mapping Partner will revise the BFEs, floodplain boundaries, and/or regulatory floodway boundaries, if appropriate, and shall direct the designated Mapping Partner to distribute corrected copies.

If no such comments are submitted to the FEMA Lead, the Preliminary FIS report and FIRM are deemed to be correct. The Mapping Partners involved in the Flood Map Project shall prepare to present and support the project results if requested by the FEMA Lead or other FEMA RO staff.

At the end of the review period, the FEMA Lead will forward all comments received to the designated Mapping Partner. These comments might come from officials and residents of the community, representatives of State and local floodplain management agencies, Mapping Partners, or FEMA RO staff. Comments may involve the revised areas or other areas not affected by the revision. They may concern technical issues involving flood discharge values, BFEs, floodplain and floodway delineations, or base map information (e.g., corporate limits, road locations, road names), or information presented in the FIS report. Comments from Mapping Partners usually concern the technical, editorial, and format changes made by the designated Mapping Partner to the draft FIS report and maps; however, they may also include recommended revisions based on information obtained by the Mapping Partners after the draft FIS report and work maps were submitted to FEMA.

The designated Mapping Partner shall make minor revisions, as necessary, but shall not undertake major revisions without prior FEMA Lead approval. In some cases, the FEMA Lead or his/her designee may direct the designated Mapping Partner to undertake major revision work involving new technical data or extensive changes in the corporate limits of the community. The designated Mapping Partner shall coordinate with the community, State NFIP Coordinator, other Mapping Partners, and FEMA RO as necessary during this process.

In an effort to provide proper public notice and explain the effects of the revised FIS report and FIRM to the community officials, citizens, and other interested parties, the FEMA RO usually will hold a public meeting—often referred to as a Final Consultation Coordination Officer (CCO) Meeting—before initiating a statutory 90-day appeal period or continuing with the processing of the FIS report and FIRM in another way. During this meeting, the FEMA Lead for the Flood Map Project and Project Team members will explain how the revised information was prepared, the entity that was responsible for the revised information, and the administrative procedures available to community officials and interested citizens who may wish to provide comments on the results prior to adoption of the new or revised FIS report.

This public meeting is not mandatory; however, certain circumstances warrant holding this meeting for the best interest of the public. Such a meeting is well advised when SFHAs have increased significantly from those shown on the currently effective FIRM. In addition, revisions that are large in scope or affect a great number of the population of the community usually necessitate a final meeting. The FEMA RO shall coordinate with the community

For other revisions that have either been extensively coordinated with the community or are not controversial, FEMA and the community may decide not to hold the Final CCO Meeting and issue a letter to the community instead.

[February 2002]

1.5.2.2 Revised Preliminary Report and Map

During or subsequent to the public coordination meeting, the FEMA Lead may decide that revisions to the FIS report and FIRM are warranted because changes to BFEs, floodway boundary delineations, or significant floodplain boundary delineation changes are required or for political reasons. In such cases, the designated Mapping Partner, at the direction of the FEMA Lead, shall prepare and distribute copies of the Revised Preliminary FIS report and FIRM.

In most cases, the Revised Preliminary copies shall be sent to the community with the official notification of the start of the 90-day appeal period. However, at the request of the FEMA Lead in coordination with the community and other Project Team members, the designated Mapping Partner shall prepare and distribute Revised Preliminary copies for review before the statutory 90-day appeal period is initiated.

When Revised Preliminary copies are prepared and submitted to the community for review, the designated Mapping Partner shall generate a SOMA and conduct a review similar to that conducted before the Preliminary copies were issued (see Section 1.4). When required, the designated Mapping Partner shall revise the Preliminary SOMA and submit it to FEMA for review with a special transmittal letter to the community. The designated Mapping Partner shall mail the revised SOMA to the CEO, RO, and State NFIP Coordinator with the special transmittal letter.

[February 2002]

1.5.2.3 Statutory Appeal Period

In the performance of a Flood Map Project, FEMA may determine new BFEs for flooding sources for which it has not previously determined BFEs or may determine that BFEs shown on the effective FIRM must be modified. When it determines new or modified BFEs for a community, FEMA must, in accordance with Section 110 of the Flood Disaster Protection Act of 1973 (Public Law 93-234), provide the community with a 90-day appeal period.

In accordance with Section 67.4 of the NFIP regulations, FEMA initiates the appeal period by publishing a proposed BFE determination notice in the *Federal Register*; by notifying the CEO of the community by certified mail, return receipt requested; and by publishing the proposed BFE determinations twice in a prominent local newspaper during the 10-day period immediately following notification of the community CEO. The proposed BFE determination notice typically is published in the legal advertisements portion of the newspaper. Although it is not required, FEMA encourages community officials to provide an even wider distribution of the notice to ensure that residents, property owners, and other interested stakeholders are aware of the proposed BFE determinations.

The designated Mapping Partner shall prepare the letter and notices in accordance with the procedures detailed in Subsection 1.6 of the FEMA *Document Control Procedures Manual* (FEMA, 2000). The designated Mapping Partner shall ensure that the notices are correct and that they include BFEs for the affected portions of all flooding sources within the community where modified or new BFEs are being proposed.

The designated Mapping Partner also shall ensure that the newspaper notices are published correctly and in accordance with the requested schedule and that payment for the notices is sent to the newspaper in a timely manner. The designated Mapping Partner shall notify the community and other Mapping Partners involved in the Flood Map Project when corrections are required.

The newspaper notice shall be published twice, with the second notice usually being published one week after the first notice is published. The 90-day appeal period begins on the date of the second publication.

At the beginning of each month, the designated Mapping Partner shall compile the proposed BFE lists for all communities receiving proposed BFE determination letters and notices during the previous month and prepare the Proposed Rule for concurrence and signature and for publication in the *Federal Register*. The designated Mapping Partner shall then submit the Proposed Rule to the designated FEMA coordinator for routing, concurrence, and signature.

The FEMA coordinator shall coordinate with GPO to ensure timely publication of the Proposed Rule in the *Federal Register*. The FEMA coordinator and the designated Mapping Partner shall review the published Proposed Rule to ensure it is accurate, and shall coordinate correction of the Proposed Rule when appropriate.

During the appeal period, in accordance with Section 67.5 of the NFIP regulations,

> ...any owner or lessee of property within a community where a proposed flood elevation determination has been made, who believes his/her property rights to be adversely affected by the proposed flood elevation, may file a written appeal of the determination with the CEO of the community.

An "appeal" is a challenge of a proposed BFE. BFEs that were not added or modified (as a result of a Flood Map Project (i.e., effective BFEs) cannot be appealed. Changes in effective BFEs must be processed as map revision requests in accordance with Part 65 of the NFIP regulations. (See Volume 2 for additional information on map revision processing requirements.)

The sole basis of an appeal, as indicated in Section 67.6 of the NFIP regulations, is the possession of knowledge or information indicating that the BFEs proposed by FEMA are scientifically or technically incorrect. The proposed BFEs are considered scientifically incorrect if the methodology or assumptions used in the determination of the BFEs is inappropriate or incorrect. The BFEs are considered technically incorrect if the BFEs were based on insufficient or poor quality data, analysis contains mathematical or measurement errors, or physical changes have occurred in floodplain.

Comments received by FEMA during the appeal period that do not challenge proposed BFEs are considered "protests." A protest is a challenge of information or data from a Preliminary FIS Report or FIRM other than BFEs. Types of protests include, but are not limited to, the following:

- Challenges of proposed floodplain boundary delineations based on more detailed or recent topographic data;
- Challenges of proposed regulatory floodway boundaries based on better modeling,
- Requests that changes effected by a previous Letter of Map Change be incorporated;
- Base map errors; and

- Errors of omission.

Appeals and protests must be supported by scientific or technical data, provide proof of error, and provide sufficient data to make revisions (bridge plans, cross-section data) and may require certification of data by a Registered Professional Engineer or Licensed Land Surveyor.

Additional information on the data required to support an appeal is presented in Chapter 3 of *Appeals, Revisions, and Amendments to National Flood Insurance Program Maps: A Guide for Community Officials* (FEMA, 1993). Additional information on the data required to support a protest is presented in Chapter 4 of *Guide for Community Officials*.

In accordance with Section 67.7 of the NFIP regulations, private persons shall submit appeals to the community CEO during the appeal period. The CEO, or a community official designated by the CEO, shall review and consolidate all appeals by private persons and prepare a written opinion stating whether or not the appeal is justifiable. The community CEO or other designated community official shall then submit the opinion and the appeal(s) to FEMA for review.

In accordance with Section 67.8 of the NFIP regulations, FEMA will "review and fully consider any technical or scientific data submitted by the community that tend to negate or contradict the information upon which the proposed determination is based." Although not specifically required by the regulations, FEMA also will consider all technical or scientific data submitted in support of a protest as well.

To assist FEMA, a designated Mapping Partner shall review and evaluate submitted data, request additional data when required, and recommend resolutions to FEMA for all appeals and protests submitted during the 90-day appeal period. An expanded discussion of these procedures also appears in the *Guide for Community Officials* (FEMA, 1993).

At the request of FEMA, the designated Mapping Partner shall perform the following tasks:

- Work with FEMA to acknowledge the receipt of an appeal or protest in writing;
- Evaluate any scientific or technical data submitted;
- Request any additional scientific or technical data required to properly review the appeal or protest;
- Make a recommendation to FEMA to resolve the appeal;
- Perform any engineering analyses required (e.g., hydrologic and hydraulic, structural, geo-technical);
- Prepare and distribute, if warranted, Revised Preliminary copies of the FIS report and FIRM; and
- Prepare an appeal or protest resolution letter or insert to the LFD.

Appeal resolutions must be made within a reasonable time. All resolution information must be made available for public inspection and shall be admissible in a court of law.

The assigned Mapping Partner shall send the signed FEMA appeal resolution letter to the community CEO and floodplain administrator and all appellants before the LFD, discussed in Subsection 1.5.2.4, is prepared and sent to the community. Most often, the designated Mapping Partner incorporates changes resulting from protests at the time that the final reproduction materials are prepared; however, if the changes are significant, the FEMA Lead or his/her designee may direct the designated Mapping Partner to prepare and distribute Revised Preliminary copies or Proof Copies of the FIS report and FIRM. Also, the protest resolution may be included in the LFD.

FEMA shall provide a comment period (usually 30 days) following the date the appeal or protest resolution letter is issued before proceeding with the processing of the revised FIS report and FIRM by preparing and issuing an LFD. FEMA, with the support of the assigned Mapping Partner and other members of the Project Team for the Flood Map Project, shall address any comments received during this comment period before proceeding with the LFD.

[February 2002]

1.5.2.4 Final Determination

After the 90-day appeal period (if required) has elapsed and all appeals and protests have been resolved, the designated Mapping Partner shall choose an LFD date/FIRM effective date from a list provided by FEMA HQ. The designated Mapping Partner shall select the LFD date such that it is no earlier than 1 week after the 90-day appeal period or 30-day review period has ended. The designated Mapping Partner shall then prepare an LFD based on community status, study type, whether BFEs were affected, and whether an appeal was received. (See Subsection 1.11 of the *Document Control Procedures Manual* [FEMA, 2000] for additional information on LFD content.)

The Mapping Partner shall then include the affected community on a docket listing all LFDs scheduled for a particular date and submit the docket to the FEMA PO or his/her designee for review and approval. The FEMA PO or his/her designee shall notify the designated Mapping Partner by concurring on the docket that the letters can be mailed. If special circumstances exist with the community, or the proposed BFEs were appealed, the FEMA PO or his/her designee may direct the designated Mapping Partner to submit an original hard copy of the LFD for review.

On the LFD date, the designated Mapping Partner shall mail the LFD and enclosures (including the SOMA, discussed in Subsection 1.5.2.5) to the community CEO and floodplain administrator, mail copies to appellants and protesters as necessary, and distribute external and in-house file copies in accordance with the requirements provided in Subsection 1.11 of the *Document Control Procedures Manual* (FEMA, 2000).

At the beginning of each month, the designated Mapping Partner shall compile the final BFE lists for all communities receiving LFDs during the previous month and prepare the Final Rule for concurrence and signature and for publication in the *Federal Register*. The designated

Mapping Partner shall then submit the Final Rule to the d FEMA coordinator for routing, concurrence, and signature. The FEMA coordinator shall coordinate with GPO to ensure timely publication of the Final Rule in the *Federal Register.* The FEMA coordinator and the designated Mapping Partner shall review the published Final Rule to ensure it is accurate, and shall coordinate correction of the Final Rule when appropriate.

[February 2002]

1.5.2.5 Final Summary of Map Action Preparation

Approximately two weeks before the LFD date, the designated Mapping Partner shall generate and review the Final SOMA. The Final SOMA shall include all LOMCs included in the Preliminary SOMA and all LOMCs issued since the Preliminary or Revised Preliminary copies of the FIS report and FIRM were distributed. The designated Mapping Partner shall mail the Final SOMA to the CEO of the community, RO, and State Coordinator with the LFD. If no LOMCs have been issued for the affected map panel(s), the designated Mapping Partner shall include an explanatory paragraph in the LFD to acknowledge this fact, and no SOMA shall be sent to the CEO or any of the other recipients of the LFD.

[February 2002]

1.5.2.6 Accelerated Processing Procedures and Schedules

Accelerated processing procedures may be initiated when a community in the NFIP requests that its FIRM become effective in less time than the 6 months allotted in the NFIP regulations for adoption of floodplain management ordinances. The procedures to be followed are outlined in FEMA Instruction No. 8400.1, entitled *Early Conversion of Communities to the Regular Phase of the National Flood Insurance* (FEMA, 1988).

As indicated in FEMA Instruction No. 8400.1 the community CEO or a community official designated by the CEO shall submit a request for accelerated processing in writing to the FEMA CCO. The CCO shall then immediately inform the appropriate FEMA HQ staff of the community's request. To meet the criteria for accelerated processing, the community must prove compliance with the appropriate floodplain management requirements of Section 60.3 of the NFIP regulations, and submit a letter from the CEO indicating that the community agrees with the Preliminary FIS report and FIRM and proposed BFEs, does not expect appeals, and agrees to shortened compliance period. If an individual property owner submits a legitimate appeal during the 90-day appeal period, FEMA shall cancel the accelerated processing and the attendant effective date of the FIRM.

[February 2002]

1.5.2.7 Floodplain Management Ordinance Updates

With the issuance of the LFD, FEMA provides the community with 6 months (or otherwise agreed-upon timeframe) to adopt floodplain management ordinances that comply with the new or updated flood hazard data presented on the FIRM as discussed in Section 60.2 of the NFIP

regulations. The new or updated ordinances, which are sometimes referred to as "compliant" ordinances, must meet the requirements Section 60.3 of the NFIP regulations.

If the community has floodplain management ordinances in effect that require no amendment as a result of the new or updated flood hazard data, the compliance period may not be required. However, if the community did not have compliant ordinances when the LFD was issued, FEMA must give the community a 6-month compliance period and remind the community that it must submit updated floodplain management ordinances to the RO for review.

If the community fails to submit compliant ordinances to the RO within the first 90 days of the compliance period, the designated Mapping Partner shall, at FEMA's request, prepare a 90-day suspension reminder letter to the community. If the community has not submitted compliant ordinances to the RO within 30 days of the effective date, the designated Mapping Partner shall prepare a 30-day suspension reminder letter for the community. For these suspension reminder letters, the designated Mapping Partner shall follow the preparation and distribution requirements presented in Subsection 1.14 of the *Document Control Procedures Manual* (FEMA, 2000).

If the community does not adopt the floodplain management ordinances by the effective date, FEMA shall suspend the community from participation in the NFIP until the community adopts compliant floodplain management ordinances.

[February 2002]

1.5.2.8 Final Reproduction Materials and Paperwork

During the 6-month compliance period, QA/QC reviews and revisions are performed, final reproduction materials and GPO paperwork are prepared, technical and administrative support data are archived, and the FIS report and FIRM are printed and distributed.

[February 2002]

Quality Assurance/Quality Control Review

The designated Mapping Partner shall conduct a QA/QC review to ensure all Post-Preliminary comments and Revised Preliminary (if applicable) information has been incorporated. In addition, the designated Mapping Partner shall perform a final QA/QC review for consistency between mapping components.

[February 2002]

Final Reproduction Materials

The designated Mapping Partner shall prepare final (camera-ready) reproduction materials for printing by GPO. The specifications for hardcopy and digital materials are provided in Appendix J of these Guidelines.

For an FIS report and FIRM that are not being processed under accelerated processing procedures and schedules (see Subsection 1.5.2.6), the designated Mapping Partner shall deliver the final reproduction materials to the MSC approximately two months after the date of the LFD,

or approximately four months before the effective date of the FIS report and FIRM. If delays in delivering the final reproduction materials beyond this date are necessitated by significant revisions submitted by the community after the LFD was issued, the designated Mapping Partner shall coordinate with the MSC as well as the FEMA Lead or his/her designee. For accelerated processing, the delivery schedule may be adjusted in coordination with the MSC and the FEMA Lead. The procedures to be followed are outlined in FEMA Instruction No. 8400.1 (FEMA, 1988).

[February 2002]

Map Packaging

The designated Mapping Partner shall follow the procedures below in packaging the hardcopy FIRM, FBFM, and DFIRM indexes and panels for printing.

- Map panels shall be rolled and sealed in brown packaging paper.
- Map indexes prepared in the Z-fold format shall be packaged by themselves.
- All other panels shall be separated according to type (FIRM, DFIRM, or FBFM) and frame size (A, B, C, D, and E); however, no more than 16 panels shall be included in any rolled package.
- Map panels using the DOQ base map option and requiring two-color printing (two negatives) shall be rolled individually by panel, with the panel number clearly marked in the lower right hand corner of each negative.
- Each set of camera-ready negatives shall be rolled and wrapped in brown kraft-paper and shall be labeled. The labeling information shall be in the order shown and include the following information: frame width, name and state of community or county, map type (FIRM or FBFM), and whether the enclosed panel is an index. See the following example:

30	FLOOD COUNTY, USA,	FIRM	INDEX (when applicable)

- For each community or county for which negatives are being submitted, corresponding GPO paperwork shall be submitted as follows:
  - Two envelopes (one 18" x 20" and one 15" x 18") shall be used in the transmittal of this paperwork. The Mapping Partner transmittal shall be attached on the front of the larger envelope.
  - The completed FEMA transmittal (179) letter(s), Print Processing Worksheet(s), and Print Requisition form(s) shall be placed in the larger envelope.

  - The FIS report materials shall be placed in the smaller envelope, and the smaller envelope shall be placed in the larger envelope.

- A final paper copy of FIRM panels shall be provided. They shall be rolled and attached as one set to the appropriate hardcopy wrapped rolls. (The paper copies are not to be wrapped or labeled.)

[February 2002]

Report Packaging

The designated Mapping Partner shall adhere to the procedures provided below in preparing FIS reports for printing.

- The FIS report shall be put together in final form, with appropriate graphics and profiles in place, and placed in an envelope. The envelope shall be marked to indicate the name of the community and the effective date of the FIS report.

- For the purpose of the GPO processing, the designated Mapping Partner shall number the pages of the report in non-photo blue pencil starting with the page following the cover, "Notice to Flood Insurance Study Users," being page 1. The pages shall be numbered consecutively (1, 2, 3, etc.) with certain exceptions.

  - No material shall be printed on the back of the "Notice to Flood Insurance Study Users" page; therefore, this page shall be numbered "1/2 blank."

  - No material shall be printed on the back of the page preceding any graphics (e.g., transect location map) prepared in 11" x 17" format. If this page has an odd number, it would be numbered "5/6 blank."

  - No material shall be printed on the page immediately preceding the first profile panel.

  It is important to note that these are not the official page numbers printed at the bottom of each page, but only reference numbers to track individual pages by the GPO.

- The Flood Profiles shall always be given two page numbers, starting with an odd number. For example, if the last text page number is 50, Panel 01P would be marked "51/52 blank."

The designated Mapping Partner shall provide the camera-ready originals only; no hard copy of the revised FIS report is required.

[February 2002]

Government Printing Office Paperwork

The designated Mapping Partner shall prepare the paperwork summarized below to accompany the final reproduction materials for the FIS report, FIRM, and FBFM (if produced).

- Transmittal to Community CEO—One letter shall accompany the material for each community. For FIRMs prepared in the Countywide Format, one letter shall be prepared for each community. The transmittal letters (179, 179-M, 179-R, 179-RS, and 179-S) that the designated Mapping Partner shall prepare and submit with the final reproduction materials are presented in Appendix A of the FEMA *Document Control Procedures Manual* (FEMA, 2000).

- Print Processing Worksheet—Although the worksheet may include several pages, only one worksheet shall be prepared for each community (including FIRMs prepared in Countywide Format). FEMA shall provide the Print Processing Worksheet to the designated Mapping Partner.

- Printing Requisition Form—One requisition form for each is prepared for the FIS report, the FIRM Index, the individual rolls of FIRM panels, the FBFM Index (as applicable), and the individual rolls of FBFM panels (as applicable). FEMA shall provide the Printing Requisition forms to the designated Mapping Partner.

- Community Map Action (CMA) List — Two copies of the CMA list shall accompany each submission to the MSC; however, several communities may be shown on one CMA list, provided that the FIRMs have the same effective date. The CMA list shall be placed in its own envelope and submitted with the other components for that MSC submission. (Note: Preliminary CMA lists are to be prepared and submitted for review to the MSC approximately two months before the other above-mentioned materials.) If the compliance period is accelerated, then the submittal time will change to reflect such.

[February 2002]

Revalidation of Letters of Map Change

Approximately 1 month before the FIRM effective date, the designated Mapping Partner shall review and update the list of LOMCs included in the Final SOMA. The designated Mapping Partner shall use the list to produce the LOMC-VALID letter that is issued to the CEO of the community. For further information on this process, see Volume 2, Section 2.5 of these Guidelines.

[February 2002]

Archived Data

Upon completion of the final QA/QC review, a standardized digital package shall be prepared by the designated Mapping Partner to archive all administrative and technical support data generated during the preparation and technical review of the FIS report and FIRM. The archival requirements, including the requirements for the TSDN, are provided in Volume 3, Section 3.3 and Appendix M of these Guidelines.

[February 2002]

1.5.3 File Maintenance Requirements

The designated Mapping Partner shall keep records and files of correspondence for each community affected by the Flood Map Project to assist FEMA in meeting the community file requirements documented in Section 66.3 of the NFIP regulations. Filing requirement for specific letters are documented in Section 1 and Appendix A of the FEMA *Document Control Procedures Manual* (FEMA, 2000).

The designated Mapping Partner also shall establish and maintain a Flood Elevation Determination Docket for each community affected by a Flood Map Project to assist FEMA in meeting the requirements of Section 67.3 of the NFIP regulations.

Additional information on file maintenance requirements is provided in Volume 3, Subsection 3.3.1.1 of these Guidelines.

[February 2002]

1.6 References

Federal Emergency Management Agency, FEMA Manual 7810.2, *Regional Project Officer Guidance for Flood Insurance Studies*, 1990.

Federal Emergency Management Agency, FEMA Instruction 8400.1, *Early Conversion of Communities to the Regular Phase of the National Flood Insurance Program*, 1991.

Federal Emergency Management Agency, FIA-12, *Appeals, Revisions, and Amendments to National Flood Insurance Program Maps: A Guide for Community Officials*, 1993.

Federal Emergency Management Agency, *Guidelines for Determining Flood Hazards on Alluvial Fans*, 1999.

Federal Emergency Management Agency, *Document Control Procedures Manual*, July 2000.

Interagency Advisory Committee on Water Data, Bulletin 17B, *Guidelines for Determining Flood Flow Frequency*, 1982.

National Research Council, *Alluvial Fan Flooding,* National Academy Press: Washington, DC, 1996.

U.S. Department of Commerce, National Oceanic and Atmospheric Administration Atlas 2, *Precipitation-Frequency Atlas of the Western United States.*

U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Weather Service, Technical Paper No. 40, *Rainfall Frequency Atlas of the United States.*

[February 2002]

Volume 2

2.1 Physical Map Revisions

FEMA will typically initiate a Physical Map Revision (PMR) in response to a map revision request when one of the following will occur:

- Changes resulting from the requested revision will be extensive and will cover more than one panel of the effective Flood Insurance Rate Map (FIRM).
- Changes will result in significantly more mapped area being added to the Special Flood Hazard Areas (SFHAs).
- Changes will result in increases in the Base Flood Elevations (BFEs) shown on the effective FIRM.

FEMA also may prepare a revised Flood Insurance Study (FIS) report and/or Flood Boundary and Floodway Map (FBFM), depending on the nature of the revision. Under certain circumstances, FEMA may issue a Letter of Map Revision (LOMR) even if the above-mentioned conditions exist. The Mapping Partner that is assigned by FEMA to process the revision request and FEMA shall use the Standard Map Revision Decision-Making Flowchart (Figure 2-1) in selecting a processing option.

At the direction of the FEMA Project Officer (PO) or his/her designee, the Mapping Partner shall prepare a revised FIRM and, as necessary, FIS report and FBFM in a standard publication format in accordance with the specifications outlined in Appendices J and K of these Guidelines. To accomplish this, the Mapping Partner shall:

- Update the base information on the affected FIRM/FBFM panels as necessary;
- Prepare manuscripts for use in drafting or digitizing the revised FIRM/FBFM panels;
- Prepare the revised FIS report, FIRM, and FBFM; and
- Prepare and ensure accuracy and completeness of final reproduction materials, including a camera-ready copy of the FIS report and negatives of the FIRM and FBFM, or positive plots on Mylar, or digital files, for printing by GPO.

Detailed information on the procedures for processing PMRs is provided in the following subsections.

[February 2002]

2.1.1 Receipt and Acknowledgment

Map revision requests and any accompanying data from community officials and other Mapping Partners may be transmitted to the Mapping Partner assigned to process the revision request by the FEMA PO, his/her designee, or other FEMA staff. If such requests are submitted directly to the Mapping Partner that processes map revision requests for FEMA, that Mapping Partner (hereinafter referred to as the processing Mapping Partner) shall inform the FEMA PO or his/her designee of any requests for such revisions submitted directly to the processing Mapping Partner.

The processing Mapping Partner shall inventory the materials received and, within 5 working days of receipt, send an acknowledgment letters to the Chief Executive Officer (CEO) of the community. If the requester is anyone other than the CEO, the Mapping Partner shall send the requester a copy of the acknowledgment letter and, if necessary, telephone the requester to explain the review procedures.

In accordance with Section 65.4 of the NFIP regulations, all requests for changes to effective maps other than those initiated by FEMA must be made in writing by the CEO of the community. The processing Mapping Partner shall request community concurrence if this information was not submitted with the request. If applicable, the processing Mapping Partner shall also request State concurrence, if that concurrence was not submitted with the revision request.

[February 2002]

2.1.2 Case Initiation

Upon receipt of the request, the processing Mapping Partner shall assign a case number (if appropriate); create a revision case file, in accordance with Section 66.3 of the NFIP regulations (see Appendix F of these Guidelines), and telephone the revision requester to obtain general information, including:

- Name and address of the CEO and community contact person
- Location of community map repository

The processing Mapping Partner also shall request, in writing, updated information from the community on other flooding sources, available hydraulic data, changes to corporate boundaries or jurisdictions, and other information pertinent to flood mapping.

The processing Mapping Partner shall enter the revision request into an in-house Management Information System (MIS) and the Letter of Map Change (LOMC) module of FEMA's Community Information System (CIS) database, make an initial determination as to the expected processing procedure (e.g., PMR, LOMR, LOMR-F), and record the date of receipt as the date from which all required processing dates are determined.

[February 2002]

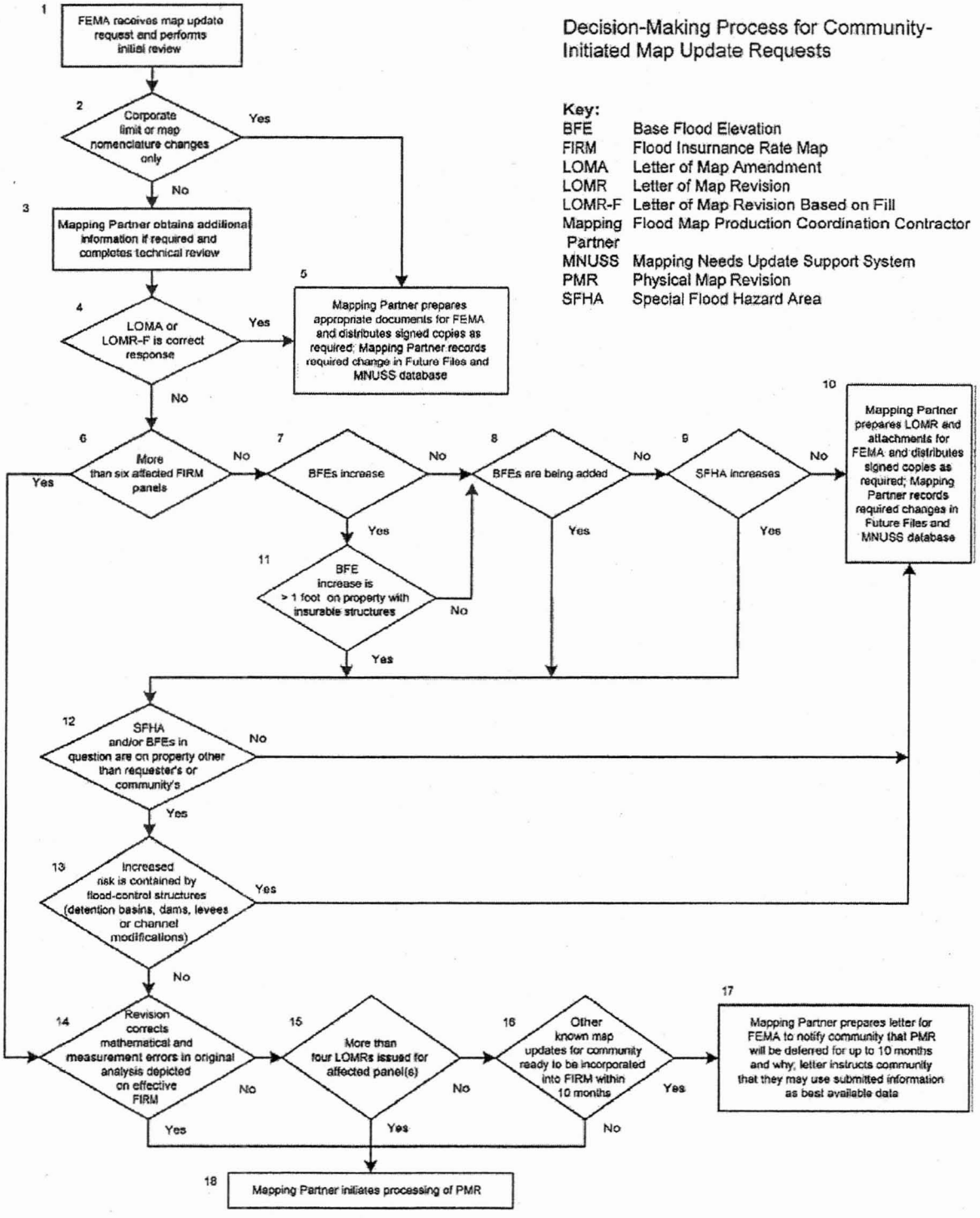


Figure 2-1. Standard Map Revision Decision-Making Flowchart

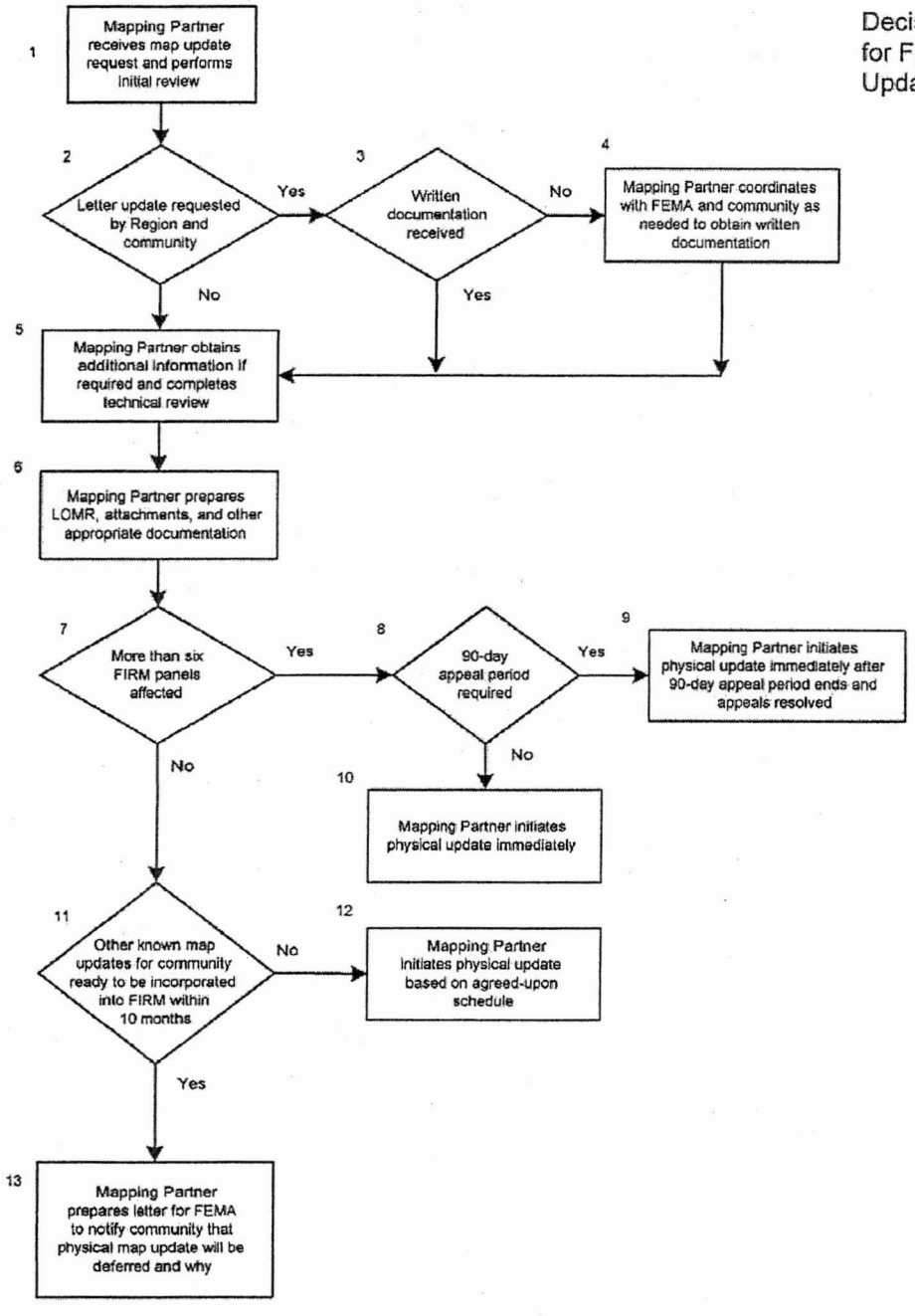


Figure 2-1. Standard Map Revision Decision-Making Flowchart (Cont'd)

[February 2002]

2.1.3 Case Initiation

Upon receipt of the request, the processing Mapping Partner shall do the following:

- Assign a case number (if appropriate);
- Create a revision case file, in accordance with Section 66.3 of the NFIP regulations (see Appendix F of these Guidelines); and
- Telephone the revision requester to obtain general information, including (1) name and address of the CEO and community contact person and (2) location of community map repository.

The processing Mapping Partner also shall request, in writing, updated information from the community on other flooding sources, available hydraulic data, changes to corporate boundaries or jurisdictions, and other information pertinent to flood mapping.

The processing Mapping Partner shall enter the revision request into an in-house Management Information System (MIS) and the Letter of Map Change (LOMC) module of FEMA's Community Information System (CIS) database, make an initial determination as to the expected processing procedure (e.g., PMR, LOMR, LOMR-F), and record the date of receipt as the date from which all required processing dates are determined.

[February 2002]

2.1.4 Initial Reconnaissance

After the case has been properly recorded, the processing Mapping Partner shall begin a search of all available records to determine the status of the community in the NFIP and to identify all past actions by FEMA in the community that may affect the request.

The processing Mapping Partner shall determine whether all data required to address the request have been submitted, advise the FEMA PO or his/her designee of the results of this review, and make a recommendation concerning action to be taken.

[February 2002]

2.1.5 Program Status and Map Actions

The processing Mapping Partner shall review various portions of FEMA's databases (i.e., CIS, Monitoring Information on Contracted Studies (MICS), Map Needs Update Support System (MNUSS)) to determine the status of the community in the NFIP and obtain information on complete, active, and future required restudies, map revisions, and map amendments.

The processing Mapping Partner also may use the *NFIP Community Status Book*, available in hardcopy form from the MSC or from the Mitigation Library on FEMA's Internet site

(http://www.fema.gov/fema/csb.htm), to determine whether the community is participating in the Emergency or Regular Phase of the NFIP.

The processing Mapping Partner shall review the following data sources to obtain more detailed information on the nature and extent of any past map actions in the community:

- **Future Revision Files**—The processing Mapping Partner shall review these files to determine if additional revisions to the FIS report, FIRM, or FBFM are warranted. These files exist because, from time to time, information is submitted by the community or identified during the course of processing a restudy or map revision that does not significantly affect the community's participation in the NFIP. Because of funding constraints, these revisions are deferred for future action and, at the request of the FEMA PO or his/her designee, placed in the future revision files. In particular, the processing Mapping Partner should review this information for changes affecting the underlying maps or models used in preparing the effective FIRM, FBFM, and FIS report.

- **LOMA and LOMR-F Files**—The processing Mapping Partner shall review these files to determine if past LOMA and LOMR-F actions are mappable (i.e., of sufficient size and scope to warrant inclusion in the ongoing revision). In general, single-lot LOMAs and LOMR-Fs do not warrant inclusion because of map scale limitations. However, multiple-lot LOMAs and LOMR-Fs may warrant inclusion in a PMR. (Additional information on LOMA and LOMR-F processing is provided in Subsection 2 of these Guidelines.)

- **MNUSS**—As with the Future Revision Files, the processing Mapping Partner shall review the data in MNUSS and any supporting information to determine if additional revisions to the FIS report, FIRM, or FBFM may be warranted.

- **Other Items**—The processing Mapping Partner shall ascertain the relevance of Coastal Barrier Resources System (CBRS) designations to the project area, and shall determine if the community has a floodplain ordinance in compliance with the latest version of the NFIP regulations.

[February 2002]

2.1.6 Required Data

Based on the reason for and extent of the request, the processing Mapping Partner shall determine whether sufficient data have been submitted by the community or other revision requester for additional data in accordance with the applicable portions of Sections 65.5, 65.6, 65.7, 65.10, 65.11, 65.12, and 65.13 of the NFIP regulations. In addition, the processing Mapping Partner shall ensure that the requester has completed and submitted the appropriate application/certification forms from the latest version of the MT-2 application/certification forms package, which may be downloaded from http://www.fema.gov/mit/tsd/dl_mt-2.htm.

All data submitted must be certified by a Registered Professional Engineer or Licensed Land Surveyor in accordance with Part 65 of the NFIP regulations. Examples of standard data requirements for various modifications include, but are not limited to, the following:

All Revisions

1. Topographic work map that includes the entire area of the revision and delineates floodplain and/or floodway boundaries, BFEs, and cross-section locations, and all applicable items required in the MT-2 package

2. Floodplain and/or floodway boundary delineations on the effective map panels and the topographic work map

3. Notification to affected adjacent communities

4. Evidence that all revisions involving structures or fill placement meet the criteria of Sections 60.3 and 65.5 of the NFIP regulations, which require that the community's NFIP permit official certify that proposed or existing structures to be removed from the SFHA be "reasonably safe from flooding"

5. Certified as-built construction or grading plans (if appropriate)

Revisions in Riverine Areas

1. Hydrologic analysis (if the discharges in the effective FIS report are not used)

2. Effective hydraulic model run duplicating original hydraulic model (multiple profile and floodway). See Appendix C, Subsection C.5.2.1 of these Guidelines for information on FEMA's policy for conversion to HEC-RAS.

3. Existing hydraulic model (multiple profile and floodway) if the calibration hydraulic model run does not reflect the floodplain conditions prior to the start of the project

4. Revised hydraulic model (multiple profile and floodway)

5. Floodplain and/or floodway boundary delineations on the effective map panels and the topographic work map

Channelizations

1. Transition structure design plans for as-built conditions

2. New hydrologic analyses or diversion channel designs

Levees (Dikes, Berms, and Embankments) (See Appendix H of these Guidelines)

1. Evidence of structural stability, certified by a Registered Professional Engineer
2. Evidence of operation and maintenance provisions
3. Interior drainage analyses and SFHA boundary delineations
4. Demonstration of compliance with Section 65.10 of the NFIP regulations
5. Additional design data as necessary

Dams (Detention Basins and Reservoirs)

1. Certification by a Registered Professional Engineer that impoundment structures will remain stable during the base flood
2. Evidence of operation and maintenance provisions
3. Hydrologic analyses for downstream reach, if the dam is designed to lower the base flood discharge

Flood-Control Structures Subject to Alluvial Fan Flooding (see Appendix G of these Guidelines)

1. Certification by a Registered Professional Engineer that the flood-control structures will be able to withstand the hazards associated with flooding, erosion, scour, and relocation of flow paths during the base flood discharge
2. Hydrologic analyses that quantify the discharges (if the discharges on which the effective FIRM is based are not used) and the volumes of water, debris, and sediment movement
3. Engineering analyses demonstrating the impact of flooding from sources other than the fan apex
4. Revised analysis of alluvial fan flooding (if the analysis on which the effective FIRM is based is not used), accompanied by a discussion of the effects of (1) the depth and velocity of flooding, and (2) the scour and sediment deposition on other areas of the fan
5. Evidence of operation and maintenance provisions
6. Revised floodplain boundary delineations on the affected panels of the effective FIRM

Evidence of maintenance provisions, where referenced above, are to be in the form of an ordinance that specifies the activities to be performed, the frequency of performance, and the community officials responsible for the performance. If maintenance is to be accomplished by an agency other than the community, a logical provision (e.g., ordinance) for community

monitoring and backup maintenance is required. The Mapping Partner shall ensure that maintenance agreements are submitted for levees and dams.

Certifications, where referenced above, are defined as follows:

- Certification of data is a statement that the data are accurate to the best of the certifier's knowledge.
- Certification of analyses is a statement that the analyses have been performed correctly and in accordance with sound engineering practices.
- Certification of structural works is a statement that the works are designed in accordance with sound engineering practices to provide protection from the base flood.
- Certification of as-built conditions is a statement that a structure has been built according to the plans being certified, is in place, and is fully functional.

The processing Mapping Partner shall ensure that certifications include the certifier's name, signature, registration number, and the registration date of the certifier.

[February 2002]

2.1.7 Technical Review

The processing Mapping Partner shall review the technical, scientific, and other information submitted by the revision requester to ensure that the data are technically accurate, consistent with standard engineering practice and FEMA standards, and sufficient to warrant a revision. The extent of the technical review will, generally, be limited to a review of the information presented on the application/certification forms and the supporting documentation submitted with them.

For revisions involving the addition of detailed flood hazard information or changes to flooding sources originally studied by detailed methods, analyses and other supporting data for the 10-, 50-, 100-, and 500-year floods and regulatory floodway may be required. At a minimum, the analyses and other supporting data provided in support of a revision request must meet the original standards employed by FEMA for the preparation of the FIS report, FIRM, and FBFM, which are documented in Appendices J and K of these Guidelines.

[February 2002]

2.1.7.1 Hydrologic Analyses

FEMA requires that the computations performed to support requests for revisions to effective FIS reports, FIRMs, and FBFMs be based on the flood discharge values used for the effective FIS report and FIRM if those flows are still applicable. However, revision requests also may be based on new hydrologic conditions or better estimates of the flood discharges if significant hydrologic changes have occurred.

The revision requester shall provide 5- and 95-percent confidence limits in support of new discharge values, when gage statistical analysis is performed in support of new hydrology. The revision requester shall provide sufficient data to support the use of the new discharges for the 100- and, if necessary, 10-, 50-, and 500-year floods; the revision requester also shall determine all changes to the FIS report, FIRM, and FBFM that would result from the use of the new flood discharges. Therefore, the revision requester usually must submit hydraulic analyses and revised floodplain and floodway boundary delineations, in addition to hydrologic analyses.

The processing Mapping Partner shall review the information presented in the MT-2 application/certification forms package to determine if the flood discharges are reasonable and adhere to the requirements listed below. The processing Mapping Partner shall check the flood discharge values for consistency, within the limitations of the methodology employed, throughout the information submitted by the revision requester. In performing this check, the processing Mapping Partner shall verify that, for flooding sources studied by detailed methods, the revision requester has submitted adequate information for any of the four recurrences interval floods that may be affected by the new hydrologic analyses.

The following requirements apply to revision requests involving revised hydrology based on existing conditions:

- The revised flood discharge must be significantly different from the effective flood discharge. The revised flood discharge shall be adopted if the effective flood discharge does not fall within the 5- and 95-percent confidence limits of the revised estimates. These limits shall be determined using methods contained in Bulletin 17B, *Guidelines for Determining Flood Flow Frequency* (Interagency Committee on Water Data, 1982).

- In cases where the new flood discharge must be approved by the State, the processing Mapping Partner shall ensure that the proper approval from the State has been acquired and submitted by the revision requester.

- In cases where the new flood discharge must be approved by a regional/local flood-control agency, the processing Mapping Partner shall ensure that the proper approval from the regional/local flood-control agency has been acquired and submitted by the revision requester.

- An alternative methodology, if used by a revision requester, must meet the requirements of Paragraph 65.6(a)(6) of the NFIP regulations and must be on FEMA's list of accepted computer models.

- For the revised hydrologic analyses, the revision requester shall analyze the same recurrence interval floods as those analyzed for the effective analyses.

- The results from the revised hydrologic analyses must match those for contiguous communities.

- The data accumulated and analyses performed must be certified by a Registered Professional Engineer and submitted by revision requester to FEMA for review.

If the community has elected to present flood hazard information based on future-conditions hydrology on the FIRM and in the FIS report, the guidance provided in Subsection 2.4.6.7 shall be followed.

[February 2002]

2.1.7.2 Hydraulic Analyses

The revision requester shall perform hydraulic analyses to support a revision request based on new hydrologic conditions or physical changes in channel or overbank conditions, if those conditions affect the elevation and extent of the base flood. For revisions involving flooding sources originally studied by approximate methods and designated as Zone A on the effective FIRM, the analyses performed by the revision requester generally must be consistent with FEMA standards for approximate studies presented in Volume 1 and Appendix C of these Guidelines. Therefore, the analyses may be in the form of hand calculations for step-backwater, normal-depth, or stage-frequency relationships, or the analyses may be based on the use of step-backwater or coastal flooding computer programs.

If the effective hydraulic model is available, the revision requester shall use it to establish baseline conditions. For revisions involving flooding sources studied by detailed methods for the effective FIS, analyses performed by the revision requester must be consistent with FEMA standards for detailed studies presented in Volume 1 and Appendix C of these Guidelines. Therefore, the analysis usually shall consist of step-backwater computations for riverine flooding sources, stage-frequency analyses for lacustrine flooding, hand computations for sheetflow areas, and storm-surge and wave-height or wave-runup calculations for coastal flooding.

The revision requester shall ensure that all submitted information and data are consistent. Therefore, the revision requester shall eliminate discontinuities between the flood hazard information shown for revised areas and the flood hazard information shown for unrevised areas in the FIS report and on the FIRM and FBFM before submitting the revision request to FEMA for review and processing.

In addition, for revisions based on the effects of levees or other flood-control structures that have been credited with providing base flood protection, the revision requester shall submit verification, in the form of technical analyses, that those structures meet the minimum criteria outlined in Section 65.10 of the NFIP regulations. (Additional information on the criteria for crediting for disaccrediting levees or other flood-control structures is provided in Appendix H of these Guidelines.)

Similarly, for flood-control structures located in areas subject to alluvial fan flooding, the revision requester shall submit technical analyses to verify that the minimum criteria of Section 65.13 of the NFIP regulations are met. (Additional information on the criteria for flood-control structures on alluvial fans is provided in Appendix G of these Guidelines.)

If a PMR is processed, the processing Mapping Partner shall verify that the effects of such structures are properly discussed in the FIS report and shown on the FIRM and FBFM.

The following requirements shall apply to requests involving revised hydraulic analyses:

- Revision requests shall be based on the effective hydraulic model. Where the input data representing the effective hydraulic model are unavailable, the revision requester shall develop an approximation. The revision requester shall establish a new model using the original cross-section topographic information, where possible, and the flood discharges on which the current FIS report and FIRM are based. The model must use the same effective-flow areas as established in the original effective analysis and must be calibrated to reproduce the original BFEs to within 0.5 foot. (See Appendix C, Subsection C.5.2.1 of these Guidelines for information on FEMA policy for conversion to HEC-RAS.)

- If the revision requester uses an alternative hydraulic methodology, that methodology must be on FEMA's list of acceptable computer models and meet the requirements of Paragraph 65.6(a)(6) of the NFIP regulations.

- To avoid discontinuities between the revised and unrevised flood data, the revision requester shall submit hydraulic analyses be that are extensive enough to ensure a logical transition can be shown between the revised flood elevations, floodplain boundaries, and floodway boundaries and those developed previously for areas not affected by the revision. The revised and unrevised water-surface elevations must match within 0.5 foot where such transitions occur; however, FEMA would prefer that the transitions match within 0.10 foot if possible. Exceptions to this standard must be approved by the FEMA PO or his/her designee.

- In general, revision requests that result in increases in BFEs because of the physical actions of an individual property owner within the regulatory floodway are to be considered a potential violation of NFIP regulations unless evidence is provided to show that the criteria described in Section 65.12 of the NFIP regulations have been met. The processing Mapping Partner shall bring any violation or potential violation of the NFIP regulations to the attention of the FEMA PO or his/her designee. The FEMA PO or his/her designee shall then bring the matter to the attention of the FEMA Regional Office (RO) for followup action with the community involved.

- The processing Mapping Partner shall consult with the FEMA PO or his/her designee to ensure that the provisions of the June 2001 revisions to Sections 65.5 and 65.6 of the NFIP regulations are met. If fill is placed in the community to raise the ground surface to or above the BFE, the community must meet the criteria of Sections 60.3 and 65.5 of the NFIP regulations, which require that the community's NFIP permit official certify that proposed or existing structures to be removed from the SFHA be "reasonably safe from flooding." "Reasonably safe from flooding" means base flood waters will not inundate the land or damage structures to be removed from the SFHA and that any subsurface waters related to the base flood will not damage existing or proposed buildings. Additional information on the June 2001 revisions to Sections 65.5 and 65.6 of the NFIP regulations is provided in FEMA Technical Bulletin 10-01, *Ensuring that Structures Built on Fill In or Near Special Flood Hazard Areas are Reasonably Safe From Flooding*, which may be downloaded directly from the FEMA website at http://www.fema.gov/mit/tb10prop.pdf.

- The processing Mapping Partner shall ensure that the map revision request conforms to all applicable NFIP regulations, and shall consult with the FEMA PO or his/her designee to determine how current FEMA policies may affect the revision.

[February 2002]

2.1.7.3 Coastal Revisions

To compute the stillwater flood level (SWFL), the revision requester shall consider many factors, and the computation is performed through the use of computer models or statistical analysis of tide gage data of adequate continuous record. Any revision of the SWFL must be based on new information that either refutes or supplements the gage data. The revision requester shall submit significant data or produce verifiable information that refutes the information FEMA used to construct the applicable computer model.

In the case of tide gages, the revision requester shall perform a statistical analysis prepared with new data that supplements the existing tide gage records or provides evidence that the data used are incorrect. The processing Mapping Partner shall review the information presented on the MT-2 application/certification forms package to determine the appropriateness of incorporating the revised data on the FIRM.

For map revision requests in coastal areas based on more up-to-date, site-specific topographic information, the revision requester shall provide a transect and a wave-height analysis based on the profile. For this analysis, the revision requester also may be required to consider other coastal processes, such as erosion and wave runup. This analysis may be conducted based on the terms of the effective FIS report and FIRM, the community, or the FEMA PO or his/her designee.

Map revisions in coastal areas also may be based on existing, new, or improved shore-protection structures, such as bulkheads, seawalls, breakwaters, and dikes. When structures designed to diminish or absorb wave energy (e.g., breakwaters, bulkheads, seawalls) are involved, the revision requester shall submit evidence that the structure will survive the base flood and associated wave action. The items that the revision requester shall address before for a map revision based on coastal structures are listed in *Criteria for Evaluating Coastal Flood Protection Structures.* (See Appendix G of these Guidelines.) Structures designed to provide flood protection (e.g., levees, dikes, floodwalls) must conform to Section 65.10 of the NFIP regulations and to the criteria outlined in Volume 1 of these Guidelines.

The revision requester also shall provide assurance from the State or local agency with maintenance responsibility that the structures involved in the revision will be maintained and will not settle, and shall submit as-built drawings of all structures. Wave height analyses based on transacts through these types of structures are valid only when these conditions are met.

The processing Mapping Partner shall review the information presented in the MT-2 application/certification forms package to determine the items that require further review and the appropriateness of incorporating the revised data on the FIRM.

2.1.7.4 Other Data

Revision requesters also may request changes to flood risk zone designations, changes to floodplain boundaries based on new or more detailed topographic information, and changes to corporate limits.

For revisions to flood risk zone designations, the processing Mapping Partner shall verify the accuracy of any calculations the revision requester submitted and determine whether a revision is warranted based on a review of the MT-2 application/certification forms package and the supporting documentation. Requests that Zone V or Zone A areas be revised to Zone A or Zone B, respectively, are to be supported by hydraulic computations in most cases.

For floodplain boundary revisions based on new or more detailed topographic information, the revision requester will not be required to submit revised hydraulic analyses unless the changes in ground contours have significantly affected the geometry of cross sections used for the effective FIS and FIRM or have altered effective-flow areas. For revisions involving only floodplain boundaries, the processing Mapping Partner shall review the information presented on the MT-2 application/certification forms package to determine whether the requested revisions may be made.

For changes to corporate limits, the revision requester shall submit an official corporate limits map or certified metes and bounds data to describe the revised boundary areas.

[February 2002]

2.1.8 Reporting and Project Officer Approval

Upon request, the processing Mapping Partner shall advise the revision requester, the FEMA RO, the FEMA PO, or his/her designee about the current status of a technical review. When the technical review is complete, the processing Mapping Partner shall discuss the results of the review, any additional data required to support the requested revision, and any problems encountered during the review with the FEMA PO or his/her designee. If appropriate, the FEMA PO or his/her designee shall direct the processing Mapping Partner to finalize the technical review by one of the following options:

- Requesting, by telephone or letter, additional or revised data to complete the technical review;
- Preparing a LOMR; or
- Preparing a PMR.

For PMRs, the processing Mapping Partner shall prepare a letter, referred to as a 316-PMR letter, to inform the CEO that a PMR will be prepared and request that the community submit any information to be incorporated into the PMR. Additional information on the 316-PMR letter and

other correspondence issued by FEMA and the processing Mapping Partner for a revision request is provided in the FEMA *Document Control Procedures Manual* (FEMA, 2000), which is available for review and downloading from the FEMA Flood Hazard Mapping website at http://www.fema.gov/mit/tsd/frm_docs.htm.

[February 2002]

2.1.9 Preparation of Preliminary Copies of Maps and Reports

Once the revision requester has submitted all required data in accordance with Part 65 of the NFIP regulations and the processing Mapping Partner has completed the technical review and discussed findings with the FEMA PO and his/her designee, The processing Mapping Partner shall prepare Preliminary copies of the revised map panel(s) in accordance with Section 1.4.6 of these Guidelines. The processing Mapping Partner also may prepare a revised FIS report if required by FEMA.

Occasionally, FIRM and/or FBFM panels may be revised to include changes that do not significantly affect the FIS report, such as redelineations of floodplain boundaries to reflect new or updated topographic data. However, because most PMRs will involve significant changes affecting BFEs, flood risk zones, and floodplain and floodway boundary delineations, revisions to the FIS report as well as the FIRM and FBFM will be necessary. The processing Mapping Partner shall follow the guidance in Appendix J of these Guidelines in preparing the revised FIS report.

[February 2002]

2.1.10 Community Review and Comment

At the request of FEMA, the processing Mapping Partner shall transmit Preliminary copies of the revised map panels and FIS report to the community CEO and floodplain management official, revision requester (if other than the CEO or floodplain management official), and others for review and comment. For all revisions, the community shall receive at least a 30-day review period. When BFEs are changed, the statutory 90-day appeal period shall be required.

[February 2002]

2.1.10.1 30-Day Review Period

For PMRs, FEMA generally will provide the community, revision requester (if other than a community), and all other interested parties with a 30-day review period. (For large-scale revisions or at the request of the community, FEMA may allow additional time to review the Preliminary copies.) During the review period, community officials shall submit comments and suggested revisions to the Preliminary copies.

Once the 30-day review period has elapsed, the processing Mapping Partner shall review any comments submitted and determine whether any additional revisions are required. The processing Mapping Partner shall discuss the comments received and any additional data

required to support them with the FEMA PO, his/her designee, and FEMA RO staff. The FEMA PO or his/her designee, in conjunction with the FEMA RO when required, shall determine whether changes are warranted. If the changes are significant (e.g., affect BFEs, affect large areas of SFHA), FEMA may direct the processing Mapping Partner to prepare and distribute Revised Preliminary copies of the revised FIS report, FIRM, and/or FBFM to the community CEO and floodplain administrator and other recipients of the Preliminary copies.

If no information is submitted during the review period or FEMA determines that the changes are not significant enough to warrant issuance of Revised Preliminary copies, FEMA shall direct the processing Mapping Partner to continue the production process. In such cases, the processing Mapping Partner shall incorporate any changes resulting from the review comments into the report and map materials before they are submitted to the FEMA Map Service Center (MSC) for publication by the U.S. Government Printing Office (GPO).

FEMA shall notify the community in a subsequent letter that the requested changes shall be shown on the printed copies of the revised FIS report, FIRM, and/or FBFM. If the PMR will result in modifications to the BFEs, the processing Mapping Partner shall initiate the 90-day appeal period as discussed in Subsection 2.1.1.2. For a PMR that does not involve modifications to BFEs, the processing Mapping Partner shall follow the procedures provided in Subsection 2.

If the PMR does not involve modifications to BFEs, the processing Mapping Partner shall prepare a Letter of Final Determination (LFD). Detailed information on procedures to be followed for preparing and distributing LFDs is provided in Volume 1, Subsection 1.5.2.4 of these Guidelines.)

[February 2002]

2.1.10.2 90-Day Appeal Period

For PMRs that involve new or modified BFEs, the processing Mapping Partner shall initiate the statutory 90-day appeal period to provide residents of the affected community an opportunity to appeal the new or modified BFEs. As in the processing of studies and restudies, the proposed or proposed modified BFEs must be published in a local newspaper with wide circulation and in the *Federal Register* to initiate the appeal period and must be finalized after the appeal period has elapsed, if no appeals are received. (Refer to Volume 1, Subsection 1.4.3.6 of these Guidelines for the procedures to be followed.)

For PMRs, the appeal period is held either before the start of or concurrent with the printing process for the revised FIS report, FIRM, and/or FBFM. The appeal period will occur prior to printing for revisions involving new or higher BFEs and may be concurrent with the printing process for revisions resulting in lower BFEs. For both the prior and concurrent procedures, the appeal period must elapse and the BFEs must be finalized before the revised FIS report, FIRM, and/or FBFM may become effective.

[February 2002]

2.1.11 Proposed Flood Elevation Determinations

When a 90-day appeal period is required for a PMR, the processing Mapping Partner shall prepare and process the correspondence for initiating the appeal period and proposing the new or modified BFEs. As mentioned earlier in this section, the processing Mapping Partner shall prepare the proposed BFE notices for publication in the *Federal Register* and a local newspaper with wide circulation and prepare all FEMA letters that will be sent to the CEO and floodplain administrator of the community, the State NFIP Coordinator, and others.

The processing Mapping Partner shall ensure that the notices are correct, that they include BFEs for all flooding sources for which revisions were made, and that they are published in the local newspaper on the correct date and in the *Federal Register*.

[February 2002]

2.1.12 Appeals and Protests

Appeals and protests concerning PMRs may be submitted by the community or affected property owners during the appeal period. Appellants shall submit appeals to FEMA through the CEO or a community official designated by the CEO in accordance with Part 67 of the NFIP regulations.

Information on the technical or scientific data that must be submitted to support an appeal or protest is provided in Chapters 3 and 4 of *Appeals, Revisions, and Amendments to National Flood Insurance Program Maps: A Guide for Community Officials* (FEMA, 1993). Appeals may be based only on information indicating that the proposed revised BFEs are scientifically or technically incorrect. Objections of other kinds are termed protests.

The processing Mapping Partner shall review, evaluate, and resolve all appeals submitted in accordance with the procedures outlined in Part 67 of the NFIP regulations and as amplified in Chapters 3 and 4 of FIA-12, *Appeals, Revisions, and Amendments to National Flood Insurance Program Maps: A Guide for Community Officials* (FEMA 1993). Within 5 working days of receipt of an appeal or protest, the processing Mapping Partner shall prepare an appeal or protest acknowledgment letter. The processing Mapping Partner shall then do the following:

- Evaluate any data submitted;
- Request any additional data required;
- Perform technical analyses if requested by FEMA;
- Prepare and distribute Revised Preliminary copies of the FIS report, FIRM, and/or FBFM, if requested by FEMA; and
- Assist FEMA in preparing and distributing an appeal or protest resolution letter to be sent to the community CEO and floodplain administrator and all appellants.

Changes resulting from protests usually shall be incorporated at the time that the final reproduction materials are prepared. However, if the changes are significant, the FEMA PO or his/her designee may direct the processing Mapping Partner to prepare and distribute Revised Preliminary copies of the revised FIS report, FIRM, and/or FBFM. If a Revised Preliminary is not required, the FEMA PO or his/her designee shall direct the processing Mapping Partner to include the protest resolution in the LFD for the PMR.

[February 2002]

2.1.13 Final Flood Elevation Determinations

When the 90-day appeal period has elapsed and all appeals have been resolved, the processing Mapping Partner shall prepare an LFD and a final BFE notice for publication in the *Federal Register*. (No notice will be published in a local newspaper.) The final BFE notice shall establish the final modified BFEs.

[February 2002]

2.1.14 Preparation of Summaries of Map Action

As mentioned in Volume 1 of these Guidelines, to assist communities in maintaining the NFIP maps, particularly the FIRM, the processing Mapping Partner shall prepare summaries of the LOMAs, LOMR-Fs, and LOMRs that will be superseded when revised FIRM panels become effective. FEMA will provide this summary, referred to as a Summary of Map Actions (SOMA), to affected communities at significant milestones during the processing of PMRs to make the affected communities aware of the effect that revised FIRM panels will have on previously issued LOMAs, LOMR-Fs, and LOMRs.

To ensure the modifications made by LOMAs, LOMR-Fs, and LOMRs are included in a PMR, the processing Mapping Partner shall perform searches for determinations at four stages: (1) before Preliminary copies of the affected FIRM panel(s) are prepared and sent to the community for review and comment, (2) before Revised Preliminary copies of the affected FIRM panel(s) are prepared and sent to the community for review and comment, (3) before the LFD is sent to the community, and (4) before the effective date of the revised FIRM panels.

At each stage, the processing Mapping Partner shall sort the LOMAs, LOMR-Fs, and LOMRs into the following categories:

- **Category 1** includes those LOMAs, LOMR-Fs, and LOMRs whose results have been shown on the revised FIRM panel(s).

- **Category 2** includes those LOMAs and LOMR-Fs whose results could not be mapped and shown on the revised FIRM panel(s) because of map scale limitations or because the affected areas were determined to be outside the SFHA as shown on the effective FIRM. These LOMCs are automatically revalidated after the revised FIRM panel(s) become(s) effective.

- **Category 3** includes those LOMAs, LOMR-Fs, and LOMRs whose results have not been, and will not be, reflected on the revised FIRM panel(s) because the flood hazard information on which the original determinations were based is being superseded by new flood hazard information.

- **Category 4** includes those LOMAs and LOMR-Fs that will be revalidated through a single letter that reaffirms the validity of a previously issued LOMC. Therefore, LOMAs and LOMR-Fs that were previously issued for multiple lots or structures where the determination for one or more of the lots or structures have changed cannot be revalidated through this administrative process.

For Category 4 LOMCs, the processing Mapping Partner shall review the data submitted in support of the original LOMA LOMR-F, or LOMR request and issue a new determination for the subject properties after the FIRM effective date. If conditions have changed since the original LOMA, LOMR-F, or LOMR was issued, and additional data and fees are required in order to issue a new determination, the processing Mapping Partner will not revalidate or reissue the LOMA, LOMR-F, or LOMR.

The processing Mapping Partner activities in preparing and distributing SOMAs are discussed in detail in Subsections 2.1.14.1 and 2.1.14.2

[February 2002]

2.1.14.1 Pre-Preliminary Activities

During the preparation of the Preliminary copies of the FIRM (and FBFM, if required), the activities below shall be completed. Additional information on SOMA production procedures is provided in Section 10 of *Document Control Procedures Manual* (FEMA, July 2000).

- The processing Mapping Partner shall produce a Preliminary SOMA, which is the product of database management software that searches the records in the CIS to identify LOMAs, LOMR-Fs, and LOMRs completed or pending for the community.

- The processing Mapping Partner shall review the in-house case files, other community-based files, hard copies of LOMAs and LOMR-Fs completed by the FEMA ROs, and case files for LOMAs and LOMR-Fs completed by the ROs to ensure all affected LOMAs, LOMR-Fs, and LOMRs are identified and listed on the SOMA. The processing Mapping Partner shall not investigate LOMAs, LOMR-Fs, and LOMRs that have already been superseded by a previous map (i.e., its determination date is prior to the current effective FIRM date) for inclusion on the SOMA.

- The processing Mapping Partner shall review each identified LOMA, LOMR-F, and LOMR to determine if it has been affected by new flood hazard information and if it can be incorporated into the FIRM. The Mapping Partner shall list those LOMAs, LOMR-Fs, and LOMRs that are unaffected by the new flood hazard information and can be reflected on the FIRM in Category 1 of the SOMA. The Mapping Partner shall list those LOMAs and LOMR-Fs that cannot be reflected on the FIRM but are unaffected by the updated flood hazard information in Category 2 of the SOMA.

- For the remaining LOMAs and LOMR-Fs, the processing Mapping Partner shall review the case files to determine if they can be revalidated. To determine this, the processing Mapping Partner shall perform the following activities: (1) locate the LOMA or LOMR-F site on the Preliminary copy of the FIRM, (2) determine the BFE for the site, and (3) compare the Lowest Adjacent Grade (LAG) or Lowest Finished Floor Elevation (LFFE), if applicable, of the structure(s) or the lowest ground elevation of undeveloped lot(s) to the proposed BFE at the site.

- If the LAG(s), LFFE(s), or lowest ground elevation at the site is above the proposed BFE, the processing Mapping Partner shall include the LOMA or LOMR-F in Category 2 of the SOMA and it will be eligible for revalidation. LOMAs or LOMR-Fs issued for properties with a LAG(s), LFFE(s), or lowest ground elevations below the BFE will be superseded; therefore, the processing Mapping Partner shall include those LOMAs and LOMR-Fs in Category 3 of the SOMA. As noted above, LOMAs and LOMR-Fs are revalidated by a single letter, referred to as the LOMC-Valid letter; therefore, the Mapping Partner shall list determinations issued for multiple structures or lots where the determinations for the lots/structures are no longer as they were originally determined to in Category 4 of the SOMA. The Mapping Partner shall consult with the FEMA PO or his/her designee to ensure that the provisions of the June 2001 revisions to Sections 65.5 and 65.6 of the NFIP regulations are met

- The processing Mapping Partner shall send the SOMA to the community CEO and floodplain administrator, RO, and State NFIP Coordinator with the transmittal letter that accompanies the Preliminary copies of the revised map panel(s).

- If no LOMAs, LOMR-Fs, or LOMRs have been issued since the affected map panel(s) became effective, the processing Mapping Partner shall include an explanatory paragraph in the transmittal letter to the community to acknowledge this fact, and no SOMA shall be sent.

[February 2002]

2.1.14.2 Post-Preliminary Activities

After mailing the Preliminary copies of the PMR to the community, the processing Mapping Partner shall complete the activities below, as required.

1. When Revised Preliminary copies are prepared and submitted to the community for review, the processing Mapping Partner shall generate a SOMA and conduct a review similar to that conducted before the Preliminary copies were issued.

2. When required, the processing Mapping Partner shall revise the Preliminary SOMA and submit it to FEMA for review with a special transmittal letter to the community. (The special transmittal letter shall be prepared by the processing Mapping Partner.)

3. The processing Mapping Partner shall mail the revised SOMA to the community CEO and floodplain administrator, RO, and State NFIP Coordinator with the special transmittal letter.

4. Approximately 2 weeks before the LFD is to be mailed, the processing Mapping Partner shall generate and review the Final SOMA. The Final SOMA shall include all LOMAs, LOMR-Fs, and LOMRs included in the Preliminary SOMA and all LOMAs, LOMR-Fs, and LOMRs issued since the Preliminary or Revised Preliminary copies of the FIRM were distributed.

5. The processing Mapping Partner shall mail the Final SOMA to the community CEO and floodplain administrator, RO, and State NFIP Coordinator with the LFD.

6. If no LOMAs, LOMR-Fs, or LOMRs have been issued for the affected map panel(s), the processing Mapping Partner shall include an explanatory paragraph in the LFD to acknowledge this fact, and no SOMA shall be sent.

[February 2002]

2.1.15 Preparation of Revised Reports and Maps for Printing

For PMRs, the Mapping Partner shall prepare final reproduction materials and submit them to the Map Service Center (MSC) for printing by GPO following the procedures discussed in Subsection 1.2.8 of these Guidelines.

[February 2002]

2.1.16 Coordination and Documentation Activities

The processing Mapping Partner shall perform the required coordination and documentation activities necessary for processing each PMR. During the processing, the Mapping Partner shall:

- Communicate with the requester and community, as necessary.
- Coordinate activities with the FEMA RO as directed by the FEMA PO or his/her designee.
- Communicate with other FEMA contractors and Federal, State, and local agencies, as needed.
- Prepare letters and other correspondence for FEMA signature.
- Maintain legal documentation, records of correspondence, and technical data.
- Provide inventory lists, printing requisition forms, status reports, and other information to FEMA as required by the FEMA PO or his/her designee.

In addition, the processing Mapping Partner shall organize, and may be required to submit to FEMA, records of the correspondence and supporting data associated with PMRs. (Refer to Volume 3 of these Guidelines for details.)

[February 2002]

2.2 Coastal Barrier Resources System Revisions

2.2.1 Overview

The U. S. Congress passed the Coastal Barrier Resources Act (CBRA) in 1982 and the Coastal Barrier Improvement Act in 1990, defining and establishing a system of protected coastal areas (including the Great Lakes), known as the Coastal Barrier Resources System (CBRS). The Acts define areas within the CBRS as depositional geologic features consisting of unconsolidated sedimentary materials; subject to wave, tidal and wind energies; and protecting landward aquatic habitats from direct wave attack. The Acts further define coastal barriers as all associated aquatic habitats, including the adjacent wetlands, marshes, estuaries, inlets and nearshore waters, but only if such features and associated habitats contain few manmade structures and these structures and man's activities on such features, and within such habitats do not significantly impede geomorphic and ecological processes.

The Acts provide protection to CBRS areas by prohibiting most expenditure of Federal funds within the CBRS. These prohibitions refer to "any form of loan, grant, guarantee, insurance, payment, rebate, subsidy or any other form of direct or indirect Federal assistance," with specific and limited exceptions.

In addition to the CBRS, the Coastal Barrier Improvement Act of 1990 established Otherwise Protected Areas (OPAs). OPAs are undeveloped coastal barriers within the boundaries of an area established under Federal, State, or local law, or held by a qualified organization, primarily for wildlife refuge, sanctuary, recreational, or natural resource conservation purposes.

The U.S. Congress designated the initial CBRS areas in 1982. Subsequent modifications to the CBRS are introduced as legislation to be acted on by the U.S. Congress, and originate from State and local requests, as well as recommendations made by the USFWS (USFWS). After the U.S. Congress approves additions to the CBRS, the new areas are assigned a unique effective date, after which Federal assistance prohibitions apply.

In cooperation with the U.S. Department of the Interior, FEMA transfers CBRS and OPA boundaries to Flood Insurance Rate Maps (FIRMs) using congressionally adopted source maps. FEMA ensures that FIRMs clearly depict the different CBRS areas and OPAs and their prohibition dates with special map notes and symbologies. Specific information on the notes and symbologies is provided in Appendix K of these Guidelines. Although FEMA shows CBRS areas and OPAs on FIRMs, the U.S. Congress is the only entity that may authorize a revision to these boundaries.

This section of the Guidelines uses the terms "Coastal Barriers" and "Coastal Barrier Resources System" units (or CBRS units). These terms are intended to be inclusive of all classifications of Coastal Barriers within the CBRS, including areas designated as OPAs.

[February 2002]

2.2.2 Coastal Barrier Unit Classifications

As of November 2000, the two classifications of Coastal Barrier units are as follows:

1. **Coastal Barrier Resources System** units were originally established by the CBRA of 1982 (Public Law 97-348). The Act established 186 units within the CBRS. The Coastal Barrier Improvement Act of 1990 greatly expanded the identified land in the CBRS established by the CBRA of 1982 and modified existing barrier units. Subsequent to the 1990 Act, new legislation has been, and will likely continue to be, passed by Congress to revise the CBRS.

2. **Otherwise Protected Areas** are undeveloped coastal barriers within the boundaries of an area established under Federal, State, or local law, or held by a qualified organization, primarily for wildlife refuge, sanctuary, recreational, or natural resource conservation purposes. The Coastal Barrier Improvement Act of 1990 established prohibitions in designated OPAs and subsequent legislation has, and will likely continue to, modify OPA boundaries.

For FIRMs prepared after 1991 and prior to November 2000, CBRS units were separated into three classifications. The 1982 Coastal Barrier Resources System units were a separate classification from the 1990 or later Coastal Barrier Resources System units.

[February 2002]

2.2.3 Flood Insurance Prohibitions

Federal flood insurance is available in a CBRS area if the subject building was constructed (or permitted and under construction) before the CBRS area's prohibition date. For CBRS areas designated by the 1982 Act, the sale of Federal flood insurance is prohibited for structures built or substantially improved after October 1, 1983. For subsequent additions to the CBRS, the insurance prohibition date is either the date of the legislation passed by the U.S. Congress or the date of the notice in the *Federal Register* for changes allowed under a previous law such as the 5-year update. For structures located in the OPAs, insurance may be obtained if written documentation is provided certifying that the structure is used in a manner consistent with the purpose for which the area is protected. All prohibition dates are shown on the FIRM.

If an existing insured structure in the CBRS or OPA is substantially improved or damaged, any Federal flood insurance policy will not be renewed. If a Federal flood insurance policy is issued in error, it will be canceled and the premium refunded; no claim can be paid, even if the error is not found until a claim is made.

Each action (legislative or administrative) that results in a revision to CBRS boundaries is relevant to the mapping of the CBRS. New legislation that adds areas to the System creates new prohibition dates. When a particular piece of legislation only removes areas from the System, there are no new prohibition dates associated with the Act. A comprehensive list of significant dates relative to the CBRS is provided in Subsection 2.3.5. Prohibition dates that coincide with

legislation or administrative actions (such as the 5-year update) that added areas to the System are identified in this list.

[February 2002]

2.2.4 Types of Revisions

FEMA has three distinctly different mechanisms for revising FIRMs to reflect modified CBRS boundaries. One of these three mechanisms shall be initiated as soon as FEMA submits the congressionally adopted source maps to the Mapping Partner that is selected by FEMA to revise the affected FIRM panels. Often, a draft set of these maps will be made available either through FEMA or the USFWS. In the event that advanced copies are made available, the Mapping Partner shall scope out the revision and prepare to make the FIRM changes using the most efficient of the methods described below.

2.2.4.1 Letter of Map Revision

The LOMR process entails making the CBRS boundary change by letter. Revising the CBRS boundaries through the LOMR process provides for a quicker turnaround time than the PMR process. This option shall be chosen only when the revision is relatively small in scope.

When the CBRS revision is processed in this fashion, the MSC shall mail a copy of the LOMR to all parties that are on record as having a copy of the subject FIRM panel(s). This ensures a wider distribution than would normally occur for LOMR distribution. The Mapping Partner shall be responsible for providing the required number of copies to the MSC and for coordinating the distribution in advance. It is imperative that advanced coordination be accomplished to ensure that the LOMR will be distributed by the MSC without delay.

Any CBRS boundary changes effected by LOMR is to be followed immediately by a PMR unless the LOMR can be incorporated into an ongoing map update as discussed below. If the ongoing map update is very early in its processing life or significant delays are expected because of an appeal, the Mapping Partner shall consult with the FEMA PO or his/her designee to determine whether a separate PMR to incorporate the changes in the CBRS LOMR is to be initiated.

2.2.4.2 Ongoing Map Update

Whenever possible, the CBRS boundary changes shall be incorporated into an ongoing map update. If the ongoing map update is very early in its processing life or significant delays are expected because of an appeal, the Mapping Partner shall consult with the FEMA PO or his/her designee to determine whether the LOMR or separate PMR methods are to be initiated to show the boundary changes so as to not excessively delay the incorporation of the CBRS boundary change into the affected FIRM panel(s). Delays incurred to include the CBRS boundary changes into an ongoing map update shall be acceptable, however, if the revision is solely to remove areas from the System.

2.2.4.3 Separate Physical Map Revision

When the area to be revised is too large to be accomplished by a LOMR and when there are no ongoing map updates for the affected FIRM panels, a separate PMR must be processed to reflect the CBRS boundary changes. As discussed above, FEMA may also choose the PMR processing option when areas being added to the System are too large to show on a LOMR attachment.

The processing Mapping Partner shall direct all questions or problems concerning the delineation of CBRS boundaries to the FEMA PO or his/her designee.

[February 2002]

2.2.5 Historical Dates

The following is a historical summary of significant dates in the history of the CBRS:

October 1, 1982 Passage of the Coastal Barrier Resources System Act (Public Law 97-348). The effect of this Act was to establish the CBRS and to provide a 1-year grace period during which communities could prepare for the Federal flood insurance funding prohibitions that would go into effect with publication of the Flood Insurance Rate Maps (FIRMs) 1 year later on October 1, 1983.

October 1, 1983 **Prohibition Date.** All Coastal Barrier units established with the passage of the Coastal Barrier Resources System Act of 1982 were mapped and finalized on FIRMs dated October 1, 1983.

November 16, 1990 **Prohibition Date.** Passage of the Coastal Barrier Improvement Act (Public Law 101-591). The effect of this Act was to significantly enlarge the CBRS and to impose Federal insurance and funding prohibitions for new construction or substantial improvements within units added to the CBRS on and after November 16, 1990. This Act also established the addition of specific public lands designated as Otherwise Protected Areas (OPAs) 1 year after passage of the Act; provided for minor and technical boundary modifications within two years from the date of enactment; and provided for a periodic (every 5 years) review of and adjustments to CBRS and OPA boundaries to account for subsequent physiographic changes.

June 6, 1991 *Federal Register* notice of availability of CBRS maps showing the changes made under Public Law 101-591.

November 16, 1991 **Prohibition Date.** Date on which Federal flood insurance prohibitions were applied to public lands designated as OPAs. The only prohibition that applies in an OPA is Federal flood insurance for new construction or substantial improvements that occur after that date, with specific and limited exceptions.

October 23, 1992 **Prohibition Date.** Passage of Public Law 102-440 (the "Wild Exotic Bird Conservation Act"). Section 303 of Public Law 102-440 modified the boundaries of OPA unit NC-01P to only include lands owned by the Audubon Society and to change the designation of this unit from OPA unit NC-01P to CBRS unit NC-01, modified the boundaries of OPA unit NC-05P to only include lands owned by the State of North Carolina, and modified the boundaries of the southern segment of OPA unit VA-60P and redesignated part of OPA unit VA-60P as CBRS unit VA-60.

November 15, 1993 **Prohibition Date.** Publication of the *Federal Register* that provided notification of the changes made under Section 4(e) of Public Law 101-591. This section of Public Law 101-591 was established to allow for minor and technical boundary modifications subsequent to the passage of the Coastal Barrier Improvement Act. This *Federal Register* also provided notification of the availability of revised CBRS maps showing the changes made under Section 303 of Public Law 102-440.

November 2, 1994 Passage of Public Law 103-461, effecting changes to several CBRS and OPA units. The changes under Section 1 of this law, which involved mostly minor exclusions from the System, removed properties that were developed prior to 1982 and were erroneously included in the CBRS. The units affected by these changes are as follows: NY-75, VA-62P, FL-05P, P11A, FL-15, FL-36P, P17, P17A, P18P, P19P, FL-72P, P31P, FL-95P, AL-01P, and MI-21.

February 23, 1995 **Prohibition Date.** Publication in the *Federal Register* of the availability of CBRS maps showing the changes made under Section 1 of Public Law 103-461. Although most changes under this act involved minor exclusions from the System, there were small areas added, thus the new prohibition date.

May 24, 1996 Passage of Public Law 104-148, which resulted in a reduction to OPA unit NY-59P to remove privately held lands.

October 9, 1996 Passage of Public Law 104-265, effecting a reduction to CBRS unit SC-01 to remove developed properties.

November 12, 1996 Passage of Public Law 104-333, effecting changes to several Florida CBRS and OPA units. The units affected by these changes are as follows: P05, P05A, P10, P11, P11A, P18, P25, P32, and P32P.

February 24, 1997 **Prohibition Date.** Publication in the *Federal Register* of the notice that finalized changes to the CBRS resulting from a 5-year review/update of CBRS and OPA unit boundaries provided for in Section 4(c) of Public Law 101-591. The intent of these changes was to keep the CBRS current with the physiographic changes that occur in coastal areas. The following units were affected by these changes: ME-17, ME-18, MA-03, C01B,

MA-20P, MA-24, C28, C31, D02B, NY-04P, NY-50, F10, NJ-09, MD-03, MD-37P, MD-38, VA-09, VA-23, VA-36, L07, L09, P16, P17, FL-89, FL-99, FL-101, Q01A, and VI-07.

April 18, 1997 Publication in the *Federal Register* of the availability of CBRS maps showing the changes made under Section 2 of Public Law 104-148 and Section 201 of Public Law 104-265.

May 28, 1997 Publication in the *Federal Register* of the availability of CBRS maps showing the changes made under Section 220 of Public Law 104-333.

March 5, 1998 Notification by the U.S. Federal District Court of the District of Columbia that the boundary changes made by Public Law 104-333 were invalidated subsequent to a successful challenge being brought before the Court.

October 21, 1998 **Prohibition Date.** Passage of Public Law 105-277, which reinstated the changes made by Public Law 104-333 that were invalidated on March 5, 1998. Public Law 105-277 also effected other minor changes to the CBRS in South Carolina and Florida. Section 335 of Public Law 105-277 reinstated the changes made by Public Law 104-333 for the following units: NY-75, VA-62P, FL-05P, P11A, FL-15, FL-36P, P17, P17A, P18P, P19P, FL-72P, P31P, FL-95P, AL-01P, and MI-21. Section 101(e) of this law revised CBRS units FL-35 and SC-03 and OPA unit FL-35P to remove developed properties from the System. Section 134 of Public Law 105-277 changed the southern and western boundary of CBRS unit M09 back to the boundary established in 1982.

August 2, 1999 Publication in the *Federal Register* of the availability of CBRS maps showing the changes made under Public Law 105-277.

November 29, 1999 **Prohibition Date.** Passage of Public Law 106-116, which replaced 7 maps relating to the System with 14 new maps. These changes affected CBRS unit L03 and OPA unit NC-03P. CBRS unit L03 was changed to meet the original intent of Congress, and OPA unit NC-03P was changed to coincide with the boundary of the Cape Hatteras National Seashore.

December 6, 1999 **Prohibition Date.** Passage of Public Law 106-128, which revised OPA unit DE-03P to add State parkland to the OPA and remove privately owned land outside the park.

December 9, 1999 Passage of Public Law 106-167, which redesignated the CBRS as the "John H. Chafee Coastal Barrier Resources System."

April 4, 2000 Publication in the *Federal Register* of the availability of CBRS maps showing the changes made under Section 1(a) of Public Law 106-116 and Section 1(a) of Public Law 106-128.

October 19, 2000 Passage of Public Law 106-332, which clarified the boundaries of National Audubon Society lands that CBRS unit NC-01 was intended to mirror.

October 27, 2000 Passage of Public Law 106-360, which clarified the boundaries of Cayo Costa State Park and resulted in changes to CBRS unit P19 and OPA unit P19P.

November 13, 2000 Passage of Public Law 106-514, the Coastal Barrier Resources Reauthorization Act of 2000, which notably mandates a pilot project to convert a number of the CBRS maps to digital format.

February 16, 2001 Publication in the *Federal Register* of the availability of CBRS maps showing the changes made under Section 1 of Public Law 106-332 and Section 1 of Public Law 106-360.

[February 2002]

2.2.6 Database Control

A Mapping Partner selected by FEMA shall maintain the national CBRS database. The designated Mapping Partner shall update the database whenever a revision to a FIRM panel containing CBRS units is processed. All such changes to the database shall be reported to the Mapping Partner assigned to the maintenance of the database. The database is made available on the NFIP website and as such shall be updated monthly and forwarded to the NFIP Bureau and Statistical Agent. The database will be provided to the NFIP Bureau and Statistical Agent in a variety of data formats for downloading from the website. The protocol to be followed by the Mapping Partner assigned to this task for monthly database translations is provided below.

On the first business day of each month, the designated Mapping Partner shall send a WinZip file to a designated individual at the NFIP Bureau and Statistical Agent via e-mail. The WinZip file shall consist of the latest version of the CBRS database in Excel, Lotus 123, Quattro Pro, ASCII, Access, and dBase formats. The designated Mapping Partner shall follow the procedures below when creating the file translations.

Quattro Pro and Lotus 123 Files

1. Open the Excel file entitled cbrsdata.xls.
2. Save the file as a WQ1 (Quattro Pro) with the same prefix, cbrsdata.
3. Save the file as a WK4 (Lotus 1-2-3) file with the same prefix, cbrsdata.

ASCII Files

1. Open the Excel cbrsdata.xls file.
2. From the File menu, select "Save As".
3. From the "Save As" type: drop-down menu, choose Text (OS/2 or MS-DOS) (*.txt) and then click Save.

Access File

1. Open a new database file in Access by selecting "Blank Database" from the startup screen.
2. Name the new Access file with the prefix cbrsdata.
3. Click "New" and then click "OK" for the datasheet view option from the Tables tab on the new database screen.
4. From the File menu, choose "Get External Data" and then click "Import."
5. Choose "Microsoft Excel" from the Files type menu.
6. Locate the Excel cbrsdata.xls file and select it for import.
7. Select "Show Worksheets" and then click "Next."
8. Select "First Row Contains Column Headings" and then click "Next."
9. Select "In a New Table" and then click "Next."
10. Choose "No Primary Key" from the next screen and then click "Next."
11. Click "Finish."

dBase File

1. Open the newly created Access file.
2. From the File menu, click "Save As/Export"
3. Click "OK" on the next screen.
4. Select "dBase IV (*.dbf)" from the "Save as Type" drop-down menu on the next screen
5. Change the file name to cbrsdata.

The designated Mapping Partner shall place all of the above file translations on a WinZip file entitled cbrsdata.zip and send the file to the current e-mail address contact for the NFIP Bureau and Statistical Agent.

[February 2002]

2.2.7 Work to be Performed

The tasks to be performed by the designated Mapping Partner include, but are not limited to, the following:

- Obtaining copies of printed FIRMs and FIRM artwork;
- Reviewing lists of active studies and restudies to determine whether the necessary revisions to CBRS unit maps can be combined with current map actions;
- Preparing the map layout and performing all manual or digital cartographic work associated with showing new boundaries and screens of CBRS boundaries from the CBRS maps on the affected FIRM panels;
- Performing a detailed quality control review of all existing and revised CBRS boundaries on the FIRM panels being revised;

- Preparing correspondence to notify affected communities of the revisions being made;
- Preparing camera-ready artwork for submittal to GPO; and
- Providing review copies of the revised FIRM panels to the USFWS

[February 2002]

2.2.8 Source Materials

Delineation of CBRS units on the FIRM shall be based on the congressionally adopted CBRS source maps produced by the U.S. Department of the Interior (DOI), which will be supplied to the Mapping Partner by the FEMA PO or his/her designee. These maps, hereinafter referred to as "System maps" were produced by the USFWS from a set of maps adopted by the U.S. Congress pursuant to the Coastal Barrier Improvement Act of 1990 and amended as new legislation warrants.

In addition, a set of maps prepared in 1988 by the DOI entitled "*Report to Congress: Coastal Barrier Resources System, Recommendations for Additions to or Deletions from the Coastal Barrier Resources System*" (U.S. Department of the Interior, 1988.) will be available to the designated Mapping Partner for reference purposes only. These maps show what was provided to the U.S. Congress when the 1990 Act was pending. They portray the 1982 extent of the CBRS and clearly define the recommended changes. Although these maps shall not be used by the Mapping Partner for the delineation of CBRS units, they are useful in determining the original extent of 1982 CBRS units and the recommended changes.

[February 2002]

2.2.9 Mapping Specifications

The designated Mapping Partner shall ensure that the mapping specifications summarized in Subsections 2.2.9.1 through 2.2.9.5 are applied to the revised FIRM panels.

[February 2002]

2.2.9.1 Coastal Barrier Resources System Boundaries and Delineations

The CBRS boundaries and delineations that are to be included on the revised FIRM panels are summarized below.

Existing 1983 CBRS Boundaries

Existing 1983 Barriers may appear more detailed on the FIRM than the Barrier delineation shown on the System maps. This does not mean that the existing Barrier has been redelineated. It is more likely that the difference between the System map and the FIRM is due to the difference in source maps used to delineate Coastal Barriers in 1983.

CBRS Unit Boundaries versus Houses

The System maps show direct horizontal relationships between existing houses and the CBRS unit boundaries; these relationships shall be maintained. Most often, the Coastal Barrier boundary has been delineated to keep existing homes out of the designated Coastal Barrier.

CBRS Unit Boundaries versus Linework Features

The System maps use thick lines to represent CBRS unit boundaries. Although standard cartographic practice is to follow the center of a boundary, if the boundary has a direct relationship with a linework feature (such as being against the edge of a road), the Mapping Partner shall be careful to maintain that relationship, even if it means the edge of the boundary line shown on the System map will be used.

Existing Floodplain Boundaries

CBRS boundaries have no direct relationship to existing floodplain boundaries. Any appearance as such shall be questioned.

Boundary Lines Between Contiguous CBRS Units of Different Classifications

Boundary lines must be shown to differentiate between contiguous Barriers of different classifications, because each CBRS classification carries a different insurance prohibition. This also means that same-screen Barriers will be shown bisected by a boundary line if the Barriers on either side of the line have a different insurance prohibition date.

Note: See the information in Subsections 2.3.9.4 and 2.3.9.5 of these Guidelines regarding the map screens and the number of CBRS notes to use.

Boundaries of Enlarged CBRS Units

If an existing CBRS unit is enlarged, the enlarged area will be considered on the System maps to be a part of the same unit. Therefore, boundaries between, for example, 1991 and 1993 OPAs of the same unit number will not be shown on the System maps. However, these boundaries must be shown on the FIRM panels to differentiate between the different years of identification for each area (as a result of the different insurance prohibitions unique to each area).

Boundary Lines Between Contiguous CBRS Units With the Same Prohibition Date

There are several occasions where CBRS units with different unit numbers are contiguous to each other on the CBRS maps; the same holds true for OPA units with different numbers. The designated Mapping Partner shall ensure that the FIRM, however, does not show a boundary line between different CBRS or different OPA units if they carry the same prohibition date.

Inaccurate CBRS Unit Delineations

Any problems with the Coastal Barrier delineation on the FIRM panels as compared to the System maps shall be corrected, and FEMA shall inform the USFWS of all such changes.

Errors on 1983 FIRMs

There will be occasions where a 1982 Coastal Barrier unit was inadvertently omitted from the 1983 FIRM because the Coastal Barrier screen was not extended past the shoreline to the full extent of the Special Flood Hazard Area (SFHA) zone screen or the 1982 Coastal Barrier was missed when the Barriers were first mapped. When this occurs, the designated Mapping Partner shall show the addition as a 1982 Coastal Barrier, not a 1990 (or later) Coastal Barrier.

[February 2002]

2.2.9.2 Flood Insurance Rate Map Index

For the 1982 Coastal Barrier FIRM revisions, a map note appeared on the FIRM Index, which itemized the CBRS panels. Use of this note was discontinued until 1996, when it was reinstituted by FEMA. Therefore, the designated Mapping Partner shall add the following note above the FIRM Index title block and north arrow for any community that contains Coastal Barrier units.

- NOTE -
Designated Coastal Barriers are
located on panels [*panel numbers*]

All printed and non-printed panels shall be listed. Non-printed panels will be footnoted with "Panel Not Printed."

[February 2002]

2.2.9.3 Reason for Revision Notes in Flood Insurance Rate Map Legend

For guidance on the proper revision note to be used in the FIRM Legend, the designated Mapping Partner shall follow Table 2-1. The proper note to be used depends on whether CBRS areas and/or OPAs are being added to, or removed from, the community. Only one of the notes shown shall be used for any given community, so it must reflect the community as a whole. These revision notes shall not to be panel-specific. They shall reflect the action taken for the entire subject jurisdiction.

[February 2002]

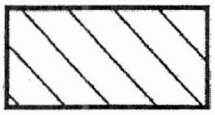
Table 2-1. Coastal Barrier Revision Notes

Revision Note	Barrier Added	Barrier Removed[1]	OPA Added	OPA Removed[1]
To add Coastal Barrier Resources Areas	X			
To remove Coastal Barrier Resources Areas		X		
To modify Coastal Barrier Resources Areas	X	X		
To add Otherwise Protected Areas			X	
To remove Otherwise Protected Areas				X
To modify Otherwise Protected Areas			X	X
To add Coastal Barrier Resources Areas and Otherwise Protected Areas	X		X	
To add Coastal Barrier Resources Areas and to remove Otherwise Protected Areas	X			X
To add Coastal Barrier Resources Areas and to modify Otherwise Protected Areas	X		X	X
To remove Coastal Barrier Resources Areas and to add Otherwise Protected Areas		X	X	
To remove Coastal Barrier Resources Areas and Otherwise Protected Areas		X		X
To remove Coastal Barrier Resources Areas and to modify Otherwise Protected Areas		X	X	X
To modify Coastal Barrier Resources Areas and to add Otherwise Protected Areas	X	X	X	
To modify Coastal Barrier Resources Areas and to remove Otherwise Protected Areas	X	X		X
To modify Coastal Barrier Resources Areas and Otherwise Protected Areas	X	X	X	X

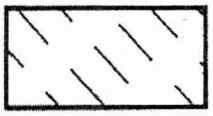
[1]This refers to any area, regardless of size, that has had the CBRS unit reduced in size in any area.

2.2.9.4 Map Screens

Although several different types of Coastal Barriers exist, only two map screens are to be used. Coastal Barriers shall be portrayed with the two map symbols shown below to differentiate between CBRS and OPA units, which contain differing prohibitions. The CBRS and OPA prohibition dates (i.e., the date that the CBRS or OPA area was originally designated) shall be shown within each separate CBRS and OPA unit to assist map users in determining the proper insurance prohibition date for each unit.

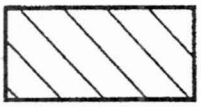


CBRS unit



OPA unit

For FIRMs prepared after 1991 and prior to November 2000, the following three map screens shall be used to reflect the three classifications of CBRS units:

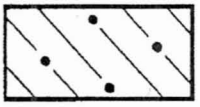


1983

Coastal Barriers

1990 or later

Coastal Barriers



1991 or later

Otherwise Protected Areas

Specifications for the CBRS screens and a graphic representation of the CBRS screens are provided in Appendix K of these Guidelines. The Mapping Partner shall not terminate CBRS screens at the shoreline unless the shoreline is coincident with the Barrier or OPA boundary. The Mapping Partner shall extend the boundary into the open water to the edge of the SFHA screen. The open-water extent of Coastal Barrier or OPA boundaries and cross-hatching on a FIRM panel also shall not extend beyond the SFHA screen unless the Coastal Barrier boundary is closed on the CBRS map.

[February 2002]

2.2.9.5 Map Notes

The designated Mapping Partner shall ensure that the correct map notes appear on the revised FIRM panels as discussed below.

Title Block Notes

The following Coastal Barrier note shall appear on the FIRM panel title block of all new or revised CBRS panels:

-NOTE-

THIS MAP INCORPORATES APPROXIMATE BOUNDARIES OF COASTAL BARRIER RESOURCES SYSTEM UNITS AND/OR OTHERWISE PROTECTED AREAS ESTABLISHED UNDER THE COASTAL BARRIER IMPROVEMENT ACT OF 1990 (PL 101-591).

Subsequent to the passage of Public Law 101-591, several changes to the CBRS units have occurred. These changes are itemized above in Subsection 2.3.5. If the map panel contains a Coastal Barrier established under an act subsequent to Public Law 101-591, the designated Mapping Partner shall modify the note that is placed in the FIRM title block to include the subject public law. One such example is provided below.

-NOTE-

THIS MAP INCORPORATES APPROXIMATE BOUNDARIES OF COASTAL BARRIER RESOURCES SYSTEM UNITS AND/OR OTHERWISE PROTECTED AREAS ESTABLISHED UNDER THE COASTAL BARRIER IMPROVEMENT ACT OF 1990 (PL 101-591) AND/OR THE WILD EXOTIC BIRD CONSERVATION ACT OF 1992 (PL 102-440).

General Map Note

Old CBRS FIRM panels may contain a general map note in the body of the FIRM panel similar to the note that is now placed in the FIRM title block. If any such general map notes exist from the previous effective FIRM, the designated Mapping Partner shall remove them.

Coastal Barrier Identification Notes

Three different Coastal Barrier identification notes may appear on the FIRM: 1983 Coastal Barriers, 1990 or later Coastal Barriers, and 1991 or later Otherwise Protected Areas. The designated Mapping Partner shall use the correct note for each barrier type and insert the proper insurance prohibition date as appropriate. Specifications for the use of an abbreviated note with a special Coastal Barrier Legend are provided below.

1983 Coastal Barrier Note:

FLOOD INSURANCE NOT AVAILABLE FOR STRUCTURES NEWLY BUILT OR SUBSTANTIALLY IMPROVED ON OR AFTER OCTOBER 1, 1983, IN DESIGNATED COASTAL BARRIERS.

1990 or Later Coastal Barrier Note:

FLOOD INSURANCE NOT AVAILABLE FOR NEW CONSTRUCTION OR SUBSTANTIALLY IMPROVED STRUCTURES ON OR AFTER (date), IN DESIGNATED COASTAL BARRIERS.

1991 or Later Otherwise Protected Area Note:

FLOOD INSURANCE NOT AVAILABLE FOR STRUCTURES - NEWLY BUILT OR SUBSTANTIALLY IMPROVED ON OR AFTER (date) - NOT USED IN A MANNER CONSISTENT WITH THE PURPOSE OF THE OTHERWISE PROTECTED AREAS.

Number of Notes to Use

Before 1994, FEMA specifications required that each FIRM panel carry a minimum of one Coastal Barrier identification note for each Coastal Barrier classification present on the FIRM panel. No requirement to label each separate Coastal Barrier within a given classification of Coastal Barrier existed. If, for example, several 1991 OPAs were on a FIRM panel, only one of them had to be labeled, because only one map screen and prohibition date per Coastal Barrier classification existed. For the 1994 CBRS revisions, FEMA began to use the same map screens to represent Coastal Barriers with different prohibition dates on the affected FIRM panels. Therefore, all separate barrier areas on a FIRM shall be labeled with one of the Coastal Barrier identification notes shown above. The only distinction between many of the Barriers on the FIRM panel will be the specific Coastal Barrier identification note.

Location of Coastal Barrier Notes

The designated Mapping Partner shall locate the Coastal Barrier and OPA notes, whenever possible, on or near the land area, and shall not overprint existing base or floodplain features. If the designated Mapping Partner cannot locate the note on the land area due to space and clarity considerations, the designated Mapping Partner shall place the note in the open water within the Coastal Barrier or OPA screen, near the land area. If the note cannot be placed within the Coastal Barrier or OPA screen without creating overprints, the designated Mapping Partner shall add a leader from the note to the land area.

Alternate Coastal Barrier Labeling

For digital FIRMs with three or more different Coastal Barrier Identification notes and for those manually produced FIRMs where excessive clutter would result from labeling all Barriers, the designated Mapping Partner shall use the following alternate Barrier labels:

COASTAL BARRIER IDENTIFIED (*DATE*) (SEE COASTAL BARRIER LEGEND)	OTHERWISE PROTECTED AREA IDENTIFIED (*DATE*) (SEE COASTAL BARRIER LEGEND)

When this procedure is used, the designated Mapping Partner shall label all Barriers on the FIRM panel in this fashion. This will involve retrofitting existing Barrier labels (from the previous edition of the FIRM) to conform to the alternate labeling procedure. In addition, when this procedure is used, the designated Mapping Partner shall place a special coastal barrier legend in the body of the map for single-border FIRMs, and in the left-hand border on double-border FIRMs. This legend will show the entire CBRS map note for each classification of Coastal Barrier present on the FIRM panels.

For manually produced FIRMs, the designated Mapping Partner shall ensure that the Coastal Barrier legend contains the entire CBRS map note for only those Barriers present on the FIRM panel in question. For digital FIRMs, the Coastal Barrier legend will contain the entire CBRS map note for all Barriers on all FIRM panels (to avoid having to create multiple legends). An example of the Coastal Barrier legend may be found in Appendix K of these Guidelines.

Coastal Barrier Coordinator Note

The designated Mapping Partner shall add a note to each CBRS FIRM to refer map users to the Regional Coastal Barrier Coordinator at the USFWS. The note reads as follows:

> **Comments or concerns regarding the Coastal Barrier Resources System or Otherwise Protected Areas should be directed to the Coastal Barrier Coordinator at the U.S. Fish and Wildlife Service; (___) ___-____.**

The phone number shall be inserted into the above note as follows:

(413) 253-8657	CT, DE, MA, ME, MD, NJ, NY, RI, VA
(404) 679-7106	AL, FL, GA, LA, NC, PR, SC, VI
(612) 713-5350	MI, MN, OH, WI
(505) 248-6454	TX

The designated Mapping Partner shall place the note in the body of the FIRM panel close to the CBRS units. If the abbreviated Coastal Barrier notes and special Coastal Barrier Legend are used, this note shall appear below the Coastal Barrier Legend. (See Appendix K for specific presentation information.)

Regulatory Floodway Note

If the Coastal Barrier or OPA screen happens to overlap an area of regulatory floodway on a FIRM, both the regulatory floodway screen and the Coastal Barrier screen shall be shown. If the designated Mapping Partner believes that it may be unclear to users that the area within the regulatory floodway is also a Coastal Barrier, the Mapping Partner shall add a leader with the following note to the area of overlap:

THIS AREA IS CONTAINED WITHIN THE
COASTAL BARRIER RESOURCES SYSTEM

[February 2002]

2.2.10 Miscellaneous Requirements

2.2.10.1 Letters of Map Revision

If a LOMR was issued to revise an effective FIRM panel, the changes effected by the LOMR shall be included on the revised FIRM. The following standard LOMR addition note shall be used in the FIRM Legend: "To incorporate previously issued Letters of Map Revision."

[February 2002]

2.2.10.2 Flood Insurance Study Report

The designated Mapping Partner shall not revise the FIS report for revisions performed solely to add, remove, or revise Barriers. For FIS reports that are being prepared to reflect other map updates, the designated Mapping Partner shall add standard CBRS paragraphs in Section 3.0 (Insurance Applications) of the FIS report to explain the CBRS. (See Appendix J of these Guidelines for specific information on the CBRS standard paragraphs.)

[February 2002]

2.2.10.3 Community Notification

The designated Mapping Partner shall prepare Proof Copies of revised FIRM panels and transmit them to the community CEO and floodplain administrator for revisions that are processed solely for the addition, deletion, or modification of Coastal Barriers. The Mapping Partner shall transmit the Proof Copies of the revised FIRM panels with a standard transmittal letter provided by FEMA HQ indicating that the subject FIRM will be revised in 6 months to show CBRS revisions that cannot be appealed. For these types of revisions, when the final reproduction materials are complete, the designated Mapping Partner shall replace the standard (179-series) transmittal letter to the CEO of the community with a special Coastal Barrier transmittal letter.

[February 2002]

2.2.10.4 U.S. Fish and Wildlife Service Review Comments

The USFWS has been given a 30-day review period to ensure that the Coastal Barriers are properly mapped. The designated Mapping Partner shall provide Proof FIRM panels of the CBRS revisions to the USFWS at the beginning of the 30-day review period and shall coordinate with the USFWS at the end of the 30-day review period to ensure proper inclusion of changes noted by the USFWS.

[February 2002]

2.2.10.5 Coastal Barrier Unit Numbers

CBRS and OPA units are numbered, and these numbers may be found on the System maps. A single letter (e.g., C14) precedes the 1983 CBRS unit numbers. New 1990 or later units (not OPAs) are preceded by the two-letter State abbreviation and will also include a hyphen (e.g., TX-05 for a Texas unit). The 1991 or later OPAs are always followed by a "P" (e.g., C14P or TX-05P). These CBRS and OPA unit numbers shall not appear on the FIRM panels.

[February 2002]

2.3 Notice-to-User Revisions

The intent of a Notice-To-User revision is to quickly and inexpensively address a nontechnical problem with a published FIS report, FIRM, or FBFM. These types of revisions are intended solely to correct an incorrect or omitted component and cannot be used to establish new or revised flood hazard information.

[February 2002]

2.3.1 Types of Incorrect or Omitted Components

The errors or omissions that can be corrected using the Notice-to-User revision process include, but are not limited to, the following:

- Typographic errors in BFEs shown on FIRM;
- Missing tables included in the FIS report;
- Incorrect entries in the tables included in the FIS report;
- Incorrect map scale shown on the FIRM and/or FBFM panels;
- Incorrect flood insurance risk zone labels shown on the FIRM panels;
- Incorrect or missing flood insurance risk zone screens on the FIRM and/or FBFM panels;
- Addition or correction of Corporate Limits shown on the FIRM and/or FBFM panels;
- Addition or correction of Township, Range, and Section lines on the FIRM and/or FBFM panels;
- Errors in Bench Marks or Elevation Reference Marks on the FIRM and/or FBFM panels; and
- Missing Elevation Reference Mark descriptions on the FIRM and/or FBFM panels.

When Notice-to-User revisions are completed, the affected FIS report, FIRM panels, and/or FBFM panels normally will receive a new effective date. However, FEMA may make exceptions on a case-by-case basis. For example, when a required correction is discovered shortly before or after the effective date of the item to be corrected, FEMA may decide to reissue the component (FIRM panel for example) without a revised date; this decision will be made by the FEMA PO.

[February 2002]

2.3.2 Identification of Incorrect or Omitted Component

The incorrect component may be identified by FEMA or by one of FEMA's Mapping Partners. FEMA's decision regarding whether to use the Notice-To-User processes to address the error or omission shall be based on the answers to the following questions:

- What is the specific error or omission?
- How long has the component been in effect?
- How was the error or omission identified?
- Who is requesting the correction?
- How many copies of the component has FEMA printed and distributed?
- Are any revisions to the defective component ongoing or planned?

[February 2002]

2.3.3 Options for Correction

When an error or omission is brought to the attention of FEMA, FEMA will select the proper course of action to take based on the criteria listed in Subsection 2.3.1. The following correction options are considered:

- Correction via a PMR;
- Correction via LOMR;
- Correction via a Notice-to-User revision; or
- Deferral of the correction.

FEMA will base its decision on which of these processes shall be used on the relative priority assessed during the identification process. The FEMA PO will make the decision on the appropriate correction process. The PMR and LOMR processes are discussed in Subsections 2.1 and 2.4, respectively. The process to be followed when the Notice-to-User revision process is chosen is discussed in Subsection 2.3.4.

[February 2002]

2.3.4 Processing Protocol for Notice-to-User Revisions

Once the Notice-to-User revision process has been chosen to address the identified error or omission, the Mapping Partner selected by FEMA to process the revision (hereinafter referred to as the processing Mapping Partner) shall proceed as follows:

[February 2002]

2.3.4.1 Research and Coordination

During the research and coordination phase of the Notice-to User revision process, the processing Mapping Partner shall:

- Determine if any previously issued LOMCs are to be reissued or incorporated into the component revision.
- Obtain FEMA PO approval of the action taken and document the decision in the Mapping Partner Monitoring Report.
- Inform the MSC of the action being taken and the timeframe for submission of the corrected component (accelerated nature of correction process requires advance coordination to ensure timely printing and delivery to FIS report, FIRM, and FBFM users).
- Contact the FEMA RO to determine if the community is already compliant or if the community requires a compliance period. If the community has model ordinances that specify that they will adopt all future revisions of the FIS report, FIRM, and FBFM then the Notice-to-User revision may be accelerated. If the community requires a compliance period to adopt new ordinances, FEMA will send a letter to the community CEO and floodplain administrator informing them of the need for the revision and the effective date for the new or revised component.

[February 2002]

2.3.4.2 Product Revision

During the product revision phase of the Notice-to User revision process, the processing Mapping Partner shall:

- Make the necessary corrections to the FIS report, FIRM, and/or FBFM.
- Determine, after consultation with the FEMA PO, if the new corrected component will have a new effective date or will be issued with the same date as currently exists.

Because it is advantageous to have the FIS report carry the same date as the FIRM Index and individual FIRM panels, the FIS report may be reissued with the same effective date and a

notation that it is being reissued on [date] with corrections. When this option is chosen, the processing Mapping Partner shall ensure that the Notice to Users page in the front of the FIS report contains a brief description of the reason for revision. A sample of this paragraph follows:

Notice To Users:

> This Flood Insurance Study report was reissued on June 11, 1999, to add the Floodway Data Table for the Allegheny River, which was inadvertently omitted from the FIS report printed on March 22, 1999.

A sample FIS report cover showing this is presented in Figure 2-2.

2.3.5 Preparation of the Notice-to-User Letter

Normally, FEMA will send a Notice-to-User letter to all individuals on the MSC distribution list to explain why a revised component is being issued. The Notice-to-User letter, prepared for FEMA by the processing Mapping Partner, shall have the following components:

- Name of community;
- Community Identification Number;
- Date;
- Description of the corrected component; and
- FEMA signature.

[February 2002]

FLOOD INSURANCE STUDY

CHARTER TOWNSHIP OF DELTA, MICHIGAN

EATON COUNTY

Charter Township of Delta

REVISED:
JUNE 2, 1999
(Reprinted with corrections on November 22, 1999)

Federal Emergency Management Agency

COMMUNITY NUMBER – 260066

Figure 2-2. Sample FIS Report Cover

2.3.6 Submittal to the Map Service Center

The processing Mapping Partner shall submit the corrected component(s) to the MSC. The MSC will coordinate with GPO, which will then print and distribute the component(s) to all individuals that previously received a copy of the product that contained the error or omission. In addition to the corrected component, the processing Mapping Partner also shall submit the following items to the MSC a minimum of 2 months before the new effective date:

- Notice-to-User letter, signed by FEMA, that takes the place of the standard 179 letter;
- Community Map Action (CMA) list; and
- Appropriate GPO paperwork.

The processing Mapping Partner shall contact the MSC to determine the requirement for providing copies of the signed letter or a digital copy for their reproduction purposes.

[February 2002]

2.4 Letter of Map Change Processing

2.4.1 Conditional Letters of Map Amendment

The processing procedures presented in Subsection 2.4.2 of these Guidelines for LOMAs also shall apply to requests for Conditional Letters of Map Amendment (CLOMAs), with the following exceptions:

- Because CLOMAs are based on proposed construction, as-built information is not required.
- The CLOMA Comment Documents that are issued by FEMA do not amend the effective Flood Hazard Boundary Map (FHBM) or FIRM.
- A review and processing fee must be submitted for CLOMA requests, but not for LOMA requests.

CLOMA requesters shall submit CLOMA requests, including the required review and processing fee, to the appropriate processing Mapping Partner address for the FEMA region in which the property that is the subject of the request is located. The addresses are provided in the application/certification forms package, referred to as MT-1, that must be used in preparing a CLOMA request for submittal. The MT-1 application/certification forms package is available for viewing or download at http://www.fema.gov/mit/tsd/dl_mt-1.htm. The processing Mapping Partner shall review requests for CLOMAs in accordance with Parts 70 and 72 of the NFIP regulations. Additional information regarding the processing of CLOMAs is provided in Section 3 and Appendix C of the FEMA *Document Control Procedures Manual* (FEMA, July 2000) and in Chapter 8 of FIA-12, *Appeals, Revisions, and Amendments to National Flood Insurance Program Maps: A Guide for Community Officials* (FEMA 1993).

[February 2002]

2.4.2 Letters of Map Amendment

Letter of Map Amendment (LOMA) requesters shall submit LOMA requests to the appropriate processing Mapping Partner address for the FEMA region in which the property that is the subject of the request is located. The addresses are provided in the MT-1 application/certification forms package, which must be used in preparing a LOMA request for multiple lots and/or multiple structures. The MT-1 application/certification forms package is available for viewing or download at http://www.fema.gov/mit/tsd/dl_mt-1.htm. For single-lot/single-structure requests, LOMA requesters may use the MT-EZ form, which is available for viewing or download at http://www.fema.gov/mit/tsd/dl_mt-ez.htm.

[February 2002]

2.4.2.1 Receipt and Acknowledgment

The requester will direct most LOMA requests to the processing Mapping Partner selected by FEMA to process LOMA requests through the address that appears in the MT-1 forms package. FEMA staff shall forward LOMA requests and accompanying data submitted directly to the FEMA RO or HQ to the processing Mapping Partner. The processing Mapping Partner shall process requests for LOMAs in accordance with Part 70. Additional information regarding the processing of LOMAs is provided in Section 3 and Appendix C of the FEMA *Document Control Procedures Manual* (FEMA, July 2000) and in Chapter 7 of FIA-12, *Appeals, Revisions, and Amendments to National Flood Insurance Program Maps: A Guide for Community Officials* (FEMA, 1993)

Upon receipt of a LOMA request and supporting data, the processing Mapping Partner shall record the requester's name, the community name, the property in question, the date of the request, and the date that the request was received in an in-house MIS or other database management system. The Mapping Partner shall establish a case number and case file for each request; the case file shall contain a summary sheet, a contact sheet, and records of all other contacts pertinent to the case, as well as a compilation of all case-related information. Eventually, this file shall include dated copies of any FEMA correspondence and all subsequent actions. Documentation in the case file shall be up-to-date and accurate, and the processing Mapping Partner shall maintain and store all LOMA files.

The processing Mapping Partner shall perform an initial review of the requester's submittal to determine if information and all application/certification forms necessary to make a determination have been provided. Within 3 days of receipt of the request, the Mapping Partner shall prepare and mail a letter to the requester acknowledging receipt of the request.

[February 2002]

2.4.2.2 Required Supporting Information

The Mapping Partner shall review the information submitted by the requester to determine whether it is sufficient to make a determination. Requesters must supply information as explained in the MT-EZ form (for single lot/structure LOMAs) or the MT-1 application/certification forms package. This information includes, but is not limited to, the following:

1. Property description documentation consisting of either a copy of the Plat Map or Deed (containing the recorder's stamp and recordation date) accompanied by a tax assessor's map or other suitable map showing the surveyed location of the property. The recordation data (e.g., Book, Volume, Page, Reel, Document Number, Date) must be evident on the copies of these documents so that FEMA may cite the legal description of the property in the Determination Document. In addition, FEMA must be able to identify the property exactly. If the property is not recorded on a Plat Map, a copy of a tax assessor's map or other suitable map must be submitted to aid FEMA in locating the property.

2. A photocopy of the effective FHBM or FIRM (and FBFM, if applicable) panel, annotated to show where the property is located. The panel number and effective date of the FHBM, FIRM, or FBFM panel must appear on the copy submitted. The actual map or a photographic copy must be used. A reproduction from a photocopy is unacceptable due to possible distortion.

3. An Elevation Form, Form 2 of the MT-1 application/certification forms package, or an Elevation Certificate must be included for all requests, **except** requests for determinations in which the FHBM or FIRM already shows the subject property to be CLEARLY located outside the SFHA.

The processing Mapping Partner shall request any additional information required by telephone and by letter, and shall notify the requester that all necessary information to process a request must be received within 90 days of the date of the letter requesting the required information. If all information is not received within the 90-day period, the Mapping Partner shall suspend processing of the case.

[February 2002]

2.4.2.3 Technical and Programmatic Review

After receiving the necessary information, the processing Mapping Partner shall make a determination concerning the property (i.e., legally defined parcel(s) of land or structure(s)) by comparing ground and/or structure elevation data with the base flood depth or BFE at the site in question. The extent of the work required for the processing Mapping Partner to make the determination will normally depend on the number of structures or lots involved and whether an approximate or detailed analysis was performed for the SFHA in which the property is located.

Approximate Analysis

For a LOMA request involving an SFHA determined by approximate-study methods and designated as Zone A on the effective FHBM or FIRM, the requester may provide data to substantiate a BFE from an authoritative Federal source (e.g., U.S. Army Corps of Engineers [USACE], U.S. Geological Survey [USGS], Natural Resources Conservation Service [NRCS]) or an authoritative State/Commonwealth source (e.g., Department of Natural Resources [DNR], Department of Environmental Quality [DEQ], Department of Transportation [DOT]). Other sources for obtaining BFEs include local Planning and Zoning or Building Departments, or a Registered Professional Engineer. BFEs supplied by the other (non-Federal or non-State) sources must include supporting technical information (i.e., hydraulic and hydrologic data). Requests for property greater than 50 lots or 5 acres, whichever is lesser, must include a BFE in accordance with Paragraph 60.3(b)(3) of the NFIP regulations.

When a requester provides a BFE, the processing Mapping Partner shall review the supporting information in light of the data used to prepare the FHBM or FIRM to verify that the BFE provided by the requester is reasonable. Providing a BFE is the responsibility of the requester. When the requester does not have the technical resources and/or the ability to provide a BFE, the

processing Mapping Partner shall contact the PO or his/her designee to determine whether the processing Mapping Partner may determine the BFE using the best available information.

Detailed Analysis

For a LOMA request involving an SFHA that was determined using detailed study methods and shown on an effective FIRM as Zone A1-30, AE, AO, or AH, the processing Mapping Partner shall make a determination using the BFE or base flood depth shown in the Summary of Elevations Table or Flood Profiles from the FIS report or the BFE shown on the FIRM. Requests based on BFEs or base flood depths that differ from those shown on the effective FIRM may not be handled under the LOMA process. Such requests must be processed as a request for a LOMR or PMR under Part 65 of the NFIP regulations.

Restrictions

LOMAs may not be issued or based on preliminary study, restudy, or map revision data; however, BFE data may be used from these sources if it is the best available. LOMAs may not be issued for properties or structures located in coastal high hazard areas (Zone V) or in alluvial fan flood hazard areas (Zone AO, (depth and velocity specified), or Zone A, AH, or AO (Active or Inactive Alluvial Fan Flooding)) or areas protected by levees that have not been recognized by FEMA as providing base flood protection. Requests of this nature will be considered LOMR or PMR requests and evaluated appropriately. LOMAs also may not be issued for structures elevated on posts, piers, or pilings if any portion of the structures, including a post, pier, or piling, is below the BFE.

[February 2002]

2.4.2.4 Document Preparation

The processing Mapping Partner shall prepare the LOMA determination document based on the results of the evaluation of the submitted data, usually, but not always, using automated software provided by FEMA and developed using Microsoft Access. In some cases a manual determination will be necessary. Structures may be determined to be in or out of the SFHA; lots may be determined to be entirely in, partially in, or entirely out of the SFHA. The determination shall include the flood risk zone designation.

Procedures for the preparation and content of LOMAs are presented in Section 3 and Appendix C of the FEMA *Document Control Procedures Manual* (FEMA, July 2000).

When directed by the PO or his/her designee, the processing Mapping Partner also shall prepare informational letters that provide FEMA's best estimate of the BFE in an SFHA.

[February 2002]

2.4.2.5 Other Coordination and Documentation Activities

The processing Mapping Partner shall perform the required coordination and documentation activities for processing each determination request. During the processing, the Mapping Partner shall communicate with the requester, as necessary; coordinate activities with FEMA; communicate with other Mapping Partners and Federal, State, and local agencies, as needed; prepare letters and other correspondence for FEMA signature; maintain legal documentation and records of correspondence and technical data; and provide inventory lists, status reports, and other information to the PO, or his/her designee, as required.

[February 2002]

2.4.2.6 Deliverable Products

Following the preparation of the LOMA determination document, the processing Mapping Partner shall include the LOMA in the list of determinations that is to be sent to FEMA for official approval. Following approval, the processing Mapping Partner shall provide the requester with FEMA's final determination for all property covered by the request. The processing Mapping Partner also shall send a copy of the LOMA determination document to the community as verification of the amendment to the FIRM.

[February 2002]

2.4.3 Conditional Letters of Map Revision Based on Fill

The processing procedures presented in Subsection 2.4.4 LOMR-Fs also shall apply to requests for Conditional Letters of Map Revision Based on Fill (CLOMR-Fs); however, because CLOMR-Fs are based on proposed construction, as-built information is not required. CLOMR-Fs do not revise the effective FIRM.

The processing Mapping Partner shall process reviews of requests for CLOMR-Fs in accordance with Parts 65 and 72 of the NFIP regulations. Additional information regarding the processing of CLOMR-Fs is provided in Section 2 and Appendix B of the *Document Control Procedures Manual* (FEMA, July 2000).

[February 2002]

2.4.4 Letters of Map Revision Based on Fill

2.4.4.1 Receipt and Acknowledgment

Most LOMR-F requests will be submitted directly to the processing Mapping Partner by the requester. Requests for LOMR-Fs and any accompanying data received by FEMA RO and HQ staff shall be transmitted to the processing Mapping Partner.

Upon receipt of a request, the processing Mapping Partner shall:

- Record the requester's name, the community name, the property in question, the date of the request, and the date the request was received.

- Assign a case number and create a case file for each request; the case file shall contain a summary sheet, a contact sheet, and records of all other contacts pertinent to the case, as well as a compilation of all case-related information. Eventually, this file shall include dated copies of any FEMA correspondence and all subsequent actions. Documentation in the case file shall be kept up-to-date and accurate and the Mapping Partner shall maintain and store all LOMR-F files.

- Perform an initial review of the requester's submittal to determine if all information, review and processing fee, and application/certification forms necessary to make a determination have been provided.

- Within 3 days of receipt of the request, prepare and mail a letter acknowledging receipt of the request.

[February 2002]

2.4.4.2 Required Supporting Information

The processing Mapping Partner shall review the information submitted by the requester to determine whether it is sufficient to make a determination. All requests for LOMR-Fs must be supported by sufficient information to demonstrate that structures or the entire area within the legal bounds of a parcel of land, having been elevated by fill, are at or above the BFE and are not subject to inundation by the base flood. This information, as explained in the MT-1 application/certification forms package, includes, but is not limited to the information summarized below.

1. Property description documentation consisting of either a copy of the Plat Map or Deed (containing the recorder's stamp and recordation date) accompanied by a tax assessor's map or other suitable map showing the surveyed location of the property. The recordation data (e.g., Book, Volume, Page, Reel, Document Number, Date) must be evident on the copies of these documents so that FEMA may cite the legal description of the property in the Determination Document. In addition, FEMA must be able to identify the property exactly. If the property is not recorded on a Plat Map, a copy of a tax assessor's map or other suitable map must be submitted to aid FEMA in locating the property.

2. A photocopy of the effective FHBM or FIRM and FBFM (if applicable) panel, annotated to show where the property is located. The panel number and effective date of the FIRM must appear on the copy submitted. The actual map or a photographic copy must be used. A reproduction from a photocopy is unacceptable due to possible distortion.

3. An Elevation Form, Form 2 of the MT-1 application/certification forms package, or Elevation Certificate must be included for all requests, except requests for determinations in which the FIRM already shows property to be CLEARLY outside the SFHA.

4. Community Acknowledgement, Form 3 of the MT-1 application/certification forms package, which the request meets the criteria described in Paragraph 65.5(a)(4) of the NFIP regulations. These requirements include:

   a. Existing residential structures built in the SFHA have their lowest floor elevated to or above the BFE;

   b. The participating community has determined the land and any existing or proposed structures to be removed from the SFHA are "reasonably safe from flooding," and that they have on file, available upon request by FEMA, all supporting analyses and documentation used to make that determination;

   c. The participating community has issued permits for all existing and proposed construction or other development;

   d. All necessary permits have been received from those governmental agencies where approval is required by Federal, State, or local law; and

   e. Fill has not been placed in a regulatory floodway, which causes a rise in flood elevations associated with the base flood discharge.

5. Appropriate review and processing fee, as published in Part 72 of the NFIP regulations

The processing Mapping Partner shall request any additional information required by telephone and by letter, and shall notify the requester that all necessary information to process a request must be received from the requester within 90 days of the date of the letter requesting the required information. If all information is not received within the 90-day period and the requester does not request an extension, the processing Mapping Partner shall suspend processing of the case.

[February 2002]

2.4.4.3 Technical and Programmatic Review

After receiving the necessary information, the processing Mapping Partner shall make a determination concerning the property or structure by comparing fill and/or structure elevation data with the 1-percent-annual-chance (100-year) flood depth or elevation at the site in question. The extent of the work required for the processing Mapping Partner to make a determination will usually depend on the number of structures or lots involved and whether the SFHA in which the structures are shown was determined based on an approximate or detailed analysis.

Approximate Analysis

For a LOMR-F request involving an approximate SFHA shown on an effective NFIP map (i.e., Zone A), the requester may provide data to substantiate a BFE from an authoritative Federal source (e.g., USACE, USGS, NRCS) or State source (e.g., DNR, DEQ, DOT). Other sources for obtaining BFEs include local Planning and Zoning or Building Departments, or a Registered Professional Engineer. BFEs supplied by the other (non-Federal or non-State) sources must include supporting technical information (i.e., hydraulic and hydrologic data). Requests for property greater than 50 lots or 5 acres, whichever is lesser, must include a BFE, in accordance with Paragraph 60.3(b)(3) of the NFIP regulations.

When a requester provides a BFE, the processing Mapping Partner shall review the supporting information in light of the data used to prepare the FHBM or FIRM to verify that the BFE provided by the requester is reasonable. Providing a BFE is the responsibility of the requester. When the requester does not have the technical resources and/or the ability to provide a BFE, the Mapping Partner shall contact the PO or his/her designee to determine whether the Mapping Partner should determine the BFE using the best available information.

Detailed Analysis

For a LOMR-F request involving a detailed SFHA shown on an effective FIRM, the processing Mapping Partner shall make a determination using the BFE or base flood depth shown in the Summary of Elevations Table or Flood Profiles from the FIS report or the BFE shown on the FIRM. Requests based on BFEs or base flood depths that differ from those shown on the effective FIRM may not be handled under the LOMR-F process; rather, they must be addressed under the LOMR or PMR processes discussed earlier in Section 2.

Restrictions

LOMR-Fs may not be issued or based on preliminary study, restudy, or map revision data, however, BFE data may be used from these sources if it is the best available. LOMR-Fs may not be issued for properties or structures located in coastal high hazard areas (Zone V), alluvial fan flood hazard areas (Zone AO (depth and velocity specified), or Zone A, AH, or AO (Active or Inactive Alluvial Fan Flooding)) or areas protected by levees that have not been recognized by FEMA as providing base flood protection. LOMR-Fs also may not be issued or structures elevated on posts, piers, or pilings, if any portion of the structure, including a post, pier, or piling, is still below the BFE.

[February 2002]

2.4.4.4 Document Preparation

The processing Mapping Partner shall prepare the LOMR-F determination document based on the results of the evaluation of the submitted data, using usually, but not always, automated software provided by FEMA and developed using Microsoft Access. In some cases a manual determination will be necessary. This letter always shall be addressed to the CEO of the

community, with copies transmitted to the requester (if different from the CEO), the community floodplain management administrator, and the State Coordinator, as applicable. Structures may be conditionally (CLOMR-Fs) or finally (LOMR-Fs) determined to be in or out of the SFHA; lots may be conditionally or finally determined to be entirely in, partially in, or entirely out of the SFHA. The determination shall include the revised flood risk zone designation. Procedures for the preparation and content of CLOMR-Fs and LOMR-Fs are provided in Section 2 and Appendix B of the FEMA *Document Control Procedures Manual* (FEMA, July 2000).

When directed by the PO or his/her designee, the Mapping Partner also shall prepare informational letters that provide FEMA's best estimate of the BFE in approximate and detailed SFHAs.

[February 2002]

2.4.4.5 Other Coordination and Documentation Activities

The processing Mapping Partner shall perform the required coordination and documentation activities for processing each LOMR-F or CLOMR-F request. During the processing, the processing Mapping Partner shall communicate with the requester, as necessary; coordinate activities with FEMA; communicate with other Mapping Partners and Federal, State, and local agencies, as needed; prepare letters and other correspondence for FEMA signature; maintain legal documentation and records of correspondence and technical data; and provide inventory lists, status reports, and other information to the PO or his/her designee, as required.

[February 2002]

2.4.4.6 Deliverable Products

Following the preparation of the LOMR-F, the processing Mapping Partner shall prepare a list of LOMR-Fs and other Letter of Map Change (LOMCs) to be sent to FEMA for approval. This list is referred to as a docket. The LOMR-F documents provide the requester with FEMA's final determination for each property covered by the request. The CLOMR-F documents provide the requester with a conditional determination for each property covered by the request. Following receipt of the approved docket from FEMA, the Mapping Partner shall send copies of the LOMR-F or CLOMR-F determination documents to the community CEO and floodplain administrator and to requesters. Additional information on the distribution of LOMR-Fs and CLOMR-Fs is provided in Section 3 and Appendix C of the FEMA *Document Control Procedures Manual* (FEMA, 2000)

[February 2002]

2.4.5 Conditional Letters of Map Revision (CLOMR)

The processing procedures presented in Subsection 2.4.6 for LOMRs also shall apply to requests for CLOMRs. Per Section 65.5 of the NFIP regulations, a CLOMR is

> FEMA's comment on a proposed project that would, upon construction, affect the hydrologic or hydraulic characteristics of a flooding source and thus result in the modification of the existing regulatory floodway, the effective base flood elevations, or the Special Flood Hazard Area (SFHA).

A CLOMR **does not** revise the effective FIS report, FIRM, or FBFM; however, the CLOMR does describe changes to the effective FIS report, FIRM, or FBFM that will result from the project, if built as proposed. The CLOMR also describes any additional information (e.g., as-built plans, fill compaction certification) required to process the final determination as a PMR or LOMR.

For communities that propose floodplain modifications, requesting CLOMRs is not only prudent but, in some circumstances, required by FEMA (Section 65.12 of the NFIP Regulations). When a participating community proposes to permit an encroachment into its 100-year floodplain where no floodway has been established, and the encroachment will cause an increase of more than 1.0 foot in the BFE, the community must first obtain FEMA's conditional approval of the proposed encroachment through submission of a CLOMR. Similarly, the community must also obtain conditional approval from FEMA before permitting an encroachment into a regulatory floodway that would result in any increases to flood levels.

The main difference between the types of supporting data required for LOMRs and CLOMRs is that any maps, plans drawings, measurements, or ground elevation data submitted in support of a request for a CLOMR will not reflect existing conditions and consequently cannot be certified "as-built." All data submitted in support of a request for a CLOMR must, however, reflect final design conditions.

The requester should not interpret the lack of a requirement for certified as-built supporting data to mean that incomplete data and vague descriptions of proposed projects will provide FEMA with an adequate basis for a conditional determination. In addition, although an "as-built" certification would not apply to design plans and other supporting data for a CLOMR, all submitted work maps and plans must still be stamped and signed with the seal of a Registered Professional Engineer or Licensed Land Surveyor, as appropriate.

Standard data requirements for CLOMRs are as follows:

- Hydraulic modeling analysis of the floodplain and floodway (as appropriate) of all flood frequencies listed in the communities Flood Insurance Study (FIS). Separate hydraulic analysis must be submitted duplicating the effective model and documenting proposed conditions though submission of a proposed conditions model. To document any physical changes within a community's floodplain since the effective model it may be

necessary to also provide an existing conditions model to accurately show the effects of a proposed project on a community's flood levels.

- Certified, dated, topographic work map, depicting scale, model cross-sections and contour interval (contour interval should be equivalent to or more detailed than that used to develop community's FIS) delineating the 1-percent-annual-chance (100-year) and 0.2-percent-annual-chance (500-year) floodplain and regulatory floodway boundaries (as appropriate).

- A copy of the community's FIRM (panel number and effective date must be included in copy) annotated to reflect the proposed 1- and 0.2-percent-annual-chance floodplain and regulatory floodway boundaries (as appropriate).

- All appropriate completed application/certification forms including community concurrence of proposed revision.

For request that incorporate revised hydrologic data, flows for all flood flow frequencies listed in the community's FIS must be submitted. Per Part 65.6 of the NFIP regulations, it must be demonstrated to FEMA that revised flows are "statistically significantly" different from the effective flows as measured by a confidence limits analysis of the new discharge estimates for effective flows to be revised. Application/certification form 3 (MT-2 Form 3) must be submitted in support of request including revised hydrologic analyses.

The processing Mapping Partner shall process reviews of requests for CLOMRs in accordance with the provisions of Parts 65 and 72 of the NFIP regulations and the procedures discussed below. Additional information regarding processing of CLOMRs is provided in Section 2 and Appendix B of *Document Control Procedures Manual* (FEMA, July 2000).

[February 2002]

2.4.6 Letters of Map Revision Based on Conditions Other Than Fill

2.4.6.1 Receipt and Acknowledgment

All map revision requests and any accompanying data will be transmitted to the processing Mapping Partner by the PO or his/her designee or other FEMA staff. The processing Mapping Partner shall

- Inform the PO or his/her designee of any requests for information submitted directly to the processing Mapping Partner.

- Inventory the materials received and, within 5 working days of receipt, send acknowledgment letters to the CEO of the community. If the requester is anyone other than the CEO, the Mapping Partner shall send the requester a copy of the acknowledgment letter and, if necessary, telephone the requester to explain the review procedures.

In accordance with Section 65.4 of the NFIP regulations, all requests for changes to effective maps other than those initiated by FEMA must be made in writing by the CEO of the community. The processing Mapping Partner shall request community concurrence if the CEO has not submitted it.

[February 2002]

2.4.6.2 Case Initiation

Upon receipt of the revision request, the processing Mapping Partner shall

- Assign a case number;
- Create a revision case file (see Appendix F), in accordance with Section 66.3 of the NFIP regulations;
- Telephone the community to obtain general information (name and address of the CEO and community contact person, and location of community map repository) and, for PMRs, to request an updated community corporate limit map;
- Enter the revision request into an in-house MIS and the LOMC module of the FEMA CIS database
- Make an initial determination as to the expected processing procedure; and
- Record the date of receipt as the date from which all required processing dates are determined.

[February 2002]

2.4.6.3 Initial Reconnaissance

After the case has been properly recorded, the processing Mapping Partner shall begin a search of all available records to determine the status of the community in the NFIP and to determine any and all past actions by FEMA in the community that may affect the request. The processing Mapping Partner shall determine whether all data required to address the request have been submitted, advise the PO or his/her designee of the results of this review, and make a recommendation concerning follow-up. The PO or his/her designee shall make the final decision on how to proceed with the request.

[February 2002]

2.4.6.4 Program Status and Map Actions

The processing Mapping Partner shall review various portions of FEMA's databases (i.e., CIS, Monitoring Information on Contracted Studies (MICS), Map Needs Update Support System (MNUSS)) to determine the status of the community in the NFIP and obtain information on

complete, active, and future required restudies, map revisions, and map amendments. The Mapping Partner also may use the *NFIP Community Status Book*, available in hardcopy form from the MSC or from the Mitigation Library on FEMA's Internet site, to determine whether the community is participating in the Emergency or Regular Phase of the NFIP. The processing Mapping Partner shall review the following data sources to obtain more detailed information on the nature and extent of any past map actions in the community:

- **Future Revision Files**—The Mapping Partner shall review these files to determine if additional revisions to the FIS report, FIRM, or FBFM are warranted. These files exist because, from time to time, information is submitted by the community or discovered during the course of processing a restudy or map revision that does not significantly affect the community's participation in the NFIP. Because of funding constraints, these revisions are deferred for future action and, at the request of the PO or his/her designee, placed in the future revision files. These files also include LOMRs and LOMR-Fs for future PMRs.

- **LOMA and LOMR-F Files**—The Mapping Partner shall review these files to determine if past LOMA and LOMR-F actions are of sufficient scope to warrant inclusion in the ongoing revision. In general, single-lot LOMAs and LOMR-Fs do not warrant inclusion because of map scale limitations. However, multiple-lot LOMAs and LOMR-Fs may warrant inclusion in a PMR.

- **Five-Year Map Update Files**—As with the Future Revision Files, the Mapping Partner shall review these files to determine if additional revisions to the FIS report, FIRM, or FBFM are warranted.

[February 2002]

2.4.6.5 Required Data

Based on the reason for the request, the processing Mapping Partner shall make a determination as to the need for additional data in accordance with the applicable portions of Sections 65.5, 65.6, 65.7, 65.10, 65.11, 65.12, and 65.13 of the NFIP regulations. As part of the revision package, the requester is required to complete the application/certification forms included in the MT-2 application/certification forms package. Examples of standard data requirements for various structural modifications include, but are not limited to, the following:

Channelizations

- Certified as-built construction or grading plans

- Hydrologic analysis (if the discharges in the effective model are not used)

- Calibration run duplicating original hydraulic model (multiple profile and floodway)

- Existing hydraulic model (multiple profile and floodway) if the calibration hydraulic model run does not reflect the floodplain conditions prior to the start of the project

- Revised hydraulic model (multiple profile and floodway)
- Floodplain and/or floodway boundary delineations on the effective map panels
- Transition structure design plans for as-built conditions
- New hydrologic analyses or diversion channels
- Evidence of adequate soil compaction and erosion protection (for placement of fill)
- Certified topographic data that include the entire area of the revision and delineate floodplain and/or floodway boundaries, BFEs, and cross-section locations

Culverts and Storm Systems

- Certified as-built construction plans
- Hydrologic analysis (if the discharges in the effective FIS report are not used)
- Calibration run duplicating the original hydraulic model (multiple profile and floodway)
- Existing hydraulic model (multiple profile and floodway) if the calibration hydraulic model run does not reflect the floodplain conditions prior to the start of the project
- Revised Hydraulic Model (multiple profile and floodway) and the determination of headwater and tailwater elevations
- Floodplain and/or floodway boundary delineations on the effective map panels
- Evidence of adequate soil compaction and erosion protection (for placement of fill)
- Certified topographic data that include the entire area of the revision and delineate floodplain and/or floodway boundaries, BFEs, and cross-section locations

Bridges

- Certified as-built construction plans
- Hydrologic analysis (if the discharges in the effective model are not used)
- Calibration run duplicating the original hydraulic model (multiple-profile and floodway)
- Existing hydraulic model (multiple profile and floodway) if the calibration hydraulic model run does not reflect the floodplain conditions prior to the start of the project
- Revised hydraulic model (multiple profile and floodway)

- Evidence of adequate soil compaction and erosion protection (for placement of fill)
- Certified topographic data that include the entire area of the revision and delineate floodplain and/or floodway boundaries, BFES, and cross-section locations

Levees (Dikes, Berms, and Embankments)

- Certified as-built construction plans
- Hydrologic analysis (if the discharges in the effective model are not used)
- Hydraulic model with levee if compliant with Section 65.10 of the NFIP regulations
- Hydraulic models with and without levee if not compliant with Section 65.10 of the NFIP regulations
- Evidence of structural stability, certified by a Registered Professional Engineer,
- Evidence of operation and maintenance provisions
- Interior drainage analyses and SFHA boundary delineations
- Floodplain and/or floodway boundary delineations on the effective FIRM/FBFM panels
- Evidence of adequate soil compaction and erosion protection (for placement of fill)
- Certified topographic data that include the entire area of the revision and delineate floodplain and/or floodway boundaries, BFEs, and cross-section locations
- Additional design data as necessary

Dams (Detention Basins and Reservoirs)

- Certified as-built construction plans
- Hydrologic analysis (if the discharges in the effective FIS report are not used)
- Certification by a Registered Professional Engineer that impoundment structures will remain stable during the base flood
- Evidence of operation and maintenance provisions
- Hydraulic analysis
- Floodplain and/or floodway boundary delineations on the effective FIRM/FBFM panels

- Hydrologic analyses for downstream reach, if the dam is designed to lower the base flood discharge
- Evidence of adequate soil compaction and erosion protection (for placement of fill)
- Certified topographic data that include the entire area of the revision and delineate floodplain and/or floodway boundaries, BFEs, and cross-section locations

Flood-Control Structures Subject to Alluvial Fan Flooding

- Certified as-built construction plans
- Certification by a Registered Professional Engineer that the flood-control structures will be able to withstand the hazards associated with flooding, erosion, scour, and relocation of flow paths during the base flood discharge
- Hydrologic analyses that quantify the discharges (if the discharges on which the effective FIRM is based are not used) and the volumes of water, debris, and sediment movement
- Engineering analyses demonstrating the impact of flooding from sources other than the fan apex
- Revised analysis of alluvial fan flooding (if the analysis on which the effective FIRM is based is not used), in accordance with the analysis approach stated in Appendix G accompanied by a discussion of the effects of (1) the depth and velocity of flooding, and (2) the scour and sediment deposition on other areas of the fan
- Evidence of operation and maintenance provisions
- Revised floodplain boundary delineations on the affected panels of the effective FIRM
- Topographic data that include the entire area of the revision and delineation of the revised floodplain boundaries (certified, if the topographic data on which the effective FIRM is based are not used)
- Evidence of maintenance provisions, where referenced above, are to be in the form of an ordinance that specifies the activities to be performed, the frequency of performance, and the community officials responsible for the performance. If maintenance is to be accomplished by an agency other than the community, a logical provision (e.g., ordinance) for community monitoring and backup maintenance is required. The Mapping Partner shall ensure that maintenance agreements are submitted for levees and dams.

Certifications, where referenced above, are defined as follows:

- Certification of data is a statement that the data are accurate to the best of the certifier's knowledge.

- Certification of analyses is a statement that the analyses have been performed correctly and in accordance with sound engineering practices.

- Certification of structural works is a statement that the works are designed in accordance with sound engineering practices to provide protection from the base flood.

- Certification of as-built conditions is a statement that a structure has been built according to the plans being certified, is in place, and is fully functional.

The processing Mapping Partner shall ensure that certifications include the certifier's name, signature, registration number, and the registration expiration date of the certifier.

[February 2002]

2.4.6.6 Technical Review

The processing Mapping Partner shall review the technical, scientific, and other information submitted by the revision requester to ensure that the data are technically accurate, consistent with standard engineering practice and FEMA standards, and sufficient to warrant a revision. The extent of the technical review will, generally, be limited to a review of the information presented on the application/certification forms and the supporting documentation submitted with them.

The processing Mapping Partner shall use the forms to identify inconsistencies and discrepancies and judge reasonableness. In certain cases, such as review of requests involving alluvial fan flooding, unique hydrologic or hydraulic analyses, or significant changes to the SFHAs shown on the effective FIRM, additional technical reviews beyond the reviews of the application/certification forms may be required, as directed by the PO or his/her designee.

For revisions involving the addition of detailed flood information or changes to flooding sources originally studied by detailed methods, analyses and other supporting data for the 10-percent-annual-chance (10-year), 2-percent-annual-chance (50-year), 1-percent-annual-chance (100-year), and 0.2-percent-annual-chance (500-year0 floods and regulatory floodway may be required. At a minimum, the analyses and other supporting data provided in support of a revision request must meet the original standards employed by FEMA for the preparation of the FIS report, FIRM, and FBFM, which are documented in Volume 1 and related appendices in these Guidelines.

Hydrologic Analyses

FEMA requires that the computations performed to support requests for revisions to effective FIS reports, FIRMs, and FBFMs be based on the flood discharge values used for the effective FIS and FIRM; however, revision requests may also be based on new hydrologic conditions or better estimates of the flood discharges. The requester must provide 5- and 95-percent confidence limits in support of new discharge values, when applicable. The requester must not only provide sufficient data to support the use of the new discharges for the 100- and, if necessary, 10-, 50-, and 500-year floods, but must also determine all changes to the FIS report,

FIRM, and FBFM that would result from the use of the new discharges. Therefore, the requester will usually be required to provide hydraulic analyses and revised floodplain and floodway boundary delineations, in addition to hydrologic analyses.

When new discharges are used, the processing Mapping Partner shall review the information presented on Form 2, entitled "Riverine Hydrology and Hydraulics Form," included in the MT-2 package to determine if the discharges are reasonable and adhere to the requirements listed below. The discharge values shall be checked for consistency, within the limitations of the methodology employed, throughout the information submitted by the requester. In performing this check, the processing Mapping Partner shall verify that, for flooding sources studied by detailed methods, adequate information has been provided for any of the four recurrence interval floods that may be affected by the new hydrologic analyses.

The following requirements apply when processing requests involving revised hydrology:

- The revised flood discharge must be significantly different from the effective flood discharge. The revised flood discharge shall be adopted if the effective flood discharge does not fall within the 5- and 95-percent confidence limits of the revised estimates. These limits shall be determined using methods contained in Bulletin 17B, *Guidelines for Determining Flood Flow Frequency* (Interagency Committee on Water Data, 1982).

- In cases where the new discharge must be approved by the State, the Mapping Partner shall ensure that the proper approval from the State has been acquired.

- In cases where the new discharge must be approved by a regional/local flood-control agency, the processing Mapping Partner shall ensure that the proper approval from the regional/local flood-control agency has been acquired.

- An alternative methodology, if used by a revision requester, must meet the requirements of Paragraph 65.6(a)(6) of the NFIP regulations and must be on FEMA's list of accepted computer models.

- The revised hydrologic analyses must analyze the same recurrence interval floods as those studied for the effective FIS.

- The methodology used in the revised hydrologic analyses must match that used for contiguous communities.

- The data accumulated and analyses performed must be certified by a Registered Professional Engineer and submitted to the processing Mapping Partner for review.

- If the processing Mapping Partner believes future-conditions discharges have been used for any revision request and the processing Mapping Partner has not received any guidance from FEMA for the community(ies) affected, the processing Mapping Partner shall discuss the revision request with the PO or his/her designee to determine followup actions to be taken.

Hydraulic Analyses

The requester must perform hydraulic analyses to support a revision request based on new hydrologic conditions or physical changes in channel or overbank conditions, if those conditions affect the elevation and extent of the base flood. For revisions involving flooding originally studied by approximate methods and designated as Zone A on the effective FIRM, the analyses performed by the requester generally must be consistent with FEMA standards for approximate studies. Therefore, the analyses may be in the form of hand calculations for step-backwater, normal-depth, or stage-frequency relationships, or the analyses may be based on the use of step-backwater or coastal flooding computer programs.

For revisions involving flooding sources studied by detailed methods for the effective FIS, analyses performed by the requester must be consistent with FEMA standards for detailed studies. Therefore, the analysis usually must consist of step-backwater computations for riverine flooding sources, stage-frequency analyses for lacustrine flooding, hand computations for sheetflow areas, and storm-surge and wave-height or wave-runup calculations for coastal flooding.

The processing Mapping Partner technical review shall generally be limited to the information presented on the application/certification forms. The Mapping Partner shall review the forms to ensure that the requirements listed below are met. All data submitted by the requester must be consistent, and there may be no discontinuities between the information shown for revised areas and that shown for unrevised areas in the FIS report and on the FIRM and FBFM.

The following requirements apply when processing requests involving revised hydraulics:

- Revision requests must be based on the effective hydraulic computer model. Where the input data representing the effective hydraulic model are unavailable, an approximation should be developed. A new model should be established using the original cross-section topographic information, where possible, and the discharges on which the current FIS report and FIRM are based. The model must use the same effective-flow areas as established in the original analysis and must be calibrated to reproduce the original BFEs to within 0.5 foot. See Appendix C, Subsection C.5.2.1 of these Guidelines for information on FEMA's policy for conversion to HEC-RAS.

- If the revision requester uses an alternative hydraulic methodology, that methodology must be on FEMA's list of acceptable computer models and meet the requirements of Paragraph 65.6(a)(6) of the NFIP regulations.

- To avoid discontinuities between the revised and unrevised flood data, the revision requester must submit hydraulic analyses be that are extensive enough to ensure a logical transition can be shown between the revised flood elevations, floodplain boundaries, and floodway boundaries and those developed previously for areas not affected by the revision. The revised and unrevised water-surface elevations must match within 0.5 foot where such transitions occur; however, FEMA would prefer that the transitions match within 0.10 foot if possible. Exceptions to this standard must be approved by the FEMA PO or his/her designee.

- In general, revision requests that result in increases in BFEs because of the physical actions of an individual property owner within the regulatory floodway will be considered a violation of NFIP regulations unless evidence is provided to show that the criteria described in Section 65.12 of the NFIP regulations have been met. Any violation or potential violation of the NFIP regulations must be brought to the attention of the PO or his/her designee.

- For revisions based on the effects of levees or other flood-control structures that provide base flood protection, the processing Mapping Partner shall obtain verification, in the form of technical analyses, that those structures meet the minimum criteria outlined in Section 65.10 of the NFIP regulations. Similarly, for flood-control structures located in areas subject to alluvial fan flooding, the processing Mapping Partner shall obtain technical analyses to verify that the minimum criteria of Section 65.13 of the NFIP regulations are met. If a PMR is processed, the processing Mapping Partner shall verify that the effects of such structures are properly discussed in the FIS report and shown on the FIRM and FBFM.

Coastal Revisions

Computation of the SWEL considers many factors and is performed through the use of computer models or statistical analysis of tide gage data of adequate continuous record. Any revision of the SWEL should be based on new information that either refutes or supplements the database. The requester must submit significant data or produce verifiable information that refutes the information used by the SC to construct the applicable computer model.

In the case of tide gages, the requester must perform a statistical analysis prepared with new data that supplements the existing tide gage records or provides evidence that the data used are incorrect. The processing Mapping Partner shall review the information presented on Form 4, "Coastal Analysis Form," from the MT-2 application/certification forms package to determine the appropriateness of incorporating the revised data on the FIRM.

For map revision requests in coastal areas based on more up-to-date, site-specific topographic information, a transect and a wave-height analysis based on the profile must be provided. This analysis may also require consideration of other coastal processes, such as erosion and wave runup. This analysis may be conducted based on the terms of the effective FIS report and FIRM, the community, or the PO or his/her designee.

Map revisions in coastal areas may also be based on existing, new, or improved shore-protection structures, such as bulkheads, seawalls, breakwaters, and dikes. When structures designed to diminish or absorb wave energy (e.g., breakwaters, bulkheads, seawalls) are involved, the requester must submit evidence that the structure will survive the base flood and associated wave action. The items that the processing Mapping Partner shall address before issuing a map revision based on coastal structures are listed in *Criteria for Evaluating Coastal Flood Protection Structures.* (See Appendix D of these Guidelines.) Structures designed to provide flood protection (e.g., levees, dikes, floodwalls) must conform to Section 65.10 of the NFIP regulations and to the criteria outlined in Section 1 of these Guidelines.

The requester must also provide assurance from the State or local agency with maintenance responsibility that the structures involved in the revision will be maintained and will not settle. As-built drawings of all structures are required. Wave height analyses based on transacts through these types of structures are valid only when these conditions are met.

The processing Mapping Partner shall review the information presented on Form 4, "Coastal Analysis Form," and/or Form 5, "Coastal Structures Form," from the MT-2 application/certification forms package to determine the items that require further review and the appropriateness of incorporating the revised data on the FIRM.

Other Data

Revisions involving changes to flood risk zones, floodplain boundaries, and corporate limits may also be requested. For revisions to flood risk zones, the Mapping Partner shall verify the accuracy of any calculations the requester submitted and determine whether a revision is warranted based on a review of Form 2, entitled "Riverine Hydrology and Hydraulics Form," from the MT-2 application/certification forms package and the supporting documentation. Requests that Zone V or Zone A areas be revised to Zone A or Zone B/Zone X (shaded), respectively, must be supported by hydraulic computations in most cases.

For floodplain boundary revisions based on new or more detailed topographic information, hydraulic analyses are usually not required unless the changes in ground contours have significantly affected the geometry of cross sections used for the effective FIS report and FIRM or have altered effective-flow areas. For revisions involving only floodplain boundaries, the processing Mapping Partner shall review the information described on Form 2, titled "Riverine Hydrology and Hydraulics Form," or Form 4, titled "Coastal Analysis Form," from the MT-2 application/certification forms package to determine whether the requested revisions are acceptable.

[February 2002]

2.4.6.7 Revision Requests Based on Future-Conditions Hydrology

Communities experiencing urban growth and other changes often use future-conditions hydrology in regulating watershed development. While some communities regulate based on future development, others are hesitant to enforce more restrictive standards without FEMA support. To assist community officials, FEMA has decided to include future-conditions flood hazard data on FIRMs and in FIS reports for informational purposes on a case-by-case basis. This decision was documented in a Final Rule published in the *Federal Register* on November 27, 2001. (The Final Rule may be downloaded from the FEMA website at http://www.fema.gov/mit/tsd/frm_fchy.pdf.)

Because multiple options exist for presenting future-conditions floodplains and related data on the FIRM and in the FIS report, interested community officials should contact the appropriate RO to discuss the available options and agree on the approach to be taken. For information on these options, FEMA encourages interested community officials to review the November 27, 2001, Final Rule and the FEMA report entitled "Modernizing FEMA's Flood Hazard Mapping

Program: Recommendations for Using Future-Conditions Hydrology for the National Flood Insurance Program" (FEMA, 2001). That report contains one possible scenario/example of depicting future-conditions flood hazard information on a FIRM and in an FIS report and may be downloaded from the FEMA website at http://www.fema.gov/mit/tsd/ft_futur.htm.

At the request of a community and with the approval of FEMA, FIRMs and FIS reports may include, for informational purposes, flood hazard areas based on projected- or future conditions hydrologic and hydraulic analyses. If community officials request that FEMA show the future-conditions 1-percent-annual-chance floodplain on the FIRM, the future-conditions floodplains and flood insurance risk zone shall be shown on the FIRM and referenced in the accompanying FIS report. Although graphic specifications are flexible for the mapping of this flood insurance risk zone, the zone label will be "Zone X (Future Base Flood)."

The future-conditions flood hazard zone shall be defined in the FIRM legend and in the FIS report as follows:

> Zone X (Future Base Flood) is the flood insurance risk zone that corresponds to the 1-percent-annual-chance floodplains that are determined based on future-conditions hydrology. No BFEs or base flood depths are shown within this zone.

FEMA opted to use the Zone X (shaded) screen, in lieu of a new flood hazard zone designation, to depict the future-conditions 1-percent-annual-chance (100-year) floodplain to minimize confusion by users of the FIRM that make determinations regarding Federal mandatory flood insurance purchase requirements. Those users now recognize that areas designated as Zone X (shaded) are floodprone, but that the mandatory flood insurance purchase requirement does not apply. Because the risk premium rates for buildings located in the future-conditions 1-percent-annual-chance (100-year) floodplain will be the rate comparable to other areas outside the SFHA, FEMA believes designating these areas as "Zone X (Future Base Flood)" will be sufficient distinction.

FEMA may develop graphic specifications for the presentation of future-conditions flood hazard data on the FIRM and specifications and guidelines for the inclusion of support information in the accompanying FIS report. However, it is FEMA's intent, as indicated in the previously referenced Final Rule, to have flexibility in the implementation of this community-requested mapping option. Because multiple options for presenting future-conditions flood hazard data exist, FEMA intends to work closely with each community to develop the presentation format that best meets community and FEMA needs. For the time being, FEMA, in coordination with the affected community(ies) and the Mapping Partner that is preparing the Preliminary FIRM and FIS report, shall establish the presentation specifications on a case-by-case basis.

Once future-conditions flood hazard data have been included on the FIRM and in the FIS report for a community, all revision submittals shall incorporate the future-conditions data developed by the community. The community is entirely responsible for developing and maintaining this data layer on a digital FIRM.

[February 2002]

2.4.6.8 Reporting and Project Officer Approval

Upon request, the processing Mapping Partner shall advise the PO or his/her designee about the current status of a technical review. When the technical review is complete, the processing Mapping Partner shall discuss the results of the review, any additional data required to support the requested revision, and any problems encountered during the review with the PO or his/her designee. The PO or his/her designee shall direct the processing Mapping Partner to finalize the technical review by one of the following options:

- Requesting, by telephone or letter, additional or revised data to complete the technical review;
- Preparing a LOMR; or
- Preparing a PMR.

For PMRs, the processing Mapping Partner shall issue a letter, referred to as a 316-PMR letter, informing the community CEO and floodplain administrator that a PMR will be prepared and requesting that the community submit any information to be incorporated into the PMR.

[February 2002]

2.4.6.9 Preparation of Letters and Attachments

When processing a LOMR, the processing Mapping Partner shall prepare the letter and attachments (FIRM and/or FBFM panels, Summary of Discharges Table, Floodway Data Table, and/or Flood Profile panels) in accordance with the procedures outlined in the FEMA memorandum dated May 13, 1986, entitled "Policies and Procedures for Flood Map Production Coordination Contractors for Processing Flood Insurance Study Revisions."

[February 2002]

2.4.6.10 Community Review and Comment

Upon completing a LOMR, the processing Mapping Partner shall provide copies of the LOMR to the revision requester and community officials for review and comment. The community shall receive a 30-day review period, for all revisions. When BFEs are changed, a 90-day appeal period shall be required.

30-Day Review Period

Because a LOMR is an official revision of the FIS report, FIRM, and/or FBFM and may become effective immediately, additional changes may be made only through the initiation of another revision; therefore, the PO or his/her designee may determine that such a revision should be deferred. If the changes are significant, a second revision may be warranted.

[February 2002]

90-Day Appeal Period

For LOMRs that involve new or modified BFEs, the processing Mapping Partner shall initiate the statutory 90-day appeal period to provide residents of the affected community an opportunity to appeal the new or modified BFEs. As in the processing of FISs and RFISs, the proposed or proposed modified BFEs must be published in a local newspaper with wide circulation and in the *Federal Register* to initiate the appeal period and must be finalized after the appeal period has elapsed. (Refer to Subsection 1.4 of these Guidelines for the procedures to be followed.). The proposed BFEs must be published in local newspapers on two separate dates, usually 1 week apart. The appeal period begins on the day of the second publication of the proposed BFEs.

Because a revision made by a LOMR becomes effective immediately in cases where the SFHA width and BFEs are decreasing, the appeal period occurs after the effective date of the LOMR. In cases where the BFEs and SFHAs are increasing, however, the LOMR may not be effective until after the appeal period has elapsed unless notification and acceptance are received from all affected property owners.

[February 2002]

2.4.6.11 Proposed and Final Flood Elevation Determinations

When a 90-day appeal period is required for a LOMR, the processing Mapping Partner shall prepare and process the correspondence for initiating the appeal period and finalizing the new or modified BFEs. The processing Mapping Partner shall prepare the proposed BFE notices for publication in the *Federal Register* and a local newspaper with wide circulation and the final BFE notice for publication in the *Federal Register*, and shall prepare and process the proposed and final BFE determination letters that will be sent to the CEO of the community, the State NFIP Coordinator, and all appellants.

For revisions involving BFEs, the LOMR and the proposed BFE determination letter sent to start the appeal period are the same. The proposed BFE notice shall be prepared using the BFEs shown in the effective FIS report and FIRM, as well as those presented in the revised FIS report and FIRM. The processing Mapping Partner shall ensure that the notices are correct, that they include BFEs for all flooding sources for which revisions were made, and that they are published in a local newspaper with wide circulation and in the *Federal Register*.

[February 2002]

2.4.6.12 Appeals and Protests

Appeals and protests concerning LOMRs may be appealed by the community or affected property owners during the appeal period, but appeals must be submitted to FEMA through the community. The processing Mapping Partner shall review, evaluate, and resolve all appeals submitted in accordance with the procedures outlined in Part 67 of the NFIP regulations and as amplified in *FIA-12, Appeals, Revisions, and Amendments to National Flood Insurance Program Maps: A Guide for Community Officials* (FEMA 1993). Appeals may be based only on

information indicating that the proposed revised BFEs are scientifically or technically incorrect. Objections of other kinds are termed protests.

Within 7 days (5 working days) of receipt of an appeal, the processing Mapping Partner shall prepare an appeal acknowledgment letter. The processing Mapping Partner shall then evaluate any data submitted; request any additional data required; perform, upon approval of the PO or his/her designee, any engineering analyses required; prepare and distribute Revised Preliminary copies of the FIS report, FIRM, and/or FBFM, if necessary; and prepare an appeal resolution letter to be sent to the appellant.

Protests shall be handled similarly, but protests will not result in revised BFEs and, generally, will not involve as much work on the part of the processing Mapping Partner.

[February 2002]

2.4.6.13 Coordination and Documentation Activities

The processing Mapping Partner shall perform the required coordination and documentation activities necessary for processing each LOMR. During the processing, the Mapping Partner shall:

- Communicate with the requester and community, as necessary.
- Coordinate activities with the FEMA RO as directed by the PO or his/her designee.
- Communicate with other FEMA contractors and Federal, State, and local agencies, as needed.
- Prepare letters and other correspondence for FEMA signature.
- Maintain legal documentation, records of correspondence, and technical data.

In addition, the processing Mapping Partner shall organize, and may be required to submit to FEMA, records of the correspondence and supporting data associated with LOMRs. (Refer to Volume 3 of these Guidelines for details.)

[February 2002]

2.5 Revalidation Letters

When a revised FIRM panel becomes effective, all previous map actions for that panel are superseded. Therefore, each time a FIRM panel is physically revised and republished, the panel must be updated to include the changes in flood hazard information resulting from previously issued map actions, including LOMCs. Frequently, the results of a LOMC cannot be shown on a revised FIRM panel due to one or more of the following reasons:

- Map scale limitations;
- Results indicated property outside the SFHA as shown on the previous effective FIRM;
- Flood hazard data that was basis for LOMC determination superseded by new detailed flood hazard data; or
- LOMC issued after LFD date.

To assist communities in maintaining the FIRM and to reflect LOMCs previously issued by FEMA, FEMA developed a process for revalidating LOMCs automatically when a revised FIRM becomes effective. The result of this process is the issuance of a revalidation letter, termed a LOMC-VALID letter.

[February 2002]

2.5.1 Technical and Programmatic Review

The procedures the Mapping Partner assigned by FEMA shall follow for automatically revalidating LOMCs are presented in Subsections 2.5.2, 2.5.3, and 2.5.4. Under these procedures, FEMA issues one letter for all affected LOMAs, LOMR-Fs, and LOMRs rather than an individual letter for each map change request. Individual property owners are no longer *required* to request that LOMCs be reissued. The result is a more effective tool for floodplain management and flood insurance purposes.

As discussed in Subsection 2.1.13, to assist communities in maintaining the NFIP maps, particularly the FIRM, FEMA directs the assigned Mapping Partner to prepare summaries of the LOMAs, LOMR-Fs, and LOMRs that will be superseded when the revised FIRM panel(s) become effective. FEMA provides the resulting SOMAs to the communities at significant milestones during the processing of studies, restudies, and PMRs to make the communities aware of the effect revised FIRM panels will have on previously issued LOMCs. A complete discussion of the requirements for producing SOMAs is provided in Section 10 of the FEMA *Document Control Procedures Manual* (FEMA, July 2000).

[February 2002]

2.5.2 Document Preparation

After reviewing the LOMAs, LOMR-Fs, and LOMRs issued for the affected community, the assigned Mapping Partner shall prepare the LOMC-VALID letter, which includes the following information for each LOMA, LOMR-F, or LOMR:

- Case number (when available);
- Date issued;
- Identifier;
- Map panel number, including suffix; and
- New flood insurance risk zone designation.

Depending on the number of LOMAs, LOMR-Fs, and LOMRs to be revalidated, the assigned Mapping Partner shall include the information for each LOMA, LOMR-F, or LOMR in the LOMC-VALID letter itself or provide it as a separate attachment.

The assigned Mapping Partner shall submit the LOMC-VALID letter to FEMA for review and approval approximately 3 weeks before the new effective date and mail the LOMC-VALID letter to the community CEO and floodplain administrator approximately 2 weeks before the new FIRM effective date.

If, subsequent to the issuance of the LOMC-VALID letter, a community official or individual property owner requests that a LOMA, LOMR-F, or LOMR be reissued and the LOMA, LOMR-F, or LOMR is listed in the LOMC-VALID letter, the assigned Mapping Partner shall send the requester a copy of the LOMC-VALID letter and, if requested, a copy of the original LOMA, LOMR-F, or LOMR. Again, no fees shall be assessed for these requests. However, subsequent requests for copies from the requester or requests from someone other than a community official or individual property owner shall be subject to the fee schedule for FIS backup data published in the *Federal Register.* (The most recent fee schedule became effective on June 1, 2000.)

[February 2002]

2.5.3 Other Coordination and Documentation Activities

Because the changes made to the effective FIRM via the LOMC process become effective without the affected panel(s) being physically revised and republished, the assigned Mapping Partner must maintain records of these modifications so they may be incorporated into the next physical update of the affected panel(s).

Approximately 1 month before the effective date of the revised map, the assigned Mapping Partner shall generate a list of the LOMAs, LOMR-Fs, and LOMRs that must be revalidated. The list is generated from the final SOMA (see Subsection 2.1.13)

The assigned Mapping Partner shall review the listed LOMAs, LOMR-Fs, and LOMRs to verify that all appropriate letter determinations are included. During the verification process, the assigned Mapping Partner shall assess the pending LOMAs, LOMR-Fs, or LOMRs for possible completion before the new effective date; pending letters that will be completed before the effective date may be revalidated. If necessary, the Mapping Partner shall obtain information from the case file to determine whether a LOMA, LOMR-F, or LOMR must be revalidated.

The intent of the LOMC-VALID letter is to indicate that the new FIRM panels did not affect the previous determination. Therefore, if one of the determinations in a multiple-determination LOMA or LOMR-F is a denial for a certain property, the assigned Mapping Partner will not be required to specify the property that was removed from the SFHA or indicate in any way that the request for a certain property was denied. If the property was subsequently removed from the SFHA, the LOMA, LOMR-F, or LOMR that included that determination also will be revalidated by the LOMC-VALID letter.

If a requester notifies FEMA about one or more LOMAs, LOMR-Fs, or LOMRs that he or she believes should have been revalidated but were not included in a LOMC-VALID letter, the assigned Mapping Partner shall review available information to determine the accuracy of the request. If the assigned Mapping Partner finds that one or more LOMAs, LOMR-Fs, or LOMRs should have been revalidated, the assigned Mapping Partner shall prepare a new LOMC-VALID letter or reissue the original LOMA, LOMR-F, or LOMR. If the assigned Mapping Partner could not locate the LOMA, LOMR-F, or LOMR in question on the FIRM, the Mapping Partner shall request appropriate information from the requester.

Following the FIRM effective date, the assigned Mapping Partner shall prepare and distribute new amending or revising LOMAs, LOMR-Fs, and LOMRs for those cases in Category 4 of the Final SOMA for which new determinations could be made based on available information.

[February 2002]

2.5.4 Deliverable Products

In preparing the LOMC-VALID letter, the Mapping Partner shall follow the general guidelines below in presenting case-specific information on revalidated LOMCs.

- A panel number must appear for each revalidated LOMR, LOMA, or LOMR-F included in the LOMC-VALID letter. If the FIRM has been reformatted since a LOMR, LOMA, or LOMR-F was issued and the Mapping Partner cannot readily identify the correct panel number, the Mapping Partner shall NOT include the LOMR, LOMA, or LOMR-F in the LOMC-VALID letter.

- If the revalidated letter is a LOMR, the Mapping Partner is not required to include a new flood insurance risk zone.

- If the revalidated letter is a multiple-determination LOMA or LOMR-F and multiple zones are cited in the letter, the word "MULTIPLE" may be included in place of the zone.

- If the new flood insurance risk zone for a revalidated LOMA or LOMR-F is a Zone X and the assigned Mapping Partner can readily determine whether it is Zone X (shaded) or Zone X (unshaded), the Mapping Partner shall include the complete flood insurance risk zone designation in the LOMC-VALID letter. If the Mapping Partner cannot make this determination readily, the term "Zone X" shall be included.

The LOMC-VALID letter is to become effective 1 day after the effective date of the newly effective FIRM panels. The LOMC-VALID letter is considered legally binding, in the same manner as the original LOMA, LOMR-F, or LOMR, provided that a copy of the original LOMA, LOMR-F, or LOMR accompanies the LOMC-VALID letter. If required by the requester, the assigned Mapping Partner shall forward a copy of the original LOMA, LOMR-F, or LOMR with the LOMC-VALID letter. No fee is to be assessed for such requests.

[February 2002]

2.6 Corporate Limit Changes

Corporate limit changes may occur in a community as a result of annexation, incorporation, or other appropriate legal actions. Paragraph 64.4 requires communities to update their ordinance within six months of such an activity, however some communities may not provide this information in a timely manner. Occasionally, communities provide this information with other information they regularly provide FEMA, such as the Biennial Report. Corporate limit change information is forwarded by FEMA to the mapping partner for processing. If the boundary change affects an SFHA, FEMA and its mapping partner need to provide appropriate guidance to the community, identifying the applicable FIRM map and FIS text for the affected area.

If there is an ongoing map action (i.e. restudy, LOMR, or PMR) for the community when the corporate limit changes are submitted, the change information will be incorporated into the study, and no additional response is necessary. However, in the majority of the cases, there is not an ongoing map action when the change is received. The procedures outlined below have been developed to provide guidance for the actions and response to such a corporate limit change submittal. It is unlikely that FEMA would receive change information from a non-participating community, and that issue is not addressed. However, it should be noted that if a non-participating community expands into an area that was previously in a participating community, the situation could result in a PMR and would warrant review by applicable parties on a case-by-case basis.

[February 2002]

2.6.1 Technical and Programmatic Review

The technical review of the data submitted consists of reviewing the corporate limit change submittal for certain information. There are two required items – a complete copy of the corporate limit change ordinance, including the date the change became effective, and a map showing the location and area involved in the change. Usually a letter from a community official is included; this is helpful contact information. If either the map or the ordinance is not submitted, the community should be contacted, and this information should be requested.

When boundary change information is received and determined to be for a community not currently in an ongoing study, its location on the FIRM panel should be reviewed. If the area of change does not include a SFHA, the Standard Response Letter should be sent. The flood hazard information on the FIRM panels for adjacent land areas should be reviewed for consistency. If they are inconsistent, action should be initiated to address the problem. If they are consistent, a letter response is appropriate. The Standard Response Letter can be used in situations where the ordinance level is the same in both impacted communities or where the ordinance level of the community assuming jurisdiction is currently higher than that currently in the affected area.

To resolve inconsistencies, it must first be verified that data is available, and whether that data is available internally or must be requested from the community. If insufficient data are available, the assigned Mapping Partner shall prepare the Standard Response Letter to advise the affected communities that the change will be incorporated into the next revision of that FIRM panel. If

sufficient data are available, the magnitude of the change needs to be considered and, if a map action is determined to be appropriate, whether a LOMR or PMR is to be initiated. LOMRs and PMRs are discussed in Sections 2.1 and 2.2. In such cases, the assigned Mapping Partner shall prepare the Restudy Response Letter to advise the community of the upcoming map action. The ordinance levels are detailed in Paragraphs 60.3(a) through (e) of the NFIP regulations. For the purpose of reviewing corporate limit change materials, a very general overview of the levels of ordinances as they apply to map information follows:

- Paragraph 60.3(a)—No data, no FIRM;
- Paragraph 60.3(a)—FIRM has only Zone A flood hazard information;
- Paragraph 60.3(c)—FIRM shows some BFEs and detailed flood hazard information;
- Paragraph 60.3(d)—FIRM or FBFM shows regulatory floodway information; and
- Paragraph 60.3(e)—FIRM shows coastal high hazard information (V zones).

If a community will be incorporating flood hazard information with the corporate limit change a that will require a higher floodplain management ordinance level, the community will have to upgrade the ordinance. For example, if the changed area includes a regulatory floodway and the panels of the community assuming jurisdiction also have floodway information, then the ordinance of the community will not change, and the Standard Response Letter is appropriate.

However, if the changed area has a regulatory floodway shown, and the FIRM or FBFM for the community assuming jurisdiction does not show regulatory floodway information, then the community will have to change its floodplain management ordinance to incorporate the requirements of Paragraph 60.3(d) of the NFIP regulations. The community needs to be advised of the change required in their ordinance, and this can be accomplished using the Ordinance Upgrade Response Letter.

The content and distribution requirements for the Standard Response Letter, Restudy Response Letter, and Upgrade Response Letter may be found in next update to the FEMA *Document Control Procedures Manual.*

[February 2002]

2.6.2 Document Preparation

The corporate limit change submittal usually shall include a copy of the ordinance, a map showing the location and area involved in the change, and a letter from a community official. The corporate limit change submittal arrives at the processing Mapping Partner, where it is assigned to a designated Processor for review and processing.

The processing Mapping Partner reviews the submittal for the required materials, specifically for the map and the ordinance, and the FIRM is obtained for the changed area and the community assuming jurisdiction. The following information is noted:

- FIRM panel name and number for the community assuming jurisdiction
- FIRM panel name and number for the changed area's previous community
- The name and title/department of the official of the community assuming jurisdiction–this is the person who wrote the letter accompanying the corporate limit change submittal (if no letter, no name)
- The name and address of the CEO of the community assuming jurisdiction
- Date of letter that accompanied the change submittal (if no letter, date the mapping partner received the change submittal)
- Date the change became effective (usually on the last page of the ordinance)

The information above is used to create the response letter to the community. The FIRM panels are reviewed as discussed in 2.6.1, and the correct response letter is mailed as appropriate.

[February 2002]

2.6.3 Other Coordination and Documentation Activities

In addition to responding to the community and making the community aware of the flood hazards information regarding the area, the change information will be used by FEMA when maps are updated. If the change is addressed by an ongoing study, by a PMR, or by a LOMR, then the change would be incorporated in the FIRM for the community. Usually a map action is not necessary and a letter acknowledging receipt of the information is sent to the community.

FEMA uses the MNUSS database to assist when prioritizing funding for map updates, and a change is considered a Map Maintenance Need. A Data Collection Worksheet is filled out for the change and this information is entered into MNUSS. The Data Collection Worksheet and a copy of the response letter are attached to the corporate limit change submittal and filed as a Future File in the MNUSS Files. The following information is entered into a spreadsheet and used to research available data when a map update is being done for a community:

- CID, name, County, State of community assuming jurisdiction
- CID, name, County, State of community losing jurisdiction
- Number of changes
- Ordinance received (Y/N or Date)

- Map received (Y/N or Date)
- Date most recent change became effective
- Date received the change submittal
- Date responded to the change submittal
- Method of response (which type of letter)

[February 2002]

2.6.4 Deliverable Products

The processing Mapping Partner shall prepare and distribute the Standard Response Letter, the Ordinance Upgrade Response Letter, or the Restudy Response Letter as indicated in Section 2.6.1.

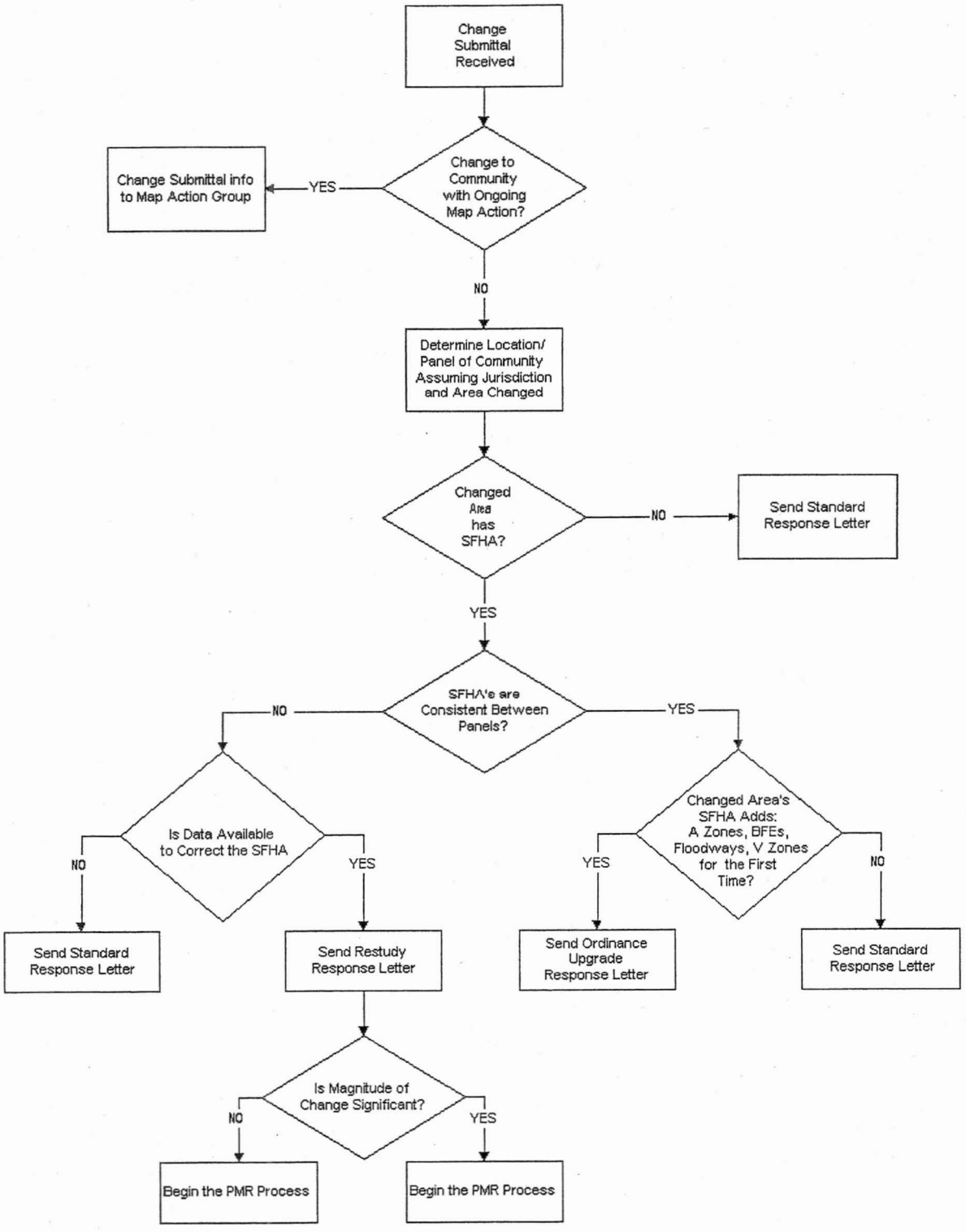


Figure 2-3. Map Revision Decision-Making Flowchart

[February 2002]

2.7 Program Implementation

2.7.1 Documentation Control Procedures

The assigned Mapping Partner shall perform the required procedures for preparing and distributing standard and nonstandard letters for conditional and final map revisions and map amendments as presented in Sections 2 and 3 and Appendices B and C of the FEMA *Document Control Procedures Manual* (FEMA, July 2000). This includes mailing letters, with their appropriate enclosures, as specified in the U.S. Postal Service Domestic Mail Manual (U.S. Postal Service, 2001).

[February 2002]

2.7.2 Standard Processing

In accordance with Section 65.9 of the NFIP regulations, when a revision to an NFIP map is requested, the CEO of the community must receive notification (in writing) of the status of the request. This notification must be provided within 90 days of the receipt of the request and will state one or more of the following:

- The effective map(s) shall not be modified.
- The BFEs on the effective FIRM shall be modified, and new BFEs shall be established.
- The changes requested are approved, and the map(s) are revised by a LOMR.
- The changes requested are approved. Revised FIRM (and FBFM) panels will be printed and distributed.
- The changes requested are not significant enough to warrant a reissuance or revision of the FIS report, FIRM, and/or FBFM and will be deferred until such time as a significant change occurs.
- The evaluation of the scientific or technical data submitted will require an additional 90 days to complete.
- The data submitted to support the revision request are not adequate. Additional data must be provided.

This notification is generally interpreted as a written response by the Administrator of the Federal Insurance and Mitigation Administration or his/her designee; therefore, the Mapping Partner shall complete all reviews or determine that such completion is not possible to allow ample time for correspondence preparation, review, signature, and mailing within the timeframe. However, to ensure a timely review of and response to any revision requests (including LOMR-Fs and LOMAs), the assigned Mapping Partner shall prepare a letter that either outlines the

additional data needed to resolve the revision request or provides an explanation of what revisions will be undertaken within 30 days of receipt of a revision request.

Furthermore, because lengthy delays in resolving requests for map revisions may occur, the assigned Mapping Partner shall develop and institute procedures to ensure that periods of 90 days or more do not elapse without FEMA corresponding with the requester. The purpose of the correspondence is to advise the revision requester of the status of his or her revision request.

[February 2002]

2.8 Fee-Collection System Responsibilities

2.8.1 Background

In January 1986, FEMA instituted a fee-collection system to recover costs incurred in reviewing proposed projects and issuing CLOMAs, CLOMR-Fs, and CLOMRs. In October 1992, FEMA expanded the system to provide for the recovery of costs incurred in reviewing completed projects and issuing LOMR-Fs, LOMRs, and PMRs. Effective October 1, 1996, FEMA established a flat fee schedule for processing most requests for conditional and final map amendments and revisions. FEMA revised the current fee schedule on June 1, 2000.

[February 2002]

2.8.2 Coordination Responsibilities

Under the fee schedule, with one exception, requesters are required to submit payment to FEMA in advance of a review. The exception is requests for changes involving structural measures on alluvial fans. For most requests, the Mapping Partner will only be required to acknowledge receipt of the payment and coordinate with the Fee-Collection System Administrator (FCSA) to ensure all payments are deposited into the National Flood Insurance Fund. For requests involving structural measures on alluvial fans, requesters must submit an initial fee, and the Mapping Partner must document all billable hours (to nearest half hour) spent on these requests. The Mapping Partner must then notify FEMA and the requester if the initial fee will be exceeded and provide a revised estimate of the total review and processing costs (calculated as the total number of hours multiplied by an hourly rate).

Additional information on the required coordination and documentation is provided in Section 2 of the FEMA *Document Control Procedures Manual* (FEMA, July 2000).

[February 2002]

2.8.3 Fee Exemptions

In accordance with Section 72.5 of the NFIP regulations, no review and processing fee shall be collected by the Mapping Partner for the following exempted types of requests:

- Map change requests based on mapping or study analysis errors;
- Map change requests based on the effects of natural changes within SFHAs;
- LOMA requests;
- Map change requests based on federally sponsored flood-control projects where 50 percent or more of the project's costs are federally funded; and

- Map change requests based on detailed hydrologic and hydraulic studies conducted by Federal, State, or local agencies to replace approximate studies conducted by FEMA and shown on the effective FIRM.

- Map changes based on flood hazard information meant to improve upon that shown on the flood map or within the flood study. NOTE: Improvements to flood maps or studies that partially or wholly incorporate man-made modifications within the SFHA will not be exempted from fees.

[February 2002]

2.9 Special Conversion Processing Procedures

Under standard conversion procedures, a newly identified community or a community that previously participated in the Emergency Phase of the NFIP enters the Regular Phase of the NFIP based on the results of the detailed analyses performed as part of a study. However, through the Special Conversion process, FEMA may also convert a community to Regular Phase of the NFIP without performing a detailed engineering study. For some communities, the Special Conversion process may be initiated at the recommendation of a Mapping Partner that has undertaken a study/restudy under contract to FEMA. In such cases, that Mapping Partner may submit some form of engineering analysis with a letter report recommending a Special Conversion.

Under this process, a community is converted, at the recommendation of the RO, through one of the following procedures:

- Non-floodprone conversion;
- Minimal conversion by letter; or
- Minimal conversion by map.

These procedures are described in more detail in Subsections 2.9.1 and 2.9.2.

The FEMA RO staff initiates the Special Conversion process by submitting a Special Conversion Recommendation Report (SCRR) and/or letter report discussed above and appropriate supporting data to the FEMA PO or his/her designee. The FEMA PO or his/her designee then forwards the SCRR and appropriate supporting data to the Mapping Partner assigned by FEMA to review and process the Special Conversion. For all Special Conversion procedures, the assigned Mapping Partner shall perform the coordination and documentation activities required to convert the community to the Regular Phase of the NFIP, in accordance with the detailed procedures documented in Section 6 of the FEMA *Document Control Procedures Manual* (FEMA, 2000).

[February 2002]

2.9.1 Non-Floodprone Conversions

Non-floodprone communities are those communities that are determined not to be subject to inundation by the 1-percent-annual-chance (100-year) flood. The administrative guidelines employed for determining whether a community is designated as non-floodprone are that all of its SFHAs are less than 200 feet wide and all drain less than 1 square mile, or physiographic features exist that preclude floodplain development in the community. If the floodprone areas in a community do not fit at least one of these guidelines, the community is not, under any circumstances, to be designated as non-floodprone. Non-floodprone communities are converted to the Regular Phase of the NFIP by letter only. No FIRM is issued, and any existing FHBM is rescinded. The entire community is designated as Zone X (unshaded).

Upon receipt of the SCRR and/or letter report from FEMA the assigned Mapping Partner shall ensure that at least one of the criteria for non-floodprone conversions are met. If these criteria are not met, the Mapping Partner shall inform the FEMA PO or his/her designee, who will request that the RO submit additional justification for its recommendation.

Once a community has been approved for a non-floodprone conversion, the assigned Mapping Partner shall prepare the necessary correspondence to effect the conversion. Depending on the community's status in the NFIP, the Mapping Partner shall prepare one of three non-floodprone conversion letters. The Mapping Partner shall distribute copies of the letters and prepare a CMA list for each community. Distribution shall occur 2 weeks prior to the effective date determined by the assigned Mapping Partner and noted on the CMA list.

The assigned Mapping Partner shall prepare the required correspondence for non-floodprone conversions to notify the community CEO and floodplain administrator, State NFIP Coordinator, affected Federal agencies, and the RO of the conversion. The types of correspondence to be prepared by the assigned Mapping Partner are discussed in detail in Section 4 of *Document Control Procedures Manual* (FEMA, July 2000).

[February 2002]

2.9.2 Minimal Conversions

Minimally floodprone communities are those communities subject to inundation by the 1-percent-annual-chance (100-year) flood, but for which existing conditions indicate that the area is unlikely to be developed in the foreseeable future. The criteria used by RO staff to evaluate a community's development potential are as follows:

- Floodplains are publicly owned and designed for open space or preservation.
- Zoning laws, sanitary codes, subdivision regulations, shore land regulations, or community regulations effectively prohibit floodplain development.
- Surrounding land use or topography effectively limits the development potential.
- Population is decreasing or stable, and there is no foreseeable pressure for floodplain development.
- Floodplains are remote and uninhabited, and future development is unlikely.

The FEMA RO may use other indicators in addition to these criteria to assess the development potential. One important indicator is the size of the undeveloped floodplain relative to the size of the entire community. The larger the proportion, the more the floodplain is likely to be subject to pressure for development.

Minimal conversions can be accomplished by map or by letter, depending on whether revisions to the existing FHBM are required. For communities for which no FHBM has been published (i.e., newly identified communities), the assigned Mapping Partner shall follow the procedures

detailed in Subsection 3.21.2 of these Guidelines and Section 6 of the FEMA *Document Control Procedures Manual* (FEMA, July 2000).

The length of the entire minimal conversion process and the assigned Mapping Partner processing times for minimal conversions are discussed in Subsections2.9.2.1 and 2.9.2.2. The length of the entire minimal conversion process depends on the conversion method used (map or letter) and on whether the community to be converted is compliant with the NFIP requirements concerning community floodplain management ordinances set forth in Sections 60.2 through 60.6 of the NFIP regulations. In general, the conversion process for compliant communities is shorter, because noncompliant communities must be allowed 6 months to enact the required ordinances before the conversion can become effective.

[February 2002]

2.9.2.1 Minimal Conversions by Map

If the SFHA shown on the existing FHBM for a community must be revised, the community is converted to the Regular Phase of the NFIP with a FIRM that is an updated version of the FHBM. The following categories of FIRMs may be printed, depending on the flooding situation in the community:

- The FIRM shows all SFHAs with a Zone A designation.
- The FIRM Index notes that all areas in the community are Zone D (used in cases where the FIRM is the community's initial map and all areas are considered remote and uninhabited).
- The FIRM (one or more panels printed) shows Zones A and C (or Zone X (unshaded)) for the community's most populated areas and notes on the Map Index that all unprinted panels are Zone D, under the remote and uninhabited criteria.

When a FIRM is to be prepared, the assigned Mapping Partner shall obtain the most current data, including USGS topographic maps; floodprone area maps; original FHBM artwork; FIS reports and FIRMs for contiguous communities; Floodplain Information Reports; watershed work plans; other reports available through USGS, NRCS, or USACE; and documentation for the effective FHBM. The assigned Mapping Partner also shall incorporate changes made previously by LOMA, LOMR-F, or LOMR, as appropriate.

With the SCRR and/or letter report, the RO will submit an annotated FHBM or community map with updated corporate limits, road names, and flooding information. The assigned Mapping Partner shall compare this information to NFIP maps for contiguous communities to ensure the flood hazard information matches. If during the review of contiguous communities, the assigned Mapping Partner finds that floodplain boundaries do not match, or if other sources are found to provide detailed flooding information, the assigned Mapping Partner shall consult with the PO or his/her designee to determine if an existing data study (XDS) is appropriate.

Unless the SCRR and/or letter report indicate an appropriate engineering review has already been completed, the assigned Mapping Partner shall review the areas of flooding designated in the available information. Any apparent errors or discrepancies shall be investigated and, if needed, corrected. Although the assigned Mapping Partner is not required to check the flood discharges, the hydrologic evaluation performed by the Mapping Partner shall include, but not be limited to, an application of the criteria for non-floodprone communities.

All SFHAs shall be designated as Zone A. All areas outside SFHAs shall normally be identified as Zone X (unshaded), unless the RO has requested that some areas in the community (primarily remote and uninhabited areas in the community) be identified as Zone D. The assigned Mapping Partner shall obtain approval from the PO or his/her designee to depict Zone D areas on FIRMs.

If the technical review performed by assigned Mapping Partner indicates that a minimal conversion for a particular community may be inappropriate, or that significant effort would be involved for such a conversion, the assigned Mapping Partner shall consult with the PO or his/her designee on the action to be taken.

Because maps are to be converted to depict the most up-to-date FEMA procedures and flood hazard information, the assigned Mapping Partner shall use the most recent graphic guidelines, presented in Appendix K of these Guidelines. Extensive changes that may require conversion from 11 x 17 format to Z-fold format must be approved by the PO or his/her designee.

At the completion of the technical review, the assigned Mapping Partner shall prepare the FHBM for the cartographic or digital mapping phase of the minimal conversion process. At this time, the assigned Mapping Partner shall assign an effective date for the FIRM and prepare a schedule in order to track the conversion through cartographic corrections, correspondence preparation and distribution, and GPO processing. The entire minimal conversion process usually requires 7 months from the receipt of the SCRR and/or letter report and all necessary data by the assigned Mapping Partner to the new FIRM effective date.

The assigned Mapping Partner shall prepare the required correspondence for minimal conversions by map to notify the community CEO and floodplain administrator, State NFIP Coordinator, affected Federal agencies, and the RO of the conversion. The types of correspondence to be prepared by the assigned Mapping Partner and the responsibilities for monitoring community review of the FIRM are discussed in detail in Section 4 of the FEMA *Document Control Procedures Manual* (FEMA, July 2000).

[February 2002]

2.9.2.2 Minimal Conversions by Letter

If no changes are required to the SFHA shown on the existing FHBM, the community may be converted to the Regular Phase of the NFIP with a letter only. In such cases, the assigned Mapping Partner shall verify that this procedure is correct by checking the accuracy of the corporate limits, floodplain boundary delineations, and other physical and cultural features. If, during the review, the assigned Mapping Partner locates sufficient data to prepare an XDS for the community, the Mapping Partner shall consult with the PO or his/her designee. If the

assigned Mapping Partner determines the FHBM is inaccurate, the Mapping Partner shall contact the RO to determine if a minimal conversion by map is warranted. For those FHBMs that meet the criteria for conversion by letter, the assigned Mapping Partner shall prepare and distribute the required correspondence. The specific procedures to be followed are discussed in detail in Section 4 of *Document Control Procedures Manual* (FEMA, July 2000).

[February 2002]

2.10 References

Federal Emergency Management Agency, *Document Control Procedures Manual*, July 2000.

Federal Emergency Management Agency, FIA-12, *Appeals, Revisions, and Amendments to National Flood Insurance Program Maps: A Guide for Community Officials*, 1993.

Federal Emergency Management Agency, "Modernizing FEMA's Flood Hazard Mapping Program: Recommendations for Using Future-Conditions Hydrology for the National Flood Insurance Program," November 2001.

U.S. Postal Service, *Domestic Mail Manual,* 2001.

U.S. Department of the Interior, Coastal Barriers Study Group, *Report to Congress: Coastal Barrier Resources System, Recommendations for Additions to or Deletions from the Coastal Barrier Resources System*, 1988.

Interagency Advisory Committee on Water Data, Office of Water Data Coordination, Hydrology Subcommittee, Bulletin 17B, *Guidelines for Determining Flood Flow Frequency*, 1982.

[February 2002]

Map MODERNIZATION

Federal Emergency Management Agency

FEMA's Flood Hazard Mapping Program

Guidelines and Specifications *for* Flood Hazard Mapping Partners

Volume 3: Program Support

FEDERAL EMERGENCY MANAGEMENT AGENCY

www.fema.gov/mit/tsd/dl_cgs.htm

FINAL

February 2002

Volume 3

Program Support

3.1 Introduction

To aid the Federal Emergency Management Agency (FEMA) in the administration of the National Flood Insurance Program (NFIP), a variety of support functions must be performed. These functions, described in detail in this Volume of the Guidelines, are primarily performed by one of the FEMA Flood Hazard Mapping Partners—the Flood Map Production Coordination Contractors (MCCs). To allow for the greatest flexibility to FEMA for coordinating these efforts, the term "assigned Mapping Partner" is used herein. The MCC or other assigned Mapping Partner and FEMA shall refer to the guidelines and specifications in this Volume when completing such support tasks.

At the direction of the Project Officer (PO) at FEMA Headquarters (HQ) or his/her designee, the assigned Mapping Partner shall:

- Hold regular and ad hoc coordination meetings with the PO and other FEMA HQ staff.
- Attend other meetings with FEMA HQ and Regional Office (RO) staff.
- Establish and maintain a courier service to deliver mail to, and pick up mail from, FEMA HQ and transport FEMA staff to and from coordination meetings at assigned Mapping Partner's offices upon request.
- Support the Letter of Map Change (LOMC) Distribution Service.
- Maintain a management information system and provide FEMA staff with regular and ad hoc reports (in hardcopy and/or electronic formats) pertaining to work status and contract performance.
- Maintain designated portions of the FEMA Community Information System (CIS), Credited Structures Inventory System (CSIS), and Monitoring Information on Contracted Studies (MICS) system.
- Store technical and administrative support data associated with the processing of initial and revised Flood Insurance Study (FIS) reports, Flood Insurance Rate Maps (FIRMs), Flood Boundary and Floodway Maps (FBFMs), conditional and final map revision requests, conditional and final map amendment requests; revalidation letters; Letters of Determination Review; and annexation requests.
- Assist FEMA in the development and distribution of guidelines and specifications, procedure manuals, and briefing guidance documents.

- Assist FEMA in the development and implementation of improved standards, procedures, methodologies, and report and map products.
- Prepare documentation for historical and future trends.
- Attend and participate in technical meetings with FEMA, other Mapping Partners, and NFIP constituents.
- Support the FEMA Map Assistance Center.
- Assist FEMA in maintaining and enhancing the Flood Hazard Mapping website (www.fema.gov/mit/tsd) and other Internet-based applications.
- Provide technical, programmatic, and administrative/logistical support for the FEMA Mapping Needs Assessment Process (MNAP), including maintenance and improvement of Mapping Needs Update Support System (MNUSS) and the MICS system.
- Assist FEMA by researching issues and preparing responses to Special Correspondence in six categories: (1) Congressional Responses, (2) Director Responses, (3) Mapping Responses, (4) E-Mail Responses, (5) Freedom of Information Act (FOIA) Responses, and (6) Other Responses.
- Provide technical, programmatic, and administrative support for the processing of Letter of Determination Review requests.
- Maintain the FEMA Engineering Study Data Package Facility (ESDPF).
- Maintain the FEMA fee-charge system for requests for technical and administrative support data and requests for conditional and final modifications to NFIP maps.
- Prepare and deliver final reproduction materials for FIS reports, FIRM panels, and FBFM panels, when requested by the FEMA Map Service Center (MSC), to replace missing or damaged products.
- Provide technical, programmatic, and administrative/logistical support for FEMA training initiatives.
- Provide technical, programmatic, and administrative/logistical support for FEMA hazard identification and risk assessment activities.
- Provide technical, programmatic, and administrative/logistical support for FEMA post-flood hazard verification activities, including development of recovery maps.
- Provide technical, programmatic, and administrative/logistical support to FEMA and its Partners for the Cooperating Technical Partners intiative.
- Provide technical, programmatic, and administrative/logistical support to FEMA for implementation of its Map Modernization objectives.

- Maintain and update the Q3 Flood Data Product for FEMA.
- Provide programmatic and administrative support for tracking communities through the conversion/compliance process and preparing documentation for communities entering into the Emergency and Regular Phases of the NFIP.
- Provide other technical, programmatic, and logistical support to FEMA in its administration of the NFIP and other hazard-related programs as required.

These activities are described in the subsections that follow.

[February 2002]

3.2 Program Coordination and Reporting

The Project Manager for the assigned Mapping Partner shall be responsible for maintaining close communication with the FEMA PO or his/her designee, other FEMA HQ staff, and FEMA RO staff. The Project Manager shall be available for consultation and conferences at the request or concurrence of the PO or his/her designee.

[February 2002]

3.2.1 Regular Coordination Meetings with FEMA and FEMA Contractors

The assigned Mapping Partner shall attend coordination meetings with FEMA personnel and other FEMA contractors, as required by the FEMA Management and with the concurrence of the PO or his/her designee. These meetings will be held to unify Program direction and to discuss ongoing work. The assigned Mapping Partner shall document the proceedings of these meetings with meeting minutes. The frequency and location of the meetings will depend on the type of contract or agreement signed with FEMA. In some cases, for some Mapping Partners, teleconferences hosted by FEMA may be held in place of in-person meetings.

[February 2002]

3.2.2 Regular Coordination with FEMA Regional Offices

The assigned Mapping Partner shall provide technical and administrative support to FEMA ROs, as directed by the PO or his/her designee, regarding studies/restudies, special conversions, conditional and final map revisions, conditional and final map amendments, and other information. Such support shall include consultation on technical, mapping, and programmatic issues. At the request of the FEMA RO and concurrence of the PO or his/her designee, the assigned Mapping Partner shall attend meetings with other FEMA Mapping Partners and other NFIP constituents.

[February 2002]

3.2.3 Ad Hoc Coordination Meetings with FEMA and FEMA Customers

The assigned Mapping Partner shall attend ad hoc coordination meetings with FEMA personnel, other FEMA Mapping Partners, and other NFIP constituents with the concurrence of the PO or his/her designee. These meetings may be held to cover study-, restudy-, or case-specific issues; general mapping issues; or controversial issues in a particular community or state.

[February 2002]

3.2.4 Monitoring

FEMA recognizes that the production and maintenance of FIS reports, FIRMs/DFIRMs, and FBFMs involves ongoing coordination between and among the FEMA and the Mapping Partner(s) involved with a particular mapping-related activity. Community-specific anomalies, inconsistencies in the processing of reports and maps in different communities, questions regarding NFIP support activities, exceptions to procedures and specifications detailed in these Guidelines, and politically sensitive cases require direct, routine FEMA guidance. This management is accomplished through regular (sometimes, weekly) monitoring visits or communication with the assigned Mapping Partner. The assigned Mapping Partner has a responsibility to document any issue needing FEMA direction, as well as the decisions rendered in each instance.

The assigned Mapping Partner shall document any issue to be discussed during a monitoring visit or conference call. At a minimum, the Mapping Partner shall include the community name and community identification number (CID), a brief summary of the Flood Map Project or other mapping-related activity, and a summary of the issue. When a resolution of the issue is reached, the Mapping Partner shall document the date, the decision, a point of contact, any action items necessary to carry out the decision, and a due date for each action item. The summaries of the issues resolved during monitoring visits or conference calls shall be documented in Monitoring Notes reports. The Mapping Partner shall establish the content, format, and distribution for the Monitoring Notes reports with the FEMA PO, FEMA Regional Project Officer (RPO), FEMA Project Engineers, and/or FEMA Regional Engineers as appropriate.

[February 2002]

3.2.5 Courier Service

The assigned Mapping Partner shall establish and maintain a courier service that delivers mail to, and picks up mail from, FEMA HQ during each workday at a regularly scheduled time to be determined with the FEMA PO. The assigned Mapping Partner also shall provide courier service on an as-needed basis to pick up or deliver priority items. The assigned Mapping Partner also shall arrange transportation of FEMA staff to and from coordination meetings at the assigned Mapping Partner's offices upon request. When requested to do so by the PO or his/her designee, the assigned Mapping Partner may deliver priority items to, and pickup priority items from, other Mapping Partners.

[February 2002]

3.2.6 Letter of Map Change Distribution Service Support

The assigned Mapping Partner shall, at the direction of the PO or his/her designee, provide administrative and technical support for the LOMC Distribution Service. The activities for the effort shall include the following twice each month:

- Preparing copies of final determination documents and associated attachments for amending or revising Letters of Map Amendment (LOMAs), Letters of Map Revision Based on Fill (LOMR-Fs), and Letters of Map Revision (LOMRs);
- Preparing copies of final determination documents and associated attachments for requests for LOMAs, LOMR-Fs, and LOMRs that are denied by FEMA;
- Preparing copies of final determination documents and associated attachments for LOMA and LOMR-F requests where property is determined to be out-as-shown;
- Preparing copies of revalidation letters;
- Organizing determination documents and attachments by FEMA Region, State, and community, in chronological order;
- Inserting a "Notice to Subscribers" sheet immediately after a LOMR determination letter when the attachments to that LOMR are larger than 8-1/2" x 11";
- Numbering the pages; and
- Preparing an index of the LOMCs included.

When requested by LOMC Distribution Service subscribers, the assigned Mapping Partner also shall provide copies of oversized attachments for LOMRs (i.e., full-sized Flood Profiles, FIRM panels, FBFM panels) to the subscribers free of charge.

The requirements for preparing the final LOMC publication on CD-ROM are provided in Subsection 3.10.3.

[February 2002]

3.2.7 Reporting

The assigned Mapping Partner shall operate a comprehensive internal financial and contractual management system sufficient to provide for effective management of all Federal funds expended as a result of a contract. At a minimum, the assigned Mapping Partner shall prepare contract status reports, time and cost estimates, computerized status reports, production reports, and other periodic reports that may be necessary to track status of work and control hours and costs.

[February 2002]

3.2.7.1 Computerized Financial Management System

The assigned Mapping Partner shall operate a financial management system to provide effective management and reporting of all Federal funds provided to the assigned Mapping Partner through its contract with FEMA.

[February 2002]

3.2.7.2 Computerized Status Reporting System

The review and preparation of the products described in Volumes 1 and 2 are a significant part of the work performed by the assigned Mapping Partner. Large numbers of studies, restudies, map revisions, and map amendments are performed each year, and the resulting report, map, and letter products must pass through numerous processing stages before they can be published. The assigned Mapping Partner must have the ability to maintain accurate records of the reports, maps, and letters being processed; those that have been completed; and the scheduled and actual dates for the completion of each processing stage for each study, restudy, map revision, and map amendment.

The assigned Mapping Partner needs this information for daily operations and short-term and long-range planning. FEMA HQ and RO staff use this information to administer the NFIP and to report to the U.S. Congress.

The assigned Mapping Partner shall maintain a database to track and report on all LOMCs and mapping actions. This database structure must be designed to interface with the FEMA CIS, an Oracle database system. The assigned Mapping Partner shall access the CIS through the FEMA Wide Area Network (WAN) or a dial-up account. The assigned Mapping Partner shall upload information on the work products being processed by the Mapping Partner twice weekly (more frequently if requested by the FEMA PO or his/her designee). Additionally, the assigned Mapping Partner also shall download data from the CIS on the same schedule.

The assigned Mapping Partner shall update are the Status of Studies (SOS) and LOMC modules as well as the Community Contact information in the CIS. Additional pertinent information on the SOS and LOMC modules is provided below.

[February 2002]

Status of Studies Module

The SOS module of the CIS contains status and processing information for FEMA-funded Flood Map Projects (i.e., studies, restudies, Special Conversions) and community-funded Physical Map Revisions (PMRs). The SOS module is comprised of three databases—the main SOS database, the SOS Flood Source Database, and the SOS Hold Status Database.

The assigned Mapping Partner shall maintain and update 85 percent of the 70+ individual fields in the SOS module; these. FEMA RO and HQ staff shall update the remaining 15 percent of the fields.

Letter of Map Change Module

The LOMC module of the CIS contains status and processing information for LOMAs, Conditional Letters of Map Amendment (CLOMAs), LOMR-Fs, Conditional Letters of Map Revision Based on Fill (CLOMR-Fs), LOMRs, Conditional Letters of Map Revision (CLOMRs) based on conditions other than fill, and Letter of Map Change Revalidation (LOMC-VALID) letters. The LOMC module is comprised of five databases—the main LOMC database, the LOMC Flood Source Database, the LOMC Property Description Database, the LOMC Map Panel Database, and the LOMC Fee Database.

The assigned Mapping Partner shall update more than 100 individual fields (with widths ranging from 1 to 60 characters) to maintain the accuracy of the LOMC module for each case. The FEMA Fee-Charge System Administrator (FCSA) shall update the remaining 10 percent of the fields.

Cost Accounting

The assigned Mapping Partner shall track and allocate costs using job-control numbers. These numbers shall be unique to a particular product or effort being supplied by the assigned Mapping Partner. Whenever a particular cost component is incurred in the provision of a product or service, it is to be charged to the job-control number for that product or service. The assigned Mapping Partner shall ensure cost accounting is performed in compliance with the accounting structure as defined by the contract in place.

3.2.7.3 Credited Structures Inventory System

The construction of levees and similar flood-protection structures, such as dikes and floodwalls, has had a significant effect on floodprone areas throughout the United States. These structures are intended to protect lives and property and are therefore of particular importance in identifying flood hazards and reducing flood losses. For several years after the inception of the NFIP, FEMA relied heavily on Study Contractors to properly evaluate the capacity of levees and similar structures to provide protection from the 1-percent-annual-chance (100-year) flood. In recognition of the need for a uniform method of evaluating these structures, FEMA issued a Levee Policy in 1981. The Levee Policy was subsequently superseded by the publication of earlier versions of *Flood Insurance Study Guidelines and Specifications for Study Contractors* and by rule-making that resulted in the requirements documented in Section 65.10 of the NFIP regulations.

Section 65.10 identifies the types of structures that qualify as flood-protection structures and outlines the criteria on which the evaluations of these structures should be based. During the preparation and revision of FIS reports and maps, assigned Mapping Partners shall use the information provided in Section 65.10 of the NFIP regulations to determine whether structures

should be credited with providing protection from the 1-percent-annual-chance (100-year) flood. (See Appendix C of these Guidelines for additional information on the evaluation and mapping of flood-protection structures.)

In 1984, in response to the growing number of NFIP maps depicting credited flood-protection structures, FEMA created the Credited Structures Inventory. FEMA designed the Inventory to identify all structures shown as providing protection from the 1-percent-annual-chance (100-year) flood on effective and soon-to-be-effective FIRMs, including levees, dikes, floodwalls, and road and railroad embankments. The objective of the Inventory was to collect information that FEMA would need to determine priorities for future levee investigations and to monitor the operation and maintenance of these structures.

In connection with the Inventory, FEMA developed the CSIS, a computerized database and information retrieval system. The results of the Inventory were entered into the CSIS.

The initial phase of the inventory was completed and the resulting information was entered into the CSIS. The assigned Mapping Partner shall provide information required to update the CSIS, which the assigned Mapping Partner shall obtain during the review and processing of FEMA-contracted Flood Map Projects and community-initiated map revisions.

[February 2002]

Standard Reports

FEMA designed the CSIS to store large amounts of information about credited structures, to retrieve all or selected portions of this information, and to generate reports. When requested to do so by FEMA, the assigned Mapping Partner shall issue reports tailored to meet specific needs using the information stored in the CSIS and addendums to the CSIS.

Stored Information

In the CSIS, each credited structure within a state is assigned a unique structure number. Information is collected for each structure and stored under that structure number. Ideally, over 40 pieces of information concerning the structure (e.g., location, construction, accreditation, operation, maintenance, and size) and the protection it provides are collected and stored under the appropriate structure number.

The assigned Mapping Partner shall record credited structure information on a Levee Inventory Data Entry Form (LIDEF), which was designed to contain information for only one structure and only for that portion of the structure that falls within a single community. Spaces are provided to record information describing the effects of the structure on the flooding depicted on a maximum of six panels of the FIRM for a community. Therefore, the assigned Mapping Partner must prepare multiple LIDEFs for a single credited structure that falls within more than one community or affects the flooding on more than six FIRM panels for one community.

Update Requirements

The assigned Mapping Partner shall, as a routine part of reviewing and processing FEMA-funded Flood Map Projects and community-initiated map revisions, identify all levees and similar structures credited with providing protection from the 1-percent-annual-chance (100-year) flood, and record this information on LIDEFs for entry into the CSIS database. The assigned Mapping Partner shall submit completed LIDEFs to the FEMA-designated repository each month. Instructions for completing LIDEFs are provided below.

Data Collection and Preparation of Data Entry Form

For each credited structure identified, the assigned Mapping Partner shall review in-house files of completed LIDEFs to verify that the information listed has been provided for entry into the CSIS database. In conducting this review, the assigned Mapping Partner may find that a structure has not been previously identified, in which case no information for that structure will be contained in the CSIS database. The assigned Mapping Partner also may find that the structure has been identified and entered into the CSIS, but the information is incomplete, out of date, or otherwise inaccurate.

In either case, the assigned Mapping Partner shall complete the required LIDEFs. If the structure has not been previously identified, the assigned Mapping Partner shall assign a structure number and obtain as much information as possible. Structure numbers are assigned in ascending order from lists the assigned Mapping Partner is to maintain for each state. The LIDEF prepared for a previously unidentified structure will be the first for that structure.

To add to or update information already in the CSIS database, the assigned Mapping Partner shall prepare a revised LIDEF. Before submitting new or revised LIDEFs, the assigned Mapping Partner shall review the LIDEFs to ensure that the information recorded on them is accurate. The assigned Mapping Partner shall also keep copies of all completed LIDEFs.

General Instructions for Completing Levee Inventory Data Entry Forms

The assigned Mapping Partner shall complete LIDEFs in the following cases:

- Credited structures are to be added to the CSIS (Addition).
- A credited structure was recorded in an earlier LIDEF, and the data should be revised (Update).
- A previously inventoried credited structure is no longer a credited structure and shall be deleted from the CSIS (Decertification).

The assigned Mapping Partner shall use the following guidelines in preparing a LIDEF:

- If any credited structures are to be added to the CSIS, complete as many of the items as possible with the information available. Item 7 (Structure Number) is not to be completed; a number will be assigned at a later date.

- If the credited structure was reported in an earlier inventory and some data must be revised, place an "X" in the box next to the word "UPDATE" in the upper right-hand corner of the form and complete Items 1 through 5, 7, 39, and 40. Other items are to be completed only if the information is new or revised.

- If a revision or upgrade is required for the "Comments" section (Item 42), include any previous comments that must be retained.

- If a structure was identified as a credited structure in an earlier inventory and, based on the updated inventory, is no longer considered a credited structure, complete Items 1 through 5, 7, 32, 33, 34, 39, 40, and 43 on the LIDEF.

- Use only capital letters to complete the LIDEF.

- Ensure numeric entries are right-justified and alphanumeric entries are left-justified.

- Leave boxes blank if data are not available unless otherwise specified in the coding instructions.

- Submit all forms with the same structure number together once a structure number has been assigned if the structure is located in more than one community.

- For Item 8, do not include dams and dam-related dikes designed to permanently impound water as levees. Use the term "floodwall" for a concrete or masonry wall or levee.

- For Item 22, show the verification agent as an appellant or a revision requester that provides data or information used to credit a structure, when appropriate

Item-by-Item Instructions for Completing a Levee Inventory Data Entry Form

The assigned Mapping Partner shall complete a LIDEF as follows:

- **Community Name (Item 1)**—Enter the community name.

- **Type (Item 2)**—Enter the community type using one of the following standard abbreviations:

  - BOR (Borough);
  - CTY (City);
  - CO (County);
  - PAR (Parish);
  - TWN (Town);
  - TWP (Township); or
  - VIL (Village).

- **County (Item 3)**—Enter the county name in which the community is primarily located. If the community type is "County," enter **UNINCORPORATED AREAS**.
- **State (Item 4)**—Enter the standard two-letter abbreviation.

- **Program Status (Item 5)**—Enter **NP** for non-participating communities or **P** for participating communities.

- **Structure Location (Item 6)**—Enter **A** if all or part of the structure is within the corporate/county limits of the community. Enter **B** if the structure lies entirely outside the corporate/county limits.

- **Structure Number (Item 7)**—Enter the seven-digit structure number from the Levee Inventory Printout when updating or decertifying a previously inventoried credited structure. Enter a new structure number when adding new structures. The first two digits of the structure number shall be assigned the two-digit state code number assigned to the state in which the structure is located. The last five digits of the number shall be assigned a number identifying the structure (e.g., "0600463" identifies structure No. 463 within California). A structure located within two or more states shall be assigned separate numbers, identifying the length of the structure within each state.

- **Structure Type (Item 8)**—Enter the two-letter structure-type code. Use **R** for the first letter of the code for a riverine flooding source and **C** for a coastal flooding source. Use one of the following as the second letter of the code:

  - **A** — Levee;
  - **B** — Floodwall;
  - **C** — Combined Levee and Floodwall;
  - **D** — Ring Levee;
  - **E** — Road Embankment;
  - **F** — Railroad Embankment; or
  - **G** — Other.

  Thus, the structure-type code for a levee on a riverine flooding source would be **RA**.

- **Coordinates (Item 9)**—Enter the latitude and longitude of the approximate midpoint of the structure to the nearest 30 seconds, as determined from U.S. Geological Survey (USGS) topographic maps.

- **Hydrologic Subregion (Item 10)**—Enter the three- or four-digit subregion code in which most of the structure is located. This code shall be taken from USGS Hydraulic Unit Maps for individual states.

- **Bank (Item 11)**—Enter **L** if the structure is located on the left overbank (facing downstream) or **R** if the structure is on the right overbank (facing downstream). Complete this item for riverine structures only.

- **Length of Structure (Item 12)**—Enter the total length of the crest of the structure, to the nearest 0.1 mile. For a levee or floodwall, identify the total length. For a road or railroad embankment, identify only the length credited with providing protection from the 1-percent-annual-chance (100-year) flood.

- **Failures (Item 13)**—Enter information on the past performance of the structure, if available. Enter **A** if a failure has occurred or **B** if no failure has occurred.

- **Official Name (Item 14)**—Enter the name if a structure or project has an accepted name. Enter **NO NAME** if there is no accepted name.

- **Year Completed (Item 15)**—Enter the year when construction of the main structure was completed. Do not enter the year(s) that remedial or maintenance work may have been performed.

- **Rated Level of Protection (Item 16)**—Enter the exceedence frequency, in years, of the flood from which the structure was designed to provide protection. Leave the space blank if there was no design flood.

- **Flooding Source (Item 17)**—Enter the name of the main river (or water body) from which the structure provides protection.

- **Freeboard (Item 18)**—Enter the minimum freeboard, in feet, of the structure.

- **Closures (Item 19)**—Enter the type(s) of closure required to operate the structure, using one of the following codes:

  - **A** — Sandbags;
  - **B** — Flood gates;
  - **C** — Stop logs;
  - **D** — Other;
  - **E** — Combination of A, B, C, and/or D; or
  - **F** — None.

- **Operational Plan (Item 20)**—Enter **A** if an approved operational plan exists. Leave the space blank if no operation plan exists.

- **Accreditation/Verification (Item 21)**—Enter one of the following codes:

  - Enter **A** if the structure has been verified as meeting the FEMA levee freeboard requirements or exceptions.
  - Enter **B** if the structure was credited prior to implementation of the FEMA Levee Policy. Apply this code to all road and railroad embankments unless FEMA has formally accredited the structure
  - Enter **C** if the structure was certified by another Federal agency as providing protection from the 1-percent-annual-chance (100-year) flood.
  - Enter **C** if both C and A apply.

- **Crediting/Verifying Agent (Item 22)**—Enter the crediting/verifying agency. If the agency is the Study Contractor, enter **SC** in the first two boxes. If not, leave the first two boxes blank. For the next three boxes, use two- and three-letter abbreviations for the agency (Federal, State, or local). If the firm or agency does not have a FEMA-established two- or three-letter code, enter the full name in the space provided.

- **Maintenance Plan (Item 23)**—Enter **A** if a FEMA-approved maintenance plan exists. Leave blank if no FEMA-approved maintenance plan exists.

- **Maintenance (Item 24)**—Enter the name of the Federal, State, or local agency with overall responsibility for maintenance of the structure. If the community is responsible for maintenance, enter the community type after the name using the two- and three-letter codes used for Item 2.

- **Date of Last Inspection (Item 25)**—Enter the year in which the structure was most recently inspected.

- **Owner (Item 26)**—Enter the name of the current owner of the structure.

- **Designer (Item 27)**—Enter the name of the firm or agency that had primary responsibility for design of the original structure.

- **Builder (Item 28)**—Enter the name of the firm or agency that had primary responsibility for construction of the original structure.

- **Design Plans (Item 29)**—Enter the name of the firm or agency that has the design plans. If such plans are available in the FEMA files, enter the name of the Mapping Partner that is maintaining those files.

- **As-Built Survey (Item 30)**—Enter the name of the firm or agency that has the as-built survey. It the survey is available in the FEMA files, enter the name of the Mapping Partner that is maintaining those files.

- **Inspection Data (Item 31)**—Enter the name of the firm or agency that has current inspection data. This would be the firm or agency that has responsibility for the actual maintenance duties, not necessarily the Federal, State, or local agency that has overall maintenance responsibility.

- **Community Number (Item 32)**—Enter the complete six-digit CID.

- **Panel Number (Item 33)**—Enter the complete four-digit FIRM panel number and suffix for each panel on which the structure is located. The panel number and suffix is to reflect the FEMA-funded Flood Map Project or map revision being processed.

- **Effective/Revised Date (Item 34)**— Enter the effective/revised date as it appears on the FIRM panels (shown as Year, Month, Day). Leave blank if the projected effective/revised date is unknown.

- **Protected Area Type (Item 35)**—Enter the code for whether the area protected from the 1-percent-annual-chance (100-year) flood on each panel is categorized as "primarily developed" (**D**) or "primarily undeveloped" (**U**). (This determination shall be made on the basis of information such as street patterns and cultural features shown on the flood map.)

- **Protected Area Zone (Item 36)**—Enter the code for the designation of the flood insurance risk zone shown on the FIRM adjacent to the landside of the structure. If more

than one zone is shown adjacent to the landside of the structure, enter the code of the most extensive zone. Use one of the following codes:

- **A** — Approximate Zone A;
- **AH** — Zone AH;
- **AO** — Zone AO;
- **A# — Zone A1-A30** and Zone A99;
- **AE** — Zone AE;
- **B** — Zone B or Zone X (shaded);
- **O** — Zone C or Zone X (unshaded);
- **D** — Zone D;
- **V** — Zone V;
- **V#** —Zone V1-V30; or
- **VE** — Zone VE.

- **Area of Protected Areas (Item 37)**—Enter the approximate area of the protected area, to the nearest 0.5 square mile, as shown on the affected FIRM panel(s).
- **Unprotected Area Zone (Item 38)**—Enter the code for the designation of the flood risk zone adjacent to the waterside of the structure. If more than one zone appears in the unprotected area, enter the code of the most extensive zone. Use the same codes as for Protected Area Zones.
- **Inventory By (Item 39)**—Enter the initials of the assigned Mapping Partner that completed the levee inventory.
- **Date of Inventory (Item 40)**—Enter the year, month, and day on which the inventory was completed or updated.
- **Study or Revision (Item 41)**— Leave blank if no FEMA-contracted Flood Map Project or community-initiated map revision is in progress. Enter one of the codes below if a FEMA-contracted Flood Map Project or community-initiated map revision is in progress.

- **A** —A FEMA-contracted Flood Map Project for which the final reproduction materials have not been sent to the FEMA MSC;
- **B** — A PMR for which the final reproduction materials have not been sent to the MSC; or
- **C** — A LOMR involving this structure has not been issued.

- **Comments (Item 42)**—Include concise comments on items that might be significant in setting priorities for the reevaluation of levees, floodwalls, or other embankments, including:
  - Additional information pertaining to Items 13, 15, 18 through 21, 23, 41, or others;
  - Structure number for this structure in an adjacent State, should the structure cross State lines;
  - Structure number for another structure operating in conjunction with the inventoried structure (in the event of a two-levee system); or
  - U.S. Army Corps of Engineers (USACE) District if the USACE is indicated for Items 22, 24, or 26 through 31.
- **Decertification (Item 43)**—Enter **A** if the structure is included in the CSIS as a credited structure and is no longer considered a credited structure based on a more recent evaluation.

[February 2002]

3.2.7.4 Periodic Reports

As directed by the PO or his/her designee, the assigned Mapping Partner shall produce or provide information on the SOS and LOMC modules to provide periodic status and production reports. These reports may include:

- **Monthly Objective Status Report**—This report provides projected and actual totals for Preliminary FIS reports and FIRMs; Part 65, 67, and 70 appeal resolutions; effective FIS reports and FIRMs; and LOMAs, LOMR-Fs, and LOMRs issued.
- **Monthly Production Report**—This report provides a summary of work receipts, completions, and work to be completed.
- **Part 67 Appeals and Protest Status Report**—This status report provides the dates of receipt and acknowledgment and the status of the evaluation and resolution of each active Part 67 appeal or protest.

- **LOMA Statistics Report**—This status report provides the numbers of single-lot and multiple-lot and subdivision LOMA requests received and the numbers of lots processed (by type of resolution).

- **Contract Status Report**—This monthly report lists the work assignments and available funding under each contract task.

[February 2002]

3.2.7.5 Ad Hoc Reports

The assigned Mapping Partner shall prepare ad hoc reports for FEMA HQ and RO staff at the direction of the PO or his/her designee.

[February 2002]

3.2.8 Compendium of Flood Map Changes

In accordance with Paragraph 1360(I) of the National Flood Insurance Reform Act of 1994, a Compendium of Flood Map Changes is published twice each year to inform interested parties of changes made by FEMA to NFIP maps. Two listings are provided in the Compendium to show communities affected by map changes made by letter—i.e., LOMCs—and communities affected by physical map changes. All LOMCs issued by FEMA and all new or revised NFIP map panels published by FEMA during the prior 6-month period are included in these listings. The two 6-month periods extend from January 1 to June 30 and from July 1 to December 31 each year.

The assigned Mapping Partner shall prepare a digital listing of LOMC and FIRM panels produced within specific FEMA Regions during the 6-month period. At the request of the FEMA coordinator for the Compendium of Flood Map Changes and with the approval of the PO, one Mapping Partner will provide technical, programmatic, and administrative support for the production and publication of the Compendium twice each year. Such support will include delivery of the Compendium in a final, print-ready form.

[February 2002]

3.2.9 Support for Monitoring Information on Contracted Studies System

Although the FEMA CIS provides some of the required information, the CIS is community-specific and does not contain all the project management or accounting tools to effectively automate the contracted study process. The MICS system is designed to complement the CIS by tracking FEMA-contracted Flood Map Projects, including projects initiated under the CTP initiative, from initiation to completion.

The MICS system is a Flood Map Project-specific system designed for use by FEMA and assigned Mapping Partners. Specifically, the MICS system is designed to:

- Include information on FEMA Mapping Partner selection and contracts and agreements for Flood Map Projects;
- Track budgets and percent completions for Flood Map Projects;
- Record details of monthly contractor contacts and regulatory visits with communities;
- Include information on Special Problem Reports; and
- Provide information about assigned Mapping Partners and contractors.

The MICS system is a user-friendly, Windows-based application. It is composed of three tiers of software that reside on two servers located at FEMA HQ. The Java-based user interface provides user-friendly screens to access and navigate the system. At the request of the FEMA PO or his/her designee, the assigned Mapping Partner shall provide technical, programmatic, and administrative/logistical support on activities relating to the MICS system including, but not limited to, the following:

- Maintaining and administering the MICS system;
- Planning, designing, programming, installing, and testing enhancements in the functionality of the MICS system;
- Entering data into selected fields;
- Participating in coordination meetings with FEMA and other Mapping Partners;
- Preparing status reports of activities relating to the MICS system;
- Generating statistical reports and charts summarizing data collected in the MICS system;
- Developing outreach materials for targeted audiences (e.g. conference attendees);
- Developing guidance documents for MICS users; and
- Assist with orientation and training of FEMA staff and other Mapping Partners.

[February 2002]

3.2.10 Fee-Charge System Administration Support

FEMA has established fee collection procedures for the processing of conditional and final map revisions and amendments and for requests for technical and administrative support data related to the processing of studies, restudies, and map revisions. To maintain an accurate accounting of

the checks, money orders, and credit card charges that are received, FEMA has established a centralized fee-collection system, administered by the FCSA.

The procedures for tracking, reporting, and handling the fees collected for reviewing and processing conditional and final map revisions and amendments and for responding to external data requests are presented in Subsection 3.17 of these Guidelines.

[February 2002]

3.3 Library and Archive Support

3.3.1 Technical and Administrative Support Data Storage and Retrieval

For studies, restudies, and map revisions, Mapping Partners are required to organize technical and administrative data in a Technical Support Data Notebook (TSDN) prior to submittal to FEMA and the assigned Mapping Partner for processing. The TSDN will contain all technical support data developed or used by the Mapping Partner during the study/restudy process, and will be prepared according to the format detailed in Appendix M of these Guidelines.

[February 2002]

3.3.1.1 Files

The assigned Mapping Partner shall:

- Establish and maintain files for all map, report, and letter products processed by the assigned Mapping Partner. These files shall contain all artwork, reproduction materials, correspondence, technical analyses, work maps, digital files, printouts, and other materials relating to the map, report, and letter products. In addition, for FEMA-contracted Flood Map Projects, the assigned Mapping Partner shall maintain the TSDN submitted and an inventory that lists the contents of the file for each community.

- Establish and maintain Flood Elevation Determination Docket files for all for FEMA-contracted Flood Map Projects and community-initiated map revisions in accordance with the provisions of Sections 66.3 and 67.3 of the NFIP regulations.

- Establish and maintain individual files for the storage of microfilmed or digitally stored technical and administrative support data, scanned data on CD-ROMs, oversized materials, and non-microfilmable or scannable support data.

[February 2002]

3.3.1.2 Storage

The assigned Mapping Partner shall establish and maintain a storage facility that provides reasonable protection for filed materials and establish and maintain an indexing system to permit rapid retrieval of filed materials. The assigned Mapping Partner shall dispose of Program materials in accordance with written instructions provided by the PO or his/her designee.

[February 2002]

3.3.1.3 Distribution Requirements

The assigned Mapping Partner shall transmit copies of original materials and supply descriptive materials and Program information, such as NFIP brochures, other publications, or regulations, to a requester at the direction of the PO or his/her designee.

For each FEMA-contracted Flood Map Project or community-initiated map revision, the assigned Mapping Partner shall maintain files of all materials submitted by the Mapping Partner that performs the flood hazard analyses and all materials developed by the assigned Mapping Partner during processing. The Mapping Partner that performs the flood hazard analyses will usually submit the following (in some combination of digital and hardcopy formats):

- Draft FIS report, including figures and profiles;
- Topographic work maps;
- Computer printouts (from hydraulic models, hydrologic models, or both);
- Base map materials;
- Copies of pertinent memorandums, correspondence, and reports; and
- Hydrologic and hydraulic computations and documentation sheets.

Materials developed by the Mapping Partner that processes FEMA-contracted Flood Map Projects usually include:

- Final copies of FIS reports and FIRMs;
- Copies of pertinent telephone conversation records;
- Copies of pertinent memorandums and correspondence;
- Corrected/revised hydrologic and hydraulic computations; and
- Corrected/revised work maps.

The Mapping Partner that performs the flood hazard analyses will prepare materials in the TSDN format. The Mapping Partner that processes the FEMA-contracted Flood Map Project and archives data shall maintain these documents and submit them to the ESDPF in the TSDN format. The requirements for the TSDN are provided in Appendix M of these Guidelines.

[February 2002]

3.3.1.4 Engineering Study Data Packages

To reduce storage requirements and to facilitate responses to requests for the administrative and technical support data developed during Flood Map Project processing, FEMA has chosen to prepare and maintain a standardized archive package of the data. The assigned Mapping

Partner's responsibilities for submitting materials to the ESDPF for permanent storage in digital form are provided below.

The assigned Mapping Partner shall categorize the data developed by other Mapping Partners as either essential or nonessential prior to submitting the data to the ESDPF. For a description and examples of essential and nonessential data, refer to Appendix M of these Guidelines. The assigned Mapping Partner shall discard nonessential data after the FIRM effective date.

When materials arrive at the ESDPF for archiving, they are logged in and reviewed. Materials categorized as essential data are indexed, scanned, and stored in digital form. Mapping materials deemed too large for scanning are permanently retained by the assigned Mapping Partner in individual files to facilitate retrieval for future reference and reproduction purposes.

After scanning and digital archiving is complete, the ESDPF staff shall provide the assigned Mapping Partner with the support data in digital form. When appropriate, the ESDPF staff shall return any supplementary hardcopy originals of essential data that could not be scanned because of the poor quality of the original material or size limitations. The assigned Mapping Partner may retain historic materials, especially work maps prepared by the Mapping Partner that performed the flood hazard analyses for the Flood Map Project, for reference purposes.

The ESDPF shall dispose of hardcopy originals of scanned material in accordance with guidance provided in FEMA Manual 5400.4, *Records Management, Records Disposition Schedules and Files Plan.* The ESDPF staff also shall duplicate and distribute the digital data to FEMA ROs and State agencies. Because of copyright restrictions, data provided by the ESDPF cannot be duplicated for distribution purposes.

[February 2002]

3.3.2 Internal Data Request Processing

The library/archival staff at the assigned Mapping Partner staff shall respond directly to requests from FEMA and other Mapping Partner staff for information stored and archived in the storage facility.

[February 2002]

3.3.3 External Data Request Processing

Data requests that are not received under the FOIA shall be processed through the FEMA fee-charge system. The assigned Mapping Partner shall respond directly to data requests and provide data (in electronic, microfilm, paper form, or some combination thereof) to the requester. Based on criteria established by FEMA, the assigned Mapping Partner will determine whether a fee is to be assessed to the requester to recover costs incurred during retrieval and reproduction of the data.

If a fee is charged, the assigned Mapping Partner shall determine the fee amount using the established rate table in effect at the time. All such fees shall be documented by the assigned

Mapping Partner and reported to the FCSA. The assigned Mapping Partner shall ensure that requesters of data submit the required user fees with requests for technical and administrative support data. The responsibilities for administration of the FEMA fee-charge system for external data requests are summarized in Subsection 3.17 of these Guidelines.

[February 2002]

3.3.4 Engineering Study Data Package Preparation and Delivery

For the ESDPF staff to handle archived materials efficiently, the assigned Mapping Partner shall, upon completion of a FEMA-contracted Flood Map Project, organize materials generated by their staff by labeling them accurately and discarding extraneous materials such as in-house checklists and duplicate copies of reports, correspondence, or maps. The assigned Mapping Partner shall ensure that LOMCs and project materials are stored separately such that the support data for each individual case or map action are clearly identifiable. The assigned Mapping Partner shall prepare an index of the material chosen for storage in the data package.

After the effective date of the revised FIRM reflecting the results of the FEMA-contracted Flood Map Project or map revision, the assigned Mapping Partner shall submit all pertinent data to the ESDPF for digital archiving. The assigned Mapping Partner shall ensure that the submittal is complete and includes all necessary data to duplicate the study.

The assigned Mapping Partner shall ensure that the final input and output files of the hydrologic and hydraulic models are provided and the models agree with the information included in the FIS report and FIRM. The assigned Mapping Partner also shall provide a copy of the FIS report for use in verifying the accuracy of the submittal and for inclusion with the digitally archived materials. The assigned Mapping Partner also shall submit a copy of all LOMCs that have been incorporated into the subject FIRM along with the associated backup data.

Generally, the assigned Mapping Partner will submit pertinent data for several Flood Map Projects or map revisions at one time. The assigned Mapping Partner shall include a list of the Flood Map Projects and map revisions forwarded for archiving with the submittal to the ESDPF. The list is to identify the community CID, project or revision type, and effective date. The assigned Mapping Partner shall ensure materials are well organized and clearly labeled.

[February 2002]

3.4 Procedure, Guidance, and Policy Development and Implementation Assistance

3.4.1 Preparation of Guidelines and Specifications

The assigned Mapping Partner shall, at the direction of the PO or his/her designee, assist in the preparation of new or revised guidelines and specifications for:

- Performing flood hazard studies and restudies;
- Submitting conditional and final map revision and map amendment requests;
- Reviewing and processing studies, restudies, conditional and final map revision requests, and conditional and final map amendment requests;
- Preparing new or revised FIS reports, flood maps, and associated correspondence; and
- Other NFIP activities where Mapping Partners have expertise.

This assistance may include technical advice and evaluation, writing, administrative support, and maintenance of these Guidelines on the FEMA Flood Hazard Mapping website.

[February 2002]

3.4.2 Preparation of Procedures Manuals

The assigned Mapping Partner shall, at the direction of the PO or his/her designee, assist in the continuing development and revision of procedures manuals for the following:

- Performing flood hazard analyses and updates;
- Submitting conditional and final map revision and map amendment requests;
- Reviewing and processing Flood Map Projects, conditional and final map revision requests, and conditional and final map amendment requests;
- Preparing new or revised FIS reports, FIRMs/DFIRMs, FBFMs, and associated correspondence; and
- Other NFIP activities where Mapping Partners have expertise.

This assistance may include technical advice and evaluation, writing, and administrative support.

[February 2002]

3.4.3 Development of Improved Standards, Procedures, and Methodologies

The assigned Mapping Partner shall, at the direction of the PO or his/her designee, assist in the development of improved standards, procedures, and methodologies for performing hydrologic and hydraulic engineering analyses for FIS reports, flood maps, and associated products and correspondence, and for processing studies, restudies, conditional and final map revision requests, and conditional and final map amendment requests.

[February 2002]

3.4.4 Development of Improved Report and Map Products

The assigned Mapping Partner shall, at the direction of the PO or his/her designee, assist in the review and development of improved formats for FIS reports, flood maps, and related products.

[February 2002]

3.4.5 Preparation of Briefings and Other Guidance Documents

The assigned Mapping Partner shall, at the direction of the PO or his/her designee, prepare briefings and other guidance documents and deliver the documents to FEMA RO and HQ staff, other FEMA contractors, and other Mapping Partners as directed.

[February 2002]

3.4.6 Preparation of Documentation for Historical and Future Trends

The assigned Mapping Partner shall, at the request of the PO or his/her designee, prepare documents that will aid in determining historical trends and in estimating future trends to provide input for the development of FEMA policy, products, and procedures.

[February 2002]

3.5 Technical Assistance

3.5.1 Meetings with FEMA and FEMA Constituents

At the request of the PO or his/her designee, the assigned Mapping Partner shall:

- Conduct onsite technical or programmatic meetings with FEMA personnel at the Mapping Partner's office;

- Attend technical or programmatic meetings with FEMA personnel, including technical conferences attended by major NFIP constituents (e.g., Association of State Floodplain Managers, American Society of Civil Engineers); and

- Participate in technical or programmatic meetings with FEMA personnel and constituents on specific issues, flood hazard studies, or conditional and final map revision and amendment requests.

[February 2002]

3.5.2 Review of Methodologies Submitted by Technical Experts

Occasionally, hydrologic and hydraulic data and related mapping that are to serve as the basis for the preparation of revised FIS reports and flood maps are determined not to meet the FEMA guidelines and specifications documented in these Guidelines. To assist FEMA in determining whether such data may be used, the assigned Mapping Partner shall, at the direction of the PO or his/her designee, review the data to determine whether the methodologies on which they are based follow sound engineering practices.

If the data are the result of analyses performed with an alternative computer model, the model must meet the requirements set forth at Section 65.6 of the NFIP regulations. Furthermore, the PO or his/her designee must approve the use of such a model.

[February 2002]

3.6 Map Assistance Center Support

One assigned Mapping Partner shall, using Government-owned telephone equipment, provide the primary staffing for a Map Assistance Center to provide toll-free telephone service to the public nationwide. The purpose of the Map Assistance Center is to enable FEMA to be more responsive to all Mapping Partners and NFIP constituents while reducing the burden on FEMA HQ and RO staff resources.

Through the Map Assistance Center, the assigned Mapping Partner shall provide qualified map specialists that will:

- Answer general questions about NFIP maps and related regulations and procedures;
- Answer specific questions about the status of active and completed studies, restudies, conditional and final map revision requests, and conditional and final map amendment requests;
- Answer questions about technical and administrative support data available from the FEMA archives;
- Link callers with other FEMA service and fax numbers and the FEMA website;
- Provide information regarding, or copies of, FEMA products, brochures, and publications; and
- Provide statistical information to FEMA HQ and RO staff, on a monthly and/or quarterly basis, on the nature and geographic origin of questions.

Map specialists in the Map Assistance Center shall receive an inquiry; access FEMA's website, fax lines, other general phone numbers, the Management Information System maintained by the assigned Mapping Partner, and reference materials for relevant information; and provide the caller with the appropriate information. The map specialists shall provide the information in one of the following forms:

- Verbal response;
- Hard copy(ies) to be sent by U.S. mail or express mail service;
- Facsimile transmission; or
- Link to FEMA website location from which information can be obtained.

The map specialists also shall have the ability to transfer calls to the Mapping Partner that is assigned to review and process a particular FEMA-contracted Flood Map Project, community-initiated map revision, or other map change action, other NFIP specialists, or to the appropriate FEMA HQ or RO contact when necessary.

The map specialists shall maintain an interactive database to record information on each incoming call. The map specialists shall capture key information on each caller including, but not limited to, call origin, type of caller (e.g. property owner, lender, community official), and type of information requested.

Other assigned Mapping Partners shall support the primary Map Assistance Center by staffing satellite operations to address specific questions that may not be answered by the primary Map Assistance Center staff.

[February 2002]

3.7 Flood Hazard Mapping Website Maintenance and Enhancement Support

3.7.1 Overview

It is important to be able to disseminate information on the Flood Hazard Mapping Program in a timely manner to the general public and the various groups interested in FEMA's Flood Hazard Mapping activities (homeowners, insurers and lenders, engineers and surveyors, and floodplain managers). The World Wide Web has come to the forefront as an excellent tool to employ in this effort. Assigned Mapping Partners shall assist FEMA in developing new ideas and tools for this effort.

The assigned Mapping Partner shall, at the request of FEMA HQ or RO staff and with the concurrence of the PO or his/her designee, provide technical and programmatic assistance to support the creation and maintenance of pages on the Flood Hazard Mapping website, other FEMA websites linked to the Flood Hazard Mapping website, and other web-based applications, such as databases.

[February 2002]

3.7.2 Website Support

The assigned Mapping Partner shall provide support primarily for the following websites:

- The Flood Hazard Mapping website that is available to the public at www.fema.gov/mit/tsd;
- The mirror of the Flood Hazard Mapping website that is available primarily to FEMA HQ, FEMA RO, and assigned Mapping Partner staff through www.floodmaps.net/mit/tsd; and
- Password-protected portions of the FEMA floodmaps.net site (www.floodmaps.net).

The assigned Mapping Partner shall be responsible for updating and maintaining content for the user groups and/or sections of the Flood Hazard Mapping website assigned by the FEMA Webmaster. In completing website development, update, and maintenance activities, the Mapping Partner shall comply with the general requirements summarized below

- Page banner, background, format, and color must conform to current FEMA format for front pages. The available templates, cascading style sheets, and JavaScript files must be used to ensure site consistency. If the need for a new template arises, then other Mapping Partners must be consulted.

- Links to other pages within the FEMA websites must always employ relative referencing. (The Mapping Partner must never use the full URL except when referencing the FEMA Flood Map Store and the FEMA MSC website).

- Links to pages outside of the FEMA websites must use the "Good-bye" Script to let users know they are leaving the FEMA web pages. This script is implemented during the deliverable preparation phase. Links to the sites below are excluded from this requirement.

  - ESRI site, located at the following address: http://www.esri.com/hazards/)

  - MSC Online Flood Map Store, located at the following address: http://web1.msc.fema.gov/webapp/commerce/command/ExecMacro/MSC/macros/welcome.d2w/report

  - MSC website, located at the following address: http://msc.fema.gov/MSC/

  - Files associated with the DFIRM Database initiative, hosted at the following address: http://206.239.151.22/

- Text equivalent request and retrieval pages, located at the following address: www.floodmaps.net/text

- The web page design must be compatible with Netscape and Internet Explorer, versions 4.0 and later. Formatting must be virtually identical for all browsers.

- New content must be designed with accessibility in mind, and must comply with the requirements of Section 508 of the Rehabilitation Act, "Final Standards for Electronic and Information Technology," as they apply to websites.

- All pages must be checked for adherence to FEMA accessibility requirements and other Federal accessibility requirements, as well as the appropriate version of HTML, every time a change is made.

- New web pages and updates to existing pages on the mirror site must be recorded in the Flood Hazard Mapping Website Tracking Log (http://www.floodmaps.net/fhmtracker) to notify the FEMA Webmaster and other Mapping Partners of the updated or new information.

- New web pages and updates to existing pages must be reviewed and approved by the FEMA Webmaster before they are posted to the FEMA web server.

- Only those files that are ready for final review by the FEMA Webmaster are to be posted on the mirror site. The assigned Mapping Partner shall post files under development to the "Practice" folder on www.floodmaps.net.

- File names must be eight characters or less (excluding file extension).

- File extensions must be three characters, unless otherwise approved by the FEMA Webmaster, to ensure consistent and comprehensive file backups.

- CD-ROM or e-mail deliverables submitted for upload to the FEMA server must receive a thorough quality control review and require no further editing. Only the files that are to be posted shall be included.

- All files that are developed in the "Practice" directory must be kept there until they are ready to be moved to the final location on the Flood Hazard Mapping website.

- The assigned Mapping Partner must perform a quality control review on all new and updated files to ensure that all site protocols have been met. This process facilitates a smooth file deliverable process. Presence of incomplete files may cause confusion and errors in the deliverable process.

- Only one directory (/mit/tsd/) is to be used for all HTML files and supporting documentation (i.e., documents with .pdf, .zip, .doc, .swf extensions). The majority of site graphics are to be placed in the "TSDimage" subdirectory (/mit/tsd/TSDimage). Graphics related to the CTP portion of the site are to be placed in the "CTPimage" subdirectory (/mit/tsd/CTPimage).

- Standard two- or three-letter prefixes (uppercase) must be used to identify files by FHM website section; for example, "MM_main" is used to identify the Map Modernization main page within the Map Modernization section. The most recent listing of file prefixes may be viewed at http://www.floodmaps.net/fhmtracker/protocols/fhmproto.htm.

- Existing logos must be used for each user constituent group (homeowners, insurers and lenders, engineers and surveyors, and floodplain managers).

- Files names must **NEVER** be deleted. Even if a file changes substantially, the same file name is to be used to support users who have book-marked or linked to the page.

- Documents on the website must be made available in pdf and/or .doc file format.

- Software on the website must be made available in a zip file.

- File sizes must be included for all downloadable files. File sizes for all files over 1 MB are to be carried out to two decimal places (e.g., 1.06 MB; not 1.1 MB).

- When possible, WinZip files must be limited to sizes no greater than 1.44 MB to facilitate the download of data from the site on floppy disks. Exceptions to this rule must be approved by the FEMA Webmaster.

- All new or modified pdf files must be saved with standard security settings in Adobe Acrobat 5 so that a (standard) password must be specified to 'Change Security Options'. The appropriate download pages for these files must include a note alerting users to download the free Acrobat 5 Reader.

- All new or modified pdf files must be made accessible with the Adobe Acrobat 5 "Make Accessible" plug-in when conversion does not cause undue burden. Whenever possible, pdf files are to be created from the source file and not from scanned documents. If a pdf file cannot be made accessible, a "Request a Text Equivalent" link must be added to the calling HTML page so that a user can request and receive an accessible equivalent of the file within 10 business days. Text equivalent files must be made available via www.floodmaps.net/text/.

- All pdf files created for documents that have a Table of Contents are to include bookmarks to allow for navigation of the documents via the Table of Contents entries. These pdf files are to be saved in the "Bookmark view" (with the Table of Contents on the sidebar).

- For large graphics, a thumbnail and file size notification is to be created to help users determine if they want to launch the graphic.

For changes to these requirements and for step-by-step instructions for implementing these requirements, the assigned Mapping Partner shall go to the following link on the FEMA floodmaps.net website: http://www.floodmaps.net/fhmtracker/protocols/default.htm.

[February 2002]

3.7.3 Other Support Activities

The assigned Mapping Partners shall, at the request of FEMA HQ or RO staff and with the concurrence of the PO or his/her designee, provide the following assistance:

- Attend Flood Hazard Mapping website meetings as scheduled by the FEMA Webmaster for updates on website activities and special web projects;
- Assist in developing various special projects, including developing online tutorials and other materials and/or applications on different aspects of the Flood Hazard Mapping Program and its various initiatives (e.g., CTP initiative);
- Investigate new technologies for web-based solutions that may assist FEMA in the management and administration of the Flood Hazard Mapping Program; and
- Advise the FEMA Webmaster and other FEMA staff on technical, legal, and regulatory issues that may have a bearing on the FEMA Flood Hazard Mapping websites.

[February 2002]

3.8 Support for Mapping Needs Assessment Process

3.8.1 Background

With the enactment of Section 575 of the National Flood Insurance Reform Act of 1994, the U.S. Congress required that FEMA

> ...once during each 5-year period...assess the need to revise and update all floodplain areas and flood risk zones identified, delineated, or established [by FEMA] based on an analysis of all natural hazards affecting flood risks.

To meet this requirement, FEMA formed a Task Force to develop a plan for the required mapping needs assessment. The Task Force developed and implemented the Five-Year Mapping Needs Assessment Process. Following the development and implementation of this process, the Task Force:

- Performed an initial screening of mapping needs nationwide by contacting State NFIP Coordinators and mapped participating communities for information;
- Verified the validity of the identified needs; and
- Compiled information on those needs into a computerized database, known as MNUSS.

The Task Force documented the results of the first 5-year assessment in a 1999 report to the U.S. Congress.

During the second 5-year mapping needs assessment, mapping needs will be identified through a variety of approaches, including data collected through the NFIP Biennial Report process and followup with individual communities that submitted Biennial Reports to FEMA.

[February 2002]

3.8.2 Mapping Needs Update Support System Enhancement and Maintenance

To accommodate multiple sources of information during the information-gathering phase, the Task Force revised the existing MNUSS software to migrate it to an online, web-enabled format. At the same time, the Task Force re-evaluated the underlying logic for computing the costs associated with the identified needs and the benefits of addressing those needs in an effort to automate and improve on the existing cost-benefit analysis approach. The new, password-protected Extranet version of MNUSS was then assigned a URL of MNUSS.com, and was tested by FEMA HQ, FEMA RO, and Mapping Partner staff.

The Extranet version of MNUSS, as currently configured, allows multiple stakeholders to enter information on mapping needs from multiple locations. Thus, the information-gathering process may be dynamic and ongoing, rather than the more traditional linear process that involves sending hardcopy letters to communities and receiving hardcopy written responses. The password security on the Extranet version of MNUSS ensures that FEMA staff make final decisions regarding the validity of a particular mapping need or group of needs for a community in coordination with the State NFIP Coordinators and local officials, and the relative rankings of communities' mapping needs.

At the request of the FEMA PO or his/her designee, the assigned Mapping Partner shall, at minimum, do the following:

- Evaluate data provided by communities and other Mapping Partners;
- Perform QA/QC reviews of the submitted data;
- Enter records for new mapping needs into MNUSS as they are identified;
- Revise records for existing mapping needs as new information is received;
- Administer passwords and user rights for MNUSS;
- Analyze data collected in MNUSS;
- Generate reports summarizing data collected in MNUSS;
- Continue to plan, design, program, install, and test enhancements in the functionality of MNUSS; and
- Incorporate MNAP/MNUSS into study process to identify mapping needs and ensure that they are incorporated onto newly published FIRMs.

[February 2002]

3.8.3 Other Support Activities

At the request of the FEMA PO or his/her designee, the assigned Mapping Partner shall provide technical, programmatic, and administrative/logistical support on other activities related to the MNAP. This support shall include, but not be limited to, the following:

- Participating in coordination meetings with FEMA and other Mapping Partners;
- Preparing status reports and action item registers;
- Maintaining a hardcopy repository of supporting data submitted by communities, regional agencies, States, and other Mapping Partners that have identified mapping needs;

- Developing an enhanced User Guide for MNUSS and other guidance documents for Mapping Partners involved in the MNAP;
- Developing outreach materials for targeted audiences (e.g., U.S. Congress, attendees at conferences);
- Enhancing content of MNAP material on FEMA website;
- Assisting with orientation and training of FEMA RO and HQ staff and other Mapping Partners that enter needs into MNUSS; and
- Performing followup activities with communities that reported mapping needs as part of the Biennial Report process.

[February 2002]

3.9 Special Correspondence

The assigned Mapping Partner shall, at the request of the PO or his/her designee, provide technical and programmatic assistance and prepare responses to inquiries from other Mapping Partners and NFIP constituents. This special correspondence is separated into the following categories:

- Congressional Responses;
- Director Responses;
- Mapping Responses;
- E-Mail Responses;
- FOIA Responses; and
- Other Responses.

The requirements for these response categories are summarized in Subsections 3.9.1 through 3.9.6.

[February 2002]

3.9.1 Congressional Responses

A Congressional Response is defined as a written response to an inquiry from a U.S. Representative, U.S. Senator, or to a constituent who has contacted the President or Vice President concerning an NFIP-related topic. Such topics shall include, but are not limited to, the following:

- Impact of the NFIP on a community or on a constituent's property;
- Data required to support a flood map change; and
- Process followed or determination made in response to a completed Flood Map Project, conditional or final map revision request, or conditional or final map amendment request.

[February 2002]

3.9.1.1 Work To Be Performed

When requested by the PO or his/her designee, the assigned Mapping Partner shall investigate the specific concerns expressed in the constituent's letter and prepare a response that answers the inquiry. The response shall be designed to educate both the inquirer (e.g., U.S. Senator) and the constituent on the intent of the NFIP. The assigned Mapping Partner shall not contact or respond to the constituent directly, unless requested to do so by the PO or his/her designee. The assigned Mapping Partner shall consider all Congressional Responses as top-priority assignments, and they shall be handled as expeditiously as possible (generally within 1 week of receipt, but as assigned by the PO or his/her designee).

After investigating the specific concerns, the assigned Mapping Partner shall prepare a final letter and submit it to the PO or his/her designee or other requester at FEMA HQ. At the direction of the PO or his/her designee, Congressional Responses may be delivered to FEMA HQ in either hardcopy form via courier or electronically via diskette or e-mail message.

When appropriate, the assigned Mapping Partner shall coordinate the response with the following before delivering the response to PO, his/her designee, or other FEMA HQ staff.

- FEMA Regional Engineers;
- Other FEMA RO staff; and
- Other FEMA HQ staff .

[February 2002]

3.9.1.2 Response Preparation Guidelines

The guidelines and suggestions that follow are to be considered by the assigned Mapping Partner when preparing a Congressional Response for signature by the Administrator of the Federal Insurance and Mitigation Administration.

- The opening paragraph is to state to the following:
  - To whom the Congressional inquiry was addressed at FEMA;
  - Date of the inquiry;
  - Name of constituent on whose behalf inquiry is being made.
  - Date of constituent's letter, if applicable; and
  - Brief summary of specific concerns raised by U.S. Representative or U.S. Senator and constituent, as appropriate.

- The second paragraph of the letter is to address the specific concerns directly and concisely.

- Subsequent paragraphs are to brief the inquirer on general topics involving the NFIP as they relate to the concerns of the constituent. In general, the assigned Mapping Partner is to assume that the inquirer and constituent have limited knowledge about the NFIP; therefore, the use of NFIP-specific terminology and acronyms is to be minimized.

- The closing the letter is to direct further questions to the FEMA Congressional and Intergovernmental Affairs Division and provide the direct line telephone number for that Division.

- Unless requested otherwise by the inquirer, the response is to be addressed to the inquirer's Washington, DC, office. However, if the inquirer requests that the response be addressed to the inquirer's home district office, a signed copy also is to be sent to the inquirer's Washington, DC, office. This distribution is to be clear in the letter.

- The appropriate FEMA RO is to be included in the cc: list at the end of the letter.

For additional information on preparing Congressional Responses, the assigned Mapping Partner shall refer to the FEMA *Congressional Correspondence Handbook* (FEMA, 1993); FEMA Manual 5200.1, *Correspondence Management*; and Procedure Memorandums issued by the FEMA Hazard Mapping Division, which are posted on the FEMA Flood Hazard Mapping website.

3.9.1.3 Case File and Correspondence Preparation Requirements

When requested to do so, the assigned Mapping Partner shall prepare the final letter for review and concurrence. The specific actions to be taken are as follows:

- Place the original incoming request and the paperwork from FEMA on the left-hand side of the case file.

- Place the outgoing response letter in a protective cover on the right-hand side of the file along with relevant backup material, envelopes for mailing (when required), and copies of documents to be transmitted with response (when required).

- Attach FEMA-designated routing and concurrence forms on top of the case file.

3.9.1.4 Deliverable Products

At the direction of the FEMA PO or his/her designee, the assigned Mapping Partner shall deliver an original hardcopy version of a draft and/or final response and/or a digital version of a draft and/or final response..

[February 2002]

3.9.2 Director Responses

The assigned Mapping Partner, at the direction of the PO or his/her designee, shall prepare informational responses to written inquiries sent directly to the FEMA Director by someone other than a U.S. Senator or U.S. Representative. These inquiries may be from Federal, State, and local agencies; State legislatures; developers; private property owners; and other FEMA constituents.

[February 2002]

3.9.2.1 Work To Be Performed

The assigned Mapping Partner shall follow the same general procedures as those followed for Congressional Responses, as documented in Subsection 3.9.1.1.

[February 2002]

3.9.2.2 Response Preparation Guidelines

The assigned Mapping Partner shall follow the same general procedures as those followed for Congressional Responses, as documented in Subsection 3.9.1.2.

[February 2002]

3.9.2.3 Case File and Correspondence Preparation Requirements

The assigned Mapping Partner shall follow the same general procedures as those followed for Congressional Responses, as documented in Subsection 3.9.1.3.

[February 2002]

3.9.2.4 Deliverable Products

The assigned Mapping Partner shall be prepared to deliver some or all of the following materials to FEMA:

- Original hard copy version of draft and/or final response as required by FEMA;
- Digital version of draft and/or final response as required by FEMA; and
- Case file that will include the draft and/or final version of the letter, FEMA routing and concurrence forms, incoming correspondence, relevant backup material, envelopes for mailing (when required), and copies of documents to be transmitted with response (when required).

[February 2002]

3.9.2.5 Completion

When requested to do so, the assigned Mapping Partner shall mail signed and dated copies of the final letter to the requester and distribute copies of the letter as directed by the FEMA PO or his/her designee. The Mapping Partner shall store the case file with other technical and administrative support data for the community that is the subject of the inquiry.

[February 2002]

3.9.3 Mapping Responses

The assigned Mapping Partner, at the direction of the PO or his/her designee, shall prepare informational responses to inquiries from communities and other FEMA Mapping Partners.

[February 2002]

3.9.3.1 Work To Be Performed

The assigned Mapping Partner shall investigate the specific concerns expressed in the incoming letter and prepare a response that answers the inquiry. These responses shall generally be provided by letter; however, under certain circumstances and at the direction of the FEMA PO or his/her designee, the Mapping Partner may handle responses by telephone conversation or facsimile transmission.

For responses handled by telephone conversation or facsimile transmission, the assigned Mapping Partner shall provide a written summary of the telephone conversation or a copy of the facsimile transmission to the FEMA PO or his/her designee.

The responses may provide information on the source(s) of the flood hazard information depicted in effective NFIP maps for particular communities, the NFIP in general, or particular FEMA policies and procedures. Frequently, the responses forward FEMA publications or direct the individuals to the proper place or person for the answers to their concerns.

When appropriate, the assigned Mapping Partner shall coordinate the response with FEMA Lead for a Flood Map Project, other FEMA RO staff, and other FEMA HQ staff before delivering the response to the PO or his/her designee.

The required signature for Mapping Responses will vary depending on the content of the letter and the respondent. The FEMA PO or his/her designee will provide the assigned Mapping Partner with the appropriate guidance.

[February 2002]

3.9.3.2 Deliverable Products

The assigned Mapping Partner shall be prepared to deliver some or all of the following materials to FEMA:

- Original hard copy version of draft and/or final response as required by FEMA;
- Digital version of draft and/or final response as required by FEMA; and
- Case file that will include the draft and/or final version of the letter, FEMA routing and concurrence forms, all incoming correspondence, relevant backup material, and copies of documents to be transmitted with response (when required).

[February 2002]

3.9.3.3 Completion

When requested to do so, the assigned Mapping Partner shall mail signed and dated copies of the final letter to the requester and distribute copies of the letter as directed by the FEMA PO or his/her designee. The Mapping Partner shall store the case file with other technical and administrative support data for the community that is the subject of the inquiry.

[February 2002]

3.9.4 E-Mail Responses

The assigned Mapping Partner shall, at the direction of the PO or his/her designee, prepare informational responses to e-mail inquiries from FEMA Mapping Partners and other NFIP constituents.

[February 2002]

3.9.4.1 Work To Be Performed

The assigned Mapping Partner shall follow the same general procedures as those followed for Mapping Responses, as documented in Subsection 3.9.3. Depending on the nature of the inquiry and the response, the assigned Mapping Partner may respond directly to the originator of the e-mail or provide a draft response for the FEMA PO, his/her designee, and/or other FEMA staff to use in responding to the inquiry.

If the assigned Mapping Partner responds directly to the originator, the Mapping Partner shall include the PO, his/her designee, and/or other FEMA staff as a "cc" on the e-mail.

[February 2002]

3.9.4.2 Deliverable Products

The assigned Mapping Partner shall be prepared to deliver some or all of the following materials to FEMA:

- Draft and/or final e-mail response as required by FEMA;

- Incoming e-mail message;
- Relevant backup material; and
- Electronic copies of documents to be transmitted with e-mail response (when required).

[February 2002]

3.9.5 Freedom of Information Act Responses

3.9.5.1 Introduction

5 U.S.C. § 552, known as the "Freedom of Information Act," was enacted in 1966. The 1966 Act is the legislative basis for allowing public access to Federal Government information. It allows the release of information to the media, academia, and citizens and specifies the time in which the requests must be filled. These requests, when received, must be addressed promptly, as indicated in Section 3.9.5.2, however the requests may be rather infrequent. .

The General Law Division of the FEMA Office of General Counsel (OGC) is responsible for receiving, acknowledging, logging, and responding to FOIA requests. The major differences between standard external data requests and FOIA requests are processing time and the materials each type of request covers. Study and restudy materials are available through FEMA's external data request and fee-charge system. Therefore, the assigned Mapping Partner shall treat FOIA requests for these materials as a standard external data request, subject to the fees and other specifications already in place. The OGC must be advised whenever a FOIA request can more appropriately be processed as a standard external data request.

[February 2002]

3.9.5.2 Processing Time

FOIA requests are highly time-sensitive because, by law, FEMA is required to respond within a given timeframe. Prior to 1996, this timeframe was 10 days. In 1996, President Clinton issued H.R. 3802, which amended 5 U.S.C. 552 and extended the legal response time to 20 days. This acknowledged the difficulty in processing FOIA requests within 10 days. It often takes the request several days to reach the assigned Mapping Partner for response.

[February 2002]

3.9.5.3 Data Gathering Requirements

Upon receipt of a FOIA request, the assigned Mapping Partner may receive special instructions from FEMA. If there is any doubt about the data that the requester needs, the assigned Mapping Partner shall contact the PO, his/her designee, and/or other FEMA staff for clarification. The assigned Mapping Partner shall **not** contact the requester directly unless directed to do so by FEMA. All questions must be relayed through FEMA.

The assigned Mapping Partner shall locate the data as soon as possible. If some or all of the data are on microfiche, the assigned Mapping Partner shall contact FEMA to determine how the data are to be handled; frequently, FEMA will direct the assigned Mapping Partner to make paper copies from the microfiche.

Different types of data may be requested under FOIA procedures. The different types of data and procedures for handling the data are summarized below.

[February 2002]

Draft, Preliminary, and Conditional Data

Draft or preliminary support data may be released to the requester; however, the assigned Mapping Partner shall clearly note on the outgoing correspondence and materials themselves that the data are draft or preliminary and subject to change.

The release of conditional information shall follow the guidelines set forth in the FEMA memorandum dated June 7, 1990. In general, the assigned Mapping Partner shall check with FEMA before releasing any data that do not support an effective FIS.

A special letter must be prepared to the originator of data supporting a request for a CLOMR to allow the originator to identify any confidential or privileged material. This letter puts the FOIA request "on-hold" for 7 working days from the date the letter is sent. The assigned Mapping Partner will also prepare a letter to the FOIA requester explaining that the data originator is being given the opportunity to object to the release of the information and that a formal time will be allowed for the requester's response before the data are released.

Effective Information

The assigned Mapping Partner shall ensure that effective data to be released are the most recent. The Mapping Partner also shall ensure that any requested hydrologic and hydraulic models match the FIRM, FBFM, and FIS report and any mapping submitted with a revision request (if appropriate).

3.9.5.4 General Requirements

The assigned Mapping Partner shall "sanitize" all information to be released (i.e., black out names of people of nonofficial standing). If it is unclear whether data are to be included in the package (especially such things as telephone conversation records, internal processing notes, and the like), the assigned Mapping Partner shall contact the PO or his/her designee for guidance.

For most FOIA requests, FEMA will need a cost estimate to give the requester. The assigned Mapping Partner shall ensure the data can be located before providing a cost estimate.

Occasionally, a request may become highly involved and much more time than expected may be spent on its resolution. Such situations may occur when extensive coordination with FEMA is

required for the release of draft or preliminary data, or if a problem exists in finding the data. Should this occur, the assigned Mapping Partner shall consult with the PO or his/her designee to determine the time to be billed and how to charge any nonbillable time.

The assigned Mapping Partner also shall advise the PO or his/her designee if the circumstances will not permit a response within the time specified in Subsection 3.9.5.2. However, the assigned Mapping Partner shall take all appropriate action to complete the response within the time specified.

[February 2002]

3.9.5.5 Cost Computation Requirements

FOIA requests fall into different billing categories, as noted in the Definitions section of the Record of FOIA Case Processing Costs form, which must be completed as a basis for FEMA's preparation of the FOIA report to the U.S. Congress. FEMA will determine the billing category before the assigned Mapping Partner receives the FOIA request. The process used to calculate labor and reproduction costs is discussed below.

The hourly wage for each person involved is used to calculate labor costs. The assigned Mapping Partner must determine exactly how much time each person charged (and will charge) to the request.

The Mapping Partner shall compute reproduction costs according to actual costs. The process for computing costs is outlined below.

1. The assigned Mapping Partner shall prepare a typed or handwritten worksheet showing the number of hours charged along with reproduction cost calculations.

2. The assigned Mapping Partner shall calculate the weighted hourly labor rate based on the salaries and time charged by the individuals working on the case.

3. The assigned Mapping Partner shall complete the Record of FOIA Case Processing Costs form based on the totals calculated on the worksheet.

4. The assigned Mapping Partner shall prepare a typed Cost Summary to be enclosed with the letter to the requester and include this Cost Summary on diskette with the cover letter.

For many FOIA requests, FEMA gives the requester 2 hours of search time and 100 pages of information at no cost. Also, FOIA requesters will not usually be charged if the total cost is less than $30.00. However, the assigned Mapping Partner shall calculate the costs following Steps 1 through 4 above for all FOIA requests.

To ensure confidentiality of staff salaries, the assigned Mapping Partner shall enclose the worksheet with this information in a sealed envelope marked "Confidential-Salary Information Enclosed." On the other copy of the worksheet, the assigned Mapping Partner shall write the weighted hourly labor rate. The sealed envelope will be part of the file the Mapping Partner submits to FEMA.

The assigned Mapping Partner must ensure that all time charged is included in these cost calculations, including the preparation and mailing of the FOIA response letter. However, if the Mapping Partner believes the requester should not be billed for all of the time charged, especially if data were misplaced or FEMA policy issues had to be resolved, the assigned Mapping Partner shall bring this concern to FEMA's attention with a short note attached to the file. The assigned Mapping Partner must ensure that all cost computations are performed correctly and that the documentation file is completed.

[February 2002]

3.9.5.6 Case File and Correspondence Preparation Requirements

The assigned Mapping Partner shall prepare the case file as follows:

- Place the incoming request (original) and paperwork from FEMA on the left-hand side of the case file.
- Place the outgoing FOIA response letter and all enclosures on the right-hand side of the file.
- Place the concurrence and cc: pages on top of the case file.

The assigned Mapping Partner shall prepare a letter from FEMA to the requester describing the information and requesting payment, if applicable. This letter may also include special verbiage as applicable (e.g., verbiage regarding draft and preliminary data, verbiage regarding FIS processing). Usually, the assigned Mapping Partner will prepare this letter in final form and submit it to FEMA. As mentioned earlier in this subsection, the assigned Mapping Partner shall include the cost summary in the submittal to FEMA.

[February 2002]

3.9.5.7 Deliverable Products

The assigned Mapping Partner shall include the following information in the file sent to FEMA:

- Incoming correspondence and other relevant correspondence generated since the request was received;
- Draft or final letter with the Cost Summary;
- Confidential cost worksheet in a sealed envelope;

- Completed Record of FOIA Case Processing Costs form; and
- All requested materials.

After their review has been completed, FEMA staff may ask the assigned Mapping Partner to send the material and the signed and dated letter to the requester. However, FEMA staff also may choose to mail the materials and letter themselves.

[February 2002]

3.9.5.8 Completion

When requested to do so, the assigned Mapping Partner shall distribute signed and dated copies of the final letter to the requester, with copies being sent to the RO, State NFIP Coordinator, FEMA FOIA Officer, other FEMA HQ staff as directed by the FEMA FOIA Officer, the PO, or their designees. The Mapping Partner shall store the FOIA case file with other technical and administrative support data for the community that is the subject of the FOIA request. The Mapping Partner also shall send a duplicate copy of the original file to the FOIA Officer for any case where redacted materials were sent to the requester. These materials are to be available for the FOIA Officer's use should the requester appeal.

[February 2002]

3.9.6 Other Special Responses

At the direction of the PO or his/her designee, the assigned Mapping Partner shall prepare informational responses to inquiries that are not covered by the categories discussed in Subsections 3.9.1 through 3.9.5. The assigned Mapping Partner shall determine the work to be performed and the deliverable products for the responses at the time of assignment by the originating FEMA staff.

[February 2002]

3.10 Letters of Determination Review

3.10.1 Background

As mandated by the National Flood Insurance Reform Act of 1994, FEMA developed a Standard Flood Hazard Determination Form that is to be used by all regulated lenders and Federal agency lenders that make flood hazard determinations for improved property used to secure loans. When a borrower contests the determination made by the lender and the borrower and lender jointly request a Letter of Determination Review (LODR) from FEMA, they must provide the completed Standard Flood Hazard Determination Form and all technical information FEMA will need to complete its review.

If sufficient information is provided, the written response from FEMA will indicate FEMA's concurrence or disagreement with the lender's determination and whether the subject building is in the Special Flood Hazard Area (SFHA) shown on the effective NFIP map. If sufficient information is not provided, the submitted information will be returned with a written response indicating the additional information to be submitted.

The procedures to be followed by the assigned Mapping Partner in processing requests for LODRs are detailed in Subsections 3.10.2 through 3.10.5. Additional information on the procedures and the letters and other documents to be produced by the Mapping Partner is provided in Section 8 and Appendix E of *Document Control Procedures Manual* (FEMA, 2000).

[February 2002]

3.10.2 Processing Fees

FEMA assesses a review and processing fee for LODR requests. The current fee is $80 per request and applies to all requests, regardless of the determination that is issued. As with other review and processing fees, FEMA will review the LODR fees annually and amend the fees as appropriate.

[February 2002]

3.10.3 Initial Review and Processing Requirements

Within 5 days of receipt of a request, the assigned Mapping Partner shall take the initial review and processing actions summarized below.

- Open, inventory, and date-stamp the submitted information.
- Log the request into the Standard Flood Hazard Tracking and Correspondence System (TCS), which automatically assigns a case number for the request, or similar tracking database.
- Confirm that the borrower/lender notice and postmark date are not more than 45 days apart.
- Confirm that the correct fee was submitted and in a form that can be deposited directly into the National Flood Insurance Fund.
- Confirm that the effective NFIP map was used in making the determination.
- Verify whether the following required items were submitted:
  - Request to FEMA for a review of the lender's determination with the signature of the borrower and lender;
  - Copy of the lender's dated notification to the borrower that the building or manufactured home is in a SFHA;
  - Completed Standard Flood Hazard Determination form;
  - Copies of all map materials used by the lender or the lender's agent to make the flood hazard determination, including Plat of Tax Assessor's map and map showing the location of the building as related to the property; and
  - Copy of FIRM panel covering area in which building is located, annotated to show the location of the building.
- Return the package to the borrower with the appropriate return notice and update the TCS database or similar tracking database if any of the required supporting information is missing, the request is too late (i.e., submitted to FEMA more than 45 days after the date on the Standard Flood Hazard Determination form), or the fee submitted is insufficient or is nonnegotiable (and therefore cannot be deposited). The return package shall include all items submitted by the borrower, including the payment.
- Process the payment, prepare and mail a written acknowledgment of the LODR request, and initiate the case review if all required items have been submitted.

[February 2002]

3.10.4 Final Review and Processing Requirements

Once the assigned Mapping Partner has mailed the written acknowledgment of the LODR request, the Mapping Partner shall:

- Verify the location, NFIP community name, and CID. If a property is in an area that has been annexed to a community, the Mapping Partner shall ensure that the name and CID for the community that has jurisdictional authority for the property is used in the determination.
- Search the CIS databases, LOMC case files, and other community-based files for completed or in-progress LOMA, LOMR-F, and LOMR requests for the area in which the property in question is located and verify the structure location.
- Evaluate the submitted information and make a preliminary determination.
- Prepare a determination letter.
- Update the TCS database or similar tracking database.

If the LODR request is denied and the elevation data submitted indicate the property may be removed by a LOMA or LOMR-F, the assigned Mapping Partner shall include a notification in the response letter to the borrower and lender. The response letter also shall indicate that the Mapping Partner has initiated processing of a LOMA or LOMR-F request. When the LODR is completed, the assigned Mapping Partner shall review the data in accordance with the procedures for LOMR-Fs or LOMAs documented in Volume 2 of these Guidelines.

[February 2002]

3.10.5 Deliverable Products

The assigned Mapping Partner shall perform the required procedures for preparing and distributing standard letters for LODRs as presented in Section 3 and Appendix C of *Document Control Procedures Manual* (FEMA, 2000). This includes mailing letters, with their appropriate enclosures, as specified in the U.S. Postal Service *Domestic Mail Manual.*

[February 2002]

3.11 Engineering Study Data Package Facility Support

3.11.1 Background

The purpose of FEMA's ESDP project is to prepare standardized digital records of the technical and administrative support data generated by FEMA and its Mapping Partners. The data archived for the ESDP project include the materials required to reconstruct a FEMA-contracted Flood Map Project or community-initiated map revision and copies of LOMRs and associated backup data that have been incorporated.

At a later date, FEMA may exercise the option to digitally archive materials submitted in support of LOMR, LOMR-F, and LOMA cases through the ESDP project. If this does occur, FEMA will issue appropriate guidelines and specifications for these materials.

[February 2002]

3.11.2 Archiving Operation

Within 30 days of the effective date for a new or revised FIS report and FIRM the Mapping Partner that processed the FIS report and FIRM for FEMA shall submit all technical and administrative support data/materials related to the study, restudy, or map revision to the ESDPF. The Mapping Partner transmittals shall include all technical and administrative support data submitted by the Mapping Partner that performed the study or restudy, data submitted by revision requesters in support of map revisions, and data generated by the Mapping Partner that processed the FIS report and FIRM for FEMA. These data include, but are not limited to, correspondence, computer diskettes or hardcopy printouts of hydrologic and hydraulic data, field survey notes, and cross-section data.

The Mapping Partner shall pay particular attention to ensuring that the data submitted are complete and include all of the technical and administrative support data needed to recreate the study, restudy, or map revision for each community submitted for archiving. To help the ESDPF staff verify the completeness of the submission, the Mapping Partner shall transmit a copy of the effective FIS report along with the data to help determine the scope of the study. The ESDPF staff shall scan the FIS report text along with the other technical and administrative support data.

The Mapping Partner shall ensure that only the data associated with producing the FIRM for the given FIRM effective date are submitted. The Mapping Partner shall exclude extraneous materials such as CLOMRs, CLOMR-Fs, CLOMAs, drop letters, and denial letters, as well as duplicate copies of materials and correspondence and internal working copies. The Mapping Partner shall submit LOMRs, LOMR-Fs, and LOMAs and associated data that have been incorporated into the effective FIS report and FIRM. The Mapping Partner shall not submit source program versions of standard programs, such as HEC-2, HEC-RAS or WHAFIS.

When the data arrive, the ESDPF staff shall inventory and record the data. The inventory records what data have been submitted for archiving, the format of the material (scanned image or data file), and what has been stored in hardcopy and how to retrieve it.

As the materials are indexed and organized, ESDPF staff shall review each document for acceptability for scanning and verify that the submitted hydrologic and hydraulic models agree with the effective FIS report. The ESDPF staff shall return all diskettes and published FIS reports to the originating Mapping Partner after scanning is completed. The ESDPF staff also shall send original materials digitally archived at the ESDPF to a repository designated by FEMA after the scanning is completed.

After scanning, the ESDPF staff shall supply each originating Mapping Partner with the digital product. The ESDPF also shall send a copy of the digital product to the appropriate FEMA RO and State NFIP Coordinator.

[February 2002]

3.11.3 Data Archiving Requirements

The ESDPF staff shall prepare the data in a format accepted by the National Archives and Records Administration and shall dispose of the records in accordance with FEMA-accepted practices. The ESDPF staff shall maintain a duplicate copy of all digital files produced by the ESDP in a separate facility.

[February 2002]

3.12 Map Service Center Support and Coordination

The MSC is the distribution center for all effective FIS reports, FIRMs, and FBFMs. The Mapping Partners that process new and revised FIS reports, FIRMs, and FBFMs for FEMA shall, with the approval of the FEMA PO or his/her designee, assist the MSC on an as-needed basis to restore, repair, or replace documents.

The MSC may request that the Mapping Partner that maintains the artwork replace or repair missing or damaged materials and produce camera-ready (composite negatives for Z-fold format and positive copies for 11″ × 17″ format) copies of FIRM and/or FBFM panels to the MSC. These composite negatives are compiled from existing mylar separates (artwork). On occasion the artwork is not be available and the negatives may have to be generated from an existing paper map. Less frequently, the MSC also may request camera-ready materials for FIS reports. The Mapping Partners will assist in maintaining a Geographic Information System (GIS)-based geo-index of all effective map panels used by the MSC.

The number of panels or reports requested and the frequency of requests will vary, because the requests are based on the volume of missing materials and the frequency of requests for map panels or reports received by MSC personnel. The general turnaround time for such requests shall be 2 to 4 weeks. With the approval of the MSC staff and the PO or his/her designee, extensions may be granted for unusually large requests.

[February 2002]

3.13 Training Support

The assigned Mapping Partner shall, at the request of the PO or his/her designee, provide logistical and technical support for new and ongoing FEMA training initiatives. This training will generally be in areas where the Mapping Partner is the subject matter expert. The level of support provided by the assigned Mapping Partner will vary depending on the training required and the location of the training.

For most support assignments, the assigned Mapping Partner shall

- Review existing training materials and recommend enhancements to improve the learning experience of the intended audience;
- Prepare new or revised training materials (e.g., PowerPoint presentations, online tutorials) targeted to specific audiences and/or specific training classes;
- Provide individuals with specific technical or programmatic knowledge to actively participate in the presentation of training materials;
- Provide logistical support for the training session; and
- Provide administrative support and support for the production of training materials.

For most training support assignments, the assigned Mapping Partner's logistical support will be to format presentation materials for trainers and prepare notebooks or CD-ROMs for workshop attendees. However, if requested by FEMA, the assigned Mapping Partner also shall handle all logistical arrangements for training sessions, including finding a place to hold the session, sending invitations to potential attendees, arranging transportation, and finalizing food service arrangements. The exact level of effort shall be decided at the beginning of the planning process.

The support from the assigned Mapping Partner may be provided onsite at FEMA HQ; onsite at one of the ROs; onsite at the Emergency Management Institute in Emmitsburg, Maryland; onsite at the Training Center at Mt. Weather in Berryville, Virginia; or onsite at the assigned Mapping Partner's office or the office of another Mapping Partner.

[February 2002]

3.14 Post-Flood Hazard Verification/Recovery Tools

3.14.1 Introduction

It is critical to establish a coordinated effort to collect and disseminate accurate flood data and risk information to aid recovery efforts after a flood disaster occurs. Furthermore, it is important to collect and share these data as soon as possible after the event's occurrence. These data shall assist in the planning, investigation, and, ultimately, in the completion of projects to remove residential and commercial structures and other infrastructure from future flood risk.

Possible applications for these data in response, recovery, and mitigation activities include the following:

- Facilitating safe rebuilding;
- Identifying heavily damaged areas;
- Identifying locations on which to focus response and recovery efforts;
- Identifying areas for which flood insurance claims shall likely be made;
- Estimating damages for residential and commercial structures, lifelines, and other infrastructure;
- Identifying areas in which buildings may be substantially damaged and which, therefore, would be the focus of flood mitigation activities;
- Determining the likelihood of future damages in floodplains;
- Identifying inaccuracies in existing flood hazard data;
- Quantifying the benefits of taking action to mitigate or of not taking any action at all; and
- Identifying mitigation success stories.

[February 2002]

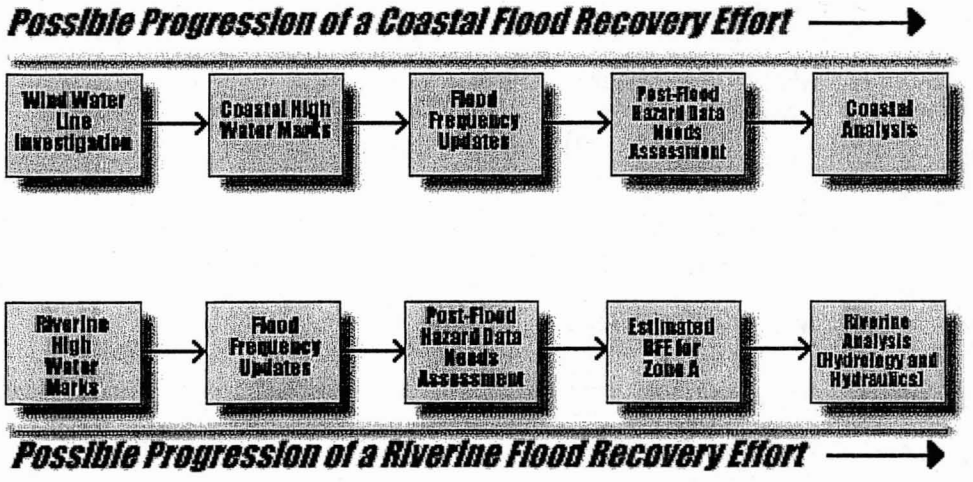
3.14.2 Guidance for Post-Flood Hazard Verification Activities

The following activities are associated with post-flood hazard verification:

- GIS support;
- Riverine high-water mark data collection;
- Coastal high-water mark collection;
- Wind water line investigation;
- Flood frequency determination;
- Post-disaster flood hazard data needs assessment; and
- Flood hazard update needs.

The diagrams below present possible progressions for recovery efforts after a coastal flooding event and after a riverine flooding event.

[February 2002]



3.14.3 Geographic Information System Support

GIS can be used to support emergency operations in the response, recovery, and mitigation efforts before and after a disaster. FEMA Regional Operations Center (ROC) and Disaster Field Office (DFO) staff can use GIS as a tool to help make emergency management decisions. Information relating to emergency operations is received constantly at the ROC and DFO. GIS can be used to analyze, synthesize, and display various information and thus expedite emergency management decisions.

The GIS support staff from the assigned Mapping Partner shall contact the following, at a minimum, to obtain data:

- State emergency management office;
- Other State offices, such as environmental protection, transportation, and GIS offices;
- Local communities (i.e., counties, townships, boroughs, towns, cities);
- USGS;
- U.S. Department of Agriculture;
- Local colleges and universities; and
- FEMA, its contractors, and other Mapping Partners.

The functions that the GIS support staff from the assigned Mapping Partner may have to perform include analysis and mapping support for the following:

- Repetitive loss locations;
- Damage assessments;
- High-water mark surveys;
- Various progress reports;
- Teleregistration activities;
- Hazard Mitigation Grant Program (HMGP) activities;
- Critical facilities and infrastructure;
- Demographics;
- Q3 Flood Data products; and
- Control structure locations and failures.

These analysis and mapping support function may be altered to address changes in FEMA requirements.

The assigned Mapping Partner shall inventory and catalog all digital data. This documentation must be designed to allow access to this digital data for any future data processing needs. The documentation must contain descriptions of digital data, file format type, creation dates, and source documentation.

At the conclusion of the assignment, the assigned Mapping Partner shall archive a hardcopy of all documentation and data, and a CD-ROM of the digital data. The assigned Mapping Partner also shall develop recommendations for standard products, applications, and procedures that could be developed for future events.

[February 2002]

3.14.3.1 Riverine High Water Mark Data Collection

Identification of Areas for Survey

The assigned Mapping Partner shall determine stream reach areas for high-water mark data collection through coordination with FEMA, USGS, State officials, and local community officials; review of any available remote-sensing data; and review of all existing media reports. The Mapping Partner shall obtain remote-sensing data and media reports from the Information and Planning Section staff at the FEMA DFO. In addition, the Mapping Partner shall contact USACE and other agencies to determine the existence of any similar activities by their respective offices. The Mapping Partner also shall perform an independent search on the Internet to determine if any additional remote-sensing data is available.

The assigned Mapping Partner shall complete an initial overview and assessment of flooding within the subject area and shall identify flooding sources/stream reaches that experienced flooding for which high-water mark data are needed. In general, the Mapping Partner must collect high-water mark data for major rivers and their tributaries and in other areas where severe flooding has occurred. The Mapping Partner must place particular emphasis on areas where flood-related damage to buildings, infrastructure, or agricultural lands occurred and/or areas that experienced record or near-record flooding. The assigned Mapping Partner shall base identification of areas for high-water mark surveys on available information regarding the recent event, such as satellite imagery, aerial photography, media reports, and knowledge of local and State emergency managers and other Federal agencies.

The assigned Mapping Partner shall submit a summary report (in digital format) to FEMA to document coordination with FEMA, USGS, and State and local community officials, as well as any additional data used in determining high-water mark collection areas. The Mapping Partner shall submit annotated USGS quadrangle maps at a scale of 1:250,000 or equivalent products with the summary report.

Riverine High Water Mark Data Collection

To locate and survey high-water marks for riverine areas identified and approved by FEMA, the assigned Mapping Partner shall establish high-water mark data collection teams based on the size of the project and deploy these teams in the field. Members of the data collection teams shall identify and flag the high-water marks. The team members shall then locate the high-water marks using differential GPS units and conventional survey equipment. The teams shall then identify GPS beacons, which are to be used as the base stations. If possible, the teams shall record all measurements in real-time.

The assigned Mapping Partner shall use traditional survey techniques in the event that GPS signals are blocked by buildings, trees, or other obstructions. An engineer from the assigned Mapping Partner shall assist the surveyor in measuring the high-water marks and shall take all field notes required for the metadata documentation. High-water mark points shall be collected with a vertical accuracy of 0.5 foot.

Spacing of High-Water Data Points

The assigned Mapping Partner shall subdivide each stream or river identified for survey into reaches based on the level of development within each reach. The assigned Mapping Partner shall use Table 3-1 as a guide for classifying the reaches based on the general land use and level of development within the flooded area of the reach.

Table 3-1. Guide for Classifying Riverine Reaches Based on Land Use and Development

Land-Use/Development Category	Description
Low	Rural, agricultural, and/or areas of no or minimal development
Medium	Areas of moderate development
High	Areas of dense development, such as large residential, urban, commercial, or industrial areas

The spacing of the high-water mark data points shall be a function of the development category for each reach. The assigned Mapping Partner shall use Table 3-2 as guidance for determining the maximum spacing between survey locations for the various development categories. The assigned Mapping Partner shall apply these spacing guidelines such that high-water mark data points are collected at locations where reliable high-water marks can be readily obtained, such as downtown areas in which buildings are flooded.

Table 3-2. Guide for Determining Maximum Spacing Between Riverine Survey Locations

Land-Use/Development Category	Guideline
Low	At upstream and downstream end of reach and no more than 10 miles apart
Medium	Upstream of the most upstream bridge or culvert within the reach and downstream of the most downstream bridge or culvert and no more than 1 mile apart
High	Upstream and downstream of each bridge or culvert within the reach and no more than 0.5 mile apart

Selection of Physical Features for High-Water Mark Survey

At each survey location, the assigned Mapping Partner shall survey at least one high-water mark data point at fixed physical features. If practicable, the assigned Mapping Partner shall survey two or more points. One point shall be on a bridge or culvert or on a building located adjacent to or near the channel that was inundated during the flood event. The second point shall be on a building that was inundated located away from the channel, in the fringe area of the flooding event.

In the absence of bridge, culvert, or buildings for collecting a high-water mark data point, the assigned Mapping Partner may use other fixed physical features, such as trees or utility poles. If a fixed physical feature is not available to survey the high-water mark data point, the assigned Mapping Partner may use the downed vegetation line as a last resort.

High-Water Mark Type

The assigned Mapping Partner shall note the type of high-water mark for each data point. In general, the mud or residue line on buildings of bridges is considered the most reliable. In a clear-water event, the assigned Mapping Partner shall exercise great care in using the water line on buildings as the high-water mark, because of the "wicking" effect of some building construction materials. This wicking effect can cause the water to penetrate the building materials and then seep upward. This effect would tend to overstate the actual flooding event. The assigned Mapping Partner may use the debris line on the ground or suspended in vegetation as a last resort. The assigned Mapping Partner shall take digital photographs of each high-water mark data point surveyed.

Other Flooding Factors

For each location surveyed, the assigned Mapping Partner shall note and photograph other information regarding the flooding event, including the following, and include these data in the GIS metadata:

- Blockage of a bridge or culvert by debris;
- Damage to or structural failure of bridge or culvert;
- Channel scouring;
- Sediment deposition in the channel; and
- Channel bank erosion, meandering, or avulsion.

For each high-water mark data point, the assigned Mapping Partner shall provide the following GIS metadata:

- Identification number (for cross referencing purposes);
- River or stream name;
- Reach identification;
- Location (city/town/borough/village, county, state);
- Address of high-water mark structure, if applicable;
- Description of physical feature surveyed (e.g., bridge, culvert, building, utility pole, tree), including name of the structure or road for bridge or culvert and street address for buildings;
- Location relative to channel (i.e., in channel, immediately adjacent to channel, in fringe area);
- Zone designation on effective FIRM (e.g., Zone A, AE, X);
- Type of high-water mark, such as mud line, debris line, clear water line, or downed vegetation line;
- Date and time high-water mark was located;
- Date and time high-water mark was surveyed (if different from above);
- Digital photograph of high-water mark;
- Name and seal of surveyor;

- Vertical datum;
- x, y, z coordinates (i.e., latitude, longitude, elevation); and
- Accuracy (i.e., good, fair, poor).

Reporting

The assigned Mapping Partner shall provide a summary report to FEMA that documents the high-water mark survey. At a minimum, this report shall document the dates of survey, survey methods used, benchmarks used, High-Water Mark Certificates, and interviews with local officials and/or residents regarding the event. The report shall be concise and approximately 10 pages in length with extensive appendices.

The assigned Mapping Partner shall submit the report in hard copy and digital formats. The assigned Mapping Partner shall supply copies to the FEMA PO, FEMA Hazards Study Branch Chief, USGS, USACE, and State NFIP Coordinator and shall coordinate making the report available through the FEMA Flood Hazard Mapping website (www.fema.gov/mit/tsd) for other interested parties.

The assigned Mapping Partner shall ensure the data for each high-water mark metadata file are submitted in a GIS map coverage file format that complies with Appendix L of these Guidelines. The assigned Mapping Partner shall provide the high-water mark survey points in a GIS point coverage. Final selection of file formats shall be coordinated with the FEMA PO or his/her designee.

The assigned Mapping Partner shall cross-reference all supporting documentation to the tabular data using the identification number, and shall include the following other items:

- Digital photographs of each high-water mark;
- Digital photographs of bridge, culverts, or channel, if other flooding factors are noted; and
- USGS (Digital Raster Graphic as minimum) quadrangle maps (or comparable base map source) showing the location, designation, and elevation of all high-water marks in hard copy and as a GIS spatial data coverage.

The assigned Mapping Partner shall create GIS maps through coordination with the FEMA PO, his/her designee, and other FEMA staff and shall submit the maps in both digital and hardcopy format. The assigned Mapping Partner shall provide copies and a CD-ROM to the FEMA DFO and RO, and shall also archive a copy of the information.

3.14.3.2 Coastal High Water Mark Data Collection

Identification of Areas for Survey

The assigned Mapping Partner that collects the coastal high-water mark data shall determine coastal shoreline and embayment reach areas for high-water mark data collection through coordination with FEMA, USGS, State and local community officials; review of any available remote sensing data; and review of existing media reports. The assigned Mapping Partner shall obtain remote-sensing data and media reports through the Information and Planning Section at the FEMA DFO.

In addition, the assigned Mapping Partner shall contact USACE and other agencies to determine the existence of similar activities by their respective offices. The Mapping Partner also shall perform an independent search of the Internet to determine if any additional remote sensing data are available.

The assigned Mapping Partner shall complete an initial overview and assessment of flooding within the subject area by identifying flooding sources and reaches of shoreline that experienced flooding for which high-water mark data may be needed. In general, high-water mark data are needed for open coast shorelines (Atlantic Ocean, Gulf of Mexico, Pacific Ocean and Great Lakes) and major embayments (e.g., Chesapeake Bay, Delaware Bay, Long Island Sound). FEMA also may require the Mapping Partner to collect high-water mark data for smaller bodies of water. The Mapping Partner shall place particular emphasis on water bodies that caused flooding damage to buildings, infrastructure (including, but not limited, to evacuation routes, wastewater treatment facilities, and schools), agricultural lands, and areas that are estimated to have experienced near-record or record flooding.

To maintain the integrity of the data, the assigned Mapping Partner may have to perform a preliminary field investigation to flag high-water marks. The Mapping Partner shall document the results of the preliminary investigation with the minimum level of metadata (detailed in the following subsection) necessary for horizontal positioning. Given the dynamic nature of the high water marks, time is of the essence in documenting these data.

The assigned Mapping Partner shall base the identification of flooding sources and their representative shoreline reaches for followup high-water mark data collection on available information regarding the recent event, such as the following:

- Wave and tide gage data from the USGS (available at www.usgs.gov) and NOAA (available at www.noaa.gov);
- Satellite imagery;
- Inundation mapping prepared by the FEMA Mapping Analysis Center;
- SLOSH simulation runs from the National Weather Service and/or National Hurricane Center;

- Aerial photography and "on-ground" reports from NOAA and/or the media;
- Media reports (Internet, newspaper, television); and
- Information provided by local and State emergency managers and other Federal Agencies (i.e., USACE Preliminary Damage Assessments for hurricane events, FEMA situation reports, FEMA Preliminary Damage Assessments, telephone logs, discussions).

As soon as possible after the flood event, the assigned Mapping Partner shall document how each area was identified for potential further study, with priority consideration given to high-water marks in coastal regions due to their perishable nature. The assigned Mapping Partner shall schedule the high-water mark data collection in those areas accordingly.

The assigned Mapping Partner shall submit a written summary report (digital format) of coordination with FEMA, USGS, and State and local community officials as well any additional data used in determining high-water mark collection areas to the FEMA Hazards Study Branch Chief in the Hazard Mapping Division. With this report, the assigned Mapping Partner also shall provide annotated USGS quadrangle maps at a scale of 1:250,000.

High-Water Mark Data Collection

To locate and survey high-water marks for areas, the assigned Mapping Partner shall establish and deploy high-water mark data collection teams based on the size of the project. These data collection teams shall locate high-water marks using differential GPS units and conventional survey equipment. The teams shall identify GPS beacons and use these beacons as the base station. If possible, the teams shall record measurements in real-time. The teams shall use conventional survey equipment in the event that GPS signals are blocked by buildings, trees, or other obstructions. An engineer from the assigned Mapping Partner shall assist the surveyor in measuring the high-water marks and shall take all field notes required for the metadata documentation.

Spacing of High-Water Mark Data Points

The assigned Mapping Partner shall subdivide each coastal flood source identified for survey into reaches based on the level of development within each reach. In coastal floodplains, the Mapping Partner shall determine the density of high-water marks based on a range of points per square mile of coverage, with higher density of points per linear mile of coastline for barrier islands at or near the hurricane or northeaster impact zone. The geographic reach of the high-water mark data collection for a coastal flood event must be the limits of the measurable storm surge flooding.

The assigned Mapping Partner shall use the guidance in Table 3-3 to classify the reaches based on the general land-use or development category within the flooded area of the reach.

Table 3-3. Guide for Classifying Coastal Reaches Based on Land Use and Development

Land-Use/Development Category	Description
Low	Rural, agricultural, and/or areas of no or minimal development
Medium	Areas of moderate development
High	Areas of dense development, such as large residential, urban, commercial, or industrial areas

The spacing of the high-water mark data points shall be a function of the development category for each reach. The assigned Mapping Partner shall use Table 3-4 as guidance for determining the maximum spacing between survey locations for the various development categories. The assigned Mapping Partner shall apply these spacing guidelines such that high-water mark data points are collected at locations where reliable high-water marks can be readily obtained, such as downtown areas that experience flooded buildings.

Table 3-4. Guide for Determining Maximum Spacing Between Coastal Survey Locations

Land-Use/Development Category	Guideline
Low	At upstream and downstream end of reach and no more than 10 miles apart
Medium	Upstream of the most upstream bridge or culvert within the reach and downstream of the most downstream bridge or culvert and no more than 1 mile apart
High	Upstream and downstream of each bridge or culvert within the reach and no more than 0.5 miles apart

Selection of Physical Features for High-Water Mark Survey

At each survey location, the assigned Mapping Partner shall survey at least one high-water mark data point at fixed physical features, such as residential or commercial buildings. When practicable, the Mapping Partner shall survey two or more points at fixed physical features.

In the absence of available structures for collecting a high-water mark data point, the assigned Mapping Partner may use other fixed physical features, such as trees or utility poles. If a fixed physical feature is not available to survey the high-water mark data point, the Mapping Partner may use the debris line on the ground within a roadway or property area as a survey point.

High-Water Mark Type

The assigned Mapping Partner shall note the type of high-water mark for each data point. In general, the mud, residue, or debris line within the interior of structures is considered the most reliable. In other areas, the exterior mud, residue or debris line on the exterior of structures can be used, with the understanding that the wave effects may be a factor in the actual measured elevation at the HWM. This effect would tend to overstate the actual flooding event. The Mapping Partner also may use the debris line on the ground or suspended in vegetation as a last resort; however, this may result in the Mapping Partner overstating the actual flooding event because of the influence of wave effects. The Mapping Partner shall take digital photographs of each data point surveyed.

Other Flooding Factors

For each location surveyed, the assigned Mapping Partner shall note and photograph other information regarding the flooding event, including the following, and include these data in the GIS metadata:

- Waterway or inlet bridge crossing blockage by debris;
- Damage to or structural failure of waterway bridges, inlet jetties, coastal structures (seawalls and revetments), and inland bulkheads;
- Channel scouring or breaching of barrier islands;
- Sediment deposition in the channel or overland due to beach and dune washover effects; and
- Beach and dune erosion, meandering, or avulsion

For each data point, the assigned Mapping Partner shall provide the following GIS metadata:

- Identification number;
- Name of flooding source;
- Reach identification number;
- Location (city/town/borough/village, county, state);
- Address of high-water mark structure, if applicable;

- Description of high-water mark (e.g., mud line, debris line);
- Type of high-water mark (inside or outside);
- Description of the physical feature being surveyed, such as bridge, culvert, residential structure, or utility pole (for buildings, street address is included);
- Zone designation on effective FIRM (e.g., Zone V, VE, X);
- Type of high-water mark, such as mud line, debris line, clear water line, or downed vegetation;
- Orientation of high-water mark on structure (e.g., interior or exterior);
- Digital photograph of high-water mark and site condition;
- Approximate location of high-water mark relative to the shoreline in feet (include time of day for this observation);
- Date and time high-water mark was located;
- Date and time high-water mark was surveyed in (if different from above);
- Determination as to whether high-water mark is indicative of surge only, wave height, or wave runup;
- Latitude, longitude, and elevation (x,y, z) coordinates;
- Vertical datum;
- Name and seal of surveyor;
- Other notes to include brief assessment of erosion; and
- Accuracy (good, fair, poor).

Reporting

The assigned Mapping Partner shall provide to FEMA a summary report that documents the high-water mark survey and inundation limits of the flood event. At a minimum, this report must document the following:

- Dates of survey;
- Survey methods;
- Benchmarks used;

- Location and elevation of high-water marks;
- Digital photographs of high-water marks;
- Completed High-Water Mark Certificates (documentation forms, see example at end of section);
- Interviews with local residents and officials regarding the event; and
- Pertinent information on other flooding factors.

The assigned Mapping Partner shall submit the report in hard copy and digital formats to the FEMA PO, FEMA Hazards Study Branch Chief in the Hazard Mapping Division, USGS, USACE, and State NFIP Coordinator. The Mapping Partner also shall coordinate making this report available on the FEMA Flood Hazard Mapping website (www.fema.gov/mit/tsd) for any other interested parties.

The assigned Mapping Partner shall submit the data outlined for each high-water mark metadata file in a GIS map coverage file format that complies with Appendix L of the these Guidelines. The Mapping Partner shall provide these survey points in a GIS point coverage. Final selection of file formats shall be coordinated with the FEMA PO or his/her designee.

Using the high-water mark data, the assigned Mapping Partner shall map a projection of the flood inundation limits and elevations on USGS topographic quadrangles or another base map approved by FEMA. The Mapping Partner shall ensure supporting documentation is clearly cross-referenced to the tabular data using the identification number.

Other items that the Mapping Partner is to submit include the following:

- Digital photographs of each high-water mark;
- Digital photographs of waterway and inlet bridges, coastal structures, and bulkhead retaining walls, if other flooding factors are noted; and
- USGS (Digital Raster Graphic as minimum) quadrangle maps (or comparable base map source) showing the location, designation, and elevation of all high-water marks in hard copy format and as a GIS spatial data coverage.

The assigned Mapping Partner shall create the GIS-based maps through coordination with the FEMA PO or his/her designee, and shall submit these maps in both digital and hardcopy format. The Mapping Partner shall provide copies on CD-ROM to the FEMA DFO and RO and shall archive a copy of the information.

[February 2002]

3.14.3.3 Wind/Water Line Investigation

The purpose of the wind/water line (WWL) investigation is to establish the geographic region of impact, distinguish between areas suffering wind and water damage from those suffering wind damage only, identify storm surge level variations, and assess the impacts on open coasts and inland bays and sounds.

Identification of Areas for Survey

The assigned Mapping Partner shall perform an initial overview and assessment of the storm-surge levels and impacts for locating a WWL and identifying physical/cultural feature changes. (This task may be performed in conjunction with a detailed coastal high-water mark data collection activity.) The Mapping Partner shall base the identification of areas for high-water mark surveys on available information regarding the recent event, such as satellite imagery, aerial photography, media reports, and information provided by local and State emergency managers and other Federal agencies.

The assigned Mapping Partner shall limit the lateral extent (perimeter) of WWL investigations to regions where the storm-surge levels caused damage to structures or property and WWLs exceed elevations of approximately 5 feet referenced to the National Geodetic Vertical Datum of 1929. (Note: The assigned Mapping Partner must modify this elevation for any work along the Great Lakes.) The Mapping Partner shall obtain WWL points along the ocean shorelines (both barrier island and mainland), in rivers, bays, estuaries, and lagoons where significant storm surge occurred.

The assigned Mapping Partner shall submit a summary of the above findings to the FEMA PO or his/her designee . The Mapping Partner shall submit the findings in the form of a brief report, supported by USGS quadrangle maps (or comparable mapping source, such as aerial photographs) identifying the areas proposed for WWL data collection. The Mapping Partner also shall submit any supporting documentation used to complete this assessment, such as satellite imagery or aerial photography.

Data Collection for Wind/Water Line Identification

The assigned Mapping Partner shall locate and survey WWL high-water marks for areas identified and approved by the FEMA PO or his/her designee. The guidelines for spacing of WWL high-water mark survey locations, selection of physical features for collecting the WWL high-water mark data points, types of WWL high-water marks to survey, and other factors to be noted are discussed in the following subsections.

For WWL investigations of mainland shorelines along inland bays and sounds, generally landward of the barrier island, the assigned Mapping Partner shall investigate and document at least one WWL high-water mark per 5-mile reach in developed regions. The preferred WWLs for mainland shoreline areas would be those inside of structures; however; any outside debris lines (i.e., on a roadway perpendicular to the shoreline or tree mudlines) are acceptable for

delineating the inundation limits and elevation of surge levels. The elevation of surge levels outside of the open coast region helps to document the inland surge reduction.

The assigned Mapping Partner shall obtain WWL high-water marks from locations inside structures to replicate stilling wells as well as outside structures to include wave effects. When conducting WWL high-water mark surveys, the Mapping Partner also shall perform preliminary site investigations of primary frontal dune impacts and new storm-induced washovers/inlets for open coast barrier islands. These site investigations shall include brief narrative description and photographic evidence of site. For primary frontal dune erosion areas, the Mapping Partner shall record spot elevations of dune toe (landward and seaward) and crest. For new storm-induced washover/inlets, the Mapping Partner shall record geographic location and dimensions (approximate width and length) of the area. Along shorelines of mainland bays and sounds, only WWLs are needed.

For WWL investigations of developed barrier islands of approximately 2 to 3 miles in length, the assigned Mapping Partner shall document at least four WWLs, one near each inlet along the open coast and back bay shoreline flooded areas, preferably inside marks outside of wave influence (i.e., splash zone). An inside mark would be a mud line or debris line located within a structure (with no wave influence). An outside WWL would be a mud line or debris line on the outside of a building (these marks would have added wave effects).

The assigned Mapping Partner shall investigate and document intermediate points between inlets (at approximately 2-mile intervals) along barrier islands greater than 4 miles in length, especially where new storm-induced washovers/inlets are located. For each WWL data point, the Mapping Partner shall provide the following metadata:

- Identification number (for cross referencing purposes);
- General Location (Street address, City/Town, County, State);
- Digital Photograph;
- Latitude, longitude, and elevation coordinate;
- Type of WWL (debris line, mud line);
- WWL location (outside or inside of structure);
- Date collected; and
- Any additional notes necessary.

The assigned Mapping Partner shall provide the documentation of primary frontal dune changes and new washover/inlet in narrative and photographic format.

Reporting

The assigned Mapping Partner shall submit a summary report that documents, at a minimum, the dates of survey, survey methods used, benchmarks used (including horizontal and vertical reference datums), interviews with local officials and/or residents regarding the event, and information on dune impacts and washovers/inlets. The Mapping Partner shall submit the report in digital format.

The assigned Mapping Partner shall submit the data outlined for each WWL outlined above in a GIS map coverage file format that meets the requirements of Appendix L of these Guidelines. The Mapping Partner shall provide the WWL survey points in a GIS point coverage. The Mapping Partner shall coordinate final selection of file formats with the FEMA PO or his/her designee. The Mapping Partner shall ensure that the supporting documentation is clearly cross-referenced to the tabular data using the identification number.

The assigned Mapping Partner also shall submit digital photographs of primary frontal dune impacts and new storm-induced washovers/inlets for open-coast barrier islands if these were noted. The assigned Mapping Partner also shall submit USGS (Digital Raster Graphic as minimum) quadrangle maps (or comparable base map source) showing the location, designation, and elevation of all WWLs in hardcopy format and as a GIS spatial data coverage. The assigned Mapping Partner shall provide map products to the PO or his/her designee that may be posted on the FEMA website.

[February 2002]

3.14.3.4 Flood Frequency Determination

The assigned Mapping Partner shall contact the USGS and National Weather Service to gather preliminary data for stream gages and rain gages in or adjacent to the impacted areas. These analyses shall be performed in conformance with Bulletin 17B (Interagency Advisory Committee on Water Data, 1982).

For those gages with peak stages that exceeded stages in the historic record, the assigned Mapping Partner shall perform a log-Pearson Type III analysis to extrapolate the frequency of the storm. These data are used to adjust the stage-discharge curves (rating curve) of the stream gage. In addition, the Mapping Partner shall research existing data, including the effective FIS reports, FIRMs, and other sources such as the USGS, USACE, State, and local communities to determine the documented 1-percent-annual-chance (100-year) flood stages at each gage site.

The assigned Mapping Partner shall develop spreadsheets to compare the new peak 1-percent-annual-chance (100-year) flood stages and/or floodflows and the flood stages and/or floodflows that are reflected in the effective FIS report and on the effective FIRM. Although these data are preliminary, the Mapping Partner must investigate areas where new peak stages exceed the

mapped stage to determine the reason for the differences in water-surface elevations. The Mapping Partner shall revisit the new stage-frequency analyses when high-water mark data and indirect measurements are available. In addition, the Mapping Partner may need to assess targeted flooding sources that did not have USGS gage data information based on future high-water mark data.

The assigned Mapping Partner shall perform stage-frequency analyses where no finite flood discharge information is available. The Mapping Partner shall perform direct and indirect discharge measurements to verify stage-frequency analyses. The Mapping Partner shall perform the discharge measurements in accordance with standards set forth in USGS Water Resources Investigation Report 94-4002 (USGS, 1994).

In the event that no direct USGS data are available for a community, the assigned Mapping Partner may establish preliminary flood frequencies on a watershed basis or based on the storm's rainfall frequency. Although these are not the most accurate methods, they do provide a characteristic of the storm. In this case, the assigned Mapping Partner shall not determine final flood frequencies shall until a new detailed flood hazard analysis is performed, if applicable.

[February 2002]

3.14.3.5 Post-Disaster Flood Hazard Data Needs Assessment

An important function of the Technical Services Branch in the DFO is to assess the available flood hazard data and determine if the accuracy and level of detail are sufficient to support benefit/cost analysis, reconstruction guidance, insurance determinations, ESF-5, and other activities. The steps outlined below describe a process that will result in the collection and identification of flood hazard data needs for the area affected by the disaster. This activity will allow priorities to be set for the development of additional flood hazard information determined for recovery activities.

Preliminary Investigation

The assigned Mapping Partner shall obtain maps (hardcopy or digital format) that show major waterways, communities; roads and railroads; Human Services (HS) applications; and flood insurance risk zone designations from the FIRMs for all affected Counties. (Th assigned Mapping Partner may obtain these maps from ESF-5 staff at the FEMA ROC or from the Information and Planning Section staff in the DFO). As additional applications for HS assistance are received, it may be necessary to obtain updated versions of these maps.

The Mapping Partner shall review the maps to determine areas for further investigation and/or field reconnaissance. The following preliminary reviews may help to identify areas for further examination:

- Identification of areas with large concentrations of Human Services applications;

- Comparison of remotely sensed flood inundation limits to the FIRM boundaries;
- Comparison of any flagged locations of any field-collected high water marks (x,y locations), with all data collected flagged with lat/long in decimal degrees and referenced to the North American Datum of 1983; and
- Any geocoded locations for potential Hazard Mitigation Grant Program projects.

The assigned Mapping Partner may need to perform field reconnaissance to clarify issues identified through this process

The assigned Mapping Partner shall determine if the state or any other entities (local communities, state USGS, USACE districts, water management districts, regional development districts, others) are collecting data that may provide information.

Detailed Data Collection

The Mapping Partner shall review the standard Disaster Data Needs Assessment Form for reporting mapping needs to FEMA, determine if any mapping needs specific to the disaster event must be added, and finalize the form. The Mapping Partner shall distribute the completed form to FEMA planners for their "to go" kits, and brief them on the form.

FEMA planners should provide the Disaster Data Needs Assessment Form to the communities when mapping issues are raised to document them for input into the flood hazard data needs database.

The assigned Mapping Partner shall do the following to complete the Mapping Needs Assessment form:

- Review hydrology from FIS text to determine date and method of hydrologic analyses.
- Review hydraulics from FIS text to determine date of hydraulic analyses.
- Compare remotely sensed flood inundation limits to the FIRM boundaries.
- Compare any flagged locations of any field-collected high water marks (x,y locations).
- Identify locations for potential HMGP projects.
- Identify geocoded substantially damaged structures.
- Identify information on severely damaged critical infrastructure.
- Identify Approximate Zone A areas/unmapped areas with damages that need BFEs for reconstruction efforts.
- Review MNUSS data for affected communities.

The assigned Mapping Partner shall input data gathered into the *Disaster Data Needs Assessment* database, which is located on the FEMA website at http://www.floodmaps.net/floodrecoverydata. The Mapping Partner shall prioritize flood hazard data collection and analyses needs for possible contract Task Orders. The Mapping Partner shall shared all data collected with ESF-5/Information and Planning staff and provide it to FEMA and other Mapping Partners as needed for the MNUSS data collection effort.

The assigned Mapping Partner shall obtain maps that show major waterways, communities, roads and railroads, human services applications, and FIRMs for all affected counties. Additionally, other useful map products may be developed using the GIS support. From a review of the maps and other resources, the Mapping Partner shall identify and conduct reconnaissance of the areas that need further investigation. The assigned Mapping Partner also shall review the FIS reports for the affected communities to determine the methods used to perform the hydrologic and hydraulic analyses. The Mapping Partner shall use other resources to perform this detailed data collection, including MNUSS, high-water mark inspections, and previous flood hazard studies in the area.

From FEMA, State officials, and other sources, the assigned Mapping Partner shall obtain input on areas that are being targeted for hazard mitigation projects. The Mapping Partner also shall document locations of areas with substantially damaged structures and consider these areas in determining needs.

[February 2002]

3.14.3.6 Flood Hazard Data Update Needs

Based on the data collected from the post-disaster flood hazard data needs assessment discussed in Subsection 3.14.2.5, the assigned Mapping Partner shall develop a priority list of flood hazard data update needs. This list is to include communities, flooding sources, reach lengths, and FIRM panels. The Mapping Partner also shall assemble data from the FIS reports, FIRMs, MNUSS, USGS, State NFIP Coordinator, local communities, and FEMA. To assist in this prioritization, the Mapping Partner shall develop a point ranking system to properly weigh all factors of flood hazard data update needs.

To determine if a new flood hazard analysis is warranted, the assigned Mapping Partner shall use the confidence limits check outlined earlier in this section. Generally, if the new 1-percent-annual-chance (100-year) storm discharge from the preliminary frequency curve produces a new 1-percent-annual-chance (100-year) flood profile that is 1.0 foot or more above that developed for the effective FIS report, then a new flood hazard analysis may be warranted.

The assigned Mapping Partner shall develop the point ranking system in coordination with the State NFIP Coordinator, local communities, and FEMA. The distribution of the points is to reflect the severity of flooding across the area. The point ranking system shall include the parameters shown in the table below.

In addition, the assigned Mapping Partner shall assign a priority category to this final ranking. The Mapping Partner shall coordinate the range of points assigned to each category with the State NFIP Coordinator, local communities, and FEMA. The priority categories are:

- **Emergency** – Immediately needed for Mitigation Recovery Activities;
- **Priority** – In support of Mitigation Recovery Activities; and
- **Routine** – Normal Restudy Needs List.

For those projects that have the same ranking, FEMA and the State NFIP Coordinator shall coordinate to decide which community has the higher ranking. The assigned Mapping Partner may list the final priorities in a spreadsheet and deliver it to FEMA, the State NFIP Coordinator, and local communities. The suggested procedures for streams and communities by priority category are outlined below. The assigned Mapping Partner shall ensure any data collected on these communities are input to the MNUSS database.

Emergency

The assigned Mapping Partner shall perform accelerated hydrologic and hydraulic analyses and present the results on a digital work map showing 1-percent-annual-chance (100-year) floodplains and regulatory floodway and the best available base map information available. These data would be used as best available data for assisting hazard mitigation recovery activities. The proposed timeframe for this action is 1 month.

Priority

The assigned Mapping Partner shall perform accelerated hydrologic and hydraulic analyses and present the results on a digital work map showing 1-percent-annual-chance (100-year) floodplains and regulatory floodway and the best available base map information available. These data would be used as best available data for assisting hazard mitigation recovery activities. The proposed time frame for this action 3 months.

Routine

These communities shall be reprioritized, as appropriate, by the FEMA RO as part of its annual review of study/restudy requests from communities.

[February 2002]

3.14.4 Development of Recovery Tools

Collection and assessment of flood data and preparation of flood recovery maps, if needed, are activities outside of FEMA's normal flood hazard mapping operations. These activities must take place in the immediate aftermath of a disaster. When a flood occurs, valuable data become available that enable FEMA and its Mapping Partners to reassess the estimates of flood risk.

Also, rebuilding efforts begin within a short period after the disaster, and timely updated flood risk data are necessary to ensure that the rebuilding will protect properties from future flooding disasters. The new data need to be evaluated and, if necessary, incorporated into new engineering analyses. Appropriate hazard identification tools (such as flood recovery maps) must be produced quickly. In some cases, there may not be any detailed flood mapping at all, and flood recovery maps may be the only detailed guidance to assist the State and community in planning and managing rebuilding efforts.

Subsections 3.14.4.1, 3.14.4.2, and 3.14.4.3 provide guidance for preparing flood recovery tools.

[February 2002]

3.14.4.1 Estimated Base Flood Elevation for Zone A Areas

When no detailed flood data exists for specific waterways, the assigned Mapping Partner may have to perform hydraulic studies to establish base flood elevations to assist in proper floodplain management and redevelopment. At FEMA request, the Mapping Partner may be required to perform hydrologic and hydraulic analyses (the type of model shall be assigned by the FEMA PO or his/her designee in the Scope of Work) and develop the 1-percent-annual-chance (100-year) Flood Profile for specific waterways.

Hydrologic Analysis

The assigned Mapping Partner shall develop the peak 1-percent-annual-chance (100-year) flood discharge using the appropriate USGS regression equations. The Mapping Partner shall develop drainage from USGS 30-Meter digital elevation model information, unless better topographic data are available. General guidance for performing the hydrologic modeling can be found in Volume 1 and Appendix C of these Guidelines.

Hydraulic Analysis

The assigned Mapping Partner shall develop the cross sections to be used in the hydraulic model from USGS 7.5-minute series quadrangle maps, unless better topographic or survey data are available. General guidance for performing the hydraulic modeling can be found in Volume 1 and Appendix C of these Guidelines.

Mapping

The assigned Mapping Partner shall produce work maps that present 1- percent-annual-chance (100-year) and 0.2-percent-annual-chance (500-year) floodplains and regulatory floodway using the best topographic data available on a suitable base map. The Mapping Partner shall ensure all digital mapping files are produce in accordance with the requirements documented in Appendix K of these Guidelines.

[February 2002]

3.14.4.2 Coastal Analyses

The assigned Mapping Partner shall perform all coastal analyses in accordance with the requirements documented in Volume 1 and Appendix D of these Guidelines.

[February 2002]

3.14.4.3 Riverine Analysis

The assigned Mapping Partner shall perform all riverine analyses in accordance with the requirements documented in Volume 1 and Appendix C of these Guidelines.

[February 2002]

3.15 Hazard Identification and Mapping Activities

The assigned Mapping Partner shall assist in obtaining information regarding natural and technological hazards from Federal, State, and local government sources. This information could be used to produce maps, perform analyses, or add to web applications and could portray a broad range of natural and technological hazards.

Work assignments under this task are optional and may be exercised at any time during the term of the contract of the assigned Mapping Partner at the discretion of the FEMA Contracting Officer (CO). At that time, the Mapping Partner shall prepare a Business and Technical Proposal with a separate Time and Cost Proposal based on instructions from the FEMA CO, the Task Manager for the particular work assignment, or the PO or his/her designee.

[February 2002]

3.16 Risk Assessment Activities

The assigned Mapping Partner shall, at the request of the PO or his/her designee, provide onsite and offsite support to FEMA's Risk Assessment mission and related functions. This support shall include acquisition of data, hardware, and software; digitizing; and database and GIS functions for daily and emergency operations. These functions will support mitigation, preparedness, response, and recovery efforts.

These functions, which primarily support the ongoing Risk Assessment mission, shall also be used in direct support to the EST/ESF-5 within FEMA. The tasks may be characterized by time-critical operations to perform the following activities:

- Acquisition of source materials (e.g., maps, reports);
- Acquisition, preparation, interpretation, and analysis of imagery;
- Digitizing of feature and related event information, characterized as geographic, property, disaster relief, flood insurance, demographic, and infrastructure data;
- Preparation of digital files for use in the FEMA-GIS software tools (e.g., ArcInfo Export file, Map Info native file, Oracle, EIS);
- Daily operation, maintenance, and upgrading of the FEMA-GIS, including within the FEMA EST/ESF-5 environment;
- Preparation of output products in digital and hardcopy formats for data exchange within FEMA; with Federal, State, and local governmental agencies; and with other Mapping Partners; and
- Development of training materials and presentation of training courses on using the FEMA-GIS.

When feasible and applicable, the digitizing and GIS support operations shall follow the requirements described elsewhere in these Guidelines.

[February 2002]

3.17 Fee-Charge System Maintenance

3.17.1 Overview

In January 1986, FEMA instituted a fee-collection system to recover costs incurred in reviewing proposed projects and issuing CLOMAs, CLOMR-Fs, and CLOMRs. In October 1992, FEMA expanded the system to provide for the recovery of costs incurred in reviewing completed projects and issuing LOMR-Fs, LOMRs, and PMRs. Effective October 1, 1996, FEMA established a flat schedule for processing most requests for LOMR-Fs, LOMRs, PMRs, CLOMAs, CLOMR-Fs, and CLOMRs. Based on its annual review of costs, FEMA has and will continue to revise the fee schedule to ensure maximum recovery of expended funds by publishing a new schedule in the *Federal Register*.

Similarly, FEMA established a system for recovering costs incurred in responding to requests for FIS technical and administrative support data. FEMA has established seven categories into which requests for FIS technical and administrative support data are separated. (See Subsection 3.3.3 of these Guidelines for additional information on these categories.)

As it has with requests for conditional and final modifications to NFIP maps, FEMA has and will continue to revise the fee schedule to ensure maximum recovery of expended funds by publishing a new schedule in the *Federal Register*. To maintain an accurate accounting of the checks, money orders, and credit card charges that are received, FEMA has established a centralized fee-charge system, administered by the Fee-Charge System Administrator (FCSA). The fee-charge system administration responsibilities of the Mapping Partners that process these requests and the FCSA for map change requests and external data requests are provided in Subsections 3.17.2 and 3.17.3, respectively.

[February 2002]

3.17.2 Map Change Requests

3.17.2.1 Mapping Partner Responsibilities

As indicated in Volume 2 of these Guidelines, the appropriate review and processing fee must be received by the Mapping Partner that is assigned to review and process a map change request and submitted to the FCSA before the review of any request requiring a review and processing fee begins. The review and processing fee is based on the type of map change requested. A list of current review and processing fees for map change requests is provided on the FEMA Flood Hazard Mapping website at http://www.fema.gov/mit/tsd/frm_fees.htm.

Upon receipt of the request, the assigned Mapping Partner shall review the submittal to determine whether the request is fee exempt. Once the Mapping Partner determines that the request is not fee-exempt, the Mapping Partner shall assign a case number in accordance with the

procedures discussed in Sections 2 and 3 of the FEMA *Document Control Procedures Manual* (FEMA, 2000). The Mapping Partner then shall perform a quick review of each check or money order to identify obvious errors (e.g., missing date, missing signature, discrepancies between the written and the numerical amount, and check made payable to incorrect entity).

Some checks have a 60- or 90-day *void clause* from the date of the check. If no void clause appears on the check, the check is good for 6 months from its issue date, unless otherwise indicated. If the check is past its expiration date, the assigned Mapping Partner shall not forward the check to the FCSA. Instead, the assigned Mapping Partner shall return the check to the requester and ask for a new check with a current date. FEMA cannot accept any check over 6 months old, unless stated otherwise on the check. The assigned Mapping Partner shall make copies of checks before sending them to the FCSA through interoffice mail.

The assigned Mapping Partner also shall ensure that any credit card payment form submitted directly to that Mapping Partner contains the required information, including the following

- Correct amount;
- Credit card number;
- Current expiration date;
- Signature of cardholder;
- Date of signature;
- Name of cardholder as it appears on the credit card;
- Address of cardholder (for the credit card receipt);
- Daytime telephone number; and
- Case number (established by the assigned Mapping Partner).

FEMA accepts only VISA and MasterCard. The credit card information form appears in the MT-1 and MT-2 application/certification packages discussed in Volume 2 of these Guidelines and which may be downloaded from the FEMA Flood Hazard Mapping website.

If any of the required information is missing, the assigned Mapping Partner shall call the requester and request a corrected credit card information form. The FCSA cannot process credit card payments unless all correct information is provided. The FCSA and MCC cannot, under any circumstances, accept a credit card authorization over the telephone.

Before forwarding checks, money orders, or credit card information to the FCSA, the assigned Mapping Partner shall ensure the check, money order, or credit card information information form has been annotated with the correct case number. The Mapping Partner shall place a copy of the annotated check or money order in the case file for the map change request. For security

reasons, the assigned Mapping Partner shall block out the credit card number and expiration date on any copy of the original credit card information form before placing the copy in the case file.

The assigned Mapping Partner shall transfer fees to the FCSA daily via the regular courier run to FEMA. The assigned Mapping Partners shall place the fees in color-coded interoffice envelopes that are clearly addressed and dated. At approximately 2:00 p.m., a courier will pick up all packages or interoffice envelopes sent to the FCSA by the assigned Mapping Partner. Before forwarding the fees to the FCSA, the Mapping Partner shall ensure that the cases have been transmitted to the CIS.

To facilitate the identification of current cases, and to reduce the number of errors and refunds, the Mapping Partner shall provide the FCSA with a copy of all letters requesting or acknowledging the receipt of fees. The letters may be sent by facsimile transmission, through the interoffice mail, or delivered in person.

[February 2002]

3.17.2.2 Fee-Charge System Administrator Responsibilities

The FCSA has the responsibility for the collection, deposit, and reporting of the fees recovered under the FEMA reimbursement procedures documented in Part 72 of the NFIP regulations. To accept the fees, the FCSA shall ascertain that a valid case number exists and all necessary documentation has been received.

Upon resolution of all problems and acceptance of the fees, the FCSA shall inform the Mapping Partner that is processing a map change request about fees received. Daily, the FCSA shall forward to the appropriate Mapping Partner, through interoffice mail, a receipt log listing all checks and money orders received through the U.S. mail. The FCSA shall forward with the receipt log along with a transmittal memorandum and a photocopy of each check or money order received. (The FCSA shall not forward copies of checks or money orders that had been transmitted by the assigned Mapping Partner, because that Mapping Partner already has a copy of each check or money order in the case file for that map change request.) The FCSA also may send a copy of the receipt log by facsimile transmission. The FCSA also shall provide the assigned Mapping Partner with a receipt log listing fees received by credit cards. However, for security reasons, the FCSA shall not provide a copy of the credit card payment form.

Twice each week, the FCSA shall deposit all fees received up to that day at a U.S. Treasury-approved bank location. The FCSA also is responsible for maintaining the fee portion of the LOMC module in the FEMA CIS.

[February 2002]

3.17.2.3 Reporting Requirements

The FCSA shall provide the following reports to FEMA and to the Mapping Partners that process map change requests:

- **Bank Deposit Information Report**, which the FCSA must provide to the FEMA Financial and Acquisition Management Division on the second business day of the month. The report shall consist of a list of all checks and money orders received and deposited and a list of all credit card payments processed during the previous month, including, if necessary, any debit voucher received regarding checks rejected by the bank. The FCSA also shall report on all refunds issued electronically. The package must contain all original 215 deposit tickets stamped by the bank and the credit card daily summary reports from the bank. (Note: The FCSA shall store a copy of every 215 deposit ticket, bank deposit ticket, list, check, money order, and credit card information form in a secure area.

- **LOMC Fee: Payment and Deposits Report**, which the FCSA must provide to the Mapping Partners that process map change requests on or about the seventh business day of the month. The FCSA shall run this report directly from the CIS. The report shall consist of a listing of all fees received and deposited the previous month.

- **LODR Payment and Deposit Report**, which the FCSA must provide to the FEMA Hazards Study Branch on or about the 15th of the month following the end of each quarter of the fiscal year. This report consists of a listing of all fees received and deposited for LODRs during the previous quarter.

[February 2002]

3.17.2.4 Refund Procedures

When it becomes obvious that a fee has been deposited for a map change request that is actually fee exempt, the Mapping Partner shall initiate the refund procedures by sending a dated copy of the appropriate refund letter and memorandum to the FCSA. Sample copies of the refund letters and refund memorandums are provided in the FEMA *Document Control Procedures Manual* (FEMA, 2000). The Mapping Partner must coordinate beforehand with the FCSA on any refund involving a payment received by credit card.

[February 2002]

3.17.3 External Data Requests

3.17.3.1 Mapping Partner Responsibilities

Upon receipt of a request for archived data, the Mapping Partner that maintains the requested archived data shall review the request to determine whether the request is fee exempt. See Subsection 3.17.4 for a list of fee exemptions. A list of current review and processing fees for requests for technical and administrative support data is provided on the FEMA Flood Hazard Mapping website at http://www.fema.gov/mit/tsd/frm_fees.htm.

If the request is not fee exempt, a non-refundable initial fee must accompany the request. If no fee was received, the Mapping Partner shall return the request to the requester along with a letter requesting the appropriate initial fee.

The Mapping Partner shall log in all fee-exempt requests and requests accompanied by the appropriate fee and assign a unique case number to each request. The Mapping Partner shall then enter all requests received into an in-house database or MIS.

If the request is not fee exempt and the correct fee has been submitted, the assigned Mapping Partner shall forward the following to the FCSA:

- Information/Data Request Form;
- Check, money order, or original credit card information form; and
- Copy of incoming letter from the requester.

FEMA accepts only VISA and MasterCard. Before submitting the payment to the FCSA, the Mapping Partner shall review the check, money order, or credit card information form for obvious errors. If obvious errors are discovered, the FCSA shall address those errors with the requester before forwarding the check, money order, or credit card information form to the FCSA for processing.

[February 2002]

3.17.3.2 Fee-Charge System Administrator Responsibilities

The Mapping Partner that processes a request for technical and administrative support data shall forward the fee (i.e., check, money order, credit card payment) to the FCSA through the interoffice mail. A courier shall collect the interoffice mail envelopes daily and deliver them to the FCSA.

In the event that the fee for a new request is submitted directly to the FCSA in the form of a check or money order, the FCSA shall forward all correspondence received, including the original check or money order, to the appropriate Mapping Partner through the interoffice mail. That Mapping Partner shall then process the request as if it had been submitted directly to the correct office.

In the event that the fee for a new request is submitted directly to the FCSA in the form of a credit card payment, the FCSA shall forward all correspondence received and a copy of the credit card information form to the appropriate Mapping Partner through the interoffice mail. The FCSA shall block out the credit card number and expiration date on the copy sent to the Mapping Partner.

If the fee submitted is for an existing request, the FCSA shall match the correct case number and the fee received with the appropriate Data/Information Request Form on file before forwarding a copy to the responsible Mapping Partner.

The FCSA shall keep a copy of every check, money order, and credit card information form that has been accepted and deposited. The FCSA shall record all checks, money orders, and credit card information forms received each day on a receipt log. Daily, the FCSA shall forward copies of the Receipt Log by facsimile transmission to the designated contact person at each of the Mapping Partners. The FCSA shall enter a record of all payments and cases processed in a database.

At least once each week, the FCSA shall dispatch a courier to the bank identified by FEMA to deposit the fees collected since the previous deposit.

[February 2002]

3.17.3.3 Reporting Requirements

The FCSA and the assigned Mapping Partners that process the external data requests shall prepare the following reports:

- **End of the Month Statistics,** which the FCSA must provide by facsimile transmission to the assigned Mapping Partner by 12:00 p.m. on the last working day of the month. The Mapping Partner shall complete the form by entering the last assigned request number for each region and the number of fee-chargeable and fee-exempt requests received during the month. The Mapping Partner must returns the completed form by facsimile transmission to the FCSA by the close of business on that same day.

- **Aging Report,** which the FCSA must provide by facsimile transmission to the assigned Mapping Partner by the close of business on the last business day of the month, categorizes requests that have not yet been completed. The Mapping Partner must make appropriate changes to the report and return it to the FCSA by facsimile transmission before the close of business on the next business day with all appropriate paperwork.

- **Bank Deposit Information Provided to FEMA Financial Management Office,** which the FCSA must prepare and deliver to FEMA Office of Financial Management on the second business day of the month. The report consists of a list of all checks and money orders received and deposited and a list of all credit card payments processed during the previous month. The report also includes, if necessary, a note on all bounced checks or refunds done electronically. With the report, the FCSA provides all original deposit tickets stamped by the bank and daily summary reports from the credit card companies.

- **Check Report**, which the FCSA must prepare and deliver to the assigned Mapping Partner by facsimile transmission by the 10th day of the month, details all deposits made during the previous month by check or money order.

- **Credit Card Report**, which the FCSA must prepare and deliver to the assigned Mapping Partner by facsimile transmission by the 10th day of the month, details all deposits made during the previous month by credit card.

- **Status Report**, which the FCSA must prepare and deliver to the assigned Mapping Partner by facsimile transmission by the 10th day of the month, provides a breakdown of data requests completed during the previous month and a breakdown of data requests that are still open.

- **Quarterly Report**, which the FCSA must prepare and deliver to the assigned Mapping Partner by facsimile transmission by the 15th day of the month following the end of a quarter, is a compilation of the statistics for the previous 3 months.

[February 2002]

3.17.3.4 Refund Procedures

When appropriate, a refund may be made to a requester. Before submitting refunds for FEMA approval, the assigned Mapping Partner must coordinate with the FCSA and ensure that the refund is well documented in the case file and the Mapping Partner's in-house database or MIS. The Mapping Partner shall prepare and forward the following to the FCSA:

- Draft refund memorandum;

- Draft refund letter;

- Copy of the check or money order received from requester; and

- Copy of the receipt log initialed and received from the FCSA.

The FCSA shall review and approve the draft or provide the Mapping Partner with corrections if needed. The Mapping Partner shall then submit to FEMA a copy of the original refund letter, the refund memorandum, a copy of the check, and a copy of the receipt log and all pertinent correspondence.

Upon return of the refund letter from FEMA, the Mapping Partner shall date and mail the letter. The Mapping Partner shall file a copy of the refund letter and memorandum in the case file and transmit a copy of each to the FCSA via interoffice mail. The Mapping Partner and the FCSA shall update their internal databases or MISs with the date and the reason for the refund.

For credit card refunds, the Mapping Partner shall coordinate in advance with the FCSA and ensure that the refund is documented in the case file and in-house database or MIS. The Mapping Partner shall prepare a draft a refund letter and submit the letter to the FCSA for review, with a copy of the official dated credit card receipt log initialed by the FCSA and a copy of the original incoming letter from the requester. The Mapping Partner shall not prepare a refund memorandum.

The FCSA shall review, approve, and finalize the refund letter. The FCSA shall then mail the refund letter, process the refund on the date the letter is mailed, and provide a copy of the refund letter to the originating Mapping Partner.

[February 2002]

3.17.4 Fee Exemptions

FEMA has established certain categories of requests for conditional and final modifications to NFIP maps and requests for technical and administrative support data for which no fee is required. These exempt request categories are discussed in Subsections 3.17.4.1 and 3.17.4.2.

[February 2002]

3.17.4.1 Map Change Requests

Section 72.5 of the NFIP regulations describes the requirements for fee exemptions to be granted for the review and processing of requests for LOMAs, CLOMAs, CLOMR-Fs, LOMR-Fs, CLOMRs, LOMRs, and PMRs. For requests processed in Fiscal Year 2002, FEMA exempts the following:

- Requests for LOMAs;
- Requests for map changes based on mapping or study analysis errors;
- Requests for map changes based on natural changes within SFHAs;
- Requests for map changes based on the federally sponsored flood-control projects where 50 percent or more of the project's costs are federally funded;
- Requests for map changes based on detailed hydrologic and hydraulic studies conducted by Federal, State, or local agencies to replace approximate studies conducted by FEMA and shown on the effective FIRM; and
- Requests for map changes based on flood hazard information that was meant to improve on the information shown on the effective FIRM or FBFM or within the effective FIS report, provided the request does not incorporate, in whole or in part, manmade modifications within the SFHA.

The assigned Mapping Partner and FCSA shall not waive a review and processing fee for a map change request that is not in one of the categories above unless directed to do so by FEMA RO or HQ staff.

[February 2002]

3.17.4.2 External Data Requests

In addition to the assigned Mapping Partner and FEMA staff, the following are exempt from fees for technical and administrative support data:

- Requests from private architectural-engineering firms under contract to FEMA to perform Flood Map Projects;

- Requests from communities, regional agencies, and State agencies participating in the CTP initiative;
- Requests from Federal agencies that perform Flood Map Projects for FEMA (i.e., USACE, USGS, Natural Resources Conservation Service, Tennessee Valley Authority);
- Requests from communities that supply digital community GIS data to FEMA and request the Digital Line Graph data or DFIRM files;
- Requests from communities that request data during the statutory 90-day appeal period for an initial or revised FIS for that community;
- Requests from mapped participating communities that request data at any time other than during the statutory 90-day appeal period, provided that the community requests the data for its use and not for third-party users;
- Requests from State NFIP Coordinators, provided that the data that they request are for use by the State NFIP Coordinators and not for use by third-party users; and
- Requests from State, regional, and local Mapping Partners participating in the Cooperating Technical Partners initiative.

The assigned Mapping Partner and FCSA shall not waive a fee for an external data request that is not in one of the categories above unless directed to do so by FEMA RO or HQ staff. Fees have been waived for graduate students; university professors; individuals, firms, or nonprofit organizations that are conducting research that will be educational or otherwise beneficial to the public or FEMA; and for hardship cases (e.g., individuals who lost LOMAs (and related materials) due to flooding, individuals on fixed incomes).

[February 2002]

3.18 Cooperating Technical Partners Initiative Support

One of the key objectives of the FEMA Map Modernization Plan is to increase local involvement in, and ownership of, the flood mapping process. To meet this objective, FEMA developed and implemented the CTP initiative. As technologies have improved and applications have expanded dramatically, many State agencies, regional agencies, and communities have become increasingly sophisticated and have invested significant financial and personnel resources in flood hazard identification and mapping. FEMA envisions that the CTP initiative will evolve as technologies and the capabilities of FEMA's Partners grow.

In support of the CTP initiative, FEMA has committed to the following:

- To recognize the contributions made by FEMA's State, regional, and local community Partners by providing timely and accurate flood hazard information;
- To maximize the use of Partners' contributions as a means of leveraging limited public funds to the fullest extent possible while maintaining essential NFIP standards;
- To fully integrate contributing Partners into the flood hazard data development process, with the corresponding authorities and responsibilities;
- To provide training and technical assistance to Partners when appropriate; and
- To facilitate mentoring to increase capabilities of both existing and potential Partners.

Additional details on the CTP initiative may be obtained from the CTP website pages located at http://www.fema.gov/mit/tsd/ctp_main.htm.

FEMA and the State agencies, regional agencies, and communities that participate in the initiative (hereinafter referred to collectively as CTPs) administer activities through close and frequent coordination and through two types of formal agreements—Partnership Agreements and Mapping Activity Statements (MASs). For mapping activities that are eligible for Federal funding, the Cooperative Agreement process also is used in the administration of the CTP initiative to allocate funds to the CTP for certain mapping activities.

The Partnership Agreement, also referred to as or Memorandum of Agreement (MOA), is a broad statement of principle, emphasizing the value of the three main components of the NFIP: insurance, floodplain management, and mapping. A template for the Partnership Agreement may be viewed or downloaded from the CTP portion of the FEMA Flood Hazard Mapping website at http://www.fema.gov/mit/tsd/dl_moa.htm.

As a CTP and FEMA identify specific mapping activities to undertake, the parties develop an MAS for those activities. Depending on the mapping activities that will be performed, an MAS

may be prepared for one of the activities listed below, other CTP-specific activities, or several activities simultaneously.

- **Refinement of Approximate Zone A Boundaries**—The CTP works with FEMA to perform analyses to refine the boundaries of the SFHAs designated Zone A. Emphasis is to be placed on automation techniques.

- **Hydrologic and Hydraulic Analyses and Floodplain Mapping**—The CTP develops digital engineering data and floodplain mapping using GIS-based or traditional hydrologic and hydraulic modeling techniques.

- **Digital FIRM Preparation**—The CTP digitizes the effective FIRM and prepares a DFIRM.

- **Redelineation of Detailed Flood Hazard Information Using Updated Topographic Data**—The CTP revises the flood hazard information shown on the effective flood map using more up-to-date topographic data. GIS technology is to be used when available.

- **Digital Topographic Data Development**—The CTP develops digital topographic data for flood hazard identification purposes.

- **Digital Base Map Data Sharing**—The CTP supplies a base map for DFIRM production. The base map must comply with FEMA minimum accuracy requirements. FEMA must be able to distribute the base map to the public in both hardcopy and electronic formats.

- **Digital FIRM Maintenance**—The CTP assumes long-term responsibility for periodic maintenance of the DFIRM. This can include base map and/or flood hazard information.

- **Hydrologic and Hydraulic Review Agreement**—The CTP evaluates hydrologic and hydraulic studies prepared for FEMA-funded flood data updates and/or map revisions under Part 65 of the NFIP regulations. The review is to focus on compliance with the technical and regulatory requirements contained in various FEMA flood mapping guidelines and specifications; the pertinent NFIP regulations; and standard, accepted engineering practices. This activity is currently under consideration.

- **Assessment of Community Mapping Needs**—The CTP performs a detailed community-by-community investigation and assessment of mapping needs in participating NFIP communities (including unmapped communities).

- **Digital Base Map Inventory**—The CTP performs an investigation and provides an inventory of base maps meeting FEMA specifications for NFIP communities in the State.

In general, participants in the CTP initiative shall follow the portion of these Guidelines that apply to the activities that they undertake. For example, if a participating CTP agreed to perform hydrologic and hydraulic analyses for a riverine flooding source, that CTP (and any contractors selected by the CTP to participate in those analyses) would be required to meet the requirements documented in Volume 1 and Appendix C of these Guidelines. The portions of these Guidelines

that a participating CTP must meet as well as any other requirements are to be documented in the MAS.

[February 2002]

3.18.1 Support Activities

Because of the size and scope of the CTP initiative, FEMA and the participating CTPs may require support to administer the intiative both nationally and locally. When required, FEMA PO, his/her designee, or the FEMA Regional CTP Coordinator may request that certain Mapping Partners provide technical, programmatic, and logistical support for the implementation of the CTP initiative. This support shall include, but not be limited to, the following:

- Participation in coordination meetings with FEMA HQ and FEMA RO staff, CTPs, and other Mapping Partners;
- General support, including monthly time and cost reports; ad hoc reports; responses to special requests for CTP information, and development and review of tools to help administer the CTP initiative;
- Repository maintenance;
- Guidance document development;
- Outreach materials development;
- Database maintenance and enhancement;
- Website maintenance and enhancement;
- Programmatic/technical support to CTPs and ROs; and
- Training program development and implementation.

Information on these support activities is provided in Subsections 3.18.1.1 through 3.18.1.8.

[February 2002]

3.18.1.1 Participation in Coordination Meetings

The assigned Mapping Partner shall be prepared to participate in coordination meetings with the FEMA National CTP Coordinator, other FEMA staff, and other Mapping Partners. The purpose

of these meetings will be to review ongoing activities and to plan future activities for the initiative. The Mapping Partner will prepare minutes for CTP meetings as assigned.

[February 2002]

3.18.1.2 Repository Maintenance

The assigned Mapping Partner shall establish and maintain a hard copy repository of the CTP-related documents (e.g., Partnership Agreements, MASs, success stories) that will be provided by the FEMA Regional CTP Coordinators and other RO staff.

[February 2002]

3.18.1.3 Guidance Document Development

The assigned Mapping Partner shall be prepared to participate in the development of the guidance documents that FEMA, the CTPs, and other Mapping Partners can use in accomplishing work under the CTP initiative. The support shall include writing portions of the guidance documents and reviewing the portions of the documents written by other Mapping Partners. This support may also include preparation of the final documents and administrative support for the production of the documents.

[February 2002]

3.18.1.4 Outreach Materials Development

The assigned Mapping Partner shall be prepared to participate in the development of outreach materials to improve communication regarding the CTP initiative within FEMA; with CTPs; and with other Federal, State, and local Mapping Partners. Such outreach materials shall include, but are not limited to, informational flyers; PowerPoint presentations that CTPs and other Mapping Partners may use to explain the CTP intiative locally; and correspondence explaining the CTP initiative.

[February 2002]

3.18.1.5 Database Maintenance and Enhancement

The assigned Mapping Partner shall be prepared to participate in the maintenance and enhancement of the CTP Database. The CTP Database is available to the FEMA Regional CTP Coordinator, other FEMA staff, and the assigned Mapping Partner through a password-protected portion of the FEMA floodmaps.net website www.floodmaps.net/ctp/login.asp.

The purpose of the CTP Database is to

1. Provide FEMA management and staff with a tool to monitor and report on activities at the State, regional, territorial, and national levels; and

2. Provide select data to the public through the CTP portion of the FEMA Flood Hazard Mapping website (http://www.fema.gov/mit/tsd/ctp_news.htm).

Because the CTP Database is an executive-style tool, the data that will be maintained in the database are limited.

The data that the assigned Mapping Partner shall enter into and maintain in the CTP Database can be broken into two categories: (1) data on a particular partnership, and (2) data on mapping activities undertaken by a particular participating CTP. The data that the assigned Mapping Partner shall enter for each category are presented below.

Data on a Particular Partnership

The assigned Mapping Partner shall enter and maintain the data for the database fields identified in bold below for each partnership entered into by FEMA with a community, regional agency, State agency, or other entity.

- **Partner Name**—The name of the CTP as it appears in the signed Partnership Agreement is to be entered.
- **Partner Type**—The following standard categories are to be used: community, regional agency, State agency, and other.
- **Partner Address**—The street address, community, state, and zip code of the CTP are to be entered and maintained.
- **Associated Communities**—The CIDs and names of all communities affected by the Partnership Agreement are to be entered and maintained.
- **FEMA Region**—The FEMA Region number is generated by the database from the State name in the CTP's address.
- **Partner Points of Contact**—The names, titles, CTP roles, addresses, telephone numbers, and fax numbers (if available) of the participating CTP's primary and secondary (if identified) points of contact identified in the Partnership Agreement are to be entered and maintained.
- **FEMA Points of Contact**—The FEMA Region, name, telephone number, and e-mail address of the Regional CTP Coordinator or other FEMA representative identified by the Regional CTP Coordinator is to be entered.
- **Effective Date of Partnership Agreement**—The date that appears in the signed Partnership Agreement is be entered, and a pdf version of the Partnership Agreement is to be linked to the date.

- **Date Testimonial Received**—The date that a testimonial concerning the CTP initiative is received by FEMA is to be entered, and a pdf version of the testimonial is to be linked to that date.

- **Date Other Feedback Received**—The date that other feedback concerning the CTP initiative is received by FEMA is to be entered, and a pdf version of the feedback is to be linked to that date.

- **FEMA CTP Coordinator Comments**—The Regional CTP Coordinator's comments about the partnership are to be entered. These comments may be added directly by the Coordinator or by the assigned Mapping Partner, if requested.

- **Partner Web Address**—The URL address for the CTP's website is to be added, if known.

- **Partner Training Information**—The dates, names, titles, telephone numbers, and e-mail addresses for CTP representatives that attend FEMA-provided training are to be entered and maintained.

Data on a Particular Mapping Activity

The assigned Mapping Partner shall enter and maintain the data for the database fields identified in bold type below for each mapping activity undertaken by a particular CTP under the Partnership Agreement.

- **Mapping Activity Statement Number**—The number that appears in the signed MAS is to be entered.

- **Date Mapping Activity Statement Signed**—The date that appears in the signed MAS is to be entered, and a pdf version of the MAS is to be linked to the date.

- **Type of Mapping Activities Covered by Statement**—One or more activities are to be selected and entered from the following choices, based on what is presented in the signed MAS:

  - Refinement of Approximate Zone A Boundaries;

  - Hydrologic and Hydraulic Analyses and Floodplain Mapping;

  - Digital FIRM Preparation;

  - Redelineation of Detailed Flood Hazard Information Using Updated Topographic Data;

  - Digital Topographic Data Development;

  - Digital Base Map Inventory;

- Digital Base Map Data Sharing;
- Digital FIRM Maintenance;
- Assessment of Community Mapping Needs;
- Technical Standards; and
- Other.

For the "Other" Category, specific information is to be added based on what is in the signed MAS.

- **Date Mapping Activities Initiated**—The projected and actual dates that the mapping activity or activities covered by the MAS were initiated are to be entered and maintained.
- **Date Mapping Activities Completed**— The projected and actual dates that the mapping activity(ies) covered by the MAS were completed and are to be entered.
- **Communities Affected by Mapping Activities**—The CIDs and names for all communities affected by the mapping activity are to be entered.
- **Status of Mapping Activities**—The status of the mapping activity(ies) covered by the MAS are to be entered and maintained. The status information will be entered by, or obtained from, the Regional CTP Coordinator.
- **Partner Points of Contact**—The names, titles, CTP roles, addresses, telephone numbers, fax numbers (if available), and e-mail addresses (if available) of the CTP's primary and secondary (if identified) points of contact for the mapping activity or activities covered by the MAS are to be entered and maintained.
- **Date Testimonial Received**—The date that a testimonial concerning the mapping activity or activities covered by the MAS is received by FEMA is to be entered, and a .pdf version of the testimonial is to be linked to that date.
- **Date Other Feedback Received**—The date that feedback other than a testimonial concerning the MAS is received by FEMA is to be entered, and a pdf version of the feedback is to be linked to that date.
- **FEMA CTP Coordinator Comments**—The Regional CTP Coordinator's comments about the MAS are to be entered. These comments may be entered directly by the Coordinator or by the assigned Mapping Partner if requested.
- **Funds Contribution by Partner, State, or Other Source**—The contributions of the CTP, State, or other source (i.e., county, regional agency) to the mapping activity or activities covered by the MAS and the fiscal year in which the contributions were made

are to be entered. Funds Contributed by FEMA—The funds contributed to the mapping activity(ies) covered by the MAS and the fiscal year in which the funds were contributed, are to be entered from documentation provided by the Regional CTP Coordinator. Individual amounts and years are to be entered for each of three categories—grants, in-kind services, and other. A total amount will be calculated by the Database.

- **Leverage Factor**—This factor, which will be calculated offline, is to be entered. This factor is the total FEMA contribution divided by the combined total of the FEMA and Non-FEMA contributions.

- **Progress Reports Submitted**—The dates for each of four progress reports, required when a participating CTP and FEMA enter into a Cooperative Agreement, are to be entered in the appropriate spaces.

An assigned Mapping Partner shall develop standardized reports that may be generated automatically from the Database. Final decisions regarding the development of reports will be the responsibility of the FEMA National CTP Coordinator. An assigned Mapping Partner also shall provide program support to enhance the functionality of the CTP Database and the associated Database User Guide.

[February 2002]

3.18.1.6 Website Enhancement, Implementation, and Maintenance

The assigned Mapping Partner shall be prepared to support the maintenance and enhancement of the CTP portion of the Flood Hazard Mapping website on the fema.gov website (http://www.fema.gov/mit/tsd/ctp_main.htm) and on the FEMA mirror website (http://www.floodmaps.net/mit/tsd/ctp_main.htm). This support consists of developing content for the website, reviewing material for the website, and upgrading the website to meet FEMA and Mapping Partner requirements as they are identified.

[February 2002]

3.18.1.7 Programmatic and Technical Support for Partners and Regional Offices

The assigned Mapping Partner shall be prepared to provide programmatic and technical support to both the CTPs themselves and to RO staff as required to assist in the completion of agreed-upon Mapping Activities. Such support may include:

- Providing copies of LOMCs, other technical and administrative support data, and data collected as part of the FEMA MNAP;

- Procuring and providing copies of FEMA documents that the CTP has difficulty locating;

- Providing training on existing hydrologic and hydraulic modeling or flood mapping techniques; flood study processing requirements; and data submittal requirements;

- Assisting CTP in obtaining approval of new hydrologic and hydraulic models; and
- Assisting Regional CTP Coordinators with development of agreements.

[February 2002]

3.18.1.8 Training Development and Implementation Support

The assigned Mapping Partner shall be prepared to participate in the development and maintenance of a training program for new CTPs. The focus of this training will be on introducing CTP administrators and key technical staff to the CTP initiative and providing them with tools that will assist them in completing mapping activities successfully. Initially, this training program will be presented at the Emergency Management Institute in Emmitsburg, Maryland. Eventually, however, the Regional CTP Coordinators may give the training at ROs or other regional sites.

The assigned Mapping Partner shall be prepared to:

- Develop PowerPoint presentations and other in-class instructional materials;
- Provide FEMA with content-specific instructors who may assist in the training sessions; and
- Provide logistical support, including working with Regional CTP Coordinators to identify potential class participants and production of Instructor Guides, Student Manuals, and CD-ROMs with other useful tools and materials.

[February 2002]

3.18.2 Deliverable Products

The deliverable products that the assigned Mapping Partner may be asked to provide as a result of the support activities summarized in Subsection 3.18.2 will vary depending on the task assigned directly by the FEMA National CTP Coordinator or by a Regional CTP Coordinator.

[February 2002]

3.19 Support for Other Map Modernization Objectives

3.19.1 Overview

As mentioned earlier in these Guidelines, FEMA has developed a plan for modernizing the NFIP maps and improving other aspects of the products and services offered through the NFIP. This plan is documented in a FEMA report entitled *Modernizing FEMA's Flood Hazard Mapping Program, A Progress Report* (FEMA, 2001). As a result of that Plan, State and community officials, private property owners, and other Mapping Partners will be made more aware of flood hazards nationwide.

The cornerstones of the plan are to use state-of-the-art technology to cost effectively develop accurate and complete flood hazard information for the entire United States; provide that information in readily available, easy-to-use format; and alert and educate the public regarding the risk of flood hazards. As indicated in the progress report, FEMA plans to use existing digital engineering, mapping, information management, and electronic communication technologies to improve the mapping program in four primary areas:

1. Map accuracy and completeness;
2. Map utility;
3. Map production; and
4. Public awareness and customer service.

[February 2002]

3.19.2 Current and Future Objectives

A complete list of current and future objectives as well as a list of completed objectives is provided in the Map Modernization portion of the FEMA Flood Hazard Mapping website (http://www.fema.gov/mit/tsd/mm_main.htm). To implement the current objectives of the plan, FEMA has formed numerous Work Groups, comprised of representatives from FEMA HQ, FEMA ROs, and FEMA Mapping Partners. These Work Groups, led by a FEMA staff member, have been charged with developing documentation for and implementing the various objectives. As FEMA identifies new objectives, more Objective Work Groups will be formed.

In general, the responsibilities of the members of each Objective Work Group are as follows:

- Assess selected old and new flood hazard mapping processes and products;
- Develop ideas for improving the identified processes and products;

- Coordinate with other Work Groups and with other Mapping Partners that may provide useful input; and
- Develop plan for implementation of improved processes and products.

[February 2002]

3.19.3 Support Activities

Assigned Mapping Partners shall, at the request of FEMA RO and HQ staff and at the direction of the PO or his/her designee, provide technical, programmatic, and logistical support for the implementation of Map Modernization Objectives, including:

- Attending Objective Work Group meetings on an as-needed basis to support development and implementation of improved processes and products;
- Setting up or hosting Objective Work Group meetings:
- Setting up or hosting conferences/seminars for multiple Objective Work Groups;
- Enhancing and maintaining the Map Modernization portion of the FEMA Flood Hazard Mapping website (http://www.fema.gov/mit/tsd/mm_main.htm);
- Preparing outreach materials (e.g., flyers, brochures, web-related materials) documenting Map Modernization activities;
- Assisting in the development of regulatory changes and guidance documents to facilitate the implementation of improved processes and products; and
- Providing information for posting on the FEMA Flood Hazard Mapping website concerning Map Modernization activities.

[February 2002]

3.19.4 Deliverable Products

The deliverable products that the assigned Mapping Partners shall provide to FEMA will vary depending on the task assigned to the Mapping Partner by the FEMA PO, his/her designee, Objective Work Group leader, or the FEMA National Map Modernization Program Coordinator. Deliverable products shall include, but are not limited to, the following:

- Meeting minutes from Objective Work Group meetings;
- Status reports for the entire Map Modernization Program;
- Outreach materials regarding Map Modernization Program, including one-page flyers and website updates;

- Logistical support for State/national floodplain management and insurance conferences;
- Summary reports of Objective Work Group findings;
- Guidance documents (e.g., guidelines and specifications, procedure manuals); and
- New map and report products, PowerPoint presentations, and other logistical support for Objective Work Group meetings.

[February 2002]

3.20 Q3 Flood Data Maintenance

To support disaster recovery operations, FEMA developed specifications for a digital product referred to as the Q3 Flood Data product. The Q3 Flood Data product is designed to serve FEMA's Response and Recovery activities as well as flood insurance policy marketing initiatives. This product is designed to allow rapid access to and distribution of digital FIRM data, and is compatible with all existing DFIRM data already available and underway. Specifications are outlined in detail in the FEMA draft document entitled *Q3 Flood Data Specifications* (FEMA, 1996).

The assigned Mapping Partner shall produce and/or update Q3 Flood Data at the request of the PO or his/her designee. The assigned Mapping Partner shall ensure all Q3 Flood Data files conform to the standards outlined in Appendix L of these Guidelines and in the FEMA draft document entitled *Q3 Flood Data Specifications* (FEMA, 1996). Highlights of these specifications are presented in Subsections 3.20.1 through 3.20.5.

[February 2002]

3.20.1 Contents

The assigned Mapping Partner shall develop and/or update the Q3 Flood Data product by scanning and vectorizing, digitizing the existing hard copy FIRM, or converting a DFIRM to the Q3 Flood Data format to create a thematic overlay of flood risks. Q3 Flood Data files contain only certain features from the existing hardcopy FIRM, including the following:

- 1-percent-annual-chance (100-year) and 0.2-percent-annual-chance (500-year) floodplain areas, including Zone V areas, certain regulatory floodways, and zone designations;
- Coastal Barrier Resource System (CBRS) areas and Otherwise Protected Areas (OPAs);
- Political areas, including CID;
- FIRM panel areas, including panel number and suffix;
- USGS 7.5-minute-series quadrangle map areas; and
- Mappable LOMCs.

In the preparation of Q3 Flood Data files, the assigned Mapping Partner shall use sources that reflect updates effected by LOMRs, LOMAs, and LOMR-Fs. These revisions and amendments are to be included in the Q3 Flood Data product if they are mappable at the publication scale of the source graphic.

The Q3 Flood Data files shall not include the following:

- Base map data (e.g., streets);
- BFE lines and values;
- Cross sections and letter identifiers;
- Elevation Reference Marks and related elevations;
- Internal boundaries of contiguous CBRS areas and OPAs; and
- Prohibition dates associated with individual CBRS areas and OPAs.

With the exception of minor graphical mismatches, the assigned Mapping Partner shall not correct edge-matching errors, overlaps and underlaps in coverage, and similar problems during digital capture.

The hard copy FIRMs from which the data for the Q3 Flood Data product are extracted contain no horizontal control. The specifications for the horizontal control of these data are consistent with those required for mapping at a scale of 1:24,000. The assigned Mapping Partner shall typically perform the horizontal controlling of these data by fitting the vectors to a georeferenced USGS 7.5-minute-series quadrangle file.

The Q3 Flood Data product is contained in one single countywide file, including all incorporated and unincorporated areas of a county. The feature items and attributes are defined in detail in the FEMA draft document entitled *Q3 Flood Data Specifications* (FEMA, 1996). The means for linking other associate NFIP data to these files can be derived from the attributes contained within the files. For example, the effective FIRM panel from the FEMA *Community Status Book* or the Flood Map Information System maintained by the MSC can be compared to the FIRM panel information in the Q3 Flood Data files to determine whether the Q3 Flood Data files reflect the current mapping.

[February 2002]

3.20.2 Identification of Q3 Flood Data Maintenance Needs

Before Q3 Flood Data product files are updated, the assigned Mapping Partner shall identify and prioritize areas with update needs. The Mapping Partner must compare the Q3 Flood Data product panels and the effective FIRM panels to identify which Q3 Flood Data product panels have been changed or superseded, while simultaneously identifying on which panels LOMCs fall.

The assigned Mapping Partner shall prioritize FIRM panels using criteria such as the amount of change, whether they are already in a digital format (i.e., DFIRMs), or other means. The Mapping Partner may also include additional information about FIRM panels with flood insurance policies or other pertinent data in the prioritization process.

The assigned Mapping Partner shall submit the list of potential Q3 Flood Data product updates to FEMA for review. FEMA reviews the list to determine which counties or panels should be updated. The Mapping Partner shall provide cost estimates for Q3 Flood Data product updates to FEMA when requested to support this review and decision process.

[February 2002]

3.20.3 Applications

The Q3 Flood Data product does not replace the existing hardcopy FIRM or, if one exists, the existing DFIRM product. The product has been designed to support disaster response, planning, and some Community Rating System activities; insurance marketing; and mortgage portfolio review. It does not provide BFE information; thus, it has limited application for engineering analysis, particularly for site design or rating of flood insurance policies for properties located in SFHAs.

The Q3 Flood Data product is not tied to a base map, it is not used to produce a new version of the hardcopy FIRM, and it is not subject to community review. The Q3 Flood Data product is intended to provide users with automated flood risk data suitable for determining whether features are inside or outside the SFHA shown on the FIRM/DFIRM.

The Q3 Flood Data product can be a valuable tool to assist in screening property addresses within a GIS environment to determine the associated flood risks. However, as the geographic processing performed to develop the Q3 Flood Data product may introduce differences with the hardcopy FIRMs, product users must exercise considerable care and judgment in the application of this product.

[February 2002]

3.20.4 Horizontal Control

The hardcopy FIRMs from the Q3 Flood Data are extracted contain no horizontal control. The assigned Mapping Partner shall typically establish horizontal control of these data by fitting the vectors to a georeferenced raster or vector 7.5-minute quadrangle file. This approach to horizontal control is consistent with that required for mapping at a scale of 1:24,000.

[February 2002]

3.20.5 Tiling

The Q3 Flood Data files shall be tiled by U.S. Census Bureau county equivalent units. In some cases, the county boundaries shown on hardcopy FIRMs will not correspond to the county equivalent boundaries in the U.S. Census Bureau Topologically Integrated Geographic Encoding and Reference system files. Where this is the case, the assigned Mapping Partner shall use the FIRM county boundary as the bounding and tiling extents of the Q3 Flood Data files.

[February 2002]

3.20.6 Data Quality

FEMA will distribute the Q3 Flood Data product only after is has passed checking routines contained in FEMA's Q3 Quality Assurance Checking Software. The data are then accompanied by documentation showing that the files have been checked and passed. Using the FEMA software and manual checks, the assigned Mapping Partner shall ensure that FEMA attribute accuracy, topology, and logical consistency requirements are met.

[February 2002]

3.20.6.1 Attribute Accuracy

The assigned Mapping Partner shall use the FEMA Q3 Quality Assurance Checking Software to test the attributes of the dataset against a master set of valid attributes and attribute combinations. In addition, the assigned Mapping Partner shall test attribute accuracy by manually comparing the source hardcopy FIRM with hardcopy plots of the Q3 Flood Data and a symbolized display on an interactive computer graphic system. The assigned Mapping Partner shall individually query those attributes that cannot be verified visually.

[February 2002]

3.20.6.2 Topology

The assigned Mapping Partner shall check the Q3 Flood Data product files to ensure certain node-area-line relationships are collected or generated to satisfy topological requirements, including the following:

- Lines begin and end at nodes.
- Lines connect to each other at nodes.
- Lines do not extend through nodes.
- Left and right areas are defined for each line segment and are consistent throughout the files.
- Lines representing the limits of the file neatlines are free of gaps.

[February 2002]

3.20.6.3 Logical Consistency

The assigned Mapping Partner shall perform tests of logical consistency using ARC/INFO software modules. The Mapping Partner also shall review check plots to ensure closure for all internal polygons.

[February 2002]

3.20.7 Formats

The assigned Mapping Partner shall prepare the Q3 Flood Data product files in one of the following formats: Digital Line Graph (DLG), ARC/INFO format, and MapInfo format. These three formats may be accessed directly by the ARC/INFO, ArcView, ArcCAD, MapInfo, and GENAMAP software packages. Some GIS software packages provide utilities to convert DLG files into their own proprietary format. Other CADD and GIS software packages may require translation of the Q3 Flood Data using a third-party utility.

[February 2002]

3.20.8 Projections

FEMA uses the Universal Transverse Mercator projection and coordinate systems for the version of the Q3 Flood Data product prepared in DLG format. The assigned Mapping Partner shall use the geographic projection and coordinate systems for the production of Q3 Flood Data products in ArcInfo and MapInfo formats.

[February 2002]

3.20.9 File Naming

To provide for efficient file retrieval and indexing, the assigned Mapping Partner shall apply a standardized naming convention for the Q3 Flood Data product. The naming convention is DOS-compatible and allows for the unique identification of any county area of digital FIRM data. All file names are in lower-case letters. The files names shall appear as "csscc," where c is the charter "c", ss is the Federal Information and Processing Standards (FIPS) code for the State, and ccc is the FIPS code for the county.

[February 2002]

3.20.10 Metadata File

The assigned Mapping Partner shall deliver one metadata file for each county file. The Mapping Partner shall produce the metadata file in a format that is in compliance with the Federal Geographic Data Committee (FGDC) guidelines. The metadata file shall be in the form of a text file on electronic medium containing the digital files. The Mapping Partner shall follow the format described by the FGDC in *Content for Digital Geospatial Data Metadata* (FGDC, 1994).

The assigned Mapping Partner shall assign the file names for the metadata files using the same naming convention as the other files, with the exception of the letter "m" appearing at the end. Examples of metadata files are outlined in detail in the FEMA draft document entitled *Q3 Flood Data Specifications* (FEMA, 1996).

[February 2002]

3.21 Support for Conversion/Compliance Process

An assigned Mapping Partner may be asked to support FEMA in tracking communities through the conversion/compliance process and preparing documentation for communities' entry into the Emergency and Regular Phases of the NFIP. Descriptions and copies of the letters and *Federal Register* notices cited in Subsections 3.21.1 and 3.21.2 are provided in Appendix E of the FEMA *Document Control Procedures Manual* (FEMA, 2000).

[February 2002]

3.21.1 Conversion/Compliance Process

The conversion/compliance process occurs after FEMA completes the initial FIRM for a community. As discussed in Volume 1, Section 1.5 of these Guidelines, FEMA provides communities with a compliance period (usually, 6 months) to enact floodplain management measures that are compliant with Section 60.3 of the NFIP regulations before the FIRM effective date. When required, FEMA sends 90- and 30-day suspension letters to communities before the end of the compliance period, which coincides with the FIRM effective date. Communities that do not adopt ordinances consistent with the NFIP regulations by the compliance/FIRM effective date are suspended from participation in the NFIP. When these suspended communities submit compliant ordinances to FEMA, FEMA reinstates the communities as participants in the NFIP.

As mentioned in Volume 1, Section 1.5 of these Guidelines, the Mapping Partner that processes the Preliminary and Final FIRM for FEMA must maintain a schedule and track communities for each scheduled conversion/effective date and process 90- and 30-day suspension letters as required. FEMA then selects one Mapping Partner to track the communities through the 6-month conversion/compliance process. Specifically, the assigned Mapping Partner shall:

- Develop a list, in order by FEMA Region, of all communities in the conversion/compliance process using lists forwarded from the Mapping Partners that are processing the new or revised FIRMs;
- Submit the consolidated list, which includes the land use code; date of entry into Emergency Phase or Regular Phase of the NFIP; and map effective date for each community, to FEMA for their use;
- Research the CIS for the required data (i.e., Emergency/Regular Phase entry dates, CID, past suspension and reinstatement dates, current map date) for processing the Final Rule entitled "Suspension of Community Eligibility";
- Prepare the Final Rule entitled "Suspension of Community Eligibility" for publication in the *Federal Register*;
- Review a FEMA-provided report to identify communities for which FEMA has withdrawn a suspension and reinstated them in the NFIP; and

- Prepare the Final Rule entitled "List of Eligible Communities" as required for publication in the *Federal Register*.

Additional information on the Final Rules cited above is provided in Subsection 6.1 and Appendix E of the FEMA *Document Control Procedures Manual* (FEMA, 2000).

[February 2002]

3.21.2 Correspondence for Newly Eligible Communities

As communities submit the necessary paperwork to become eligible for participation in the NFIP, appropriate correspondence must be prepared for the newly eligible communities. The tasks that the assigned Mapping Partner shall complete in support of FEMA are as follows:

- Prepare the appropriate eligibility letter and sample news release based on the status of the community in the NFIP;
- Submit the required letter and news release to FEMA for signature within 3 working days;
- Mail the letter, news release, notice regarding 30-day waiting period for insurance, and the FEMA brochure entitled *Answers to Questions About the National Flood Insurance Program* (if appropriate); and
- Distribute external and in-house file copies.

Additional information on the documents cited above is provided in Subsection 6.2 and Appendix E of the FEMA *Document Control Procedures Manual* (FEMA, 2000).

[February 2002]

3.22 Other Program Support

The assigned Mapping Partner shall, at the request of FEMA RO and HQ staff and at the direction of the PO or his/her designee, provide technical, programmatic, and logistical support to FEMA other than what is documented in this section in its administration of the NFIP and other hazard-related programs.

[February 2002]

3.23 References

Federal Emergency Management Agency, *Congressional Correspondence Handbook*, February 26, 1993.

Federal Emergency Management Agency, FEMA Manual 5200.1, *Correspondence Management*, undated.

Federal Emergency Management Agency, FEMA Manual 5400.4, *Records Management, Records Disposition Schedules and Files Plan*, undated.

Federal Emergency Management Agency, *Document Control Procedures Manual*, July 2000.

Federal Emergency Management Agency, *Modernizing FEMA's Flood Hazard Mapping Program: A Progress Report*, May 2001.

Federal Emergency Management Agency, *Q3 Flood Data Specifications, Draft,* March 1996.

Federal Geographic Data Committee, *Content Standards for Digital Geospatial Metadata*, June 8, 1994.

Interagency Advisory Committee on Water Data, Office of Water Data Coordination, Hydrology Subcommittee, Bulletin No. 17B, "Guidelines for Determining Flood Flow Frequency," September 1981, Revised March 1982.

U.S. Department of the Interior, Geological Survey, Water Resources Investigation Report 94-4002, *Nationwide Summary of U.S. Geological Survey Regional Regression Equations for Estimating Magnitude and Frequency of Floods for Ungaged Sites, 1993*, M.E. Jennings, W.O. Thomas, Jr., and H.C. Riggs, 1994.

U.S. Postal Service, *Domestic Mail Manual*, undated.

[February 2002]

Map MODERNIZATION

Federal Emergency Management Agency

FEMA's Flood Hazard Mapping Program

Guidelines and Specifications *for* Flood Hazard Mapping Partners

Appendix A: Guidance for Aerial Mapping and Surveying

FEDERAL EMERGENCY MANAGEMENT AGENCY

www.fema.gov/mit/tsd/dl_cgs.htm

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February 2002

Appendix A

Guidance for Aerial Mapping and Surveying

A.1 Introduction

This Appendix presents Federal Emergency Management Agency (FEMA) aerial mapping and surveying guidelines and specifications that have been established to specify the quality of the spatial data products to be produced, including work maps and base maps used in the production of Flood Insurance Rate Maps (FIRMs), Digital Flood Insurance Rate Maps (DFIRMs), and DFIRM-Digital Line Graphs (DFIRM-DLGs). The term "FIRM" is used generically hereinafter to specify this "family" of FEMA spatial products.

This Appendix also includes guidance for ground surveys of control points, cross sections, and hydraulic structures; topographic mapping using photogrammetry, LIght Detection and Ranging (LIDAR) or other airborne remote-sensing technologies, consistent with FEMA and industry standards.

[February 2002]

A.1.1 Base Maps

A FIRM base map is a planimetric map, in digital or hardcopy format, showing the georeferenced horizontal location of mapped features, without depiction of elevation data such as contour lines. Georeferencing means that the map depicts the spherical earth projected as a plane map, normally with Universal Transverse Mercator (UTM) or State Plane coordinates, with or without tick marks or lines that depict parallels (lines of equal latitude) or meridians (lines of equal longitude). Base maps may be categorized as either vector maps or raster image maps, depending on how they are produced.

Vector maps result from linear features (e.g., roads, railroads, streams) digitized as single-line centerlines or, alternatively, as dual-lines showing the outer extremities of linear features (e.g., left and right banks of streams, curb lines on both sides of streets). Vector maps are digitized in a way so that a Geographic Information System (GIS) can automatically derive intelligence from the vector features and perform analyses (e.g., adjacency analyses, proximity analyses, and connectivity analyses).

Raster image maps result from digital scanning of paper maps, map negatives, aerial photographs, and orthorectification of those images so that they are accurately georeferenced with distortions removed. Raster image maps rely on human interpretation of scanned or imaged features to derive intelligence therefrom. The most common form of raster image map is the digital orthophoto, especially the standard digital orthophoto quarter-quad (DOQ) produced by the U.S. Geological Survey (USGS).

For a more detailed discussion of FIRM base maps, see Appendix K of these Guidelines.

[February 2002]

A.1.2 Work Maps

FIRM work maps are discussed in Volume I, Subsection 1.4.2.3.4, as part of the discussion of requirements for flood hazard analyses performed as part of a Flood Map Project.

[February 2002]

A.1.3 Manual and Automated Analysis Procedures

A distinction is made in this Appendix between manual and automated hydrologic and hydraulic analysis procedures. Manual procedures rely on maps with contours for human interpretation and a relatively few number of cross sections selected to be representative of average conditions in reaches that are as long as possible without permitting excessive conveyance change between cross sections. Automated procedures normally use high-density elevation points (in lieu of contours) and computer generation of a potentially larger number of cross sections representative of shorter reaches.

[February 2002]

A.2 Industry Geospatial Standards

In 1998, the Federal Geographic Data Committee (FGDC) published *Geospatial Positioning Accuracy Standards*, that replaced both the *United States National Map Accuracy Standards* (NMAS) published by the Office of Management and Budget in 1947 (Bureau of the Budget, 1947) and the *ASPRS Accuracy Standards for Large-Scale Maps* (ASPRS, 1990) published in 1990 by the American Society for Photogrammetry and Remote Sensing (ASPRS). Designed specifically for digital spatial data products, this new FGDC standard has three parts:

- Part 1, Reporting Methodology (FGDC-STD-007.1-1998)
- Part 2, Standards for Geodetic Networks (FGDC-STD-007.2-1998); and
- Part 3, National Standard for Spatial Data Accuracy (FGDC-STD-007.3-1998)

FGDC-STD-007.1-1998-STD-007.1- provides a common methodology for reporting the accuracy of horizontal and vertical coordinate values of digital geospatial products. Specifically, the reporting standard in the horizontal component ($Accuracy_r$) is the radius of a circle of uncertainty, such that the true or theoretical location of the point falls within that circle 95-percent of the time. The reporting standard in the vertical component ($Accuracy_z$) is a linear uncertainty value, such that the true or theoretical location of the point falls within $\pm$ of that linear uncertainty value 95-percent of the time. It also defines the meanings of "local accuracy" and "network accuracy" and other terms used in the FGDC standard. Part 1 of the *Geospatial Positioning Accuracy Standards* is available on-line at: www.fgdc.gov/standards/documents/standards/chapter1.pdf.

FGDC-STD-007.2-1998 provides a common methodology for determining and reporting the accuracy of horizontal and vertical coordinate values for geodetic control points represented by survey monuments, such as brass disks and rod marks. It provides a means to directly compare the accuracy of coordinate values obtained by one method, e.g., a classical line-of-sight traverse, with the accuracy of coordinate values obtained by another method, e.g., a Global Positioning System (GPS) geodetic network survey, for the same point. It explains how "network accuracy" is achieved by properly connecting survey and mapping data to control points in the National Spatial Reference System (NSRS). Part 2 of the *Geospatial Positioning Accuracy Standards* is available on the FGDC website at www.fgdc.gov/standards/documents/standards/chapter2.pdf.

FGDC-STD-007.3-1998 implements a statistical and testing methodology for estimating the positional accuracy of points on maps and in digital geospatial data, with respect to georeferenced ground positions of higher accuracy. If errors have a normal distribution and if systematic errors have been eliminated as best as possible, the National Standard for Spatial Data Accuracy (NSSDA) uses root-mean-square error (RMSE) to estimate positional accuracy of x, y and z coordinates ($RMSE_x$, $RMSE_y$ and $RMSE_z$ respectively). FGDC-STD-007.3-1998 defines RMSE as the square root of the average of the set of squared differences between dataset coordinate values and coordinate values from an independent source of higher accuracy for identical points and it defines (horizontal) radial accuracy in terms of $RMSE_r$ computed as a function of $RMSE_x$ and $RMSE_y$. FGDC-STD-007.3-1998 provides NSSDA testing guidelines, it relates $Accuracy_r$ and

$Accuracy_z$ (horizontal and vertical accuracies at the 95-percent confidence level) to $RMSE_r$ and $RMSE_z$, and it documents the statistical relationship between the NSSDA and the prior National Map Accuracy Standard (NMAS) and ASPRS 1990 standards. Part 3 is available on-line at www.fgdc.gov/standards/documents/standards/chapter3.pdf.

Other industry standards relevant to this Appendix include:

- National Oceanic and Atmospheric Administration Technical Memorandum NOS NGS-58, *Guidelines for Establishing GPS-Derived Ellipsoid Heights (Standards: 2 cm and 5 cm), version 4.3, (*NOAA, 1997) which is available on-line at www.ngs.noaa.gov/PUBS_LIB/NGS-58.html and is referred to hereinafter as "NGS-58;"

- *Digital Elevation Model Technologies and Applications: The DEM Users Manual* (ASPRS, 2001);

- *ASPRS Draft Aerial Photography Standards,* "Photogrammetric Engineering & Remote Sensing" (ASPRS, 1995);

- U.S. Army Corps of Engineers, Engineer Manual 1110-1-1000, *Photogrammetric Mapping* (USACE, 1993); and

- U.S. Army Corps of Engineers, Engineer Manual 1110-2-1003, *Hydrographic Surveying* (USACE, 1994)

[February 2002]

A.3 Accuracy Guidelines

For decades, when topographic maps were produced photogrammetrically and printed in hardcopy form, users became accustomed to specifying map requirements in terms of the published *map scale* and *contour interval.* Users generally understood the meaning of those terms, and photogrammetrists had well-established procedures for determining the flying height, forward overlap and sidelap, aerial triangulation, and map compilation procedures necessary to consistently produce a map to the required map scale and contour interval, in conformance with the National Map Accuracy Standard (NMAS).

With the new NSSDA designed for digital geospatial data, the defining parameters are much more complex. What once had been a simple standard printed on one page (i.e., the NMAS) has become a complex standard (i.e., the NSSDA) that is nearly one inch thick. The more complex standard was necessary to accommodate the variables and options available with digital geospatial data and the increased complexity of digital data that are subject to use (and misuse) in many different ways.

FEMA has chosen to define its digital topographic data accuracy requirements in terms of map scale and contour interval *equivalent* to NMAS terminology, but also cross-referenced to radial root-mean-square-error ($RMSE_r$) and/or $Accuracy_r$ (to define horizontal accuracy at the 95-percent confidence level), and $RMSE_z$ and/or $Accuracy_z$ (to define vertical accuracy at the 95-percent confidence level) as defined by the NSSDA, assuming the errors have a normal distribution. The NSSDA does not say what to do when errors do not follow a normal distribution, as is often the case with LIDAR datasets. ASPRS, 2001, Chapter 12 (DEM Quality Assessment) proposes a 5-step approach that includes the use of the 95th percentile error as the next best method for estimating $Accuracy_z$ when it is determined (through statistical "outliers," discussed in Section A.8.3.1.3) that checkpoint errors do not follow a normal distribution.

As shown in Tables A-1 and A-2 below, these NMAS and NSSDA terms are also cross-referenced to ASPRS, 1990 Class 1, Class 2, and Class 3 standards -- terms still used by the industry. To simplify the terminology, FEMA has reduced the complex requirements to two standard choices for digital elevation data, expressed as equivalent contour intervals:

- Two-foot equivalent contour interval for flat terrain ($Accuracy_z$ = 1.2 foot at 95% confidence level). This means that 95% of the elevations in the dataset will have an error with respect to true ground elevation that is equal to or smaller than 1.2 ft.

- Four-foot equivalent contour interval for rolling to hilly terrain ($Accuracy_z$ = 2.4 ft at 95% confidence level.) This means that 95% of the elevations in the dataset will have an error with respect to true ground elevation that is equal to or smaller than 2.4 ft.

The FEMA Lead for a Flood Map Project -- usually, the Regional Project Officer (RPO) or the Project Officer (PO) at FEMA Headquarters -- may select non-standard alternatives when valid and compelling reasons for specifying other accuracy standards exist.

[February 2002]

A.3.1 Horizontal Accuracy Criteria

Several accuracy standards are still in use today for the mapping industry. The following is a description and comparison of the different standards used and which apply.

The NMAS (Bureau of the Budget, 1947) states: "Horizontal accuracy: For maps on publication scales larger than 1:20,000, not more than 10% of the points tested shall be in error by more than $1/30^{th}$ of an inch, measured on the publication scale." This 1/30 inch standard for large-scale maps is called the Circular Map Accuracy Standard (CMAS). The NMAS became obsolete for digital mapping products because computers can easily change the scale of a map, and maps do not become more accurate just because the computer enables users to "zoom in" on the map to display it at a larger scale.

To prevent abuse of digital mapping data, the mapping industry operated during much of the 1990's under ASPRS, 1990. ASPRS 1990 standards established limiting RMSEs for three classes of maps (Class 1, Class 2, Class 3), along with typical map scales associated with the limiting errors. Three times the "limiting RMSE" was essentially a 100-percent confidence level standard.

In 1998, the FGDC published NSSDA which superseded both the NMAS and ASPRS 1990 standards for digital mapping products. NSSDA implemented a statistical and testing methodology for estimating the positional accuracy of points on maps and in digital geospatial data, with respect to georeferenced ground positions of higher accuracy. Radial RMSE ($RMSE_r$) calculations were established, and radial accuracy ($Accuracy_r$) at the 95-percent confidence level was established as 1.7308 x $RMSE_r$. $Accuracy_r$ is defined as "the radius of a circle of uncertainty, such that the true or theoretical location of the point falls within that circle 95-percent of the time." NSSDA specifies horizontal errors at the 95-percent confidence level, whereas the NMAS specified horizontal errors at the 90-percent confidence level, and ASPRS 1990 specified horizontal errors at nearly the 100-percent confidence level. When assuming all horizontal errors have a normal distribution, the NSSDA/NMAS conversion factor is as follows:

$$Accuracy_r = CMAS \times 1.1406.$$

With NSSDA, $RMSE_r$ is defined in terms of feet or meters at ground scale rather than in inches or millimeters at the target map scale. The $RMSE_r$ of a DFIRM panel is the cumulative result of all errors including those introduced by Mapping Partners in performing ground surveys, aerial triangulation, map compilation, and digitization activities. The $RMSE_r$ and $Accuracy_r$ values shown in Table A-1 are the maximum permissible values established by NSSDA for base maps compiled at 1"=500' and 1"=1000' under NMAS. Table A-1 serves as a "crosswalk" between the NMAS, NSSDA, and ASPRS 1990 horizontal accuracy standards. Note that $RMSE_r$ = square root of ($RMSE_x^2 + RMSE_y^2$).

Table A-1 Comparison of Horizontal Accuracy Standards

NMAS Map Scale	**NMAS** CMAS 90% confidence level	**NSSDA** $Accuracy_r$ 95% confidence level	**NSSDA** $RMSE_r$	**ASPRS 1990** Class 1/2/3 Limiting $RMSE_r$
1" = 500'	16.7 feet	19.0 feet	11.0 feet	7.1 feet (Class 1) 14.1 feet (Class 2) 21.2 feet (Class 3)
1" = 1,000'	33.3 feet	38.0 feet	22.0 feet	14.1 feet (Class 1) 28.3 feet (Class 2) 42.4 feet (Class 3)
1" = 2,000'	40.0 feet	45.6 feet	26.3 feet	28.3 feet (Class 1) 56.5 feet (Class 2) 84.9 feet (Class 3)

Thus, when FEMA specifies a base map at 1" = 500', for example, this is the same as FEMA specifying that a digital base map should have a horizontal (radial) $RMSE_r$ of 11 feet or $Accuracy_r$ of 19 feet at the 95-percent confidence level, for consistency with the new NSSDA.

When a base map is compiled at 1"=1,000' and is published at a hardcopy map scale of 1"=500', the horizontal accuracy remains that of the 1"=1,000' map scale. Therefore, such a 1"=500' map would be compiled to meet 38-foot horizontal accuracy at 95-percent confidence level, rather than 19-foot horizontal accuracy at 95-percent confidence level as is normally expected of maps published at a scale of 1"=500'. This is an example where "zooming in" on a map image does not make the map any more accurate.

[February 2002]

A.3.2 Vertical Accuracy Criteria

Several standards for computing vertical accuracy also are in use by the mapping industry. These are discussed and compared below.

The NMAS (Bureau of the Budget, 1947) states:

> Vertical accuracy, as applied to contour maps on all publication scales, shall be such that not more than 10 percent of the elevations tested shall be in error more than one-half the contour interval. In checking elevations taken from the map, the apparent vertical error may be decreased by assuming a horizontal displacement within the permissible horizontal error for a map of that scale.

This one-half contour interval under NMAS is called the Vertical Map Accuracy Standard (VMAS). NMAS became obsolete for digital mapping products because computers can easily change the scale and contour interval of a map, and maps don't get more accurate just because the computer can take 10-foot contours, for example, and regenerate 5-, 2- or 1-foot contours for higher resolution display purposes.

Under ASPRS 1990 standards, which were used during much of the 1990s, the mapping industry operated with vertical RMSEs equal to one-third of the contour interval for ASPRS Class 1 maps, two-thirds of the contour interval for ASPRS Class 2 maps, and full contour interval for ASPRS Class 3 maps. Again, three times the limiting $RMSE_z$ was a standard at almost the 100-percent confidence level (99.75-percent).

In 1998, NSSDA also superseded both the NMAS and ASPRS 90 vertical accuracy standards for digital mapping products. Vertical RMSE ($RMSE_z$) calculations were established, and vertical accuracy ($Accuracy_z$) at the 95-percent confidence level was established as 1.9600 x $RMSE_z$ when errors follow a normal distribution. $Accuracy_z$ is defined as "the linear uncertainty value, such that the true or theoretical location of the point falls within ± of that linear uncertainty value 95-percent of the time." Again, note that NSSDA specifies vertical errors at the 95-percent confidence level whereas NMAS specified vertical errors at the 90-percent confidence level, and the ASPRS 1990 specified vertical errors at nearly the 100-percent confidence level. When assuming all vertical errors have a normal distribution, the NSSDA/NMAS conversion factor is as follows:

$$Accuracy_z = VMAS \times 1.1916$$

Contrary to NMAS, NSSDA does not specifically state that the apparent vertical error may be decreased by assuming a horizontal displacement within the permissible horizontal error.

With NSSDA, $RMSE_z$ is defined in terms of feet or meters at ground scale rather than in terms of the contour interval of the published map. The $RMSE_z$ and $Accuracy_z$ values shown in Table A-2 are the maximum permissible values established by the NSSDA for digital elevation data equivalent to maps compiled with 2-foot and 4-foot contours compiled under NMAS. Table A-2 serves as a "crosswalk" between the NMAS, NSSDA and ASPRS 1990 vertical accuracy standards. This comparison is only statistically valid, however, when vertical errors have a normal distribution.

Table A-2 Comparison of Vertical Accuracy Standards

NMAS Contour Interval	**NMAS** VMAS 90% confidence level	**NSSDA** $Accuracy_z$ 95% confidence level	**NSSDA** $RMSE_z$	**ASPRS 1990** Class 1/2/3 Limiting $RMSE_z$
2 feet	1 foot	1.2 feet	0.6 foot 18.5 cm	0.7 foot (Class 1) 1.3 feet (Class 2) 2.0 feet (Class 3)
4 feet	2 feet	2.4 feet	1.2 feet 37.0 cm	1.3 feet (Class 1) 2.7 feet (Class 2)

				4.0 feet (Class 3)

Thus, when FEMA specifies 2-foot contour interval mapping, for example, this is the same as specifying that digital topographic data, regardless of whether the data are digital contours, mass points and breaklines, Triangulated Irregular Networks (TINs), or Digital Elevation Models (DEMs), should have vertical $RMSE_z$ of 0.6 foot (18.5 cm) or $Accuracy_z$ of 1.2 feet (37 cm) at the 95-percent confidence level, for consistency with the NSSDA.

[February 2002]

A.3.3 Accuracy Labeling

Since contours or DEMs are not printed on DFIRMs, their vertical accuracy does not need to be labeled on DFIRMs, but the vertical accuracy is still recorded in the metadata of elevation datasets used for hydrologic and hydraulic modeling. If tested to a vertical RMSE of 0.6 foot (18.5 centimeters), for example, and recognizing that $Accuracy_z = 1.9600 \times RMSE_z$ when errors have a normal distribution, the metadata would read as follows:

Tested 1.2-foot vertical accuracy at 95-percent confidence level

DFIRMs published at 1"=500' scale with community-provided base maps or digital orthophotos compiled at 1"=500' or smaller scales (e.g., 1"=400', 1"=200', 1"=100') would be labeled as follows:

Compiled to meet 19-foot horizontal accuracy at 95-percent confidence level

DFIRMs published at either 1"=500' or 1"=1,000' with default USGS DOQs, compiled at 1"=1000', would be labeled as follows:

Compiled to meet 38-foot horizontal accuracy at 95-percent confidence level

Similarly, DFIRMs published at 1"=2,000' would be labeled as follows:

Compiled to meet 45.6-feet horizontal accuracy at 95-percent confidence level

[February 2002]

A.4 Data Requirements

Requirements for topographic mapping, cross-sections and hydraulic structure surveys will vary from Flood Map Project to Flood Map Project, depending on the flood hazard being addressed (e.g., riverine, coastal, alluvial fan) and the option that is selected for generating flood hazard data. Detailed information on the options for generating flood hazard data is presented in Volume 1, Section 1.4 and in Appendix C of these Guidelines.

New flood hazard data may be generated through detailed or approximate analyses. Updated flood hazard data may be developed through detailed or approximate analyses or redelineation of floodplain boundaries from the effective FIRM using more up-to-date and/or accurate topographic data than were used to prepare the effective FIRM. The topographic mapping, cross section, and hydraulic survey requirements for each analysis option are summarized below.

- For a *detailed flood hazard analysis*, which will generally include a detailed hydraulic analysis, digital topographic data, cross sections (to include underwater elevations), and surveys of hydraulic structures are required. Ground surveys and either photogrammetric mapping or LIDAR-generated mapping are normally required unless suitable topographic information is already available from other sources.

- For an *approximate flood hazard analysis*, cross sections may be interpolated from contours on topographic maps, and underwater elevations may be interpolated from upstream/downstream data, assuming the channel bottom information has not changed significantly. Hydraulic structure surveys are not required.

- For a *redelineation of floodplain boundaries using more up-to-date or more accurate topographic data,* the topographic data needed to update the floodplain boundaries are required, but no new cross sections or hydraulic structure surveys are required.

The requirements summarized in this Appendix are based on the assumption that suitable data do not exist from alternative sources and that new ground/aerial surveys will be required.

[February 2002]

A.4.1 Map Scale of DFIRMs and Base Maps

Detailed information on how DFIRM map scales are determined is presented in Appendix K of these Guidelines.

[February 2002]

A.4.2 Data Models and Surfaces

Mapping Partners may produce digital elevation datasets in many forms. For purposes of the National Flood Insurance Program (NFIP), the default surface is the bare-earth terrain, devoid of vegetation and manmade structures. The FEMA Lead for the Flood Map Project (usually, the

Regional Project Officer (RPO) or Project officer at FEMA Headquarters) may specify the use of one or more of the following data models:

- Digital contours;
- Mass points;
- Breaklines;
- TINs; and
- DEMs

These models are discussed in Subsections A.4.2.1 through A.4.2.5.

[February 2002]

A.4.2.1 Digital Contours

Digital contours, or hardcopy plots of such contours, are normally used in manual hydrologic and hydraulic analyses. Contours normally depict breakline features of interest to hydraulic engineers.

[February 2002]

A.4.2.2 Mass Points

LIDAR produces irregularly spaced mass points. "First-return" LIDAR data provide elevation mass points on reflective surfaces (e.g., treetops, rooftops, towers). "Last-return" LIDAR data provide elevation mass points of the bare-earth terrain, but only after successful completion of automated and manual post processing for vegetation removal and cleaning (removal) of manmade features and artifacts. Mass points can also be produced when using photogrammetric methods.

[February 2002]

A.4.2.3 Breaklines

Breaklines are linear features that describe a change in the slope, smoothness, or continuity of a surface. "Soft breaklines" ensure that known z-values along a linear feature are maintained, and they ensure that linear features and polygon edges are maintained in a Triangulated Irregular Network (TIN) surface model, by enforcing the breakline as TIN edges; but they do not define interruptions in surface smoothness. "Hard breaklines," which define interruptions in surface smoothness, are used to define streams, shorelines, dams, ridges, building footprints, sea walls, and other locations with abrupt surface changes. Automated techniques for generating digital elevation data, from LIDAR data for example, normally do not do a good job of generating breaklines.

Breaklines are best produced by either stereo photogrammetric procedures where three-dimensional breaklines are produced (coordinate line strings having x/y/z coordinates) or from digital orthophotography where shorelines, stream centerlines and other breakline features are digitized as two-dimensional breaklines (coordinate line strings having x/y coordinates but no z-values). Regardless of the technology used, the Mapping Partner shall normally produce breaklines

for stream centerlines, drainage ditches, tops and bottoms of streambanks, ridge lines, road crowns, levees, bulkheads, seawalls, road/highway embankments, and selected manmade features that constrict or control the flow of water (e.g., curb lines). The Mapping Partner also shall specify the sources and accuracy of breakline data.

[February 2002]

A.4.2.4 Triangulated Irregular Networks (TINs)

A TIN is a set of adjacent, non-overlapping triangles, computed from irregularly spaced points with x/y coordinates and z-values. The TIN data structure is based on irregularly-spaced point, line, and polygon data interpreted as mass points and breaklines. The TIN model stores the topological relationship between triangles and their adjacent neighbors (i.e., which points define each triangle and which triangles are adjacent to each other). This data structure allows for the efficient generation of surface models for the analysis and display of terrain and other types of surfaces while preserving the continuous structure of features such as levees and stream banks that are critical in hydrologic and hydraulic analyses.

Because breakline information is important for hydraulic analyses, TINs are normally required for floodplains and surrounding buffer zones where automated hydraulic analyses and modeling are performed. TINs are also ideal for performing independent Quality Assurance/Quality Control (QA/QC) reviews, because TIN surfaces are easily interpolated to determine elevation z-values at checkpoint x/y coordinates that fall somewhere between the TIN triangle corners.

[February 2002]

A.4.2.5 Digital Elevation Models (DEMs)

DEMs model the elevation of the land (z-values) at regularly spaced intervals in x and y directions (eastings and northings). DEMs are usually displayed as uniformly-spaced grids. Because of the uniform point spacing, DEMs can "jump over" breaklines without identifying ditches, stream centerlines, steep banks, and other similar features. However, DEMs are simple data models, easy to store, and suitable for automated hydrologic analyses and modeling where breakline information is unimportant.

DEMs are normally produced by interpolation from surrounding mass points or TIN corners. DEMs are normally required for entire watersheds, for which automated hydrologic analyses and modeling will be performed. Because they are interpolated, DEMs are slightly less accurate than the TINs, mass points, or breaklines from which they are derived.

[February 2002]

A.4.3 Vertical Accuracy

As explained in Section A.3, one of the fundamental requirements that the FEMA Lead must establish is to which of the following standards the digital topographic data will be compiled:

- Standard 2-foot equivalent contour interval accuracy ($Accuracy_z$ = 1.2 foot) appropriate for flat terrain,
- Standard 4-foot equivalent contour interval accuracy ($Accuracy_z$ = 2.4 foot) appropriate for rolling to hilly terrain, or
- Some alternative standard.

The specified accuracy of FIRM work maps produced by Mapping Partners must be sufficient to ensure that the final FIRMs produced by FEMA can be reliably used for the purpose intended. However, the accuracy and resolution requirements of a mapping product must not surpass that required for its intended functional use. Specifying map accuracies in excess of those required results in increased costs, delays in project completion, and reduction in the total numbers of new or revised products that the Mapping Partner may generate. Mapping accuracy requirements must originate from functional and realistic accuracy requirements.

[February 2002]

A.4.3.1 Vertical Accuracy as a Function of Horizontal Accuracy

The vertical accuracy of mass points, TINs or DEMs also is a function of horizontal accuracy because NMAS traditionally has allowed apparent vertical errors to be decreased by assuming a horizontal displacement within the permissible horizontal error for a map of that scale. As indicated in Table A-1, according to NMAS, 90 percent of horizontal test points are to be accurate within 16.7 feet for maps published at a scale of 1" = 500', the most common scale for DFIRM panels. This equates to a horizontal (radial) RMSE ($RMSE_r$) of 11.0 feet. Nevertheless, LIDAR vendors normally advertise that their systems deliver data with a $RMSE_r$ of 1-meter or less. This horizontal accuracy is difficult to verify, except for calibration test ranges where coordinates of the four corners of rooftops of several buildings are accurately surveyed (in addition to ground control points) and compared with LIDAR calibration flights flown over the calibration area from four cardinal directions (north, south, east, west). The horizontal accuracy with which these building breaklines can be determined provides a good estimate of the overall horizontal accuracy of LIDAR datasets obtained under similar conditions.

[February 2002]

A.4.3.2 Vertical Accuracy as a Function of Horizontal Resolution

The vertical accuracy of mass points, TINs or DEMs also is a function of the horizontal resolution of the digital topographic data. Horizontal resolution refers to the average point spacing of irregularly spaced mass points (from LIDAR for example) or uniformly spaced DEM points, and is more commonly known as the DEM "post spacing." To provide multiple surrounding points for interpolation of DEM elevation posts, the horizontal resolution of mass points normally is narrower than the DEM resolution. For example, to derive a DEM with uniform post spacing of 5 meters, it is common for LIDAR dataset mass points to have average post spacings of 3 to 4 meters, a denser dataset from which some points will be eliminated as a result of post-processing to remove points that impinged on manmade structures or dense vegetation.

No established rules directly correlate the horizontal resolution of digital elevation data with vertical accuracy, even though there is general agreement that TINs or DEMs equivalent to 2-foot contours ought to have narrower post spacing than TINs or DEMs equivalent to 4-foot contours. Cartographers typically associate map scale with contour intervals as follows:

- Maps compiled at 1"=100' with 1-foot contours need DEM post spacing of 1 meter
- Maps compiled at 1"=200' with 2-foot contours need DEM post spacing of 2 meters
- Maps compiled at 1"=500' with 5-foot contours need DEM post spacing of 5 meters
- Maps compiled at 1"=1000' with 10-foot contours need DEM post spacing of 10 meters
- Maps compiled at 1"=2000' with 20-foot contours need DEM post spacing of 20 meters.

USGS 7.5-minute-series topographic quadrangle maps are generally prepared at a scale of 1"=2,000', and DEMs have traditionally been produced by USGS with post spacing of 30 meters. However, new standard USGS DEMs, produced from the contour lines on quadrangle maps, are being produced with 10-meter post spacing. Depending on the ruggedness of the terrain, the USGS may have compiled these quadrangle maps with contour intervals of 5, 10, 20, or 40 feet -- all published at a scale of 1"=2,000'. Thus, no rigid rules that link DEM resolution to map scale or contour interval exist.

However, mass points and breaklines, or TINs derived therefrom, are typically used for hydraulic modeling. When breakline data are available (e.g., at the tops and bottoms of stream banks), the average mass point or DEM post spacing can be wider than indicated above. For example, if Mapping Partners are producing DFIRM workmaps in flat terrain with digital topographic data equivalent to 2-foot contours, 2-meter post spacing may be appropriate if no supplemental breaklines are provided, but 5-meter post spacing is appropriate if supplemental breaklines are provided.

[February 2002]

A.4.4 File Size, Tile Size and Buffers

The size of the data file will have an effect on how the Mapping Partner will be able to manage and manipulate the DEM or TIN. File size could have limiting factors such as data storage, transfer media size, and software limitations. A DEM file with 2-meter post spacing will be 6.25 times larger than a DEM file with 5-meter post spacing; the same ratio applies to the average point spacing of mass points and TINs. File sizes shall not exceed 1 gigabyte unless otherwise specified by the FEMA Lead.

In some cases, Mapping Partners may choose to limit files by "tile" size (e.g., 10,000-meter x 10,000-meter tiles, 5,000-meter x 5,000-meter tiles) by DFIRM panel size, by USGS DOQ size, or by the size of community-provided base maps. Depending on the horizontal resolution of data within these "tiles," the file sizes will vary.

Supplemental to the exact tile size, a buffer surrounding the tile may be required in the event that individual tiles are to be mosaicked together. Due to the interpolation and extrapolation at tile

edges, single tiles may not "fit" adjoining tiles without overlapping buffers. For these reasons, a buffer zone equal to five percent of the tile size must be incorporated around adjoining tiles so that a seamless interpolation will occur between them. No new data are required as a result of buffering, but file sizes for individual tiles with such buffers will be 5 percent larger than without such buffers.

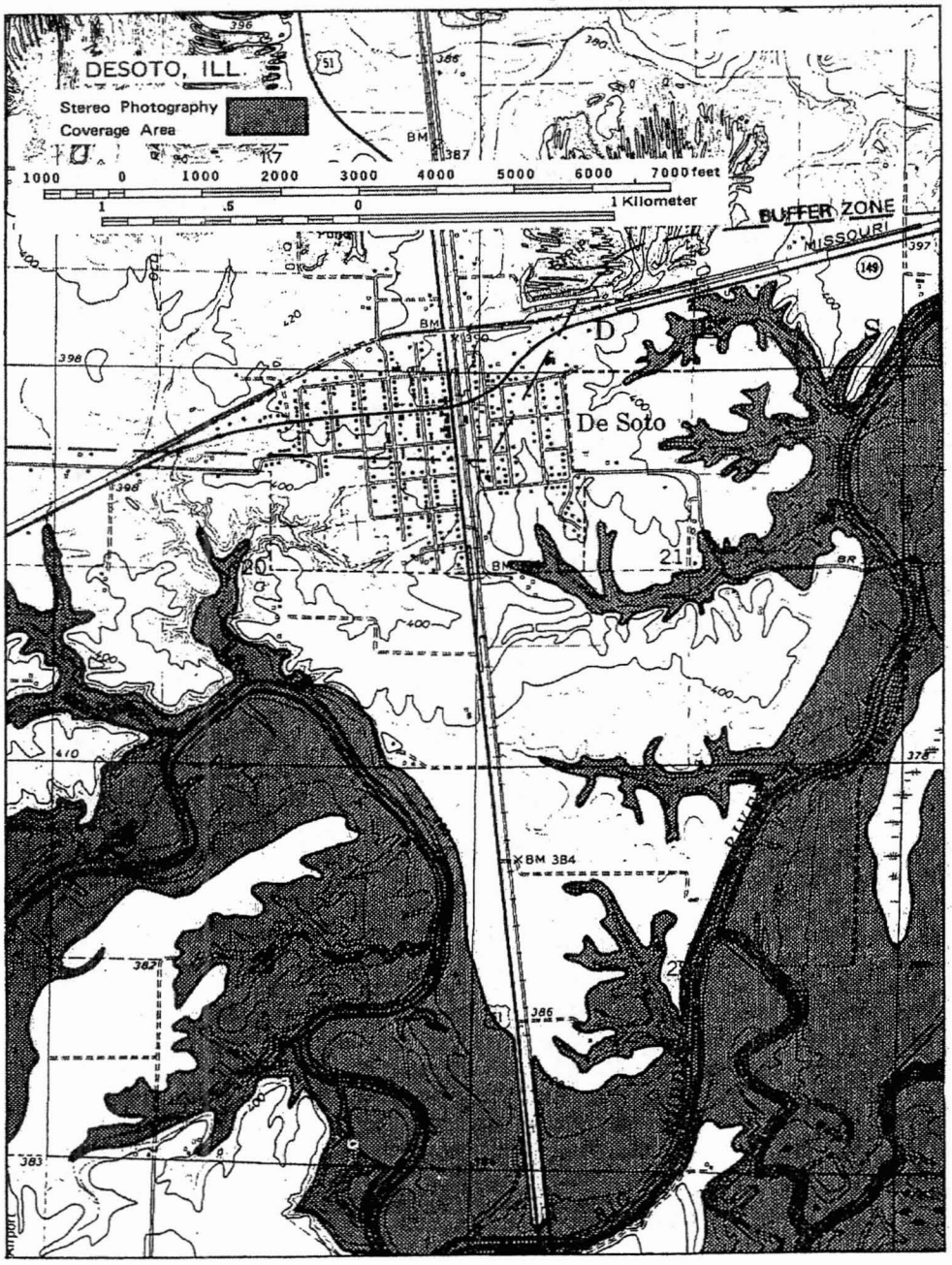
[February 2002]

A.4.5 Mapping Area

High-accuracy digital elevation data are not required for hydrologic analyses. If no better form of digital elevation data is available, Mapping Partners may use USGS "off-the-shelf" DEMs for hydrologic analyses and modeling of entire watersheds. A Mapping Partner can purchase an "off-the-shelf" DEM from USGS at a nominal cost.

Hydraulic analyses require high-accuracy contours, mass points and breaklines, TINs or DEMs, but of floodplain areas only, and not of entire watersheds. The area to be mapped normally consists of the projected 0.2-percent-annual-chance (500-year) floodplain, plus a specified buffer of 1000 feet beyond the 0.2-percent-annual-chance floodplain, as shown in Figure A-1. Although data for the entire study area normally are acquired by an aerial survey contractor using photogrammetric methods or LIDAR, only the polygon areas within the projected 0.2-percent-annual-chance floodplain and buffer zones are to be processed to produce the high-accuracy elevation data required for hydraulic analyses.

Figure A-1 Sample Location Map



[February 2002]

A.4.6 Cross Sections

For detailed flood hazard analyses, the assigned Mapping Partner shall survey cross sections immediately upstream and downstream of bridges and culverts, using field survey methods, to include survey of channel invert elevations (the elevation at the deepest part of a channel cross section). The assigned Mapping Partner shall survey Intermediate cross sections when bridges or culverts are more than 1,000 feet apart, especially where a significant change in conveyance occurs between cross sections. The assigned Mapping Partner may "cut" Intermediate cross sections from stereophotogrammetric models or from LIDAR datasets so long as no significant change in the stream channel geometry below the water level occurs. When flooding sources have little change in conveyance, the assigned Mapping Partner may determine whether fewer cross sections are needed. The assigned Mapping Partner shall determine cross section elevations and stations at those points that represent significant breaks in ground slope and at changes in the hydraulic characteristics of the floodplain. The assigned Mapping Partner shall ensure that each cross section crosses the entire 0.2-percent-annual-chance floodplain.

For hydrologic and hydraulic analyses performed using manual techniques, the assigned Mapping Partner shall select ground surveyed or photogrammetric cross section locations carefully to ensure they are representative of reaches that are as long as possible, without permitting excessive conveyance change between cross sections. When the assigned Mapping Partner compiles elevation data photogrammetrically, the elevations shall be taken to the nearest 0.5 foot at the three most significant gradient breaks on each bank and at enough intermediate points to satisfy the following three criteria:

1. No adjacent points separated vertically by more than 20 percent of range;

2. No adjacent points separated horizontally by more than 5 percent of the complete channel cross section width; and

3. No adjacent points in the main channel separated by more than 10 percent of main channel width or 2 feet, whichever is greater.

Specified spacing is illustrated in Figure A-2. The assigned Mapping Partner shall read elevations and stations at each edge of water. The Zero Station (initial point) for each cross section must be the finally adopted terminus on the left bank (looking downstream). Stations must be the distance to the nearest foot measured along the straight, curved, or zigzag alignment of the cross section.

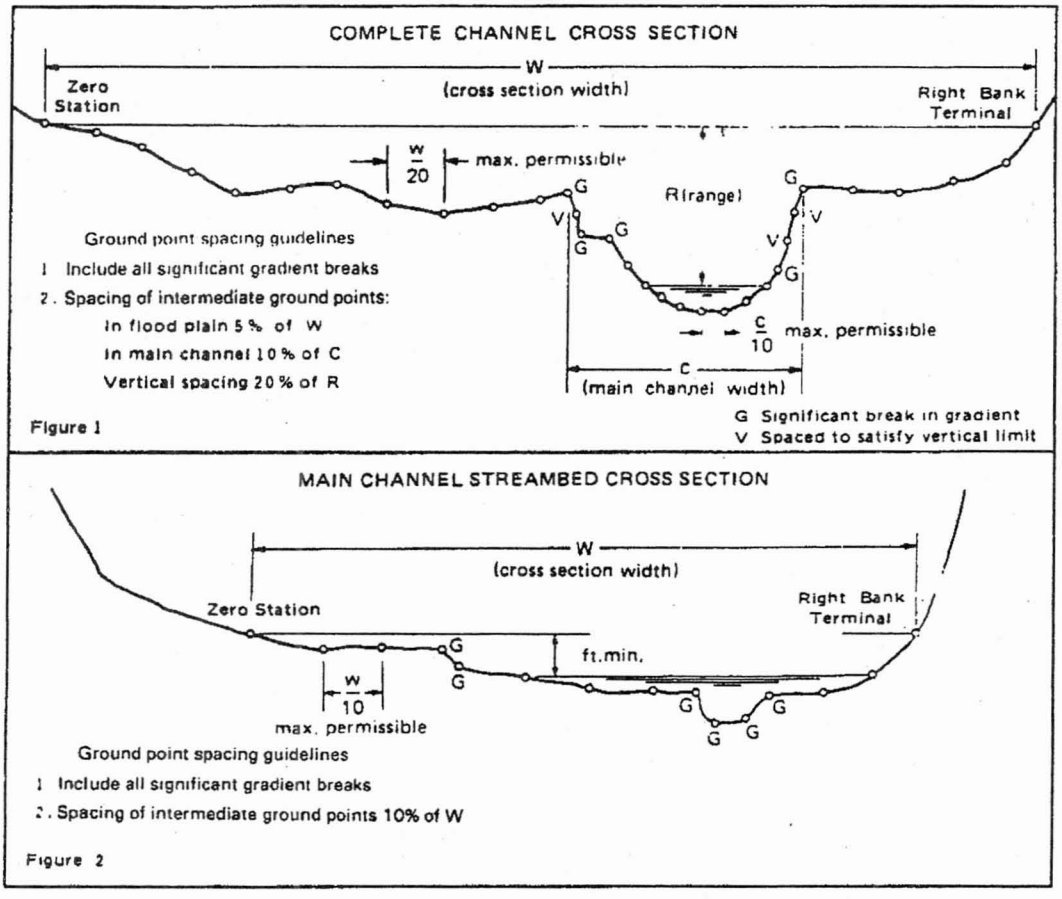
With automatic hydrologic and hydraulic analyses and LIDAR datasets, the cross sections established by the assigned Mapping Partner can be more numerous and represent shorter reaches. Because they can be easily "cut" from high-density datasets, multiple LIDAR cross sections enable the Mapping Partner to determine cross sections that are more truly representative of reaches.

For surveying cross sections beneath the water level, the method to be used depends upon the depth and velocity of the stream. When water is shallow and can be waded, traditional differential leveling is used with conventional elevation rod (including rod extensions), using an attached bottom plate as necessary to prevent the rod from penetrating silt and mud. When water is deeper or too swift for wading, various hydrographic survey methods described in Chapter 8 of U.S. Army Corps of Engineers EM 1110-2-1003 (USACE, 1994) may be used. These may include small work

boats with sounding poles or lead lines, or specialized hydrographic survey vessels with echo sounders, either single (vertical-beam) or multi-beam transducers.

Figure A-2 Examples of Cross Section Ground Point Spacing

[February 2002]



A.4.7 Hydraulic Structures

For detailed flood hazard analyses, the assigned Mapping Partner shall obtain the required dimensions and elevations of all hydraulic structures and underwater sections adjacent to the structures from available sources or by field survey where necessary. The assigned Mapping Partner shall not establish dimensions and elevations of hydraulic structures by aerial survey methods (i.e., photogrammetry, LIDAR).

For bridges, sufficient data for input to modeling software usually includes the following:

- Size and shape of the opening;
- Upstream and downstream channel invert elevations;
- Entrance conditions (e.g., wingwalls, vertical abutments)

- Bridge deck thickness, low-steel elevation, and bridge parapet type (i.e., solid railing, open railing);
- Roadway embankment side-slope rate;
- Type and width of roadway pavement; and
- Top-of-road section for sufficient length for weir-flow calculations.

For culverts, sufficient data for input to modeling software or Federal Highway Administration culvert nomographs usually includes the following:

- Size and shape;
- Upstream and downstream channel invert elevations;
- Entrance conditions (i.e., headwall, wingwalls, mitered to slope, projecting);
- Roadway embankment side-slope rate;
- Type and width of roadway pavement; and
- Top-of-road section for sufficient length for weir-flow calculations.

For dams and weirs, sufficient data for input to modeling software usually includes the following:

- Top of dam elevation;
- Normal pool elevation;
- Principal spillway type, inlet and outlet elevations, and dimensions; and
- Emergency spillway (if applicable) type, elevation, and dimensions.

For approximate flood hazard analyses, the assigned Mapping Partner may estimate the bridge, culvert, dam, and weir data from photographs, orthophotos, or existing topographic mapping without performing field surveys.

[February 2002]

A.4.8 Datums, Projections, Coordinate Systems, Coordinates

The horizontal and vertical datums, projection and coordinate system for a Flood Map Project must be determined during the Project Scoping phase. Details are discussed in Appendices B and K of these Guidelines.

In addition to determining whether coordinates are to be in feet or meters, the assigned Mapping Partner must determine the number of decimal places to be used for x/y/z coordinates. Normally, feet are specified to two decimal places, and meters are specified to either two or three decimal places.

When dealing with decimal degrees, one arc degree equals approximately 367,000 feet. Therefore, decimal degrees to six decimal places would record latitude and longitude to the nearest 0.367 foot.

When dealing with degrees/minutes/seconds, one arc second equals approximately 102 feet. Therefore, seconds to two decimal places would record latitude and longitude to the nearest 1 foot.

[February 2002]

A.4.9 Data Formats

The following digital file formats are acceptable with contours, breaklines, and other vector data, but additional software-specific formats may also be acceptable if preferred by Mapping Partners:

- DGN: MicroStation design file, internal proprietary drawing data base format;
- DO: Digital Line Graph (DLG) Optional file format for vector data (USGS);
- DWG: AutoCAD drawing file, internal proprietary drawing data base format;
- DXF: Drawing Exchange (Interchange) file, American Standard Code for Information Interchange (ASCII) or binary file format used to transfer data between CAD and GIS;
- E00: ARC/INFO Export (Interchange) file of either binary coverages or grids;
- MIF/MID: MapInfo data set, which contains vector drawings and tables (databases);
- SHP: ArcView Shape file, collection of files used in ArcView for vector drawings and database storage;
- SDTS: Spatial Data Transfer Standard, ASCII or binary file format designed to handle earth-referenced spatial data between dissimilar computer systems; and
- VPF: Vector Product Format, A published vector format used by NIMA.

The following digital file formats are acceptable with mass points and TINs, but other software-specific formats may also be acceptable if preferred by Mapping Partners:

- ASCII x, y, z: Predominant character set encoding of computers;
- ASCII x, y, z with Attributes: Additional attributes such as acquisition dates, sensor make and model (when different sensors are used on a project), or LIDAR intensity values;
- BIN: Binary encoding of ASCII data; and
- TIN Arc/Info Export file format (other GIS software programs have similar formats).

The following digital file formats are acceptable with uniformly-spaced DEMs, but other software-specific formats may also be acceptable if preferred by Mapping Partners:

- BIL: Band Interleaved by Line format, treats each line of pixels as separate units and then stores by lines;
- BIP: Band Interleaved by Pixel format, treats pixels as separate storage units
- BSQ: Band Sequential format, all data for a single band (in this case DEM) is written to one file;
- DEM: is a raster format used by USGS to record elevation data. Cell values reflect elevation data and not pixel brightness;
- ESRI Float Grid: 32 bit floating point raster grids for ESRI products;
- ESRI Integer Grid: 16 bit integer format;
- GeoTiff: Georeferenced Tagged Image File Format, one of the most widely supported file formats for storing bit-mapped images. Can be used with TWF (Tagged World File) for georeferencing; and
- RLE: Run Length Encoding, a band sequential format that stores the cell value and the number of times it occurs along a given raster line.

[February 2002]

A.4.10 Hydrologically Enforced Elevation Data

It is normal for uniformly spaced DEM points to "jump" across a flooding source and fail to show that a flooding source passes through. Similarly, it is possible for irregularly spaced mass points (from LIDAR for example) to fail to capture the lowest elevations of ditches and shorelines. Artificial "puddles" may then be created with no apparent outlet drain. When this occurs, breaklines are necessary to depict the true three-dimensional shape of the terrain, especially drainage features used for hydrologic and hydraulic modeling.

A hydro-enforced TIN uses drainage system breaklines to form triangle edges in the TIN data structure. A hydro-enforced DEM uses breaklines to lower selected DEM cells to enforce natural drainage in the Digital Terrain Model (DTM). The horizontal locations of these breaklines are determined from hydrographic vector data or from imagery. The z-values assigned to these breaklines start with the lowest elevation upstream from a "puddle" and slope downstream to an elevation where the natural drainage system resumes, as depicted by the TIN or DEM.

A similar situation occurs with bridges and culverts. Elevations on the tops of bridges and culverts will appear identical to a dam, so a hydraulic model would erroneously indicate that water can't pass through these dams. Hydro-enforced TINs, DEMs or contours ensure that top surfaces of bridges and culverts are cut by stream breaklines so that computer models will accurately represent drainage flow. Hydro-enforcement normally requires human intervention to "cut" breaklines so that TIN/DEM elevations and contours will correctly follow drainage patterns, rather than erroneously model the terrain to depict dams or puddles that don't actually exist.

[February 2002]

A.4.11 Other Digital Topographic Data Requirements

Other requirements in the Digital Topographic Data Requirements Checklist (Table A-3), unique to LIDAR data, will be addressed in Section A.8.

Table A-3 Digital Topographic Data Requirements Checklist

Surface Description (choose one)
- ☐ Bare-earth surface (FEMA default)
- ☐ Top surface (e.g., treetops/rooftops)
- ☐ Bathymetric surface

Reflective surface (if using LIDAR)
- ☐ First ☐ Last (FEMA default) ☐ All
- ☐ LIDAR intensity returns
- ☐ Other simultaneous imagery

Vertical Accuracy (choose one)
- ☐ 1' contour equiv. ($Accuracy_z$ = 0.6 ft.)
- ☐ 2' contour equiv. ($Accuracy_z$ = 1.2 ft.)
- ☐ 4' contour equiv. ($Accuracy_z$ = 2.4 ft.)
- ☐ 5' contour equiv. ($Accuracy_z$ = 3.0 ft.)
- ☐ Other: $Accuracy_z$ = ___ ft.

Vertical accuracy at the 95% confidence level ($Accuracy_z$) = $RMSE_z$ x 1.9600 with normal distribution

Horizontal Accuracy (choose one)
- ☐ 1" = 500' equiv. ($Accuracy_r$ = 11' or 3.35 m)
- ☐ 1" = 1000' equiv. ($Accuracy_r$ = 22' or 6.7 m)
- ☐ $RMSE_r$ = 1 m
- ☐ $RMSE_r$ = _____

Horizontal accuracy at the 95% confidence level ($Accuracy_r$) = $RMSE_r$ x 1.7308

Data Model (choose one or more)
- ☐ Contours ☐ Mass points ☐ TIN (average point spacing = ___meters) *
- ☐ Cross sections ☐ Breaklines ☐ DEM (post spacing = ___meters)

* FEMA's standard DEM post spacing is 5-meters when mass points are supplemented with breaklines for hydraulic modeling. The TIN point spacing is typically smaller than the DEM post spacing to allow a denser network of irregularly-spaced points for interpolation of the uniformly-spaced DEM.

Horizontal Datum (choose one)
- ☐ NAD 27 ☐ NAD 83 (default)

Vertical Datum (choose one)
- ☐ NGVD 29 ☐ NAVD 88 (default)

Coordinate System (choose one)
- ☐ UTM ☐ State Plane ☐ Geographic

Units Note: For feet and meters, vertical (V) units may differ from horizontal (H) units
- ☐ Feet to ___ decimal places ☐ V ☐ H
- ☐ Meters to ___ decimal places ☐ V ☐ H
- ☐ Decimal degrees to ___ decimal places
- ☐ DDDMMSS to ___ decimal places

Feet are assumed to be U.S. Survey Feet unless specified to the contrary

Data Format (choose one or more)

Digital contour lines and breaklines
- ☐ .DGN
- ☐ .DO (DLG Optional)
- ☐ .DWG
- ☐ .DXF
- ☐ .E00
- ☐ .MIF/.MID
- ☐ .SHP
- ☐ SDTS
- ☐ VPF
- ☐ Other _____

Mass points and TINs
- ☐ ASCII x/y/z
- ☐ ASCII with attribute data
- ☐ BIN
- ☐ TIN Arc/Info Export File
- ☐ Other _____

DEMs
- ☐ ASCII x/y/z
- ☐ .BIL
- ☐ .BIP
- ☐ .BSQ
- ☐ .DEM (USGS standard)
- ☐ ESRI Float Grid
- ☐ ESRI Integer Grid
- ☐ GeoTiff
- ☐ .RLE
- ☐ Other _____

File size or Tile size (choose one)
- ☐ File size ____ MB or 1 GB (max)
- ☐ Tile size _____ x _____ (specify feet or meters)
- ☐ Other tile size: _____
- ☐ Buffer size: _____

Other Quality Factors (optional, explain on separate page)
- ☐ Cleanness from artifacts
- ☐ Limits on size/location of void areas where there are no elevation data shown
- ☐ How elevations are to be shown for void areas
- ☐ Hydro-enforcement Bridges/culverts removed? ☐Yes ☐ No
- ☐ Other requirements

[February 2002]

A.5 Ground Control

Ground control is used to control the network accuracy of derived ground and aerial surveys so that data are correctly registered to the horizontal and vertical datums. When properly controlled, DFIRM work maps (including topographic data, cross sections, and hydraulic structure surveys) will accurately register to DOQs or other DFIRM base maps that are similarly registered to our National horizontal and vertical datums in compliance with applicable FGDC standards.

Elevation Reference Marks (ERMs), used by FEMA in the past, are not suitable for NFIP ground control as defined herein because ERMs lack both the minimum accuracy and stability needed for three-dimensional ground control points. ERMs are suitable only for Temporary Bench Marks (TBMs) established during the performance of a Flood Map Project, and the assigned Mapping Partner shall provide documentation for the TBMs in the Technical Support Data Notebook. ERMs must not be shown on DFIRMs. The only ground control points printed on DFIRMs are those that are included in the National Spatial Reference System (NSRS).

[February 2002]

A.5.1 National Spatial Reference System

Aerial mapping and surveying projects, and products derived therefrom, must be connected to NSRS monuments. Mapping Partners can search the NSRS database by accessing the National Geodetic Survey (NGS) home page at www.ngs.noaa.gov, selecting the "Data Sheets" option, and retrieving NGS data sheets by using either the "Rectangular Search" or "Radial Search" option. With the "Rectangular Search" option, the user must define the minimum and maximum values for the latitudes and longitudes that bound the area of interest. For the "Radial Search" option, the user must specify the search radius and latitude/longitude for a point near the center of the area of interest, or at selected points elsewhere. From all available NGS Data Sheets, users can select data sheets from the following options:

- Any Horz. And/or Vert. Control;
- GPS Sites Only;
- Any Horizontal Control;
- Horizontal Order-A;
- Horizontal Order-B or Better (HARN);
- Horizontal Order-1 or Better;
- Horizontal Order-2 or Better;
- Any Vertical Control;
- Vertical Order-1;

- Vertical Order-2 or Better;
- FBN and/or CBN; or
- PAC and/or SAC.

"HARN" stands for High Accuracy Reference Network, some of which have high horizontal accuracy only. "FBN" stands for the Federal Base Network of control monuments. "CBN" stands for the Cooperative Base Network, established by states, counties and/or municipalities. "PAC" stands for Primary Airport Control stations. "SAC" stands for Secondary Airport Control stations.

The "GPS Sites Only" option provides three-dimensional control points that have been surveyed using GPS and have "network accuracy" relative to the national geodetic datum. These control points have "Ellipsoid Order" specified on the NGS Data Sheets. The "Any Horz. And/or Vert. Control" option provides conventional horizontal control points and vertical bench marks, as well as GPS control points. If these control points and bench marks do not specify "Ellipsoid Order," they have "local accuracy" relative to the coordinates of other directly connected, adjacent control points, but have not yet been surveyed using GPS relative to the national geodetic datum. Such local control points can be connected to the NSRS, to determine their "network accuracy," by 2 to 3 days of GPS surveys (in accordance with NGS-58 procedures for Secondary or Primary Base surveys) relative to NSRS monument(s) for which "Ellipsoid Order" has been specified.

If the rectangular or radial search area is so large that more than 100 NSRS monuments are identified within the defined area, an error message will specify that the rectangular area must be subdivided, or the radius of the circular search area must be reduced, so that there will be fewer than 100 NSRS monuments within the specified area.

GPS is the preferred method for extending any survey control from NSRS monuments to other control points and bench marks so that all control used for a Flood Map Project will have "network accuracy" relative to the NSRS and the horizontal and vertical datums used.

[February 2002]

A.5.2 Horizontal Control

At a minimum, all horizontal control must be to an accuracy level of NGS Second Order or better. This horizontal accuracy is easily achievable when NGS-58 5-centimeter local network accuracy procedures are used and when NSRS monuments are used for GPS base stations.

[February 2002]

A.5.3 Vertical Control

The assigned Mapping Partner must perform necessary field surveys to maintain vertical control, with all elevations referred to the National Geodetic Vertical Datum of 1929 (NGVD29) or the successor North American Vertical Datum of 1988 (NAVD88). The vertical datum may be either NGVD29 or NAVD88, but not mixed within a single Flood Map Project. It is recommended that all new Flood Map Projects be referenced to NAVD88. See Appendix B of these Guidelines for additional information on the use of NGVD29 and NAVD88. During the Project Scoping phase of

a Flood Map Project, the assigned Mapping Partner must clarify whether to use NGVD29 or NAVD88 before beginning any survey work.

For vertical control surveys, the assigned Mapping Partner must use 5-centimeter or better GPS procedures (as specified in NGS-58 for local network accuracy) or Third-Order (or better) differential leveling, or trigonometric leveling for short distances. The assigned Mapping Partner shall establish vertical control points, for leveling of photogrammetric stereo models, with elevations accurate to within ± 5 centimeters, relative to the NSRS bench marks of Second-Order or higher accuracy used for the survey. For county-size and smaller areas, GPS is preferred by FEMA for establishing vertical control points if the assigned Mapping Partner uses precise differential GPS (DGPS) techniques , with the base station receiver simultaneously measuring the elevation of a local NSRS bench mark of Second-Order or higher accuracy.

NGS has published a national geoid model and PC-based computer software, called GEOID99, which converts from ellipsoid heights (derived from GPS) to orthometric heights (derived from precise leveling) nationwide with a standard deviation of 1 centimeter for points spaced 10 kilometers apart. When the assigned Mapping Partner uses DGPS techniques within a single county, this correction for variable height of the geoid above the ellipsoid in non-mountainous areas is insignificant. GEOID99 was designed to be used with elevations referenced to NAVD88, not NGVD29. NGS has also published another PC-based software program, called VERTCON, which converts elevations referenced to NGVD29 to NAVD 88 for any horizontal coordinate pair entered (longitude/latitude or easting/northing). Both GEOID99 and VERTCON programs may be downloaded from the NGS portion of the NOAA website at www.ngs.noaa.gov.

[February 2002]

A.6 Ground Surveys

Monuments selected for differential GPS base stations for all surveys listed in this section will have the best available Horizontal Order, Vertical Order and/or Ellipsoid Order, and Stability C or better. Where possible, these monuments must be the same NSRS monuments used for airborne GPS control of mapping aircraft for photogrammetric or LIDAR surveys. This eliminates the possibility that discrepancies may be caused by inconsistencies between different control points.

[February 2002]

A.6.1 Photogrammetric Control Surveys

Primary photogrammetric control will consist of a network of control points adequate to produce maps with a 4-foot (rolling/hilly terrain) or 2-foot (flat terrain) contour interval. The assigned Mapping Partner shall include enough points in the primary network so that no stereomodel ground-surveyed control point (picture point) is farther than 15,000 feet from the nearest primary control point in that network. The assigned Mapping Partner shall use sufficient points to produce a stable aerotriangulation solution.

Points must be located in areas where they can be read from as many stereomodels as possible, except in cases where the point lies within 0.33 inch of the edge of the stereomodel. The assigned Mapping Partner shall ensure that no more than two stereomodels are without vertical control points unless direct georeferencing is used (See Subsection A.7.3). The assigned Mapping Partner shall locate and number the points on the image side of the contact print and shall number and describe the points on the reverse side. To ensure sufficient and accurate selection, points must be selected under the supervision of an ASPRS certified photogrammetrist.

[February 2002]

A.6.2 Cross Section Surveys

The assigned Mapping Partner must "anchor" terminal ends of cross sections by GPS surveys relative to NSRS monuments having both "Ellipsoid Order" and "Vertical Order" specified on the NGS data sheets. The assigned Mapping Partner may use traditional traverse/trigonometric leveling procedures between the terminal points to determine x/y/z coordinates of points that represent significant breaks in ground slope and at changes in the hydraulic characteristics of the floodplain. Each cross section must cross the entire 0.2-percent-annual-chance floodplain. Elevations must be determined at each edge of water, and invert elevations must be determined at the deepest part of the stream. Underwater surveys should be performed per instructions in section A.4.6.

[February 2002]

A.6.3 Hydraulic Structure Surveys

For bridges and culverts, survey information to support hydraulic modeling includes the following:

- Size and shape of bridge/culvert openings;

- Upstream and downstream channel invert elevations;
- Entrance conditions (vertical abutments, headwalls, wingwalls, mitered to slope, projecting);
- Bridge deck thickness, low steel elevation, and bridge parapet type (i.e., solid, open railing);
- Roadway embankment side-slope rate;
- Type and width of roadway pavement; and
- Top-of-road section for sufficient length for weir-flow calculations

For dams and weirs, survey information to support hydraulic modeling includes the following:

- Top of dam elevation;
- Normal pool elevation;
- Principal spillway type;
- Inlet and outlet elevations and dimensions; and
- Emergency spillway type, elevation and dimensions.

[February 2002]

A.6.4 Checkpoint Surveys

Checkpoint surveys must be performed to establish independent QA/QC checks for points of higher accuracy than the geospatial datasets being evaluated. Checkpoints are used to check the horizontal accuracy of base maps or the vertical accuracy of digital elevation data. They are most commonly used to determine the vertical accuracy of LIDAR datasets. Checkpoint surveys are performed to achieve 5-centimeter Local Network accuracy per NGS-58. The assigned Mapping Partner shall select checkpoint locations on Government-owned or public areas, where possible, to avoid the need for obtaining individual land owner permission.

Checkpoints are normally surveyed with transections or small clusters of points, at least two of which have been surveyed using GPS relative to NSRS monuments that have both "Ellipsoid Order" and "Vertical Order" specified on their NGS data sheets. If selected monuments are farther than 20 kilometers from the test areas to be surveyed, the assigned Mapping Partner shall establish Secondary Base Stations so that final surveys of checkpoints satisfy NGS-58 requirements for Local Network accuracy of 5-centimeters at the 95-percent confidence level.

Alternatively, the assigned Mapping Partner may use GPS real-time-kinematic (RTK) procedures provided:

1. The base station is an existing NGS three-dimensional mark or a new NGS-58 mark,

2. RTK procedures are used only in open areas and each RTK point is occupied twice with at least 2 hours difference in time between observations, and

3. The difference between observations does not exceed 5 cm.

The assigned Mapping Partner may use third-order conventional surveys to extend control from GPS "anchor points" to other transection or cluster points, especially when checkpoints are in forested areas where GPS signals are blocked.

When checkpoints are to be used for QA/QC reviews of digital elevation data (e.g., TINs, DEMs), the checkpoints must be at least 5 meters away from any breakline where there is a change in slope. Such checkpoints must be on flat or uniformly sloping terrain. The assigned Mapping Partner shall take photographs to record the location of the checkpoint relative to its surroundings, and to verify the vegetation category within which the checkpoint is located. The assigned Mapping Partner shall mark each checkpoint with a 60d nail or larger. The assigned Mapping Partner shall write the station ID number on an adjacent above-ground stake within 1 foot of the referenced stake, to aid in subsequent recovery if required during the course of the Flood Map Project. The assigned Mapping Partner shall use "to reach" location descriptions and photographs to document the location, the land cover surrounding each stake, and the uniform slope of the terrain surrounding each stake.

[February 2002]

A.6.5 Survey Records

Upon completion of the project, the assigned Mapping Partner shall deliver information meeting the requirements described below, upon request, to the FEMA Lead.

- Field notebooks must be carefully and neatly prepared, identified, indexed, and preserved.
- All data regarding the establishment and extension of vertical and horizontal control, including descriptions of all established and recovered monuments, must be recorded.
- Each field notebooks must contain the name and the field address/location of the Party Chief, and the identity of the survey instruments.
- Each field notebook must be numbered and marked with a brief description of the contents on the cover, carefully indexed, and each page numbered.
- For conventional surveys, each horizontal traverse line and vertical control line must be identified by number and brief description in the field book.
- The first page used on each day of field work must be dated.
- Each field notebook must be free of erasures; any line of horizontal and vertical control may be rejected by the FEMA Lead if any erasure is made in recording the data for that line.
- If the field notes are electronically recorded, printouts of the electronically recorded field notes must be provided.

- For GPS surveys, the full network adjustment report must be provided.

The assigned Mapping Partner must furnish a schematic control diagram of the survey records on a photo index for all basic horizontal and vertical control pertinent to the project. The schematic diagram must show all existing and established control points properly identified in their approximate location. The schematic diagram also must show all traverse lines with their designations to include the beginning and ending points.

[February 2002]

A.7 Photogrammetric Surveys

The aerial photogrammetric surveys that may be performed by a Mapping Partner or a contractor to a Mapping Partner generally will include establishment of the following:

- Photogrammetrically obtained stream and valley cross sections (portions above water);
- Planimetric compilation manuscript of key hydraulic structures (bridges, culverts, dams, levees);
- For rolling/hilly terrain, 4-foot contours of floodplains from the waterline to the nearest 4-foot contour above the 0.2-percent annual chance flood elevation line; for flat terrain, 2-foot contours of floodplains from the waterline to the nearest 2-foot contour above the 0.2-percent-annual-chance flood elevation line;
- Contours of 1-percent-annual-chance and 0.2-percent-annual-chance floodplain elevations (if profiles have been determined from previous studies); and
- Tabulations of spot heights on hydraulic structures and temporary bench marks (TBMs).

[February 2002]

A.7.1 Aerial Photography

The assigned Mapping Partner shall first determine the area to be flown, the approximate location and vertical ranges of the cross-sectional information to be flown, and the approximate location and vertical ranges of the cross-sectional information needed to represent all reaches under study. In planning for photogrammetry, the assigned Mapping Partner shall perform an approximate analysis to estimate the 1- and 0.2-percent-annual-chance flood elevations for every reach for which a detailed flood hazard analysis is required in order to estimate the extent of horizontal aerial photo coverage required. Where available, FIRMs, USGS floodprone area maps, or similar studies may be used for this purpose. The area of detailed study, for which stereophotography is required, normally includes a 1,000-foot buffer zone outside the 0.2-percent-annual-chance flood limits. (See Figure A-1).

Schedule requirements are an important consideration in the decision regarding the applicability of aerial photogrammetry. In many areas, good aerial photography can be obtained only during short periods of the year, when foliage does not obscure the landscape, the ground is free of snow, and the sky is clear. Poor weather and difficult terrain conditions can also delay required ground surveys. However, these factors have no effect on the schedule for determination of cross sections and contours by photogrammetry once photography and ground control have been completed. The Flood Map Project schedule must reflect these considerations to avoid delays.

The photography must be flown while the sun angle is above 30 degrees, when there is no snow cover, when the flooding sources are in the main channels, and when leaves are off the trees.

The assigned Mapping Partner shall perform aerial surveys under the direct supervision of a Registered Land Surveyor or ASPRS-Certified Photogrammetrist, consistent with State regulations.

The aerial photography deliverables consist of the following:

- One photo index of all photography on a sheet that is no larger than 24 inches x 36 inches;
- One set of black-and-white contact prints of photographs on resin-coated, neutral-toned, medium-weight paper with matte surface; and
- Two sets of black-and-white prints of alternate photographs enlarged two times on resin-coated, neutral-toned, medium-weight paper with matte surface (optional if requested).

All deliverables must provide complete single coverage of the flight area. The screen must be appropriate so that quality bluelines of a pilot sheet can be made and accepted prior to quantity production.

[February 2002]

A.7.2 Aerial Triangulation (AT)

The assigned Mapping Partner normally shall use Fully Analytical Aerial Triangulation (FAAT) of the entire floodplain area and buffer zone for which stereo coverage is required. No analog or semi-analytical aerial triangulation procedures is to be used. The positional accuracy of horizontal and vertical photo control established by FAAT must meet or exceed each of the following conditions:

- The horizontal RMSE of the final block adjustment must not exceed 1/10,000 of the flight height.
- The vertical RMSE of the final block adjustment must not exceed 1/9,000 of the flight height.
- The maximum allowable error of any vertical or horizontal point must not exceed 3 RMSE.
- The mean of all points (taking into account positive and negative signs) must not exceed 1/15,000 of the flight height.

Upon completion of all aerial triangulation work, the assigned Mapping Partner shall prepare an aerial triangulation report for submission to the FEMA Lead. The report shall include, but not necessarily be limited to, flight lines; exposure stations or model layout; and control points appropriately labeled with station designations, computer designations (if any), and agency responsible for establishing the stations. Aerial triangulation results shall include the following:

- All residuals (misclosures) at ground control points with and without use of checkpoints;
- Computer printout of the final adjusted aerial triangulation solution to horizontal and vertical ground control, including the final State Plane and/or UTM coordinates for all ground control points, pass points, and check points;

- Identification of all points included in the initial solution that were subsequently discarded, with an explanation of the reasons for being discarded;
- Identification of the weighting factors applied to all points used in the final solution;
- Diskette containing the coordinate data in ASCII format; and
- A brief narrative explaining the above solutions as well as descriptions of equipment, procedures, and computer programs used.

The report will include RMS error summaries for bundle adjustment photographic measurement residuals or strip tie point residuals and misclosures at control/check points. In addition, significant misfits encountered at control points, and steps taken to analyze such misfits and to rectify the discrepancies, shall be described.

[February 2002]

A.7.3 Direct Georeferencing

A primary purpose of aerial triangulation is to use ground control points, pass points, and tie points in a FAAT least squares block adjustment to determine the position and orientation of the mapping camera at the instant of each film exposure. The *position* consists of the x/y/z coordinates of the camera's focal point in the air, and the *orientation* is the angular roll (ω), pitch (φ), and yaw (κ) of the camera about the x, y and z axes. Collectively, these six position and orientation terms (x, y, z, ω, φ, κ) are called the "exterior orientation (EO) parameters" of each photograph. These EO parameters for each photograph are needed to correctly establish the stereomodel needed to prepare accurate three-dimensional mapping from two-dimensional photographs.

"Direct Georeferencing" is the direct measurement of the position and orientation parameters of a remote sensor. The state-of-the-art technology in Direct Georeferencing is the GPS-aided inertial navigation system (INS). The INS consists of an inertial measurement unit (IMU) and a navigation processor (NP). The IMU comprises three accelerometers, three gyroscopes, and the electronics to provide digitally encoded samples of the accelerometer and gyro data on a serial interface to measure the specific force vector experienced by the IMU. The force vector is the vector sum of the local gravity vector and the acceleration vector experienced by the IMU. The NP solves Newton's equations of motion of the IMU on the rotating earth, and establishes the local North, East, and Down directions. The INS essentially provides direct measurements of the ω, φ, and κ EO parameters. A GPS-aided INS uses a Kalman filter to regulate the INS position and velocity errors to be consistent with GPS position and velocity errors, regulating the INS angular errors and continuously improving the INS alignment The net result is that GPS-aided INS provides direct recording of the six EO parameters for each photograph, providing Direct Georeferencing of those photographs without the normal FAAT solution.

It is becoming common practice with direct georeferencing solutions to use only a few ground control points, at the outer perimeter of a mapping project area, in conjunction with GPS-aided INS data to perform a complete aerial triangulation, without the need for hundreds of surveyed ground control points. Although direct georeferencing is an acceptable alternative to FAAT, it is a new technology that is more commonly used in inaccessible or sensitive terrain (e.g., wetlands) where

there is additional reason to avoid the survey of numerous ground control points. Technically, with direct georeferencing solutions, no ground control points are needed; however, a few are advisable for overall quality control of the mapping project.

[February 2002]

A.7.4 Photogrammetric Compilation

Photogrammetric compilation for a Flood Map Project normally must include determination of floodplain cross-section geometry; compilation of 4-foot (or 2-foot) contours in the floodplain; and preparation of limited planimetric map features for registration to digital orthophoto base maps, for example. The compilation of such FIRM work map information requires high-precision photogrammetric equipment, hardware/software, and experienced operators.

[February 2002]

A.7.4.1 Cross Sections

On the enlarged photographs, the assigned Mapping Partner shall designate the position, approximate termini, and minimum range in elevation for each cross section to be read, and the position of approximately two photo-identifiable ground points near each cross section. The range in elevation is the vertical distance from the water surface at the time of photography to the upper limit of the cross section. If the channel is dry, the lowest point in the streambed is used to define the range.

The assigned Mapping Partner shall compile cross sections in accordance with requirements specified in Subsection A.4.6.

[February 2002]

A.7.4.2 Contours

The assigned Mapping Partner shall compile contours of the areas within the estimated 0.2-percent-annual-chance floodplain and buffer zone. The assigned Mapping Partner may use DEMs with uniformly spaced elevation points, non-uniformly spaced mass points and breaklines, and TINs to generate contours so long as the resulting contours satisfy the specified vertical accuracy requirements. The Mapping Partner shall start the contours at the next even foot elevation above the water surface and continue at 4-foot (or 2-foot for flat terrain) intervals until the shaded area edge is reached. The specified format is illustrated in Figure A-3.

In the compilation manuscript, the assigned Mapping Partner shall include 4-foot contour lines (or 2-foot contours for flat terrain) on each bank of each flooding source for which cross sections are read. The assigned Mapping Partner shall use the contours to delineate floodplain boundaries between cross sections after precise flood elevations are computed.

In situations where the 1- and 0.2-percent-annual-chance flood elevations are available, or can be closely approximated in advance of the photogrammetric compilation, the assigned Mapping Partner shall consider the use of "bracketing contours" that cover only the ranges of elevations near those of the floods for which floodplain boundaries are to be delineated on the work maps.

Compilation costs can often be reduced in this manner by eliminating the plotting of contours above or below the expected range of these floods. The assigned Mapping Partner shall obtain approval from the FEMA Lead before using this approach.

[February 2002]

A.7.4.3 Planimetric Work Maps

The assigned Mapping Partner shall compile a work map, compiled on different GIS layers, that shows the following:

- Alignment of all cross sections read, with zero stations plotted and labeled;
- Low water outlines of streams;
- Limited planimetric features of hydraulic structures, e.g., bridges, culverts, dams, dikes and levees; and
- Any contours that are specified.

Streets, highways, and railroads are not required because they should be visible on community base maps or DOQ base maps.

Work map specifications are provided in Volume I, Subsection 1.4.2.3.4 of these Guidelines. Digital data submittal requirements are provided in Appendix L of these Guidelines.

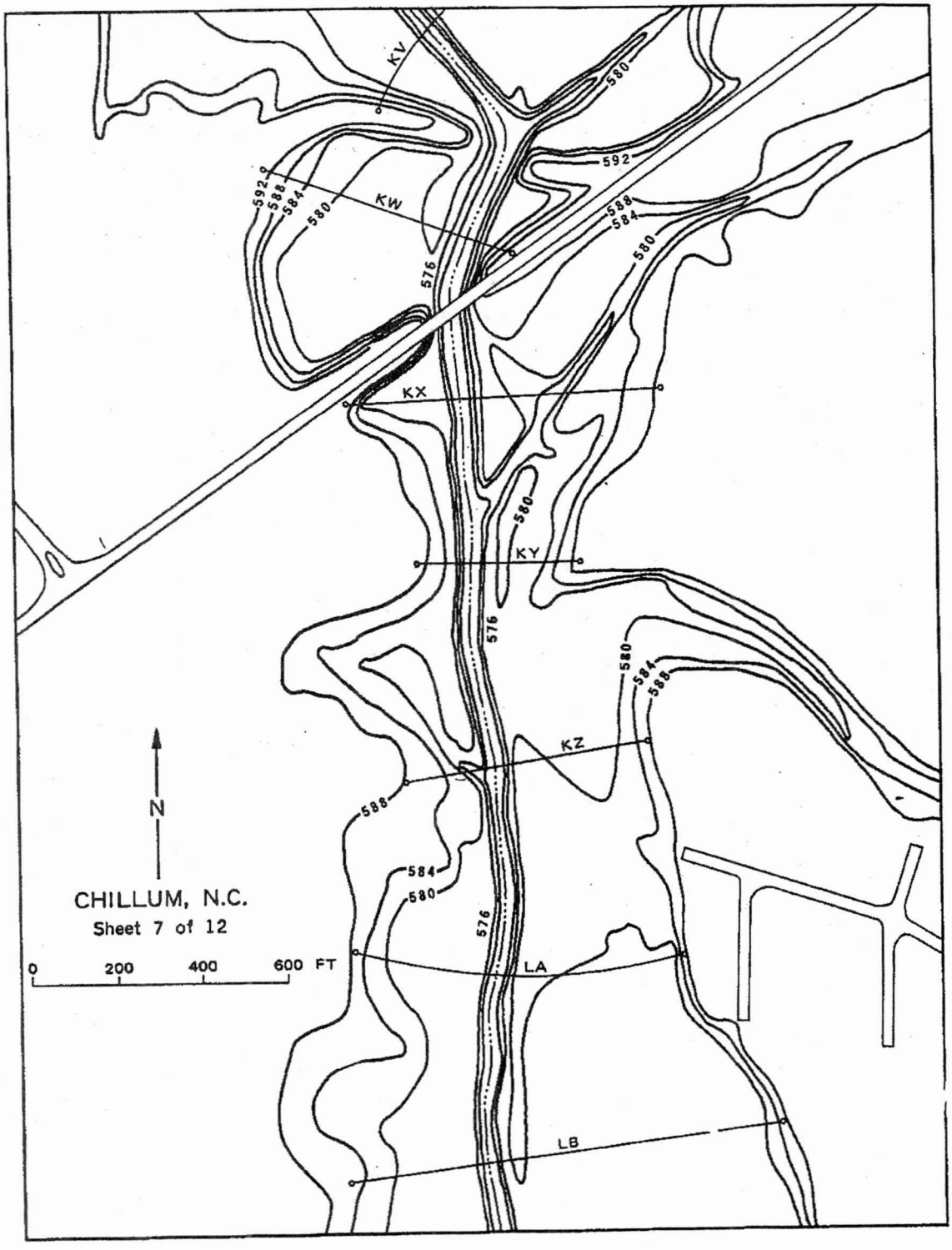


Figure A-3 Example Floodplain Contours

[February 2002]

A.7.5 Quality Control and Quality Assurance

FEMA uses qualifications-based criteria for selection of contracted photogrammetric Mapping Partners, recognizing that quality FIRM work maps result from professional Mapping Partners with superior engrained QA/QC procedures that are routinely adhered to. Overall QA/QC is the responsibility of the assigned Mapping Partner and is exercised at specific stages of the map production process. FEMA's role during data acquisition and map/data base compilation generally must be limited to performing QA/QC reviews, which may involve only cursory spot-checking of the FIRM work maps and supporting data, or to performing formal field map testing using FEMA or third-party forces. This philosophy is especially true for photogrammetric mapping which is a mature technology and for which procedures have been well established for many decades

The QA/QC process for photomapping work may be divided into two categories: process QC and product QA.

[February 2002]

A.7.5.1 Process Quality Control

Process QC is primarily the responsibility of the assigned Mapping Partner. This includes QC reviews of flight alignments, photographic quality, aerial triangulation, stereocompilation, and completeness of supporting data (e.g., cross sections, profiles). The degree of QC required will be governed by the contract specifications.

[February 2002]

A.7.5.2 Product Quality Assurance

FEMA's primary role is that of product QA reviewer. Product quality will be assured by FEMA using a variety of inspection and testing techniques on the final deliverables. FEMA may perform the product QA reviews or they may task other Mapping Partners to perform the QA reviews. Product QA checks, tests, or field inspections likely will be called for in the contract documents for each Flood Map Project; however, FEMA has the option to waive any or all tests and accept the delivered product without formal field testing/checking.

The assigned Mapping Partner shall be responsible for internal QC functions involved with field surveying, photography and laboratory processing, aerial triangulation, stereocompilation and field checking and editing of the photogrammetrically made measurements and compiled maps to ascertain their completeness and accuracy. Also, the assigned Mapping Partner shall make the additions and corrections that are required to complete the FIRM work maps, cross sections, and Flood Profiles.

[February 2002]

A.7.5.3 Quality Assurance of DEMs and/or TINs

See Subsection A.8.6 for detailed QA/QC procedures for DEMs and/or TINs produced from LIDAR, photogrammetry or other source.

[February 2002]

A.7.5.4 Quality Assurance of Contours

The accuracy of contouring on FIRM work maps must be tested by comparing a photogrammetrically derived cross section on the FIRM work map with a cross section established by ground survey. The FEMA Lead shall designate the location of each test traverse. The assigned Mapping Partner shall record the elevation and station for each break in the terrain and for each contour elevation. Ground-surveyed cross sections must be at least 6 inches long at final map scale, with an elevation measured at least every 100 feet on the ground, and must cross at least 10 contour lines when possible. Cross sections must start and close upon map features or previously established control points. In flat areas and at principal road and rail intersections, spot elevations may be checked. In general, one cross section per map sheet is sufficient.

[February 2002]

A.7.5.5 Acceptance/Rejection

FEMA will accept a Flood Map Project when FEMA or a Mapping Partner designated by FEMA has performed sufficient testing to ensure that each phase of the mapping meets FEMA standards and specifications. When a series of FIRM work maps are involved, the existence of errors (i.e., map test failure) on any individual sheet will constitute prima facie evidence of deficiencies throughout the project (i.e., all other sheets are assumed to have similar deficiencies); and field map testing will cease.

When the first ground-surveyed test cross section indicates that a FIRM work map fails to comply with accuracy requirements, FEMA or an assigned Mapping Partner shall make an additional test cross section. This cross section generally shall be parallel to the first cross section at a distance from the first as specified by FEMA. No FIRM work map is to be rejected unless the sum of the lengths of the test cross sections completed is 12 inches or more at final map scale. To determine acceptability of the contouring, the data from all the cross sections are combined and treated as a unit.

[February 2002]

A.8 Airborne Light Detection and Ranging (LIDAR) Surveys

When Mapping Partners choose to use airborne LIDAR systems for gathering the data necessary to create digital elevation data for hydraulic modeling of floodplains, digital terrain maps, and other NFIP products, the guidelines and specifications presented in this section of these Guidelines must be used.

LIDAR systems may not be able to gather all of the data necessary to create those products. Data in areas such as bodies of water or dense forests may not meet the requirements of this Appendix. For FEMA products containing such areas, the assigned Mapping Partner shall supplement LIDAR data with data acquired by other means, as needed for hydraulic modeling. Lesser standards may be applied for hydrologic modeling of watersheds or other studies.

The guidelines and specifications herein are to be used by FEMA Mapping Partners who use LIDAR systems for data gathering purposes.

[February 2002]

A.8.1 System Definitions

For the purpose of these Guidelines, LIDAR is defined as an airborne laser system, flown aboard rotary or fixed-wing aircraft, that is used to acquire x, y, and z coordinates of terrain and terrain features that are both manmade and naturally occurring. LIDAR systems consist of an airborne GPS with attendant GPS base stations, Inertial Measurement Unit (IMU), and light-emitting scanning laser.

The system measures ranges from the scanning laser to terrain surfaces within a scan width beneath the aircraft. The time it takes for the emitted light (LIDAR return) to reach the earth's surface and reflect back to the onboard LIDAR detector is measured to determine the range to the ground. Scan widths will vary, depending on mission purpose, weather conditions, desired point density and spacing, and other factors.

The other two components of LIDAR systems are the airborne GPS, which ascertains the in-flight three-dimensional position of the sensor, and the IMU, which delivers precise information about the attitude of the sensor, i.e., the roll, pitch and heading.

[February 2002]

A.8.2 General Guidelines for Use

Two important factors in the LIDAR system mission planning are the point density of the randomly spaced LIDAR points and the point spacing of the uniformly spaced DEM points derived from the randomly spaced LIDAR returns. The correct point density necessary to accurately represent terrain and terrain features will depend on flight conditions, mission purpose, and required accuracy. As discussed in Sections A.3 and A.4, DEM point spacing of 5 meters or less and

vertical accuracy of 1.2 feet at the 95-percecent confidence level ($Accuracy_z$) is required for digital elevation data equivalent to 2-foot contours for flat terrain, and $Accuracy_z$ of 2.4 feet is required for digital elevation data equivalent to 4'-foot contours for rolling to hilly terrain.

Flight-path planning is another important factor in the LIDAR system mission. The flight path shall cover the study area satisfactorily including both parallel and enough cross flight lines to eliminate shadowing and allow for proper quality control.

Unlike aerial photogrammetry, LIDAR missions can be flown without regard to sun angle. Flights may take place at night, if conditions otherwise allow. However, it is recommended that some form of imagery exist over the LIDAR area. Simultaneous video or digital imagery cannot be acquired if LIDAR data are acquired at night, but LIDAR intensity returns can be acquired day or night, and these help to identify features during LIDAR post-processing. Alternatively, digital orthophotos acquired at a different time can be used for this purpose.

Elevation and measurement information related to subsurface channel and hydraulic structure geometry shall be obtained through the use of other mapping technologies over deep or turbid water. In some instances, shallow water and near-shore coastal surveys can be accomplished using airborne LIDAR bathymetric systems equipped with lasers operating in portions of the light spectrum that allow transmission through water.

LIDAR system tolerance for inclement weather conditions (e.g., high winds, wet snow, rain, fog, high humidity, low cloud cover) generally is higher than that of photogrammetric methods. However, such conditions have been known to degrade the accuracy of laser return data. Therefore, Mapping Partners shall generally avoid missions during inclement weather.

High point densities may allow satisfactory data collection in areas of dense foliage. Still, care shall be taken in planning missions with regard to both natural (vegetative) and manmade (structure) ground cover. Pulse width, beam divergence, first and last pulse return discrimination, and choice of the post-processing algorithms used for vegetation or structure removal may all affect the accuracy of LIDAR-derived data in areas of dense foliage.

[February 2002]

A.8.3 Performance Standards

The accuracy standards in Sections A.3 and A.4 of this Appendix also shall apply to NFIP maps and map products derived from LIDAR systems. LIDAR-derived data shall have the accuracy required to produce topographic maps and products that meet NSSDA.

FEMA is not aware of any existing LIDAR system performance standards. Current information about LIDAR systems is available from ASPRS (See ASPRS, 2001), National Oceanic and Atmospheric Administration (NOAA), National Aeronautic and Space Administration, U.S. Army Corps of Engineers, LIDAR system manufacturers and venders, and private firms that provide LIDAR system services. As professional or trade associations issue specifications and standards, FEMA may adopt those standards and specifications and amend this Appendix.

[February 2002]

A.8.3.1 Overall Standards

The assigned Mapping Partner shall furnish all necessary materials and equipment. The assigned Mapping Partner also shall supply the supervisory, professional, and technical services personnel required to manage, survey, document, and process all data associated with LIDAR system mapping, scanning, and digital image processing. The assigned Mapping Partner shall provide all deliverables in accordance with the contract or other agreement with FEMA and the requirements in this Appendix.

DEM posting shall be the minimum allowed by the data and shall not exceed 5 meters. As specified in Section A.3, $Accuracy_z$ shall normally be 1.2 foot (equivalent to 2-foot contours) in flat terrain and 2.4 feet (equivalent to 4-foot contours) in rolling to hilly terrain.

[February 2002]

A.8.3.1.1 Data Voids

For the purposes of this Appendix, areas not within two times the DEM posting of data points are *data voids*. Data voids may occur from several different causes, including the following:

- LIDAR pulses may be naturally absorbed by water bodies or areas recently covered with asphalt. Such voids are normally considered to be unavoidable.
- The LIDAR system may have malfunctioned for some reason.
- Heavy winds, flight navigation system (FMS) error or pilot error may have caused "holidays" between flight lines.
- Data points may be intentionally removed as part of the bare-earth post-processing to delete points that impinged on the tops of manmade structures or failed to penetrate dense vegetation.

Data voids caused by system malfunctions or flight line holidays are unacceptable, requiring new flights. Data voids caused by removal of LIDAR data points on manmade structures are always acceptable. Data voids caused by removal of LIDAR data points on dense vegetation are subject to additional guidelines, depending on whether or not the voids exist inside or outside the floodplain for which hydraulic modeling is to be performed:

When data voids exist outside the floodplain, hydrologic modeling of the watershed can still be performed acceptably by "filling" the voids through interpolation from surrounding points.

When data voids exist inside the floodplain, the cause of the data voids, the size of the voids, and the location of the voids all have a bearing on whether additional ground surveys will be required to "fill" the voids. For example, if the data voids are caused by dense mangrove or sawgrass areas, supplemental ground surveys within such areas are not needed. These voids are normally "filled" by interpolation from elevation points immediately surrounding the mangrove or sawgrass areas. When small data voids of less than 1 acre are caused by removal of points in other types of dense vegetation, similar interpolation procedures may be employed at the discretion of the FEMA Lead.

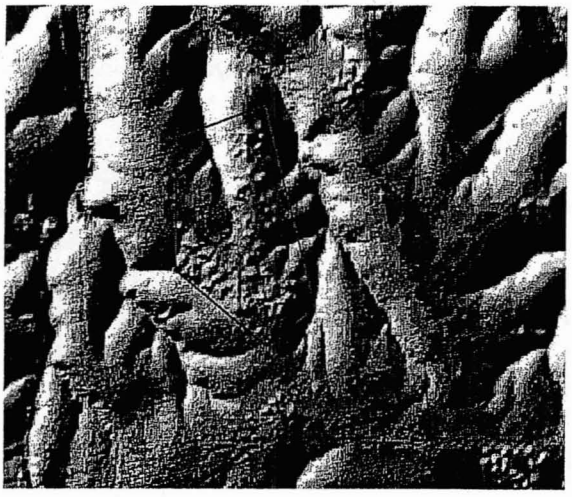
The principal scenario where additional ground surveys are required involves larger void areas, normally larger than 1 acre, located in areas where representative cross sections must be cut. If equally acceptable areas exist elsewhere to cut representative cross sections, the FEMA Lead may decide that the additional expense is unwarranted for filling larger data voids by ground surveys. This "judgment call" is roughly equivalent to photogrammetric mapping where the photogrammetrist cannot see through the dense vegetation, determines areas to be "obscured," and maps the contours with dashed lines. In such cases, the photogrammetrist compiles representative cross sections only where the bare earth terrain can be seen in stereo, and performs ground surveys of additional cross sections only if alternative photogrammetrically compiled locations for cross sections are determined to be unacceptable.

[February 2002]

A.8.3.1.2 Artifacts

Artifacts are regions of anomalous elevations or oscillations and ripples within the DEM data resulting from systematic errors, environmental conditions, or incomplete post-processing. They may result from malfunctioning sensors, poorly calibrated instrumentation, adverse atmospheric conditions, or processing errors. When artifacts are not totally removed, the assigned Mapping Partner shall provide an analysis of the effects of the remaining artifacts on DEM accuracy. The analysis shall include a description of the causes (contributing sources) of the artifacts and a description of the steps taken to eliminate them. Again, imagery is helpful in identification of artifacts. Figure A-4 shows examples of artifacts that remain after automated post-processing and prior to manual post-processing of LIDAR data. Since a major portion of post-processing costs pertain to manual post-processing which could consume as much as 80 percent of the total budget for a LIDAR project, the FEMA Lead may decide that it is not cost effective to require the bare-earth digital terrain data to be 100 percent clean and free of artifacts. As with data voids, the severity of such artifacts depends upon their size and location. In fact, the removal of such artifacts would create new data voids; therefore the guidelines are essentially identical. Artifacts outside the floodplain, but inside the watershed, have no bearing on hydraulic modeling and can be neglected. Often, LIDAR cross sections can be "cut" in areas other than where the artifacts remain; and additional ground surveys are required only if necessary to "cut" cross sections through such artifact areas.

Figure A-4 Example of Artifacts



The exception to this policy is in the event that the Mapping Partner needs DEMs to be 100 percent clean of artifacts for reasons other than hydraulic modeling (e.g., for community GIS requirements). In such cases, other criteria must be applied to justify the additional costs for removal of all artifacts.

[February 2002]

A.8.3.1.3 Outliers

During the RMSE calculation process in which survey checkpoints are compared to the interpolated TIN values, for example, discrepancies may exist between the two values. Some of the discrepancies may be larger than expected, especially in steep terrain or if a "blanket" of dense vegetation such as mangrove, sawgrass, or dense wheat fields exists where the LIDAR may accurately survey the top surfaces of such vegetation rather than penetrating to the ground; in areas of complex topography (e.g., levees that look like hedge rows, boulders that look like haystacks); or in forested areas where removal of the top canopy may yield a lower canopy of underbrush that still does not represent the bare-earth terrain. If there are a limited amount of larger than normal differences between the LIDAR interpolated elevations and the elevations of surveyed checkpoints, this may have a significant impact on the final RMSE calculation.

Outliers often occur as a result of the failure to achieve a true bare-earth surface from the vegetation removal process. A single outlier can override dozens or hundreds of accurate checkpoints, making the entire RMSE value appear to be poor. When this occurs, the coefficient of skew may indicate that the errors do not have a normal distribution, a sign that the RMSE calculation may be misleading. (See Subsection A.8.6.3.4.) Having a large quantity of outliers may highlight improper post processing. In order to deal with outliers, a criterion may be established to remove a small percentage of the total number of checkpoints surveyed which exhibit the largest discrepancies. Statisticians almost unanimously agree that errors exceeding the "3-sigma" level are outliers; the "3-sigma" level provides confidence at the 99.75% confidence level, enabling only the worst 0.25% of a dataset to be discarded as outliers. Less stringent criteria consider the discarding of the worst 1%, 5% or 10% of the data. Allowing 10% outliers would be in accord with the traditional National Map Accuracy Standard where the worst 10% of all checkpoints are treated as outliers that can be discarded, regardless of size. The PO is free to consider the provision of a limited percentage of outliers, especially if the skew calculation indicates that the dataset lacks a normal distribution. The option to collect additional check points to replace the outliers may be considered.

[February 2002]

A.8.3.2 System Calibration

LIDAR system components are most effectively tested and calibrated by the equipment manufacturer. Therefore, the Mapping Partner shall provide FEMA with evidence of manufacturer calibration.

In addition to evidence of manufacturer calibration of system components, the Mapping Partner shall submit evidence that the total LIDAR system was calibrated prior to project initiation for the purposes of identifying and correcting systematic errors. Proper system calibration requires repetitive overflight of terrain features of known and documented size and elevation using flight paths similar to those that will be used in the study area. For some projects, daily in-situ calibrations may be required.

[February 2002]

A.8.3.3 Flight Planning

Planning a flight path that considers all aspects of data collection is critical to the success of the mission. An analysis of the project area, project requirements, topography, proximity to restricted air space, and other factors will determine the flight path configuration. The mission should include parallel flight lines and, for quality control purposes, at least one cross flight line. The spacing between the flight lines will depend on the desired amount of sidelap between swaths and the terrain.

The density and accuracy of data generated by different equipment vary widely. The assigned Mapping Partner shall have the flexibility of providing a flight path to create the necessary point density to meet the posting and accuracy requirements and minimize the occurrence of data voids.

The assigned Mapping Partner shall check the Position Dilution of Precision (PDOP) in the study area. The PDOP is an indicator of the positional accuracy that can be derived from the current GPS satellite geometry, which varies continuously; the smaller the PDOP number, the higher the data quality.

The assigned Mapping Partner shall document mission date, time, flight altitude, airspeed, scan angle, scan rate, laser pulse rates, and other information deemed pertinent. For a sample mission data recordation checklist, refer to Table A-4, which appears at the end of this Appendix.

[February 2002]

A.8.3.4 Global Positioning System (GPS) Base Stations

The assigned Mapping Partner shall select the GPS base stations carefully to ensure reliable differential processing of airborne GPS data. NGS recommends the simultaneous use of two GPS base stations during the mission. Either public- or private-domain GPS base stations are suitable for use for this purpose, provided they are within the acceptable GPS baseline limits. Normally 20 kilometer baseline lengths are maximum for high-accuracy LIDAR surveys, where the airborne GPS error component should contribute no more than 5 centimeters to the vertical error budget.

Where possible, GPS base stations shall have ellipsoid heights to an accuracy of 2 centimeters relative to the Continuously Operating Reference Stations or the High Accuracy Reference Network. The assigned Mapping Partner shall use high-quality, dual-frequency GPS receivers and associated antennae at the GPS base stations.

[February 2002]

A.8.4 Accuracy Reporting Methodology

FGDC documented a common methodology for determining and reporting the accuracy of horizontal and vertical coordinates for geodetic control points (survey monuments) in FGDC-STD-007.1 and FGDC-STD-007.2. Additional guidance is included in NGS-58 (NOAA, 1997).

[February 2002]

A.8.5 Post-Processing of Data

For hydraulic modeling, the assigned Mapping Partner shall provide high-resolution, high-accuracy, "bare-earth" ground elevation data. To restrict data to ground elevations only, the Mapping Partner shall remove elevation points on bridges, buildings and other structures, and on vegetation from the LIDAR-derived data. In addition to randomly spaced LIDAR points, before and after removal of data associated with structures and vegetation, the assigned Mapping Partner shall produce a bare-earth TIN as well as a DEM, with the minimum regular point spacing, no greater than 5 meters, allowed by the data in eastings and northings. The assigned Mapping Partner shall use TIN linear interpolation procedures when validating the vertical accuracy of the elevation dataset. Accuracy assessments should normally be performed on the TIN and not on the DEM which is a derived product of slightly lower accuracy.

Using digital orthophotos, stereo photogrammetry, or other source materials, the assigned Mapping Partner shall produce breaklines for stream centerlines, drainage ditches, tops and bottoms of streambanks, ridge lines, road crowns, levees, bulkheads, seawalls, road/highway embankments, and selected manmade features that constrict or control the flow of water (e.g., curb lines). When merged with mass points, breaklines are used to enforce TIN triangle edges. The assigned Mapping Partner also shall specify the sources and accuracy of breakline data. Breaklines are not depicted for small culverts that pass under roads unless those culverts (or ditches leading in and out of them) are visible on available imagery without the use of photogrammetric stereo compilation which is normally too expensive for this purpose.

[February 2002]

A.8.6 Quality Assurance/Quality Control

QA/QC of the LIDAR-derived data is primarily the responsibility of the assigned Mapping Partner. This QA/QC process shall include reviews of flight alignments and completeness of supporting data (e.g., cross sections, profiles). Until LIDAR technology and procedures become mature, FEMA will normally provide funding for independent QA/QC testing.

[February 2002]

A.8.6.1 Vertical RMSE Standards

When systematic errors have been corrected and remaining errors have a normal distribution, the NSSDA uses the root mean square error (RMSE) to estimate both horizontal and vertical accuracy. RMSE is the square root of the average of the set of squared differences between dataset coordinate values and coordinate values from an independent source of higher accuracy for identical points. If those differences are normally distributed and average zero, 95 percent of any sufficiently large sample should be less than 1.96 times the RMSE. Therefore, vertical RMSE of 18.5-centimeters is often referred to as equivalent to 2' contours, or "37-centimeter accuracy at the 95-percent confidence level." Following that convention, the vertical accuracy of any digital elevation dataset is defined as 1.96 times the RMSE of linearly interpolated elevations in that dataset, as compared with known elevations from high-accuracy test points.

For the NFIP, TINs (and DEMs derived therefrom) should normally have a maximum RMSE of 18.5 cm, equivalent to 2' contours, in flat terrain; and a maximum RMSE of 37 cm, equivalent to 4' contours, in rolling to hilly terrain. The Mapping Partner shall field verify the vertical accuracy of this TIN to ensure that the 18.5 cm or 37.0 cm RMSE requirement is satisfied for all major vegetation categories that predominate within the floodplain being studied.

[February 2002]

A.8.6.2 Ground Cover Categories

The assigned Mapping Partner shall separately evaluate and report on the TIN accuracy for the main categories of ground cover in the study area, including the following:

1. Bare-earth and low grass (plowed fields, lawns, and golf courses);
2. High grass, weeds, and crops (hay fields, corn fields, and wheat fields);
3. Brush lands and low trees (chaparrals, mesquite);
4. Forested, fully covered by trees (hardwoods, evergreens, and mixed forests);
5. Urban areas (high, dense manmade structures);
6. Sawgrass; and
7. Mangrove.

Ground cover Categories 1 through 5 above are fairly common everywhere. FEMA experience with Categories 6 and 7 is that sawgrass and mangrove each have vegetation so dense that LIDAR pulses do not penetrate to the ground, but instead map the top reflective surface. The assigned Mapping Partner must treat such areas like "obscured terrain" with conventional photogrammetry whereby bare earth elevations within such vegetation category polygons can only be estimated by interpolating elevations from ground points surrounding such polygons.

The assigned Mapping Partner may further subdivide and expand the above definitions to better accommodate the predominant vegetation types in the study area. The assigned Mapping Partner shall distribute sample points throughout each category area being evaluated and not group the sample points of the same type in a small sub-area.

The assigned Mapping Partner shall select a minimum of 20 test points for each major vegetation category identified. Therefore, a minimum of 60 test points shall be selected for three (minimum) major land cover categories, 80 test points for four major categories, and so on. The Mapping Partner shall consider establishing test points when planning field surveys to gather cross section data for hydraulic modeling. Confidence in the calculated RMSE value increases with the number of test points and is a function of sample size. By specifying a minimum of 60 checkpoints (20 each in three or more land cover categories), FEMA is specifying that 60 test points are the minimum necessary for a practical level of confidence in the calculated RMSE statistic but recognizing that a higher number of checkpoints will provide higher confidence that performance standards have been achieved.

The test points are to be selected in terrain that is flat or uniformly sloped within 5 meters in all directions. The uniform slope must not exceed 20 percent. The test points must never be located near to breaklines, such as bridges or embankments. Test points on sloping or irregular terrain

would be unreasonably affected by the linear interpolation of test points from surrounding TIN points and, therefore, shall not be selected.

[February 2002]

A.8.6.3 Analysis of Error Frequency Distribution

The RMSE process assumes that errors have a normal distribution (bell curve) with zero mean, and that all systematic errors have been removed. This is rarely the case, especially with LIDAR data. Some systematic errors or biases remain undetected, even after regular calibrations of LIDAR systems. This Subsection addresses statistical processes for evaluating whether the errors have a central tendency close to zero, evaluating the measure of general variability, and evaluating the measure of skewness. Unfortunately, no hard and fast rules to pinpoint problems exist, but each of the statistical processes mentioned have some value in detecting the potential presence of systematic errors, for which further investigations are warranted, especially if the RMSE calculation fails to pass the vertical accuracy criteria established for the project.

[February 2002]

A.8.6.3.1 Histograms

The most common form of error analysis is to develop a histogram of all errors. If a dataset tabulates errors for all checkpoints, a histogram might show how many of those errors fell within different 5-centimeter ranges, for example, graphing the number of errors between the following error values: - 50 cm, -45 cm, -40 cm, -35 cm, -30 cm, -25 cm, -20 cm, -15 cm, -10 cm, -5 cm, 0, +5 cm, +10 cm, +15 cm, +20 cm, +25 cm, +30 cm, +35 cm, +40 cm, +45 cm, and +50 cm. Histograms illustrate whether the errors are unimodal, bimodal, or multimodal, have small or large variability, or are skewed on either the positive or negative side. Often, such histograms for LIDAR data appear to approximate a normal distribution, except that it does not have a zero mean; this would appear to indicate the presence of uncorrected systematic error. Separate histograms for individual land cover categories often depict significantly different characteristics that help to understand LIDAR system performance (including post-processing) in the different categories. Figure A-5 is an example of a histogram reflecting checkpoint errors from a LIDAR dataset that does approximate a normal error distribution.

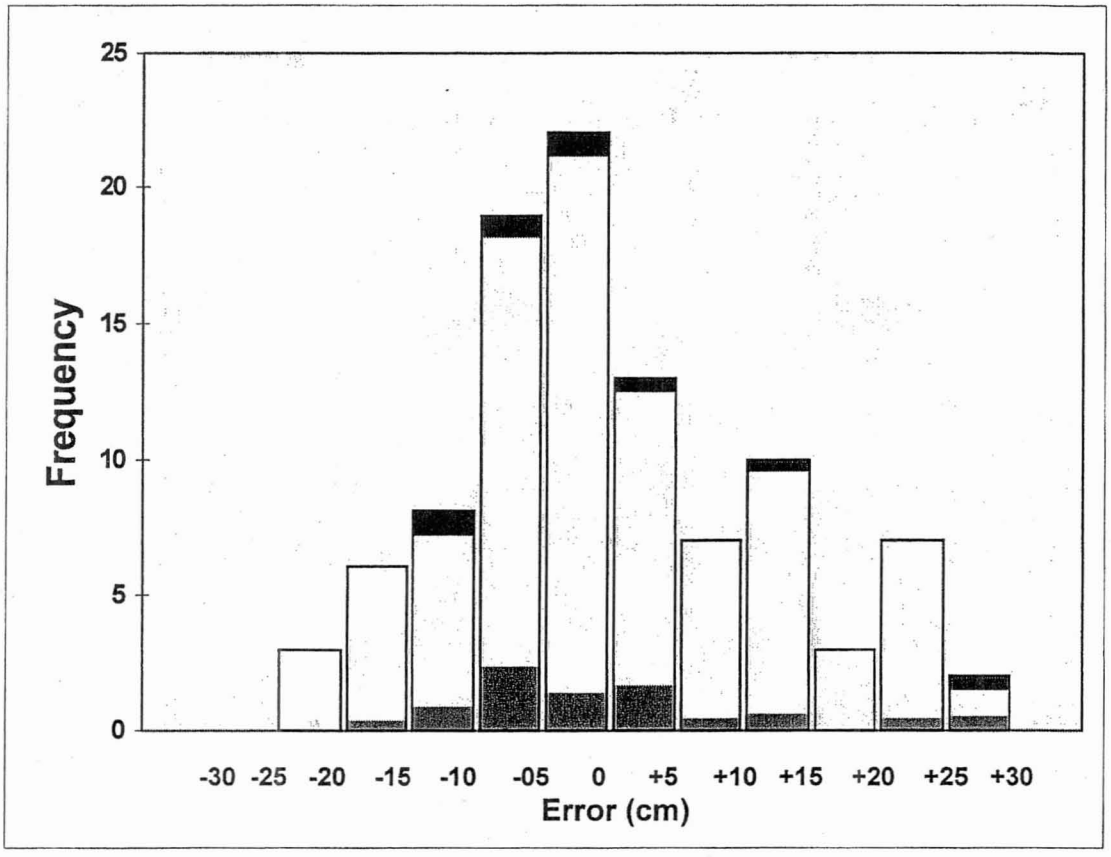


Figure A-5 Histogram for Checkpoint Errors in LIDAR Dataset

[February 2002]

A.8.6.3.2 Measures of Central Tendency

Three common measures of the central tendency of errors in a dataset may be used to quantify the nearness to or departure from the expected central tendency of zero:

- The *Arithmetic Mean* is the sum of all the errors, divided by the number (n) of checkpoints. When the mean error is large, this is an indicator that systematic errors may be present.
- The *Median* is the value at which there are as many larger errors as there are smaller errors.
- The *Mode* is the value at which the greatest number of errors is concentrated. In a histogram, the mode is the error value or error range which has the highest ordinate value at the peak of the histogram.

[February 2002]

A.8.6.3.3 General Variability

Various measures of general variability for statistical data exist, including range, average deviation, RMSE, standard deviation, and variance. However, the industry standard for geospatial data is the RMSE explained in Sections A.2 and A.3. For the dataset used to compute the histogram in Figure A-5, the $RMSE_z$ = 11.7-centimeters which equates to vertical $Accuracy_z$ of approximately 22.9-centimeters at the 95-percent confidence level. The standard deviation (σ or sigma) is primarily used for determination of statistical outliers, i.e., elevation errors that exceed the 3-sigma level.

[February 2002]

A.8.6.3.4 Skewness

Skewness is the condition of being asymmetrical or lopsided, and departing from the expected normal distribution shown by the "bell curve." The coefficient of skewness (a unitless number) is used to compute the asymmetry of the errors about the arithmetic mean error. When the absolute value of the skew exceeds 0.5, this means that the error distribution is asymmetrical and may not represent a normal distribution. The Mapping Partners should investigate all datasets with skew values exceeding ± 0.5 to determine if there is a valid reason why the errors do not have a normal distribution (a basic assumption in calculation of RMSE values). For the dataset used to compute the histogram in Figure A-5, the skew is 0.429. The skew is computed automatically by Microsoft Excel and other spreadsheets, and uses calculations of the second and third central moments of the dataset.

The coefficient of skew is zero when the error distribution is perfectly symmetrical.

[February 2002]

A.8.6.4 Error Assessment

When a LIDAR dataset does not pass the vertical accuracy standard, steps must be taken to identify the cause of the errors. Systematic corrections should never be applied without first identifying the cause of errors. Many factors could have contributed to errors, including the following:

- The LIDAR aircraft may have flown at too high of an altitude, causing IMU angular errors to propagate to larger errors on the ground from a higher altitude.
- The GPS baselines may be too long, flying too far from the GPS base stations, and causing larger than normal errors in airborne GPS positions.
- The scan angle may have been too large or the airspeed too fast, causing wider point spacings and fewer laser pulses that were near vertical.
- The satellite PDOP may have been too high, reducing the accuracy of airborne GPS positions.
- The post-processing algorithms may have been applied incorrectly.
- There may have been systematic errors with the airborne GPS, IMU, or laser scanner.

The list of potential causes is a long one because the process is complex.

Many of the statistical tools described in Subsection A.8.6.3 may point to the apparent existence of systematic errors. The following are standard procedures to be used by FEMA's Mapping Partners to "trouble shoot" total LIDAR systems in order to isolate systematic errors:

[February 2002]

A.8.6.4.1 Assessments by Land Cover

If ground cover category 1 (bare earth, sand, rock, dirt, short grass) does not pass the vertical accuracy standard, the potential causes are different from potential causes when vegetated or urban areas do not pass. Ground cover category 1 essentially should always pass accuracy standards, unless something systematic is wrong. Daily calibration tests help to confirm that the system performed well at the calibration test site (on that same day with the same sensor), and the calibration site normally includes bare earth terrain and short grasses. If ground cover categories 3 or 4 (see Subsection A.8.6.2) alone do not pass the vertical accuracy standard, the most probable causes are shortcomings in the vegetation-removal procedures used in post-processing. If ground cover category 5 (urban terrain) does not pass, something systemic about urban buildings may cause the errors.

[February 2002]

A.8.6.4.2 Assessments by Error Locations

The Mapping Partner shall assess errors relative to their location within flight lines, or near the beginning or end of swaths. This may indicate IMU errors or high satellite residuals due to aircraft banking causing cycle slips and multipath.

[February 2002]

A.8.6.4.3 Assessments by Dates/Sensors

When LIDAR datasets are flown on different dates, or with different sensors, the Mapping Partner must consider these variables in the error analyses.

[February 2002]

A.8.6.4.4 Airborne GPS Verification

The Mapping Partner shall examine GPS flight trajectories, compare the forward and reverse flight trajectories' combined separation, check satellite health, check geo-magnetic observations, and verify the following:

- PDOP;
- GPS satellite residuals;
- Satellite phase RMS;

- Weighting adjustments when two or more differential base stations are used;
- Base station distance separation;
- Position standard deviations;
- Vertical datum used; and
- Correct application of Geoid99 calculation of orthometric heights.

[February 2002]

A.8.6.4.5 Inertial Measurement Unit (IMU) Verification

The Mapping Partner normally shall do the following to verify the accuracy of the IMU:

- Review the Kalman filter, the measurement residual ratio (MRR), and the consecutive measurement rejections settings;
- Confirm IMU was in "fine align" mode for the whole of the dataset;
- Check accelerometer drift and scale factor, and the gyro drift and scale factor to ensure they are within specifications;
- Compare GPS trajectory with recomputed IMU trajectory and investigate large discrepancies; and
- Review IMU to lever arm parameter measurements and ensure they are entered correctly in the proper reference system.

[February 2002]

A.8.6.4.6 Laser Range Verification

The Mapping Partner shall normally do the following to verify the accuracy of the laser ranges:

- Review raw laser ranges;
- Identify areas of high dropouts (no returns) and correlate them to justifiable features;
- Review scanner mirror angles (galvanometers or micro-controller);
- Examine intensity images if collected; and
- Review system generated error log sheets.

[February 2002]

A.8.6.4.7 Total System Verification

To verify the accuracy of the whole system, the Mapping Partner shall do the following:

- Review calibration flights and compare to system flight parameters;
- Use CAD software to analyze individual flightlines and verify pitch, roll and heading errors;
- Check overlap for roll and scaling errors;
- Check ground features for pitch (i.e., buildings, bridges, etc.);
- Check scaling errors if water bodies exist;
- Compare cross flight data for attitude; and
- Verify vegetation removal procedure and review parameters if data were "corrected" or adjusted for pitch, roll and heading errors; for example, was the iteration angle too high for the terrain type? Is the morphological window within a reasonable size for area features (e.g., is it too large and removes key components such as large dunes?).

[February 2002]

A.8.6.4.8 Systematic Error Corrections

It is relatively easy to determine the magnitude of systematic errors and adjust all data accordingly, however, the assigned Mapping Partner must not be "correct" such errors until the error source is clearly identified and documented. The Mapping Partner must report systematic errors to the FEMA Lead for review before systematic reprocessing of data that initially failed to pass the accuracy criteria.

[February 2002]

A.8.6.5 Cross Flight Verification

To supplement the QA/QC process for LIDAR data, the Mapping Partner may employ different optional techniques to check not only the accuracy but also the precision. The balance is to address the need for additional verification checkpoints with cost-effective methods that aid in identifying the internal consistency (precision) of LIDAR data. Two GPS techniques that may be utilized are *continuous kinematic* and *Real Time Kinematic (RTK).* Continuous kinematic collects positional data every epoch while maintaining fixed ambiguities on a minimum of five satellites. In the event of loss of lock on satellites, the integer ambiguities must be recomputed to their fixed integer value before a sub decimeter position can be calculated. Post processing is required to obtain the positional data. RTK is similar to continuous kinematic except that the data do not need to be post-processed. The estimated ambiguities are fixed to their integer values and positional data are calculated and stored in real time. Both methods are efficient for GPS surveys along highways.

With both types of GPS procedures the process is to survey checkpoints perpendicular to the LIDAR flight paths at different strategic locations, with these additional checkpoints along roads or

highways that transect the survey area. The assigned Mapping Partner shall conduct surveys close to the center of roads and highways, but avoiding bridges, elevated roads, or roads with steep embankments so that LIDAR points can be interpolated accurately without concern for steep slopes. If the flights are flown north to south, then the checkpoints must traverse east and west across the project area. A minimum of three cross lines must be measured, one at each end of the flight lines and another through the center. Typically the weakest data will be at the beginning of the flight line if the GPS and IMU have not stabilized due to the turning of the aircraft. The center cross line will help identify if the airborne data are stabilized. Ideally checkpoints should have a minimum point spacing of one half the LIDAR swath width to ensure each swath has at least one checkpoint. Increasing the number of cross flight checkpoints will assist in verifying confidence within the data. Because such surveys are less accurate than the surveys of checkpoints to NGS-58 5-centimeter standards, these additional verification points are not to be mixed with the survey checkpoints used to compute the vertical RMSE or $Accuracy_z$. However, this is a relatively inexpensive way to generate a relatively large number of somewhat less-accurate checkpoints when there is concern that the 60, 80 or 100 checkpoints (20 each in the major land cover categories) are insufficient for providing a high degree of confidence in the accuracy statistics.

[February 2002]

A.8.7 Deliverables

All data and products associated with contract deliverables shall meet or exceed relevant NSSDA standards and fully comply with the FGDC metadata format standard with the provisions in the contract. The Mapping Partner shall use Appendix I of these Guidelines as a guide for preparing and submitting deliverable products to FEMA in digital format.

[February 2002]

A.8.7.1 Pre-Project Deliverables

Prior to data collection, the Mapping Partner shall submit the following to the FEMA Lead or a Mapping Partner designated by the FEMA Lead:

A map showing the study area boundaries and flight path, at a medium scale (1:24,000) or small scale (1:50,000); typically, USGS maps are desirable for this purpose

- Documentation specifying altitude, airspeed, scan angle, scan rate, LIDAR pulse rates, and other flight and equipment information deemed appropriate; and
- A chart of areas of high PDOP, or a list showing the time of the beginning and end of high PDOP.

[February 2002]

A.8.7.2 Post-Project Deliverables

Following project completion, the Mapping Partner shall submit the following to the FEMA Lead or a Mapping Partner designated by the FEMA Lead:

- A LIDAR system data report;
- A flight report;
- A ground control report;
- Data processing procedures for selection of postings, and all orthometric values of x, y, and z coordinates for LIDAR returns. Elevations shall be orthometric heights; and
- A system calibration report.

The LIDAR system data report shall include discussions of the following:

- Data processing methods used, including the treatment of artifacts;
- Final LIDAR pulse and scan rates;
- Scan angle;
- Capability for multiple returns from single pulses;
- Accuracy and precision of the LIDAR data acquired;
- Accuracy of the topographic surface products;
- Any other data deemed appropriate;
- Companion imagery, if any; and
- A digital spatial index showing the orientation of all data tiles within the project site with tile labels corresponding to the CD (or other media) ID and file name on that CD.

The flight report shall document mission date, time, flight altitude, airspeed, and other information deemed pertinent. The report shall include information about GPS-derived flight tracks, provide a detailed description of final flight line parameters and GPS controls (i.e., benchmarks), and include ground truth and complementary reference data.

The ground control report shall include, at a minimum, all pertinent base station information and mission notes, including information on GPS station monument names and stability.

[February 2002]

A.8.7.3 Delivery of Digital Data

In addition to the pre- and post-project deliverables described above, the Mapping Partner shall submit the following:

- All raw datasets, dataset of survey points filling voids, dataset of transects (if generated), bare-earth DEM data, and breaklines in separate data files; and

- Uniformly spaced DEM(s), on ISO 9660 standard CD-ROM (or DVD) media in a format specified in Appendix L.

The Mapping Partner shall deliver raw datasets and LIDAR system data, including orthometric heights for each point, in comma-delimited ASCII files in x, y, and z format. The Mapping Partner shall deliver the DEM in the format designated on the Table A-4 checklist. The Mapping Partner also shall flag raw datasets from sidelap and overlap areas of separate flight lines. Breaklines shall be produced, and breakline files shall contain a flag record that identifies them as breakline features and identifies their source and accuracy. The Mapping Partner shall submit raw datasets in tiles or data models matching those of the DEM.

The Mapping Partner shall ensure that all deliverables conform to the projection, datum, and coordinate system specified in the agreement with FEMA. File sizes cannot exceed 1 gigabyte, unless otherwise specified by the FEMA Lead. Each file shall be organized to facilitate data manipulation and processing.

[February 2002]

A.8.8 Acceptance/Rejection

The terms of acceptance/rejection in Section A.7.5.5 of this Appendix shall apply.

Table A-4. LIDAR System Mission Data Collection Checklist

Notes	A. Data collection (each flight)
	1. Record flight date and time.*
	2. Record flight altitude(s).*
	3. Record LIDAR system scan angle, scan rates, and pulse rates.*
	4. Record time LIDAR system receiver is activated/ deactivated.*
	5. Record all Position Dilution of Precision values.*
	6. Record height of instrument (before and after flight).
	7. Record on-board antenna offsets.
	8. Note any site obstructions at GPS base station(s).
	9. Record airborne and ground-site GPS receiver types and serial numbers.
	10. Record ground site GPS station monument names and stability.*
	11. Record flight staff.
Notes	**B. Data handling (each flight)**
	1. Record that all files have been labeled correctly and cross indexed.
	2. Record analyst name(s) responsible for processing and product generation .
	3. List any auxiliary information used during processing of LIDAR to generate products delivered.
	4. List major data processing components used.

• Denotes Minimum Required Information

[February 2002]

A.9 References

American Society for Photogrammetry and Remote Sensing, ASPRS 1990, "ASPRS accuracy standards for large-scale maps," *Photogrammetric Engineering and Remote Sensing,* Vol. 56, No. 7, pp 1068-1070.

American Society for Photogrammetry and Remote Sensing, ASPRS 1995, Draft Aerial Photography Standards, *Photogrammetric Engineering and Remote Sensing,* Vol. 61, Number 9, pp. 1097-1103.

American Society for Photogrammetry and Remote Sensing, ASPRS 2001, *Digital Elevation Model Technologies and Applications: The DEM Users Manual*, Chapter 2 (Vertical Datums), Chapter 3 (Accuracy Standards), Chapter 5 (Photogrammetry), Chapter 7 (Topographic LIDAR), Chapter 12 (DEM Quality Assessment), Chapter 13 (DEM User Requirements), and Appendices A and B (Acronyms and Definitions).

Bureau of the Budget, 1947, *National Map Accuracy Standards,* Office of Management and Budget, Washington, D.C.

Federal Geographic Data Committee, FGDC-STD-007.1-1998, *Geospatial Positioning Accuracy Standards, Part 1: Reporting Methodology,* FGDC, c/o USGS, Reston, VA, www.fgdc.gov/standards/documents/standards/accuracy/chapter1.pdf

Federal Geographic Data Committee, FGDC-STD-007.2-1998, *Geospatial Positioning Accuracy Standards, Part 2: Standards for Geodetic Networks,* FGDC, c/o USGS, Reston, VA, www.fgdc.gov/standards/documents/standards/accuracy/chapter2.pdf

Federal Geographic Data Committee, FGDC-STD-007.2-1998, *Geospatial Positioning Accuracy Standards, Part 3: National Standard for Spatial Data Accuracy,* FGDC, c/o USGS, www.fgdc.fgdc.gov/standards/documents/standards/accuracy/chapter3.pdf

Federal Geographic Data Committee, FGDC 1999, *Content Standards for Framework Land Elevation Data (final draft),* FGDC, c/o USGS, Reston, VA, www.fgdc.gov/standards/documents/standards/elevation/ele_199.pdf.

National Oceanic and Atmospheric Administration, NOAA 1997, *Guidelines for Establishing GPS-Derived Ellipsoid Heights (Standards: 2 cm and 5 cm), version 4.3,* NOAA Technical Memorandum NOS NGS-58, www.ngs.noaa.gov/PUBS_LIB/NGS-58.html.

U.S. Army Corps of Engineers, USACE 1993, Engineer Manual 1110-1-1000, *Photogrammetric Mapping,* dated 31 March 1993.

U.S. Army Corps of Engineers, USACE 1994, Engineer Manual 1110-2-1003, *Hydrographic Surveying*, dated 31 October 1994.

Map MODERNIZATION

Federal Emergency Management Agency

FEMA's Flood Hazard Mapping Program

Guidelines and Specifications *for* Flood Hazard Mapping Partners

Appendix B: Guidance for Converting to the North American Vertical Datum of 1988

FEDERAL EMERGENCY MANAGEMENT AGENCY

www.fema.gov/mit/tsd/dl_cgs.htm

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February 2002

Appendix B

Converting to the North American Vertical Datum of 1988

B.1 Background

Every Flood Insurance Study (FIS) Report and Flood Insurance Rate Map (FIRM) that contains detailed flood hazard information is prepared based on hydraulic analyses that are referenced to a specific vertical datum. The two standard datums in use nationwide are the National Geodetic Vertical Datum of 1929 (NGVD29) and the North American Vertical Datum of 1988 (NAVD88). Information on these datums and on software that is available to convert NGVD29 to or from NAVD88 is provided in Subsections B.1.1, B.1.2, and B.1.3.

[February 2002]

B.1.1 National Geodetic Vertical Datum of 1929

Historically, the most common vertical datum used for FEMA flood hazard studies/restudies and map revisions has been NGVD29. NGVD29 assumed that 26 tide gages in the United States and Canada all represented the same zero elevation, which was mean sea level. As survey technologies became more accurate, it became increasingly apparent that NGVD29 constraints were incorrectly forcing surveys to fit different tide stations (all zero elevation or mean sea level) that actually had different elevations relative to each other. NGVD29 essentially warped the geoid, which represents an equipotential surface where gravity, and elevations, should be the same. Fortunately, the maximum warp anywhere in the United States, caused by forced constraints of NGVD29 at 26 tidal stations, is no more than 1.5 meters. Although there are exceptions, the warping found over smaller geographic areas, such as the area within a county, is small.

[February 2002]

B.1.2 North American Vertical Datum of 1988

In the 1970s, the National Geodetic Survey (NGS), and counterpart agencies in Mexico and Canada, decided to adopt a vertical datum based on a surface that would closely approximate the Earth's geoid. The new adjustment, NAVD88, was completed in June 1991 and is now the only official vertical datum in the United States. NAVD88 was created by adding 625,000 kilometers of leveling, performed since NGVD29 was established, and performing a major least squares adjustment that constrained only a single tide station at zero elevation. The height of the primary tidal bench mark at Father Point/Rimouski, Quebec, Canada, was held fixed as the constraint, enabling NAVD88 and the International Great Lakes Datum of 1985 (IGLD85) to be one and the same.

Now, other tide stations may have elevations other than zero. Subsequent to the establishment of NAVD88, new flood hazard studies are preferably referenced to that datum.

[February 2002]

B.1.3 Conversion Software

The NGS and the U.S. Army Corps of Engineers (USACE) have developed software, which may be obtained free of charge, for performing conversions between NGVD29 and NAVD88. Interested Mapping Partners may download the PC-compatible NGS VERTCON software from the NGS home page at www.ngs.noaa.gov, by selecting the NGS Geodetic Tool Kit option. Similarly, interested Mapping Partners may download the USACE CORPSCON software from the U.S. Army Topographic Engineering Center home page at www.tec.army.mil; by selecting What We Do; Products and Services; Software Available, and CORPSCON. The CORPSCON software can be use to convert horizontal datums (between the North American Datum of 1927 [NAD27] and NAD 83) as well as vertical datums (between NGVD 29 and NAVD 88) based on NGS NADCON and VERTCON software. Both programs compute the modeled differences in orthometric heights (elevations) between NGVD29 and NAVD88 for a given location specified by geographic coordinates (latitude and longitude). CORPSCON also allows Universal Transverse Mercator or State Plane coordinates to be entered in lieu of geographic coordinates. The Mapping Partner may obtain identical results using either the VERTCON or CORPSCON software.

[February 2002]

B.2 Data Collection

One of the stated goals of FEMA's Map Modernization Program is to convert all flood maps from NGVD29 to NAVD88. The Mapping Partner that performs a study/restudy for FEMA or submits a map revision request will be responsible for applying proper vertical datum protocols for new and/or revised flood hazard data when preparing or revising flood hazard study/restudy materials that have been chosen for the datum conversion. FEMA recognizes that there are, and will continue to be, limiting factors in achieving this conversion. To evaluate the suitability of a subject jurisdiction for datum conversion, the Mapping Partner shall gather the following information during the initial coordination efforts for a study or restudy:

- Datum used for the existing study, if one exists, and the extent of changes that will occur as a result of the restudy;
- Number (percentage) of streams that will be revised and the number of unrevised flooding sources that must be converted from NGVD29 to NAVD88 if the datum conversion option is chosen;
- Conversion factor from NGVD29 to NAVD88 for the subject community, whether or not the conversion factor for the community is constant, and maximum offset from the established conversion factor (see Section B.4.1);
- Reference datum used by FEMA for adjacent communities;
- Datum of choice for the local surveyors and any known difficulties that the community would have with the use of NAVD 88; and
- Approximate effort (man-hours) associated with conversion to NAVD 88.

[February 2002]

B.3 Conversion Criteria

To eliminate possible confusion and misuse of elevation information, the flood elevations for all flooding sources studied by detailed methods within a given community must be referenced to the same datum. Therefore, if a Mapping Partner undertakes a restudy or map revision that does not include all flooding sources studied by detailed methods, the elevations for the flooding sources also must be converted to NAVD88.

Therefore, it is essential for the Regional Project Officer (RPO) and the Mapping Partner to make an initial sound decision about which vertical datum can and should be used for a study, restudy, or map revision. Once the Mapping Partner has gathered the information specified in Subsection B.2, FEMA, in consultation with the Mapping Partner, will make the final decision regarding the datum to which the new, revised, and unrevised flood hazard information will be referenced. When a new or revised study is being processed, the decision to use NAVD88 over NGVD29 will depend largely on the data gathered early in the process. Criteria that facilitate a conversion from NGVD29 to NAVD88 are as follows:

- All flooding sources in the community are being studied or restudied by detailed methods.
- Less than 50 percent and fewer than 20 miles of detailed study streams that are not being restudied will have to be converted from NGVD29 to NAVD88.
- No more than 5 percent of the total printed FIRM panels for the community have to be revised solely to convert the elevations for the flooding sources that were not restudied from NGVD29 to NAVD88.
- The maximum offset from an established average conversion (from NGVD 29 to NAVD 88) for the subject jurisdiction does not exceed 0.25 foot. Protocol for determining an average conversion factor as well as a maximum offset value is provided in Subsection B.4.1.
- The Mapping Partner performing the flood hazard analysis is able to use NAVD88 for the study/restudy or map revision.
- The community is familiar with NAVD88.

If the mapping activity undertaken by the Mapping Partner is a comprehensive restudy of all flooding sources studied by detailed methods, or if the Flood Map Project is resulting in a first time FIRM, all flood elevations shall be referenced to NAVD88 unless otherwise specified during the Scoping process.

The above criteria are provided for general guidance to aid the RPO and Mapping Partner in making a technically sound, cost-effective, and user-friendly decision.

[February 2002]

B.4 Conversion of Unrevised Flood Elevations

There will be occasions were a Mapping Partner submits restudy or map revision information referenced to NAVD88 to FEMA to support preparation of a new or revised FIRM but does not address the remainder of the unrevised flood elevations. In those circumstances, FEMA will decide whether the Mapping Partner that performed the study/restudy or the Mapping Partner that prepares the Preliminary FIS Report and FIRM will convert the flood hazard information for the entire community to NAVD88. This decision will be made on a case-by-case cost-benefit assessment. If FEMA determines that the cost to convert the entire community is reasonable (considering the other scope of work), the Mapping Partner that is selected to complete the conversion shall follow the procedures in Subsections B.4.1, B.4.1.1, B.4.1.2, and B.4.1.3 of this Appendix.

[February 2002]

B.4.1 Protocol for Determining Conversion Factor

The Mapping Partner responsible for conducting the new or revised flood hazard analyses shall establish single or multiple conversion factors to be applied to the unrevised 1-percent annual-chance flood elevations in the FIS Report and on the FIRM. To determine an average conversion factor from NGVD29 to NAVD88, the steps below shall be followed:

Step 1 - Locating the Subject Jurisdiction

The Mapping Partner shall locate the subject jurisdiction on U.S. Geological Survey 7.5-minute series topographic quadrangle maps.

Step 2 - Determining Conversion Factors for Quadrangle Corners

The Mapping Partner shall use VERTCON or CORPSCON to determine the conversion factor for each quadrangle corner that falls inside the jurisdiction boundary and each quadrangle corner that lies within 2.5 miles outside of the jurisdiction boundary. This information is to be entered into a table that will be used in the FIS Report (sample table provided below.) Details for the production of FIS Reports are provided in Appendix J.

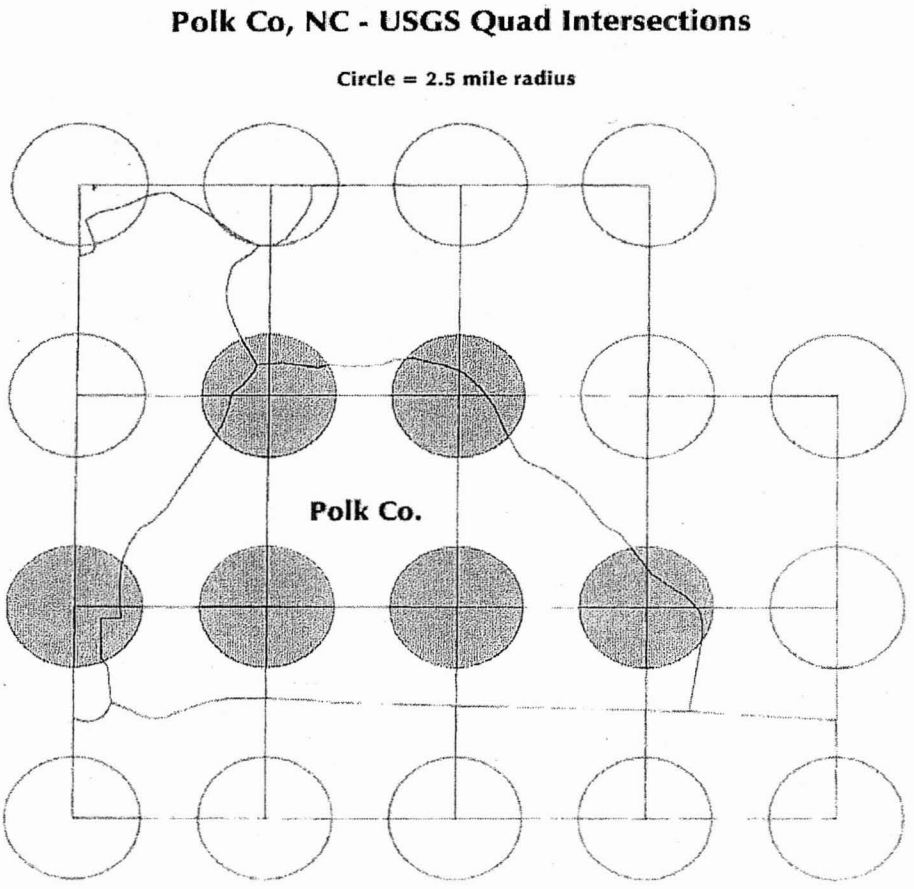
Quad Name	Corner	Latitude	Longitude	Conversion from NGVD29 to NAVD88
Johnsonville West	SE	35.375	82.125	-0.54 ft
Johnsonville East	SE	35.375	82.250	-0.32 ft
Gilberts Corner	SW	35.250	82.000	-0.54 ft
Farmville	SW	35.250	82.125	-0.37 ft
Taylor's Grove	SW	35.250	82.250	-0.25 ft
Thompsonville	SW	35.250	82.375	-0.14 ft

Figure B.1 shows five quadrangle corners within the county, and one outside the county but within 2.5 miles of the county boundary. (This corner is thus to be included in the calculation of

average conversion factors.) The shaded circles represent the quad intersections that meet the selection criteria.

[February 2002]

Figure B-1



For quadrangles that include oceans or other major water bodies, quadrangle corners that are more than 2.5 miles away from land shall not be used, except in the case of small islands or narrow bands of land that would not be represented by quadrangle corners on either side. When this occurs, the Mapping Partner's discretion may be used in selecting the nearest quadrangle corner to ensure that conversion factors for small islands or terrain such as the North Carolina Outer Banks are considered in determining the average conversion factor to be applied to a county.

Step 3 - Determining an Average Conversion Factor

Once conversion factors for all eligible quadrangle corners have been established, the Mapping Partner shall determine an average conversion factor by calculating a simple, unweighted arithmetic mean of all points for the entire jurisdiction. In the example shown in Figure B.1, the average conversion factor is –0.36 foot.

Step 4 - Establishing a Range of Conversion Factors

The Mapping Partner shall establish a range of conversion factors from all eligible points (minimum and maximum values) for the subject jurisdiction from the values documented in Step 2. In the sample table above, the range of conversion factors is between –0.14 foot and –0.54 foot. The Mapping Partner shall use the range of conversion values, combined with the average conversion factor determined above, to determine if a conversion is needed, or if a passive-conversion approach is feasible. A passive conversion, discussed in more detail in Step 6 (below), is defined as applying the average conversion factor determined above to the FIS Report (tables) only. The FIRM and Flood Profiles would not be affected by a passive conversion decision.

Step 5 - Determining the Maximum Offset

The Mapping Partner shall determine the maximum offset from the average conversion factor, compared with the minimum and maximum conversion factors. In the above example, the maximum offset is 0.22 foot (0.36 foot to 0.14 feet). If the Mapping Partner determines that the maximum offset exceeds 0.25 foot for any of the qualifying quadrangle corners, the multiple-conversion protocol (stream-by-stream conversion) detailed in Section B.4.1.2 shall be applied. The exception to this rule is situations whereby qualifying exterior quad corners are the sole cause for the subject jurisdiction being ineligible for the application of a standard conversion value. To determine if this is the case, the Mapping Partner shall replace anomalous conversion values that are obtained from quadrangle corners outside the subject jurisdiction with locations along the jurisdiction boundary closest to the anomalous quadrangle corner (one per quadrangle corner). Once this has been done, if the jurisdiction continues to be mathematically ineligible for conversion to NAVD88 using a standard jurisdiction-wide conversion value, the Mapping Partner shall use the stream-by-stream conversion approach detailed in Section B.4.1.2.

Step 6 - Establishing the Conversion Factor

Using the values documented above, the Mapping Partner shall establish a single average conversion factor or multiple conversion factors and apply the factor(s) to existing effective data to be converted to NAVD88. The criteria for determining whether a single conversion factor, or multiple conversion factors will be used, are described in Subsections B.4.1.1, B.4.1.2, and B.4.1.3. If the average conversion factor above is less than 0.1 foot, there may be only a passive datum conversion applied. As noted in Step 4, a passive conversion would affect the values shown on data tables in the FIS Report, but would not affect the 1-percent-annual-chance flood elevations shown on the FIRM or on the Flood Profiles in the FIS Report. The Mapping partner shall apply the average conversion factor determined in Step 3 above to all data tables in the FIS Report containing flood elevations referenced to NGVD29. The use of this option is contingent on the range of conversion values determined in Step 4. An average conversion of 0.1 foot or less could be deceiving in areas that contain conversions to NAVD88 that show plus and minus values. To illustrate this point, the following table shows a hypothetical county where the average conversion to NAVD88 was calculated to be -0.09 foot. However, it is also shown that the county contained a large range of conversion values thereby rendering a passive-conversion decision inappropriate.

Range of conversion values	- 0.38 through + 0.24
Average conversion factor	- 0.09
Maximum variance from the average conversion	0.33
Maximum variance from a no-conversion value	0.38

This table demonstrates that, although a jurisdiction may have an insignificant average conversion value (0.1 foot or less), the range of conversion values indicates that there are quadrangle corners that are more than 0.25 foot askew of a zero conversion factor. The situation shown in the above table indicates that a passive-conversion approach could yield up to a 0.38-foot discrepancy in the jurisdiction. For this reason, a 0.25-foot tolerance was established as the maximum variance acceptable from a passive-conversion value. It is also worth noting that this hypothetical jurisdiction also would be ineligible for the application of an average conversion factor. A multiple conversion (stream-by-stream) approach as detailed in Section B.4...1.2 below would be required for this jurisdiction.

[February 2002]

B.4.1.1 Single Conversion Factor

A single conversion factor from NGVD29 to NAVD88 may be applied when the maximum offset from the average conversion factor does not exceed 0.25 foot. When a decision has been made during the Project Scoping phase (discussed in detail in Volume I, Section 1.3) to apply a datum conversion and a single conversion factor is appropriate, the Mapping Partner responsible for the new or updated flood hazard analyses shall apply the following procedures.

1. Determine an average conversion factor for the subject community following the procedures detailed in Subsection B.4.1 and apply the average to the dynamic flood elevations.

2. Convert static (primarily, lacustrine) flood elevations using VERTCON or CORPSCON.

3. Apply the conversion factor to the FIRM and to all components of the FIS Report that display 1-percent-annual-chance flood elevations (i.e., Flood Profiles, data tables).

4. Document the datum conversion details as specified in Appendix J of these Guidelines.

5. Ensure that all unrevised hydraulic models and supporting backup information are clearly labeled in the Technical Support Data Notebook (see Appendix M of these Guidelines) to indicate that the FIRM and FIS Report reflect a datum conversion and specify the conversion criteria that was applied.

[February 2002]

B.4.1.2 Multiple Conversion Factors (Stream by Stream)

In situations where the range of conversion factors across the subject community is prohibitively high (thereby resulting in a maximum offset from the established average conversion factor of greater than 0.25 foot), the Mapping Partner shall not apply a standard conversion factor for the

entire community. In the event that conversion to NAVD88 remains a desirable option, the Mapping Partner shall convert the unrevised flood elevations on a stream-by-stream basis.

Under this approach, the Mapping Partner shall develop an average conversion factor for each stream or flooding source by establishing three conversion factors at three locations and developing an average conversion factor from those data. If the maximum offset from the average conversion factor determined for a flooding source converted in this fashion exceeds 0.25 foot, the Mapping Partner shall follow the protocol described in Subsection B.4.1. When multiple conversion factors are applied, on a stream-by-stream basis, the Mapping Partner shall present the conversion factors in a table to be placed on the FIRM and in the FIS Report. An example of the table to be used in this scenario is shown in the below as well as in Appendix J of these Guidelines. As noted in Subsection B.4.1.1 when a datum conversion is conducted on unrevised flood elevations, the Mapping Contractor responsible for preparing the Technical Support Data Notebook (see Appendix M) shall ensure that all unrevised hydraulic models and supporting backup information are clearly labeled to indicate that the FIRM and FIS Report reflect a datum conversion and shall specify the conversion criteria that was applied.

[February 2002]

Stream Name	Minimum Conversion	Maximum Conversion	Average Conversion	Maximum Offset
Jones Branch	-0.74	-0.92	-0.81	0.11
Mud River	-0.59	-0.80	-0.74	0.15

B.4.1.3 Conversion of Hydrologic and Hydraulic Models

In situations where the range of conversion factors for a given flooding source is prohibitively high (thereby resulting in a maximum offset from the average established for the flooding source of greater than 0.25 foot) the Mapping Partner shall remodel the subject stream by applying either the VERTCON or the CORPSCON program to the effective hydrologic and hydraulic models. (NOTE: To date, these details and protocols have not been finalized and FIS Report paragraphs have not been formulated to address this situation.)

[February 2002]

B.5 Conversion from NAVD88 to NGVD29

Although a datum selection shall normally be determined during the Project Scoping phase (Volume I, Section 1.3) of a study/restudy, situations may be encountered when the Mapping Partner responsible for the new or revised flood hazard analysis provides flood hazard data referenced to NAVD88, but FEMA determines that a full conversion is not an acceptable solution because of cost constraints or other reasons. In this case, the Mapping Partner responsible for preparation of the Preliminary FIS Report and FIRM shall develop an average conversion factor and apply it to convert the flood elevations provided by the Mapping Partner responsible for the new or revised flood hazard analysis from NAVD88 to NGVD29. For static flood elevations, the Mapping Partner responsible for preparation of the Preliminary FIS Report and FIRM may apply VERTCON or CORPSCON to convert the NAVD88 elevations to NGVD29. In those situations where an average conversion factor is not practical, the Mapping Partner responsible for preparation of the Preliminary FIS Report and FIRM may apply the approaches outlined in Subsections B.4.1.2 and B.4.1.3 as warranted.

[February 2002]

B.6 Paragraphs for Flood Insurance Study Report

For all studies/restudies and map revisions, the Mapping Partner responsible for preparing the Preliminary copies of the FIS Report and FIRM shall follow the guidelines provided in Appendix J, which detail the appropriate paragraphs to address datums and datum conversions.

[February 2002]

Map MODERNIZATION

Federal Emergency Management Agency

FEMA's Flood Hazard Mapping Program

Guidelines and Specifications *for* Flood Hazard Mapping Partners

Appendix C: Guidance for Riverine Flooding Analyses and Mapping

FEDERAL EMERGENCY MANAGEMENT AGENCY

www.fema.gov/mit/tsd/dl_cgs.htm

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February 2002

APPENDIX C

GUIDANCE FOR RIVERINE FLOODING ANALYSES AND MAPPING

This Appendix documents the study methods and review procedures that assigned Mapping Partners shall use in performing detailed and approximate hydrologic and hydraulic analyses for riverine flooding sources, preparing floodplain mapping to reflect the results of those analyses, and performing hydrologic analyses of closed-basin lakes.

C.1 Detailed Hydrologic Analyses

As part of the initial scope of work defined by the Federal Emergency Management Agency (FEMA) Regional Project Officer (RPO) and other members of the Flood Map Project Management Team (detailed in Volume I, Section 1.3 of these Guidelines), the flooding sources for which detailed hydrologic analyses must be conducted will be identified. This section addresses methods and assumptions to be used in performing detailed hydrologic analyses for riverine flooding sources.

[February 2002]

C.1.1 General Guidance

For detailed hydrologic analyses, the exceedance probability of flood events to be studied must be determined. At a minimum, the Mapping Partner that is performing the hydrologic analysis shall analyze the 1-percent-annual-chance (100-year) event; however, determinations of the 10-percent-annual-chance (10-year), 2-percent-annual-chance (50-year), and 0.2-percent-annual-chance (500-year) flood discharges will often be requested as well. Where appropriate, the Mapping Partner that is performing the hydrologic analysis shall use all available flood flow-frequency information and shall not duplicate previous work by Federal, State, or local agencies, or work performed as part of a new or revised Flood Insurance Study (FIS) for FEMA. Where such data are not available, where conditions have changed invalidating the published information, or where the methodologies or data used in the previous FIS(s) are not appropriate, a new hydrologic analysis will be required.

The Mapping Partner that is performing the hydrologic analysis shall estimate the flood discharges for existing land-use conditions. However, FEMA and the Mapping Partner may also consult with community officials to determine whether they want to consider developing hydrology based on future land-use conditions for local floodplain management purposes. If a community decides to include future-conditions hydrology within the scope of work for a Flood Map Project, the technical information shall be developed by the community and provided to FEMA and the Mapping Partner that is performing the hydrologic and hydraulic analyses for the Flood Map Project in accordance with the requirements in Section C.8.

The Mapping Partner that is performing the hydrologic analysis shall consider gaged versus ungaged streams and the appropriateness of developing a rainfall-runoff model. Each of these approaches is briefly discussed later in this section. When an expected probability adjustment (Interagency Advisory Committee on Water Data, 1982) has been included in published flood discharge determinations, the Mapping Partner shall contact the RPO for approval before proceeding.

Prior to performing a hydrologic analysis, the Mapping Partner that is performing the hydrologic analysis shall work with the RPO to identify which, if any, of the hydraulic structures are to be included in the analysis (such as a large impoundment) and to identify appropriate methodologies for analyzing their impacts on peak flows and volumes. If effective FIS flood discharge data are to be used, the Mapping Partner shall verify that the data are current before proceeding.

[February 2002]

C.1.1.1 Floodplain Storage Considerations

Large storage areas that exist in a floodplain will significantly attenuate flooding within a community. The Mapping Partner that is performing the hydrologic analysis shall evaluate attenuation using a standard flood routing technique. Storage in the floodplain may be uncontrolled, such as in detention ponds, isolated small natural depressions, and in wide floodplains of large rivers, or controlled with reservoirs. The requirements for performing hydrologic analyses of uncontrolled flood storage and controlled flood storage are presented below.

[February 2002]

Uncontrolled Flood Storage

Uncontrolled detention ponds and natural depressions both provide uncontrolled flood storage. Detention ponds typically are used in developed areas for onsite storage, and these ponds limit post-development peak flow rates from a design storm to those of the pre-development stage. The ponds also are used for regional detention based on a master plan for the watershed area of interest. Depending on climate characteristics and local design standards that vary across the nation, detention ponds may be able to attenuate peak flow rates for a 1-percent-annual-chance storm for arid areas; however, in more humid areas, most ponds are designed for storms with 20- to 50-percent-annual-chance storms.

Usually, an ungated spillway and a low-level, ungated conduit comprise the detention pond outflow structure. The effectiveness of a detention pond in attenuating peak flow rates in the downstream reach depends on the pond's location in the watershed and its storage and release characteristics. While an onsite detention pond may be effective for a single development site, it may not be as effective for a large urban watershed that has many onsite detention facilities that are not located and designed systematically (Maidment, 1993). The Mapping Partner that is performing the hydrologic analysis shall analyze floodplain storage in small isolated natural depressions, where outflow is only

through overflow, as uncontrolled detention ponds with appropriate outflow characteristics.

The Mapping Partner that is performing the hydrologic analysis may use both hydrologic and hydraulic routing methods to route the flow through ponds. Hydrologic routing methods are to be used when the outflow from the pond is not dependent on tailwater. Most of the single-event hydrologic models (e.g., HEC-HMS, HEC-1, TR-20) use hydrologic routing methods. The Mapping Partner that is performing the hydrologic analysis shall use hydraulic routing methods when outflow from the pond is dependent on tailwater conditions. For example, tailwater condition is a control factor where a series of interconnected detention ponds are used for flood attenuation in a relatively flat watershed. The hydraulic routing for ponds is often performed with an unsteady-flow model. A list of models accepted by FEMA for this purpose may be found on FEMA's Flood Hazard Mapping website at http://www.fema.gov/mit/tsd/en_modl.htm.

Wide floodplains with significant storage areas often exist along large rivers in relatively flat watersheds. The Mapping Partner that is performing the hydrologic analysis may use the unsteady-flow models, both one-dimensional models with quasi-two-dimensional capabilities and two-dimensional models that appear on FEMA's accepted models list to simulate flood attenuation due to this type of storage.

Controlled Flood Storage

Most large reservoirs on large river systems are operated with outflow controls. In these reservoirs, gates are used for regulating flow through outlet structures. The gates are operated according to established rules that determine the relationship between inflow, outflow, storage, and water demand.

The Mapping Partner that is performing the hydrologic analysis normally shall not consider storage capability below the Normal Pool Elevation of reservoirs operated primarily for purposes other than flood control because the availability of such storage is uncertain. The exception is when all of the following conditions have been met:

- Operation of the project in accordance with its documented water control plan could affect the 1-percent-annual-chance flood elevations in a community by 1 foot or more.

- The storage capability to be considered is totally dedicated to flood control. Where different amounts of storage can be totally dedicated during different parts of the year, the Mapping Partner shall obtain flood discharges from the joint probability combination of frequency curves established for each part of the year that the different storage levels are dedicated. Joint use storage based on forecasted inflow is not acceptable for NFIP purposes.

- A project water control plan providing explicit details of operation during flooding conditions is in effect and has been reviewed and approved by FEMA or another Federal agency responsible for Federal flood-control activities. The

Mapping Partner that is performing the hydrologic analysis shall contact the RPO to discuss the review and approval process.

- A written commitment to dedication of the flood-storage capacity and to the approved reservoir operation plan is assured through a mandatory condition of Federal or State licensing or through a direct agreement between the project operator and FEMA for non-Federal projects.

[February 2002]

C.1.1.2 Gaged Streams

Flood discharges may be determined directly from gage data in areas where river gages are located, or may be estimated based on data from gages in nearby areas having similar characteristics.

At a Gaging Station

The Mapping Partner that is performing the hydrologic analysis shall perform floodflow-frequency analyses in accordance with the guidelines for determining floodflow frequency presented in Bulletin 17B (Interagency Advisory Committee on Water Data, 1982) and subsequent modifications. To use analysis techniques other than those outlined in Bulletin 17B, the Mapping Partner that is performing the hydrologic analysis shall obtain approval by the RPO and provide written justification for their use. The basic floodflow-frequency curve for gaged sites on unregulated streams may be obtained from the U.S. Geological Survey (USGS), Water Resources Division; from published reports of the USGS; or derived using methods described in Bulletin 17B. The annual maximum peak flows used in floodflow-frequency analyses are available on the USGS web page at http://water.usgs.gov/nwis/sw. Computer programs for performing Bulletin 17B analyses are available from the U.S. Army Corps of Engineers (USACE) *HEC-FFA Frequency Analysis* (USACE, 1992) and the USGS *PEAKFQ, Annual Flood Frequency Analysis Using Bulletin 17B Guidelines* (USGS, 1998).

The Mapping Partner that is performing the hydrologic analysis shall use the floodflow-frequency curve and adjust it, if necessary, to provide reliable flood discharge estimates for the site under consideration. The Mapping Partner that is performing the hydrologic analysis also may use the methodologies outlined in the USACE Engineering Manual No. 1110-2-1415 (USACE, 1993) to develop frequency curves for gaged streams. The Mapping Partner that is performing the hydrologic analysis shall document reasons for the modification and procedures that were used to modify the published USGS floodflow-frequency curves. When modeling mixed populations of hydrologic events, the Mapping Partner shall refer to Engineering Manual No. 1110-2-1415 (USACE, 1993) or Appendix F of these Guidelines.

Near a Gaging Station

Generally, for peak flood discharges for ungaged sites on a gaged stream, both the gaged site information and information from an appropriate regional estimate, where available,

are to be considered. The Mapping Partner that is performing the hydrologic analysis shall select an appropriate transfer technique for establishing flood discharges at the ungaged location. The selected transfer technique shall consider the difference in the drainage areas at the gaged and ungaged sites. The procedures prescribed in most regional floodflow-frequency reports published by the USGS are recommended for this purpose. These transfer procedures usually use information from the gaged site and the regional estimate when the ungaged site is within 50 to 200 percent of the drainage area at the gaging station. In cases where a more specialized local study of a watershed may be more appropriate than one prepared by the USGS, the Mapping Partner shall consult with the RPO before proceeding.

For gaged streams with regulated flows, the Mapping Partner that is performing the hydrologic analysis may obtain peak flood discharges from the agency responsible for regulation. If the effects of regulation on floodflow frequency have not been established, the Mapping Partner that is performing the hydrologic analysis shall determine the most appropriate analysis technique and obtain approval from the RPO before proceeding. Guidance on regulated frequency analysis can be found in USACE Engineering Manual No. 1110-2-1415 (USACE, 1993)

[February 2002]

C.1.1.3 Ungaged Streams

Acceptable hydrologic analysis methods that the Mapping Partner that is performing the hydrologic analysis may use for ungaged streams include regional regression analyses and the rainfall-runoff model. These methods are discussed below.

Regional Regression Analysis

The Mapping Partner that is performing the hydrologic analysis shall make use of any valid existing floodflow-frequency analysis conducted by a Federal, State, or local agency that have authoritatively established and officially adopted the flood discharges for the ungaged stream under consideration, or the Mapping Partner shall make use of flood discharges from published FISs. In the absence of such an analysis or in cases in which the analysis is outdated, the Mapping Partner that is performing the hydrologic analysis shall use, where appropriate, the most recently published USGS report for estimating flood magnitude and frequency that is applicable to the Flood Map Project area. Such reports are generally available on a statewide basis. The Mapping Partner that is performing the hydrologic analysis shall exercise caution to ensure that these reports are used only for conditions and locations for which they are recommended.

USGS has published regression equations for estimating flood discharges for urban watersheds in several states including Alabama, Florida, Georgia, Missouri, North Carolina, Ohio, Oregon, Pennsylvania, Tennessee, Texas, Virginia, Washington, and Wisconsin. Where the statewide reports do not contain procedures to account for urbanized conditions, or the statewide equations do not apply to the watershed conditions, the Mapping Partner that is performing the hydrologic analysis shall adjust the flood discharges determined for the rural condition. The Mapping Partner that is performing

the hydrologic analysis shall use the techniques described in *Flood Characteristics of Urban Watersheds in the United States* (USGS, 1983) to adjust the flood discharges.

The Mapping Partner that is performing the hydrologic analysis may use the USGS "National Flood Frequency" program (USGS, 1994) to determine flood discharges of different frequencies for the continental United States, Alaska, Hawaii, and Puerto Rico for both rural and urbanized conditions. When a regression equation other than those published by the USGS is proposed, the Mapping Partner that is performing the hydrologic analysis shall obtain the approval of the RPO and shall justify the use of this equation.

USGS also has developed the region-of-influence method to estimate flood discharges, and computer programs have been published for Arkansas, Louisiana, and North Carolina. In the region-of-influence method, regression equations are computed for an ungaged site by selecting from a statewide database of gaging stations a predetermined number of stations having characteristics similar to the ungaged site. This method does not involve published regression equations. The Mapping Partner that is performing the hydrologic analysis may use the region-of-influence method; however, the Mapping Partner shall obtain the approval of the RPO and shall justify the use of this method.

Rainfall-Runoff Model

Where USGS regional regression equations are not applicable due to flow regulation, storage, watershed development, or other unique basin characteristics, the Mapping Partner that is performing the hydrologic analysis may obtain RPO approval to develop a rainfall-runoff model using a computer program such as HEC-HMS, HEC-1 or TR-20. A list of models accepted by FEMA for this purpose may be found on FEMA's Flood Hazard Mapping website at http://www.fema.gov/mit/tsd/en_modl.htm.

A wide variety of automation tools have been developed to facilitate hydrologic modeling. These products range from simple graphical user interfaces that help input model parameters to highly advanced GIS-based tools that contain state-of-the-art software and modeling approaches with fully integrated data processing, graphics, and visualization capabilities. The tools have been organized into three categories based on their relationship to accepted FEMA models. The following is the policy for their acceptance for use in FEMA's flood hazard mapping program.

- Category 1 Tools: These simple tools can be either pre-processing or post-processing independent modules. They function in conjunction with, but separately from, the executable file of a computer model that is on FEMA's accepted models list. These tools are considered acceptable for use in the flood hazard mapping program because they are not computer models themselves.

- Category 2 Tools: These software tools are computer models that perform modeling routines that emulate a model on FEMA's accepted model list; however, their source code has been rewritten to perform these tasks, instead of

using the accepted model's source code. Category 2 software tools must be reviewed and placed on the list of accepted models.

- Category 3 Tools: These software tools use new hydrologic modeling methods and/or models not currently on the FEMA-accepted models list. They may add pre- or post-processing functions similar to the other categories of tools as well. Because these are new computer models, Category 3 software tools must be reviewed and placed on the list of accepted models.

In developing a rainfall-runoff model, the Mapping Partner that is performing the hydrologic analysis shall consider the following factors:

- The unit hydrograph method is preferred when developing hydrographs. However, subwatershed drainage areas shall be appropriately defined within the limit that the unit hydrograph is able to reflect watershed response to changing conditions.

- Loss rates must be varied when computing different frequency floods. Urbanization effects must be reflected in the loss rates.

- Time of concentration or lag computations must reflect effects of increases in velocities due to channel modifications and urbanization.

- Rainfall duration, at a minimum, must exceed the time of concentration for the watershed and must be large enough to capture all excess rainfall as well as provide reasonable runoff and sediment volumes when performing storage analyses. The Mapping Partner that is performing the hydrologic analysis may use the critical storm concept to determine the storm duration, or use the duration specified in guidelines developed by state agencies responsible for flood control or floodplain regulation. The critical storm is a design storm (total amount, duration, temporal distribution) which provides the highest flood discharge/water-surface elevation for the flooding source. The Mapping Partner that is performing the hydrologic analysis shall determine the critical storm through a sensitivity analysis of various storm durations to determine which storm duration produces the highest flood discharge/water-surface elevation (e.g., 6-hour vs. 24-hour). Note that for communities that only get short duration storms, the storm durations to be evaluated must be longer than the time of concentration of the watershed, and not the duration of the rainfall.

- Temporal distributions developed or recommended by Federal or State agencies responsible for flood control or regulating floodplains must be used.

- Streamflow routing methods must be able to analyze the attenuation and translation of hydrographs.

The Mapping Partner that is performing the hydrologic analysis shall calibrate the parameters in the models against known storms in the study area and, when available data

permits, against a floodflow-frequency curve before the model is used to estimate flood discharges. The Mapping Partner that is performing the hydrologic analysis shall compare computed peak flood discharges from the hydrologic model to flood discharges from published regional studies (e.g., USGS regression equations) when they are applicable, or to flood discharges developed from gaging station data in watersheds with similar characteristics. If the discharge values are not comparable, the Mapping Partner that is performing the hydrologic analysis shall submit a Special Problem Report to the RPO to explain the differences before beginning the hydraulic analysis.

[February 2002]

C.1.2 Considerations for Restudies

In general, a restudy of hydrologic analyses could be initiated for any of four reasons:

1. To reflect longer periods of record or revisions in data;
2. To reflect changed physical conditions;
3. To take advantage of improved hydrologic analysis methods; or
4. To correct an error in the hydrologic analysis performed for the effective study.

Examples of changed physical conditions include the addition of a hydraulic structure or other watershed development that has affected the effective analyses. Regardless of the reason for the restudy, the Mapping Partner that is performing the hydrologic analysis shall provide detailed documentation of the changes that have been addressed in the restudy and why flood discharges developed for the restudy are more accurate than those developed for the effective FIS. If the reason for the restudy is an improved method, the Mapping Partner that is performing the hydrologic analysis shall provide documentation as to why the alternative method is superior and shall obtain RPO approval to use the improved method.

A study of a community's flood hazards may include a flooding source for which FEMA has not established BFEs. In these cases, the Mapping Partner that is performing the hydrologic analysis shall consult Subsection C.1.2.1 for necessary guidance on establishing flood discharges.

[February 2002]

C.1.2.1 Preliminary Hydrologic Analysis

The Mapping Partner that is performing the hydrologic analysis shall compare the proposed flood discharges to all available floodflow-frequency data that exist for the study area to ensure compatibility. The Mapping Partner that is performing the hydrologic analysis also shall inform the RPO, as well as Federal, State, and local agencies involved in water resources programs in the area, of the proposed flood discharges.

The Mapping Partner that is performing the hydrologic analysis shall resolve any discrepancies between available information and the flood discharges proposed for the Flood Map Project. That Mapping Partner shall bring such discrepancies shall to the attention of the RPO in a Special Problem Report, as flood discharge discrepancies shall not be the cause for delay in the study. In addition, the Mapping Partner that is performing the analysis shall keep the RPO informed of progress made in resolving such discrepancies.

Comparing Proposed and Effective Flood Discharges

In determining whether to grant a revision request, or to fund a detailed restudy of a community's flood hazards, revisions shall be considered only when a more recent floodflow-frequency analysis yields flood discharge values that are statistically significant from the effective flood discharges, or when flood discharges yield significant differences in base (1-percent-annual-chance) flood elevations (BFEs).

Determining Statistical Significance

The Mapping Partner that is performing the hydrologic analysis shall base the test for significance on the confidence limits of the more recent analysis. The new flood discharges shall be adopted if the previous flood discharges do not fall within the 95 and 5-percent confidence limits (90-percent confidence interval) of the recent estimates; the previous flood discharges shall be adopted if they fall within the 75 and 25-percent confidence limits (50-percent confidence interval) of the recent estimates. The Mapping Partner that is performing the hydrologic analysis shall consult Bulletin 17B for procedures on computing confidence limits for gaged streams. The computation of confidence and prediction limits for regression estimates is documented in statistical textbooks (Montgomery and Peck, 1982).

Significant Changes in Base Flood Elevations

When the effective flood discharges fall between the 50 and 90-percent confidence limits, the Mapping Partner that is performing the hydrologic analysis may use the step-backwater computation performed for the effective study to evaluate the effect of the new flood discharges on effective BFEs. If the new flood discharges yield BFEs that differ from the effective BFE obtained from the effective water-surface profile by more than 0.5 foot, a detailed hydrologic analysis shall be conducted. Otherwise, the Mapping Partner that is performing the hydrologic analysis for a selected stream shall not restudy the stream at this time, unless other substantial changes in hydraulic conditions exist, such as channelization and construction of flood-control structures; or unless there are errors in the effective study.

Where significantly different flood discharges are proposed for use, the Mapping Partner that is performing the hydrologic analysis shall contact the RPO immediately for approval. Where confidence limit tests are not applicable, the Mapping Partner that is performing the hydrologic analysis shall bring unresolved discrepancies to the attention

of the RPO. The determining factor then becomes the effect on the BFE as described above.

Choice of Methodology

The hydrologic methodology shall be determined during the scoping process for the study and include input from FEMA and the Mapping Partner(s). The complexity of the study and the effective models and methodology shall be considered in making this choice.

The Mapping Partner that is performing the hydrologic analysis shall apply frequency analysis of flow data at gaging stations, using procedures provided in Bulletin 17B (Interagency Committee on Water Data, 1982) wherever possible. When the systematic record at a gaging station is less than 50 years, the Mapping Partner that is performing the hydrologic analysis shall weight the results with estimates from other methods, such as USGS regression equations. The Mapping Partner that is performing the hydrologic analysis may use the method developed by Hardison, published in USGS Professional Paper 750-C, to estimate the equivalent years of record for regression equations that are needed in the weighting process (USGS, 1971). Guidance on weighting two estimates of flood discharges is also given in Bulletin 17B (Interagency Advisory Committee on Water Data, 1982), and USGS regression equation reports.

USGS regression equations, adjusted for urbanization if appropriate, are recommended for estimating the existing-conditions base flood discharges for restudied streams if a flood hydrograph is not required and if the regression equations are applicable to the restudied streams. The regression equations are to be applied only to streams having characteristic parameter values that are within the range of values of the gages used to develop the regression equations.

For watersheds with existing hydrologic models, the Mapping Partner that is performing the hydrologic analysis may use an existing model in lieu of USGS regression equations if the model was calibrated. Such models must, however, be updated to account for any development that has occurred in the watershed since the existing model was created. The Mapping Partner that is performing the hydrologic analysis shall exercise caution when selecting a methodology for watersheds that are undergoing or are projected to undergo development. In such cases, the Mapping Partner that is performing the hydrologic analysis shall consider developing a rainfall-runoff model in lieu of a gaged analysis with non-homogeneous data or the use of regression equations.

The Mapping Partner that is performing the hydrologic analysis shall calibrate the parameters in rainfall-runoff models against major known storms that exceed 10-percent-annual-chance events for single-event analysis if the data are available. The data to calibrate the model are to include the following:

- Peak flood discharges developed at gaging stations, computed by indirect methods (e.g., computations at bridge cross sections based on high-water marks), or flood discharge hydrographs from responsible agencies;

- Rainfall distribution, reported at a minimum of hourly intervals, at rain gages within the storm area and within or near the watershed being studied;

- Total rainfall values at rain gages within the storm area or isohyetal map of the storm, indicating the duration of the storm;

- Rainfall and soil moisture conditions before the storm for single-event analysis.

Observed high-water marks may also be of value when calibrating both hydrologic and hydraulic models against historical events.

The Mapping Partner that is performing the hydrologic analysis may calibrate the rainfall-runoff model against the various flood discharges of a frequency analysis. Regardless of whether models have been calibrated against historical events, further calibration may be required to produce floodflows from the 10-percent-annual-chance, 2-percent-annual-chance, 1-percent-annual-chance, and 0.2-percent-annual-chance rainfall that are comparable to the floodflows from the frequency analysis, if records are available. If reasonable matches cannot be reached by maintaining calibration parameters within acceptable ranges, then the Mapping Partner that is performing the hydrologic analysis shall review the model methodology and its application to the watershed.

Where models are calibrated against historical events and are applied properly, and where the modeled floodflows and frequency floodflows do not agree, the Mapping Partner that is performing the hydrologic analysis shall consider adjusting the design rainfall's volume and distribution. The design rainfall distribution is typically selected from traditional distributions prepared by the Natural Resources Conservation Service (NRCS) and USACE, but recommendations from State agencies responsible for flood control or floodplain management regarding state or regional distributions also may be accepted.

Where feasible, in coordination with Federal and State agencies, the Mapping Partner that is performing the hydrologic analysis shall select a reasonable rainfall distribution for the model to best simulate floodflows corresponding to a frequency analysis in accordance with the guidance of Bulletin 17B (Interagency Advisory Committee on Water Data, 1982). For flooding sources where the volume of flood discharge is the major concern, such as ponds in a closed basin, the Mapping Partner that is performing the hydrologic analysis may determine the rainfall duration by comparing the calculated lake stages with the stage-frequency curve.

[February 2002]

C.1.2.2 Preliminary Hydrologic Analysis Submittal Requirements

The Mapping Partner that is performing the hydrologic analysis shall submit the preliminary results of the analysis to the FEMA RPO or other identified FEMA regional engineer for review prior to completing and submitting the hydraulic analysis. The FEMA Lead, RPO, or other regional engineer shall forward the analysis to the appropriate PO at FEMA HQ for subsequent review by a Mapping Partner selected by FEMA to review the hydrologic analysis.

To avoid internal discontinuities in the restudy data, proposed flood discharge values must be compatible with those in the effective analyses at the limits of detailed study. Should significant discontinuities exist between the updated flood discharges and those used in the effective FIS, the Mapping Partner that is performing the hydrologic analysis shall consult with the RPO and submit a Special Problem Report.

[February 2002]

C.2 Hydrologic Review

A Mapping Partner selected by FEMA, identified during the initial Scoping Meeting (see Volume I, Section 1.3 of these Guidelines), shall review the proposed flood discharges prior to their being used in hydraulic analyses. The intent is to agree on the 1-percent-annual-chance flood discharges before the hydraulic analyses are conducted, and to avoid hydraulic and mapping analysis revisions necessitated by subsequent flood discharge revisions. Therefore, the Mapping Partner that is performing the hydrologic analysis shall work with FEMA to ensure that hydrology issues are identified as early as possible. This early review could reduce the level of effort during both the study and the production of the FIS Report and FIRM.

The goal of the hydrologic review is to provide an assessment of the "reasonableness" of the proposed 1-percent-annual-chance flood discharges and, if necessary, to suggest alternative methods that may provide more reasonable flood discharges. The reasonableness of a flood discharge depends on the requirements of the study and its selected methodologies. The Mapping Partner that is reviewing the hydrologic analysis (hereinafter referred to as the reviewing Mapping Partner) shall check all methods for the reasonableness of their specific application and the sources of the data. A comparison of proposed flood discharges against criteria related to the regression equations is a good first screening tool; however, it does not replace the need to review the applied methodology.

In addition to comparing proposed flood discharges to those derived from gaged data and regression equations, the reviewing Mapping Partner shall compare the proposed flood discharges to the effective flood discharges, noting any significant discrepancies and possible reasons for those discrepancies. Also, the reviewing Mapping Partner shall consider the effect on BFEs as a result of different flood discharges (not just changes in flood discharges) as a check on reasonableness.

The procedures detailed below are recommended for preliminary hydrologic reviews of analyses submitted in support of studies and restudies, map revisions, and appeals. They are applicable to hydrologic analyses conducted using gaging station data, regional regression equations, and rainfall-runoff models.

[February 2002]

C.2.1 Hydrologic Analysis Based on Gaging Station Data

Proposed 1-percent-annual-chance flood discharges based on gaging station data are generally reviewed for conformance to the guidelines in Bulletin 17B (Interagency Committee on Water Data, 1982). If procedures other than those outlined in Bulletin 17B were applied, then the reviewing Mapping Partner shall determine whether these procedures are reasonable. At least 10 years of record are needed to define the 1-percent-annual-chance flood discharge; however, estimates based on shorter periods of record shall be compared to flood estimates based on precipitation data and to regional estimates for similar watersheds as described in Bulletin 17B. In more arid regions, there are often

many years when the annual peak flow is zero. For these conditions, at least 10 years of nonzero flow are recommended for defining the 1-percent-annual-chance flood discharge.

Floodflow-frequency curves for gaging stations are routinely published by the USGS as part of regional floodflow-frequency studies. The reviewing Mapping Partner can compare these published flood discharges to the proposed flood discharges to judge their reasonableness. The Mapping Partner shall compare the effective flood discharges to the confidence limits of the proposed flood discharges to determine which flood discharges are more appropriate.

For regulated watersheds, floodflow-frequency curves are often developed for unregulated conditions and then converted to regulated conditions by utilizing the current reservoir operation criteria. The designated Mapping Partner shall review the regulated floodflow-frequency curve to determine whether acceptable procedures were used to convert to regulated conditions. Guidance on regulated frequency analysis can be found in USACE Engineering Manual No.1110-2-1415 (USACE, 1993).

[February 2002]

C.2.2 Hydrologic Analysis Based on Regional Regression Equations

The reviewing Mapping Partner shall compare the proposed 1-percent-annual-chance flood discharges computed from regional regression equations to the effective flood discharge, to flood discharges from other (published) regression equations that are applicable to the region, and to flood discharges at gaging stations in the vicinity. In general, proposed regional regression equations should be the most recent published equations developed by the USGS for the region unless justification is provided for the use of earlier equations.

The reviewing Mapping Partner shall assume the proposed regression equations are applicable if the watershed, climatic, and urbanization characteristics of the ungaged sites are within the range of those at the gaging stations used to develop the equations, and if flow is not regulated. If appropriate, the regional regression equations may be adjusted for urbanization using procedures in *Flood Characteristics of Urban Watersheds in the United States* (USGS, 1983) or, if available, urban regression equations for the applicable state or metropolitan area.

The reviewing Mapping Partner shall compare the proposed regression estimates to gaging station estimates in nearby watersheds having similar characteristics to those of the studied streams. The reviewing Mapping Partner may obtain estimates of 1-percent-annual-chance flood discharges at nearby gaging stations from published USGS regional flood reports if the frequency curves were published in the last 10 years and if no major floods have occurred in the intervening time. Otherwise, floodflow-frequency estimates for the gaging stations are to be updated in accordance with Bulletin 17B (Interagency Advisory Committee on Water Data, 1982).

The reviewing Mapping Partner shall plot the 1-percent-annual-chance flood discharge estimates from these sources against drainage area on logarithmic paper to determine whether the proposed flood discharges are reasonable. Confidence intervals of the gaging station estimates may be estimated using Bulletin 17B (Interagency Advisory Committee on Water Data, 1982) or procedures given in *Frequency and Risk Analysis* (Kite, 1999) or in *Handbook of Hydrology* (Maidment, 1993). The reviewing Mapping Partner may use the 68-percent confidence interval, which is analogous to plus or minus one standard error for a normal distribution, to judge the reasonableness of flood discharges derived from regression equations. If the proposed flood discharges generally lie within the 68-percent confidence interval of the gaged data, then these flood discharges are accepted as reasonable for the hydraulic analysis. If not, then options for obtaining more reasonable flood discharges shall be provided.

The reviewing Mapping Partner shall use caution in reviewing 1-percent-annual-chance flood discharges derived from regression equations that are significantly different from those derived from gage data. When the regression estimates differ significantly from data from long-term gaging stations and the elevation difference is significant, the regression estimate may be adjusted based on the gaging station data.

[February 2002]

C.2.3 Hydrologic Analysis Based on a Rainfall-Runoff Model

The reviewing Mapping Partner shall first verify that the rainfall-runoff model used by the Mapping Partner that performed the hydrologic analysis is included on FEMA's Acceptable Models List, which is posted on the FEMA Flood Hazard Mapping website at http://www.fema.gov/mit/tsd/en_modl.htm. The reviewing Mapping Partner shall compare the proposed 1-percent-annual-chance flood discharges from the rainfall-runoff model to the flood discharges from USGS regional regression equations (if they are applicable) and to flood discharges at gaging stations in the vicinity. Procedures for developing estimates from gaging station data and regression equations are discussed in Subsections C.2.1 and C.2.2.

The reviewing Mapping Partner shall plot the flood discharge estimates from these sources against drainage area on logarithmic paper to determine if the proposed flood discharges are reasonable. Plus or minus one standard error bars (68-percent confidence intervals) shall be shown about the regression and gaging station estimates. The USGS regional flood reports typically provide the standard error of prediction or estimate. The reviewing Mapping Partner shall use the standard error of prediction, if available, because this is more indicative of the predictive accuracy of the equations.

The proposed flood discharges from the rainfall-runoff model are considered reasonable if they are generally within one standard error of the regression and gaging station estimates. If not, the reviewing Mapping Partner shall review the rainfall-runoff model in greater detail to determine why there are significant differences. Some unique characteristics of the watershed may explain these differences and justify the use of the proposed rainfall-runoff model estimates, and the reviewing Mapping Partner that

performed the hydrologic analysis shall provide detailed information to explain these unique characteristics.

Even if the criteria for flood discharge reasonableness are satisfied, a review of the rainfall-runoff model is advisable to determine that the model was applied appropriately. Recommendations to use a reasonable flood discharge in the hydraulic model cannot be made if the calculation of the flood discharges was incorrect and yielded reasonable flood discharges only by chance. Such a study is subject to appeal or protest on the basis of being scientifically or technically incorrect.

In watersheds with significant storage, hydrologic routing may be needed in estimating the flood discharges. Some hydrologic routing methods require a relationship between the water-surface elevation and the cross-sectional area, or the floodplain storage area between cross sections. For those methods, a hydraulic model is required as part of the hydrologic analysis, and the hydraulic model used to generate rating curves shall be provided for review with the hydrologic model.

The reviewing Mapping Partner shall ensure that the rainfall-runoff model has been calibrated against available data as described in Subsection C.1.1.3. Where reliable gaging station data are available, the rainfall-runoff model must be calibrated against them.

In ungaged watersheds where high-water marks from major flood events are available, the reviewing Mapping Partner shall ensure that the rainfall-runoff model and the hydraulic model have been calibrated against the high-water marks. If no high-water marks from major events exist, and regression equations are determined not to be applicable, the Mapping Partner that performed the hydrologic analysis shall provide a detailed explanation of the rainfall-runoff model, and the designated Mapping Partner shall review the model in detail to determine flood discharge reasonableness.

[February 2002]

C.2.4 Hydrologic Review Documentation

The reviewing Mapping Partner shall document the results of the review in a memorandum or letter that will be sent to the RPO and to the Mapping Partner that performed the hydrologic analysis. The documentation shall describe the review approach and conclusions (whether flood discharges are reasonable or unreasonable) and shall provide options for resolving any concerns.

If the proposed flood discharges are determined to be unreasonable, the options may include, but are not limited to:

- Requesting further justification or documentation that the proposed 1-percent-annual-chance flood discharges shall be used;
- Suggesting an alternative study method; or
- Revising the analysis to obtain more reasonable results.

[February 2002]

C.3 Detailed Hydraulic Analyses

During the initial Scoping Meeting (Volume 1, Section 1.3 of these Guidelines), the RPO or other FEMA Lead and other members of the Flood Map Project Management Team will decide which flooding sources within the community will be studies using detailed hydraulic analyses. Guidance for performing these analyses is provided in the subsections that follow.

[February 2002]

C.3.1 General Guidance

The Mapping Partner that is performing the hydraulic analysis shall use, to the maximum extent possible, all valid existing flood elevation, survey, and other pertinent information for the study area. Whenever existing 1-percent-annual-chance flood elevations are available for the study area, the Mapping Partner that is performing the hydraulic analysis shall assess their validity without undertaking extensive computations or reanalysis. Except where significant changes in flood discharges, floodplain geometry, or flooding characteristics have occurred, or errors in the original computations have been found, such elevations shall be considered valid for use in a Flood Map Project carried out for NFIP purposes.

If an existing study that contains a valid 1-percent-annual-chance Flood Profile does not provide other profiles or a required floodway that may be required for the Flood Map Project, the Mapping Partner that is performing the hydraulic analysis shall attempt to obtain the original hydraulic model and use it to generate this information. Whenever the original model is unavailable or unusable, the RPO, through the Assistance Officer, may choose to remove the requirement for these additional elevations and floodway data or request that they be determined by a simplified analysis.

In any case, the Mapping Partner that is performing the hydraulic analysis shall obtain approval from the RPO before performing hydraulic analyses for flooding sources that have previously established 1-percent-annual-chance flood elevations. The Mapping Partner shall not study areas having a drainage area less than 1 square mile unless RPO approval has been obtained.

The Mapping Partner that is performing the hydraulic analysis shall carefully estimate the roughness coefficients for use in backwater computations. The estimates, prepared by experienced engineers, shall include the consideration that roughness may vary with flood stages, depending on such factors as the width-to-depth ratio of streams, vegetation in the channel and overbanks, and materials of the channel bed. Wherever possible, the Mapping Partner that is performing the hydraulic analysis shall calibrate hydraulic models using measured profiles, reliable high-water marks, or reliable stage information at stream gages for past floods. Models must match known high-water marks within 0.5 foot.

The Mapping Partner that is performing the hydraulic analysis shall not calibrate against data that result in roughness coefficients out of the realm of published roughness coefficients for similar observed conditions. If such data are lacking or are out of date, the Mapping Partner that is performing the hydraulic analysis shall determine the roughness coefficients using Cowan's method (Federal Highway Administration, 1984) based on a field inspection of the channel and floodplain and compare the new roughness coefficients to roughness coefficients published in Federal agencies documents and hydraulic text books.

It is extremely important that the Mapping Partner that is performing the hydraulic analysis select roughness coefficients in overbank areas to carefully represent the effective flow in those areas. There is a general tendency to overestimate the amount of flow occurring in overbank areas, particularly in broad, flat floodplains. The Mapping Partner shall document the use of roughness coefficients to define ineffective-flow areas clearly in the FIS Report.

Before preparing work maps, the Mapping Partner that is performing the hydraulic analysis shall reconcile the 1-percent-annual-chance Flood Profile proposed for the Flood Map Project with all available published or unpublished information. Any discrepancies shall be identified and resolved by the Mapping Partner that is performing the analysis in consultation with the RPO and the Mapping Partner producing the final FIS Report and FIRM (in most cases, the reviewing Mapping Partner). Except where a clearly identified change in flooding characteristics or an error in the existing data can be shown, the proposed 1-percent-annual-chance flood elevations must agree with those of other contiguous studies of the same flooding source within 0.5 foot of the contiguous elevation. However, the final 1-percent-annual-chance flood elevation or Flood Profile submitted with the FIS report must match the contiguous study exactly.

Where elevations cannot be reconciled within 0.5 foot because of changed flooding conditions or an error in the previous analysis, the Mapping Partner that is performing the hydraulic analysis shall provide a full explanation and justification for the difference to the RPO in a Special Problem Report. The Mapping Partner that is performing the hydraulic analysis shall obtain approval for the discrepancy in 1-percent-annual-chance flood elevations from the RPO before proceeding.

[February 2002]

C.3.2 Flood Insurance Studies

The detailed hydraulic analysis for a FIS will include flood elevation determination for the communities under Part 60.3(c) of the NFIP regulations, and the flood elevation determination and floodway determination for the communities under Part 60.3(d) of the NFIP regulations.

[February 2002]

C.3.2.1 Flood Elevation Determination

The Mapping Partner that is performing the hydraulic analysis normally shall determine flood elevations for the 10-, 2-, 1-, and 0.2-percent-annual-chance floods, unless otherwise instructed by the RPO. These flood elevations must be referenced to the National Geodetic Vertical Datum of 1929 (NGVD29) or the North American Vertical Datum of 1988 (NAVD88).

Flood elevations for riverine areas are normally determined by step-backwater computer models such as the USACE Hydrologic Engineering Center's HEC-RAS Computer Program (USACE, 2001) or the USGS/Federal Highway Administration (FHWA) WSPRO computer model (USGS and FHWA, 1999). Regardless of the hydraulic model used, the Mapping Partner that is performing the hydraulic analysis shall follow modeling techniques specified in the most recent version of the appropriate user's manual.

In addition, the Mapping Partner that is performing the hydraulic analysis using HEC-RAS shall provide input and output files in the HEC-RAS native file format, although the Mapping Partner may use a variety of shell programs to conduct analyses. The numerical models currently accepted by FEMA for use in the NFIP are listed on the FEMA Flood Hazard Mapping website (http://www.floodmaps.net/mit/tsd/en_modl.htm).

A wide variety of automation tools have been developed to facilitate hydraulic modeling. These products range from simple graphical user interfaces that help input model parameters to highly advanced GIS-based tools that contain state-of-the-art software and modeling approaches with fully integrated data processing, graphics, and visualization capabilities. The tools have been organized into three categories based on their relationship to accepted FEMA models. The following is the policy for their acceptance for use in FEMA's flood hazard mapping program.

- Category 1 Tools: These simple tools can be either pre-processing or post-processing independent modules. They function in conjunction with, but separately from, the executable file of a computer model that is on FEMA's accepted models list. These tools are considered acceptable for use in the flood hazard mapping program because they are not computer models themselves.

- Category 2 Tools: These software tools are computer models that perform modeling routines that emulate a model on FEMA's accepted model list; however, their source code has been rewritten to perform these tasks, instead of using the accepted model's source code. Category 2 software tools must be reviewed and placed on the list of accepted models.

- Category 3 Tools: These software tools use new hydraulic modeling methods and/or models not currently on the FEMA-accepted models list. They may add pre- or post-processing functions similar to the other categories of tools as well. Because these are new computer models, Category 3 software tools must be reviewed and placed on the list of accepted models.

[February 2002]

C.3.2.2 Floodway Determination

A regulatory floodway is defined as the channel of a river or other watercourse and the adjacent land areas that must be reserved in order to discharge the 1-percent-annual-chance flood without cumulatively increasing the water-surface elevation by more than a designated height. The NFIP regulations designate a height of 1.0 foot. Regulatory floodways are developed as unobstructed waterways to convey floodwaters. The community is responsible for maintaining the conveyance of flooding sources to mitigate flood hazards.

If the State in which the Flood Map Project is being performed has established more stringent regulations for the maximum allowable rise in water-surface elevations, through legally enforceable statutes, then these regulations shall take precedence over the NFIP regulatory standard. In the case of streams that form the boundary between two or more States, the 1.0-foot maximum allowable rise criterion shall be used unless the States have previously agreed on a lesser rise criterion. The Mapping Partner that is performing the hydraulic analysis shall obtain the written approval of the RPO, through the Assistance Officer, before computing or mapping a second regulatory floodway based on a criterion established by the community.

When flow is in the supercritical regime for manmade channels, or where velocity conditions are such that normal encroachment analyses are not possible or are inappropriate, the encroachment stations may be computed so that the allowable rise in water-surface elevation may match the target water surface without exceeding the target energy.

Surcharge values must be between zero and the maximum allowable value. Negative surcharge values may be caused by excessive encroachment, errors in bridge modeling, or insufficient encroachment at a downstream section. If attempts to eliminate negative surcharges are unsuccessful, the Mapping Partner that is performing the hydraulic analysis shall contact the RPO and the reviewing Mapping Partner for guidance.

Normally, the Mapping Partner that is performing the hydraulic analysis shall determine the regulatory floodway using equal reduction of conveyance on opposite sides of the stream. If equal reduction of conveyance is not technically appropriate, or where unusual flow patterns are encountered (e.g., interbasin flow, divided flow), the Mapping Partner that is performing the analysis shall coordinate with the RPO in selecting the most appropriate engineering methods. Where the regulatory floodway designation affects

contiguous communities on opposite sides of a flooding source, the Mapping Partner that is performing the hydraulic analysis must use equal reduction of conveyance.

The Mapping Partner that is performing the hydraulic analysis shall compute the regulatory floodway on a tributary stream based on the 1-percent-annual-chance flood discharge and elevation of that stream only and normally shall not include consideration of any backwater flooding from the main stream. Therefore, the floodway elevations in the lower reach of a tributary subject to backwater flooding may be lower than those used to plot the Flood Profiles.

The Mapping Partner that is performing the hydraulic analysis shall achieve the maximum allowable surcharge (e.g., 1.0 foot) at the upstream-most cross section in a downstream community that does not have a regulatory floodway, when performing a floodway analysis for upstream communities. This is necessary to avoid excessive increases that would occur if the downstream community decides to establish a floodway. In addition, the Mapping Partner that is performing the hydraulic analysis shall determine the starting water-surface elevation for a floodway analysis at the first cross section using the same friction slope as the 1-percent-annual-chance natural Flood Profile.

The Mapping Partner that is performing the hydraulic analysis shall use an equal conveyance reduction method to establish the regulatory floodway. The total conveyance between the natural Flood Profile and the floodway profile must not differ by more than 1 percent. If they differ, then the Mapping Partner that is performing the hydraulic analysis shall use the encroachment stations obtained from the equal conveyance reduction method and the same starting friction slope of the natural Flood Profile for the floodway profile to determine the starting floodway water-surface elevation and the surcharge value. The computed surcharge value must not be more than the allowable surcharge value of each State.

If a regulatory floodway has been determined for the downstream community, the Mapping Partner that is performing the hydraulic analysis shall use the same flood discharges and corresponding flood elevations for different flood frequencies, floodway water-surface elevation, and the floodway width of the most upstream cross section of the downstream community as the starting conditions for the upstream community.

If storage areas behind structures are accounted for in the flood discharge computations by routing the 1-percent-annual-chance flood hydrograph, and no encroachment is to be allowed, the floodway encroachment stations must be equal to the 1-percent-annual-chance floodplain boundary of the storage area. In this case, the Mapping Partner that is performing the hydraulic analysis shall use the same flood discharge for the unencroached and encroached profiles in the step-backwater analysis to determine the surcharge values. However, if the storage area is to be encroached, then the Mapping Partner must determine the flood discharges for the encroached profile downstream of the structure by routing the 1-percent-annual-chance flood hydrograph through the reduced storage area. In this case, the flood discharge for the encroached profile may be greater than the flood discharge for the unencroached profile in the step-backwater analysis.

Regulatory floodways are not normally delineated in coastal high-hazard areas (Zones V1-30, VE, and V). The Mapping Partner that is performing the hydraulic analysis shall base the computation of regulatory floodways on rivers in coastal floodplains on the 1-percent-annual chance flood discharge and elevations of the rivers only. The Mapping Partner that is performing the hydraulic analysis shall terminate the regulatory floodway at the boundary of the V1-30, VE, or V Zone or where the mean high tide exceeds the 1-percent-annual chance riverine flood elevation, whichever occurs further upstream.

The Mapping Partner that is performing the hydraulic analysis shall begin to coordinate all regulatory floodway determinations with State and community officials and FEMA as early as possible. Where the floodplain is entirely contained within one community, the Mapping Partner that is performing the hydraulic analysis shall coordinate the location of the regulatory floodway with the State NFIP Coordinator, the community, and the FEMA Consultation Coordination Officer through the RPO. This coordination shall not be a reason for delaying the Flood Map Project. If the coordinating parties cannot reach an agreement regarding a floodway determination before the final community coordination meeting, the Mapping Partner that is performing the hydraulic analysis shall determine the regulatory floodway as described earlier in this subsection.

[February 2002]

C.3.3 Restudies

The physical data in the detailed hydraulic analysis for restudies are to be based on the data from the effective study, subsequent revisions, and additional data that are not in the effective study and the revisions. The Mapping Partner that is performing the hydraulic analysis shall recompute flood discharges to reflect the existing condition of the watershed. Detailed guidance on the flood elevation determination and the floodway determination are provided below.

[February 2002]

C.3.3.1 Flood Elevation Determination

Except in cases where errors in measurements or modeling have been found, or where substantial changes in topographic conditions are not reflected in the effective FIS, the Mapping Partner that is performing the hydraulic analysis shall obtain cross-sectional and structural information for the hydraulic model from step-backwater computer models of the effective FIS. In the case of topographic changes, the Mapping Partner that is performing the hydraulic analysis shall revise only the affected cross sections; the remaining data are to come directly from the existing models. The Mapping Partner shall review the existing data for accuracy. If errors in the existing data are detected, the Mapping Partner that is performing the hydraulic analysis shall coordinate a solution with the RPO.

It is important to note that a Flood Map Project may include a detailed study for flooding sources that do not have established BFEs. In these cases, the Mapping Partner that is performing the hydraulic analysis shall consult Subsection C.3.2 for necessary guidance.

To compute the water-surface profiles the Mapping Partner that is performing the hydraulic analysis shall use the existing-conditions 10-percent-annual-chance, 2-percent-annual-chance, 1-percent-annual-chance, and 0.2-percent-annual-chance flood discharges as determined during the hydrologic analysis in the standard step-backwater computer program used to prepare the effective FIS report and FIRM. The Mapping Partner that is performing the hydraulic analysis shall use the most recent version of the effective computer models to reduce the cost in setting up the hydraulic model. The use of alternative computer programs must be approved by the RPO and satisfy the criteria outlined in Subsection C.3.2.1. Roughness coefficients in the model must reflect existing conditions and must be verified by field reconnaissance and backwater studies of observed floods.

The Mapping Partner that is performing the hydraulic analysis shall obtain RPO approval in choosing the standard step-backwater computer program.

[February 2002]

C.3.3.2 Floodway Determination

The Mapping Partner that is performing the hydraulic analysis shall maintain the effective regulatory floodway configuration wherever possible. If it is not possible to retain the existing configuration, then the Mapping Partner that is performing the hydraulic analysis shall contact the FEMA Lead RPO for guidance. If a revised floodway analysis is deemed necessary, the Mapping Partner that is performing the hydraulic analysis shall consult the information pertaining to regulatory floodways presented in Subsection C.3.2.2.

Because the community has implemented floodplain management decisions based on the effective regulatory floodway, it is important that the Mapping Partner that is performing the hydraulic analysis determine initially whether the effective floodway may be retained given the changes that have occurred along a particular flooding source. However, floodway revisions are justifiable and necessary if data indicate an increase in surcharge above the maximum limit, or if, as a result of improved data, the width or configuration of the regulatory floodway necessitates a change from that shown on the effective FIRM or FBFM. When revisions to the regulatory floodway will necessitate changes to the effective FIRM or FBFM, the Mapping Partner that is performing the hydraulic analysis shall notify the RPO immediately so that the RPO can coordinate with the community as soon as possible.

[February 2002]

C.3.4 General Modeling Methodologies and Guidance

During the course of a Flood Map Project, the Mapping Partner that is performing the hydraulic analysis may encounter unique hydraulic situations that require specialized modeling techniques to determine potential flood hazards accurately. Guidance to be considered in selecting a model to handle these situations is presented below. The

complete list of models accepted by FEMA for use in the NFIP is listed on the FEMA Flood Hazard Mapping website at http://www.floodmaps.net/mit/tsd/en_modl.htm.

[February 2002]

C.3.4.1 One-Dimensional Unsteady Flow Models

The Mapping Partner that is performing the hydraulic analysis may use one-dimensional unsteady flow models where appropriate (e.g., floodplains with substantial overbank storage areas; streams where a reversal of flow may occur; complex pipes, channels, ponds, and reservoir systems). To use a one-dimensional unsteady flow model, the Mapping Partner that is performing the hydraulic analysis must first obtain approval from the RPO. Regulatory floodways determined using unsteady flow models must be developed through an interactive trial-and-error procedure and must be based on equal conveyance reduction.

[February 2002]

C.3.4.2 Two-Dimensional Water-Surface Computer Models

Two-dimensional computer models are used to simulate surface-water flow in two directions in a horizontal plane, such as in shallow flooding areas, split-flow situations, and at complex bridge sites. The Mapping Partner that is performing the hydraulic analysis also may use two-dimensional models in areas subject to alluvial fan flooding. This type of model will be used where one-dimensional models, currently accepted techniques, and engineering judgment will not provide satisfactory information for floodplain management and NFIP purposes. Regulatory floodways determined using two-dimensional models must be developed through an interactive trial-and-error procedure and must be based on equal conveyance reduction.

[February 2002]

C.3.4.3 Starting Water-Surface Elevations

In general, the starting water-surface elevations chosen for profile computations are to be based on normal depth (or slope-area), unless known water-surface elevations are available from other sources. When using normal depth on the main channel of any flooding source, the Mapping Partner that is performing the hydraulic analysis shall start the model several cross sections downstream of the corporate limits. For starting conditions on tributaries, the Mapping Partner that is performing the hydraulic analysis shall use normal depth unless a coincident peak situation is assumed, or the tributary flow depths are higher than the corresponding mainstream events.

The assumption of coincident peaks may be appropriate if all of the following are true:

- The ratio of the drainage areas lies between 0.6 and 1.4;
- The times of peak flow are similar for the two combining watersheds; and

- The likelihood of both watersheds being covered by the storm being modeled is high.

If gage records are available for the basins, the Mapping Partner that is performing the hydraulic analysis shall obtain guidance from the RPO on coincidence of peak flows using streamflow records.

[February 2002]

C.3.4.4 Modeling Techniques for Flooding Sources with Supercritical Flow Regimes

Step-backwater analyses are normally performed in a hydraulic model from downstream to upstream as subcritical profile runs for the stream reach studied. Critical depth messages appear in the computer model output of backwater runs at several consecutive cross sections if supercritical flow occurs.

For natural streams, the Mapping Partner that is performing the hydraulic analysis shall use critical depth at all times where supercritical flows occur, including the plotting of water-surface profiles. For concrete-lined channels, the Mapping Partner that is performing the hydraulic analysis shall perform a supercritical run for the project area.

For modified channels, the composite roughness coefficient accounts for the sediment that accumulates on the channel bottom and for the lined surface of the sides of the channel. The hydraulic analysis must extend both upstream and downstream of the project area to have a smooth transition between subcritical and supercritical profiles. The Mapping Partner that is performing the hydraulic analysis shall draw the water-surface elevations from the subcritical run downstream of the project horizontally until they cross the supercritical profiles to eliminate drawdowns. The Mapping Partner that is performing the hydraulic analysis shall check velocities at bends to determine potential erosion. The Mapping Partner must obtain approval to deviate from these procedures from the RPO.

[February 2002]

C.3.4.5 Split-Flow Analyses

The Mapping Partner that is performing the hydraulic analysis is to consider split-flow analyses when a stream overflows its banks and takes a different flow path. The analyses are to address the reduction of flow in the downstream reach with respect to the multiple-Flood Profile and regulatory floodway. Because overbank flood discharges may flow into another stream, the Mapping Partner that is performing the hydraulic analysis shall consider possible increases in flood discharges on the other stream. The Mapping Partner that is performing the hydraulic analysis shall ensure that the overflow segment on the mainstream remains open by determining a separate regulatory floodway for the overflow path, or by a note on the FIRM or FBFM stating that the overflow area remains unencroached until a detailed hydraulic analysis is performed to establish a regulatory floodway. The Mapping Partner that is performing the hydraulic analysis shall inform

the RPO when overbank flow paths lead into another jurisdiction where a regulatory floodway has not been computed, thus necessitating that the overflow area remain unencroached.

The RPO may approve, as an alternative, that the Mapping Partner determine the floodway on the mainstream downstream of the overflow area by determining the floodway profile with the total flow (including the flow lost as overflow). The Mapping Partner that is performing the hydraulic analysis shall compare the water-surface elevations from the floodway profile to the water-surface elevations of the 1-percent-annual-chance natural Flood Profile (which has been reduced because of flow lost as overflow) to determine surcharges. If the calculated surcharge is less than or equal to the allowable surcharge, then the Mapping Partner that is performing the hydraulic analysis shall depict the regulatory floodway on the mainstream only. Otherwise, this Mapping Partner shall compute a separate regulatory floodway for the overflow path.

[February 2002]

C.4 Approximate Analyses

Flooding sources that are selected for study by approximate methods will fit into one of the following four categories:

1. Flooding sources for which previously determined approximate 1-percent-annual-chance floodplain boundaries will be adjusted in accordance with updated topographic information;

2. Flooding sources for which new technical information will be used to update approximate 1-percent-annual-chance floodplain boundaries;

3. Flooding sources that were previously unstudied or that have been studied but the previous approximate 1-percent-annual-chance floodplain boundaries are considered unreasonable from an engineering standpoint; for which simplified hydraulic analyses will be performed to delineate the approximate 1-percent-annual-chance floodplain; or

4. Flooding sources that were previously studied by detailed methods, with appropriate floodplain boundaries and BFEs, where the Special Flood Hazard Area is being redesignated as an approximate Zone A because of uncertainty regarding the BFEs. The redesignation of detailed-study area to approximate Zone A must be approved by the RPO.

For those areas for which approximate hydrologic and hydraulic analyses are to be performed, the Mapping Partner that is performing the hydraulic analysis shall select appropriate methods in coordination with the RPO. The most common methods and models are discussed in Subsections C.4.1, C.4.2, and C.4.3. The Mapping Partner that is performing the hydraulic analysis and RPO shall consider the factors of cost, watershed development potential, and existing development when selecting the methods to use. In addition, the Mapping Partner that is performing the hydraulic analysis may recommend or the RPO may specify that the flood elevations be established using the methods discussed below.

[February 2002]

C.4.1 Hydrologic Methods for Determining Approximate Flood Discharges

The Mapping Partner that is performing the hydraulic analysis may select one of the following methods to determine approximate flood discharges for a flooding source:

- Transfer Methods, where peak flows are interpolated from peak flow values upstream and downstream of the area of interest or extrapolated from other sites where frequency curves have been developed;

- Regional regression equations (i.e., USGS regional equations);

- Rational Formula, which is used primarily for drainage areas less than 1 square mile but not to be used for an area larger than 2 square miles; or

- TR-55 urban hydrology procedures (U.S. Soil Conservation Service, 1986).

[February 2002]

C.4.2 Hydraulic Methods for Determining Approximate Base Flood Elevations

The Mapping Partner that is performing the hydraulic analysis may select one of the following methods to determine approximate BFEs for a flooding source:

- Normal-depth calculations using Manning's Equation;

- Highway culvert nomographs from *Hydraulic Design of Highway Culverts* (FHWA, 1985); or

- Computer program Quick-2, which may be used to compute critical depth, and normal depth.

The Mapping Partner that is performing the hydraulic analysis shall obtain all cross sections from existing topographic maps, and shall minimize the number of cross sections for each flooding source (i.e., one or two sections that are representative of the entire flooding source). The Mapping Partner that is performing the hydraulic analysis shall estimate any Manning's "n" values used from field inspection; this effort also shall be minimized by choosing values that are representative of the entire flooding source.

[February 2002]

C.4.3 Limited Hydraulic Modeling for Determining Approximate Base Flood Elevations

The Mapping Partner that is performing the hydraulic analysis may perform limited hydraulic modeling if a Triangular Irregular Network of Light Detection and Ranging (LIDAR) data with the breaklines combined with digital orthophotos is available. The Mapping Partner that is performing the hydraulic analysis may obtain cross sections, road profiles, and openings of structures from these data, and may estimate Manning's "n" values without conducting a field survey. The structures are to be identified from these data as follows:

- The Mapping Partner that is performing the hydraulic analysis may model the structure as a bridge if the width of the water body upstream and downstream of the structure does not change appreciably and no sloping embankment exists upstream and downstream of the road crossing within the stream channel area. The Mapping Partner that is performing the hydraulic analysis may approximate the area of the bridge opening by obtaining the cross section shape at the upstream

face of the bridge, assuming that the elevations of the top of the abutments are equal to the low chord elevations, and inserting a pier width of 3 feet for every 50-foot span of the bridge.

- The Mapping Partner that is performing the hydraulic analysis may model the structure as a culvert if the width of the water body upstream and downstream of the structure does not change appreciably, if a sloping embankment exists upstream and downstream of the road crossing within the stream channel area, and if the headwall and the wing walls are at a lower level than the road crossing. The Mapping Partner that is performing the hydraulic analysis may assume that the opening shape of the culvert is a single box culvert. The Mapping Partner that is performing the hydraulic analysis shall measure the width at the upstream face of the culvert between the wing walls as the span and shall measure the difference in elevation between the headwall and the bottom elevation of the stream as the rise of the culvert. The Mapping Partner shall reduce the measured span and rise by 10 percent each to account for the area of the walls between the culverts for multiple openings.

- The Mapping Partner that is performing the hydraulic analysis may model the structure as a weir if the width of the water body upstream and downstream of the structure does not change appreciably, if no sloping embankment exists upstream and downstream of the crossing within the stream channel area, and if no road crosses the stream.

- The Mapping Partner that is performing the hydraulic analysis may model the structure as a dam if the width of the water body upstream and downstream of the structure changes appreciably and a sloping embankment exists upstream and downstream of the crossing within the stream channel area.

The Mapping Partner that is performing the hydraulic analysis may use a Geographic Information System-based tool to create cross-section and structure data for the HEC-RAS program to determine 1-percent-annual-chance water-surface elevations.

Because the 1-percent-annual-chance water-surface elevations are determined using approximate hydrologic and hydrologic methods with topographic and structural data, BFEs will not be shown on the FIRM.

[February 2002]

C.4.4 Map Change Requests Submitted Under Parts 65 and 70 of the National Flood Insurance Program Regulations

In areas designated as approximate Zone A, where BFEs have not been provided by FEMA, communities must ensure that any new development is constructed using methods that will minimize flood damage as outlined in Paragraph 60.3(b) of the NFIP regulations. Subparagraph 60.3(b)(3) of the NFIP regulations requires that all new subdivision proposals and the other proposed development (including proposals for

manufactured home parks and subdivisions) greater than 50 lots or 5 acres, whichever is the lesser, must include BFE data.

Community officials, property owners, developers, surveyors, and engineers who need to determine BFEs in special flood hazard areas designated as approximate Zone A may use FEMA 265, *Managing Floodplain Development in Approximate Zone A Areas* (FEMA, 1995). FEMA 265 lists Federal, State, and local agencies that might have information about the BFEs; provides simplified and detailed methods for estimating or developing BFE data; and includes the computer program QUICK-2, which may be used to compute critical depth, normal depth, rating curves, and step-backwater analysis.

One of the primary goals of FEMA 265 is to provide a means of determining BFEs at a minimal cost. The guidance provided in FEMA 265 is primarily intended for use in riverine and lacustrine areas where flow conditions are fairly uniform and do not involve unusual flow regimes, such as rapidly varying flow, two-dimensional flow, supercritical flow, and hydraulic jump.

Property owners and others also may use the detailed methodologies described in FEMA 265 to develop the BFE information necessary to obtain a request for a Letter of Map Amendment or a Letter of Map Revision Based on Fill to remove a legally defined property or structure from a Special Flood Hazard Area. In addition, Physical Map Revision and Letter of Map Revision requesters may use the detailed methods in FEMA 265 to develop the BFE information that must be submitted to FEMA to demonstrate that an area will not be inundated during the 1-percent-annual-chance flood. Detailed information on all of these map change processes and products is provided in Volume 2 of these Guidelines.

[February 2002]

C.5 Hydraulic Review

This section provides a general discussion of the Hydraulic Review philosophy, the specific procedures for performing Basic and Detailed Reviews, and guidelines for documenting Reviews.

[February 2002]

C.5.1 Review Philosophy

The reviewing Mapping Partner shall ensure that the most appropriate review process is used. A two-tiered review approach consisting of a Basic Review and a Detailed Review is the best way to achieve this goal.

The Basic Review will usually consist of two areas. One area is to satisfy NFIP regulations and FEMA mapping requirements for all analyses, irrespective of the hydraulic models or methods used. The other area is to satisfy engineering standards in determining water-surface elevations. This second area is model- or method-specific, and the requirements set forth in the specific computer model user's manual must be satisfied. The user's manual of each model may also contain other references having requirements that must be satisfied.

A Detailed Review must be performed for a Flood Map Project where the Basic Review reveals errors or inconsistencies in the determination of flood elevations and indicates that a more detailed review is appropriate. In such cases, the reviewing Mapping Partner shall perform a Detailed Review of a limited number of flooding sources. The RPO may also decide to conduct a Detailed Review on additional flooding sources based on the outcome of the Detailed Review of the initial group of flooding sources.

The reviewing Mapping Partner must perform a Detailed Review for all flooding sources for which appeals have been filed or map revisions initiated, where stricter guidelines have to be followed in accordance with Part 67 and Part 65 of the NFIP regulations, respectively.

For the purposes of this discussion, the analyses are broadly categorized as being externally generated or FEMA-generated. Externally generated analyses are those that have been completed by communities or private parties and sent to FEMA with a request to use them to update effective FIS Reports and FIRMs. These analyses shall be given a level of review appropriate to the extent of the requested revision.

FEMA-generated analyses are divided into those that have had a qualified, independent, third-party review and those that have not. The independent review is to follow the guidance for the basic review and the detailed review provided above and for the use of FEMA's automated review tools if applicable. Examples of this situation include those analyses reviewed by a State or Federal agency that was not involved in the preparation of the analyses, or by an outside contractor. A detailed review may be required for FEMA-generated analyses that have not been reviewed independently.

The hydraulic review procedures are results based. During the Detailed Review, the reviewing Mapping Partner shall repeat the analysis and compare the results against those submitted by the Mapping Partner that performed the hydraulic analysis. If differences in 1-percent-annual-chance water-surface elevations, 1-percent-annual-chance floodplain boundary delineations, and/or regulatory floodway boundary delineations are found, the reviewing Mapping Partner shall ensure that these differences are not due to any requirements of the model or method before recommending to FEMA and the Mapping Partner that performed the hydraulic analysis that the model or method be changed.

If the reviewing Mapping Partner and FEMA determine that magnitude of change is insufficient to affect the revised Flood Profiles or floodplain mapping, the model need not be changed or reviewed further. However, in some cases, corrections may be required to meet engineering standards, although the magnitude of change is insignificant, or to meet certain standards established during the scoping process, such as the placement of cross sections and the selection of Manning's roughness coefficients, transition loss coefficients, and loss coefficients at structures. These changes will eliminate the majority of error messages generated by the FEMA automated review tools, CHECK-2 and CHECK-RAS.

[February 2002]

C.5.2 Review Procedures

The specific procedures to be followed by the reviewing Mapping Partner in performing a Basic or Detailed Hydraulic Review are defined below.

[February 2002]

C.5.2.1 Basic Review

A Basic Review consists of basic checks of all studied flooding sources to ensure that NFIP regulations, FEMA mapping requirements, and the requirements of the selected hydraulic model or method are satisfied. These requirements are further described below.

National Flood Insurance Program Regulations Requirements for Modeling Software

The reviewing Mapping Partner shall check that the same model used to prepare the effective FIS Report and FIRM is used in the new analyses and is on FEMA's list of acceptable models (http://www.floodmaps.net/mit/tsd/EN_modl.htm). In checking the model, the reviewing Mapping Partner must note that the USACE has replaced the HEC-2 program with the HEC-RAS program. FEMA's policy for using HEC-RAS in the NFIP (FEMA, 2001) is as follows:

Mapping Partners are encouraged to use HEC-RAS rather than HEC-2 for FISs that have not yet been started and for streams for which there is not an effective detailed study. However, it is important to note that any computer software that appears on the list of acceptable models may also be used.

For revisions or restudies of detailed-studied streams, where the effective model is a HEC-2 model, the conversion to HEC-RAS is encouraged. The following guidelines shall be followed to convert an effective HEC-2 model to HEC-RAS:

- The Mapping Partner that is performing the analysis shall run the effective HEC-2 model in HEC-RAS to create the duplicate effective model. Any differences in water-surface elevation between the effective model and the duplicate effective model shall be fully documented and thoroughly explained. Most differences in water-surface elevation can be attributed to (1) differences in bridge or culvert modeling routines, (2) the method of conveyance calculation, (3) critical depth default, and (4) floodway computations. The Hydraulics Reference Manual of the HEC-RAS User's Manual (USACE, 2001) provides details on computational differences between the two models and guidance on simulating HEC-2 results; this manual shall be consulted to explain the differences between the effective and duplicate effective models.

- Once the duplicate effective model has been established, the corrected effective, existing conditions, and post-project conditions models can be created in HEC-RAS, using the duplicate effective HEC-RAS model as the basis.

- The HEC-RAS models must tie in to the effective water-surface Profile within 0.5 foot at the upstream and downstream ends of the revised reach, in compliance with Subparagraph 65.6(a)(2) of the NFIP regulations.

National Flood Insurance Program Regulations Requirements for Modeling Studies

The reviewing Mapping Partner shall ensure the following requirements are met:

- Elevations in the new model must tie into the elevations of the effective model exactly or within 0.5 foot lower at the upstream end of the new model; and elevations in the new model must tie into the elevations of the effective model exactly at the downstream end of the new model.

- Floodplain widths at the upstream and downstream ends of the studied reach match those shown on the effective FIRM.

- "With floodway" elevations at the downstream end of the new model match those in the effective model.

- "With floodway" elevations at the upstream end of a revised model and beyond do not create surcharge values greater than the allowable limits.

- Regulatory floodway widths at the downstream and upstream end of the new model match the effective model.

- The surcharge throughout the area of study is within acceptable limits.

- The revised 1-percent-annual-chance water-surface elevation is not higher than the effective 1-percent-annual-chance water-surface elevation if the effective regulatory floodway is encroached.

- A floodway run is included in the new model if the effective model included one.

- Construction of all new hydraulic structures reflected in the model has been completed or will be completed within 12 months (only models submitted with requests for Conditional Letters of Map Revision may show proposed structures).

FEMA Requirements for Profile, Map, and Model Agreement

The reviewing Mapping Partner shall ensure the following requirements are met:

- The results of the new model match the work maps and revised Flood Profiles, including the distances between cross sections, water-surface elevations, regulatory floodway widths, and surcharges.

- Any backwater flooding is properly included in the profile.

- All hydraulic structures in the model are reflected on the work maps and vice versa.

- The water-surface profiles of different flood frequencies do not cross one another.

- The water-surface profiles do not show drawdowns (i.e., water-surface elevation at an upstream cross section is not lower than a water-surface elevation at a downstream cross section).

FEMA Requirements for Documentation

The reviewing Mapping Partner shall ensure the following requirements are met:

- All proper documentation is included in the submittal, in the Technical Support Data Notebook format, and appropriate application/certification forms, if applicable.

- The most up-to-date topographic information is used.

FEMA Requirements for Hydraulic Models or Methods

The FEMA requirements for hydraulic models or methods with regard to flood discharges, starting conditions, basic hydraulic modeling, and reality checks are summarize below.

Flood Discharges

The reviewing Mapping Partner shall ensure the following requirements are met:

- Flood discharges used as inputs in the new hydraulic modeling correlate with the hydrologic analysis being used (whether it is new hydrologic analysis or effective hydrologic analysis).

- All frequencies of flood events used to prepare the effective FIS Report and FIRM are included in the new model.

Starting Conditions

The reviewing Mapping Partner shall ensure the following requirements are met:

- Starting water-surface conditions for the 10-, 2-, 1-, and 0.2-percent-annual-chance flood runs are appropriate and follow FEMA guidelines.

- Starting water-surface conditions and encroachment methodology for the floodway run are appropriate and follow FEMA guidelines.

Basic Hydraulic Modeling

The reviewing Mapping Partner shall ensure the following requirements are met:

- Cross sections, Manning's roughness coefficients, transition loss coefficients, and loss coefficients at structures are modeled in accordance with the scoping agreement or the user's manual of the model (for detailed analyses) and/or the standards of the selected approximate-study method.

- The Mapping Partner that performed the hydraulic analysis has coordinated with FEMA to establish basic requirements for unsteady-flow and two-dimensional models.

- The CHECK-2 and CHECK-RAS report files are submitted if HEC-2 and HEC-RAS were used by the Mapping Partner that performed the hydraulic analysis.

- The Mapping Partner that performed the hydraulic analysis has resolved all CHECK-2 and CHECK-RAS error messages or has included explanations why the messages are not applicable.

- The hydraulic parameters for the submitted flooding sources are spot checked against topographic maps.

Reality Checks

The reviewing Mapping Partner shall ensure the following requirements are met:

- The 1-percent-annual-chance water-surface profile has been compared to the bottom slope. For long, straight channels, the water-surface profile shall be parallel to the bottom slope, because open channels tend toward the normal depth, and a problem likely exists if the profile and bottom slope are not parallel.

- The water-surface elevations at bridges or culvert sections have been compared to the top-of-roadway elevations. If a bridge or culvert is not designed to carry the 1-percent-annual-chance flood discharge, yet the 1-percent-annual-chance model shows low flow, a problem likely exists. On the other hand, almost all culverts and bridges are designed to pass the 10-percent-annual-chance flood; if the 10-percent-annual-chance water-surface elevation overtops the bridge or culvert, a problem may exist with the model or profile.

- The elevations in the new model are reasonable relative to high-water marks, where available.

[February 2002]

C.5.2.2 Detailed Review

If the standards of a basic review are not met, or if the items required to conduct a basic review are not included, the reviewing Mapping Partner shall conduct a detailed review using automated review tools such as CHECK-2 or CHECK-RAS, if applicable. If the submitted models are not HEC-2 or HEC-RAS, the reviewing Mapping Partner shall ensure that the model satisfies the requirements in the user's manual or the standards of the selected method.

Where necessary, and with FEMA approval, the reviewing Mapping Partner shall conduct detailed sensitivity tests to verify questionable modeling parameters and approaches. The reviewing Mapping Partner shall ensure that models have been calibrated against all available high-water marks and/or post-flood hazard verification data, if included in the scope of the hydraulic analysis. All concerns shall be resolved by coordination between FEMA and the community, the Mapping Partner, the model developer (if necessary), the revision requester, or the appellant.

For FEMA-contracted studies and restudies involving numerous flooding sources, a limited number of flooding sources will be selected for the Detailed Review. If technical concerns are uncovered, FEMA and the reviewing Mapping Partner shall determine whether a Detailed Review of additional flooding sources is necessary.

Mapping Partners typically will perform analyses for a selected subset of streams, submit them for review, and await the completion of the review before performing additional analyses. If technical concerns are uncovered, Mapping Partners will resolve those issues before analyzing the remainder of the streams.

[February 2002]

C.5.3 Hydraulic Review Documentation

The reviewing Mapping Partner shall provide review comments to the Mapping Partner that performed the hydraulic analysis if there are concerns with any aspect of the review. Concerns may be related to the following:

- Acceptability of the model used in the analysis;
- Water-surface elevation and floodway width tie-ins at the downstream and upstream end of the studied area;
- Increase in BFE if the effective regulatory floodway is encroached;
- Agreement of structures, distances, water-surface elevations, and regulatory floodway widths among the map, profile, and model;
- Acceptability of surcharge values;
- Water-surface profiles crossing each another;
- Proper documentation of the study and application/certification forms;
- Agreement in discharges between hydrologic and hydraulic analysis;
- Selection of starting water-surface elevation options;
- Deviation of hydraulic parameters from recommended values; and
- Messages and comments in the CHECK-2 and CHECK-RAS reports.

[February 2002]

C.6 Floodplain Mapping

Upon completion of the hydrologic and hydraulic analyses and review, the Mapping Partner that performed the analyses shall determine the boundaries of the new or revised floodplains as well as the floodplain boundaries and the regulatory floodway that are being revised to reflect new topographic data and/or a new base map. The Mapping Partner also shall plot BFEs to reflect the results of the hydraulic analyses.

[February 2002]

C.6.1 Floodplain Boundaries

The Mapping Partner that performed the hydraulic analysis shall delineate the floodplain boundaries resulting from the hydraulic analyses on a work map. This Mapping Partner shall present the 1-percent-annual-chance and 0.2-percent-annual-chance floodplain boundaries using the standard symbologies and map screens detailed in Appendix K of these Guidelines.

The Mapping Partner that performed the hydraulic analysis shall submit a work map delineating the 1-percent-annual-chance floodplain, which shall be designated as Zone A. The work map also shall include any hydraulic information generated on water-surface elevations or water depths. The Mapping Partner that performed the hydraulic analysis shall submit all backup data and calculations used to obtain the 1-percent-annual-chance floodplain delineation.

The plotting of floodplain boundaries may be separated into three distinct action classifications:

1. New or revised floodplains;

2. Floodplains that are being redelineated to reflect updated topographic data, but are not otherwise reflecting new analyses; and

3. Floodplains that are being "fitted" to new base maps (including new streamline locations) without using new topographic date and are not otherwise reflecting new analyses.

[February 2002]

C.6.1.1 New or Revised Floodplains

The Mapping Partner that performed the hydraulic analysis shall determine the boundaries of the 1- and 0.2-percent-annual-chance floods using the topographic data that was identified during the Project Scoping phase of the Flood Map Project. (See Volume 1, Section 1.3 of these Guidelines for further detail.)

The Mapping Partner that performed the hydraulic analysis shall ensure that floodplain boundaries are normalized to (in agreement with) the best available topographic

information. In addition, the Mapping Partner shall ensure that the regulatory floodway boundary does not lie outside of the 1-percent-annual-chance floodplain, and the 1-percent-annual-chance floodplain boundary does not lie outside of the 0.2-percent-annual-chance floodplain. The Mapping Partner that performed the hydraulic analysis also shall "smooth" floodplain boundaries derived from a digital output file to ensure that rectilinear floodplain boundaries are not shown on the final FIRM.

[February 2002]

C.6.1.2 Effective Floodplain Boundaries

During the course of the flood hazard analyses and floodplain mapping preparation, the Mapping Partner that performed the hydraulic analysis shall ensure that effective (unrevised) floodplain boundaries are redelineated using updated topographic data and/or new base map data, when available.

[February 2002]

C.6.1.3 Effective Floodplain Boundaries Adjusted to New Topographic Data

The Mapping Partner that performed the hydraulic analysis will often be required to normalize otherwise unrevised floodplain boundaries to new or updated topographic data. The process will require that the Mapping Partner superimpose the unrevised floodplain boundaries onto the new topographic data and adjust the boundaries to reflect the new or updated topographic data.

[February 2002]

C.6.1.4 Effective Floodplain Boundaries Adjusted to New Base Map Data

When new/updated topographic data are being used to redelineate the effective floodplain boundaries, a Mapping Partner selected by FEMA (usually, the reviewing Mapping Partner) shall superimpose the adjusted floodplain boundaries onto the new/updated base map source and assess the impact of using new base map data with unrevised floodplains. The floodplain/road relationships are to be maintained whenever possible; however, the application of new topographic data is to take precedence over these relationships.

If new/updated topographic data are not provided by the Mapping Partner that performed the hydraulic analysis, the reviewing Mapping Partner shall ensure that the effective floodplain boundaries being transferred to new base maps fit the new base map features. Issues that could affect a flood insurance determination are to be given special consideration. Effective floodplain boundaries may need to be adjusted to fit new base maps to ensure that relationships with base map features (roads, streamlines, etc.) are maintained as closely as possible.

Where modeled hydraulic structures (i.e., structures appearing on the Flood Profiles) cross streams that were studied by detailed methods and were not revised as a result of

the revised flood hazard analyses, the reviewing Mapping Partner shall adjust the unrevised floodplain boundaries so that the subject structures fall at or near the crossing as indicated in the hydraulic model to within a tolerance of 25 feet. Because the mapped regulatory floodway boundary configurations, cross sections, and BFEs have a direct relationship to hydraulic structures, the reviewing Mapping Partner shall maintain these relationships as closely as possible.

If significant unmodeled hydraulic structures are identified during the adjusting of unrevised floodplain boundaries to new topographic information or new base map information, the reviewing Mapping Partner shall contact the FEMA RPO, PO, and/or their designees to assess the possible need for floodplain analyses to account for new structures.

[February 2002]

C.6.1.5 Effective Floodplain Boundaries Adjusted to New Streamlines

In cases where the stream has moved significantly, causing the unrevised floodplain boundary configuration to no longer fit the new stream location, the reviewing Mapping Partner shall adjust the floodplain boundaries to fit the new stream, ensuring that the regulatory floodway boundary configuration relative to the new stream data is maintained. The effective regulatory floodway boundaries were delineated with a relationship between the left and right floodway boundaries and the stream. Whenever possible, the reviewing Mapping Partner shall maintain that relationship.

At a minimum, the regulatory floodway shall contain the new stream. In addition, the floodway fringe areas (i.e., the portion of the 1-percent-annual-chance floodplain considered encroachable) have a direct relationship to the regulatory floodway boundary. The reviewing Mapping Partner shall ensure that this relationship is also maintained to whatever degree is reasonably possible. In other words, it is important that the relationship of the regulatory floodway to the entire floodplain is maintained as closely as possible.

The process of fitting unrevised floodplain boundaries to new streamlines likely will result in changes in stream channel distances from the unrevised hydraulic model to the new FIRM. These changes shall be addressed by placing a note in the FIRM legend on a case-by-case basis. The decision on which note to use is based on the number of occurrences of effective floodplain boundaries being superimposed on new stream data. See Appendix K for examples of this note.

[February 2002]

C.6.2 Regulatory Floodway Boundaries

The Mapping Partner that performed the hydraulic analysis shall develop regulatory floodway boundaries to reflect the results of the floodway analysis and delineate them on a work map. The Mapping Partner that performed the hydraulic analysis shall connect the regulatory floodway boundaries computed at the cross-section locations of the

floodway model to form a hydraulically smooth flow path, which shall be shown as the floodway boundary configuration for the flooding source.

The floodway boundary is to be shown by long dashed lines as indicated in Appendix K. The floodway boundary must be plotted to within a maximum tolerance of 5 percent of the map scale. The location and the width of the floodway shown on the FIRM shall be consistent with the locations and widths computed by the floodway model and those tabulated for the lettered cross sections in the Floodway Data table of the FIS Report. In cases where the regulatory floodway and the 1-percent-annual-chance floodplain boundaries cannot be shown separately due to the map scale, only the floodway boundary is to be shown. When a floodway boundary follows an existing feature, such as a levee or a road, the floodway boundary is to be clearly indicated.

Separate regulatory floodway analyses are to be computed for a split flow path considered in a hydraulic analysis. The provision of a regulatory floodway will assure that the overland flow section remain open to convey flow. If storage areas behind structures were accounted for in the hydrologic analysis by routing the 1-percent-annual-chance hydrograph, the regulatory floodway boundary is to encompass the storage area. Regulatory floodways are not normally delineated for coastal high hazard areas.

Revisions to regulatory floodway boundaries are justified when a revised area within the effective regulatory floodway boundary configuration indicate surcharges above the maximum limit, or if, as a result of improved data, the regulatory floodway boundary configuration necessitates a change from that shown on the effective FIRM or FBFM.

[February 2002]

C.6.3 Base Flood Elevations

Whole-foot, rounded BFEs are to be located on the work map for all detailed study flooding sources. The basic intent of plotting BFEs on a FIRM is to represent the Flood Profile to within 0.5 foot of elevation tolerance. If BFEs are plotted correctly, the FIRM can be used to recreate the Flood Profiles within 0.5 foot.

BFEs are to be plotted at significant Profile inflection points (Profile breaks), or as close to them as possible. These points are critical to the accuracy of the FIRM, because the Flood Profiles could not be reproduced accurately without them.

Intermediate BFEs are to be plotted between inflection points and required BFEs. Intermediate BFEs are to be placed at whole-foot elevations whenever possible. The main factor in determining the proper interval at which intermediate BFEs are to be plotted is the Profile slope (gradient). The general guidelines below are to be followed, keeping in mind that the profile slope should be relatively constant between inflection points.

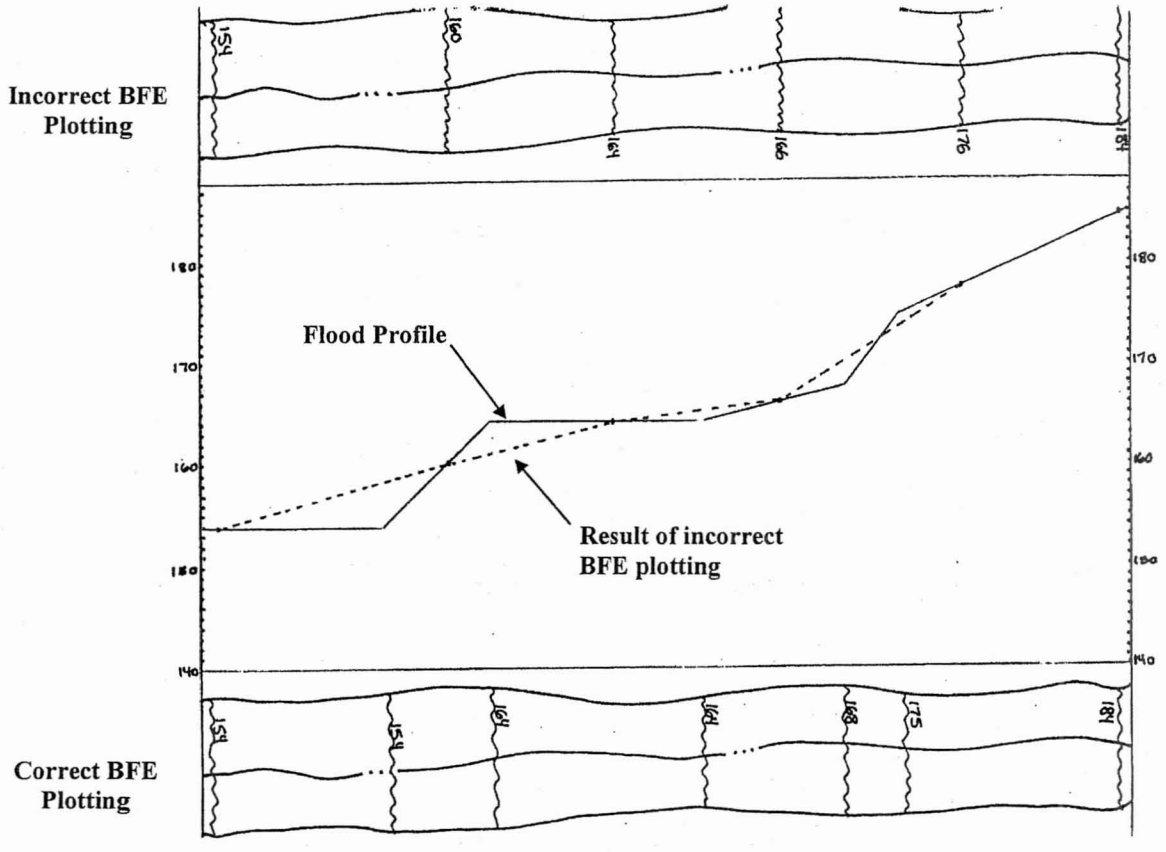
- Gentle Gradient – If BFEs rise less than 1 foot per 1 inch of map distance, the BFEs shall be plotted at every whole foot of elevation rise.

- Moderate Gradient – If BFEs rise more than 1 foot, but less than 5 feet per 1 inch of map distance, the BFEs shall be plotted at approximately 1-inch intervals.

- Steep Gradient – If BFEs rise 5 feet or more per 1 inch of map distance, the BFEs shall be plotted at 0.5-inch intervals of map distance or at 5-foot intervals, whichever is greater (i.e., whichever results in a wider BFE spacing).

To determine the proper method for the intermediate BFE interval, the amount of BFE rise is divided by the map distance over which it rises. For example, 10 inches of map distance with a 30-foot BFE rise equals a 3-foot BFE rise per inch, and BFEs shall be plotted at 3-foot intervals.

Once all BFEs have been plotted, the Mapping Partner that performed the hydraulic analysis shall test whether all significant inflection points have been plotted. It is critical that the FIRM reflect the BFEs shown on the Flood Profile to within a 0.5-foot tolerance. The diagram shown below demonstrates how the FIRM could show accurate BFEs, but still not reflect the BFEs shown on the Flood Profile to within the required tolerance. As demonstrated in the diagram, the difference between the line drawn to reflect the FIRM and the actual 1-percent-annual-chance flood elevation could be significantly skewed if BFEs are not plotted at significant inflection points, even if the BFE values shown on the FIRM are correct where they are plotted.



The following general rules are to be applied to the plotting of BFEs on work maps and FIRMs:

- BFEs must not rise more than 1 foot across panel edges (unless the stream gradient is very steep at the panel edge).
- The maximum rise between plotted BFEs must not exceed 10 feet.
- Extreme BFEs at corporate limits and Limits of Detailed Study do not have to be shown if graphically impossible (e.g., when the elevation is 65.5 at the corporate limits, BFE 65 may be plotted within 0.5 inch of the corporate limits).
- In a static 1-percent-annual-chance flood insurance risk zone (tidal or lacustrine flooding), elevation numbers under zone labels must be used in lieu of BFE lines. For tidal flooding only, a zone break (or gutter) must be placed at the point where the static zone becomes a rising elevation zone, and a BFE line of the same elevation as the static zone must be placed immediately upstream of the gutter.
- BFEs must be shown as wavy lines perpendicular to the flow of the 1-percent-annual-chance flood.
- All BFEs must be labeled with an elevation value that is located above, below, or at the end of the line (i.e., where it meets the 1-percent-annual-chance floodplain boundary).
- If the BFE value cannot be placed within 0.1 inch of the BFE line, a leader line must be used to connect the BFE value to the BFE line.

[February 2002]

C.7 Hydrologic and Hydraulic Analyses of Lake Levels for Closed Basins

Conventional floodflow-frequency analysis, such as that described in Bulletin 17B (Interagency Advisory Committee on Water Data, 1982), is based on the assumption that the data are stationary and independent. These conditions are usually satisfied when analyzing annual maximum peak discharges on a river. However, some notable exceptions do occur. For example, annual maximum lake levels or lake volumes are usually significantly correlated with time (autocorrelated) and hence violate the independence requirement.

In the presence of autocorrelation, flood-frequency analysis takes on a new meaning. The floodflow-frequency curve depends on an initial condition and evolves over time to a steady-state or equilibrium distribution. As a consequence, when conventional flood-frequency analysis is applied to autocorrelated lake data, the results must be interpreted as the long-term or steady-state distribution of annual maximum lake levels. This is in marked contrast to a conventional analysis of independent riverine data where a single flood-frequency distribution applies at all times. This fundamental difference between conventional flood-frequency analyses for lakes and rivers has important ramifications in developing sound floodplain management strategies for lakeshore communities.

A closed-basin lake, as defined by FEMA, is a natural lake from which water exits primarily through evaporation and whose surface area exceeds or has exceeded 1 square mile at any time in the recorded past. Most of the nation's closed-basin lakes are in the western half of the United States, where annual evaporation exceeds annual precipitation and where lake levels and surface areas are subject to considerable fluctuation due to wide variations in the climate. These lakes may overtop their basins on rare occasions. (See Section 61.17 Appendices A(1), A(2), and A(3) of the NFIP regulations.) Because of the unique type of flooding, special policy and procedural considerations are warranted.

[February 2002]

C.7.1 Insurance and Ordinance Issues

FEMA has amended the Standard Flood Insurance Policy to address the closed-basin lake continuous flooding circumstance. FEMA has added an endorsement to all policies allowing policyholders to file a total loss claim for an insured building that is actually damaged or under imminent threat of flooding, without the requirement for the building to be continuously inundated for 90 days. Policyholders must use claim payments, less salvage value, relocate their structures to a site outside the area subject to flooding. This special floodprone area around closed basin lakes is referred to in this Appendix and on the affected FIRM panels as an Area of Special Consideration (ASC). The insurance claim provision provides the means for homeowners and commercial business interests to relocate outside the ASC, thereby affording the community and its residents a permanent means of eliminating future flood losses in these areas.

The special endorsement for closed-lake basins is established in Paragraph 61.13(d) of the NFIP regulations. The insurance claim provisions are described in Appendices A(1), A(2), and A(3) of Section 61.17 of the NFIP regulations. Local and State governments must establish ordinances and building restrictions as described in Section 61.17 to be eligible for the special insurance claim provisions.

[February 2002]

C.7.2 Mapping Protocol

As mentioned earlier, FEMA established the ASC to accommodate the unique type of flooding around closed-basin lakes. The ASC may include the 1- and 0.2-percent-annual-chance floodplains and additional areas to account for the continuous and often uncertain fluctuations in the water-surface elevation due to the closed-basin lake phenomenon. An ASC is an area subject to flooding, but the percent chance of being flooding in any given year is not defined. For example, the elevation shown within the ASC may be determined by using the natural spill elevation of the closed lake, the historical (or geological) elevation of record, and other criteria. The FEMA RO shall determine whether closed-basin lake flooding conditions exist and shall implement the closed-basin lake policy accordingly.

FEMA shall exclude those areas that are landward of certified levees that provide protection from flooding from the ASC. FEMA and its Mapping Partners shall not take into account all flood hazards that may exist from other flooding sources, such as local streams or other floodwaters that are not hydraulically connected to the closed-basin lake, in determining the ASC.

[February 2002]

C.7.3 Technical Methodologies

For large closed-basin lakes, such as Devils Lake in North Dakota and the Great Salt Lake in Utah, historical water level data and other data are available to estimate the 1-percent-annual-chance lake level. If the data are available, autoregressive moving average models can be used to model annual lake levels and volumes.

In North Dakota, Wiche and Vecchia developed a stochastic water balance model to estimate the 1-percent annual chance lake elevation (USGS, 1995). Wiche and Vecchia used long-term seasonal precipitation, evaporation, and inflow to Devils Lake to develop a stochastic water balance model for generating possible future lake-level elevations, namely 10,000 traces of 50 years in length. Wiche and Vecchia determined the chance that a given lake level will be exceeded in any given year by evaluating the proportion of the generated annual maximum lake levels that exceeded the given level.

The chance that a given lake level will be exceeded in any given year is dependent on the current or existing water level on the lake. The equilibrium level corresponding to a given percent chance of exceedance is reached when the current lake level has no effect

on the given percent chance of exceedance. The equilibrium level for the 1- and 0.2-percent-annual-chance floods are mapped on the FIRM.

[February 2002]

C.7.4 Future Actions

Special considerations are needed to define the potential flooding in and around closed-basin lakes. FEMA has amended the Standard Flood Insurance Policy to address insurance and relocation issues relative to this phenomenon. FEMA is finalizing and adopting methodologies for determining the frequency of water-surface elevations for closed-basin lakes. These methodologies will be provided in future updates to these Guidelines.

[February 2002]

C.8 Future-Conditions Flood Mapping

Communities experiencing urban growth and other changes often use future-conditions hydrology in regulating watershed development. While some communities regulate based on future development, others are hesitant to enforce more restrictive standards without FEMA support. To assist community officials, FEMA has decided to include future-conditions flood hazard data on FIRMs and in FIS reports for informational purposes on a case-by-case basis. This decision was documented in a Final Rule published in the *Federal Register* on November 27, 2001. (The Final Rule may be downloaded from the FEMA website at http://www.fema.gov/mit/tsd/frm_fchy.pdf.)

Because multiple options exist for presenting future-conditions floodplains and related data on the FIRM and in the FIS report, interested community officials should contact the appropriate RO to discuss the available options and agree on the approach to be taken. For information on these options, FEMA encourages interested community officials to review the November 27, 2001, Final Rule and the FEMA report entitled "Modernizing FEMA's Flood Hazard Mapping Program: Recommendations for Using Future-Conditions Hydrology for the National Flood Insurance Program" (FEMA, 2001). That report contains one possible scenario/example of depicting future-conditions flood hazard information on a FIRM and in an FIS report and may be downloaded from the FEMA website at http://www.fema.gov/mit/tsd/ft_futur.htm.

At the request of a community and with the approval of FEMA, FIRMs and FIS reports may include, for informational purposes, flood hazard areas based on projected- or future conditions hydrologic and hydraulic analyses. If community officials request that FEMA show the future-conditions 1-percent-annual-chance floodplain on the FIRM, the future-conditions floodplains and flood insurance risk zone shall be shown on the FIRM and referenced in the accompanying FIS report. Although graphic specifications are flexible for the mapping of this flood insurance risk zone, the zone label will be "Zone X (Future Base Flood)."

The future-conditions flood insurance risk zone shall be defined in the FIRM legend and in the FIS report as follows:

> Zone X (Future Base Flood) is the flood insurance risk zone that corresponds to the 1-percent-annual-chance floodplains that are determined based on future-conditions hydrology. No BFEs or base flood depths are shown within this zone.

FEMA opted to use the Zone X (shaded) screen, in lieu of a new flood hazard zone designation, to depict the future-conditions 1-percent-annual-chance (100-year) floodplain to minimize confusion by users of the FIRM that make determinations regarding Federal mandatory flood insurance purchase requirements. Those users now recognize that areas designated as Zone X (shaded) are floodprone, but that the mandatory flood insurance purchase requirement does not apply. Because the risk premium rates for buildings located in the future-conditions 1-percent-annual-chance

(100-year) floodplain will be the rate comparable to other areas outside the SFHA, FEMA believes designating these areas as "Zone X (Future Base Flood)" will be sufficient distinction.

FEMA may develop graphic specifications for the presentation of future-conditions flood hazard data on the FIRM and specifications and guidelines for the inclusion of support information in the accompanying FIS report. However, it is FEMA's intent, as indicated in the previously referenced Final Rule, to have flexibility in the implementation of this community-requested mapping option. Because multiple options for presenting the future-conditions flood hazard data exist, FEMA intends to work closely with each community to develop the presentation format that best meets community and FEMA needs. For the time being, FEMA, in coordination with the affected community(ies) and the Mapping Partner that is preparing the Preliminary FIRM and FIS report, shall establish the presentation specifications on a case-by-case basis.

Once future-conditions flood hazard data have been included on the FIRM and in the FIS report for a community, all revision submittals shall incorporate the future-conditions data developed by the community. The community is entirely responsible for developing and maintaining this data layer on a digital FIRM.

[February 2002]

C.9 References

Akan, A. O. *Urban Stormwater Hydrology: A Guide to Engineering Calculations*, Technomic Publishing Company, Inc., 1993.

Federal Emergency Management Agency, FEMA 265, *Managing Floodplain Development in Approximate Zone A Areas,* 1995.

Federal Emergency Management Agency, "Policy for Use of HEC-RAS in the NFIP," FEMA Memorandum, 2001.

Federal Emergency Management Agency, *Examination of the Use of Future Floodplain Conditions on NFIP Maps,* 1989.

Interagency Advisory Committee on Water Data, Hydrology Subcommittee, Bulletin 17B, *Guidelines for Determining Flood Flow Frequency*, 1982.

Kite, G.W., *Frequency and Risk Analysis*, New York: Water Resources Publications, 1999.

Maidment, D.R. (Editor in Chief), *Handbook of Hydrology*, New York: McGraw-Hill, Inc., 1993.

McCuen, R. H., *Hydrologic Analysis and Design*, Englewood Cliffs, NJ: Prentice Hall, 1989.

McCuen, R. H., *Microcomputer Applications in Statistical Hydrology*, Englewood Cliffs, NJ: Prentice Hall, 1993.

Montgomery, Douglas C., and Elizabeth A. Peck, *Introduction to Linear Regression Analysis*, New York: John Wiley & Sons, 1982.

U.S. Department of Agriculture, Soil Conservation Service, Technical Release No. 55, *Urban Hydrology for Small Watersheds,* 1986.

U.S. Department of the Army, Corps of Engineers, Engineering Manual No.1110-1-1415, *Hydrologic Frequency Analysis*, 1993.

U.S. Department of the Army, Corps of Engineers, *Risk-Based Analysis for Flood Damage Reduction Studies*, Davis, California, 1996.

U.S. Department of the Army, Corps of Engineers, Hydrologic Engineering Center, *HEC-1 Flood Hydrograph Package, User's Manual*, Davis, CA, 1990.

U.S. Department of the Army, Corps of Engineers, Hydrologic Engineering Center, *HEC-FFA Flood Frequency Analysis*, 1992.

U.S. Department of the Army, Corps of Engineers, Hydrologic Engineering Center, *HEC-RAS, River Analysis System, User's Manual, Version 3.0,* 2001.

U.S. Department of the Interior, Geological Survey. Professional Paper No. 750-C, *Prediction Error of Regression Estimates of Streamflow Characteristics at Ungaged Sites*, C.H. Hardison, 1971.

U.S. Department of the Interior, Geological Survey, Water-Supply Paper 2001-C, *Effects of Urban Development on Floods in Northern Virginia,* D.G. Anderson, 1970.

U.S. Department of the Interior, Geological Survey, Water-Supply Paper No. 2207, *Flood Characteristics of Urban Watersheds in the United States*, V.B. Sauer, W.O. Thomas, Jr), V.A. Stricker, and K.V. Wilson, 1983.

U.S. Department of the Interior, Geological Survey, Water Resources Investigations Report No. 94-4002, *Nationwide Summary of U.S. Geological Survey Regional Regression Equations for Estimating Magnitude and Frequency of Floods for Ungaged Sites*, 1994.

U. S. Department of the Interior, Geological Survey, Open-File Report No. 95-123, *Lake-Level Frequency Analysis for Devils Lake, North Dakota.* G.J. Wiche and A.V. Vecchia, 1995.

U.S. Department of the Interior, Geological Survey, *PEAKFQ, Annual Flood Frequency Analysis Using Bulletin 17B Guidelines*, 1998.

U.S. Department of the Interior, Geological Survey, and U.S. Department of Transportation, Federal Highway Administration, *User's Manual for WSPRO- A Computer Model for Water Surface Profile Computations*, 1990.

U.S. Department of Transportation, Federal Highway Administration, Report No. FHWA-TS-84-204, *Guide for Selecting Manning's Roughness Coefficients for Natural Channels and Flood Plains*, 1984.

U.S. Department of Transportation, Federal Highway Administration, Report No. FHWA-IP-85-15, *Hydraulic Design of Highway Culverts*, 1985.

[February 2002]

Map MODERNIZATION

Federal Emergency Management Agency

FEMA's Flood Hazard Mapping Program

Guidelines and Specifications *for* Flood Hazard Mapping Partners

Appendix D: Guidance for Coastal Flooding Analyses and Mapping

FEDERAL EMERGENCY MANAGEMENT AGENCY

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February 2002

Appendix D

Guidance for Coastal Flooding Analyses and Mapping

D.1 General Guidance

A variety of analytical methodologies may be used to establish Base Flood Elevations (BFEs) and floodplains throughout coastal areas of the United States. These methodologies are too voluminous to be included in these Guidelines. This Appendix itemizes references for the methodologies currently in use by FEMA for specific coastal flood hazards, provides general guidance for documentation of a coastal flood hazard analysis, specifies flood hazard analysis procedures for the Great Lakes coasts, and outlines intermediate data submissions for coastal flood hazard analyses with new storm surge modeling and revised stillwater flood level (SWFL).

[February 2002]

D.1.1 Coastal Flood Hazard Analysis Methodologies

The publications cited below were prepared for, and are available from, FEMA, or they are used to prepare a coastal flood hazard assessment and establish BFEs. The publications prepared for FEMA will be provided to the Mapping Partners responsible for performing coastal flood hazard analyses. The Mapping Partners responsible for final production of Flood Insurance Studies (FISs) for the Atlantic Ocean, Gulf of Mexico and Great Lakes shall obtain copies of the published data used to prepare the coastal flood hazard analyses and establish BFEs, and shall be familiar with the use and application of the information presented in the publications cited below. Mapping Partners responsible for final production of FISs for the Pacific Ocean coastal areas shall consult with the appropriate FEMA Regional Project Officer (RPO) to determine the appropriate methodologies that shall be followed.

Northeaster Flooding

Stone & Webster Engineering Corporation, "Development and Verification of a Synthetic Northeaster Model for Coastal Flood Analysis," 1978.

U.S. Department of the Army, Corps of Engineers, New England Division, Hydraulics and Water Quality Section, "Tidal Flood Profiles, New England Coastline," September 1988.

Hurricane Flooding

U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Weather Service, *Hurricane Climatology for the Atlantic and Gulf Coasts of the United States (NWS 38),* April 1987.

Federal Emergency Management Agency, *FEMA Coastal Flooding Storm Surge Model,* Volumes 1, 2, and 3, August 1988.

Pacific Northwest Storm Flooding

CH2M HILL, Inc., "Determination of Flood Levels on the Pacific Northwest Coast for Federal Insurance Studies," *Journal of Hydraulics Division, ASCE*, D. E. Dorratcague, J. H. Humphrey, and R. D. Black, 1977, Vol. 103, 73–81.

U.S. Department of the Army, Corps of Engineers, Pacific Ocean Division, *Manual for Determining Tsunami Runup on Coastal Area of Hawaii*, August 1978.

U.S. Department of the Army, Corps of Engineers, Waterways Experiment Station, Technical Report H-80-16, *Tsunami-Wave Elevation Predictions for American Samoa*, September 1980.

Tsunami Flooding

U.S. Department of the Army, Corps of Engineers, Waterways Experiment Station, Technical Report H-77-16, *Tsunami-Wave Elevations, Frequency of Occurrence for the Hawaiian Islands*, August 1977.

U.S. Department of the Army, Corps of Engineers, Waterways Experiment Station, Technical Report CERC-87-7, *Tsunami Predictions for the Coast of Alaska, Kodiak Island to Ketchikan*, April 1987.

U.S. Department of the Army, Corps of Engineers, Waterways Experiment Station, Technical Report H-80-16, *Tsunami-Wave Elevation Predictions for American Samoa*, September 1980.

U.S. Department of the Army, Corps of Engineers, Waterways Experiment Station, Technical Report HL-80-18, *Type 19 Flood Insurance Study: Tsunami Predictions for Southern California*, 1980.

U.S. Department of the Army, Corps of Engineers, Pacific Ocean Division, *Manual for Determining Tsunami Runup on Coastal Area of Hawaii*, August 1978.

Great Lakes Mapping of Coastal Flooding Areas

U.S. Department of the Army, Corps of Engineers, *Revised Report on Great Lakes Open-Coast Flood Levels, Phases I and II*, April 1988.

U.S. Department of the Army, Corps of Engineers, *Great Lakes Wave Runup Methodology Study*, June 1989.

Federal Emergency Management Agency, *Guidelines for Great Lakes Wave Runup Computation and Mapping*, June 1991.

Dewberry & Davis, *Basic Analyses of Wave Action and Erosion with Extreme Floods on Great Lakes Shores,* Draft Report, October 1995.

Federal Emergency Management Agency, *Guidelines and Specifications for Wave Elevation Determination and V Zone Mapping – Great Lakes,* Draft Report, August 1996.

Mississippi River Delta Flooding

Joseph N. Suhayda, *Attenuation of Storm Waves over Muddy Bottom Sediments*, August 1984.

Wave Height and Runup Analyses

National Academy of Sciences, *Methodology for Calculating Wave Action Effects Associated with Storm Surges*, 1977.

Federal Emergency Management Agency, *Assessment of Current Procedures Used for the Identification of Coastal High Hazard Areas (V Zones)*, September 1986.

Federal Emergency Management Agency, *Basis of Assessment Procedures for Dune Erosion in Coastal Flood Insurance Studies*, January 1989.

U.S. Department of the Army, Corps of Engineers, Waterways Experiment Station, Coastal Engineering Research Center, WIS Report 19, *Hurricane Hindcast Methodology and Wave Statistics for Atlantic and Gulf Hurricanes from 1956-1975*, April 1989.

Federal Emergency Management Agency, *Wave Height Analysis for Flood Insurance Studies (Technical Documentation for WHAFIS Program Version 3.0)*, September 1988, amended with software, July 1989.

Federal Emergency Management Agency, *Wave Runup Model Version 2.0 (RUNUP 2.0), 1991.*

U.S. Department of the Army, Corps of Engineers, *Shore Protection Manual, Volumes I and II,* 1984.

U.S. Department of the Army, Corps of Engineers, Waterways Experiment Station, *Automated Coastal Engineering System*, Version 1.07, September 1992.

U.S. Department of the Army, Corps of Engineers, Waterways Experiment Station, Coastal Engineering Research Center, WIS Report 20, *Southern California Hindcast Wave Information*, December 1992.

U.S. Department of the Army, Corps of Engineers, Waterways Experiment Station, Coastal Engineering Research Center, WIS Report 30, *Hindcast Wave Information for the U.S. Atlantic Coast*, March 1993.

Evaluation of Coastal Structures

U.S. Department of the Army, Corps of Engineers, *Shore Protection Manual, Volumes I and II,* 1984.

U.S. Department of the Army, Corps of Engineers, *Design of Coastal Revetments, Seawalls and Bulkheads*, April 1985.

U.S. Department of the Army, Corps of Engineers, Waterways Experiment Station, Technical Report CERC-89-15, *Criteria for Evaluating Coastal Flood Protection Structures*, December 1989.

Atlantic and Gulf Mapping of Coastal Areas

Federal Emergency Management Agency, *Guidelines and Specifications for Wave Elevation Determination and V Zone Mapping*, Final Draft, March 1995.

[February 2002]

D.1.2 Study Documentation

Mapping Partners responsible for producing coastal FISs must document fully the coastal flood hazard determination for each study. This documentation shall identify the methodology employed as well as the computational approach and the input data used in the calculation of the coastal flood elevations. The technical specifications under which all coastal FISs will be documented are provided in the various internal and public FEMA reports outlining the approved coastal storm surge elevation methodology that are referenced in Subsections D.1.1 and D.1.4. These reports include algorithms, computer codes, guidelines for model use, and examples of model runs.

Although some of these reports provide relatively specific information on both the general procedures to be employed in processing the meteorological and hydrologic data, and the specifics of the hydrodynamic and windfield models to be employed, the reports contain no information on the application of the methodology to a particular coastal site. Therefore, the Mapping Partner responsible for performing a coastal study shall document the specific meteorological and hydrologic data, ocean bathymetry, shoreline characteristics, surface and bottom friction coefficients, and other parameters used in the particular model application. For this purpose, the Mapping Partner shall produce an engineering report for each coastal study.

The purpose of the engineering report is to provide the detailed site-specific data needed by FEMA and the affected coastal communities to reconstruct or defend, on technical grounds, the study results. In general, the documentation shall include the input data; modeling approach; model parameter values; and all assumptions, decisions, and judgments that influence model outputs. The material to be included in the engineering report is summarized in the subsections below. Although the emphasis is on coastal studies incorporating storm surge models, Mapping Partners using other methods shall nonetheless adhere to the appropriate subsections. The Mapping Partner performing a coastal study shall obtain RPO approval for any deviations from the requirements documented in these Guidelines.

[February 2002]

D.1.2.1 Introductory Material

In the first section of the engineering report, the Mapping Partner shall describe the geographic setting of the study site, discuss the local surge-producing climatology of both tropical and

extratropical storms, and provide a history of extreme storm surges. The Mapping Partner shall also report on unique aspects of each component of the stillwater flood elevation (SWEL) that was investigated (e.g., inverted barometer setup, wind transport, astronomical tide level, pre-surge anomaly, wave action, and abnormal hydrological conditions). The Mapping Partner also shall include a short discussion of the coastal study results and how they will be used in producing the Flood Insurance Rate Map (FIRM).

[February 2002]

D.1.2.2 Outline of Methodology

In the second section of the engineering report, the Mapping Partner shall provide an outline of the basic technical approach employed in the study. Topics to be covered include identification of the storm (wind) model, the hydrodynamic model, and the statistical procedure used to determine flood frequencies. The purpose of this section is to outline the relationship between the technical material to be covered in the main body of the engineering report and the basic methodological approach used in the study. This outline should be logically organized and sufficiently complete so that the detailed documentation that follows can be easily read and understood.

[February 2002]

D.1.2.3 Storm Climatology and Storm Windfield Methodology

In this section of the engineering report, the Mapping Partner shall:

- Describe the basic climatological storm data used and the windfield methodology employed.
- Map, tabulate, and discuss in terms of local surge impact the storm paths used in the analysis.
- Tabulate and describe in written form the storm parameters (including central pressure deficit, radius to maximum wind, forward speed, shoreline crossing point, and shoreline crossing angle) used in the analysis.
- Identify sources of the basic data used to develop the storm climatology and the method used to sort the data and compare them with the National Weather Service (NWS) *Hurricane Climatology for the Atlantic and Gulf Coasts of the United States (NWS 38)*.
- Describe the technique employed to determine the spatial/temporal distribution of storm occurrences (i.e., storms/nautical mile/year), derivation and discretization of storm intensity parameters, and exceedence probability distributions.
- Provide graphical presentation of the results, including an overlay with orientation of coast to storm path/direction.
- Provide a discussion of storm parameter independence and any unique storm model treatments.

- Give the exact equations used to parameterize the model windfield along with any unique values of all the appropriate coefficients and constants used. The windfield used in the analysis is a key component in the determination of the storm surge elevation.

- Include a diagram of the windfield model that gives the surface velocity structure as it changes radially outward from the storm center.

- Provide a comparative graph depiction of measured windfield(s) and modeled windfield, if available.

- Describe the method by which winds are reduced as the storm approaches land and moves inland in detail.

- Report the constants used in windspeed reduction.

[February 2002]

D.1.2.4 Hydrodynamic Storm Surge Model

This section of the engineering report is to address the hydrodynamic storm surge model employed in performing the coastal study. The model used to calculate the surge elevation has been described in detail in various FEMA documents and need only be cited by reference. In this section of the engineering report, the Mapping Partner shall:

- Report the unique model characteristics used for the study, including a discussion of the specific grid system and sub-grid systems employed, the grid used for bottom topography and shoreline, small-scale features such as harbors and barrier islands, and the location and conditions applied for the open boundaries to the grid.

- Describe and document the adjustment to land features to account for erosion.

- Describe and document the method used to determine average ground elevations and water depths within the cells of the grid system. This discussion should be augmented by diagrams that show the grid systems as computer listings of the grid data used in the actual model calculations.

- Describe the method used to relate windspeed and surface drag coefficient is to be described.

- Discuss the Manning's "n" values used in the calculation of bottom and overland friction and provide values in tabular form. This information will include a discussion of any sensitivity tests used to estimate these values in nearshore water. Nearshore bottom and overland friction is an important part of the overall analysis and, therefore, shall be described with care and sufficient detail.

- Provide a graphical depiction of the model cells and grid system as an overlay to the bathymetric charts and topographic maps covering the study area, annotated with the individual cell inputs for the grid system.

- Discuss the method by which barriers, inlets, and rivers have been treated.
- Explain the procedures used to determine inland flooding, including parameterization of local features and selection of the friction factors used for the terrain.

[February 2002]

D.1.2.5 Calibration and Verification of Hydrodynamic Storm Surge Model

In this section of the engineering report, the Mapping Partner shall document the calibration and verification of the hydrodynamic surge model. Once the hydrodynamic storm surge model and grid have been set up, calibration and verification are performed. Calibration is done to determine the adjustable "tuning parameters" (e.g., Manning's "n", barrier overflow coefficients) and to validate the chosen grid schematization. Verification is used to validate the model and grid for situations other than the case used to calibrate the model. Sensitivity runs are used to make sure that small changes in the chosen grid and "tuning parameters," will not give rise to unacceptable large changes in the computed flood and tide levels. Calibration and verification computer runs compare computed results with observed water levels. Sensitivity runs compare computed results with other computed results.

When observed (or model simulation) data are employed to calibrate (or compare) hydrodynamic storm surge model results with other available studies, the Mapping Partner shall give a complete description of this calibration procedure (or model comparison), including a listing of measured and simulated tidal data. Calibration (and model comparison) is an important aspect of the model analysis; therefore, the Mapping Partner shall described these activities with sufficient detail and care to allow an independent reviewer to understand the exact procedures employed and the local historical records employed.

[February 2002]

D.1.2.6 Statistical (Joint Probability) Methodology

If the joint probability method was used, the Mapping Partner shall summarize, map, and report the values and combinations used for storm parameters, annual storm density, spacing between storms, and the storm tracks used in the analysis in this section of the engineering report. In this section, the Mapping Partner also shall compare the information above with the probabilities reported in *Hurricane Climatology for the Atlantic and Gulf Coasts of the United States (NWS 38)*. Specifically, the Mapping Partner shall:

- Note the total number of simulations.
- Summarize tidal elevation data, if used, in sufficient detail to remove any doubt as to the values used in the simulations.
- Describe the method by which the tidal elevation data are convoluted with surge data including tidal constants and tidal records.

- Describe storm occurrence rate or storm density, the definition of the storm region used to define storm density, and storm kinematics and intensity with respect to their use in the joint probability calculation.
- Report and discuss comparisons to long-term gage statistics.
- Describe and report adjustments to account for the combined probability of coastal and riverine flooding for each area where such an approach was taken.

[February 2002]

D.1.2.7 Unique Computer Programs

Several different computer codes may be used in the wind, hydrodynamic, and joint probability analysis. Several basic computer programs have been listed in numerous FEMA reports. In this section of the engineering report, the Mapping Partner shall list and describe any modifications of these programs and special data inputs used in the study.

[February 2002]

D.1.2.8 Wave Height, Runup, and/or Erosion Analysis

In this section of the engineering report, the Mapping Partner responsible for performing the coastal analysis shall reference the wave height, runup, and/or erosion analysis methodology used for the study. Specifically, the Mapping Partner shall:

- Document fully any deviation or expansion of that approach.
- Describe the selection of input data, including a reference to source data and material.
- Document fully all erosion considerations.
- Include one or more transect location maps as appropriate.
- Include computer printout listings for input and output data as an appendix to the report, keyed to the transect location map(s).

[February 2002]

D.1.2.9 References

In the final section of the engineering report, the Mapping Partner shall provide a complete list of technical references, including computer program references, indicating how to obtain copies of the exact program and the input data sources used in the analysis.

[February 2002]

D.1.3 Great Lakes Wave Runup Computations and Mapping

Mapping Partners performing coastal studies for communities along the Great Lakes shoreline should use the wave runup analysis guidance in Section D.3. Section D.3 provides a wave runup study flow chart, the detailed study procedure steps, sample computations, and mapping policies. An overview of the coastal study procedures is presented below.

[February 2002]

D.1.3.1 Wave Runup Calculation Procedures

The guidelines for Great Lakes wave runup calculations have emerged from methodologies recommended by the Detroit District of the U.S. Army Corps of Engineers (USACE) in the study report entitled *Great Lakes Wave Runup Methodology Study*. The figures and tables in Section D.3 have been drawn from various references cited in this USACE study report. Further guidance on the wave runup approach is included in Section D.3. Although this guidance is subject to change based on new information and methodology improvement, it provides the framework and information on the application of the methodologies.

Three types of shorelines are considered: a natural beach profile and two types of armored shoreline profiles (vertical wall and rock revetment). Therefore, three runup methodologies corresponding to the three shoreline types are employed. The flow of tasks begins with site profile data-gathering, tracks through various intermediate steps, such as the 1-percent-annual-chance flood level determination, and the calculation of the deep water and shallow water wave height, and ends with the wave runup determination for each type of shoreline.

[February 2002]

D.1.3.2 Wave Runup Computation Steps and Sample Calculations

When the site location is identified, the Mapping Partner shall follow the step-by-step study procedures below to determine the maximum wave runup elevations to be used in coastal floodplain boundary delineations.

- Step 1. Profile Data Gathering
- Step 2. 1-percent-annual-chance Flood Level Determination
- Step 3. Offshore (Deep Water) Wave Height Determination
- Step 4. Nearshore (Shallow Water) H_{mo}, H_s, and T_p Computation
- Step 5. Wave Runup Computation
- Step 6. Determination of Maximum Wave Runup Elevation

[February 2002]

D.1.3.3 Delineation and Mapping Policy

Six general policies and 12 specific-case mapping policies accompanied with illustration diagrams may be used in the coastal FIS map delineation for Great Lakes coastal communities. (See Section D.3 for detailed information.) Mapping Partners shall apply the general policies to all cases and the specific-case policy to a certain situation. Three types of shoreline profiles are typical in the Great Lakes region and are used to classify the cases:

- Beach profile with a natural dune system;
- Beach profile with a bluff system; and
- Beach profile with coastal structures.

For each type of shoreline profile, the Mapping Partner shall consider four separate cases, depending on the computed wave height profile, wave runup height, 1-percent-annual-chance stillwater level, and the predicted post-storm erosion profile. For other special cases that cannot be covered by the above policies, the Mapping Partner shall consult with the RPO.

[February 2002]

D.1.4 Intermediate Data Submission for Coastal Flood Studies

Coastal analyses involving storm surge modeling are highly specialized and complex and require a highly specialized review process. Experience has shown that attempting to make changes or corrections to coastal storm surge and wave height analyses after they have been run and mapped is not practical due to the time, cost, and contractual problems involved. Many questions and problems that arise during the review process could be answered or resolved much more readily if these issues were raised early in the study process. Therefore, FEMA has established intermediate data submission requirements to permit review of the Mapping Partner's progress on model development at appropriate milestones. The Mapping Partner performing the study shall submit the data to the reviewing Mapping Partner, as specified by the RPO, in accordance with the sequence discussed below.

The Mapping Partner will receive review comments within 30 days of the receipt of each data submission. The Mapping Partner performing the study shall establish a work plan so that the interim review does not cause any delay in the submission of the FIS Report draft and the maps reflecting the results of the coastal study.

[February 2002]

D.1.4.1 Before Storm-Surge Model Calibration Runs Are Made

The Mapping Partner performing the study shall submit the following to the reviewing Mapping Partner before calibration runs are made:

1. A large-scale map of the coastal area which delineates both the coarse grid basin(s) and fine grid basin(s);

2. A schematic of each basin (coarse grid and fine grid) showing sub-grid channel locations, widths, bed elevations, and proposed Manning's "n" values for each channel;

3. Historical evidence establishing the importance of various coastal flooding mechanisms (e.g., tropical and extratropical storms, rainfall and riverine events);

4. Basic data relating to the study area (e.g., documented storm erosion, available design analyses for shore protection or other coastal projects, historical shoreline changes);

5. Aerial photographs, coastal setback maps, and other maps used to determine more accurate topographic-bathymetric values and land cover features in the study area;

6. Table listing astronomical tide events and historical storms selected for use in model calibration and verification, and a plot showing the observed storm surge elevation against the predicted tide elevations;

7. Plots of exceedence probability vs. parameter value for the meteorological storm parameters that vary in the joint probability analysis, as developed for the study area following *NWS 38*, with documentation to include a tabular presentation of all meteorological storm parameter data used in development of the exceedence probability curves; and

8. Table showing storm parameter values and assigned probabilities.

[February 2002]

D.1.4.2 Before Operational Storm Surge Runs Are Made

The Mapping Partner performing the study shall submit the following to the reviewing Mapping Partner before operational storm surge runs are made:

1. A map of each basin (coarse grid and fine grid) showing water depths, ground elevations, and Manning's "n" values for each grid cell;

2. A map of each basin (coarse grid and fine grid) showing barrier locations, barrier heights, barrier widths, barrier Manning's "n" values, location of inlets cutting through barriers, inlet widths, inlet bed elevations, inlet Manning's "n" values and inlet entrance and loss coefficients;

3. A computer printout listing of the water depth, ground elevations, Manning's "n" values, barrier and inlet input, and the sub-grid channel input, and any other input data used in the calibration and verification runs and that will be used in the production runs;

4. Description of sensitivity runs used to optimize model parameters for the study area, for example, in final choices of Manning's "n" values;

5. Tide and storm calibration results (including extreme water elevations and time histories) showing computed results and a comparison of these with observations where such observations are available;

6. Grid overlay and work maps used in storm surge analyses for all fine and open-coast grid basins; and

7. Written documentation, including justification, of any modifications made to the standard FEMA storm surge methodology and a listing of the computer source code annotated where the modifications were made.

The work maps listed in No. 6 above should generally be the 7.5-minute series U.S. Geological Survey quadrangle maps and the hydrographic charts that were used to gather topographic, bathymetric, roughness, and other input data for the storm surge calculations. The Mapping Partner performing the study shall draw the grid pattern on the maps or use one or more transparent overlays registered to the work map(s) to indicate where the grid cells fall with respect to various map features. The Mapping Partner also shall indicate the location and extent of each wave transect on the overlays or work maps.

[February 2002]

D.1.4.3 Before Operational Wave Elevation Determination Are Made

The Mapping Partner performing the study shall submit the following to the reviewing Mapping Partner before operational wave elevation determinations are made:

1. Documentation of conclusions on the interaction between storm surge and astronomical tide;

2. Output of PROBS program for all open coast and fine grid basins;

3. Grid showing 10-, 2-, 1-, and 0.2-percent-annual-chance SWFLs for each open coast and fine grid basin; and

4. Location map of proposed transects to be used in the wave elevation determination analyses.

[February 2002]

D.1.4.4 Before Wave Elevation Determinations Are Mapped

The Mapping Partner performing the study shall submit a copy of all wave height and wave runup transect computations, and all modeling assumptions to the reviewing Mapping Partner before wave elevations and resulting BFEs are mapped.

[February 2002]

D.2 Wave Elevation Determination and V Zone Mapping: Gulf of Mexico and Atlantic Ocean

The mapping of V Zones under the NFIP began in the early 1970s. The objective was to identify hazardous coastal areas in a manner consistent with the original regulatory definition of coastal high hazard areas as an "area subject to high velocity waters, including but not limited to hurricane wave wash." The initial technical guidance for identifying V Zones was provided in a June 1973 report by the USACE, Galveston District entitled *General Guidelines for Identifying Coastal High Hazard Zone, Flood Insurance Study - Texas Gulf Coast Case Study*, prepared by the U.S. Army Corps of Engineers (USACE), Galveston District (1973). The USACE report identified a breaking wave height of 3 feet as critical in terms of causing significant structural damage and illustrated procedures for mapping the limit of this 3-foot wave (V Zone) in two distinct situations along the Texas coast: undeveloped areas and highly developed areas.

In June 1975, the USACE issued a follow-up report entitled *Guidelines for Identifying Coastal High Hazard Zones* which maintained the basic recommendations contained in the 1973 report for identifying V Zones in undeveloped and developed areas; however, the 1975 report also included guidance for determining effective fetch lengths, a technical discussion justifying the 3-foot wave height criterion for V Zones, an abbreviated procedure for V Zone mapping in undeveloped areas, an expanded discussion of V Zone mapping in developed areas, and historical accounts of several severe storms that have impacted developed areas along the Atlantic and Gulf coasts.

Between 1975 and 1980, the Federal Government (U.S. Department of Housing and Urban Development until 1978 and FEMA thereafter) published FIRMs with V Zones for approximately 270 communities along the Atlantic and Gulf coasts using the USACE guidance for V Zone mapping. During this period, the procedures for determining and delineating V Zones in developed areas differed among studies. At that time, the regulatory BFEs, for both insurance and construction purposes, were the 1-percent-annual-chance stillwater elevations (SWELs), which consisted of the astronomical tide and storm surge caused by low atmospheric pressure and high winds. Although V Zones were identified, the increase in water-surface elevation due to wave action was not included. The Federal Government recognized that this practice did not accurately represent the flooding hazard along the open coast, but an adequate method for estimating the effects of wave action, applicable to most coastal communities, was not readily available at the time.

In 1976, the National Academy of Sciences (NAS) was asked to provide recommendations about how calculations of wave height and runup should be incorporated in FISs for Atlantic and Gulf coast communities to provide an estimate of the extent and height of stormwater inundation having specified recurrence intervals. The NAS concluded that the prediction of wave heights should be included in FISs for coastal communities and provided a methodology for the open coast and shores of embayments and estuaries on the Atlantic and Gulf coasts. The 1977 report documenting the NAS findings, *Methodology for Calculating Wave Action Effects Associated with Storm Surges* included means for taking into account varying fetch lengths, barriers to wave transmission, and regeneration of waves likely to occur over flooded land areas. NAS did not

address the extent and elevation of wave runup, amount of barrier overtopping, and coastal erosion.

In 1979, FEMA adopted the NAS methodology. In 1980, FEMA issued *Users Manual for Wave Height Analysis*, which was subsequently revised in February 1981. FEMA also introduced a computer program, Wave Height Analyses for Flood Insurance Studies (WHAFIS), in 1980. With WHAFIS, FEMA initiated a large effort to incorporate the effects of wave action on the FIRMs for communities along the Atlantic and Gulf coasts.

Along the New England coast with its very steep shore, the NAS methodology proved to be insufficient. Structures that were shown as being outside of the SFHA on effective FIRMs experienced considerable wave damage from storms, most notably the northeaster of February 1978, a near 1-percent-annual-chance flood event. The need to account for the effects of wave runup was recognized. In 1981 FEMA approved a methodology that determined the height of wave runup landward of the stillwater line. Stone & Webster Engineering Corporation developed the methodology in November 1981. In 1987, FEMA modified its computer model for runup elevations slightly to increase the convenience of preparing input conditions. In 1990, FEMA modified the model again to improve computational procedures and application instructions to conform to the best available guidance on wave runup (Dewberry & Davis, 1990).

Two additions were made to the NAS methodology in 1984 to account for coastal situations involving either marsh grass or muddy bottoms. The NAS methodology did not account for flexible vegetation; in particular, marsh plants. Experts surmised that the motion of submerged marsh plants absorbed wave energy, reducing wave heights. In 1984, a FEMA task force examined this phenomenon in detail and developed a methodology that adjusted the wave height to reflect energy changes resulting from the flexure of various types of marsh plants and the wind, water, and plant interaction (FEMA, 1984). FEMA incorporated the new methodology into WHAFIS.

The muddy bottom situation occurs only at the Mississippi Delta in the United States. The Mississippi River has deposited millions of tons of fine sediments into the Gulf of Mexico to form a soft mud bottom in contrast to the typical sand bottom of most coastal areas. This plastic, viscous bottom deforms under the action of surface waves. This wave-like reaction of the bottom absorbs energy from the surface waves, thus reducing the surface waves. A methodology was developed for FEMA to calculate the wave energy losses due to muddy bottoms (Suhayda, 1984). Waves in the offshore areas are tracked over the mud bottom, resulting in lower incident wave heights at the shoreline. This is a phenomenon unique to the Mississippi Delta, and FEMA has not incorporated the methodology into WHAFIS.

In 1988, FEMA upgraded WHAFIS to incorporate revised wave forecasting methodologies described in the 1984 Edition of the USACE *Shore Protection Manual* (USACE, 1984) and to compute an appropriately gradual increase or decrease of SWELs between two given values (FEMA, September 1988).

In the performance of wave height analyses and the preparation of FISs, erosion considerations were left to the judgment of FEMA contractors. Coastal erosion was to be considered a hazard

when there was historical evidence of erosion from previous storms, but prior to 1986, objective procedures for treating erosion were not available. Consequently, some shorefront dunes were designated as stable barriers to flooding and some were not. In 1986, FEMA initiated studies aimed at providing improved erosion assessments in FISs for coastal communities.

In response to criticisms indicating a significant underestimation of the extent of Coastal High Hazard Areas, FEMA undertook an investigation to reevaluate V Zone identification and mapping procedures. The resulting report, entitled *Assessment of Current Procedures Used for the Identification of Coastal High Hazard Areas (V Zones)* presented a number of recommendations to allow for more realistic delineation of V Zones and to better meet the objectives of the NFIP for actuarial soundness and prudent floodplain development (FEMA, 1986). One recommendation was for full consideration of storm-induced erosion and wave runup in determining BFEs and mapping V Zones. As part of its investigation, FEMA performed a study of historical cases of notable dune erosion. In this quantitative analysis, field data for 30 events (later increased to 38 events) yielded a relationship of erosion volume to storm intensity as measured by flood recurrence interval. For the 1-percent-annual-chance storm, FEMA determined that, to prevent dune breaching or removal, an average cross-sectional area of 540 square feet is required above the SWEL and seaward of the dune crest. That standard for dune cross section has a central role in erosion assessment procedures.

The USACE Coastal Engineering Research Center (CERC) performed a study of the available quantitative erosion models for FEMA (Birkemeier, Kraus, Scheffner, & Knowles, 1987). USACE determined that only empirically based models produce reasonable results with a minimum of effort and input data, that each available model for simple dune retreat has certain limitations, and that dune overwash processes are poorly documented and unquantified. After further investigations, FEMA decided to employ a set of extremely simplified procedures for objective erosion assessment (FEMA, November 1988). These procedures have a direct basis in documented effects due to extreme storms and are judged appropriate for treating dune erosion in FISs for coastal communities.

As the official basis for treating flood hazards near coastal sand dunes, FEMA published new rules and definitions in the *Federal Register* that became effective on October 1, 1988. FEMA included the following revised definition in Section 59.1 of the NFIP regulations:

> *Coastal high hazard area* means an area of special flood hazard extending from offshore to the inland limit of a primary frontal dune along an open coast and any other area subject to high velocity wave action from storms or seismic sources.

FEMA also added a clarification of this matter, a definition of primary frontal sand dune, in Section 59.1:

> *Primary frontal dune* means a continuous or nearly continuous mound or ridge of sand with relatively steep seaward and landward slopes immediately landward and adjacent to the beach and subject to erosion and overtopping from high tides and waves during major coastal storms. The inland limit of the primary frontal dune occurs at the point where there is a distinct change from a relatively steep slope to a relatively mild slope.

FEMA also included a new section in Part 65 of the NFIP regulations, identifying a cross-sectional area of 540 square feet as the basic criterion to be used in evaluating whether a primary frontal dune will act as an effective barrier during the 1-percent-annual-chance flood. Another consideration is the documented historical performance of coastal sand dunes in extreme local storms.

In 1989, USACE completed a review for the NFIP regarding coastal structures as protection against the 1-percent-annual-chance flood (Walton, Ahrens, Truitt, & Dean, 1989). Predictions of wave forces, wave overtopping, and wave transmission for commonly occurring structures were among technical topics addressed in the USACE report. The guidelines in this Appendix incorporate procedural criteria recommended by the USACE for evaluating structural stability.

[February 2002]

D.2.1 Organization and Overview

Figure D-1 presents a flowchart of appropriate procedures for defining coastal hazards of the 1-percent-annual-chance flood. Fundamental aspects of the 1-percent-annual-chance flood are addressed in the following sequence:

1. SWEL,
2. Accompanying wave conditions,
3. Stability of coastal structures,
4. Storm-induced erosion,
5. Wave runup and overtopping, and
6. Overland wave heights.

Determination of SWELs usually involves detailed statistical analyses, but added effects due to surface wave action are treated by simplified deterministic methodologies. This strategy avoids any potential complications due to conditional probabilities for simultaneous flooding effects. The sequence for treating these effects is entirely consistent in principle; for example, added wave effects are not resolved within the equations commonly used to simulate coastal storm surges and establish SWEL for the 1-percentannual-chance flood.

The order indicated in Figure D-1 for activities, assessments, and analyses also outlines the organization of topics treated in these guidelines. Subsection D.2.2 provides general data requirements for conducting a coastal study, including that data needed as input to computer models. Subsection D.2.3 discusses requisite evaluation of coastal structures potentially providing wave and/or flood protection. Subsection D.2.4 considers the erosion assessment needed to project the configuration of the shore profile during the 1-percent-annual-chance flood. Subsection D.2.5 treats wave runup, wave setup, and overtopping occurring at shore barriers in flood conditions. Subsection D.2.6 addresses the analysis of nearshore wave heights

and wave crest elevations relevant to a study. Each of these sections provides guidance on the models and procedures for treating individual transects at a study site.

FEMA has established specific models and procedures for the evaluation of shore structures, erosion, wave runup, and wave heights in the determination of coastal flood hazards. For many coastal areas, all four topics must be considered for an adequate treatment; for other coastal areas, application of only one or two of the FEMA methodologies may be required to produce reasonable results. Table D-1 lists some typical shoreline types and the models that should be used for them.

Table D-1. Model Selection for Typical Shorelines

TYPE OF SHORELINE	MODELS TO BE APPLIED		
	EROSION	RUNUP	WHAFIS
Rocky bluffs		x	x
Sandy bluffs, little beach	x	x	x
Sandy beach, small dunes	x		x
Sandy beach, large dunes	x	x	x
Open wetlands			x
Protected by rigid structure		x	x

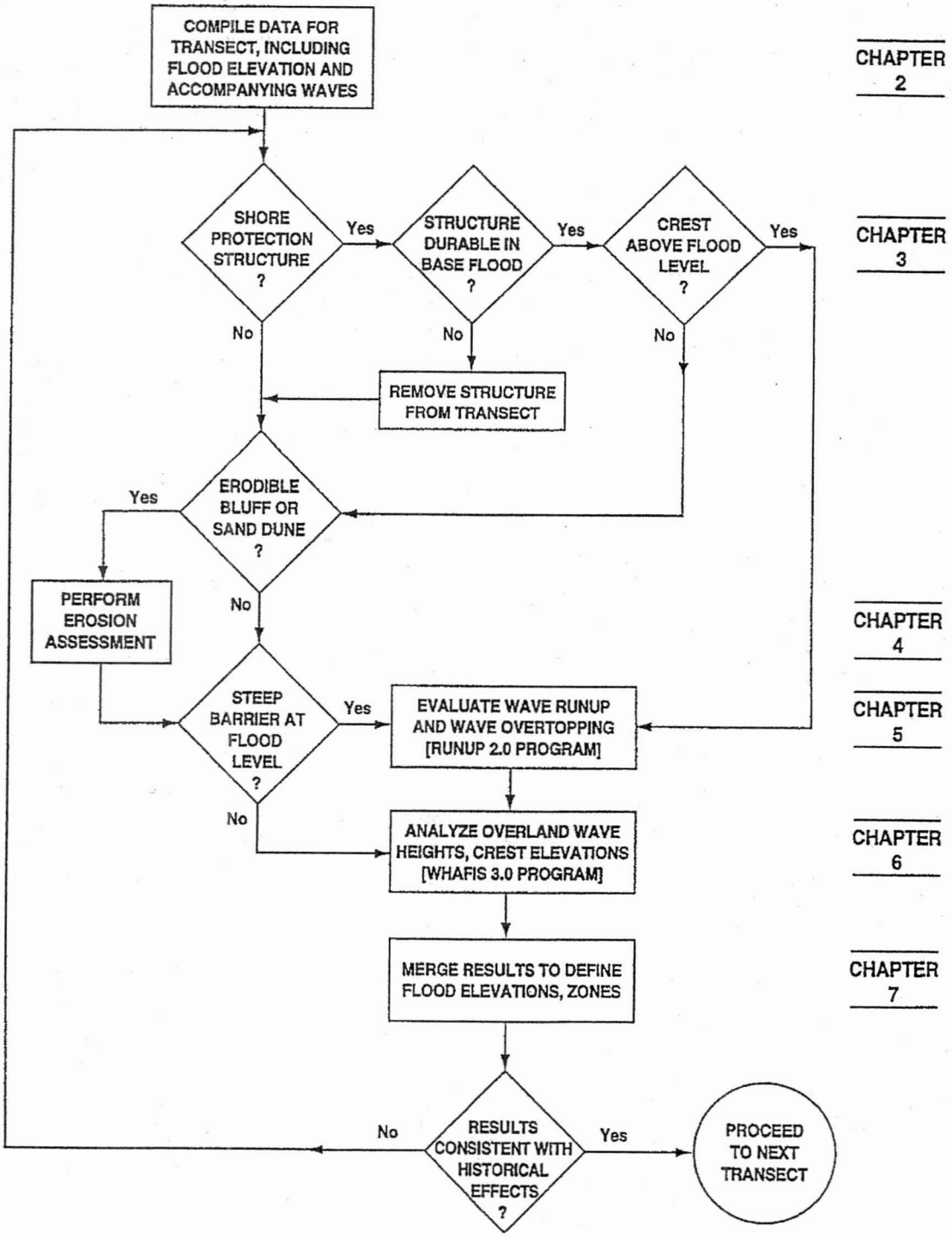


Figure D-1. Procedural Flowchart for Defining Coastal Flood Hazards

The remaining material in these guidelines adopts a more comprehensive view toward completion of an FIS. Subsection D.2.7 addresses the integration of basic results into a coherent map for flood elevations and hazard zones. Subsection D.2.8 defines required documentation of the process, decisions, and data used in determining coastal flood hazards for a community. For consistency with the NFIP and compatibility with FISs, these guidelines use standard English units for all variables.

[February 2002]

D.2.2 Data Requirements for Coastal Flood Hazard Analyses

To conduct a study for a coastal community, the Mapping Partner performing the study shall first collect the wide variety of quantitative data and other site information required in ensuing analyses. This subsection describes how coastal flood elevations and boundaries are determined, including an outline for the storm expected to cause the 1-percent-annual-chance flood, and characteristics of nearshore seabed through upland regions. Some data are directly input to computer models of flood effects, and other data are used to interpret and integrate the calculated results.

Each computer model of a separate flood effect is executed along transects, which are cross sections taken perpendicular to the mean shoreline to represent a segment of coast with similar characteristics. Thus, collected data are compiled primarily for transects, in turn situated on work maps at the final scale of the FIRM. Work maps are used both to locate and develop the transects, and to interpolate and delineate the flood zones and elevations.

Aside from needed quantitative information, the Mapping Partner shall collect descriptions of previous flooding and the community in general to aid in the evaluation of flood hazards and for inclusion in the FIS Report. The Mapping Partner shall start data collection at the community level and proceed with county, state, and Federal agencies. The Mapping Partner also shall contact private firms specializing in topographic mapping and/or aerial photography, following up suggestions provided by government agencies.

[February 2002]

D.2.2.1 Stillwater Elevations

The Mapping Partner shall determine the SWELs in a rational, defensible manner and shall not include contributions from wave action either as a result of the mathematics of the predictive model or of the data used to calibrate the model. Only the 1-percent-annual-chance SWEL is required for the coastal analyses, although 10-, 2-, and 0.2-percent-annual-chance elevations are provided in the FIS Report, and the 0.2-percent-annual-chance floodplain boundary is mapped on the FIRM.

SWELs may be defined by statistical analysis of available tide gage records or by calculation using a storm surge computer model. A minimum of 20 years of recorded tide data is needed if the SWEL is to be based on tide gage records alone. Measured tide levels are preferred over

synthetic models provided they have a significant period of continuous record over 20 years and can accurately represent the geographic area of the study. FEMA has available a self-contained hurricane storm surge model that can provide flood elevations (FEMA, August 1988) and a synthetic northeaster model that simulates the wind and pressure fields of an extratropical storm for input to a storm surge computer model (Stone & Webster Engineering Corporation, 1978). The Mapping Partner shall use these computer models for complex shorelines where gage records are limited, nonexistent, or non-representative, and usually indicate appreciable variations in flood elevations within a community. FEMA also has specified procedure and documentation for coastal flood studies using a storm surge model, as presented previously in Subsections D.2.2, D.2.3 and D.2.4. Of particular importance here, the surge model study can provide winds and water levels over time likely with the 1-percent-annual-chance flood.

[February 2002]

D.2.2.2 Selected Transects

The Mapping Partner shall locate transects with careful consideration given to the physical and cultural characteristics of the land so that they will closely represent conditions in their locality. The transects are to be placed closer together in areas of complex topography, dense development, unique flooding, and where computed wave heights and runup may be expected to vary significantly. Wider spacing may be appropriate in areas having more uniform characteristics. For example, a long stretch of undeveloped shoreline with a continuous dune or bluff having a fairly constant height and shape, and similar landward features may require a transect only every 1 to 2 miles, whereas a developed area with various building densities, protective structures, and vegetation cover may require a transect every 1,000 feet.

Good judgment exercised in placing required transects will avoid excessive interpolation of elevations between transects, while also avoiding unnecessary study effort. In areas where runup may be significant, the proper location of transects will be governed by variations in shore slope or gradient. On coasts with sand dunes, the Mapping Partner shall site transects according to major variations in the dune geometry and the upland characteristics. In other areas where dissipation of wave heights may be most significant to the computation of flood hazards, the Mapping Partner shall base transect location on variations in land cover: buildings, vegetation, and other factors. Generally speaking, the Mapping Partner shall site a separate transect at each flood protection structure. However, if areas with similar characteristics are scattered throughout a community and have the same SWEL, the Mapping Partner may apply the results from one transect at various locations within this common area. This should be done only after careful consideration is given to topographic and cultural features to assure the accurate representation of the coastal hazards.

The Mapping Partner shall locate the transects on the work map with the input data compiled on a separate sheet for each transect. The data for the transect are not taken directly along the line on the work map; they are taken from the area, or length of shoreline, to be represented by the transect so that the input data depict average characteristics of the area. Because of this, the Mapping Partner may find it is useful to divide the work map into transect areas for data compilation.

D.2.2.3 Topography

The topographic data must have a contour interval no greater than 5 feet or 1.5 meters. FEMA does not require more detailed information such as spot elevations or a smaller contour interval, although they can be useful in the definition of the dune or bluff profile and in the delineation of floodplain boundaries. The topographic data, usually in the form of maps, must be recent and reflect current conditions or, at a minimum, conditions at a clearly defined time. Transects need not be specially surveyed unless available topographic data are unsuitable or incomplete. The Mapping Partner shall examine the topographic data to confirm that the information to be used in the analysis and mapping represents the actual planimetric features that might affect identification of the coastal hazards.

If possible, the Mapping Partner shall field-check shore topography to note any changes due to construction, erosion, coastal engineering, and other factors. The Mapping Partner shall document any significant changes with location descriptions, drawings, and/or photographs. The community, county, and state are usually the best sources for topographic data. The Mapping Partner shall examine USGS 7.5-minute series topographic maps. The USGS maps may have a 5-foot contour interval; if not, they are still often useful as reference or base maps.

[February 2002]

D.2.2.4 Land Cover

The land-cover data include information on buildings and vegetation. Stereoscopic aerial photographs can provide the required data on structures and some of the data on vegetation. The Mapping Partner shall ensure that aerial photographs are not more than 5 years old unless they can be updated by surveys. Local, county, or state agencies may have the coastline photographed on a periodic basis, and may provide photographs or permission to obtain them from their source.

Aerial photographs can provide the required data on tree- and bush-type vegetation. However, although they are useful in identifying areas of grass-like vegetation, they cannot identify specific types. National Wetland Inventory maps from the U.S. Fish and Wildlife Service and color infrared aerial photographs can provide some more specific data required for marsh plants. Ground-level photographs are also useful in providing information on plants. State offices of coastal zone management, park and wildlife management, and/or natural resources should be able to provide information. The Mapping Partner also may contact local universities with coastal studies and/or Sea Grant programs. The Mapping Partner may conduct field surveys in lieu of the above sources, but are more cost effective when used only to supplement or verify data obtained from these sources.

[February 2002]

D.2.2.5 Bathymetry

The Mapping Partner may acquire bathymetric data from National Ocean Service nautical charts, although any reliable source may be used. The bathymetry must extend far enough offshore to include the breaker location for the 1-percent-annual-chance flood; although that depth may not be exactly known during the data collection phase, the Mapping Partner may assume that a mean water depth of 40 feet will encompass all typical breaker depths. Bathymetry further offshore also may be useful in interpreting likely differences between nearshore and offshore wave conditions and necessary where offshore waves are more readily specified.

[February 2002]

D.2.2.6 Storm Meteorology

The 1-percent-annual-chance flood elevations represent a statistical summary and likely do not correspond exactly to any particular storm event. However, the meteorology of storms expected to provide approximate realizations of the 1-percent-annual-chance flood can be useful information in deciding recurrence intervals for historical events and in assessing wave characteristics likely associated with the 1-percent-annual-chance flood. An important distinction of the flood source from Delaware to Maine is whether the 1-percent-annual-chance flood is more likely to be caused by a hurricane or by a Northeaster. The Mapping Partner shall establish this distinction in the course of defining the SWELs, because time history of water levels can be radically different in the two possible cases (see Figure D-2).

For a Northeaster, commonly a winter storm occurring between October and March, sustained winds seldom reach much above 60 mph, storm surge has relatively modest magnitude, and surge coincidence with spring high tides is usually required to attain the 1-percent-annual-chance SWEL. Extreme storms that occurred with lower tides can indicate wind and wave conditions also likely to accompany the 1-percent-annual-chance flood. Thus, the Mapping Partner can assemble a fair amount of pertinent historical evidence regarding expected meteorological conditions for the 1-percent-annual-chance flood arising from an extratropical storm. The dominant conditions include speed and duration of sustained winds, along with the storm size controlling fetch along which waves may be generated.

Where hurricanes are of primary importance, the 1-percent-annual-chance flood is likely associated with central pressure deficits having exceedance probabilities between 5 and 10 percent (FEMA, August 1988). That description generally corresponds to a major hurricane, where sustained winds exceed 120 mph. Other meteorological characteristics are likely to be fairly typical for the study area and may be determined using the hurricane climatology documented in *Hurricane Climatology for the Atlantic and Gulf Coasts of the United States* (Ho, Su, Hanevich, Smith, & Richards, 1987). That guidance includes localized probabilities for central pressure deficit, radius to maximum winds, and speed and direction of storm motion.

Figure D-2. Gage Records of Floods Peaking near the Local 1-Percent-Annual-Chance SWELs, Caused by, A- a Hurricane; and B- an Extratropical Storm

D.2.2.7 Storm Wave Characteristics

The basic presumption in conducting coastal wave analyses is that wave direction must have some onshore component, so that wave hazards occur coincidentally with the 1-percent-annual-chance flood. That presumption appears generally appropriate for open coasts and along many mainland shores of large bays, where the 1-percent-annual-chance SWEL must include some contribution from direct storm surge and thus requires an onshore wind component. However, an assumption of onshore waves coincident with a flood may require detailed justification along the shores of connecting channels, in complex embayments, near inlets, and behind protective islands. Once it is confirmed that sizable waves likely travel onshore at a site during the 1-percent-annual-chance flood, the storm wave condition must be defined for assessments of coastal structure stability, sand dune erosion, wave runup and overtopping, and overland elevations of wave crests.

It is important to recognize that somewhat different descriptions of storm waves (Table D-2) can be appropriate in assessing each distinct flooding effect. This depends mainly on the formulation of an applicable empirical or analytical treatment for each effect. In FIS models and analyses, the different wave descriptions include the following:

- Various wave statistics (e.g., mean wave condition for runup elevations, but an extreme or controlling height for overland waves);
- Various dominant parameters (e.g., incident wave height for overtopping computation, but incident wave period for overland crest elevations); and
- Various specification sites (e.g., deep water for estimating runup elevations, but waves actually reaching a structure in shallow water for most stability or overtopping considerations).

To proceed with general orientation, the Mapping Partner may develop storm wave conditions from actual wave measurements, from wave hindcasts or numerical computations based on historical effects, and from specific calculations based on assumed storm meteorology. Where possible, the Mapping Partner shall pursue two or all three of these possibilities in estimating wave conditions expected to accompany the 1-percent-annual-chance flood at a study site. Using all available information can improve the level of certainty in estimated storm wave characteristics.

Wave measurements for many sites over various intervals have been reported primarily by the USACE and by the National Data Buoy Center. Available data include records from nearshore gages in relatively shallow water (Thompson, 1977) and from sites further offshore in moderate water depths (Gilhousen, Meindl, Changery, Franks, Burgin, & McKittrick, 1990). The potential sources of storm wave data also include other Federal agencies and some State or university programs.

Table D-2. Some Commonly Used Specifications of Irregular Storm Waves

SYMBOL	NAME	DESCRIPTION
Wave Heights (water depth must be given)		
H_s	Significant	average over highest one-third of waves
H_c	Controlling	defined as (1.6 H_s) in NAS (1977)
$\overline{H}$	Mean	average over all waves
H_{mo}	zero moment	defined by the variance of water surface, and about equal to H_s in deep water
Wave Periods (basically invariant with water depth)		
T_s	significant	associated with waves at significant height
T_p	peak	represents the maximum in energy spectrum
$\overline{T}$	mean	average over all waves

The USACE is the primary source for long-term wave hindcasts along open coasts. That information is conveniently summarized as extreme wave conditions expected to recur at various intervals, for Atlantic hurricanes in *Hurricane Hindcast Methodology and Wave Statistics for Atlantic and Gulf Hurricanes from 1956-1975* (Abel, Tracy, Vincent, & Jensen, 1989) and for extratropical storms in *Hindcast Wave Information for the U.S. Atlantic Coast* (Hubertz, Brooks, Brandon, & Tracy, 1993) and *Southern California Hindcast Wave Information* (Jensen, Hubertz, Thompson, Reinhard, Borup, Brandon, Payne, Brooks, & McAneny, 1992), as examples. In some vicinities, other wave hindcasts may be available from the design activities for major coastal engineering projects.

Either measurements or hindcast results pertain to some specific (average) water depth. However, the Mapping Partner may need to convert such wave information into an equivalent condition at some other water depth for appropriate treatment of flood effects. The Mapping Partner shall consult the following publications for guidance regarding transformation of storm waves between offshore and nearshore regions, where processes to be considered include wave refraction, shoaling, and dissipation: the USACE *Shore Protection Manual* (USACE, 1984), *Random Seas and Design of Maritime Structures* (Goda, 1985), and *Automated Coastal Engineering System, Version 1.07* (Leenknecht, Szuwalski, & Sherlock, 1992).

The Mapping Partner may also consider determining local storm wave conditions by developing a specific estimate for storm meteorology taken to correspond to the 1-percent-annual-chance flood. That can be done with relative ease for deep-water waves associated with a hurricane of specified meteorology, using the estimation technique provided in the USACE *Shore Protection Manual* (USACE, 1984). For extratropical storms, the ACES program in *Automated Coastal Engineering System, Version 1.07* (Leenknecht et al., September 1992) executes a modern method of wave estimation for specified water depth, incorporating some basic guidance from the *Shore Protection Manual* (USACE, 1984) and *Random Seas and Design of Maritime Structures* (Goda, 1985). The Mapping Partner may prepare an outline of important considerations to assist in developing a site-specific wave estimate.

Major factors in wave generation are windspeed, wind duration, water depth, and fetch length. Fetch length is he over-water distance toward the wind along which waves arise (USACE, 1994). These factors determine flux of momentum and energy from the atmosphere into waves on the water surface. For some cases, fetch length might be estimated as straight-line distance in the wind direction, but the current ACES guidance pertinent to many partially sheltered coastal sites indicates that a more involved analysis of restricted fetches must be performed for water basins of relatively complex geometry. The effective fetch length is derived as a weighted average of over-water distance with angle from the wind direction. With specified geometry for a restricted fetch, the ACES program carries out computations necessary for the desired estimates of representative wave height and wave period (Leenknecht et al., 1992).

The resulting wave field is commonly summarized by the significant wave height and wave period; namely, average height of the highest one-third of waves and the corresponding time for a wave of that height to pass a point. Another useful measure is wave steepness, the ratio of wave height to wavelength: in deep water, the wavelength is 0.16 times the gravitational acceleration, times the wave period squared, that is, $(gT^2/2\pi)$. On larger water bodies and in relatively deep water, typical wave steepness is approximately 0.03 for extreme extratropical storms and 0.04 for major hurricanes. The Mapping Partner may use these values for wave steepness to determine the wave period if only the wave height is known, and the wave height if only the wave period is known.

[February 2002]

D.2.2.8 Coastal Structures

The Mapping Partner shall obtain documentation for each coastal structure possibly providing protection from 1-percent-annual-chance flood. That documentation shall include the following:

- Type and basic layout of structure;
- Dominant site particulars,(e.g., local water depth, structure crest elevation, ice climate);
- Construction materials and present integrity;
- Historical record for structure, including construction date, maintenance plan, responsible party, repairs after storm episodes; and.
- Clear indications of effectiveness or ineffectiveness.

The Mapping Partner shall develop much of this information through office activity, including a careful review of aerial photographs. In some cases of major coastal structures, site inspection would be advisable to confirm preliminary judgments.

[February 2002]

D.2.2.9 Historical Floods

While not required as input to any of the FEMA coastal models, local information regarding previous storms and flooding can be very valuable in developing accurate assessments of coastal flood hazards and validation of storm surge models. General descriptions of flooding are useful in determining what areas are subject to flooding and in obtaining an understanding of flooding patterns. More specific information, such as the location of buildings flooded and damaged by wave action, can be used to verify the results of the coastal analyses. Detailed information on pre- and post-storm beach or dune profiles is valuable in checking the results of the erosion assessment.

When quantitative data are available on historical flooding effects, the Mapping Partner shall make a special effort to acquire all recorded water elevations and wave conditions for the vicinity. That information can be used in estimating recurrence intervals for SWELs and for wave action in the event, assisting an appropriate comparison to the 1-percent-annual-chance flood.

Local, county, and state agencies are usually good sources of historical data, especially more recent events. It is becoming common practice for these agencies to record significant flooding with photographs, maps, and/or surveys. Some Federal agencies (e.g., the USACE, USGS, and National Research Council) prepare post-storm reports for more severe storms. Local libraries and historical societies may also be able to provide useful data.

[February 2002]

D.2.3 Evaluation of Coastal Structures

The purpose of the evaluation is to determine whether each individual coastal structure appears properly designed and maintained in order to provide protection from the 1-percent-annual-chance flood. If a particular structure can be expected to be stable through the 1-percent-annual-chance flood, the structure geometry may figure in all ensuing analyses of wave effects accompanying the flood: coastal erosion, runup and overtopping, and wave crest elevations. Otherwise, the coastal structure is considered to be destroyed during the 1-percent-annual-chance flood and removed from the transect representation before proceeding with analyses of wave effects.

Criteria for Evaluating Coastal Flood-Protection Structures presents a technical review and recommends procedural criteria for evaluating coastal flood protection structures in regard to the 1-percent-annual-chance flood (Walton, Ahrens, Truitt, & Dean, 1989). The FEMA "Memorandum on Criteria for Evaluating Coastal Flood Protection Structures for National Flood Insurance Program Purposes" includes an account of the evaluation process (FEMA, 1990). FEMA has adopted that memorandum as the basis for NFIP accreditation of new or proposed coastal structures in reducing effective flood hazard areas and elevations. Ideally, these evaluation criteria could be applied to existing coastal structures, but available information about older structures typically is not sufficient to complete the detailed evaluation. Where complete information is not available for an existing structure, the Mapping Partner shall make an

engineering judgment about its likely stability based on a visual inspection of physical conditions and any historical evidence of storm damage and maintenance.

Criteria for Evaluating Coastal Flood-Protection Structures addressed coastal flood protection structures and identified the four primary types according to a functional standpoint: gravity seawalls, pile-supported seawalls, anchored bulkheads, and dikes or levees. The report recommends as a general policy that "FEMA not consider anchored bulkheads for flood-protection credit because of extensive failures of anchored bulkheads during large storms" (Walton et al., 1989, p. 100).

Flood protection structures can have a significant effect on the flood hazard information shown on a FIRM, perhaps directly justifying the removal of sizable areas from the coastal high hazard area. The focus on flood protection structures in the FEMA memorandum cited above should not divert a recognition that similar considerations are appropriate in crediting the protection provided by structures in categories other than those named in the memorandum, and that such credit can be important. In contrast to flood protection, a breakwater primarily may act to limit wave action and a revetment primarily may control shore erosion, but any stable coastal structure can notably affect results of various hazard analyses for the 1-percent-annual-chance flood, and the Mapping Partner shall take these effects into account. The FEMA memorandum places the responsibility on local interests to certify new structures, but the primary consideration in an FIS must be that the structure evaluation yields a correct judgment based on available evidence. This is necessary for accurate hazard assessments, because a structure might decrease flood effects in one area while increasing erosion and wave hazards at adjacent sites. Of course, the greater the potential effects of a coastal structure, the more detailed should be the evaluation process.

In areas where buildings conforming to V-Zone construction standards are elevated above the wave crest elevation, the Mapping Partner shall model the piles supporting the structure as obstructions in the wave height analysis. The building itself, being elevated, shall not be modeled as an obstruction to wave propagation.

[February 2002]

D.2.4 Erosion Assessment

Coastal sand dunes usually extend above the 1-percent-annual-chance SWEL, but such barriers to flooding may not be durable because of massive shorefront erosion occurring during a 1-percent-annual-chance flood. Storm-induced erosion will remove or significantly modify most frontal dunes on U.S. coasts. This is particularly true on barrier islands known historically to be susceptible to storm overwash. Therefore, the Mapping Partner shall assess coastal erosion before determining wave elevations and mapping V Zones for the 1-percent-annual-chance flood.

Available procedures for computing erosion show limited precision in documented hindcasts of recorded erosion quantities and have questionable pertinence to the entire range of erosion effects possible on U.S. coasts. Therefore, a rather schematic treatment of expected erosion quantities and geometries has been developed as an appropriate approach for treating erosion in

FISs. The overall rationale and level of detail in these erosion assessment procedures closely parallel the simple and effective NAS methodology for calculating wave action effects associated with storm surges (NAS, 1977).

The procedures described here are empirically valid for treating dune erosion during the 1-percent-annual-chance flood. These procedures are meant to give schematic estimates of eroded profile geometry suitable for FEMA flood study purposes. The simplified estimates are suitable erosion approximations for extreme storms at sandy sites with typical open-coast wave and flood climate. The erosion assessment procedures that follow are intended for application to natural sites where there are no coastal structures such as breakwaters, groins, or revetments. Scour in front of certified structures can account for eroded sand quantities and an adjustment of the shore profile.

Quantitative considerations here are based on measured sand erosion accompanying extreme floods from hurricanes or extratropical storms on the U.S. Atlantic and Gulf coasts (FEMA, November 1988). For the study site, the Mapping Partner may use storm meteorology along with associated flood and wave characteristics to assess whether such open-coast effects can be typical of anticipated local erosion for the 1-percent-annual-chance flood. Of course, the Mapping Partner shall examine any local historical evidence on storm erosion in deciding applicability of the procedures below.

[February 2002]

D.2.4.1 Basic Erosion Considerations

The primary factor controlling the basic type of dune erosion is the pre-storm cross section lying above the 1-percent-annual-chance SWEL (frontal dune reservoir). The Mapping Partner shall determine this area to assess the stability of the dune as a barrier. If the elevated dune cross-sectional area is very large, erosion will result in retreat of the seaward duneface with the dune remnant remaining as a surge and wave barrier. On the other hand, if the dune cross-sectional area is relatively small, erosion will remove the pre-storm dune leaving a low, gently sloping profile. Different treatments for erosion are required for these two distinct situations because no available model of dune erosion suffices for the entire range of coastal situations.

Figure D-3 introduces terminology for two representative dune types. A frontal dune is a ridge or mound of unconsolidated sandy soil, extending continuously alongshore landward of the sand beach. The dune is defined by relatively steep slopes abutting markedly flatter and lower regions on each side. For example, a barrier island dune has inland flats on the landward side, and the beach or back beach berm on the seaward side. The dune toe is a crucial feature and can be located as the junction between gentle slope seaward and a slope of 1:10 or steeper marking the front duneface. The rear shoulder, as shown on the mound-type dune in Figure D-3, is defined by the upper limit of the steep slope on the dune's landward side.

The rear shoulder of mound-type dunes corresponds to the peak of ridge-type dunes. Once erosion reaches those points, the remainder of the dune offers greatly lessened resistance and is highly susceptible to rapid and complete removal during a storm. Figure D-3 shows the location of the "frontal dune reservoir," above 1-percent-annual-chance SWEL and seaward of the dune

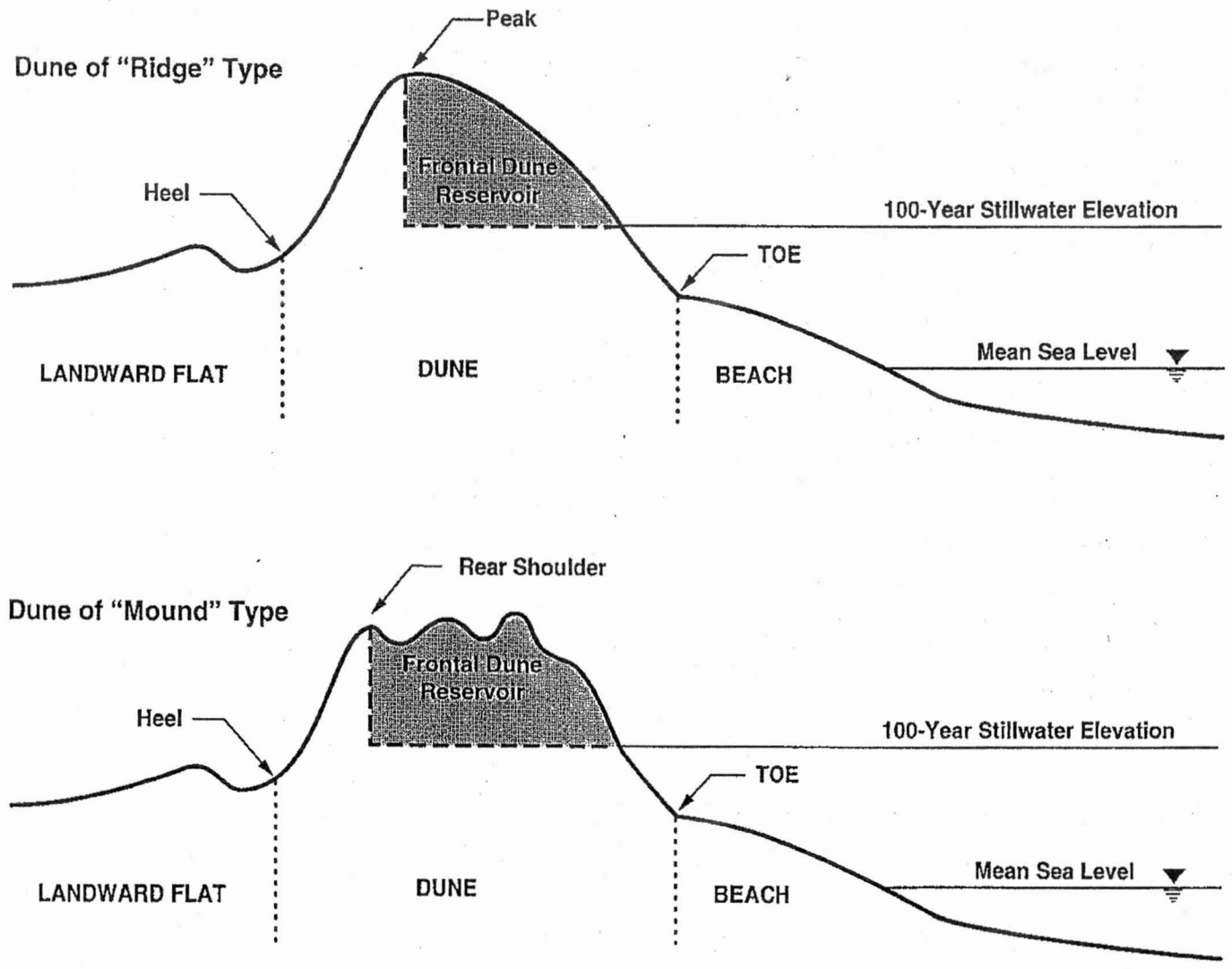


Figure D-3. Dune Features and Present Terminology

peak or rear shoulder. The amount of frontal dune reservoir determines dune integrity under storm-induced erosion.

To prevent dune removal during the 1-percent-annual-chance storm, the frontal dune reservoir must typically have a cross-sectional area of at least 540 square feet (or 20 cubic yards volume per foot along the shore) (FEMA, September 1986; FEMA, November 1988). For more massive dunes, erosion will result in duneface retreat, with an escarpment formed on the seaward side of the remaining dune. To compute the eroded profile in such cases, FEMA has adopted a simplified version of the dune retreat model developed by Delft Hydraulics Laboratory of the Netherlands. This treatment is also appropriate in cases with sandy bluffs or headlands extending above the 1-percent-annual-chance SWEL. The simplified treatment of duneface retreat is described in Subsection D.2.4.3.

If a dune has a frontal dune reservoir less than 540 square feet, storm-induced erosion can be expected to obliterate the existing dune with sand transported both landward and seaward. The Mapping Partner shall estimate the eroded profile using procedures presented in Subsection D.2.4.2. Those procedures provide a realistic eroded profile across the original dune, but do not determine detailed sand redistribution by dune erosion, overwash, and breaching.

Quantitative treatment of overwash processes is not feasible at present (Birkemeier, Kraus, Scheffner, & Knowles, June 1987), so the frontal dune is simply removed.

The initial decision in treating erosion as duneface retreat or as dune removal is based entirely on the size of the frontal dune reservoir. For coastal profiles more complicated than those in Figure D-3, the Mapping Partner shall use judgment to separate the sand reservoir expected to be effective in resisting dune removal from the landward portion of the pre-storm dune. The Mapping Partner shall complete the erosion assessment for the shoreline conditions representative of either the summertime shore profile for hurricane effects or the wintertime shore profile for Northeaster storm effects, whichever is the appropriate and predominant source of coastal flooding that has been selected for use in the coastal hydraulic analyses and erosion assessment.

Figure D-4 presents a complete flowchart of necessary erosion considerations, outlining the major alternatives of duneface retreat and dune removal. Figure D-5 provides schematic sketches of the different geometries of dune erosion arising in coastal flood hazard assessments.

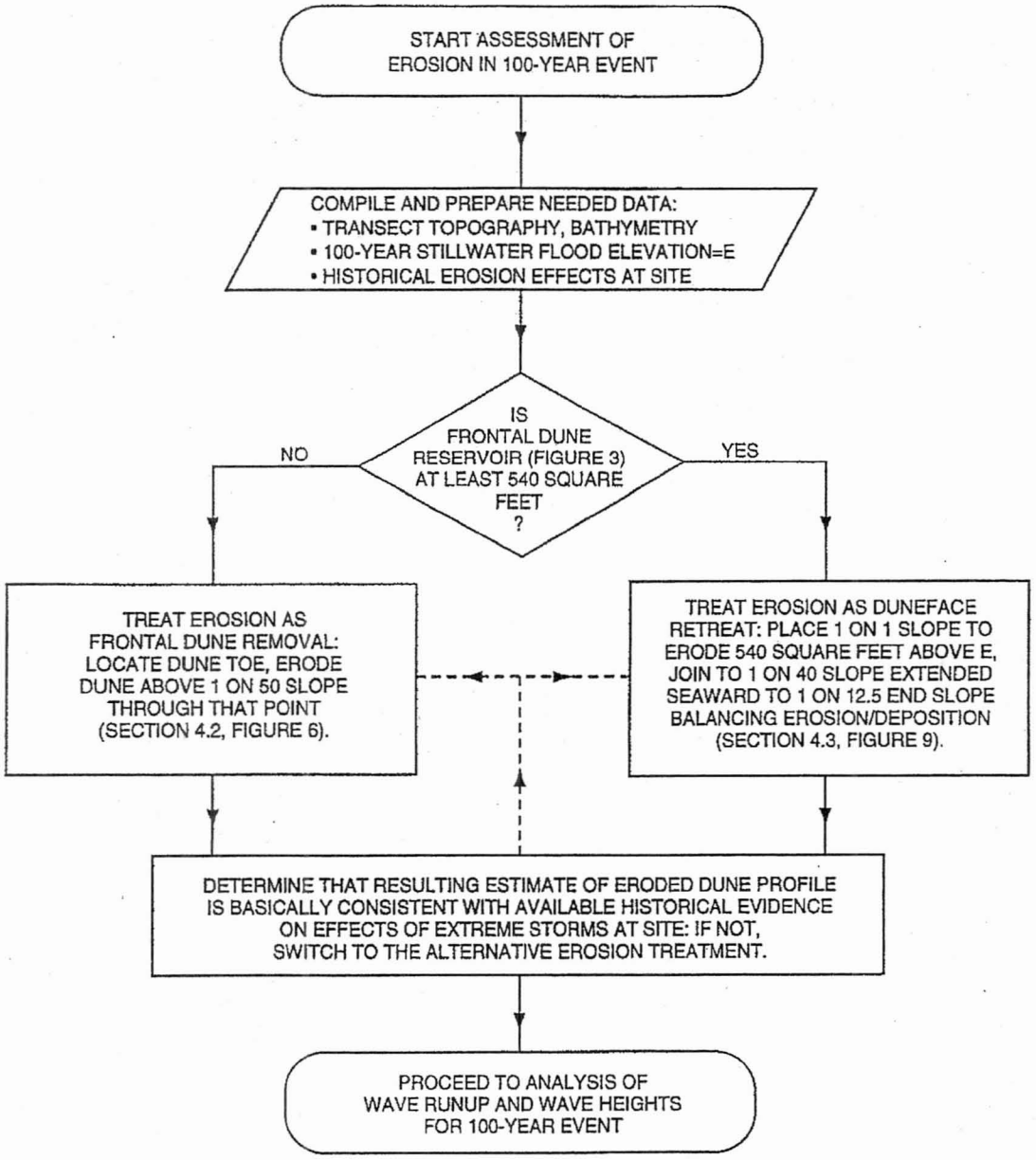


Figure D-4. Flowchart of Erosion Assessment for a Coastal Flood Insurance Study

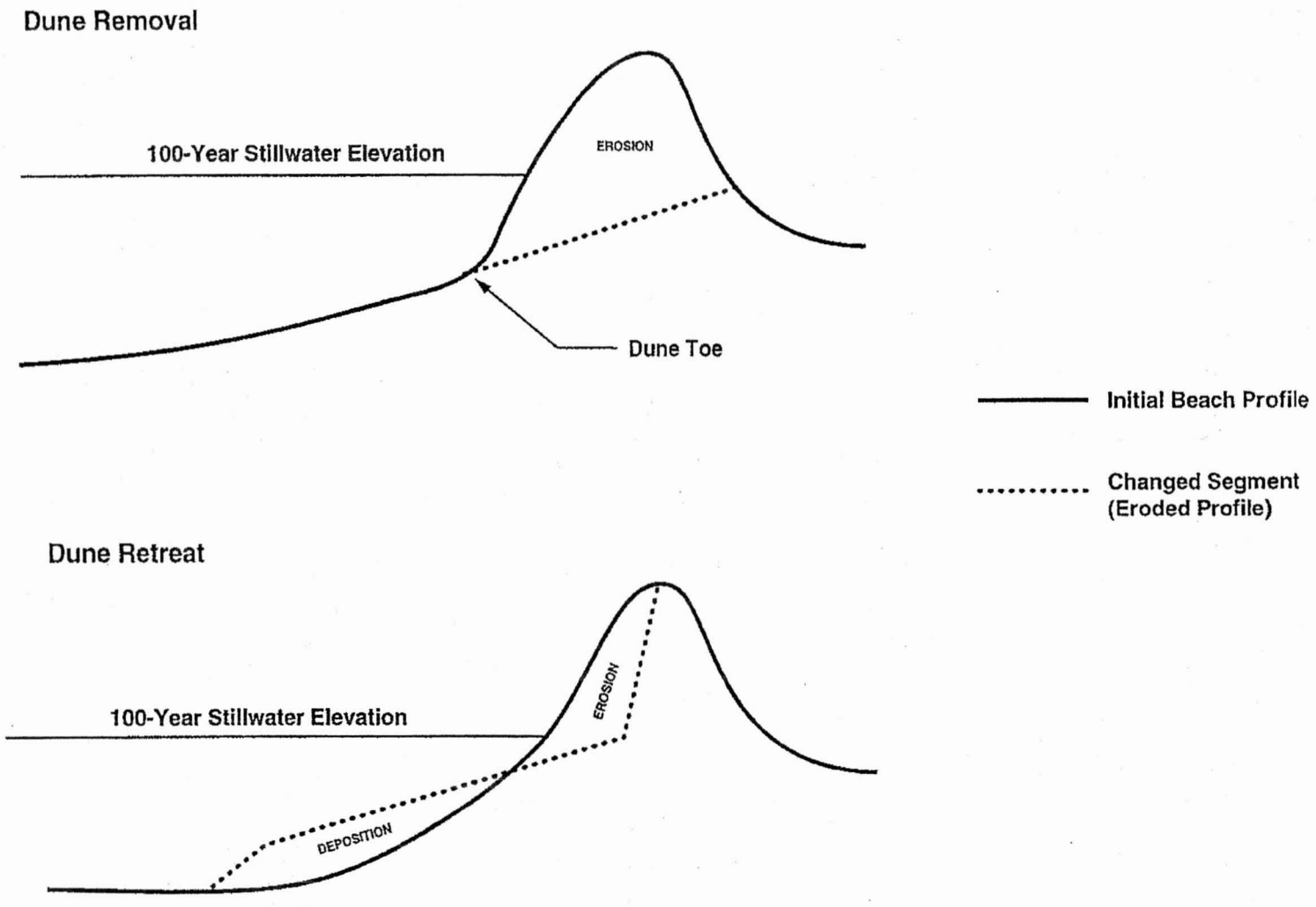


Figure D-5. Schematic Cases of Eroded Dune Geometries with Planar Slopes

One additional factor complicating erosion assessment is the dissipative effect of wide sand beaches that shelter dunes from the full storm impact and retard retreat or removal. If the existing slope between mean level and the 1-percent-annual-chance SWEL is 1:50 or gentler, overestimation of erosion is possible during the 1-percent-annual-chance flood; therefore, the Mapping Partner shall examine this carefully. This effect and other variables, such as sand size, dune vegetation, and actual storm characteristics at a specific site, make thorough comparison of estimated erosion to documented historical effects in extreme storms necessary.

[February 2002]

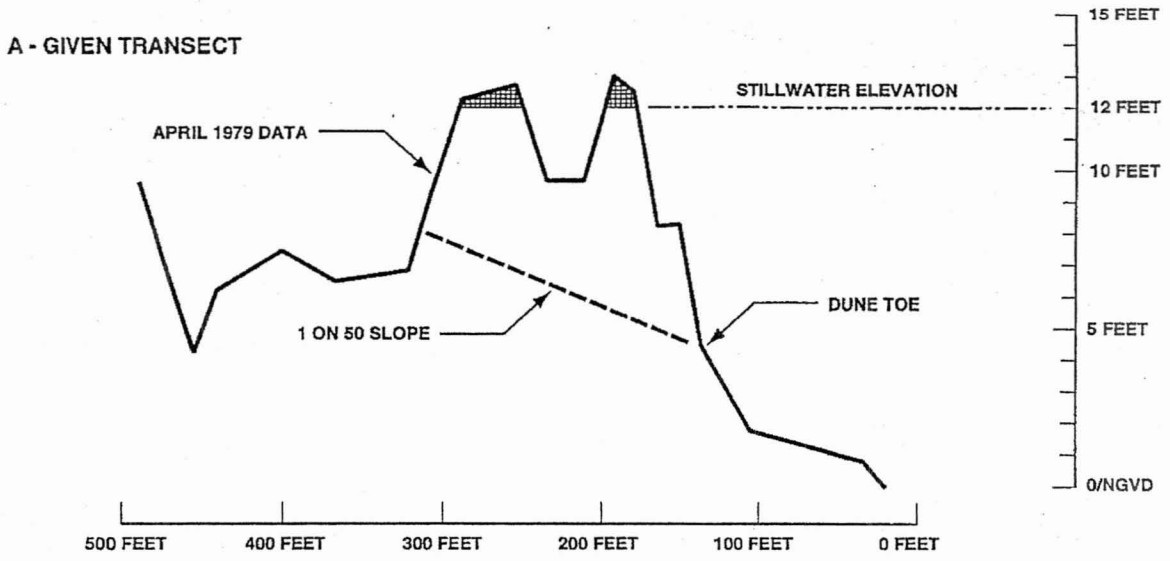
D.2.4.2 Treatment of Dune Removal

Determining the dune reservoir requires assessing the profile area located above the 1-percent-annual-chance flood level and seaward of the crest of the primary dune (see Figure D-3). Where the frontal dune reservoir is less than 540 square feet, construction of the eroded profile is extremely simple: dune removal is effected by means of a seaward-dipping slope of 1:50 running through the dune toe. The eroded profile is taken to be that slope across the pre-storm dune, simply spliced onto the flanking segments of a given transect. This gives a gentle ramp across the extended storm surf zone adequate as a first approximation to the profile existing at the storm's peak. This treatment simply removes the major vertical projection of the frontal dune from the transect.

Construction of an eroded profile focuses on the usually distinct feature termed the dune toe. The dune toe is taken to be the junction between the relatively steep slope of the front duneface and the notably flatter seaward region of the beach or the backbeach berm (including any minor foredunes). If a clear slope break is not apparent on a given coastal transect, its location should be taken at the typical elevation of definite dune toes on nearby transects within the study region. The alternative is to set the dune toe at the 10-percent-annual-chance SWEL in the vicinity: that appears to be a generally adequate approximation along the Atlantic and Gulf coasts. In every case, the dune toe must be taken at an elevation above that of any beach berms on local shores.

Figures D-6, D-7, and D-8 display examples of this treatment for a removed dune. These simple constructions give appropriate estimates for the limits of high ground removed during the 1-percent-annual-chance flood, but cannot provide accurate representations of eroded profiles because of the complicated processes of dune failure. One example of overly simplified results is that deeper scour appears to occur where the frontal dune reservoir is relatively large.

The present viewpoint is consistent with this basic description of storm-induced erosion: greater erosion occurs where the pre-storm barrier provides more resistance; that is, has a relatively large cross section but still is removed during the 1-percent-annual-chance flood. Net shore erosion appears to be maximum for situations where the dune barrier apparently just failed, and the eroded cross section can be much greater than in cases of duneface retreat. A slight opening to landward flow as an eroded dune becomes an overwash channel can result in much deeper scour than in cases of duneface retreat, where most shore erosion is above the SWEL as duneface sand is continuously deposited in shallow water during the storm.



B - ANALYSIS

1 - FRONTAL DUNE RESERVOIR ABOVE STILLWATER FLOOD ELEVATION (SHOWN CROSS-HATCHED) TOTALS ABOUT 35 SQUARE FEET, SO DUNE REMOVAL IS EXPECTED IN THIS 100-YEAR EVENT.
2 - DUNE TOE IS LOCATED AT JUNCTION BETWEEN 1 ON 3.8 AND 1 ON 11.5 SLOPES ON DUNEFACE.
3 - 1 ON 50 SLOPE THROUGH DUNE TOE PROVIDES APPROPRIATE ESTIMATE OF ERODED PROFILE ACROSS REMOVED DUNE.

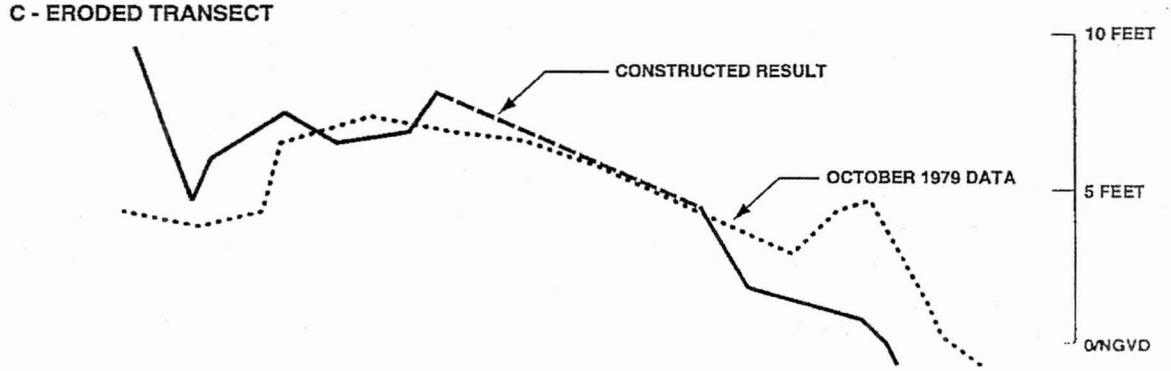


Figure D-6. Quantitative Example of Dune Removal Treatment for Alabama Profile Eroded by 1979 Hurricane Frederic. Situation Is Profile B-35 in Baldwin County, Alabama

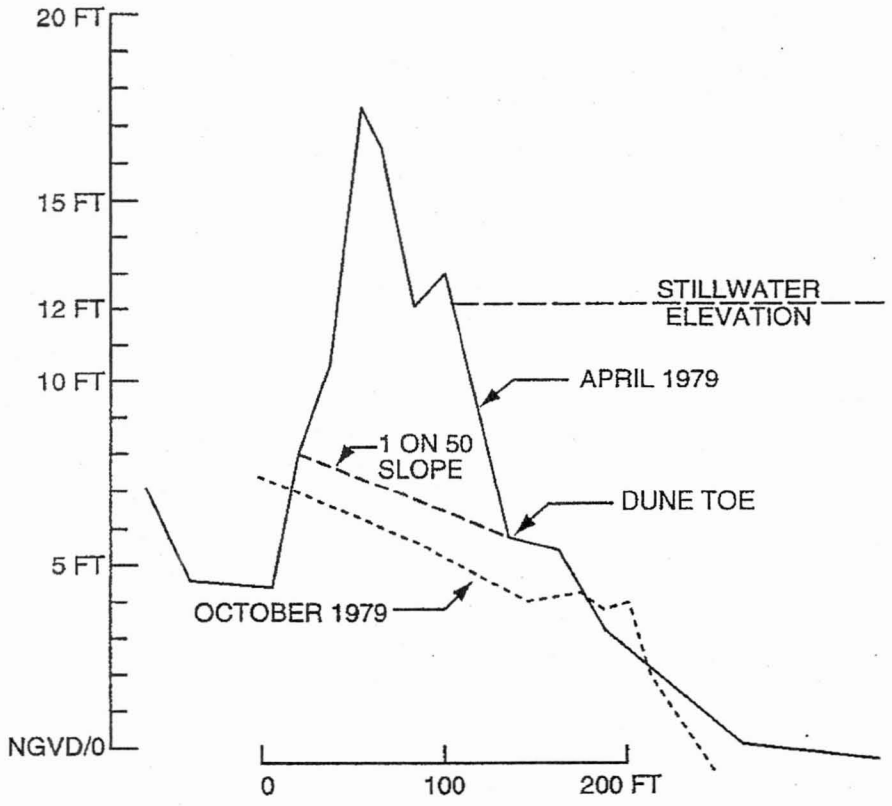


Figure D-7. Case of Relatively Large Dune Removed by 1979 Hurricane Frederic in Baldwin County, Alabama

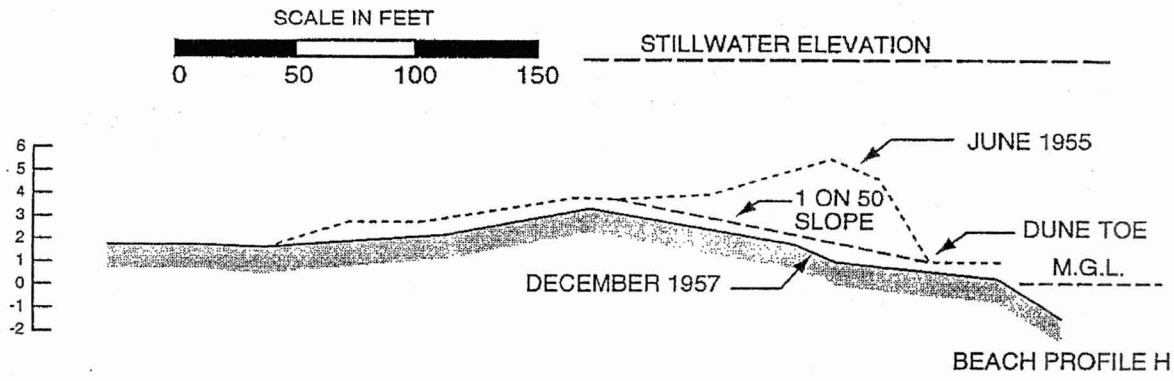


Figure D-8. Erosion of Relatively Low Profile by 1957 Hurricane Audrey in Cameron Parish, Louisiana

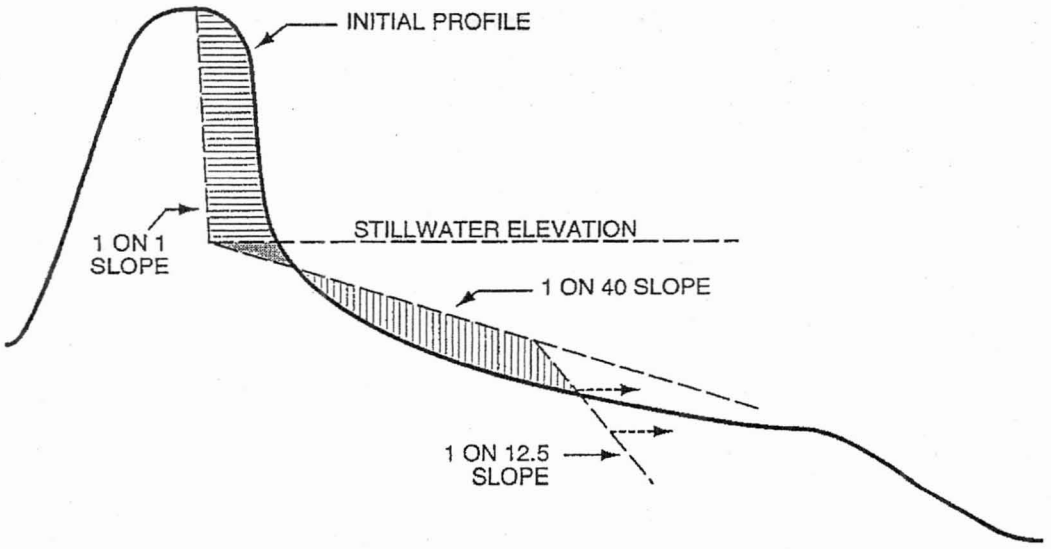
[February 2002]

D.2.4.3 Treatment of Duneface Retreat

The procedure described here yields an eroded profile for duneface retreat in the 1-percent-annual-chance flood, for cases where the frontal dune reservoir is at least 540 square feet. During such retreat, the frontal dune barrier remains basically intact and eroded sand is transported in the seaward direction. The post-storm profile provides a balance between sand eroded from the duneface and sand deposited at lower elevations seaward of the dune.

The following procedure for constructing the eroded profile constitutes a simplification of the dune retreat model developed by Delft Hydraulics Laboratory (DHL) of the Netherlands (Vellinga, 1986). Erosion above 1-percent-annual-chance SWEL is fixed at 540 square feet, to guarantee an appropriate amount for the U.S. Atlantic and Gulf coasts (FEMA, 1986 and November 1988). (In the DHL model, erosion is determined as the variable depending on specified storm and site conditions.)

Figure D-9 summarizes the simple procedure adopted to treat cases of duneface retreat. The eroded profile consists of three planar slopes: uppermost is a retreated duneface slope of 1:1, joining an extensive middle slope of 1:40, which is terminated by a brief segment with a slope of 1:12.5 at the limit to storm deposition. Upper dune erosion is specified to be 540 square feet above the 1-percent-annual-chance SWEL and in front of the 1:1 slope. Geometrical construction balances the nearshore deposition with the total dune erosion of somewhat more than 540 square feet by an appropriate seaward extension of the 1:40 slope. The resulting eroded profile is spliced onto the unchanged landward and seaward portions of the pre-storm profile. This procedure gives a complete profile suitable for use with the Wave Runup Model in assessing an appropriate flood elevation on the dune remnant.



PROCEDURE:

1 - CONSTRUCT RETREATED DUNEFACE WITH 540 FT^2 EROSION [≡] ABOVE 100-YEAR STILLWATER ELEVATION AND SEAWARD OF 1 ON 1 SLOPE.

2 - DETERMINE ADDITIONAL DUNE EROSION QUANTITY, SHOWN DOTTED, IN WEDGE BETWEEN STILLWATER ELEVATION, 1 ON 40 SLOPE, AND INITIAL PROFILE.

3 - BALANCE TOTAL DUNE EROSION WITH POSTULATED DEPOSITION [|||||||] BY APPROPRIATE PLACEMENT OF 1 ON 12.5 SLOPE AS LIMIT TO DEPOSITION.

Figure D-9. Procedure Giving Eroded Profile in Cases of Duneface Retreat, and Simplification of Dune Retreat Model Developed by Delft Hydraulics Laboratory of the Netherlands)

Figure D-10 presents an example of duneface retreat according to the present procedure. This simple construction of a retreated dune profile gives appropriate eroded slopes important to the wave runup analysis of the remaining barrier. For this example, estimated erosion and deposition do not match well with those recorded, because there is a net sand loss shown on this profile and the event appears somewhat less extreme than a 1-percent-annual-chance flood (judging from reported characteristics of Hurricane Eloise). Where historical data on duneface retreat are available for comparison, agreement of estimated erosion slopes with those recorded should be considered of primary importance in verifying the present treatment. Actual quantities of dune erosion are subject to large variations in natural situations, and this procedure presumes a generally representative value for 1-percent-annual-chance flood conditions.

The Mapping Partner shall apply the basic procedure illustrated in Figure D-9 in estimating erosion of high open-coast headlands or bluffs of sandy material.

This modification to the DHL model eliminates potential problems associated with computation sensitivity to storm wave height and with uncertain capabilities for situations dissimilar to the Netherlands coast (Birkemeier et al., 1987; FEMA, November 1988). The other modifications of the model and treatment of duneface retreat have been implemented in an attempt to simplify the treatment by ignoring the variation of sand size and approximating the planar slope to the curved segment of the DHL post-storm profile.

In such cases, parallel retreat of the existing face slope should be presumed, rather than using the typical 1:1 slope for the escarpment on an eroded sand dune, because that existing slope reflects actual consolidation properties of the headland or bluff material.

[February 2002]

D.2.4.4 Finalizing Erosion Assessment

Based on measured erosion along the Atlantic and Gulf coasts, the demarcation between duneface retreat and dune removal in a 1-percent-annual-chance flood has been set at a frontal dune reservoir of 540 square feet (FEMA, 1986 and November 1988). This quantitative criterion might appear too precisely stated, in view of potential inaccuracies in available dune topography, possible complications in delineating the effective frontal dune reservoir, and documented variability of dune erosion during extreme storms. In fact, the likelihood of duneface retreat or dune removal cannot be assessed with full certainty, so that validating the present erosion assessment by means of available evidence for a specific site is advisable.

At many sites, some historical evidence may be available regarding the extent of flooding, erosion, and damage in an extreme event comparable to the local 1-percent-annual-chance flood. Then the erosion treatment giving results more consistent with historical records must be selected as appropriate. That choice may be relatively clear-cut, given potential differences in expected erosion and inland flood penetration for duneface retreat versus dune removal. Where available historical evidence is not definitive, the decision between retreat and removal on a given transect should be based solely on size of the frontal dune reservoir. Present procedures for erosion assessment are highly simplified, but provide an unbiased estimation and a level of detail appropriate to coastal FISs.

[February 2002]

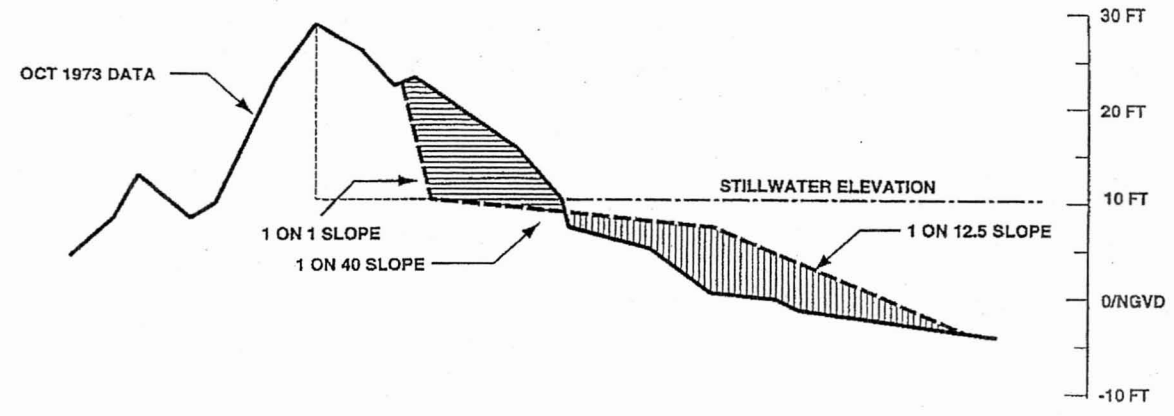
D.2.4.5 Wave Overtopping for Cases of Duneface Retreat

Where the erosion assessment indicates duneface retreat, an eroded dune remnant persists as an appreciable barrier to the 1-percent-annual-chance flood. However, storm wave action can result in occasional extreme runups overtopping that barrier, yielding floodwaters running off or ponding landward of the dune. DHL has determined the mean overtopping rate with storm waves incident on a typical duneface retreat geometry determined by the DHL (1983) to be

$$\overline{Q} = 5.26 \exp [-0.253 F] \quad (1)$$

Here the overtopping rate $\overline{Q}1$ has units of cubic feet per second per foot alongshore (cfs/ft), and F is maximum height (in feet) of the dune remnant above SWEL.

A - GIVEN TRANSECT



B - ANALYSIS

1 - FRONTAL DUNE RESERVOIR, OUTLINED BY---- , GREATLY EXCEEDS 540 FT^2 SO DUNEFACE WILL RETREAT.
2 - SPECIFYING EROSION ABOVE STILLWATER ELEVATION AS 540 FT^2, TOTAL DUNE EROSION ABOVE TWO UPPERMOST SLOPES IS FOUND TO BE APPROXIMATELY 620 FT^2.
3 - EROSION [≡] IS MADE TO EQUAL DEPOSITION [|||||||] BY EXTENDING MIDDLE (1 ON 40) SLOPE.

C - ERODED TRANSECT

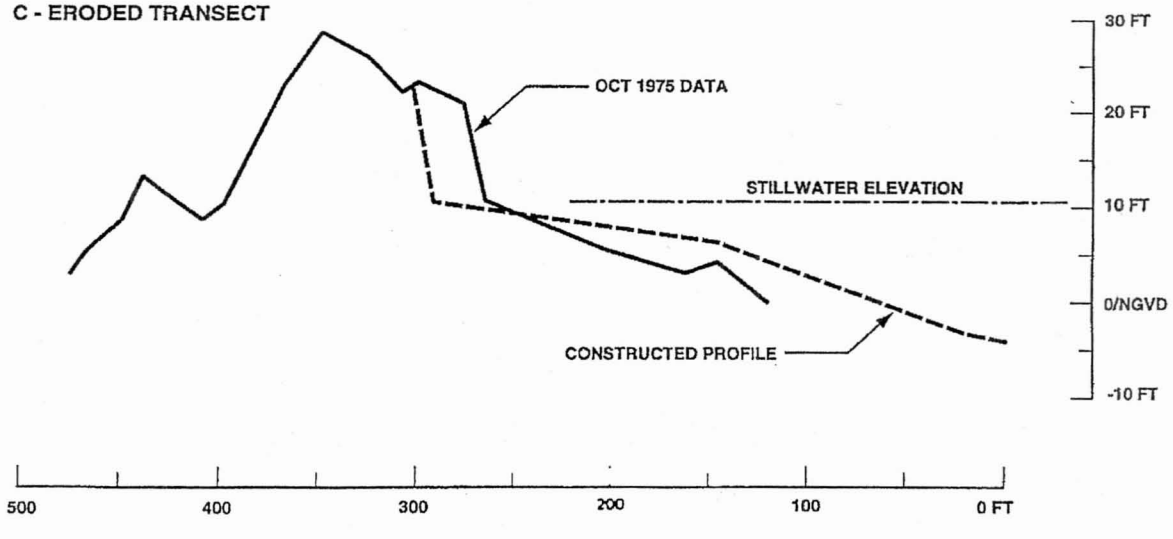


Figure D-10. Example of Duneface Retreat Treated by Simplified version of D.H.L. model, with erosion Above SWEL Fixed at 540 Square Feet. Situation Is Profile R-105 in Walton County, Florida, Surveyed Before and After 1975 Hurricane Eloise

This result was measured in DHL tests scaled to reproduce a specific extratropical storm on the Dutch seacoast, with a significant deep-water wave height of 25 feet and a peak wave period of 12 seconds. Those wave conditions seem roughly representative for the 1-percent-annual-chance flood along U.S. seacoasts, although expected wave characteristics will differ between hurricanes and extratropical storms at various sites. Recorded rates of overtopping can show sizable departures from the expected mean even with steady flood conditions (Goda, 1985; Owen, 1980).

Despite uncertainties about actual overtopping rates for a dune remnant, the equation gives a useful basis for outlining expected effects. The order of magnitude for severe overtopping may be taken as 1 cfs/ft, past allowable thresholds for structural integrity with bare soil behind steep barriers exposed to storm waves (Goda, 1985). From Equation 1, $\overline{Q}2$ of approximately 1 cfs/ft corresponds to F of approximately 7 feet, so retreated remnants with less relief above the 1-percent-annual-chance SWEL certainly require consideration of possible flood hazards landward of the dune. Appropriate treatments for ponding or runoff behind barriers are outlined in Subsection D.2.6.

[February 2002]

D.2.5 Wave Runup, Setup, and Overtopping

Wave runup is the uprush of water from wave action on a shore barrier intercepting stillwater level. The water wedge generally thins and slows during its excursion up the barrier, as residual forward momentum in wave motion near the shore is fully dissipated or reflected. The notable characteristic of this process for present purposes is the wave runup elevation, the vertical height above stillwater level ultimately attained by the extremity of uprushing water. Wave runup at a shore barrier can provide flood hazards above and beyond those from stillwater inundation and incident wave geometry, as illustrated in Figure D-11.

Two additional phenomena, wave setup and wave overtopping, may require explicit consideration for adequate treatment of the coastal flood hazards linked to wave runup. Wave setup generates a mean water surface elevated above the SWFL, caused by accumulation of water against a barrier exposed to wave heights attenuating in shallow water. Wave overtopping consists of any wave-induced flow passing over the barrier crest, so that flood water may exhibit wave, sheet flow, or ponding characteristics over an inland area. These phenomena and their quantitative evaluation will be addressed later in this Appendix.

The extent of runup can vary greatly from wave to wave in storm conditions, so that a wide distribution of wave runup elevations provides the precise description for a specific situation. Current policy for the NFIP is that the mean runup elevation (rather than some occasional extreme) for a situation is appropriate in mapping coastal hazards of the 1-percent-annual-chance flood.

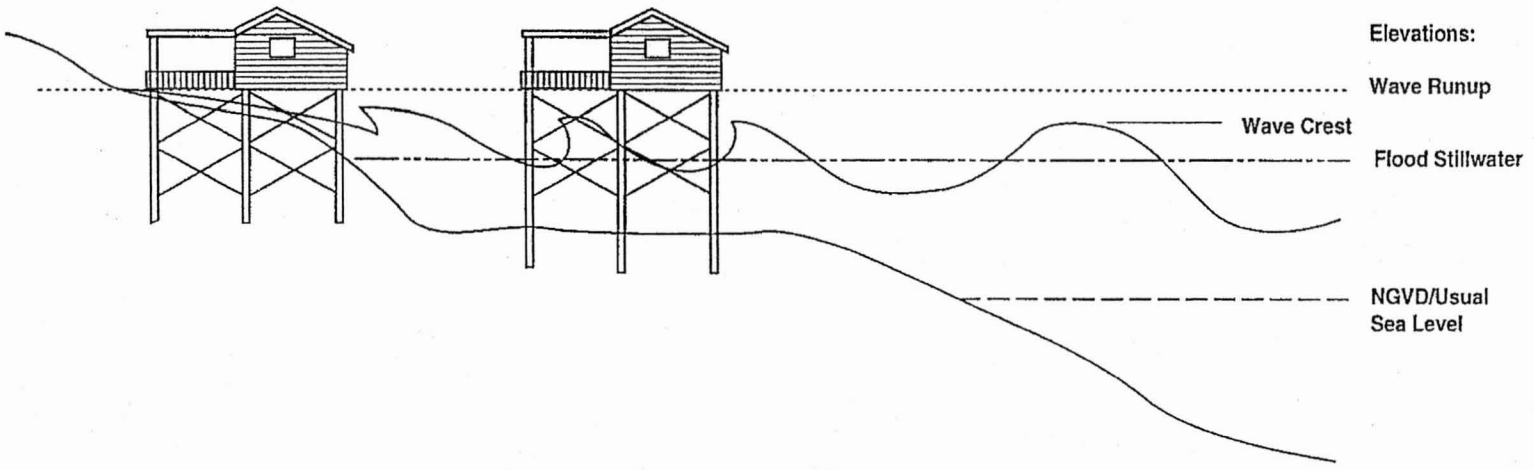


Figure D-11. Schematic Illustration of Wave Effects Extending Above and Landward of Stillwater Intercept on Transect

[February 2002]

D.2.5.1 Wave Runup Model Description

The current version of the FEMA Wave Runup Model, RUNUP 2.0, may be run either on a minicomputer (e.g., DEC VAX 11/750) or on an IBM-compatible personal computer (PC or PC/AT). Given the flood level, shore profile and roughness, and incident wave condition described in deep water, the program computes by iteration a wave runup elevation fully consistent with the most detailed guidance available (Stoa, 1978). This determination includes an analysis separating the profile into an approach segment next to the steeper shore barrier, and interpolation between runup guidance for simple configurations bracketing the specified situation.

Some additional description of the workings of the Wave Runup Model can assist informed preparation of input and interpretation of output. The incorporated guidance gives runup elevation as a function of wave condition and barrier slope, for eight basic shore configurations distinguished by water depth at the barrier toe, along with the approach geometry. Where those basic geometries do not appropriately match the specified profile, reliance is placed on the composite slope method (Saville, 1958); this assumes the input shore profile (composite slope) is equivalent to a hypothetical uniform slope, as shown in Figure D-12. The runup elevations are derived from laboratory measurements in uniform wave action, rather than the irregular storm waves usually accompanying a flood event. Runup guidance for uniform waves, however, also pertains to the mean runup elevation from irregular wave action with identical mean wave height and mean wave period. Figure D-13 presents an overview of the basic computation procedure within RUNUP 2.0.

Basic empirical guidance incorporated within this computer model generally does not extend to vertical or nearly vertical flood barriers. For such configurations, RUNUP 2.0 usually will provide a runup elevation, but the result may be misleading because reliance on the composite-slope method can yield an underestimate of actual wave runup with the abrupt barrier. Where a vertical wall exists on a transect, the Mapping Partner shall develop a runup estimate using specific guidance in Figure D-14, taken from the *Shore Protection Manual* (USACE, 1984). As within RUNUP 2.0, these empirical results for uniform waves should be utilized by specifying mean wave height and mean wave period for entry, and taking the indicated runup as a mean value in storm wave action. Shore configurations with a vertical wall are also addressed separately in Subsection D.2.5.7.

[February 2002]

D.2.5.2 Wave Runup Model Input Preparation

The input to the Wave Runup Model is done by transects. As specified in Subsection D. 2.2, the Mapping Partner shall locate transects along the shoreline. Because the runup results are very sensitive to shore slope or steepness, it is important to have at least one transect for each distinct type of shore geometry. Often, areas with similar shore slopes are located throughout a community, and the results of one transect can be applied to all the areas that are similar. This is

especially typical of New England communities with rocky bluffs. When the Wave Runup Model is being applied to dune remnants where eroded slopes are fairly uniform, transect location is governed by the upland land-cover characteristics, which are major considerations in

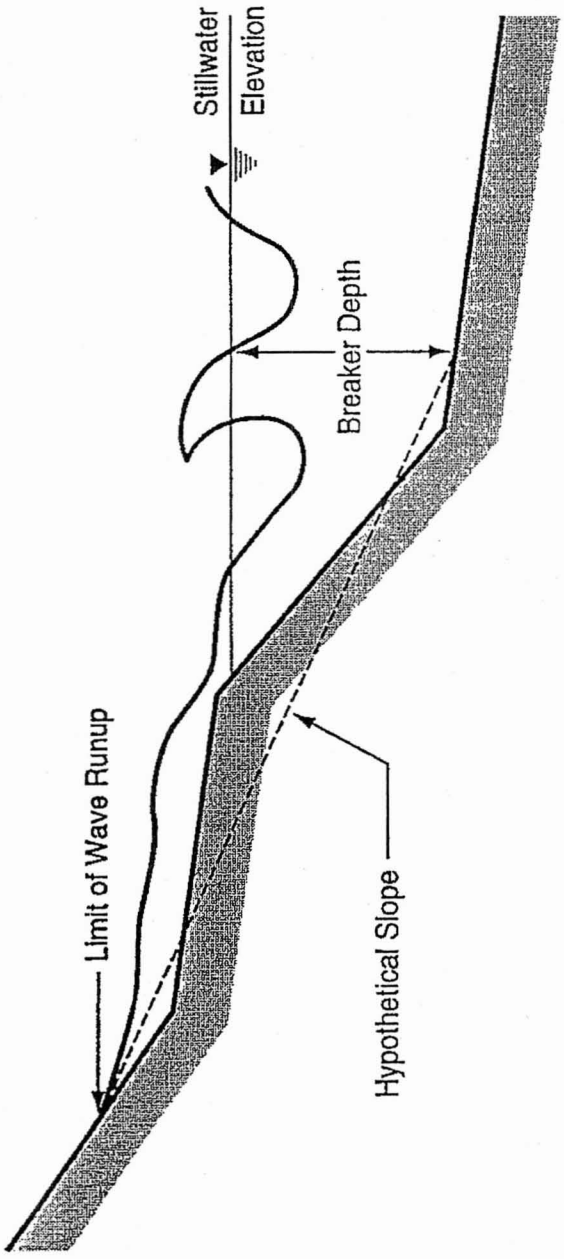


Figure D-12. Hypothetical Slope for Determining Wave Runup on Composite Profiles

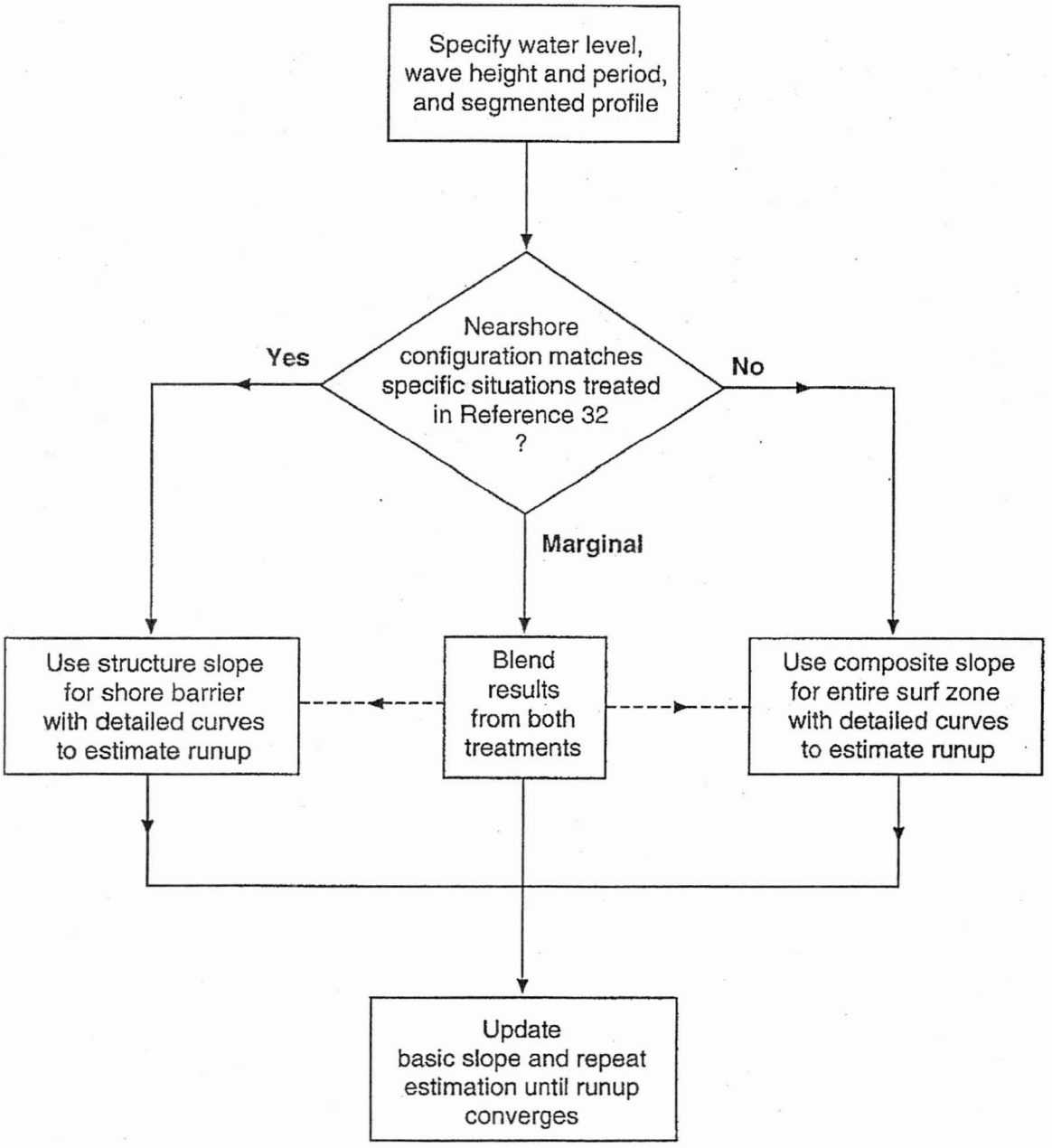


Figure D-13. Overview of Computation Procedure Implemented in Modified FEMA Wave Runup Model

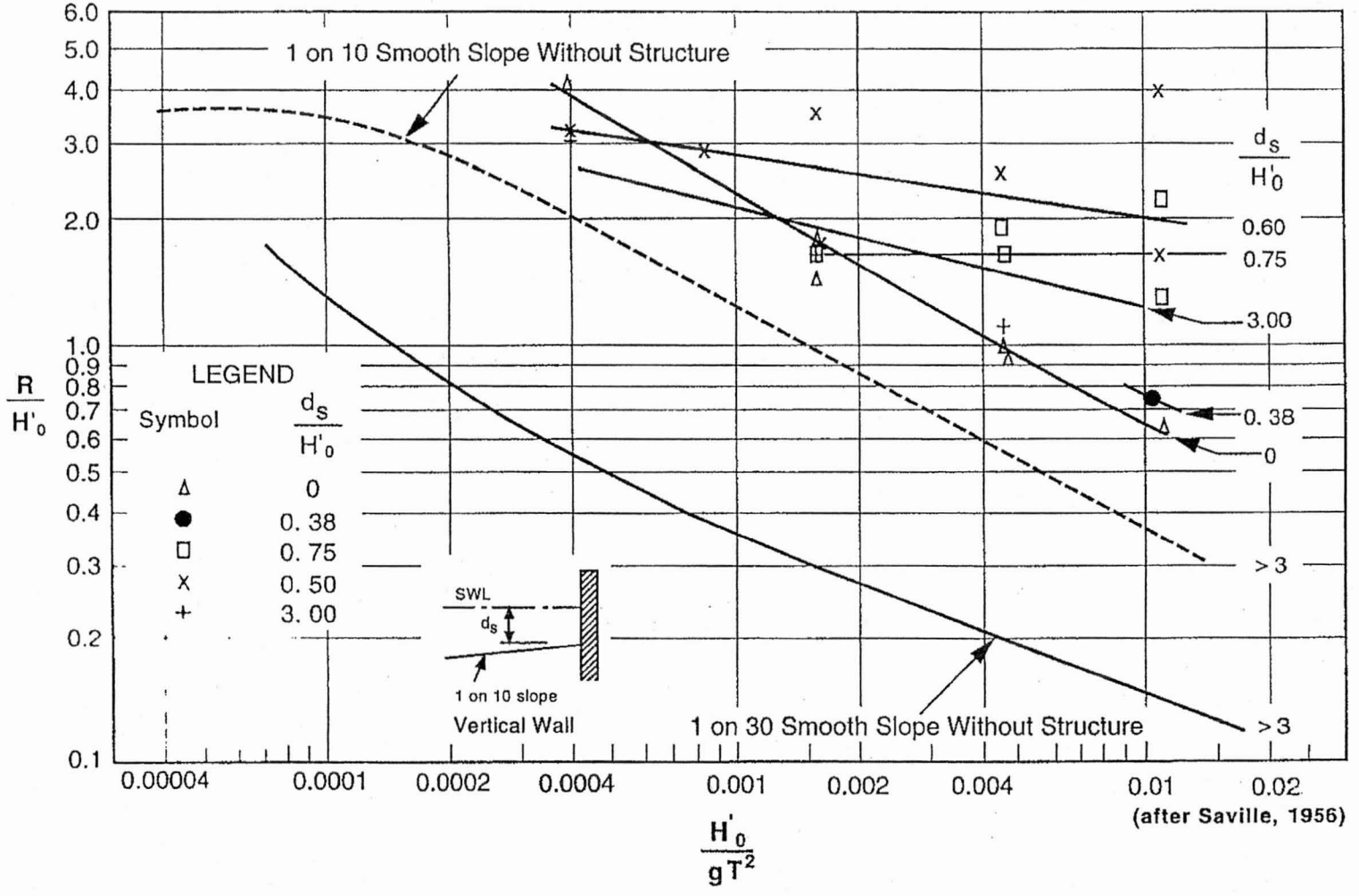


Figure D-14. Wave Runup Guidance from Vertical Wall, From *Shore Protection Manual* (USACE, 1984)

in the WHAFIS model.

The ground profile for the transect is plotted from the topography and bathymetry after the data have been referenced to the National Geodetic Vertical Datum (NGVD). The profile must extend from an elevation below the breaker depth to an elevation above the limit of runup or to the maximum ground elevation. An adequate vertical extent for the transect description will usually be 1.5 times the wave height above and below the SWEL. If the landward profile does not extend above the computed runup (30 feet NGVD is commonly a maximum), it will be assumed that the last positive slope segment continues indefinitely. This is very common with low barriers, so the Mapping Partner shall select the last slope carefully so it is representative. To complete the description, each slope segment of the profile will need a roughness coefficient, with some common values presented in Table D-3. The roughness coefficient must be between zero (maximum roughness) and one (hydraulically smooth), and values for slope segments above the SWFL control the estimated runup. The roughness coefficient *(r)* is used as a multiplier for runup magnitude *(R)* defined on a smooth barrier to estimate wave runup with a rough barrier.

Table D-3. Values for Roughness Coefficient in Wave Runup Computations

ROUGHNESS COEFFICIENT	DESCRIPTION OF BARRIER SURFACE
1.00	Sand; smooth rock, concrete, asphalt, wood, fiberglass
0.95	Tightly set paving blocks with little relief
0.90	Turf, closely set stones, slabs, blocks
0.85	Paving blocks with sizable permeability or relief
0.80	Steps; one stone layer over impermeable base; stones set in cement
0.70	Coarse gravel; gabions filled with stone
0.65	Rounded stones, or stones over impermeable base
0.60	Randomly placed stones, two thick on permeable base; common rip-rap installations
0.50	Cast-concrete armor units: cubes, dolos, quadripods, tetrapods, tribars, etc.

Transects are approximated by the minimum adequate number of linear segments, up to a limit of 20. Segments may be horizontal, or higher at the landward end; portions with opposite inclination should be represented as horizontal when developing the transect approximation. Using many linear segments to represent a transect can be wasted effort, because the Wave Runup Model may combine adjacent segments in defining the appropriate approach and barrier extents. With the runup computation procedure, the Mapping Partner shall apply engineering judgment to transect representation to assist in obtaining the most valid estimate of wave runup elevation.

The input transect must reflect wave-induced modifications expected during the 1-percent-annual-chance event, including erosion on sandy shores with dunes. The Mapping Partner shall represent only coastal structures expected to remain intact throughout the 1-percent-annual-chance event on a specific transect. Besides the transect specification, other required input data for the Wave Runup Model are the 1-percent-annual-chance SWEL and the incident mean wave condition described in deep water. The specified SWEL should exclude any contributions from

wind-wave effects. If available elevations include wave setup, the Mapping Partner shall remove that component before using this model so that calculated runup elevations do not indicate a doubled wave setup. Basic empirical guidance relates runup at a barrier to the water level in the absence of wave action and thus includes the wave setup component.

The mean wave condition to be specified for valid results with the Wave Runup Model may be derived from other common wave descriptions by simple relationships. Wave heights in deep water generally conform to a Rayleigh probability distribution, so that mean wave height equals 0.626 times either the significant height based on the highest one-third of waves or the zero-moment height derived from the wave energy spectrum. No exact correspondence between period measures exists; but, mean wave period usually can be approximated as 0.85 times the significant wave period or the period of peak energy in the wave spectrum.

Table D-4 lists a series of wave height and period combinations, of which one should be fairly suitable for runup computations at fully exposed coastal sites (depending on the local storm climate). These mean wave conditions have wave steepness values typical of U.S. hurricanes or within 30 percent of a fully arisen sea for extratropical storms. Commonly, the Mapping Partner may have some difficulty in specifying a precise wave condition as accompanying the 1-percent-annual-chance flood. In that case, is the Mapping Partner also shall consider wave heights and periods both 5 percent higher and 5 percent lower than that selected (or whatever percentages suit the level of uncertainty) and shall run the model with all nine combinations of those values. The average of computed runup values then provides a suitable estimate for mean runup elevation. A wide range in computed runups signals the need for more detailed analysis of expected wave conditions or for reconsideration of the transect representation.

Table D-4. Appropriate Wave Conditions for Runup Computations Pertaining to 1-Percent-Annual-Chance Event in Coastal Flood Insurance Studies

MEAN WAVE PERIOD (SECONDS)	MEAN DEEP WATER WAVE HEIGHT (FEET)
HURRICANES	
8	12
9	15.5
10	19
11	23
12	27.5
EXTRATROPICAL STORMS	
11	18
12	21.5
13	25
14	29
15	33.5

[February 2002]

D.2.5.3 Wave Runup Model Operation

The input to the FEMA Wave Runup Model consists of several separate lines specifying an individual transect and the hydrodynamic conditions of interest within particular columns. All input information is echoed in an output file, which also includes computed results on wave breaking and wave runup.

The input format is outlined in Table D-5. The first two lines of the input give the Name and Job Description, which must be included for each transect. The next line of input is the Last Slope, which contains the cotangent of the shore profile continuing from the most landward point provided. This is followed by the profile points, which define the nearshore profile in consecutive order from the most seaward point. Each line gives the elevation and station of a profile point and the roughness coefficient for the segment between that point and the following point. The roughness coefficient on the last profile line is for the continuation defined in the Last Slope line. The number of profile points cannot exceed 20. The final input is the series of hydrodynamic conditions of interest. Each line here contains the SWEL along with a mean wave height in deep water and a mean wave period.

Table D-5. Description of Five Types of Input Lines for Wave Runup Model

Name Line

This line is required and must be the first input line.

Columns	Contents
1-2	Blank
3-28	Client's Name
29-60	Blank
61-70	Engineer's Name
71-80	Job Number

Job Description Line

Columns	Contents
1-2	Blank
3-76	Project description or run identification
77-80	Run Number

Last Slope Line

This line is required and defines the slope immediately landward of the profile actually specified in detail.

Columns	Contents
1-4	Slope (horizontal over vertical or cotangent) of profile continuation
5-80	Blank

Profile Lines

These lines must appear in consecutive order from the most seaward point landward. Each line has the elevation and station of a profile point and the roughness coefficient for the section between that point and the following point. The roughness coefficient on the last profile line is for the continuation defined in the Last Slope Line. The Mapping Partner shall ensure that at least one profile point with a ground elevation greater than the SWEL is specified. The number of Profile Lines cannot exceed 20.

Columns	Contents
1	Last point flag. The most landward point on the profile is indicated by a 1. If not the last point, leave blank.

2	Blank
3-7	Elevation with respect to NGVD, in feet
8	Blank
9-14	Horizontal distance. It is common to assign the shoreline (elevation 0.0) as Point 0 with seaward distances being negative and landward distances positive.
15	Blank

Table D-5. Description of Five Types of Input Lines for Wave Runup Model (Cont'd).

Columns	Contents
16-20	Roughness coefficient in decimal form between 0.00 (most rough) and 1.00 (smooth).
21-80	Blank

Water Level and Wave Parameter Lines

These lines specify hydrodynamic conditions for runup calculations on each profile. Namely, 1-percent-annual-chance SWEL along with mean wave height and period for deep water. Typically, SWEL remains constant for a given profile, while the selected wave conditions closely bracket that expected to accompany the 1-percent-annual-chance flood. A maximum of 50 of these lines can be input for each profile.

Columns	Contents
1	Last line, new transect flag. A 1 indicates the last line for a given transect and notifies that another transect is following. If not the last line, or if the last line of the last transect, leave blank.
2-6	SWEL with respect to NGVD, in feet.
7	Blank
8-12	Deepwater mean wave height, $\overline{H}$3o, in feet, greater than 1 foot
13	Blank
14-18	Mean wave period, $\overline{T}$4, in seconds
19-80	Blank

The output as shown in Table D-6 has two parts. The first page is a printout of the transect listed as a numbered set of profile points, cotangents (slopes) of the segments, and the roughness coefficient for each segment. The second page is the output table of computed results for each set of conditions: the values of runup elevation and breaker depth, each with respect to the specified SWEL, along with an identification of the segment numbers giving the seaward limit to wave breaking and the landward limit to mean wave runup.

[February 2002]

D.2.5.4 Wave Runup Model Output Messages

Several output messages alert the user to specific problems encountered in running the program. All but the last three indicate that the program has stopped execution without completing runup calculations.

- "NEGATIVE RUN PARAMETER, PROGRAM STOPS"

An input value of wave height or wave period is read as negative or zero. Check that the input has been entered in the correct columns.

- "MORE THAN 20 POINTS IN PROFILE, PROGRAM STOPS"

  The program accepts a maximum input of 20 points defining the nearshore profile. This encourages a profile approximation that is not overly detailed, because each transect is to represent an extensive area.

- "**** H_o/L_o LESS THAN 0.002 ****" or
  "**** H_o/L_o GREATER THAN 0.07 ****"

  These limits on wave steepness pertain to the extent of incorporated guidance on breaker location. They should be adequate to include appropriate mean wave conditions for extreme events and also conform to the usual limits in detailed guidance on wave runup elevations.

- "DATA EXCEEDED TABLE"

  An entry into subroutine LOOK of the program is not within the parameter bounds of the data table from which a value is sought.

- "SOLUTION DOES NOT CONVERGE"

  After 10 iterations, the current and previous estimates of runup elevation continue to differ by more than 0.15 foot, and both values are provided in the output table. The calculation is usually oscillating between these two runup estimates when this occurs.

- "COMPOSITE SLOPE USED BUT WAVE MAY REFLECT, NOT BREAK"

  The output runup elevation relies to some extent on a composite-slope treatment, but the overall slope is steep enough that the specified wave may reflect from the nearshore barrier. Thus, the application of a calculated breaker depth in determining overall slope and runup elevation is questionable.

- "WARNING; COMPOSITE SLOPE USED, BUT INPUT PROFILE DOES NOT EXTEND TO BREAKER DEPTH"

  If the input profile does not extend seaward of the breaker depth, an incorrect breaker depth may be computed and the associated runup elevation will also be incorrect. The input profile should include bathymetry to 30 or 40 feet in depth.

[February 2002]

D.2.5.5 Wave Runup in Special Situations

To interpret and apply the calculated results properly, the Mapping Partner shall examine the output of the Wave Runup Model carefully for each situation. One important consideration is that a mean runup elevation below the crest of a given barrier does not necessarily imply the barrier will not occasionally be overtopped by floodwaters; the necessary supplementary examination of wave overtopping is addressed in Subsection D.2.5.7. Other cases may yield

CLIENT- FEMA ** WAVE RUNUP-VERSION 2.0 ** ENGINEERED BY DAB JOB 1
PROJECT-Runup calculations on Eroded Transect RUN 1 PAGE 1

****

CROSS SECTION PROFILE

	LENGTH	ELEV.	SLOPE	ROUGHNESS
1	-2670.0	-34.0		
			97.50	1.00
2	-1500.0	-22.0		
			76.25	1.00
3	-585.0	-10.0		
			72.50	1.00
4	-150.0	-4.0		
			36.43	1.00
5	-99.0	-2.6		
			42.22	1.00
6	53.0	1.0		
			24.64	1.00
7	223.0	7.9		
			39.60	1.00
8	322.0	10.4		
			.99	1.00
9	335.0	23.5		
			10.00	1.00
10	350.0	25.0		

LAST SLOPE 1.00 LAST ROUGHNESS 1.00

Table D-6. Output Example for the FEMA Wave Runup Model

results of more immediate concern, in that the Wave Runup Model may calculate a runup elevation exceeding maximum barrier elevation; this outcome can occur because the program assumes the last positive slope to continue indefinitely. For bluffs or eroded dunes with negative landward slopes, a general rule has been used that limits the wave runup elevation to 3 feet above the maximum ground elevation. When the runup overtops a barrier such as a partially eroded bluff or a structure, the floodwater percolates into the bed and/or runs along the back slope until it reaches another flooding source or a ponding area. The runoff areas are usually designated as Zone AO with a depth of 1, 2, or 3 feet. Ponding areas are designated as Zone AH (depth of 3 feet or less) with a BFE. Standardized procedures for the treatment of sizable runoff and ponding are presented in Appendix E of these Guidelines.

A fairly typical situation on the Atlantic and Gulf coasts is that wave runup exceeds the barrier top and flows to another flooding source such as a bay, river, or backwater. It may not be necessary in this situation to compute overtopping rates and ponding elevations; only the flood hazard from the runoff must be determined. Simplified procedures have been used to determine an approximate depth of flooding in the runoff area (Williams, 1983). These procedures are illustrated in Figure D-15 and discussed below.

When the runup computed on the imaginary extension of the last positive slope is greater than or equal to 3 feet above the maximum ground elevation, the maximum runup shall be 3 feet above the ground crest elevation. This elevation decays to 2 feet above the ground profile at 50 feet behind the crest and continues at this depth until it encounters other flooding. Computed runup is not adjusted if it is less than 3 feet above the ground crest. In the same initial 50 feet, this elevation decays to 1 foot above the ground and continues at this depth until it encounters other flooding. The runoff area from the ground crest to the limit of the other flooding is designated Zone AO with the appropriate depth of flooding.

A distinct type of overflow situation can occur at low bluffs or banks backed by a nearly level plateau, where calculated wave runup may appreciably exceed the top elevation of the steep barrier. A memorandum entitled "Special Computation Procedure Developed for Wave Runup Analysis for Casco Bay, FIS - Maine, 9700-153" provides a simple procedure to determine realistic runup elevations for such situations, as illustrated in Figure D-16 (French, 1982). An extension to the bluff face slope permits computation of a hypothetical runup elevation for the barrier, with the imaginary portion given by the excess height $R' = (R\text{-}C)$ between calculated runup and the bluff crest. Using that height R' and the plateau slope m, Figure D-17 defines the inland limit to wave runup, X, corresponding to runup above the bluff crest of (mX) or an adjusted runup elevation of $R_a = (C + mX)$. This procedure is based on a Manning's "n" value of 0.04 with some simplifications in the energy grade line and is meant for application only with positive slopes landward of the bluff crest. A different treatment of wave overflow onto a level plateau, for possible FIS usage, is provided in "Overland Bore Propagation Due to an Overtopping Wave" (Cox & Machemehl, 1986).

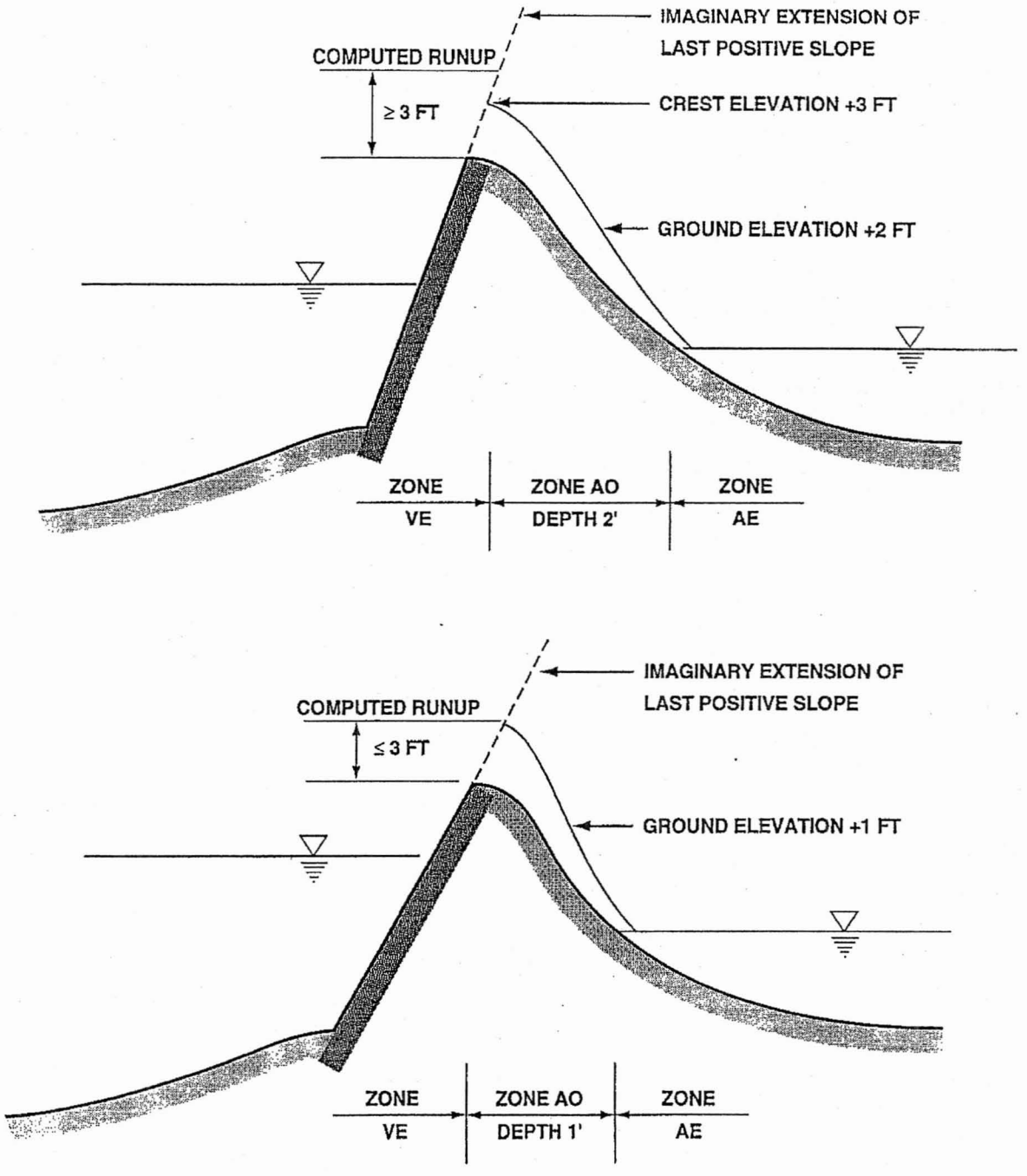


Figure D-15. Simplified Runoff Procedures (Zone AO)

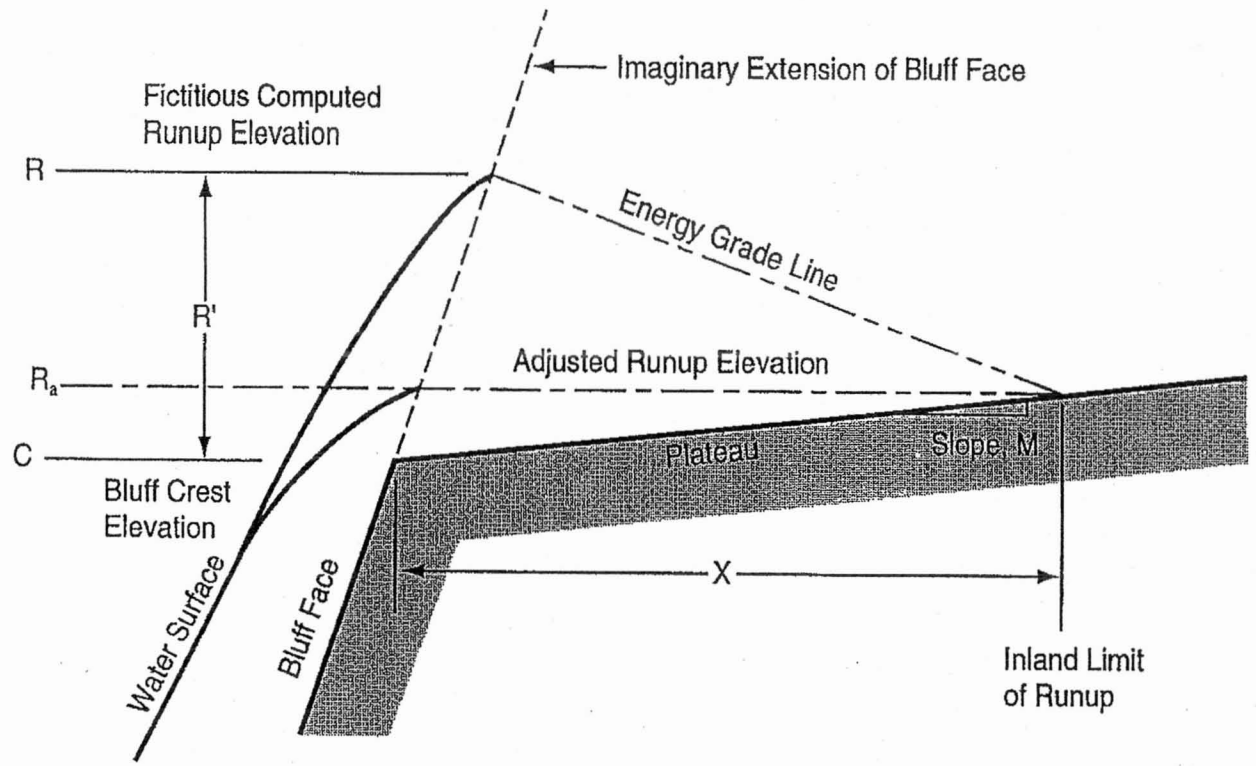


Figure D-16. Treatment of Runup onto Plateau above Low Bluff

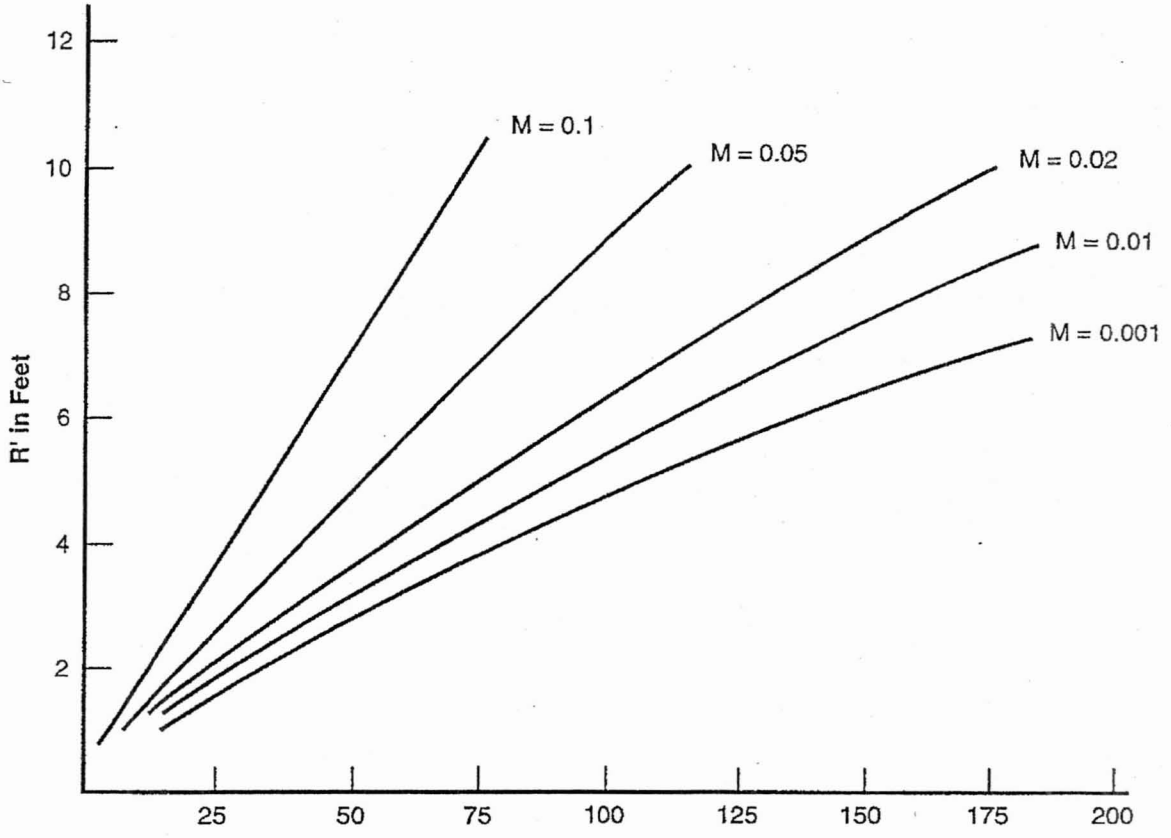


Figure D-17. Curves for Computation of Runup Inland of Low Bluffs

These runup assessment procedures are given for general guidance, but situations may exist where they are not entirely applicable. For example, runup elevations need to be fully consistent with wave setup and wave overtopping assessments described in subsections that follow. In problematic cases, the Mapping Partner shall use good judgment and rely on the historical data to reach a solution about realistic flood hazards associated with a shore barrier. Subsection D.2.7 considers the integration of separately calculated wave effects into coherent hazard zonations for the 1-percent-annual-chance flood. When a unique situation is encountered, the Mapping Partner shall prepare a Special Problem Report and discuss it with the FEMA RPO.

[February 2002]

D.2.5.6 Wave Setup

Nearshore wave action can increase mean water elevation in front of a shore barrier by the phenomenon called wave setup, which is related to wave attenuation by breaking in shallow water. In treating the 1-percent-annual-chance flood, focus may be restricted to the cumulative setup effect in the immediate vicinity of the shore barrier. Laboratory measurements of wave runup generally include the contribution due to wave setup, because runup elevations are defined relative to stillwater level in the absence of wave action.

A separate calculation for wave setup can be appropriate even if a wave runup elevation has already been determined, in part because the changed mean water depth can increase wave heights and crest elevations to be expected near the shore. In addition, empirical guidance within the Wave Runup Model is based on uniform laboratory wave action, so that incorporated setup might pertain to the field situation of swell waves from distant storms; setup effects may be much different in the local storm waves accompanying the 1-percent-annual-chance flood. If storm wave setup is found to exceed the wave runup calculated for a particular situation, the Mapping Partner shall apply the setup estimate as a lower bound for actual wave runup in further analysis of wave effects and 1-percent-annual-chance flood elevations.

The USACE *Shore Protection Manual* provides straightforward empirical guidance on wave setup for various storm wave conditions and plane bottom slopes, as reproduced in Figure D-18 (USACE, 1984). Setup magnitude is given in dimensionless form, as normalized by incident significant wave height. This guidance, given typical significant storm-wave steepness of 0.03 to 0.04, indicates shore setups of 7 to 8 percent of incident wave height. Incident wave conditions are specified in deep water as the significant wave height and the wave steepness, $H_{os}/L_{op)}$, where $L_p = gT_{op}^2 / 2\pi 5$ is wavelength in deep water. Bottom slope may be taken as an overall average over the breaker zone between $d = 2H_0$ and d=0, if the bottom geometry is relatively simple. For other geometries, e.g., with a berm or reef in front of the shore barrier, the wave setup can be larger than given by Figure 18 and a more detailed examination may be required.

Wave setup also appears appreciably larger according to an independent treatment of storm waves on plane slopes, as outlined for a relatively narrow spectrum describing incident wave energy in *Random Seas and Design of Maritime Structures* (Goda, 1985). If historical evidence indicates greater setup increases of mean water depth in extreme floods than Figure D-18 gives

for the study site, the Mapping Partner shall develop a wave setup estimate based on that independent guidance through the ACES computer program provided in *Automated Coastal Engineering System, Version 1.07* (Leenknecht, Szuwalski, & Sherlock, 1992). The program does not permit direct calculation of wave effects at d=0; however, the Mapping Partner may linearly extrapolate setup results from about $d=H_o$ to the shallow limit of computations to the stillwater shoreline.

[February 2002]

D.2.5.7 Wave Overtopping

Wave overtopping results when a shore barrier does not contain incident wave action, so that floodwater penetrates to the protected area landward. This process of a partial halt and dissipation to storm waves is more difficult to treat than wave runup or wave setup. Important rates of wave overtopping can vary over several orders of magnitude, and can depend strongly on the detailed geometry of the barrier. That complicates the development of empirical guidance on wave overtopping, but little demand exists for such guidance in coastal engineering practice. According to *Criteria for Evaluating Coastal Flood-Protection Structures*, the design process for a major coastal flood protection structure relies on site-specific model testing, rather than generalized overtopping guidance (Walton, Ahrens, Truitt, & Dean, 1989).

Of course, the assessment of potential wave overtopping for present purposes must rely on readily available empirical guidance, historical effects, and engineering judgment. Except for very heavy overtopping, useful guidance is derived from tests with irregular waves, because the intermittently large overtopping discharges in storm situations could not be reproduced otherwise. Adding to the formal complexity of an adequate treatment for flood hazard assessment, overtopping effects may be cumulative so that the entire course of a flood event could require consideration, not just the peak conditions. However, the Mapping Partner shall estimate only the order of magnitude of overtopping rates because there are clearly documented thresholds below which wave overtopping may be classified as negligible. On the other hand, if a preliminary estimate indicates severe overtopping that threatens the stability of a given structure, that structure might be removed from the transect for analyses of the 1-percent-annual-chance flood, and no further overtopping consideration would be required.

Two publications, *Design of Seawalls Allowing for Wave Overtopping* (Owen, 1980) and *Random Seas and Maritime Structures* (Goda, 1985) appear to provide the most trustworthy and wide-ranging summaries of mean overtopping rates with storm waves. The former publication addresses smooth plane or bermed slopes, and the latter publication considers vertical walls with or without a fronting rubble mound. Before surveying those primary sources of overtopping guidance, however, some introductory considerations can help to determine whether detailed assessment is needed for 1-percent-annual-chance flood conditions at a specific shore barrier.

The initial consideration is an interpretation of mean runup elevation already calculated ($\overline{R}$ 6), in terms of likely extreme elevations according to the Rayleigh probability distribution usually appropriate for wave runups. To parallel the extreme wave height addressed in coastal studies (NAS, 1977), a controlling runup magnitude may be defined as 1.6 times significant runup, or

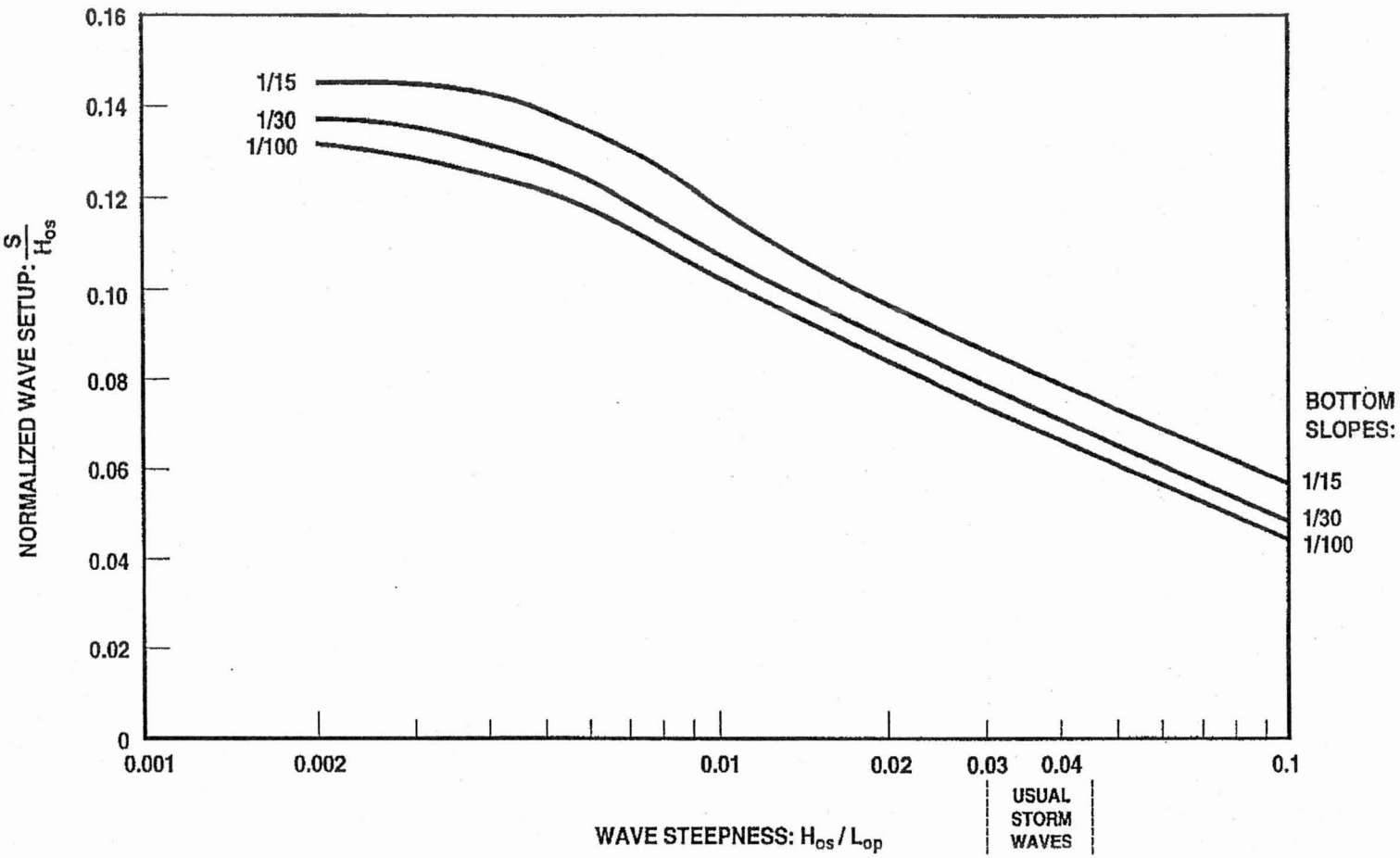


Figure D-18. Guidance on Wave Setup in Irregular Wave Action, From Shore Protection Manual (USACE, 1984)

2.5 times mean runup according to the Rayleigh distribution. If elevation of the barrier crest above 1-percent-annual-chance SWEL, or the barrier freeboard F, equals or exceeds ($2.5\ \overline{R}7$), then the landward area is not subject to wave-induced discharges during the 1-percent-annual-chance flood. That requirement might be supplemented by consideration of F near ($2\ \overline{R}8$), corresponding to 4.5 percent of the runup reaching the barrier crest according to the Rayleigh distribution. If $F \leq (2\,\overline{R}9)$, wave overtopping can certainly be appreciable during the 1-percent-annual-chance flood, and the Mapping Partner shall assess ponding or runoff behind the barrier. The extreme runups introduced here, ($2\,\overline{R}10$) and ($2.5\,\overline{R}11$), bracket the elevation exceeded by the extreme 2 percent of wave runup, a value commonly considered in structure design.

Once the need for quantitative overtopping assessment is established, wave runup considerations become inapplicable because a runup elevation generally cannot be converted to an overtopping estimate. Also, the composite-slope method used in determining wave runup does not appear applicable for overtopping of barriers with composite geometry, because details of the wave transformation on a barrier influence the resultant overtopping rates. Wave overtopping estimates for a specified situation generally must be based on measurements in a similar configuration. Before considering some implications of quantitative guidance for idealized cases, an overview of overtopping magnitudes gives a useful introduction (Goda, 1985; Gadd, Potter, Safaie, & Resio, 1984).

Wave overtopping is specified as a mean discharge: water volume per unit time and per unit alongshore length of the barrier, commonly cfs/ft. By interpreting or visualizing a given overtopping rate, the Mapping Partner may take into account that the actual discharges generally are intermittent and isolated, being confined to some portion of occasional wave crests at scattered locations. Distinct regimes of wave overtopping may be described as spray, splash, runup wedge, and waveform transmission, in order of increasing intensity. Flood discharges corresponding to those regimes naturally depend on the incident wave size, but certain overtopping rates have been associated with various characteristics (Goda, 1985). Among those rates, 0.01 cfs/ft seems to correspond to flooding that generally should be considered appreciable, and 1 cfs/ft appears to define an approximate threshold where structural stability of the shore barrier commonly becomes threatened by severe overtopping.

Once the mean overtopping rate has been estimated for the 1-percent-annual-chance flood, determining resultant flooding may require a representative duration for the interval of overtopping. That duration can vary widely depending on the coastal flood cause, from a fast-moving hurricane to a nearly stationary extratropical storm. A minimum assumption for the duration of flood-peak overtopping would generally be 1 to 2 hours. Durations of 10 hours or more could be appropriate for cumulative effects in an extratropical storm causing flooding over multiple high tides.

Figure D-19 summarizes some empirical overtopping guidance for storm waves, in a schematic form meant to assist deciding the likely significance of flooding behind a coastal structure. Variables describing the basic situation are cotangent of the front slope for a smooth structure with ideally simple geometry, and freeboard of the structure crest above stillwater level, as

normalized by incident significant wave height, F/H_s. The mean overtopping rate, $\overline{Q}$12, is provided in dimensionless form as

$$Q^* = \overline{Q}13/(gH_s^3)^{0.5} \quad (2)$$

with test results shown for structure slopes of 1:1, 1:2, and 1:4 (Owen, 1980) and for a smooth vertical wall (Goda, 1985). These results pertain to: significant wave steepness of approximately $2\pi H_s/gT^2$
$_p$ = 0.035, fairly appropriate for extreme extratropical storms or hurricanes; water depth near the structure toe of approximately $d_t = 2H_s$, so that incident waves are not appreciably attenuated; and moderate approach slopes of 1:30 for a vertical wall or 1:20 for other structures. The major feature of interpolated curves is fixed as a maximum in overtopping rate for structure slope of 1:2, corresponding to the gentlest incline producing (at this wave steepness) total reflection rather than breaking, and thus peak waveform elevations (Nagai & Takada, 1972).

These measured results for smooth and simple geometries clearly show severe or "green water" overtopping even at relatively high structures ($F \geq H_s$) for a wide range of common inclinations (cotangents between 0 and 4). Also, for freeboards considered here, a vertical wall (cotangent 0) permits less overtopping than common sloping structures with cotangent less than approximately 3.5. Gentler barriers are uncommon because the construction volume increases with the cotangent squared, so steep coastal flood-protection structures usually face attenuated storm waves and/or have rough surfaces. Basic effects of those differences can be outlined for use in simplified overtopping assessments.

For sloping structures sited within the surf zone ($d_t < 2H_s$), *Design of Seawalls Allowing for Wave Overtopping* indicates that basic overtopping guidance in Figure D-19 can be used with attenuated rather than incoming wave height (Owen, 1980). A simple estimate basically consistent with other analyses of the 1-percent-annual-chance flood is that significant wave height is limited to $H'_s = d_t/2$ at the structure toe. The value of $(2F/d_t)$ describes the effectively increased freeboard in entering Figure D-19, and the indicated Q* value is then converted to $\overline{Q}$ using H'_s. The presumed wave attenuation ignores any wave setup as a small effect with the partial barrier, and d_t should always correspond to the scour condition expected in wave action accompanying the 1-percent-annual-chance flood.

Figure D-19 might also be made applicable to rough slopes, using a roughness coefficient (r) from Table D-3 to describe the effectively increased freeboard with greater wave dissipation on the structure. *Design of Seawalls Allowing for Wave Overtopping* proposed formulating effect of structure roughness as F/r, and *Beach and Dune Erosion during Storm Surges* confirmed a similar dependence of overtopping on roughness in measured results for irregular waves (Owen,

1980; Vellinga, 1986). The overtopping relation reported as reliable in "Wave Runup and Overtopping on Coastal Structures" is

$$Q^* = 8 \bullet 10^{-5} \exp[3.1(rR^* - F / H_s)] \quad (3)$$

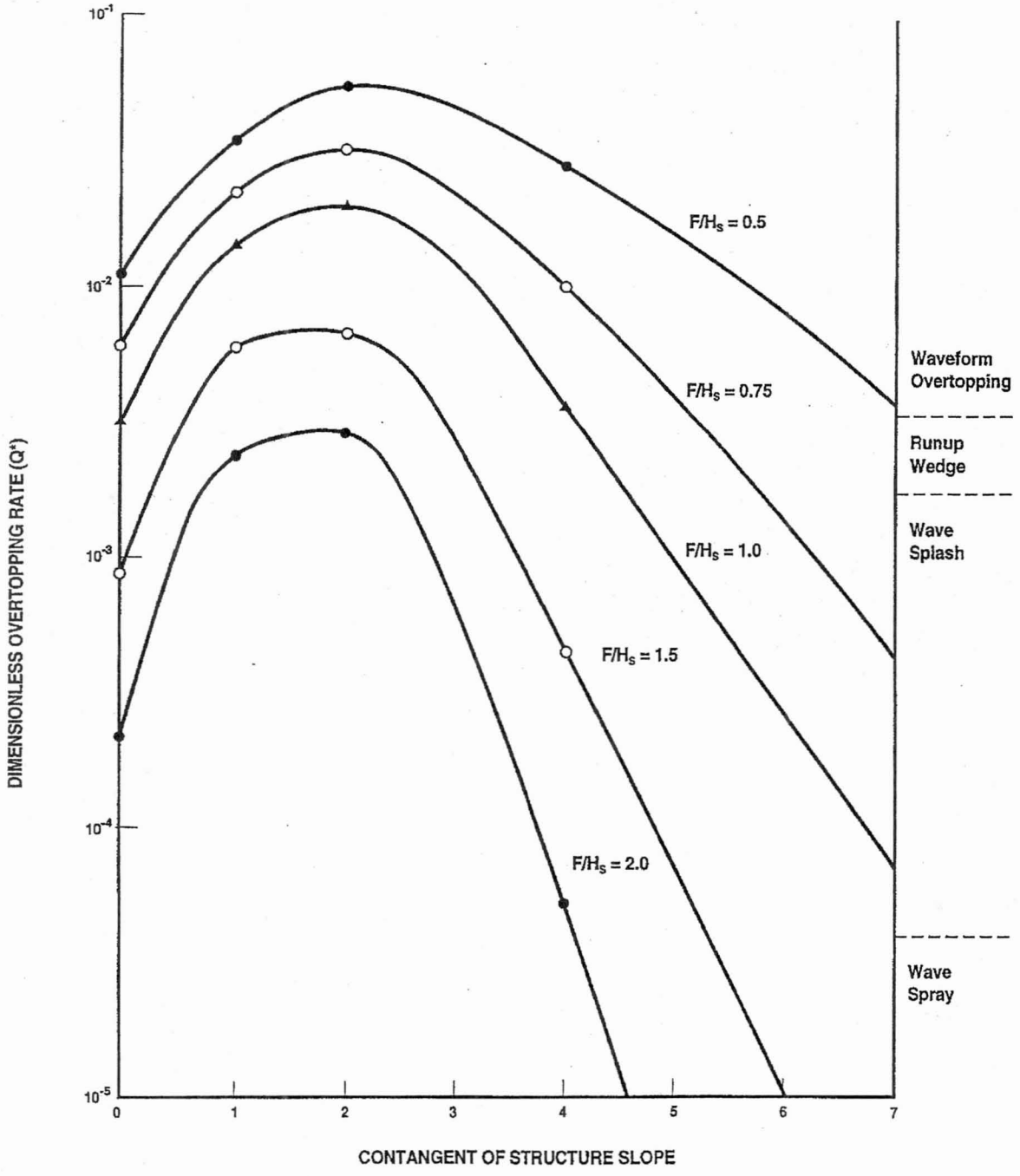


Figure D-19. Schematic Summary of Storm-Wave Overtopping at Structures of Various Slopes and Freeboards, Based on Goda, 1985, and Owen, June 1980.

where $R^* = [1.5\ m/(H_s/L_{op})^{0.5}]$, up to a maximum value of 3.0, is an estimated extreme runup normalized by H_s, for a barrier slope given as the tangent m (de Waal & van der Meer, 1992). Equation 3 is meant to pertain to very wide ranges of test situations with moderate overtopping, but appears very approximate in comparison with specific results for r=1 shown in Figure D-19. It may be advisable to evaluate Equation 3 for both smooth and rough barriers, then to use the ratio to adapt a value from Figure D-19 for the case with roughness. *Design of Seawalls Allowing for Wave Overtopping* (Owen, 1980) and "Wave Runup and Overtopping on Coastal Structures" (de Waal & van der Meer, 1992) provide further overtopping guidance on the effects of composite profiles, oblique waves, and shallow water with sloping structures.

For overtopping of vertical walls, effects of wave attenuation appear relatively complex, but *Random Seas and Design of Maritime Structures* (Goda, 1985) provides extensive empirical guidance on various structure situations with incident waves specified for deep water. Figure D-20 converts basic design diagrams for wave overtopping rate at a vertical wall, to display wall freeboard required for rates of 1 cfs/ft and 0.01 cfs/ft with various incident wave heights. Goda (1985) also provides a convenient summary on the effect of appreciable fronting roughness in storm waves: the required freeboard of a smooth vertical wall for a given overtopping rate is approximately 1.5 times that which is needed when a sizable mound having concrete block armor is installed against the wall. With this information, a specific vertical wall can be categorized as having only modest overtopping ($\overline{Q}14 < 0.01$ cfs/ft), intermediate overtopping, or severe overtopping ($\overline{Q}15 > 1$ cfs/ft) expected for the 1-percent-annual-chance flood. Likely runoff or ponding behind the wall must then be identified; severe overtopping requires delineation of the landward area susceptible to wave action and velocity hazard. Subsection D.2.7 outlines several common zonations of flood hazards near shore barriers in describing the integration of computed wave effects.

Considering Figure D-20 with respect to common wall and wave heights, wave overtopping dangerous to structural stability appears the usual case during the 1-percent-annual-chance flood.

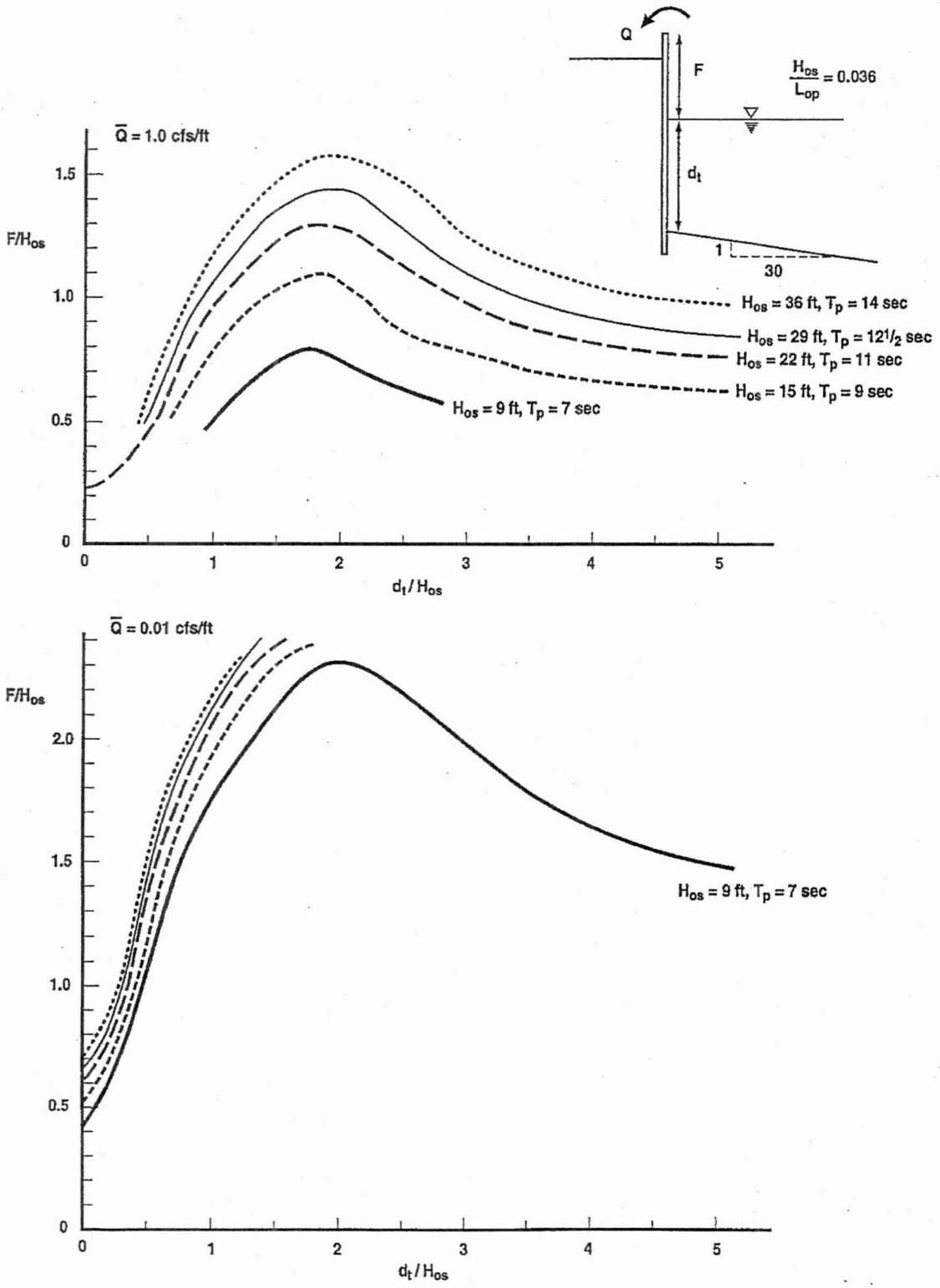


Figure D-20. Required Freeboard of Vertical Wall to Limit Mean Overtopping Rate to Certain Values, Based on Design Curves of *Random Seas and Design of Maritime Structures* (Goda, 1985)

An assessment of failure during the 1-percent-annual-chance flood for typical walls would be fully consistent with one recommendation of *Criteria for Evaluating Coastal Flood-Protection Structures*: that "FEMA not consider anchored bulkheads for flood-protection credit because of extensive failures" (Walton et al., 1989).

Interpretation of estimated overtopping rate in terms of flood hazards is complicated by the projected duration of wave effects, by the increased discharge possible under storm winds, by the varying inland extent of water effects, and by the specific topography and drainage landward of the barrier. However, guidance is provided in Table D-7 as potentially applicable to typical coastal situations.

Table D-7. Suggestions for Interpretation of Mean Wave Overtopping Rates

$\overline{Q}16$ ORDER OF MAGNITUDE	FLOOD HAZARD ZONE BEHIND BARRIER
<0.0001 cfs/ft	Zone X
0.0001-0.01 cfs/ft	Zone AO (1 ft depth)
0.01-0.1 cfs/ft	Zone AO (2 ft depth)
0.1-1.0 cfs/ft	Zone AO (3 ft depth)
>1.0 cfs/ft*	30-ft width[+] of Zone VE (elevation 3 ft above barrier crest), landward Zone AO (3 ft depth)

*With estimated $\overline{Q}17$ much greater than 1 cfs/ft, removal of barrier from transect representation may be appropriate.

[+]Appropriate inland extent of velocity hazards should take into account structure width, incident wave period or wavelength, and other factors.

For each coastal structure experiencing sizable wave runup in the 1-percent-annual-chance flood (for example, $\overline{R}18 > 2$ ft), a brief report to the Project Officer should outline overtopping assessments and document conclusions consistent with historical evidence for the site.

[February 2002]

D.2.6 Analysis of Overland Wave Dimensions

As water waves propagate near the shore and over flooded land, they can undergo marked transformations due to local winds, interaction with the bottom, and physical features such as buildings, trees, or marsh grass. Figure D-21 illustrates schematic effects on the wave crest elevations and on the type of flood zone. The fundamental analysis of wave effects for an FIS is provided by the WHAFIS 3.0 computer program, entitled "Wave Height Analysis for Flood Insurance Studies" (FEMA, 1988). This program or model calculates wave heights, wave crest elevations, flood hazard zone designations, and the location of zone boundaries along a transect.

Wave description for NFIP purposes addresses the controlling wave height, equal to 1.6 times the significant wave height common as a representative wave description. Significant wave

height is the average height of the highest one-third of waves, and controlling wave height is approximately the average height of the highest one percent of waves in storm conditions. The original basis for wave treatment under the NFIP was the NAS methodology, which accounted for varying fetch lengths, barriers to wave transmission, and the regeneration of waves over flooded land areas (USACE, 1975). Because of the introduction of the NAS methodology, periodic upgrades have been made to incorporate improved or additional wave considerations.

Technical details of the current WHAFIS model are fully documented *(Technical Documentation for WHAFIS Program Version 3.0)*, but a brief overview indicates the level of wave treatment in WHAFIS 3.0 (FEMA, September 1988). A wave action conservation equation governs wave regeneration due to wind and wave dissipation by marsh plants. This equation is supplemented by the conservation of waves equation, which expresses the spatial variation of the wave period at the peak of the wave spectrum. The wave energy (equivalently, wave height) and wave period respond to changes in wind conditions, water depths, and obstructions as a wave propagates. These equations are solved as a function of distance along the transect. A predominant element in this wave treatment remains unchanged from the NAS methodology: controlling wave height is limited to 78 percent of the local mean water depth.

[February 2002]

D.2.6.1 Use of WHAFIS 3.0 Model

Careful preparation and input of required site data are necessary in using WHAFIS. Like the other coastal treatments, the WHAFIS model considers the study area by representative transects. For WHAFIS, transects are selected with consideration given to major topographic, vegetative, and cultural features. The ground profile is defined by elevations referenced to NGVD and usually begins at elevation 0.0 and proceeds landward until either the ground elevation exceeds the meanwater elevation for the 1-percent-annual-chance flood or another flooding source is encountered.

Other fundamental specifications among WHAFIS input include the 1-percent-annual-chance mean water elevation and a description of waves existing at the transect start. In the wave description, provision is made for an overwater fetch length, an initial significant wave height, or an initial period of dominant waves. In most applications, the wave period is the input description, because that parameter is readily available from information about offshore storm waves and the period does not change during most wave transformations. WHAFIS then computes an appropriate depth-limited wave height at the transect start. The only check necessary is to confirm that incident waves likely exceed that height and a wave condition limited by water depth occurs.

Different wave specifications can be appropriate for sites not on an open, straight coast. Where land shelter or wave refraction may result in reduced incident waves, it is appropriate to specify an initial significant wave height for the transect. Also, at sites on restricted water bodies, the overwater fetch length should be specified for likely wind direction at the flood peak. WHAFIS then computes an appropriate incident wave condition for the transect, but such waves are limited and any fetch length exceeding 24 miles yield the same results.

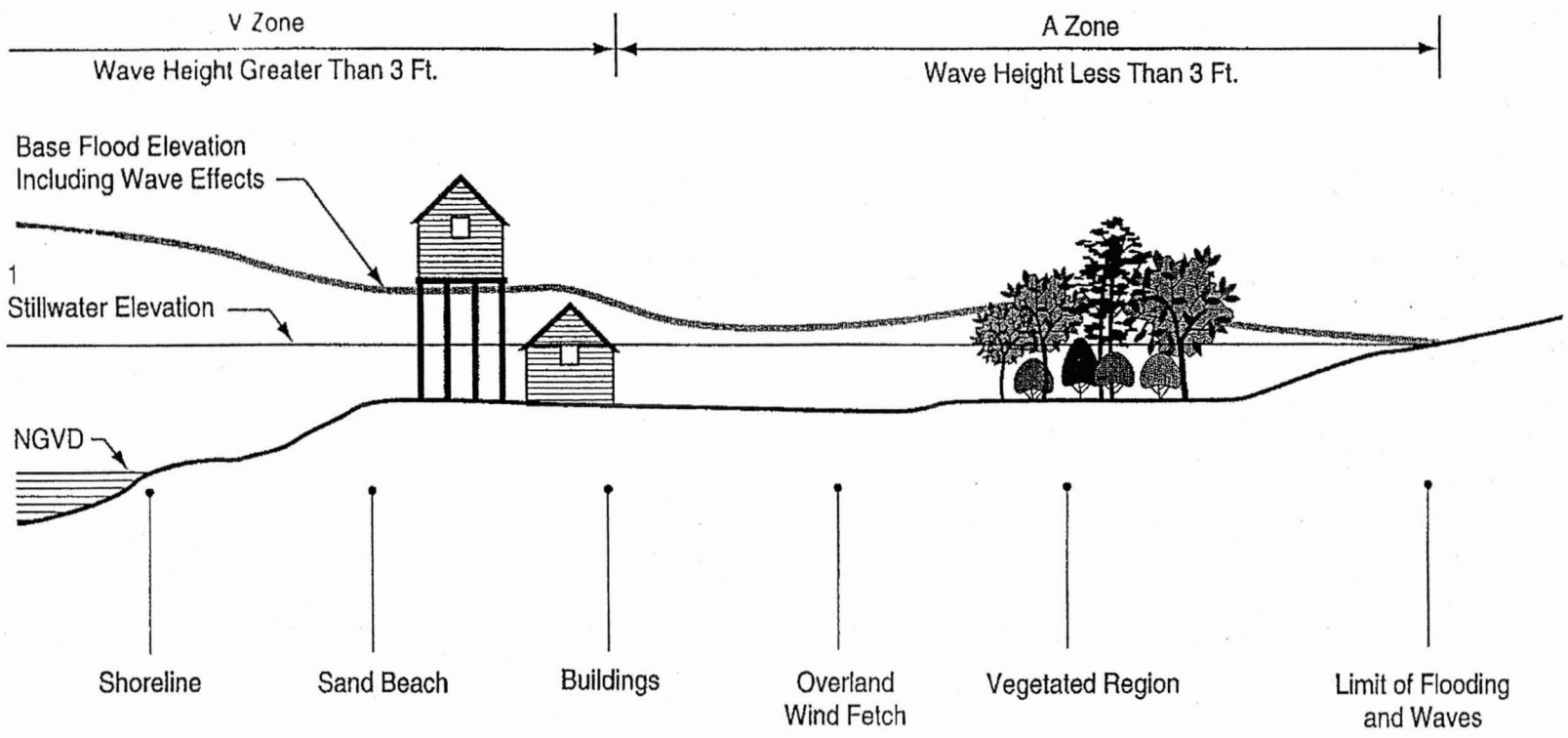


Figure D-21. Schematic Wave Effects on a Transect

In preparing WHAFIS input, transects are to be located on the work maps and the transect ground profile is to be plotted from the topographic data, adjusted for erosion. Each transect is to have all the input data identified on the profile plot for ease of input coding. The location, height, and extent of elongated manmade structures is to be identified and shown as part of the ground profile, after the structure's stability under forces of the 1-percent-annual-chance flood is confirmed as discussed in Subsection D.2.3. When locating transects across barrier islands or sand spits, common practice is to continue the transect across the back bay and onto the mainland. If there is a large and/or unusually shaped embayment behind the island, it may be necessary to place additional transects just along the mainland shore. These transects may not parallel the transects from the open coast, and they may cross one another. The Mapping Partner shall keep crossing transects to a minimum; however, where it is not possible to avoid this, the transect determining greatest flood hazards shall control in mapping the flood hazards.

Once representative transects are located, the local 1-percent-annual-chance mean water levels can be defined for WHAFIS input. Wave setup should be included in this water elevation, as a part of the appropriate mean depth controlling wave dimensions (FEMA, September 1988). If wave setup was not calculated separately for the site, 1-percent-annual-chance SWEL is the appropriate specification. WHAFIS also has an input field for a 10-percent-annual-chance SWEL; however, it is only employed to determine Flood Hazard Factors, which FEMA no longer uses. Still, the Mapping Partner shall provide this input if it is readily available, because it could help in distinguishing between transects.

When a transect covers two or more flooding sources, the Mapping Partner shall identify an area of transition between the different SWELs. This is a common situation for barrier islands with ocean elevations on one side and bay elevations on the other side. It is usually assumed that the higher ocean elevations extend inland to the highest point of the reduced ground profile. WHAFIS performs a linear interpolation within a transect segment where elevations differ at the end stations. The interpolated elevations are compared to the ground elevations and adjusted, if necessary, to be above the ground elevations. The Mapping Partner may have to input the SWEL a second time to identify areas of constant elevation and elevation transition.

The proper transect representation of some land features, particularly buildings and vegetation, merits further discussion. Buildings are specified on the transect as rows perpendicular to the transect. Because buildings are not always situated in perfect rows, the Mapping Partner shall exercise judgment to determine which buildings can be represented by a single row. The required input value for each row of buildings is the ratio of open space to total space. This is simply the sum of distances between buildings in a row, divided by the total length of that row. The Mapping Partner shall examine whether the first row or two of buildings along the shoreline should be considered as obstructions. During a 1-percent-annual-chance event, it is sometimes appropriate to assume that these buildings will be destroyed before the peak of the flood occurs if they are not elevated on pilings. If they are elevated, the waves should propagate under the structure with minimal reduction in height. It is useful to contact local officials to obtain typical construction methods and the lowest elevations of structures.

The WHAFIS program has two separate routines for vegetation: one for rigid vegetation that can be represented by an equivalent "stand" of equally spaced circular cylinders (NAS, 1977),

and one for marsh vegetation that is flexible and oscillates with wave action (FEMA, 1984). For either type, the Mapping Partner shall exercise considerable care in selecting representative parameters and in ruling out that the vegetation will be intentionally removed or that effects would be markedly reduced during a storm through erosion, uprooting, or breakage.

For the areas of rigid vegetation located on the transect, the required input values are the drag coefficient, C_D; mean wetted height, h; mean effective diameter, D; and mean horizontal spacing, b. The value of C_D should vary between 0.35 and 1.0, with 1.0 being used in most cases of wide vegetated areas. When the vegetation is in a single stand, the Mapping Partner shall use a value of 0.35. The Mapping Partner may obtain representative values for h, D, and b from stereoscopic aerial photographs or by field surveys. Various guides for terrain analysis can provide advice on estimating values from aerial photographs. Table D-8 provides a useful process developed from *Terrain Analysis Procedural Guide for Vegetation* (Messmore, Vogel, & Pearson, 1979).

For marsh vegetation, a more complicated specification is required for completeness. The eight parameters used to describe the dissipational properties of a specific type are explained in Table D-9. However, WHAFIS incorporates considerable basic information on the eight common types of seacoast marsh plants listed in Table D-10 (FEMA, 1984). That information can be used either by specifying the Table D-10 abbreviation or a geographical region as indicated in Figure D-22. Figure D-22 shows the coastal wetland regions of the Atlantic and Gulf coasts, along with the identifying number used in WHAFIS. If the site is near a region border, the likely plant parameters can be interpolated using an input weighting factor. Although the South Texas region has insignificant amounts of marsh grass, it is included for usage in spatial interpolation.

Climate affects the geographic range of each marsh plant type, so that some plant types are not found in all regions. Table D-11 lists the dominant plant type in each region, where the term "dominant" refers to the plant types that cover the largest amount of area in the marshes. Table D-12 shows the significant plant types in each region, where the term "significant" refers to the plant types that occur in large enough patches (at least 10,000 square feet) to significantly affect waves. For marsh plants, simply the coastal wetland region, plant type, and area or percent of coverage may be specified. Given this information, WHAFIS will supply default values for the other marsh plant parameters appropriate to the site (FEMA, 1984).

Following the identification of the marsh plant types present, the area and fraction of coverage, F_{cov}, for each plant type must be calculated. For each transect, the total area of marsh vegetation coverage is determined. The different types of vegetation within this area usually occur in patches. F_{cov} is defined for each plant type as the ratio of the patch area for that type to the total marsh area. Using the above data, a fairly good determination can be made of the plant types present, but an attempt should be made to confirm these plant types. Local, county, or state officials may provide some assistance, and a site visit can be very useful.

Table D-8. Procedures for Vegetation Analysis Using Stereoscopic Aerial Photographs.

1. Using the parallax bar or wedge, determine the height of three representative trees and compute the average height, h.

2. Locate three representative tree crowns, measure the diameters, and compute the average crown diameter, CD.

3. Determine the type of vegetation and calculate the stem diameter, D, using the following formulae:

Southern Pines	D (inches) = 5 + 0.5 CD (feet)
Eastern Hardwoods, Northern Pines and Others	D (inches) = 0.75 CD (feet)

4. Based on the scale of the aerial photographs, determine the diameter of a circle containing 0.08 hectares using Table 8a. Place the circle on the photograph, over a representative area of trees, and count the number of trees, n, in the circle. A magnifier may be needed. More than one area can be counted and an average used for n. Calculate the number of trees per hectare, N, using the following formula:

$$N = \frac{n}{0.08}$$

5. Determine the horizontal spacing between trees using the following formula:

$$b\ (feet) = \left(\frac{12732}{N} - \frac{D\ (inches)}{12}\right)$$

Table D-8. Procedures for Vegetation Analysis Using Stereoscopic Aerial Photographs (Cont.)

(800 Square Meters, 8712 Square Feet)

PHOTO SCALE	.08 HECTARE CIRCLE	CIRCLE DIAMETER	
		INCHES	MILLIMETERS
1:5,000		.253	6.38
1:6,000		.211	5.32
1:7,000		.1805	4.56
1:8,000		.158	3.99
1:9,000		.140	3.55
1:10,000		.126	3.192
1:11,000		.115	2.90
1:12,000		.105	2.66
1:13,000		.092	2.46
1:14,000		.090	2.28
1:15,000		.084	2.13
1:16,000		.079	1.99
1:17,000		.074	1.88
1:18,000		.070	1.77
1:19,000		.067	1.68
1:20,000		.063	1.60
1:21,000		.060	1.52
1:22,000		.057	1.45
1:23,000		.055	1.39
1:24,000		.053	1.33
1:25,000		.051	1.28

Table D-9. Marsh Plant Parameters

PARAMETER	EXPLANATION
C_D	Effective drag coefficient. Includes effects of plant flexure and modification of the flow velocity distribution. Default value is 0.1, usually appropriate for marsh plants without strong evidence to the contrary.
F_{cov}	Fraction of coverage. A default value is calculated by the program so that each plant type in the transect is represented equally, and the sum of the coverage for the plant types is equal to 1.0.
h	Unflexed stem height (feet). The stem height does not include the flowering head of the plant, the inflorescence.
N	Number density. Expressed as plants per square foot. The relationship to the average spacing between plants, b, can be expressed as $N = 1/b^2$.
D_1	Base stem diameter (inches). Default value may be determined from stem height and regression equations built into the program.
D_2	Mid stem diameter (inches). Default value may be determined from plant type and base stem diameter.
D_3	Top stem diameter (inches), at the base of the inflorescence. Default value may be determined from plant type and base stem diameter.
CA_b	Ratio of the total frontal area of the cylindrical portion of the leaves to the frontal area of the stem below the inflorescence. Default value may be determined from the plant type.

Table D-10. Abbreviations of Marsh Plant Types used in WHAFIS

SPECIES OR SUBSPECIES	ABBREVIATION
Cladium jamaicense (saw grass)	CLAD
Distichlis spicata (salt grass)	DIST
Juncus gerardi (black grass)	JUNM
Juncus roemerianus (black needlerush)	JUNR
Spartina alterniflora (medium saltmeadow cordgrass)	SALM
Spartina alterniflora (tall saltmeadow cordgrass)	SALT
Spartina cynosuroides (big cordgrass)	SCYN
Spartina patens (saltmeadow grass)	SPAT

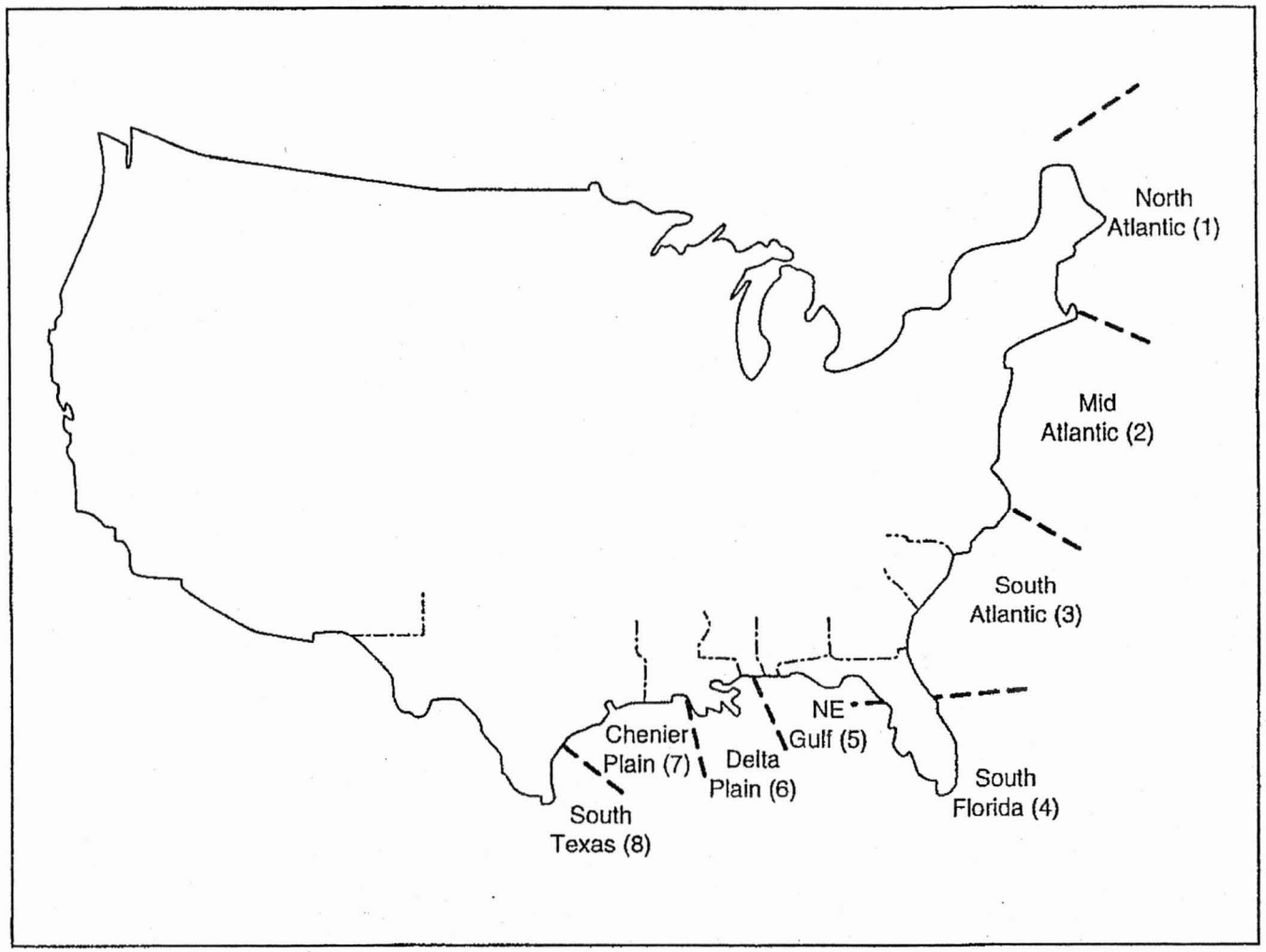


Figure D-22. Coastal wetland regions of Atlantic and Gulf coasts having enough marsh grass to significantly affect wave heights. Region numbers are indicated in parentheses.

Table D-11. Dominant Marsh Plant Types by Region and Habitat

REGION NUMBER	REGION NAME	HABITAT	DOMINANT SPECIES
1	North Atlantic	salt[1] brackish[2]	**S. alterniflora* (medium, tall) *Spartina patens*
2	Mid-Atlantic	salt brackish	*S. alterniflora* (medium, tall) **Juncus roemerianus/S. patens*
3	South Atlantic	salt brackish	**S. alterniflora* (medium, tall) *J. roemerianus*
4	South Florida	salt brackish	*S. alterniflora* (medium, tall) **C. jamaicense*
5	Northeastern Gulf	salt brackish	--- **J. roemerianus*
6	Delta Plain	salt brackish	**S. Alterniflora* (medium, tall) *S. patens*
7	Chenier Plain	salt brackish	*S. alterniflora* (medium, tall) **S. patens*
8	South Texas	salt brackish	--- ---

[1]Salt concentration is greater than 20 parts per thousand (ppt)

[2]Salt concentration is between 5 and 20 ppt

*When more than one dominant plant type occurs within the region, the indicated type covers the largest geographic area (acreage)

--- Insignificant amounts of marsh plants within the given habitat in the region

Table D-12. Significant Marsh Plant Types in Each Seacoast Region and WHAFIS Default Regional Plant Parameter Data

REGION NO.	1	2	3	4	5	6	7	8
REGION NAME:	**NORTH ATLANTIC**	**MID-ATLANTIC**	**SOUTH ATLANTIC**	**SOUTH FLORIDA**	**NORTHEASTERN GULF**	**DELTA PLAIN**	**CHENIER PLAIN**	**SOUTH TEXAS**
CLAD	---	---	---	7.50(+) 0.0656 6	6.00(2) 0.0260 6	---	---	---
DIST	---	0.78(1) 0.0039 211	1.00(1) 0.038 243	1.00(+) 0.0038 248	--- ---	1.08(4) 0.0035 102	1.08(+) 0.0035 102	---
JUNM	1.23(1) 0.0042 300	1.23(+) 0.0042 300	---	---	---	---	---	---
JUNR	---	2.95(+) 0.0095 147	2.95(+) 0.0095 147	---	2.95(3) 0.0095 147	3.00(4) 0.0106 83	2.95(+) 0.0095 147	---
SALM	1.39(1) 0.0184 45	1.06(1) 0.0103 36	1.63(1) 0.0141 12	1.63(+) 0.0141 12	---	1.67(4) 0.0141 21	2.62(5) 0.0211 16	---
SALT	1.86(1) 0.0175 37	2.21(1) 0.0169 18	3.20(1) 0.0183 10	3.20(+) 0.0183 10	---	3.20(4) 0.0183 10	3.20(+) 0.0183 10	---
SCYN	---	---	8.29(+) 0.0492 6	---	---	4.00(4) 0.0267 7	---	---
SPAT	1.03(1) 0.0025 409	0.85(1) 0.0019 327	1.65(1) 0.0019 236	---	2.58(2) 0.0026 236	1.88(4) 0.0016 333	1.88(+) 0.0019 333	---

Data arranged in vertical triplets:

h, stem height below inflorescence, in feet
D, base diameter, in feet
N, number density, in inverse square feet

Parenthetical references indicate data source:

1 = Hardisky and Reimold, 1977
2 = Monte, August 1983
3 = Kruczynski, Subrahmanyam, Drake, 1978
4 = Hopkinson, Gosselink, Parrondo, 1980, Diameters extrapolated
5 = Turner and Gosselink, 1975, Diameters extrapolated
+ = Extrapolated Data
--- = Insignificant amounts of this plant type in the region

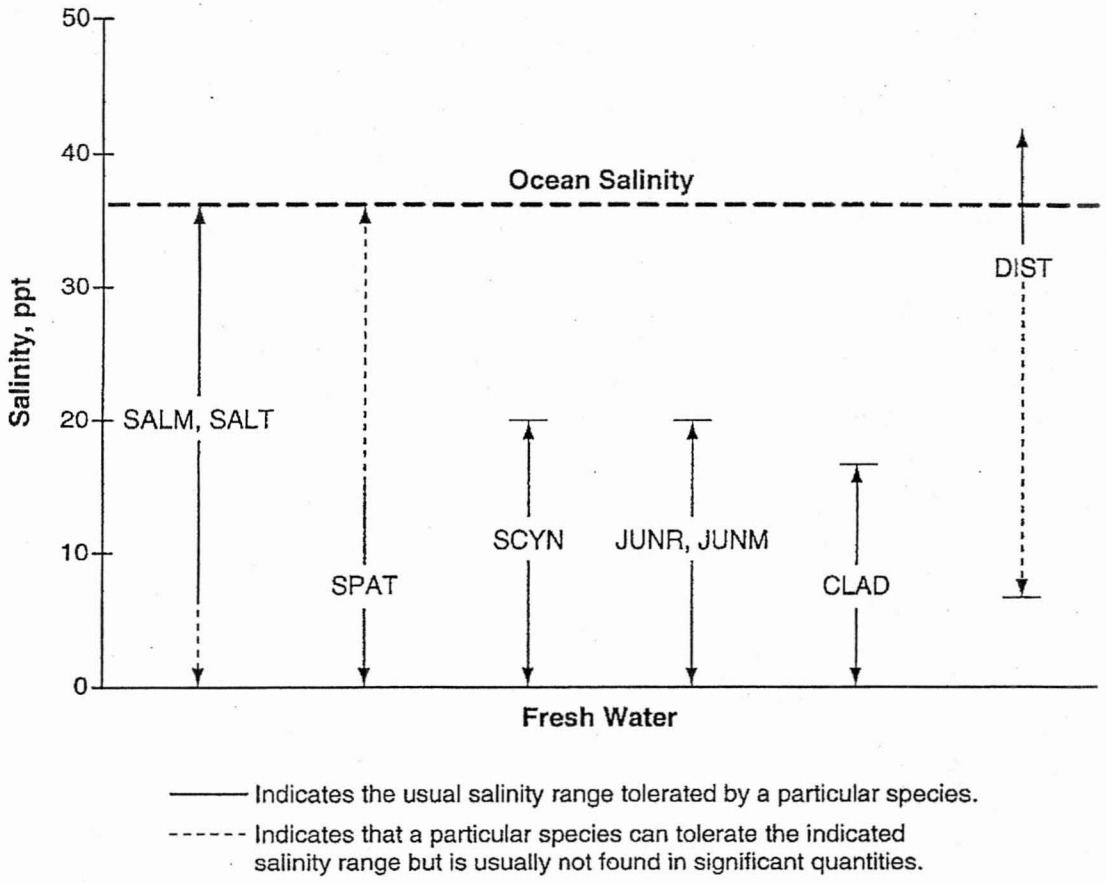


Figure D-23. Salinity Tolerance of Marsh Plants, from Knutson & Woodhouse, 1983

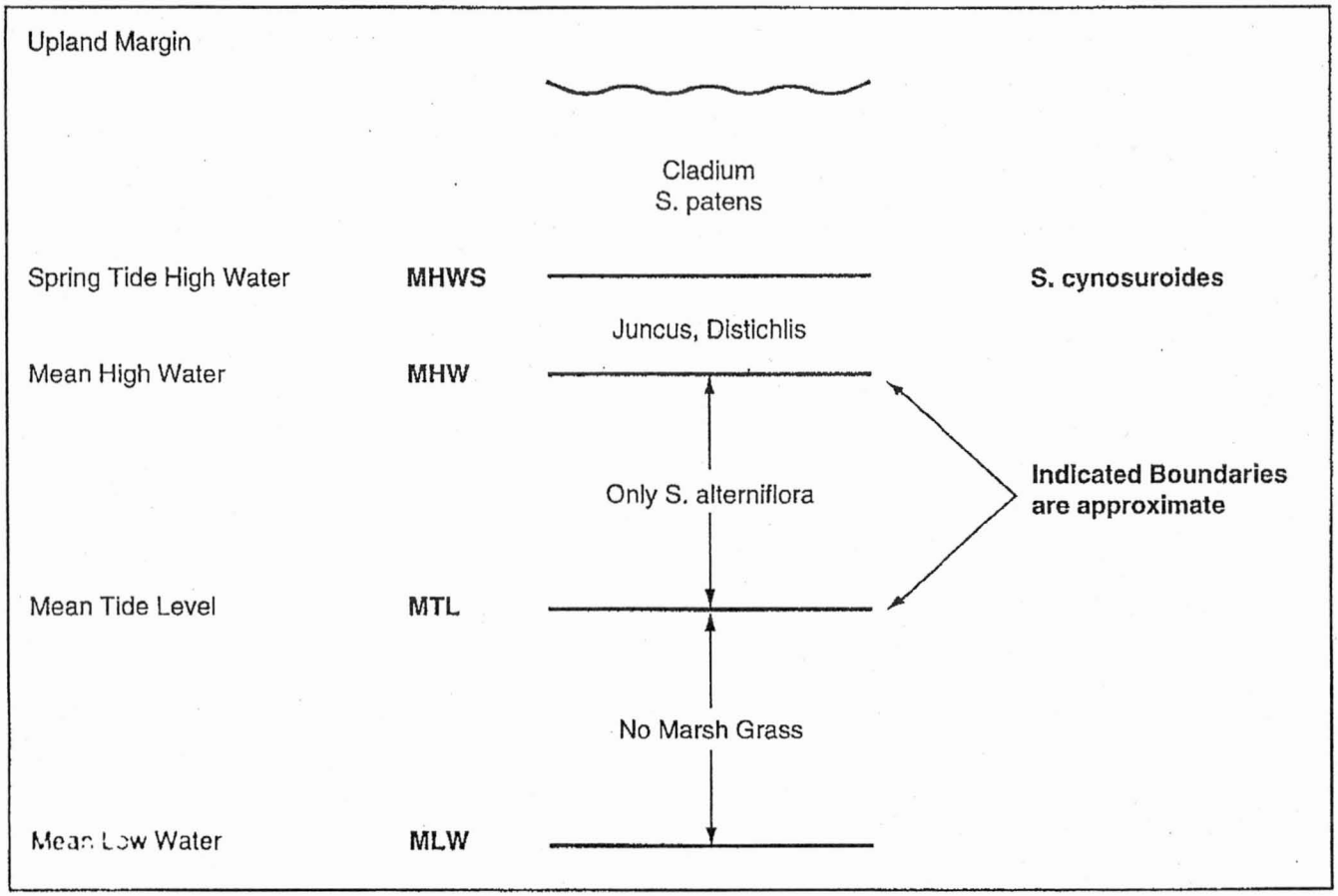


Figure D-24. Tidal Control on Salt Marsh Plant Viability

D.2.6.2 Input Coding for WHAFIS

After all the necessary input data have been identified on the transect, the Mapping Partner shall divide the transect into contiguous segments, each representing a continuous open fetch or a single obstruction. Fetches are flooded areas with no obstruction, while obstructions include dunes, manmade barriers, buildings, and vegetation. The Mapping Partner shall subdivide the fetches at points where the ground elevation abruptly changes and in the transition area of changing SWELs. The Mapping Partner shall subdivide obstructions into smaller segments at the transect's seaward edge to model the wave dissipation more accurately. Rigid vegetation shall have two to three seaward segments extending 10 to 50 feet, and the first two or three rows of buildings shall have a segment for each row. Marsh vegetation will be subdivided within WHAFIS, so segmented input from the Mapping Partner is not necessary.

The Mapping Partner shall enter the necessary data using 11 line types, including the Title line. The ten remaining lines, each describing a certain type of fetch or obstruction, are listed as follows:

- The IE (Initial Elevation) line describes the initial overwater fetch and the initial SWELs.
- The IF (Inland Fetch) and OF (Overwater Fetch) lines define the endpoint stationing and elevation of inland and overwater fetches, respectively.
- Obstructions are categorized either as buildings (BU line), rigid vegetation (VE line), marsh vegetation (VH and MG lines), dunes and other natural or manmade elongated barriers (DU line), or areas where the ground elevation is greater than the 1-percent-annual-chance SWEL (AS line).
- The ET (End of Transect) line enters no data but indicates the end of the input data.

Each line has an alphanumeric field describing the type of input for that line, followed by ten numeric fields describing the parameters.

To ensure proper modeling, the Mapping Partner shall enter all segments of each transect either as fetches or obstructions, with one input line required for each fetch or obstruction segment. The first two columns of each line identify the type of fetch or obstruction. The remaining 78 columns consist of one field of six columns followed by nine fields of eight columns. The Mapping Partner shall right-justify the numbers in any data field only if no decimal point is used. Decimal points are permitted but not required. The end point of one fetch or obstruction is the beginning of the next. The first two numeric fields of each line are used to read in the stationing (measured in feet from the beginning of transect) and elevation (in feet) of the end point. The last two fields used on each line are for entering new SWELs. An interpolation is performed within a transect segment starting at the closest station with an input SWEL. This interpolation uses the new SWEL input at the end point of the segment and the SWEL input at a previous segment. If these fields are blank or zero, the SWELs remain unchanged.

The input data requirements are summarized below for each line type. The Title line must be the first line, followed by the IE line, followed by any combination of the various fetch and obstruction lines. The ET line must be the last card entered for the transect. A blank line must follow to signify the end of the run. If multiple transects are being run, the Title line for the next transect will follow the blank line. All units are in feet unless otherwise specified.

TITLE Line (Title)

This line is required and must be the first input line.

DATA FIELD	COLUMNS	CONTENTS OF DATA FIELDS
0	1-2	Blank
1-10	3-80	Title information centered about column 40

IE Line (Initial Elevations)

This line is required and must be the second input line. This line is used to begin a transect at the shoreline and compute the wave height arising through the overwater fetch.

DATA FIELD	COLUMNS	CONTENTS OF DATA FIELDS
0	1-2	IE
1	3-8	Stationing of end point of initial overwater fetch in feet (zero at beginning of transect)
2	9-16	Ground elevation at end point in feet (usually zero at beginning of transect)
3	17-24	Overwater fetch length (miles), if wave condition is to be calculated. Values of 24 miles or greater yield identical results.
4	25-32	10-percent-annual-chance SWEL in feet
5	33-40	1-percent-annual-chance SWEL in feet
6	41-48	Initial wave height in feet; a blank or zero causes a default to a calculated wave height
7	49-56	Initial wave period (seconds); a blank or zero causes a default to a calculated wave period. The period is usually the most convenient wave specification for open coasts.
8-10	57-80	Not used

AS Line (Above Surge)

This line is used to identify the end point of an area with ground elevation greater than the 1-percent-annual-chance SWEL (such as a high dune or other land mass). This is used when the ground surface temporarily rises above the 1-percent-annual-chance SWEL. The line immediately preceding the AS line must enter the stationing and elevation of the point at which the ground elevation first equals the 1-percent-annual-chance SWEL. SWEL on the inland side may differ from SWEL on the seaward side. The ground elevation entered on the AS line must

equal the SWEL that applies to the inland side of the land mass. Computer calculations will be terminated if a ground elevation greater than the 1-percent-annual-chance SWEL is encountered.

DATA FIELD	COLUMNS	CONTENTS OF DATA FIELDS
0	1-2	AS
1	3-8	Stationing at end point in feet of area above 1-percent-annual-chance SWEL
2	9-16	Ground elevation in feet at end point
3	17-24	A blank or zero indicates no change to the 10-percent-annual-chance SWEL; otherwise new 10-percent-annual-chance SWEL
4	25-32	A blank or zero indicates no change to the 1-percent-annual-chance SWEL; otherwise new 1-percent-annual-chance SWEL
5-10	33-80	Not used

BU Line (Buildings)

This line enters information needed to compute wave dissipation at each group of buildings.

DATA FIELD	COLUMNS	CONTENTS OF DATA FIELDS
0	1-2	BU
1	3-8	Stationing of end point in feet of group of buildings
2	9-16	Ground elevation at end point in feet
3	17-24	Ratio of open space between buildings to total transverse width of developed area
4	25-32	Number of rows of buildings
5	33-40	A blank or zero indicates no change to 10-percent-annual-chance SWEL; otherwise new 10-percent-annual-chance SWEL
6	41-48	A blank or zero indicates no change to 1-percent-annual-chance SWEL; otherwise new 1-percent-annual-chance SWEL
7-10	49-80	Not used

DU Line (Dune)

This line enters information necessary to compute wave dissipation over flooded sand dunes and other natural or manmade elongated barriers (e.g., levees and seawalls).

DATA FIELD	COLUMNS	CONTENTS OF DATA FIELDS
0	1-2	DU
1	3-8	Stationing at top of dune or barrier in feet
2	9-16	Elevation at top of dune or barrier in feet
3	17-24	A blank or zero indicates a dune or other natural barrier; any other number indicates a seawall or other manmade barrier
4	25-32	A blank or zero indicates no change to 10-percent-annual-chance SWEL; otherwise new 10-percent-annual-chance SWEL
5	33-40	A blank or zero indicates no change to 1-percent-annual-chance SWEL;

DATA FIELD	COLUMNS	CONTENTS OF DATA FIELDS
		otherwise new 1-percent-annual-chance SWEL
6-10	41-80	Not used

IF Line (Inland Fetch)

This line enters the parameters necessary to compute wave regeneration through somewhat sheltered fetches and over shallow inland water bodies. The IF regeneration is computed using a sustained wind speed of 60 mph.

DATA FIELD	COLUMNS	CONTENTS OF DATA FIELDS
0	1-2	IF
1	3-8	Stationing at end point of fetch in feet
2	9-16	Ground elevation at end point in feet
3	17-24	A blank or zero indicates no change to 10-percent-annual-chance SWEL; otherwise new 10-percent-annual-chance SWEL
4	25-32	A blank or zero indicates no change to 1-percent-annual-chance SWEL; otherwise new 1-percent-annual-chance SWEL
5-10	33-80	Not used

OF Line (Overwater Fetch)

This line enters the parameters necessary to compute wave regeneration over large bodies of water (i.e., large lakes, bays) using a sustained wind speed of 80 mph. If an inland body of water is sheltered and has a depth of ten feet or less, the IF line calling for reduced wind speed should be used.

DATA FIELD	COLUMNS	CONTENTS OF DATA FIELDS
0	1-2	OF
1	3-8	Stationing at end point of fetch in feet
2	9-16	Ground elevation at end point in feet
3	17-24	A blank or zero indicates no change to the 10-percent-annual-chance SWEL; otherwise new 10-percent-annual-chance SWEL
4	25-32	A blank or zero indicates no change to 1-percent-annual-chance SWEL; otherwise new 1-percent-annual-chance SWEL
5-10	33-80	Not used

VE Line (Vegetation)

This line enters parameters necessary to compute wave dissipation due to rigid vegetation stands.

DATA FIELD	COLUMNS	CONTENTS OF DATA FIELDS
0	1-2	VE
1	3-8	Stationing at end point of vegetation in feet
2	9-16	Ground elevation at end point in feet
3	17-24	Mean effective diameter of equivalent circular cylinder in feet
4	25-32	Average actual height of vegetation in feet
5	33-40	Average horizontal spacing between plants in feet
6	41-48	Drag coefficient; a blank or zero causes a default to 1.0
7	49-56	A blank or zero indicates no change to 10-percent-annual-chance SWEL; otherwise new 10-percent-annual-chance SWEL
8	57-64	A blank or zero indicates no change to 1-percent-annual-chance SWEL; otherwise new 1-percent-annual-chance SWEL
9-10	65-80	Not used

VH Line (Vegetation Header for Marsh Grass)

Marsh grass is often part of a plant community that may consist of several types. The VH line is used to enter data that apply to all plant types modeled in the transect segment. To enter data for each plant type, MG lines for each plant type must follow the VH line.

DATA FIELD	COLUMNS	CONTENTS OF DATA FIELDS
0	1-2	VH
1	3-8	Stationing at end point of marsh vegetation segment in feet
2	9-16	Ground elevation at end point in feet
3	17-24	Reg_p, number of the primary seacoast region for default plant parameters. See Figure 22.
4	25-32	Wt_p, weighting factor for the primary seacoast region.
5	33-40	Reg_s, number of secondary seacoast region. See Figure D-22.
6	41-48	N_{pl}, number of plant types; range is 1 to 10, inclusive. One MG line is required for each plant type.
7	49-56	A blank or zero indicates no change to the 10-percent-annual-chance SWEL; otherwise new 10-percent-annual-chance SWEL
8	57-64	A blank or zero indicates no change to the 1-percent-annual-chance SWEL; otherwise new 1-percent-annual-chance SWEL
9	65-72	Not used
10	73-80	This field is for overriding the default method of averaging flood hazard factors

DATA FIELD	COLUMNS	CONTENTS OF DATA FIELDS
		in A Zones; if 1 in column 80, averaging process begins or ends at end of vegetation segment; otherwise, default averaging method is used

MG Line (Marsh Grass)

This line is used to enter data for a particular plant type. The first MG line must be preceded by a VH line. For the common seacoast marsh grasses listed in Table D-10, some potentially useful default values are supplied in Table D-12, and the program can provide additional default values (FEMA, October 1984). If a plant type not listed in the table is used, then appropriate data must be developed for Fields 2-9.

DATA FIELD	COLUMNS	CONTENTS OF DATA FIELDS
0	1-2	MG
1	5-8	Marsh plant type abbreviation (see Table 10)
2	9-16	C_D, effective drag Coefficient; default value is 0.1
3	17-24	F_{cov}, decimal fraction of vegetated area to be covered by this plant type; a blank or zero causes a default to be calculated so that each plant type is represented equally
4	25-32	h, mean unflexed height of stem (feet); for marsh plants, the inflorescence is not included
5	33-40	N, number of plants per square foot
6	41-48	D_1, base stem diameter (inches)
7	49-56	D_2, mid stem diameter (inches)
8	57-64	D_3, top stem diameter (inches)
9	65-72	CA_b, ratio of the total frontal area of cylindrical part of leaves to frontal area of main stem
10	73-80	Not used

ET Line (End of Transect)

This line is required and must be the last input card because it identifies the end of input for the transect.

DATA FIELD	COLUMNS	CONTENTS OF DATA FIELDS
0	1-2	ET
3-10	3-80	Not used

[February 2002]

D.2.6.3 Error Messages

The error messages that may appear when running the model are described below.

- "AS card ground elevation less than SWEL, should use other type card, job dumped."

  Only use AS (above surge) line when the ground elevation is above the SWEL. Can otherwise use IF, OF, BU, DU, VE, or VH.

- "Ground elevation greater than surge elevation encountered, job dumped."

If ground elevation is above surge elevation, AS card should be used.

- "Average depth less than or equal to zero, job dumped."

  The water depth must be greater than zero or a wave height cannot be computed. Check the SWEL and the ground elevation if point of job dump is not the last point along the transect profile.

- "The above card contains illegal data in the first 2 columns."

  Check input data for incorrect values or input within wrong columns. Aside from the title line, the first two columns in each line should contain the card identifiers.

- "Transmitted wave height at last fetch or obstruction = _____ which exceeds 0.5."

  Code the transect profile up to the inland limit where ground elevation intersects the SWEL so that wave height should decrease to zero. If the scope of work ends at the corporate limits before the ground elevation meets the SWEL, this message can be ignored.

- "Array dimensions exceeded. Job dumped."

  Size of the array is limited and the number of input parameters has exceeded the array. Check the number of input parameters at the location where the job dumped.

- "Invalid data in field 1 of IF card," etc.

  Check input data to make sure that data are in correct columns.

- "Wave period less than or equal to zero in subroutine fetch. Abort run."

  Either a fetch length or a wave period must be input for the program to run properly. Check input data.

- "Invalid data in field 3 or field 5 of VH card."
  Check input data.
- "Invalid data in field 4 of VH card."

  Check input data.

- "Invalid data in field 3 of MG card."

  Check input data. The fraction of vegetated area covered by the stated plant type should be a decimal number between 0.0 and 1.0.

- "Missing MG card or incorrect data in field 6 of VH card."

  A MG card must always follow the VH card. Field 6 of the VH card pertains to the number of plant types, and one MG card is required for each plant type.

- "Invalid input data."

  Check input data for invalid characters, such as an O instead of a zero. Check to be sure that all data are in their correct columns.

- "Fcov was found to be negative for plant type = _____."

  Check input data to be sure that the decimal fraction of the vegetated area covered by the plant type is not negative.

- "Ncov is .LE. zero in Sub.Lookup when it should be .GT. zero. Abort run."

  Check input for number of plants covering the area.

- "The first card is not an IE card, this transect is aborted. Continued to next transect."

  The first card after the title line must always be an IE card. Check input data.

- "**** The surge elevation at this station (stationing ____), which is ____ card, is less than the ground elevation. The interpolation process is continued. *** Please double check the surge and ground elevations in the vicinity of this station"

  The surge elevation should not be below the ground elevation. If the interpolated surge elevation is interpolated below the ground elevation, insert additional cards to specify surge and ground elevations and use an AS card if necessary.

- "Interpolation line cuts off more than two portions of high ground ridge. This transect is aborted, re-assign 1-percent-annual-chance elevations at high ground stations."

  When the interpolated value falls below the ground elevation, insert additional cards to better model the area and set the SWEL equal to the ground elevation where appropriate. Insert AS cards as necessary.

- "**** Unreasonable high ground elevation at station ____ which is ____ card. This transect is aborted, continued to next transect. **** Double check the surge and ground elevations in the vicinity of this station. If the ground elevations are correct, either assign a higher surge elevation or use AS cards."

  Add additional input data as necessary to better define the ground elevation and surge elevation in this area.

[February 2002]

D.2.6.4 Output Description

The output of the program provides all the data necessary for plotting the BFEs and flood insurance risk zones along the transect. The output is in six parts:

Part 1 - Input

This is a printout showing all input data lines and the parameters assigned to each line, both manually and by default. This is followed by a more detailed printout with column headings for each input data line. When VH and MG Lines are used, a separate insert will be printed directly beneath the MG Line showing any default values supplied by the computer.

Part 2 - Controlling Wave Heights, Spectral Peak Wave Period, and Wave Crest Elevations

This is a list of the calculated controlling wave heights, spectral wave peak periods, and wave crest elevations at the end point of each fetch and obstruction of the input, and at calculation points generated between the input stations.

Part 3 - Location of Areas Above 1-Percent-Annual-Chance Surge

This is a list of the locations of areas where the ground elevation is greater than the 1-percent-annual-chance stillwater (surge) elevation. Only areas identified by AS lines are listed.

Part 4 - Location of Surge Elevations

This is a list of the 10- and 1-percent-annual-chance stillwater (surge) elevations and the stationing of the points where each set of SWELs first becomes fully effective.

Part 5 - Location of V Zones

This is a list of the locations of the V/A Zone boundary and locations of the V Zone areas relative to these boundaries. The stationing is given for each V/A Zone boundary. The locations of the V Zone areas in relation to these boundaries are given as windward or leeward of the boundary.

Part 6 - Numbered A Zones and V Zones

This is a list of the zone data needed to delineate the flood hazard boundaries on the FIRM. The location of a flood zone boundary and the wave crest elevation at that boundary are given on the left. Between the boundary listings are the zone designations and FHFs. Under FEMA's Map Initiatives Procedure guidelines, all numbered V and A Zones should be changed to VE and AE Zones, respectively (elevations will not change), and the FHFs can be ignored (FEMA, 1991). When the same zone and elevation are repeated in the list, they should be treated as a single zone.

[February 2002]

D.2.7 Mapping of Flood Elevations and Zones

Requirements for reviewing the initial model results and identifying flood insurance risk zones, guidance and examples for determining transects, and guidance for depicting the analysis on the FIRM are presented in this subsection.

[February 2002]

D.2.7.1 Review and Evaluation of Basic Results

Prior to mapping the flood elevations and zones, the Mapping Partner shall review results from the models and assessments from a common-sense viewpoint and compare them to available historical data. When using these models, there is the potential to forget that the transects represent real shorelines of sandy beaches, rocky or cohesive bluffs, wetlands being subjected to extremely high water, waves, and winds. Familiarity and experience with the coastal area being modeled or similar areas should provide an idea of what is a "reasonable" result.

Use of the historical data is also very important in evaluating whether the results are reasonable. It would be very convenient if data from a storm closely approximating the 1-percent-annual-chance event were available, but this is seldom the case. Although most historical flood data are

for storms less intense than a 1-percent-annual-chance event, these data will still indicate, at a minimum, what areas should be in flood zones. For instance, if a storm that produced an extreme flood below the 1-percent-annual-chance SWEL generally caused structural damage to houses 100 feet from the shoreline, a "reasonable" Zone VE width must be at least 100 feet. Similarly, houses that collected flood insurance claims for the same storm should be at least in a Zone AE, AH, or AO. If the analyses of the 1-percent-annual-chance flood produce flood zones and elevations indicating lesser hazards than those recorded for a more common storm, the analyses should be reevaluated. One possible explanation can be that a new coastal structure acts to reduce flood hazards locally.

If there are indications that a reevaluation is needed, the Mapping Partner shall determine whether the results of the erosion assessment are appropriate. The Mapping Partner shall attempt to compare the eroded profile to past effects, whether in the form of profiles, photographs, or simply descriptions. A general idea of what happened previously can be sufficient. The Mapping Partner shall use judgment and experience to project previous storm effects to the 1-percent-annual-chance conditions and to ensure that the eroded profile is consistent with previous events.

The Mapping Partner shall examine other data input to the assessments of wave effects. This includes checking that the SWELs, wave heights, wave periods, and fetch lengths were used correctly and are consistent with the historical data. Further consideration might be given to examining if the buildings or structures modeled would be destroyed by the storm or if the buildings are on pilings above the flooding.

The main point to be emphasized here is that the results should not be blindly accepted. There are many uncertainties and variables in coastal processes during an extreme flood and many possible adjustments to methodologies for treating such an event. The validity of any model is demonstrated by its success in reproducing recorded events. Therefore, the model results must be in basic agreement with past flooding patterns, and historical data must be used to evaluate these results.

[February 2002]

D.2.7.2 Identification of Flood Insurance Risk Zones

The Mapping Partner shall identify the flood insurance zones and BFEs including wave heights be identified on each transect plot before delineating the flood insurance zones on the work maps, because of additional wave effects along with the 1988 redefinition of Coastal High Hazard Area to include the primary frontal dune. The existing topography, eroded transect, combination of shore effects in the wave envelope, and other results from wave overtopping assessment are all important to the proper identification of flood insurance risk zones.

Specifically, as discussed in Subsection D.2.1.2, the existing ground profile defines an appropriate extent of the primary frontal dune, as a ridge of sand bounded by relatively steep slopes. As discussed in Subsection D.2.4.5, the eroded transect for cases of duneface retreat may imply that flood hazards due to wave overtopping extend into an area landward of the WHAFIS results. In addition, as discussed in Subsection D.2.5.7, wave overtopping of stable shore barriers can result in flooding to areas above the mean elevation of wave runup. However, the

main consideration for integrated treatment of wave-controlled flood elevations is to define the wave envelope joining height and runup effects.

This wave envelope is a combination of representative wave runup elevation with the controlling wave crest profile determined by WHAFIS. The wave crest profile is plotted on the transect from the data in Part 2 of the WHAFIS output. A horizontal line is extended seaward from the wave runup elevation to its intersection with the wave crest profile to obtain the wave envelope, as shown in Figure D-25. If the runup elevation is greater than the maximum wave crest elevation, the wave envelope will be a horizontal line at the runup elevation. Conversely, if the wave runup is negligible or was not modeled, the wave crest profile becomes the wave envelope.

Flood insurance risk zones are defined basically by the wave envelope along with the general zone descriptions in Table D-13. Those results are supplemented by runup and overtopping considerations, as introduced previously. The following material outlines the process of flood insurance risk zone identification, with specific examples presented in the next section to illustrate some usual results.

Table D-13. Descriptions of Coastal Flood Insurance Risk Zones

Zone VE	Coastal High Hazard Areas where wave action and/or high-velocity water can cause structural damage in the 1-percent-annual-chance flood. These areas are primarily identified by: (1) the area where 3-foot or greater wave height could occur (this is the area where the WHAFIS wave crest profile is 2.1 feet or more above the SWEL), (2) the area where the eroded ground profile is 3 feet or more below the representative runup elevation, and (3) the entire primary frontal dune, by definition. Subdivided into elevation zones with BFEs assigned.
Zone AE	Areas of inundation by the 1-percent-annual-chance flood, including wave heights less than 3 feet and runup elevations less than 3 feet above the ground. These areas are also subdivided into elevation zones with BFEs assigned.
Zone AH	Areas of shallow flooding or ponding, with water depths of 1 to 3 feet. These areas are usually not subdivided, and a BFE is assigned.
Zone AO	Areas of sheet-flow shallow flooding where overtopping water flows into another flooding source. These areas are designated with 1-, 2-, or 3-foot depths of flooding.
Zone X	Areas above 1-percent-annual-chance flood inundation. On the FIRM, shaded Zone X is inundated by the 0.2-percent annual chance flood, unshaded Zone X is above the 0.2-percent annual chance flood.

For a complete listing of flood insurance risk zones, refer to Section 1.4.2.7.1 of Volume 1 of these Guidelines.

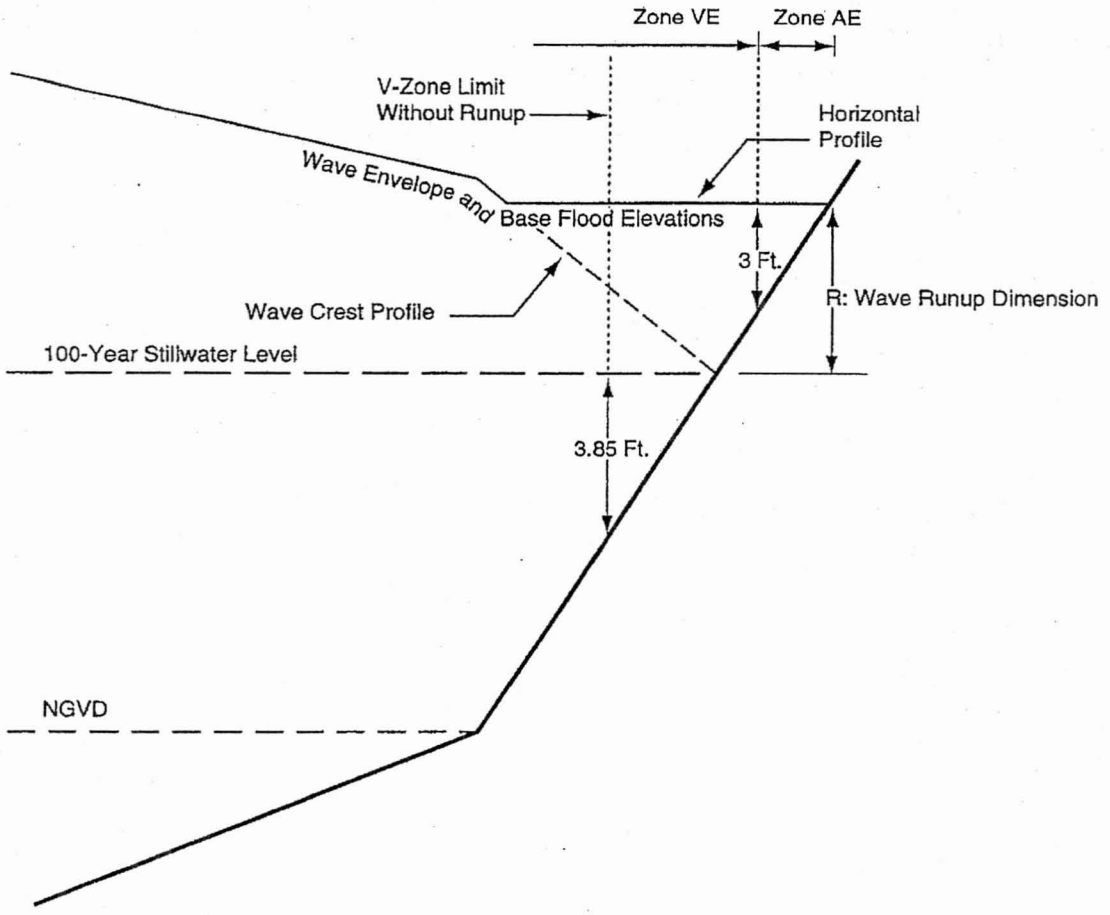


Figure D-25. Wave Envelope Resulting from Combination of Nearshore Crest Elevations and Shore Runup Elevation

The first step in identifying the flood insurance risk zones on the transect is locating the inland extent of the VE Zone, also known as the VE/AE boundary. The VE-Zone limit for each of the three criteria is identified, and the VE/AE boundary placed at the one furthest landward, as shown in Figure D-26. The Mapping Partner may need to move that boundary further inland in the vicinity of a wave barrier where severe overtopping is indicated for the 1-percent-annual-chance flood, so high-velocity impacts occur over a limited landward area.

The Mapping Partner shall extend the Zone AE from the VE/AE boundary to the inland limit of 1-percent-annual-chance inundation, which is a ground elevation equal to the representative runup elevation, or the 1-percent-annual-chance SWEL if runup is negligible. The Mapping Partner may designate additional areas of shallow flooding or ponding for the 1-percent-annual-chance event as Zone AH or Zone AO. In cases of severe wave overtopping effects, a VE Zone may abut areas designated as Zone AH or Zone AO. The Mapping Partner shall label all areas above the 1-percent-annual-chance inundation as Zone X.

The Mapping Partner shall then subdivide the Zone AE and VE areas into elevation zones with whole-foot BFEs assigned according to the wave envelope. Ideally, the Mapping Partner would establish an elevation zone for every BFE in the wave envelope; but because these zones are mapped on the FIRM so that buildings or property can be located in a flood insurance risk zone, the Mapping Partner shall use a minimum width for the mapped zone to provide a usable FIRM. For coastal areas, the minimum zone width is 0.2 inch on the FIRM. For identifying elevation zones on the transect, the minimum width is 0.2 times the final FIRM scale; for example, a width of 80 feet for a FIRM at a scale of 1 inch equals 400 feet, or a width of 100 feet for a FIRM at a scale of 1 inch equals 500 feet.

The Mapping Partner shall not subdivide the horizontal runup portion of the wave envelope, if any; the runup elevation, rounded to the nearest whole foot, is the BFE. The Mapping Partner shall subdivide the WHAFIS wave crest profile. Generally, the VE Zone is subdivided first. Initially, the Mapping Partner shall mark the location of all elevation zone boundaries on the transect. Because whole-foot BFEs are being used, these should always be at the location of the half-foot elevation on the wave envelope.

The Mapping Partner shall combine elevation zones that do not meet the minimum width with an adjacent zone or zones to yield an elevation zone wider than the minimum. The BFE for this combined zone is a weighted average of the combined zones. Often, in subdividing VE Zones, the maximum BFE is located just inside the mapped shoreline, and the remainder of the VE Zone is then subdivided into elevation zones of the minimum width.

The Zone AE, if wide enough, shall be subdivided in the same manner. If the total AE Zone is less than the minimum width, the lowest elevation VE Zone is usually assigned to that area. This situation typically occurs for steep or rapidly rising ground profiles, and it is not unreasonable to designate the entire inundated area as a VE Zone. In some cases, however, it may be appropriate for the Mapping Partner to extend the AE Zone slightly into the next zone seaward in order to satisfy the minimum width requirement.

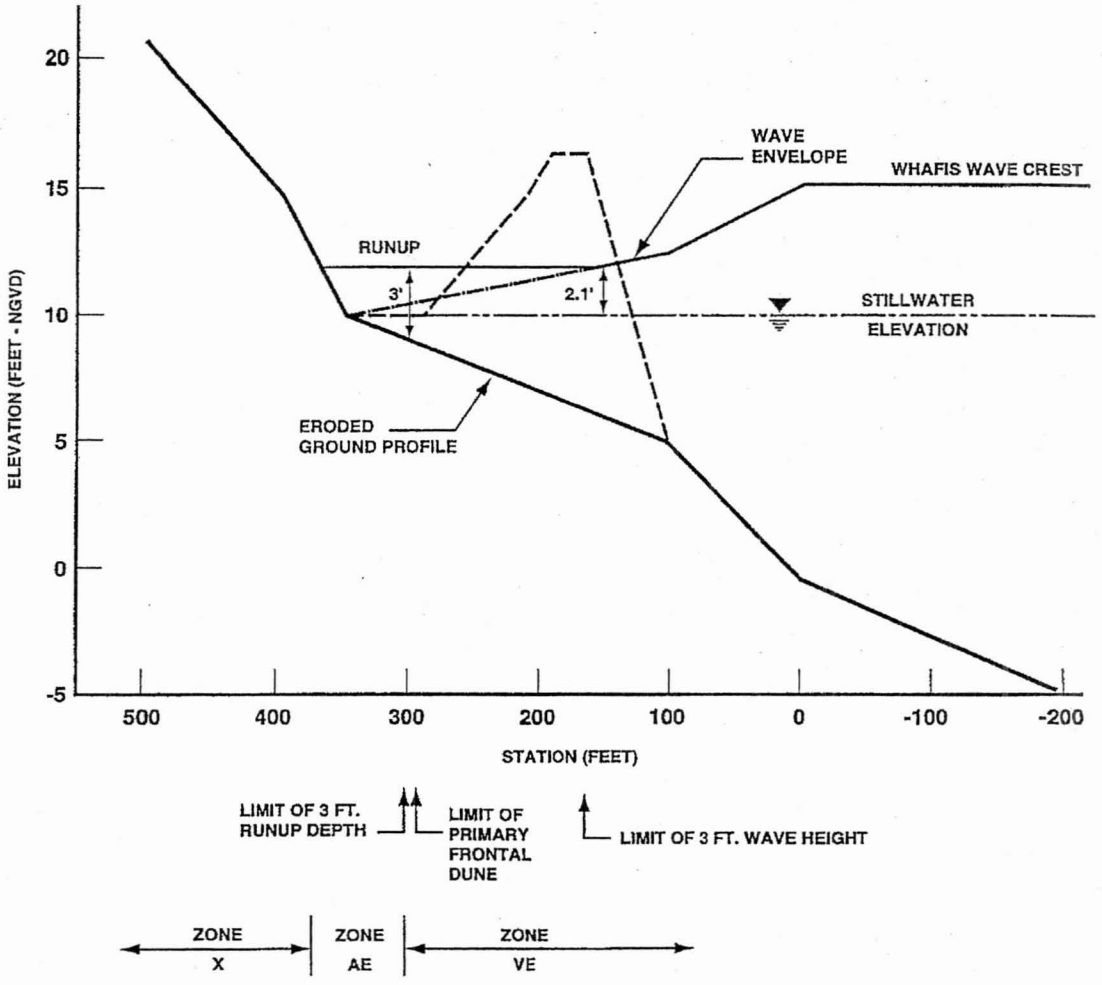


Figure D-26. Possible V-Zone Limits at Eroded Dune

Relatively low areas inland of zones with assigned wave elevations may be subject to shallow flooding or ponding of flood water; the Mapping Partner shall designate these areas as Zone AH or Zone AO. Such designations can be relatively common landward of coastal structures and dunes, where wave overtopping occurs. Identifying appropriate zones and elevations may require particular care for dunes, given that the entire primary frontal dune is defined as Coastal High Hazard Area. Although the analyses may have determined a dune will not completely erode and wave action should stop at the retreated duneface with only overtopping possibly propagating inland, the Mapping Partner shall designate the entire dune as Zone VE. The Mapping Partner shall assign the BFE at the duneface for the remainder of the dune.

It may seem unusual to use a BFE that is lower than the ground elevation, although this is actually fairly common. Most of the BFEs for areas where the dune was assumed to be eroded are also below existing ground elevations. In these cases, it is the VE Zone designation that is most important to the NFIP, under current regulations, structures in VE Zones must be built on pilings and prohibits alterations to the dune.

[February 2002]

D.2.7.3 Transect Examples

Figure D-26 provides a schematic summary for the three criteria potentially defining the landward limit to the Coastal High Hazard Area. The examples discussed below depict idealized transects of typical types to illustrate common flood hazard zonations in a quantitative way. Coastal erosion is a dominant consideration for the first set of examples. The second set of examples addresses some usual effects at stable shore barriers exposed to extreme wave action.

Figure D-27 presents an example of dune removal with appreciable runup occurring on the eroded profile. For this transect, the VE Zones with BFEs of 13, 14, and 15 feet are too narrow to be mapped, so they are averaged to a BFE of 14 feet. The Zone VE, elevation 12 feet, is enlarged slightly to include some of the elevation 13-foot area so that the boundary would be located at the dune toe or 5-foot contour line, a feature easily identified on the work map. The boundary between the Zone VE, elevation 14 feet and the Zone VE, elevation 16 feet is located just landward of the shoreline. The Zone AE, elevation 12 feet, in Figure D-27 is only 70 feet wide, slightly less than the minimum mapping width. In this example, the Mapping Partner would have to examine the work map to determine if this zone might be wider or narrower in the contiguous area. If wider, the Zone AE should be used; if narrower, the designation extended through this area should be Zone VE, elevation 12 feet.

Figure D-28 illustrates an example of a relatively high retreated duneface. A mean runup elevation of 13 feet is calculated for the eroded duneface. This elevation is assigned through the dune, all of which is designated as Zone VE. Because the dune remnant extends more than 7 feet above the SWEL, no flooding landward of the dune is indicated by designating the area as Zone X. Note that the retreated dune profile shifts the 0.0 foot elevation shoreline 65 feet seaward. Because the existing 0.0 foot elevation shoreline is used on the work map, the Zone VE, elevation 16 feet, is located just landward of the existing shoreline.

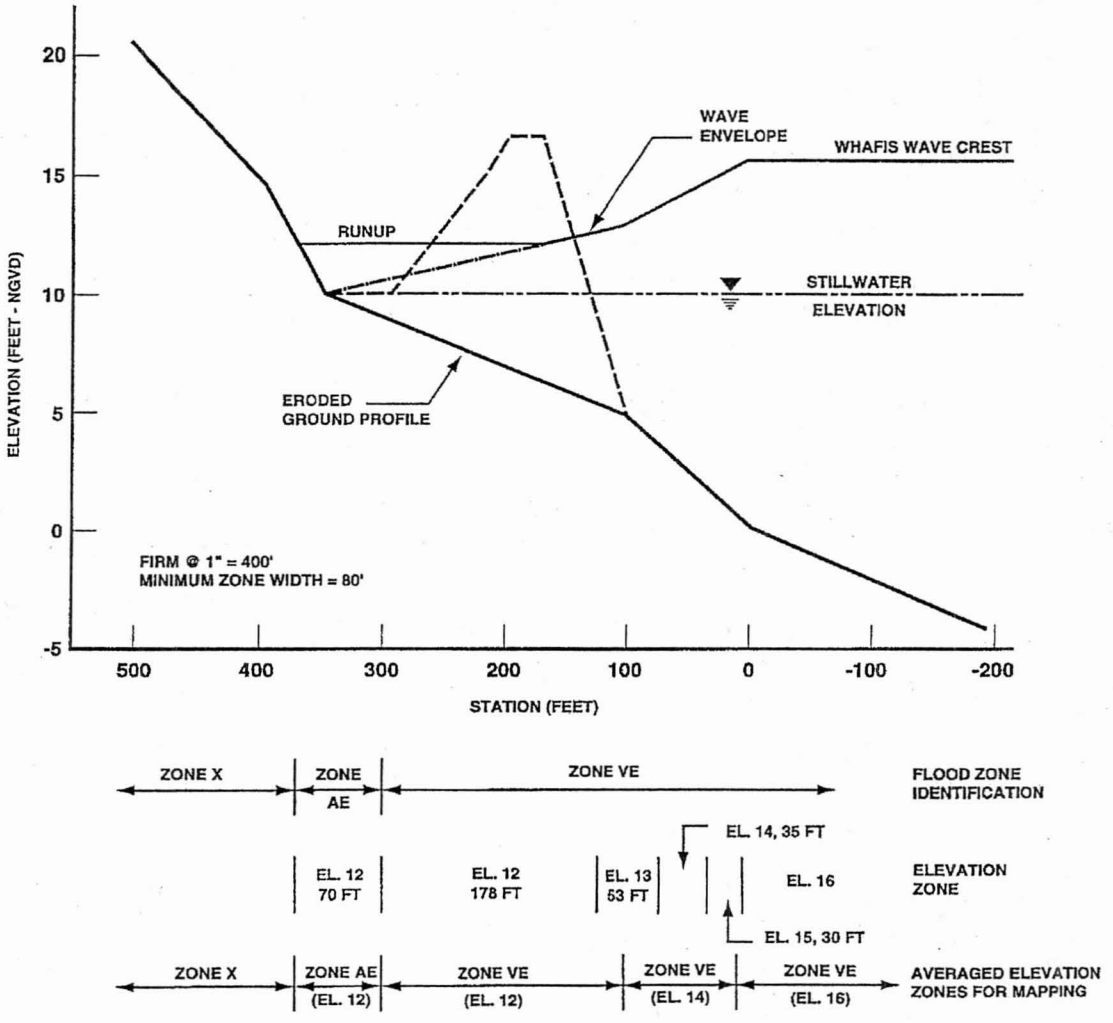


Figure D-27. Identification of Elevation Zones, Example 1: Dune Removal with Wave Runup Landward

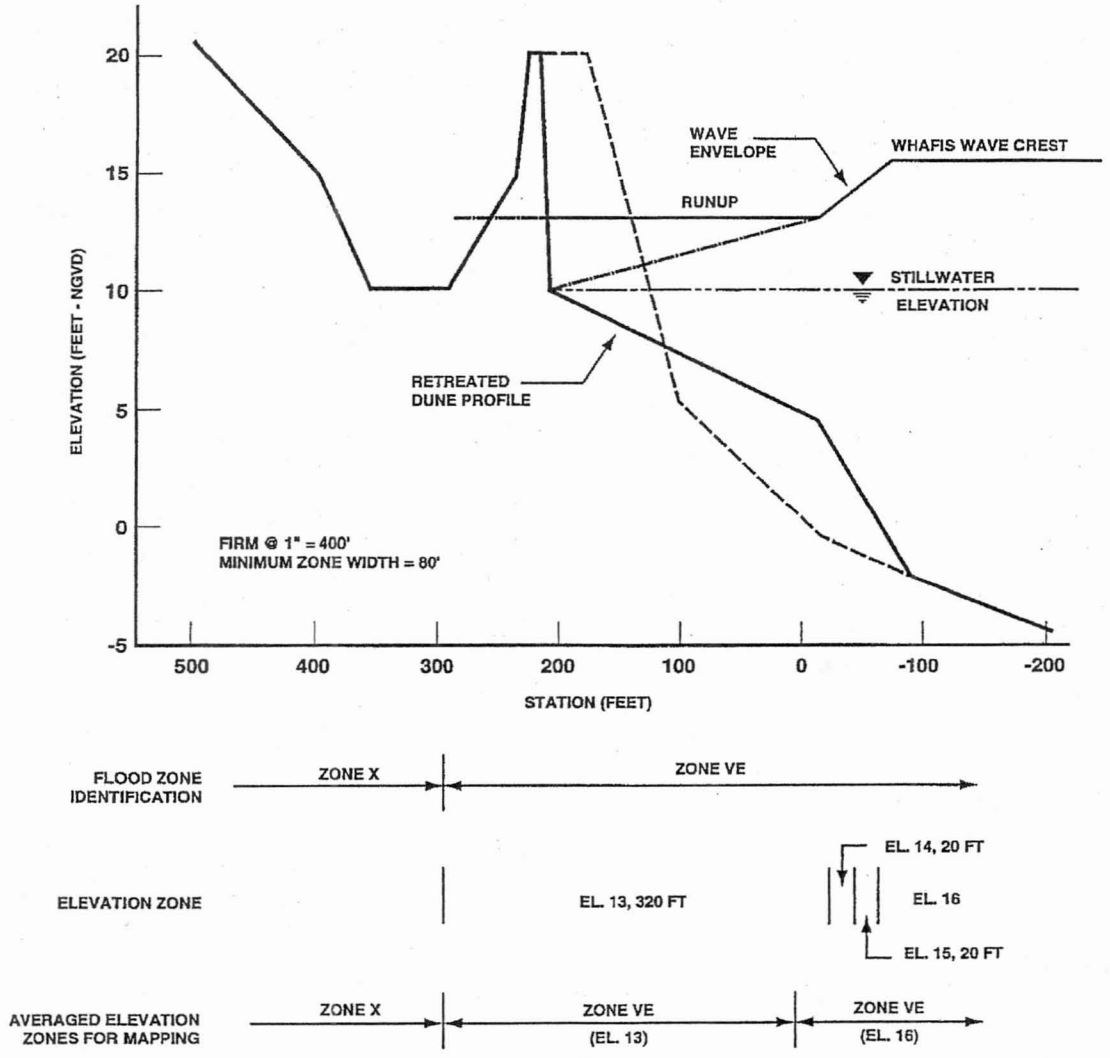


Figure D-28. Identification of Elevation Zones, Example 2: Duneface Retreat with Relatively High Remnant.

Figure D-29 illustrates an example of a retreated duneface with a relatively small remnant having low relief. A mean runup elevation of 12 feet is calculated for the eroded profile, and this flood elevation is assigned through the dune, all of which is designated as Zone VE . The division into separate map zones is similar to the division in Figure D-28. Because the dune remnant extends less than 7 feet above the SWEL, appreciable wave overtopping is expected during the 1-percent-annual-chance flood. An area landward of the dune of about the minimum mapping width is designated as a Zone AO, depth 1 foot.

Figure D-30 illustrates an example of dune removal where there is some runup and overtopping of the remaining stub. As in Figure D-27, the VE Zone with a runup elevation of 11 feet is extended to the dune toe and the Zone VE, elevation 16 feet, is located just landward of the shoreline. Although elevation 14 feet is shown on Figure D-30 for the intermediate VE Zone, elevation 13 feet could also be used; adjacent transects should be examined and a compatible BFE should be selected. Also note that the boundary between the Zone AO, depth 1 foot, and the Zone AE, elevation 7 feet, is at the intersection of the SWEL and ground profile.

An eroded bluff is shown in Figure D-31. The angle of the bluff face remains the same while the seaward extension from the toe is a 1:40 slope. The computed runup elevation slightly exceeds the bluff crest and is higher than the maximum wave crest elevation. The area is designated Zone VE, elevation 18 feet, until the difference between the runup elevation and the ground is less than 3 feet. In this figure, the Zone AE, elevation 18 feet, is slightly narrower than the minimum mapping width. As was recommended for the example in Figure D-27, the neighboring area on the work map should be examined to determine if this zone should be mapped. AE Zones are usually not mapped for bluffs unless computed runup exceeds the bluff crest, as shown in Figure D-31. (Note: Figures D-16 and D-17 outline another flooding treatment of bluffs where computed runup is well above the crest.)

On sandy shores, transects usually are extended across barrier islands, marshes, inland water bodies, etc., such that at least two VE Zones can be identified. Procedures in these cases are the same, with elevation averaging also very common. With a little practice, identification of the flood zones and elevations becomes fairly routine using the wave envelope and transect profile.

With shore structures having steep slopes, runup elevations are relatively high and a wide range of wave hazards can occur, including erosion or scour near the structure. These circumstances may result in a variety of distinct and compact situations, where appreciable engineering judgment can be required for appropriate assessment of flood hazards.

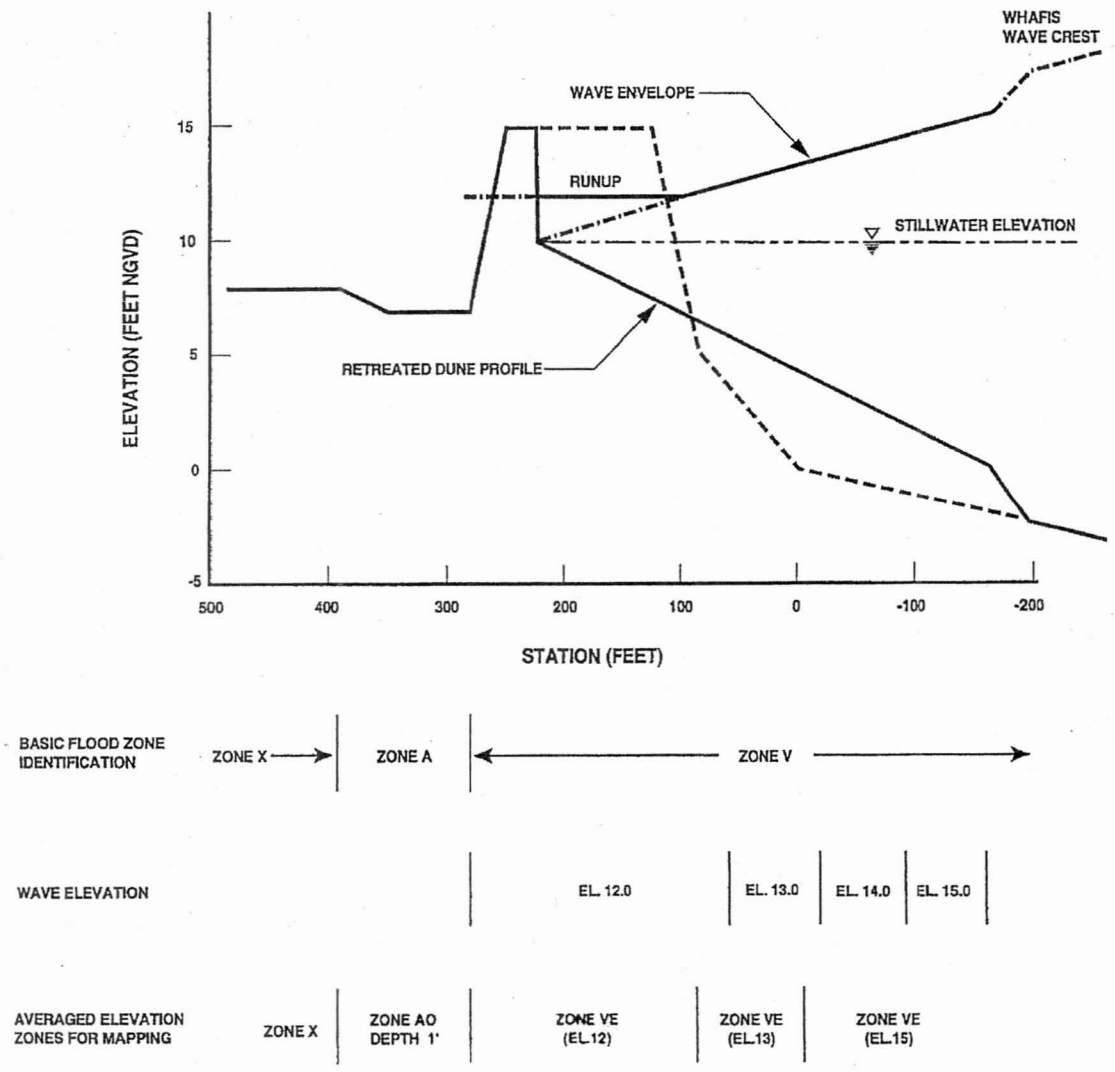


Figure D-29. Identification of Elevation Zones, Example 3: Low Retreated Dune with Wave Overtopping.

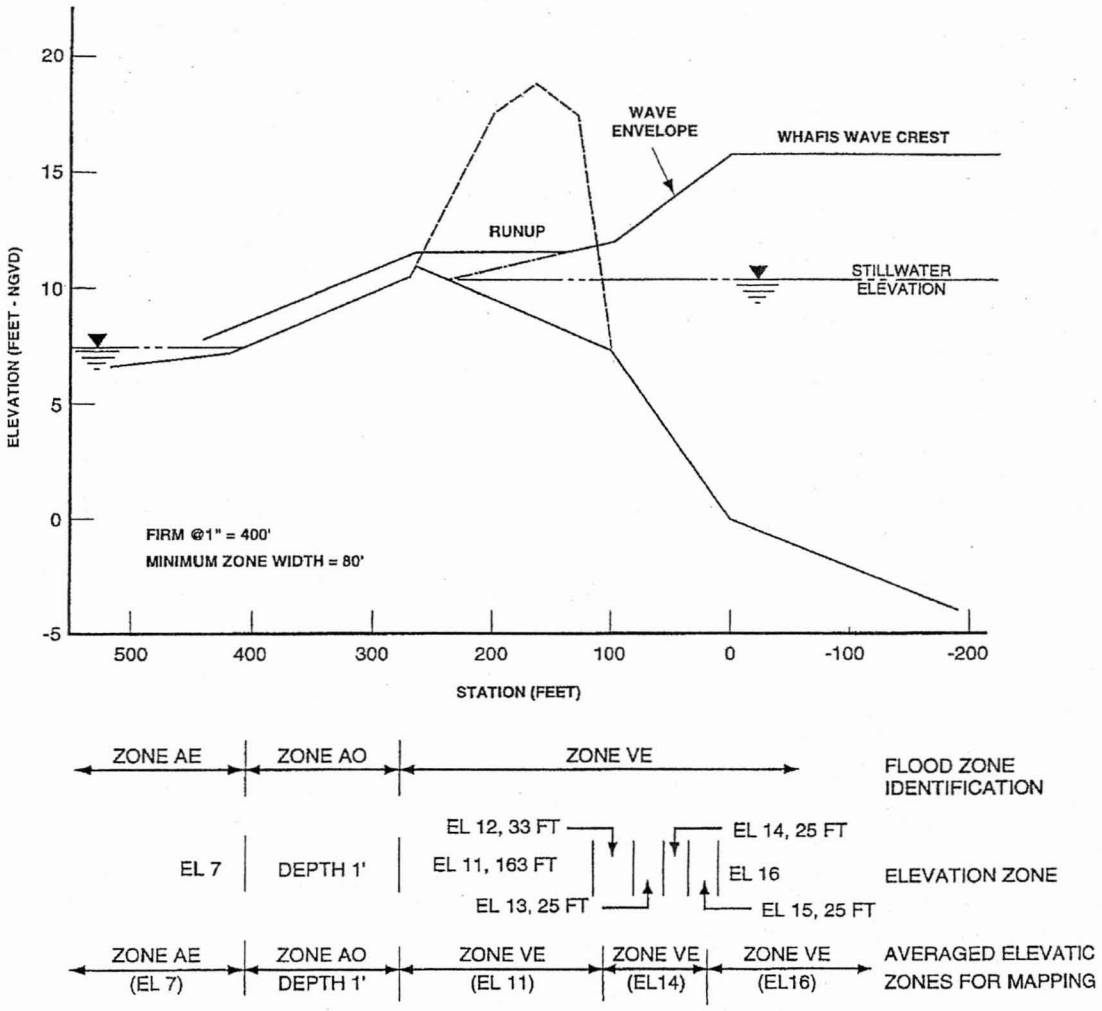


Figure D-30. Identification of Elevation Zones, Example 4: Dune Removal with Wave Runup and Runoff

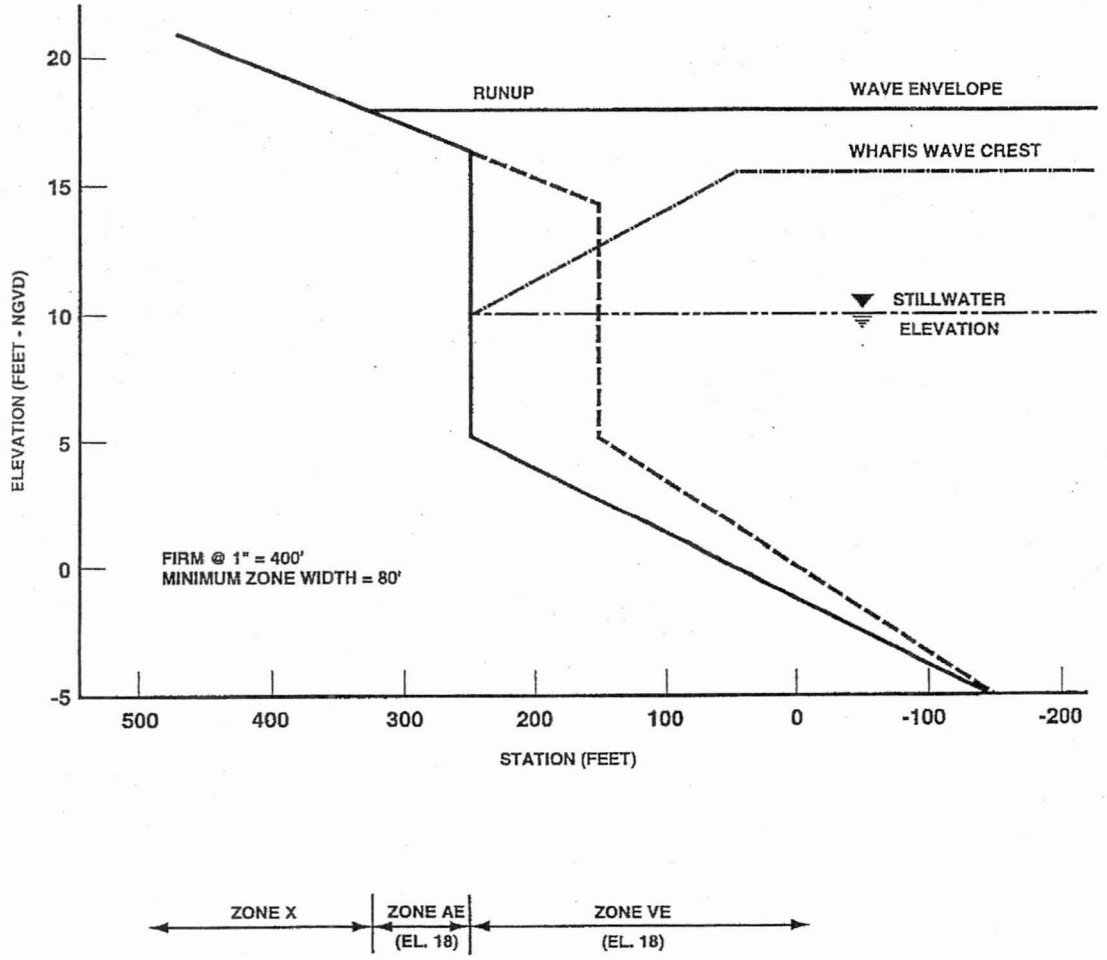


Figure D-31. Identification of Elevation Zones, Example 5: Eroded Bluff with Wave Runup

Figures D-32, D-33, and D-34. illustrate schematic effects for a few basic configurations, presuming the structures remain intact through the 1-percent-annual-chance flood and no appreciable shore erosion occurs

Figure D-32 illustrates an example of moderate structure overtopping expected for waves accompanying the 1-percent-annual-chance flood. The structure crest has sufficient freeboard above the 1-percent-annual-chance SWEL to contain a calculated mean runup of 6 feet, but extreme wave runups are likely to overtop the structure intermittently. The entire extent of shore structure is treated as a unit and designated as a VE Zone, and is assigned the mean runup elevation of 16 feet. Landward of the structure, an area with at least the minimum mapping width is appropriate for designation as Zone AO, depth 1 foot, with the extent of the zone depending on ground profile.

Figure D-33 illustrates an example of a structure extending above the 1-percent-annual-chance SWEL but heavily overtopped by wave action. The calculated mean runup elevation is 5 feet above the seaward face, but that is reduced to the maximum excess runup of 3 feet in assigning a flood elevation of 16 feet for the shorefront VE Zone. That zone extends through the entire structure and over an additional 30 feet landward, because likely wave impact area reaches beyond the structure during the 1-percent-annual-chance flood. Cumulative wave overtopping yields ponding within an additional landward area that is 100 feet wide, which is designated as Zone AO, depth 2 feet.

Figure D-34 illustrates an example of a structure covered by 3 feet of water during the 1-percent-annual-chance flood. Flood depth is not sufficient for waves 3 feet in height to propagate inland of the structure, but the V Zone must extend to 30 feet landward of the structure, in view of likely wave effects through the flood's course. The shore structure is too narrow for multiple V Zones to be delineated, so there is one designation of Zone VE, elevation 13 feet. Landward of that zone, further wave hazards occur in the Zone AE, elevation 11 feet.

In examining Figures D-32, D-33, and D-34, it may seem surprising that relatively high structures can result in higher flood elevations, compared to an inundated structure. However, a structure with more freeboard can deflect incident wave action to greater elevations during the 1-percent-annual-chance flood, so the present zonations are physically appropriate. The hazard zonations landward of coastal structures generally have more importance, and they reflect the greater protection provided by higher but durable structures.

[February 2002]

D.2.7.4 Mapping Procedures

Properly integrated delineation of the results of flooding analyses involves judgment and skill in reading topographic and land cover maps. The time and effort put forth to determine the flood elevations and extents will be negated if the results of these analyses are not properly delineated on the FIRM. The FIRM is usually produced from the work maps described in Subsection D.2.2. Therefore, the Mapping Partner shall transfer the flood zones and elevations identified on the transects to the work maps and interpolate boundaries between transects. The Mapping Partner shall set up the work maps with contour lines, buildings, structures, vegetation, and

transect lines clearly located. Because roads are often the only fixed physical features shown on the FIRM, the

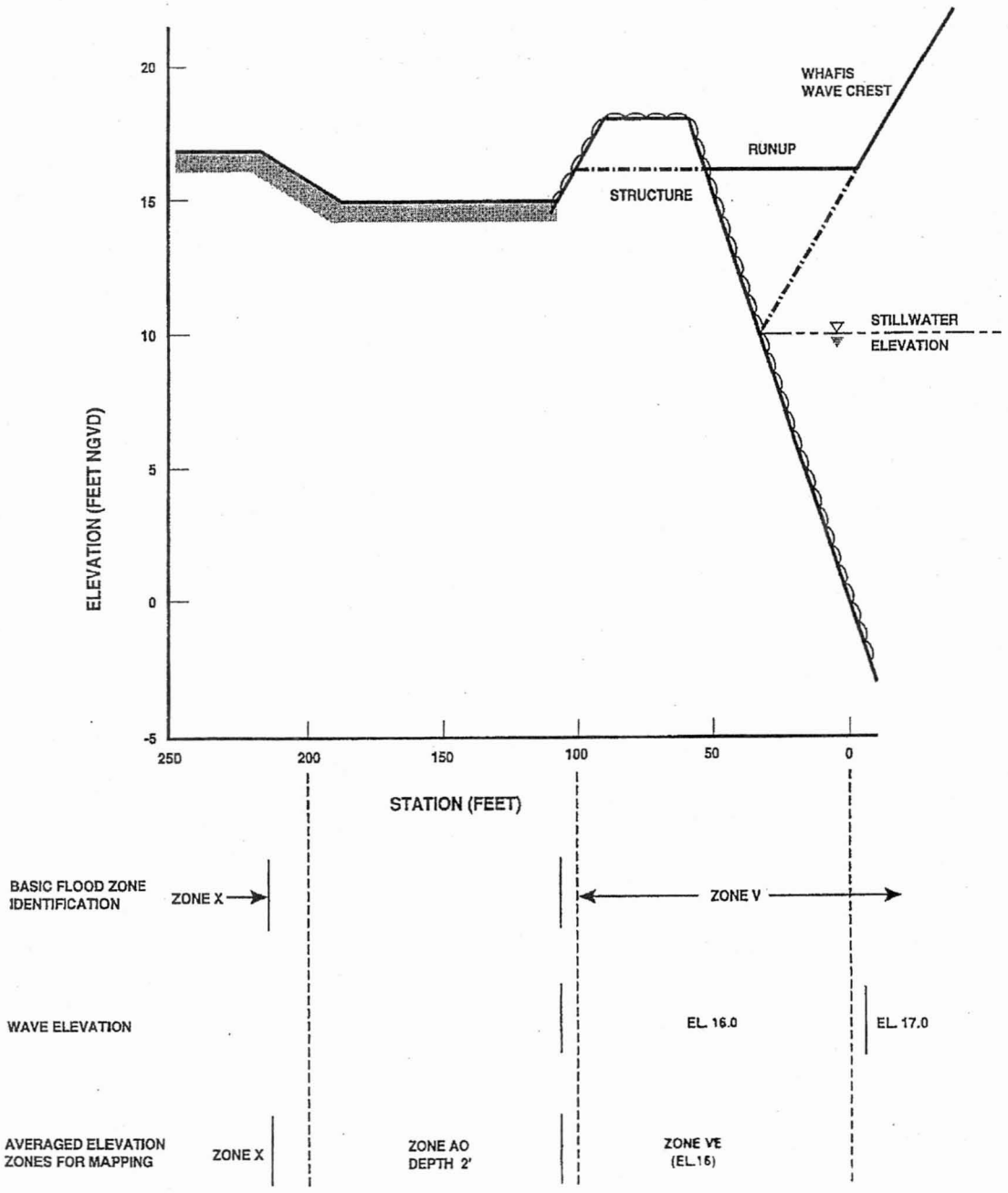


Figure D-32. Identification of Elevation Zones, Example 6: Coastal Structure with Moderate Wave Overtopping

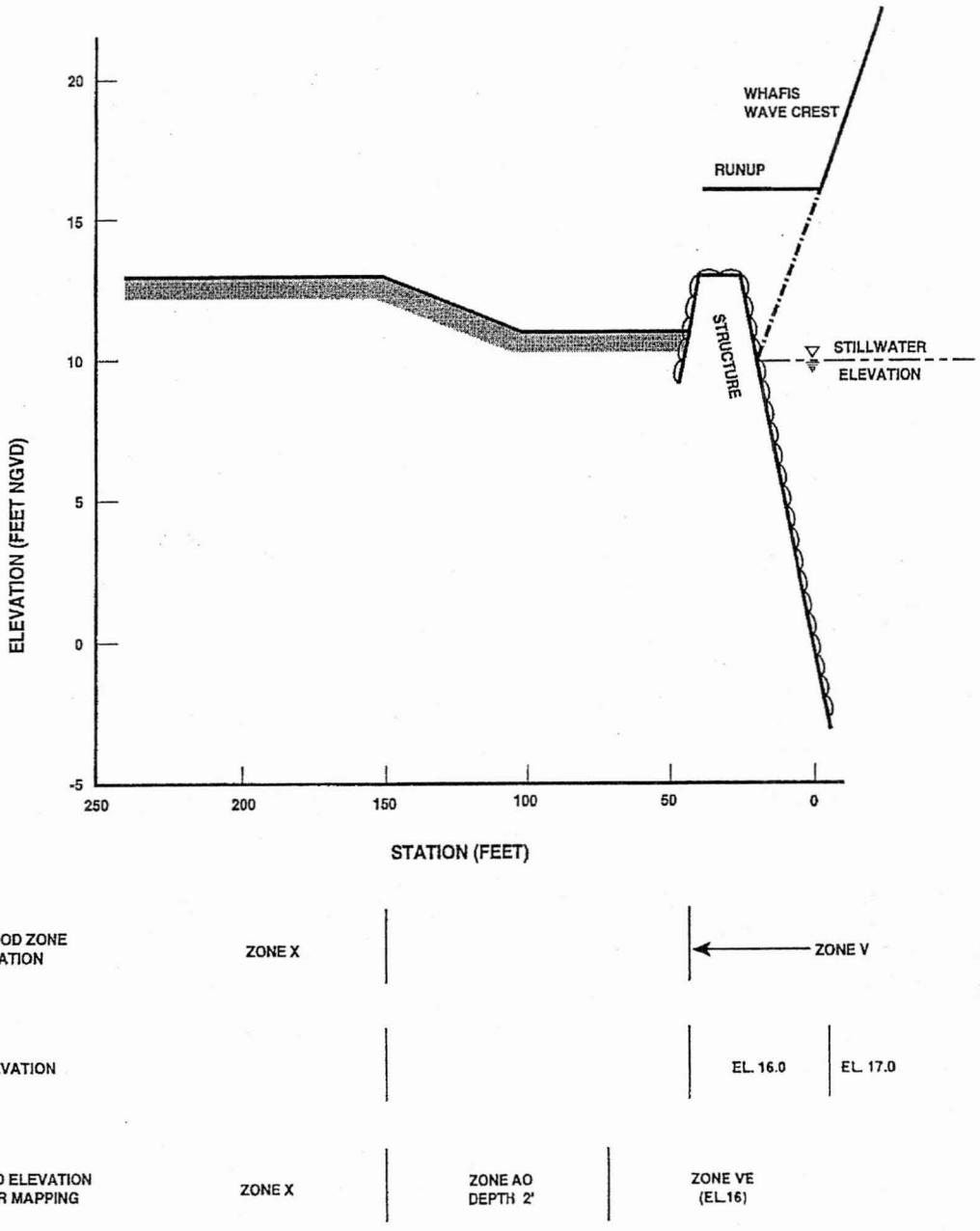


Figure D-33. Identification of Elevation Zones, Example 7: Coastal Structure with Severe Wave Overtopping

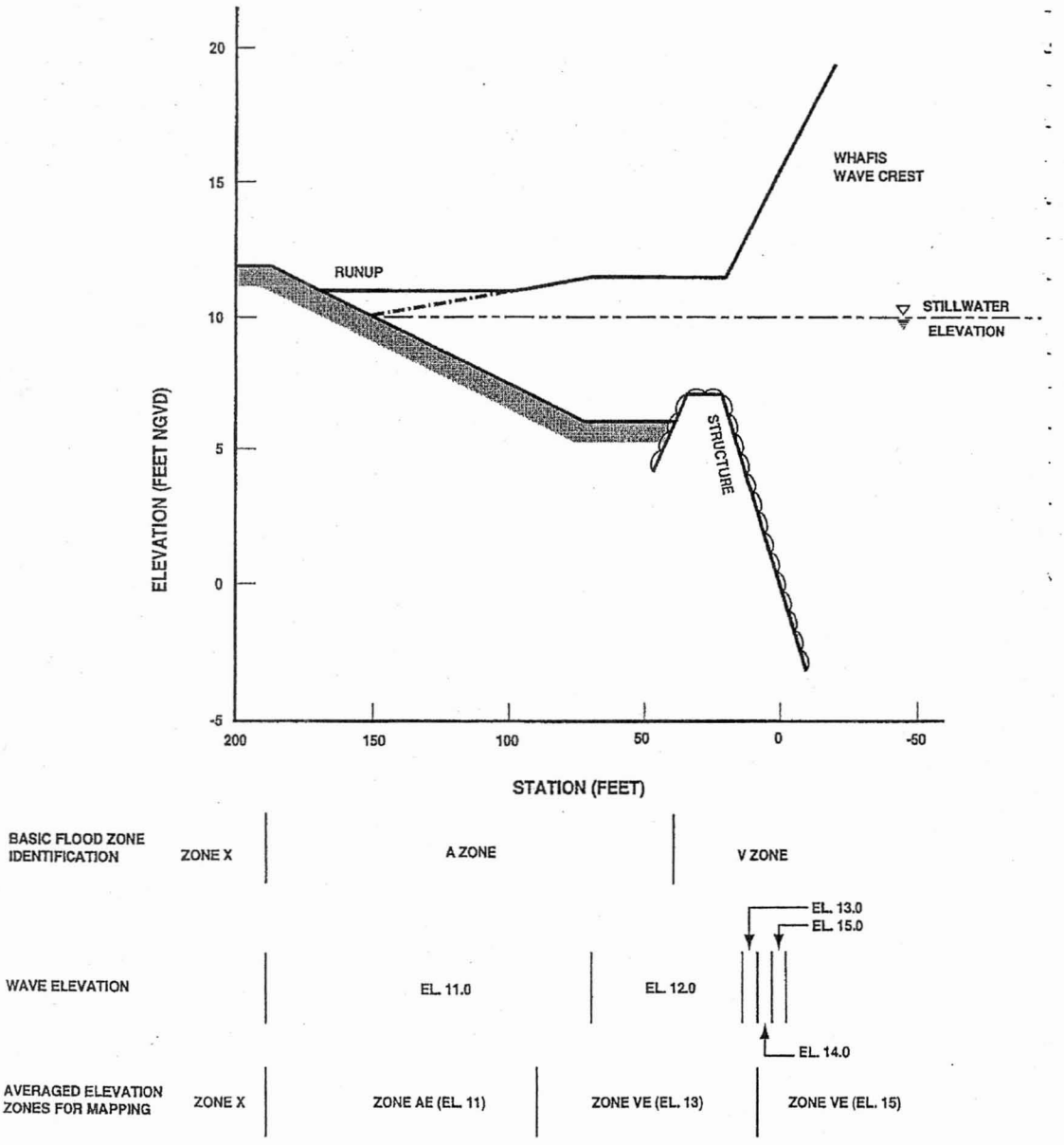


Figure D-34. Identification of Elevation Zones, Example 8: Coastal Structure with Inundation

Mapping Partner shall ensure that other features and the flood zone boundaries are properly located on the work maps in relation to the centerline of the roads as they will appear on the FIRM.

For each transect, the Mapping Partner shall transfer the identified elevation zones from the transect to the work maps, marking the location of the boundaries along the transect line so that boundary lines can be interpolated between transects. The Mapping Partner shall ensure that boundaries are marked at the correct location. Because of erosion assumptions, the location of the elevation 0.0 shoreline changes on the transect but not the work maps.

Using the transect profile, the Mapping Partner shall determine the location of the zone change in relation to a physical feature (e.g., ground contour, back side of a row of houses, 50 feet into a vegetated area) and delineate the boundary line for the area represented by that transect along this feature. The Mapping Partner shall measure the widths of the zones carefully; zones that narrow to less than 0.2 inch must be tapered to an end. Likewise, if the zone becomes much wider, it may be possible to break an averaged elevation zone into two mapped elevation zones.

One of the more difficult steps in delineating coastal flood zones and elevations is the transition between transect areas. Good judgment and an understanding of typical flooding patterns are the best tools for this job. Initially, the Mapping Partner shall locate the area of transition (an area not exactly represented by either transect) on the work maps. The Mapping Partner shall then delineate the floodplain boundaries for each transect up to this area. The Mapping Partner shall examine how a transition can be made across this area to connect matching zones and still have the boundaries follow logical physical features. Other transects similar to this area could give an indication of flooding. Sometimes the elevation zones for the two contiguous transects are not the same; in such cases, the Mapping Partner may have to taper the zones to an end or enlarge the zones and subdivide them in the transition area.

Communities with significant flooding hazards from wave runup may have one transect representing more than one area because the areas have similar shore slopes. In this case, the Mapping Partner shall identify the different areas and delineate the results of the typical transect in each area. Transition zones may be necessary between areas with high runup elevations to avoid large differences in BFEs and to smooth the change in flood boundaries. These zones are to be fairly short and cover the shore segment with a slope not exactly typical of either area. The Mapping Partner shall determine the transition elevation using judgment in examining runup transects with similar slopes. The Mapping Partner shall not use transition zones if there is a very abrupt change in topography, such as the end of a structure.

Lastly, Mapping Partner shall map the Zone X areas. The Mapping Partner shall show areas below the 0.2-percent annual chance SWEL that are not covered by any other flood zone as Zone X (shaded) on the FIRM. Often the maximum runup elevation is higher than the 0.2-percent-annual-chance SWEL; in such cases, the Zone X (shaded) designation will be used in that area. All other areas are designated Zone X without shading.

Because flood elevations are rounded to the nearest whole foot, the Mapping Partner does not need to spend hours resolving a minor elevation difference. Also, because structures or proposed structures must be located on the FIRM, the Mapping Partner shall attempt whenever possible to smooth the boundary lines and to follow a fixed feature such as a road. In preparing the FIRM,

the Mapping Partner shall ensure that the mapped results are technically correct and but the FIRM is easy for the local insurance agent, building inspector, or permit officer to use.

[February 2002]

D.2.8 Required Documentation

The Mapping Partner shall fully document the coastal flood hazard determination for each affected community. Because FIS Reports and FIRMs form the basis of Federal, State, and local regulatory and statutory enforcement mechanisms and are subject to administrative appeal and litigation, Mapping Partners shall ensure that all technical processes and decisions are recorded and documented. The FIS Report may not contain all the documentation that would be needed for a response in the event that the study results are questioned. Therefore, the Mapping Partner shall prepare an engineering report for each study. This report will provide detailed data needed by FEMA or the community to reconstruct or defend the study results on technical grounds. The minimum information required for the engineering report is summarized below.

Basic Data.

In this section, the Mapping Partner shall include all contacts made to obtain data for the study. All basic data used must be fully referenced and, if possible, reproduced in the report. All historical flood information must be documented in this section, even if the Mapping Partner did not use the information in quantitative analyses.

Transects

The Mapping Partner shall show all transects on a transect location map. Each transect must be plotted separately and show the erosion assessment, input data for wave models, wave envelope, and zone determination.

Model Input and Output

The Mapping Partner shall provide computer printout listings for input and output data for both the Wave Runup and Wave Height Models for all the transects. These listings must be keyed to the transect location map and transect plots.

Study File

During the course of the study, the Mapping Partner shall maintain a file containing records of all coordination, activities, and decisions. This is especially important where nonstandard approaches were used and engineering judgment played a significant role. The Mapping Partner shall ensure this file meets the requirements for a Technical Support Data Notebook as documented in Appendix M of these Guidelines.

[February 2002]

D.3 Wave Elevation Determination and V Zone Mapping: Great Lakes

Methodologies for determining coastal flood elevations and flood insurance risk zones have been adopted and refined over a period of time, as recounted in Section D.2 and in FEMA's *Guidelines and Specifications for Wave Elevation Determination and V Zone Mapping* (1995). Standard treatments for U.S. seacoast sites address wave heights, wave crest elevations, wave runup, and coastal erosion accompanying the 1-percent-annual-chance flood (FEMA, 1995). The effects of such waves determine flood elevations and the extent of Coastal High Hazard Areas (V Zones).

Until recently, wave effects were not taken into account along Great Lakes shores, but storms during the high water levels from 1985 to 1987 prompted reconsideration of this omission. A USACE study in 1989 concluded that recent significant storm damage at New York, Michigan, and Illinois sites confirmed the importance of wave runup contributions to actual coastal flooding on the Great Lakes. That finding led to specific calculation procedures to determine runup elevations appropriate to Great Lakes coasts with barriers to wave propagation (FEMA, 1991). Later, the standard NFIP seacoast model for wave height analysis was modified to apply to the lower wind speeds typical of Great Lakes events, and a detailed review addressed wave conditions and coastal erosion processes and quantities accompanying extreme floods at various U.S. lake sites (Dewberry & Davis, 1995). All necessary guidance has now been developed for treating wave effects in communities located along the Great Lakes

This subsection unifies the technical policies, procedures, and methodologies relevant to conducting a flood hazard study for a Great Lakes coastal community. In addressing coastal studies for specific geographical regions, these Guidelines and FEMA's *Guidelines and Specifications for Wave Elevation Determination and V Zone Mapping* (1995) serve as user guides. Appropriate application of this guidance, along with an understanding of coastal engineering principles, will assist Mapping Partners in determining coastal flooding elevations and hazards and presenting this information on the FIRM.

[February 2002]

D.3.1 Appropriate Treatments

The methodologies that shall be used to treat all the wave hazards possibly associated with a 1-percent-annual-chance flood are summarized in Table D-14. However, Mapping Partners must recognize that not every wave effect that occurs on the Great Lakes must be addressed for every flood hazard study or for every lakeshore community. To minimize unnecessary effort, it is useful early in the study process to identify those wave effects that can contribute noticeably to the BFEs and thus should be analyzed. Whether or not a wave treatment is appropriate depends primarily on the basic type of coastal topography, as outlined in Table D-14.

Table D-14. Important Wave Treatments for Typical Coastal Topographies

COASTAL TOPOGRAPHY	IMPORTANT WAVE TREATMENTS		
	EROSION	RUNUP	WHAFIS
Rocky bluff		x	x
Sediment bank or bluff	x	x	x
Sandy beach, small dunes	x		x
Sandy beach, large dunes	x	x	x
Open wetlands			x
Shore protection structure		x	x

The objective of a coastal study is to provide legible and accurate flood hazard maps with appropriate BFEs including wave contributions. Although procedures to define V Zones are fully documented in these Guidelines, mapping V Zones may not be appropriate in some Great Lakes areas. Both engineering and practical judgment are required for a proper decision on this matter. The typical study finding is a narrow V Zone, making its usefulness uncertain on maps at usual scales. Also, relatively small numbers of existing coastal buildings are likely to be affected by possible V-Zone designations along some Great Lakes.

V Zones are to be mapped only when the Regional Project Officer (RPO) approves such action. Some common exceptions to required approval might include coastal areas lakeward of sizable bluffs or designated as primary frontal dunes, so that the V Zone can be clearly delineated.

A flowchart with the basic study procedures for defining flood hazards in the Great Lakes region is presented in Figure D-35.

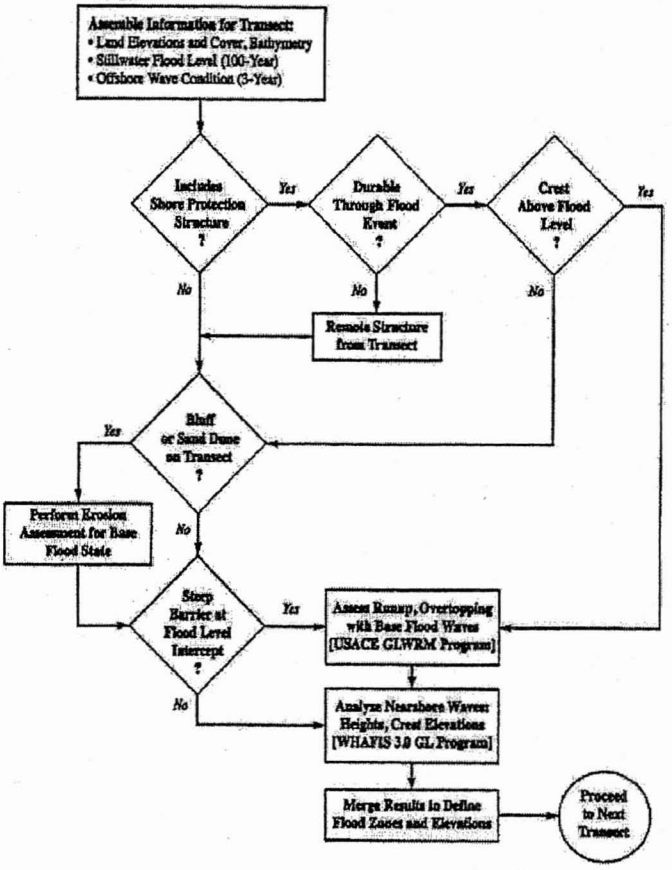


Figure D-35. Procedure for Defining Flood Hazards on Great Lakes Shores

[February 2002]

D.3.2 Data Requirements for Coastal Flood Hazard Analyses

A coastal flood hazard analysis begins with collecting the data and information required for the ensuing analyses, including the input needed for the computer models. The coastal models discussed here are executed along transects, which, as discussed earlier in this Appendix, are cross sections taken perpendicular to the mean shoreline to represent a segment of coast with similar characteristics. Thus, collected data are compiled primarily for use in developing transects and for locating and detailing the results on work maps. Work maps are to show the topography and land cover at a scale with sufficient detail to properly delineate the results of the analyses and interpolate between transects.

Data collection is to start at the community level and proceed with inquiries to appropriate county, State, and Federal agencies. To pursue any suggestions provided by government agencies, private firms specializing in topographic mapping or aerial photography may also be contacted.

This subsection describes the data requirements for coastal flood hazard analyses.

[February 2002]

D.3.2.1 Stillwater Elevations

The USACE's *Revised Report on Great Lakes Open-Coast Flood Levels* (1988) is FEMA's source for SWELs on the Great Lakes, at recurrence intervals of 10, 50, 100, and 500 years (reflecting 10-, 2-, 1-, and 0.2-percent-annual-chance flood elevations, respectively). Documented flood elevations pertain to specific U.S. reaches of open coast, defined as "lake shoreline which is unprotected by the presence of islands and which is uninterrupted by bays." These elevations are based on a standardized analysis of maximum annual water levels from long-term gage records (1900 to 1986) and are referenced to NGVD.

The USACE report on Great Lakes flood levels is divided into Phase I and Phase II reports. The Phase I report provides SWELs for most of the U.S. shoreline of Lake Superior (divided into five separate reaches), Lake Michigan (nine reaches), Lake Huron (eight reaches), Lake St. Clair (one reach), Lake Erie (24 reaches), and Lake Ontario (five reaches). In Subsection D.3.9, charts identifying separate reaches and the flood elevations on each lake are reproduced; except on Lake Erie, flood elevations usually remain constant over tens of miles along the shore. The Phase II report provides the flood levels for connecting channels and addresses general methods for developing flood levels in other areas, such as bays, inlets, and sheltered shorelines. For some of these areas, separate reports such as the "Saginaw Bay Flood Levels Report" for Lake Huron, have been prepared to document the SWELs (USACE, September 1989).

[February 2002]

D.3.2.2 Transect Locations

Transects for coastal flood hazard analyses are to be located with careful consideration given to the physical and cultural characteristics of the land so that they will closely represent conditions in the vicinity of the transect. If they are carefully placed, excessive mapping interpolation of the BFEs between transects, as well as unnecessary study effort, can be avoided. The transects are to be placed more closely together in areas of complex topography, dense development, and unique flooding, and where computed wave heights and runup may be expected to vary significantly. Wider spacing may be appropriate in areas having more uniform characteristics. For example, a stretch of developed shoreline with various building densities, protective structures, and vegetation may require a transect every 1,000 feet or so, whereas a long stretch of undeveloped shoreline with a continuous dune or bluff of fairly constant height and shape, and similar landward features may require a transect only every 1 to 2 miles.

In areas where runup is significant, the location of transects is governed by variations in shore slope or steepness. In other areas where dissipation of wave heights is significant to the computation of flood hazards, transect location is based on variations in land cover, such as buildings and vegetation. Often, areas with similar characteristics may be scattered throughout a community, and the results from one transect are also representative of other locations and can be delineated accordingly.

The Mapping Partner performing the coastal flood hazard study shall locate transects on the work map to be submitted with the analysis, and shall compile the input data and displayed the data on individual profiles for each transect. The Mapping Partner shall take the data (e.g., topography, development, vegetation) not only at the transect site, but for the entire area or length of shoreline represented by the transect so that the input data depict average characteristics of the area. The Mapping Partner may divide the work map into transect areas to help in compiling the data.

[February 2002]

D.3.2.3 Topographic Data

Topographic data must have a contour interval of equal or greater detail than that used for the effective FIS, and a minimum interval of 5 feet or 1.5 meters. While more detailed information, such as spot elevations or a smaller contour interval, can be useful in defining the dune or bluff profile and in delineating floodplain boundaries, it is required only when a map revision request with new coastal analyses is based on new detailed topographic data. As discussed in Volume 2, the data, usually in the form of maps, shall be certified and shall reflect current conditions in the area of the analysis or, at a minimum, conditions at a time more recent than the topographic data used in the effective FIS.

Topography must extend lakeward at least to the Low Water Datum defined for each Great Lake, as listed in Table D-14. The Low Water Datum corresponds to extremely low annual means of lake level during the 1900s and is described in terms of the International Great Lakes Datum of

1985 (IGLD85). The relation of NGVD29 to IGLD85 needs to be defined for each coastal flood hazard analysis site. NGVD29 is required as the datum for the topographic map.

If possible, the Mapping Partner shall check the shore topography to note any changes caused by construction, erosion, or other causes and document any significant erosion by location with descriptions, drawings, and/or photographs. The Mapping Partner is not required to field survey transects unless available topographic data are unsuitable or incomplete.

The community, county, and state are usually the best sources for topographic data. The Mapping Partner shall examine USGS 7.5-minute series topographic maps. The USGS maps may have a 5-foot contour interval, and if not, they are still often useful as a reference for planimetric features in the study area.

Table D-14. Elevations of Low Water Datum on the Great Lakes

LOCATION	LOW WATER DATUM ELEVATION:	
	FEET ABOVE IGLD85	FEET ABOVE NGVD29 (APPROXIMATE)
Lake Superior	601.1	601
Lake Michigan	577.5	578
Lake Huron	577.5	578
Lake St. Clair	572.3	573
Lake Erie	569.2	570
Lake Ontario	243.3	244

[February 2002]

D.3.2.4 Land-Cover Data

The land-cover data include information on structures and vegetation. Stereoscopic aerial photographs can provide the required data on structures and some of the data on vegetation. The aerial photographs must not be more than 5 years old unless they are updated by surveys. A local, county, or State agency may have the coastline photographed on a periodic basis. That agency may provide the photographs or give permission to obtain them from its contractor. Because topographic maps are often developed from aerial photographs, the Mapping Partner also shall contact the mapping contractor for the topographic maps for data.

Aerial photographs can provide the required data on tree- and bush-type vegetation and can be used to identify areas although not the specific type of grass-like vegetation. National Wetland Inventory maps from the U.S. Fish and Wildlife Service and color infrared aerial photographs can provide more specific data required for marsh plants. Ground-level photographs and surveys also are useful in providing information on the plants (e.g., density, species). State offices of coastal zone management, park and wildlife management, and/or natural resources should be able to provide information on significant vegetation types. Also, the Mapping Partner shall contact local universities with coastal studies and/or Sea Grant programs. The Mapping Partner

may conduct field surveys in lieu of the above sources, but these are more cost effective when used only to verify some of the data obtained from these sources.

[February 2002]

D.3.2.5 Bathymetric Data

It is not possible to provide precise guidance on the extent of bathymetry needed for a Great Lakes FIS. In some cases, only typical water depths in the vicinity of shore structures will be required in the analysis of wave effects. For sand beaches, bathymetry out to water depths of approximately 30 feet is required for wave treatments. Bathymetry further offshore may be useful for interpreting likely differences between nearshore and offshore wave conditions. (See Subsection D.3.2.6). An advisable procedure for studies of Great Lakes sites is to gather any readily available bathymetric data, but to defer all data reduction or analysis until the need is firmly established. Bathymetric data can be acquired from National Ocean Survey nautical charts, although any reliable source can be used.

[February 2002]

D.3.2.6 Offshore Wave Characteristics

One basic assumption in conducting coastal wave analyses is that wave direction must have some onshore component, so wave hazards occur coincidentally with the 1-percent-annual-chance flood. That assumption appears generally appropriate on open coasts and bay shores of the Great Lakes, where the 1-percent-annual-chance SWEL must include some contribution from storm surge and usually requires an onshore wind component. However, the assumption of onshore waves along the shores of connecting channels, near inlets, and behind protective islands may require detailed examination.

Once the Mapping Partner has confirmed that sizable waves travel onshore during the 1-percent-annual-chance flood, the most important specification is wave period rather than wave height. This is because wave heights are severely limited by shallow water at sites where the models described in Subsections D.3.5 and D.3.6 are applied. Wave treatments within those models provide depth-limited wave heights controlled by the wave period, so that the specified period influences the results of coastal wave analyses. The specified wave period can pertain to offshore storm waves in deep water, because dominant or spectral peak period is commonly unchanged during complex wave transformations near the shore. The most notable sources of suitable storm-wave information along Great Lakes coasts are the USACE Coastal Engineering Research Center (CERC) Wave Information Studies (WIS) Nos. 22, 23, 24, 25, and 26, with one report for each Great Lake on computed wave conditions in deep water from 1956 to 1987 (Driver, Reinhard, & Hubertz, 1991 and 1992; Hubertz, Driver, & Reinhard, 1991; Reinhard, Driver, & Hubertz, 1991). Maps locating approximately 300 sites for which computed wave information is available, one map for each lake, are included in Subsection D.3.9.

The draft of "Basic Analyses of Wave Action and Erosion with Extreme Floods on Great Lakes Shores" (Dewberry & Davis, 1995) concluded from historical evidence that extreme floods were

usually accompanied by the local 1/2-year wave condition on Lake Ontario, or by the 3-year wave condition on Lakes Erie, Huron, Michigan, and Superior. Those wave heights can be determined using the simple treatment illustrated by Figure D-36. Tabulated significant wave heights in the CERC WIS reports include the extremes for each month/year at every calculation site, and the median of each set of results gives the 2-month/2-year wave height. Extreme wave heights at various recurrence intervals usually are well approximated by an exponential distribution, so those two known values on a semi-logarithmic graph define other significant wave conditions of interest, as demonstrated in Figure D-36.

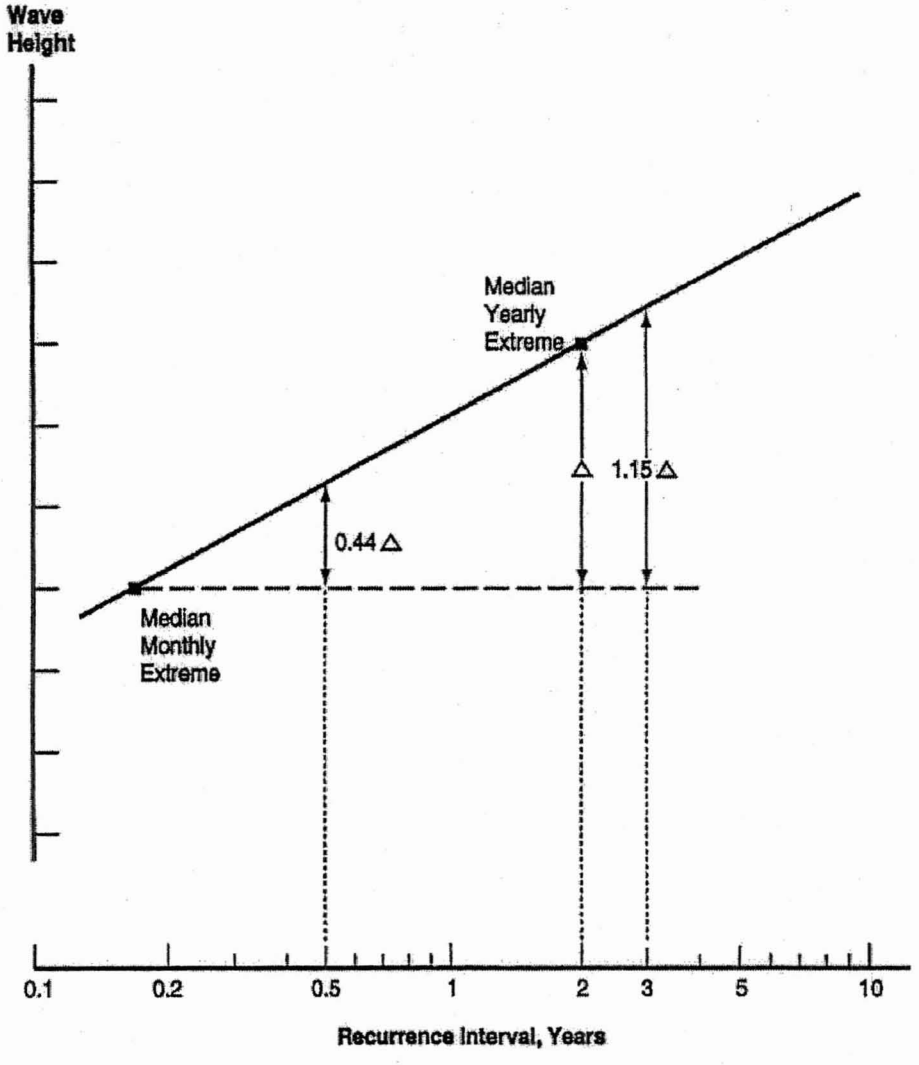


Figure D-36. Defining ½ Year or 3-Year Wave Height in an Exponential Distribution Using a Semi-Logarithmic Graph.

Once a suitable offshore wave height is specified from the CERC WIS reports, the Mapping Partner shall determine the wave period crucial to coastal analyses in one of two ways. The more rigorous determination examines the electronic file of calculated conditions for 1956 to 1987, extracting cases with the specified wave height and with wave direction toward shore; prevalent wave period in those cases should be appropriate to the flood. Section D.3.9 includes examples of appropriate wave conditions derived for several sites on each of the Great Lakes. An alternative procedure considers wave steepness, or ratio of wave height to wavelength, with these typical values for storm waves: 0.035 for Lake Ontario or Lake Erie, 0.04 for Lake Huron or Lake Michigan, and 0.045 for Lake Superior. In deep water, the wavelength is 0.16 times the gravitational acceleration times the wave period squared, so specified wave steepness and wave height imply a suitable wave period for the site.

The hindcast wave study of the CERC WIS reports provides no information for Lake St. Clair, or within major embayments and connecting channels of the Great Lakes. Such sites require an independent assessment to define likely wave characteristics associated with the 1-percent-annual-chance flood. Fundamental information for such an assessment includes the water basin geometry at a site and the meteorology of storms potentially yielding the 1-percent-annual-chance SWEL, i.e., capable of generating the surge magnitude needed in addition to a high mean lake level.

Major factors in wave generation are windspeed and duration, local water depth, and fetch length. Fetch length is the over-water distance along which waves arise (USACE, 1984). In the Great Lakes vicinity, a windspeed of 40 mph sustained for several hours is usually appropriate to the 1-percent-annual-chance flood. For some cases, fetch length might be estimated as straight-line distance in the wind direction, but current guidance specified in the USACE ACES manual (USACE, 1992) pertinent to many Great Lakes sites indicates that a more involved analysis of restricted fetches must be performed for water basins of relatively complex geometry. The effective fetch length is derived as a weighted average of available distance with angle from the wind direction, as outlined in Figure D-37. A PC-compatible computer program included with the ACES manual is convenient for evaluating restricted fetch geometries and provides estimates of representative wave height and wave period based upon recommendations by CERC on wave generation.

[February 2002]

D.3.2.7 Coastal Structures

Documentation gathered for each coastal structure that may provide protection from 1-percent-annual-chance flood hazards should include the following:

- Type and basic layout of structure;
- Dominant site particulars (e.g., local water depth, structure freeboard, ice climate); etc.
- Construction materials and present integrity;

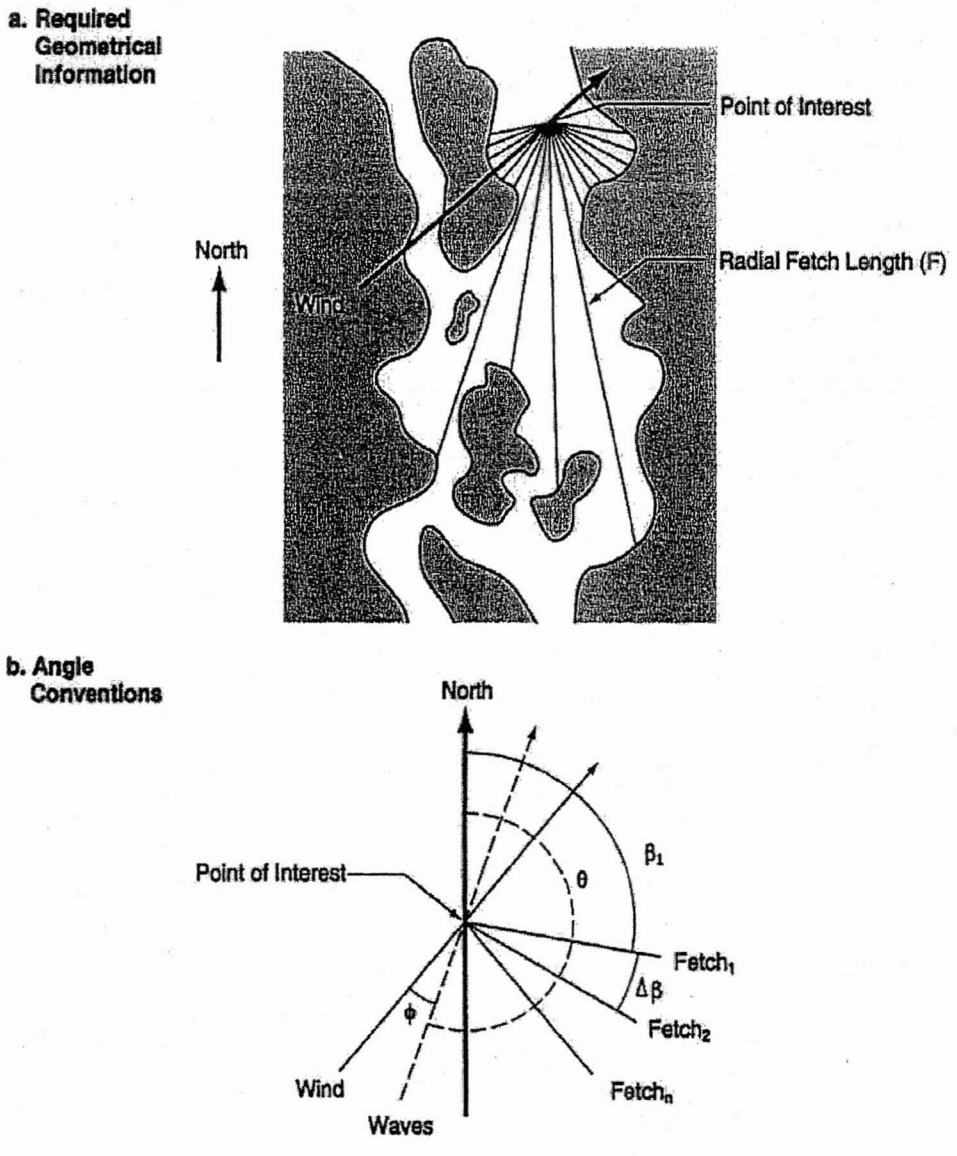


Figure D-37. Outline of Geometry for Wave Development on Restricted Fetches, from ACES Direction of Wave Development (θ) is Defined by Maximizing the Product $[(F_\phi)^{0.25} \cdot (\cos \phi)^{0.44}]$.

- Historical record for structure, including construction date, maintenance plan, responsible party, and repairs after storm episodes; and
- Clear indications of effectiveness/ineffectiveness.

The Mapping Partner may develop much of this information through office activity, including a careful review of aerial photographs. In some cases of major coastal structures, site inspection could be advisable to confirm preliminary judgments.

[February 2002]

D.3.2.8 Historical Erosion Accounts

Coastal erosion can occur during any major storm; however, the most significant erosion events for the purpose of a coastal FIS are those that occur with major storms during historical periods of high lake levels. Ideal information documenting storm-eroded cross sections will seldom be available because studies including repetitively surveyed profiles appear rare, except at some Lake Michigan sites. Although quantitative data may not be available, qualitative information can be valuable in confirming that reasonable results are obtained from the erosion assessment. The Mapping Partner shall conduct a search for erosion descriptions in newspaper articles or other publications, focusing on recent intervals of high mean lake levels. In addition, State agencies may be able to provide long-term recession rates over the study area. These are helpful in demonstrating local susceptibilities to storm-induced erosion.

[February 2002]

D.3.2.9 Historical Flood Information

Information from previous storms and floods can be valuable in developing proper assessments of coastal flood hazards. This is particularly true on the Great Lakes, because many notably extreme events occurred on the four western lakes during 1985, 1986, and 1987 and ample information should be readily available for many study sites.

General descriptions of flooding are useful in determining what areas are subject to flooding and in obtaining an understanding of flooding patterns. More specific information, such as erosion associated with the event or the location of buildings damaged by wave action, can be used to verify the results of the coastal analyses. When quantitative data on the effects, recorded water elevations, and offshore wave conditions are available, the Mapping Partner shall check those data for proximity to the coastal site and impact on the evaluation. Those data can be used to estimate recurrence intervals for SWEL and wave action during the event and assist in the appropriate comparison to the 1-percent-annual-chance flood conditions and SWELs established by the USACE for the specific recurrence intervals (1988).

Local, county, and State agencies are usually good sources for historical data, especially during the more recent events. It is becoming common practice for these agencies to record significant

flooding with photographs, maps, and/or surveys. Federal agencies such as the USACE, USGS, and NRC prepare post-storm reports for the more severe storms. Local libraries, newspapers, and historical societies may also be able to provide some useful data.

Additional criteria and submittal requirements for historical information are identified in the certification forms package for Study Contractors (SC-1) and the application/certification forms package (MT-2) for map revision requests.

[February 2002]

D.3.3 Evaluation of Coastal Structures

The crucial first consideration in evaluating a coastal structure is whether it was properly designed and has been maintained to provide protection during the 1-percent-annual-chance flood. If it can be expected to survive the 1-percent-annual-chance flood, the structure should figure in all ensuing analyses of wave effects (erosion, runup, and wave height). Otherwise, it should be considered destroyed before the 1-percent-annual-chance flood and removed from subsequent transect representations.

The USACE technical report entitled *Criteria for Evaluating Coastal Flood-Protection Structures* (Walton, Ahrens, Truitt, & Dean, 1989) recommends specific criteria for evaluating coastal flood-protection structures in regard to the 1-percent-annual-chance flood. A FEMA memorandum dated April 23, 1990, entitled "Criteria for Evaluating Coastal Flood Protection Structures for National Flood Insurance Program Purposes," based on the USACE report, provides a self-contained account of the evaluation process. The criteria in the memorandum have been adopted as the basis for NFIP accreditation of new or proposed coastal structures to reduce the flood hazard areas and elevations designated on the current NFIP maps. Ideally, these evaluation criteria could be applied to existing coastal structures, but for older structures, design and construction information sufficient to complete the formal evaluation is typically unavailable. For these structures, engineering judgment based on visual inspection and any historical evidence should be used.

In general, for evaluation of coastal structures on the Great Lakes the Mapping Partner shall rely on engineering judgment firmly based on experience regarding structural stability at sites with similar flood and wave climate. Because extreme floods have been relatively common over the past decade on the Great Lakes, the Mapping Partner shall consider historical information about a particular structure in its evaluation. Construction date and damage history of a structure permit a performance record to be accumulated for events potentially comparable to the 1-percent-annual-chance flood.

Analysis based on historical information and past performance may be complicated by one unique aspect of Great Lakes design considerations. The 1990 FEMA memorandum specifies that representative analyses be carried out at a range of water levels, usually from the Low Water Datum to the 1-percent-annual-chance SWEL for Great Lakes sites. However, incident wave conditions associated with the 1-percent-annual-chance flood may be markedly less extreme than those expected for lower but more persistent water levels near long-term Mean Lake Level.

Nevertheless, even where water depth at the structure site strongly limits local wave heights, the most severe conditions for design could still occur during the 1-percent-annual-chance flood; therefore, the Mapping Partner must consider these conditions.

The USACE technical report identifies the four primary functional types of coastal flood protection structures: gravity seawalls, pile-supported seawalls, anchored bulkheads, and dikes or levees. The report recommends as a general policy that "FEMA not consider anchored bulkheads for flood-protection credit because of extensive failures of anchored bulkheads during large storms" (p. 100). However, the report provides no examples for the Great Lakes. Seacoast storm conditions are possibly quite different from the 1-percent-annual-chance flood on the Great Lakes; therefore, this structure type cannot be completely discredited.

The FEMA memorandum focuses on structures designed for flood protection. Such structures can have a significant impact on the information shown on a FIRM, perhaps directly justifying the removal of sizable areas from the Coastal High Hazard Area. However, structures in other categories also are to be considered. Although a breakwater may act primarily to limit wave action, and a revetment primarily to control shore erosion, these structures also can provide 1-percent-annual-chance flood protection. The FEMA memorandum places the responsibility on local interests to certify new structures; however, it is crucial that the Mapping Partner evaluate the structure accurately and consider its effects. For example, a structure might decrease flood impacts in one area, yet increase erosion or wave hazards at adjacent sites. Of course, the greater the potential effects of a coastal structure, the more detailed the evaluation process should be.

As discussed in Volume 2, additional requirements regarding coastal structures are included on Form 10 of the Application/Certification forms package (MT-2) for map revision requesters.

[February 2002]

D.3.4 Erosion Assessment

Along many Great Lakes shores, erosion accompanying the 1-percent-annual-chance flood may change the location and alter the form of an existing sedimentary barrier extending above the local 1-percent-annual-chance SWEL. Mapping Partners must assess the likely erosion before proceeding to determination of additional flood effects dependent on topography, such as wave runup or overtopping, or overland wave heights. Procedures described here are meant to give schematic estimates of eroded transect geometry suitable for the purposes of a coastal FIS or map revision request on the Great Lakes.

In an erosion assessment relating to the 1-percent-annual-chance flood, Great Lakes coasts may be separated into three basic site categories:

1. Sandy shores with backing dunes or banks;

2. Backshore bluffs of cohesive material; and

3. Other shore situations more resistant to erosion during extreme floods, with bedrock, wetlands, shore protection, and other conditions.

For the third category, erosion is usually not too important a consideration, so the major distinction for present purposes is between sand dunes and cohesive bluffs. Besides up-to-date coastal topography, information about the basic shore type is crucial for an appropriate erosion assessment pertaining to the 1-percent-annual-chance flood. Also, documented erosion effects during a historical flood at the study site can be useful in a valid assessment of 1-percent-annual-chance flood effects, but such evidence requires careful interpretation, as discussed below.

Detailed examination of recent record episodes of lake levels (Dewberry & Davis, 1995) provides several notable findings:

- Extreme Great Lakes floods usually involve rather moderate storms during relatively brief intervals when mean lake level is significantly higher than the long-term average.
- The storm situation for an extreme flood on Lake Ontario is markedly different than on Lake Erie, Lake Huron, Lake Michigan, Lake Superior.
- Coastal erosion on the Great Lakes exhibits extreme geographical and temporal variability during intervals of high mean lake level.

Quantitative analysis establishes that Great Lakes erosion cross sections expected during the 1-percent-annual-chance flood are 270 square feet on Lake Erie, Lake Huron, Lake Michigan, and Lake Superior and 190 square feet on Lake Ontario.

These amounts refer to the flood episode alone and lie entirely above the local 1-percent-annual-chance SWEL. The stated results derive from Great Lakes verification of an analysis similar to that which was performed for Atlantic Ocean and Gulf of Mexico regions for the 540-square-feet erosion cross section in seacoast 1-percent-annual-chance floods. Appropriate application of this erosion guidance can depend on basic type of shore morphology, as illustrated in Figures D-38 (bluff) and D-39 (sand dune).

The cases consider no shore features lakeward of the basic flood barrier, because any distinct topography presumably will be removed by storm erosion before the peak effects to be considered. For the bluff case in Figure D-38, erosion projection is based on a retreated profile parallel to the existing bluff, but with a potential adjustment to the eroded face governed by soil stability considerations for the site. For the dune case in Figure D-39, erosion projection makes use of an escarpment slope of 45°, corresponding to the usual duneface geometry for storm conditions. In each case, the barrier is presumed to be appreciably more sizable than the specified erosion cross section, even though that usually is more appropriate for bluff erosion where the barrier in effect is unlimited. Erosion analysis may be unnecessary for very large coastal dunes, extending 20 feet or more above the SWEL; such sand accumulations may be considered resistant to notable storm erosion and to wave overtopping on the Great Lakes.

These quite simplified depictions of eroded profile geometry for Great Lakes shores may require modification in accordance with site-specific factors, engineering judgment, or the more detailed erosion considerations usually appropriate on seacoasts (FEMA, 1995). Comparison of present assessment results to historical effects for notable local floods must recognize the extreme variability evident in Great Lakes shore erosion during a given storm. Documented large or small amounts of erosion during a notable historical storm or flood at a particular Great Lakes site do not imply that similar effects should be expected for the 1-percent-annual-chance

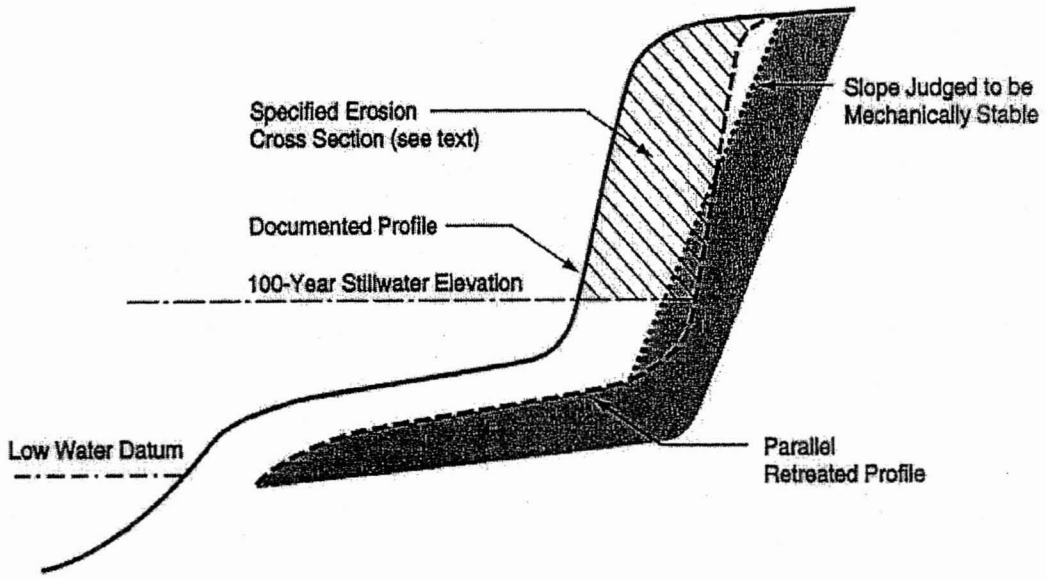


Figure D-38. Basic Erosion Considerations for Coastal Bluff Provides Shaded Shore Profile for Great Lakes Base Flood.

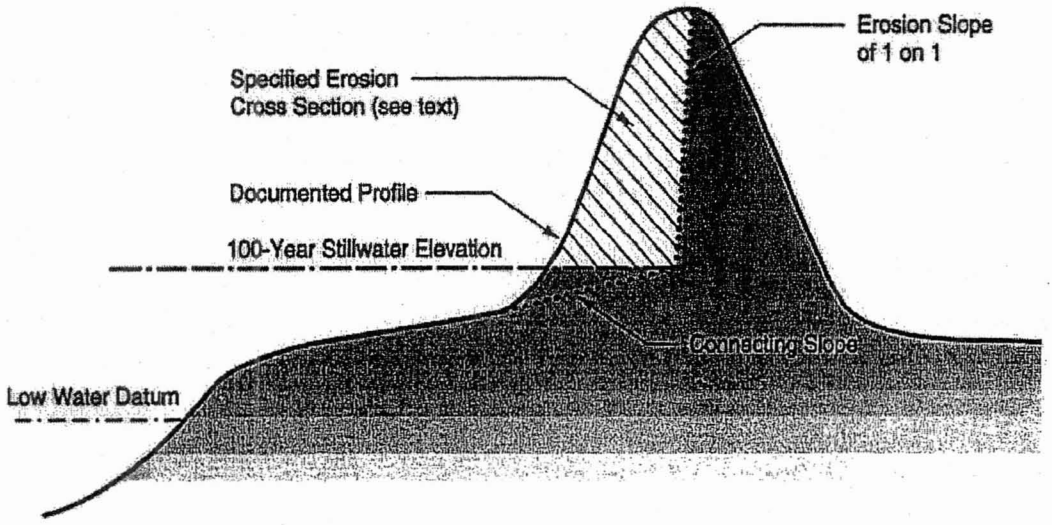


Figure D-39. Basic Erosion Considerations for Coastal Sand Dune Provides Shaded Shore Profile for Great Lakes Base Flood.

flood. The only appropriate conclusion to be based directly on historical effects is that if a Great Lakes site has experienced no erosion over the past ten years, one should not assume that erosion will accompany the 1-percent-annual-chance flood.

The present evaluation guidelines outlined in Figures D-38 and D-39 lead to appropriate flood hazard identification, given that sizable wave effects on Great Lakes shores seldom penetrate inland past an erodible flood barrier in accordance with the geometrical consideration outlined in Figure D-40. In a Great Lakes FIS, the major result of an erosion assessment is a barrier profile both convenient and appropriate for ensuing wave analyses.

[February 2002]

D.3.5 Wave Runup and Overtopping

Wave runup and overtopping constitute coastal hazards beyond those associated with stillwater coastal flooding and incident wave geometry. Wave runup is the uprush of water on a shore barrier intercepting the stillwater level. The water wedge both thins and slows during its excursion up the barrier, as residual momentum from wave motion near the shore is fully dissipated. The most significant characteristic of this process for present purposes is wave runup elevation: the vertical height above stillwater level ultimately attained by the extremity of uprushing water. Likely runup must be assessed for wave conditions expected to accompany the 1-percent-annual-chance flood. The extent of runup can vary greatly from wave to wave in storm conditions, so that a wide distribution of wave runup elevations provides the precise description of a specific situation. Wave overtopping occurs when an individual runup impulse surpasses the barrier crest and flood water penetrates inland of the shore barrier, perhaps with wave-like effects or with ponding of the flood waters behind the barrier.

Current NFIP policy is that the mean runup elevation (rather than some occasional extreme) for a situation is appropriate in mapping coastal hazards of the 1-percent-annual-chance flood. The FEMA Great Lakes Wave Runup Model (GLWRM), which is based on methodologies recommended by the USACE, Detroit District, can be used to compute the mean runup elevation, as discussed in Subsection D.3.5.1. Although the GLWRM provides an entirely suitable runup elevation, it can treat only the three types of shore situation judged to be most frequently encountered on the Great Lakes. Therefore, adjustment or modification to computed results may be needed in applications at some sites. Section D.3.5.2 introduces some methods for extending the applicability of the GLWRM and also discusses other considerations potentially important for a Great Lakes coastal flood hazard evaluation.

[February 2002]

D.3.5.1 Use of Great Lakes Wave Runup Model

The runup analysis begins with the determination of significant wave conditions near the shore. The site must be categorized as one of three shore types typical of the Great Lakes: smooth vertical wall, rip-rap revetment having a single face slope, or sloping sand beach. For a revetment or beach, the characteristic slope, considered the grade of the slope from the mean

lake

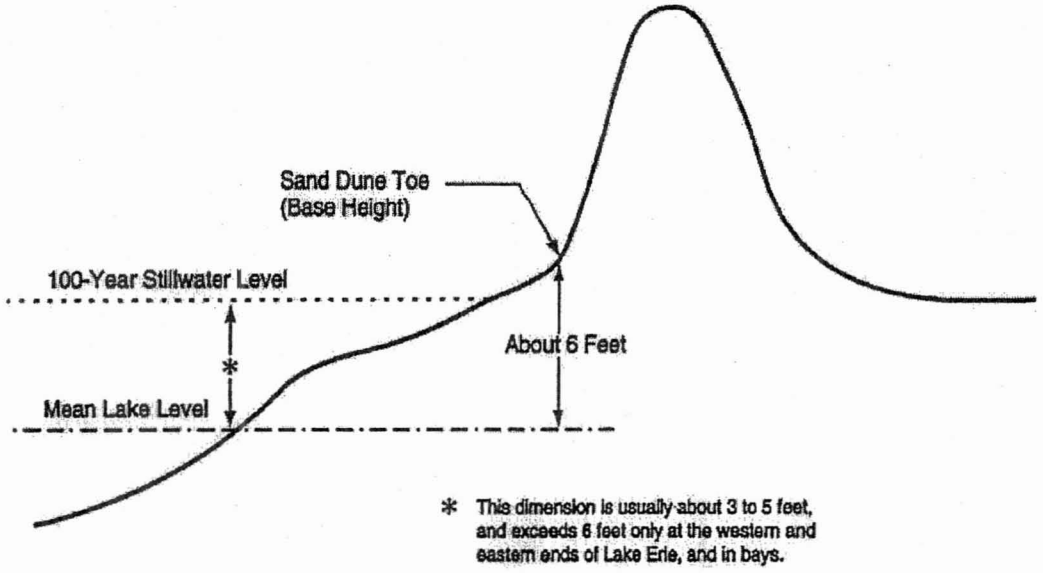


Figure D-40. Typical Great Lakes Coastal Geometry Prevents Wave Penetration Inland of Eroded Dune Site in Base Flood.

level up to the 1-percent-annual-chance SWEL, must be determined. For a vertical structure or a sloping revetment, the wave conditions must be determined at the specified water depth of the structure toe and at a water depth of 26 feet for a sand beach. The depths to be used in analyzing wave conditions should be the depths of water below the local 1-percent-annual-chance flood level.

The wave runup elevation for the shore barrier can be estimated using the GLWRM, which is available from FEMA in digital format. The program executes step-by-step procedures for runup computation at Great Lakes sites, following the recommendations from the *Great Lakes Wave Runup Methodology Study* (USACE, June 1989). The interactive format occasionally prompts the user for input or review of hydraulic and topographic descriptions of a site, including the shore barrier specification, the 1-percent-annual-chance SWEL (see Subsection D.3.2.1), and offshore storm-wave characteristics (see Subsection D.3.2.6).

Tables D-15, D16, and D-17 present examples of computation input and output for the three distinct situations, namely, a vertical structure, a sloping revetment, and a sand beach.

Table D-15. Final GLWRM Results for Wave Runup on Vertical Structure. Diamonds Added to Identify Lines with Site Specific Specifications Input or Confirmed in Response to Interactive Screen Prompts.

```
                wave runup on◆  vertical wall
     1% annual chance flood◆ 582.6 feet
         water depth at toe◆   5.5 feet
      3-year wave period  T◆   9.1
                         T':   2.6
                          L: 121.01
3-year deep water wave  H◆  20.0 feet
                          K:   5.5
                     alpha:   0.0180
                        Hmo:   3.3
                     d bar:   0.0021
                   epsilon:   0.0068
                    Hs/Hmo◆   0.907
          Hs at structure:   3.3
                       d/Lo:   0.0130
                    H/Ho'◆   1.3500
                      Ho':   2.4
          Ho'/(gT**2):   0.00090
                 ds/Ho':   2.3
              runup/Ho':   2.58
    vertical wall runup:   6.2
        runup elevation: 588.8 feet
```

Table D-16. Final GLWRM Results for Wave Runup on Sloping Revetment. Diamonds Added to Identify Lines with Site Specific Specifications Input or Confirmed in Response to Interactive Screen Prompts.

```
                wave runup on◆ revetment
  1% annual chance flood◆ 581.6 feet
      water depth at toe◆   4.5 feet
   3-year wave period  T◆   9.1
                      T':   2.4
                       L: 109.45
3-year deep water wave  H◆  20.0 feet
                       K:   6.1
                   alpha:   0.0189
                     Hmo:   2.7
                   d bar:   0.0017
                 epsilon:   0.0062
                  Hs/Hmo◆   0.920
          H at structure:   2.7
              tan(theta)◆   0.22500
revetment (Greek ltr) xi:   2.8
        revetment runup:    3.4
        runup elevation: 585.0 feet
```

Table D-17. Final GLWRM Results for Wave Runup onto Sand Beach. Diamonds Added to Identify Lines with Site Specific Specifications Input or Confirmed in Response to Interactive Screen Prompts

```
          wave runup on◆ beach
1% annual chance flood◆ 582.6 feet
    water depth at toe:  26.0 feet
3-year wave period  T◆   9.1
                    T':   5.7
                     L: 263.09
3-year deep water wave  H◆ 20.0 feet
                     K:   2.6
                 alpha:   0.0125
                   Hmo:   9.4
                 d bar:   0.0098
               epsilon:   0.0089
                Hs/Hmo◆   1.084
     Hs in deep water:   10.2
           beach slope◆   0.17300
beach (Greek ltr) xi:   1.115
           beach runup:  11.0
      runup elevation: 593.6 feet
```

D.3.5.2 Additional Considerations

As mentioned earlier in this Appendix, the GLWRM treats three shore configurations: smooth vertical wall, rip-rap revetment having a single face slope, or sloping sand beach. For some studies, the Mapping Partner may be required to evaluate other shore situations (e.g., grass or gravel shore slopes, mounds formed of other material or with a compound front slope). Although other methods and models for determining wave runup elevations could be used (see USACE, 1984 and 1992; Dewberry & Davis, 1991), the GLWRM runups can be adjusted to analyze these other shore situations. Using the GLWRM will provide consistency of results within a single study.

One parameter frequently used in NFIP coastal assessments is a roughness coefficient measuring barrier surface effects along the runup excursion (Dewberry & Davis, 1995; Stone & Webster, 1981). Table D-18 presents typical values of the roughness coefficient, usually designated as r, for common barrier materials. Wave runup elevation is assumed to vary directly with roughness coefficient, given no other difference in the geometrical configuration. Thus, GLWRM results for a sand beach (having a situation otherwise identical to that shown in Table D-13) may be multiplied by 0.90 to apply with grass, or by 0.70 to apply with gravel. For relatively steep slopes common to manmade shore structures, GLWRM results for a rip-rap revetment might be adjusted for application with other construction materials, using the appropriate ratio between roughness coefficients. Expressed formally, the runup on a rough surface is given as r times runup for a smooth surface, so that for rip-rap

$$R_1 = r_1 R \tag{1}$$

and for some other rough barrier material

$$R_o = r_o R = r_o R_1/r_1 \tag{2}$$

where the value R_1 is obtained directly from the GLWRM.

Another simplification long employed in NFIP coastal assessments is the composite-slope method (Saville, 1958), where a hypothetical uniform slope is taken to represent the segmented barrier profile (Figure D-41). That equivalent slope customarily extends from the water depth with initial wave breaking to the limit of wave runup, or from a water depth equal to incident wave height when waves do not break (at a very steep shore). For a man-made structure, the GLWRM assumes a clearly identifiable toe or seaward limit to the wave barrier, so it is appropriate to start the equivalent uniform slope at that point. Because the landward limit assumed for the uniform slope is at the runup limit, some manual computation may be needed in iterative adjustment of the input slope to attain suitable consistency with calculated runup elevation.

Table D-18. Appropriate Values for Roughness Coefficient in Wave Runup Calculations

ROUGHNESS COEFFICIENT	DESCRIPTION OF BARRIER SURFACE
1.00	Sand; smooth rock, concrete, asphalt, wood, fiberglass
0.95	Tightly set paving blocks with little relief
0.90	Turf, closely set stones, slabs, blocks
0.85	Paving blocks with sizable permeability or relief
0.80	Steps; one stone layer over impermeable base; stones set in cement
0.70	Coarse gravel; gabions filled with stone
0.65	Rounded stones, or stones over impermeable base
0.60	Randomly placed stones, two thick on permeable base
0.50	Cast-concrete armor units: cubes, dolos, quadripods, tetrapods, tribars, etc.

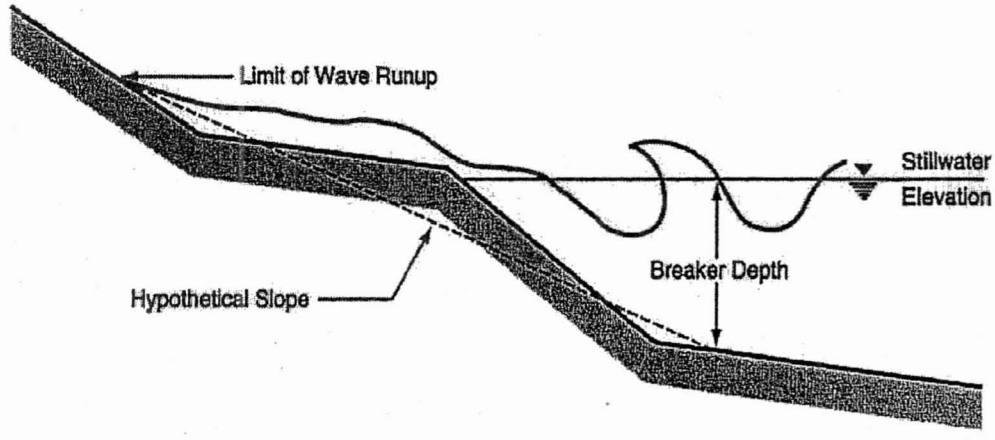


Figure D-41. Hypothetical Slope for Determining Wave Runup on Composite Profiles.

Once a definite runup elevation has been obtained for the shore situation, the Mapping Partner must compare it with barrier crest elevation to assess the possibility of wave overtopping. The examination takes into account that calculated runup elevation refers to common rather than extreme water excursions on the barrier, whereas all expected hazards of the 1-percent-annual-chance flood must be projected. If wave runup elevation reaches more than halfway from the stillwater level to the barrier crest, the Mapping Partner shall perform an overtopping assessment for flood hazards because likely wave runups occasionally will proceed over the shore barrier. Overtopping discharges in storm conditions may be estimated using empirical results in *Random Seas and Design of Maritime Structures* (Goda, 1985) for vertical walls, in "Design of Seawalls Allowing for Wave Overtopping" (Hydraulics Research Station, 1980) for sloping structures, and in "Wave Runup and Overtopping at Dunes during Extreme Storm Surge" (Delft Hydraulics Laboratory, 1983) for sand dunes with common erosion geometry. The Mapping Partner shall evaluate the effects of the discharge in terms of potential wave impacts, runoff depths, or ponding areas on ground landward of the shore barrier.

A distinct type of overflow situation can occur at low bluffs or banks backed by a nearly level plateau, where calculated wave runup may appreciably exceed the top elevation of the steep barrier. A memorandum entitled "Special Computation Procedure Developed for Wave Runup Analysis for Casco Bay, FIS - Maine, 9700-153" provides a simple procedure to determine realistic runup elevations for such situations, as illustrated in Figure D-42 (French, 1982). An extension to the bluff face slope permits computation of a hypothetical runup elevation for the barrier, with the imaginary portion given by the excess height $R' = (R\text{-}C)$ between calculated runup and the bluff crest. Using that height R' and the plateau slope m, Figure D-43 defines the inland limit to wave runup, X, corresponding to runup above the bluff crest of (mX) or an adjusted runup elevation of $R_a = (C + mX)$. This procedure is based on a Manning's "n" value of 0.04 with some simplifications in the energy grade line and is meant for application only with positive slopes landward of the bluff crest. A different treatment of wave overflow onto a level plateau, for possible FIS usage, is provided in "Overland Bore Propagation Due to an Overtopping Wave" (Cox & Machemehl, 1986).

A less common situation on the Great Lakes is that calculated wave runup exceeds a relatively high barrier crest backed by negative slopes. In such cases, a general rule limits the appropriate runup elevation to 3 feet above maximum ground elevation. Floodwaters overtopping the barrier percolate into the bed, or run along the back slope until encountering another flooding source or a ponding area. A runoff area is usually designated as Zone AO, with depth of flooding of 1, 2, or 3 feet; a ponding area may be designated as Zone AH, with a flood elevation. Standardized NFIP procedures have been developed for the treatment of sizable runoff and ponding, but are beyond the scope of this presentation; see *Guidelines and Specifications for Wave Elevation Determination and V Zone Mapping* (FEMA, 1995).

Aside from these considerations relating to the inland limit of flooding from wave runup and overtopping, the Mapping Partner must integrate the runup elevation at the shore barrier with calculated wave crest elevations near the shore.

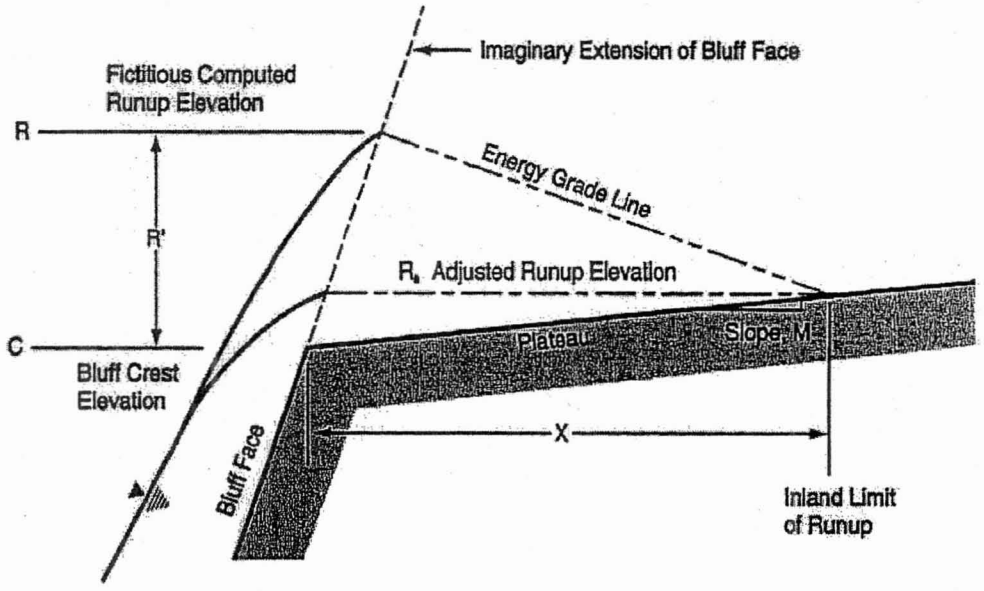


Figure D-42. Treatment of Wave Runup onto Plateau above Low Bluff.

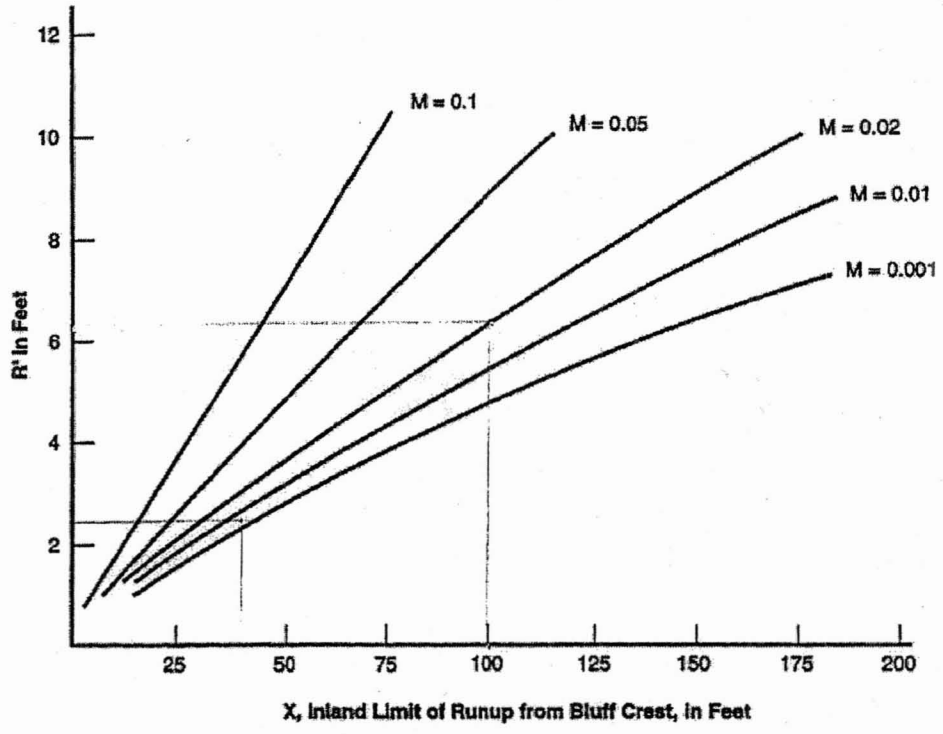


Figure D-43. Computation of Wave Runup for Low Bluffs.

D.3.6 Nearshore Wave Dimensions

As waves propagate near the shore and over a flooded area, they undergo transformations caused by local winds, interaction with the bottom, and physical features such as buildings, trees, or marsh grass. Figure D-44 illustrates the effects at a transect of obstructions on the wave crest elevations and the flood zone. For Great Lakes coasts, the effects must be calculated objectively along each transect, from the Low Water Datum to the flooding limit. Fundamental analysis of wave effects for an FIS is provided by the FEMA computer program Wave Height Analysis for Flood Insurance Studies (WHAFIS). The program calculates wave heights, wave crest elevations, flood hazard zone designations, and the location of zone boundaries along a transect. The current program version for the Great Lakes region, WHAFIS 3.0 GL, incorporates windspeeds appropriate to Great Lakes events (40 mph over fully exposed waters and 30 mph for inland waters or marsh).

Wave description for an FIS addresses the controlling wave height, equal to 1.6 times the significant wave height common as a basic wave description, with the dominant (or spectral peak) wave period. Significant wave height is the average height of the highest one-third of waves, and controlling wave height is slightly less than average height of the highest one percent of waves in storm conditions. The wave condition of interest is that expected to accompany the 1-percent-annual-chance flood.

Within WHAFIS, a wave action conservation equation governs wave regeneration caused by wind and wave dissipation caused by marsh plants. This equation is supplemented by the conservation of waves equation, which expresses the spatial variation of the wave period at the peak of the wave spectrum. The wave energy (i.e., wave height) and wave period respond to changes in wind conditions, water depths, and obstructions as a wave propagates. These equations are solved as a function of distance along the transect. Technical details are fully documented in the WHAFIS program documentation (FEMA, September 1988).

The current NFIP treatment of wave dimensions has resulted from periodic upgrades of technical procedures, with the original basis being the NAS methodology documented in *Methodology for Calculating Wave Action Effects Associated with Storm Surges* (NAS, 1977). The NAS methodology, which was developed to be suitable for manual computations, accounts for varying fetch lengths, barriers to wave transmission, and the regeneration of waves over flooded land areas. Several aspects of usual Great Lakes situations suggest that simplified analysis, considering only water depth and thin vertical barriers, might give a useful outline of wave effects for some sites.

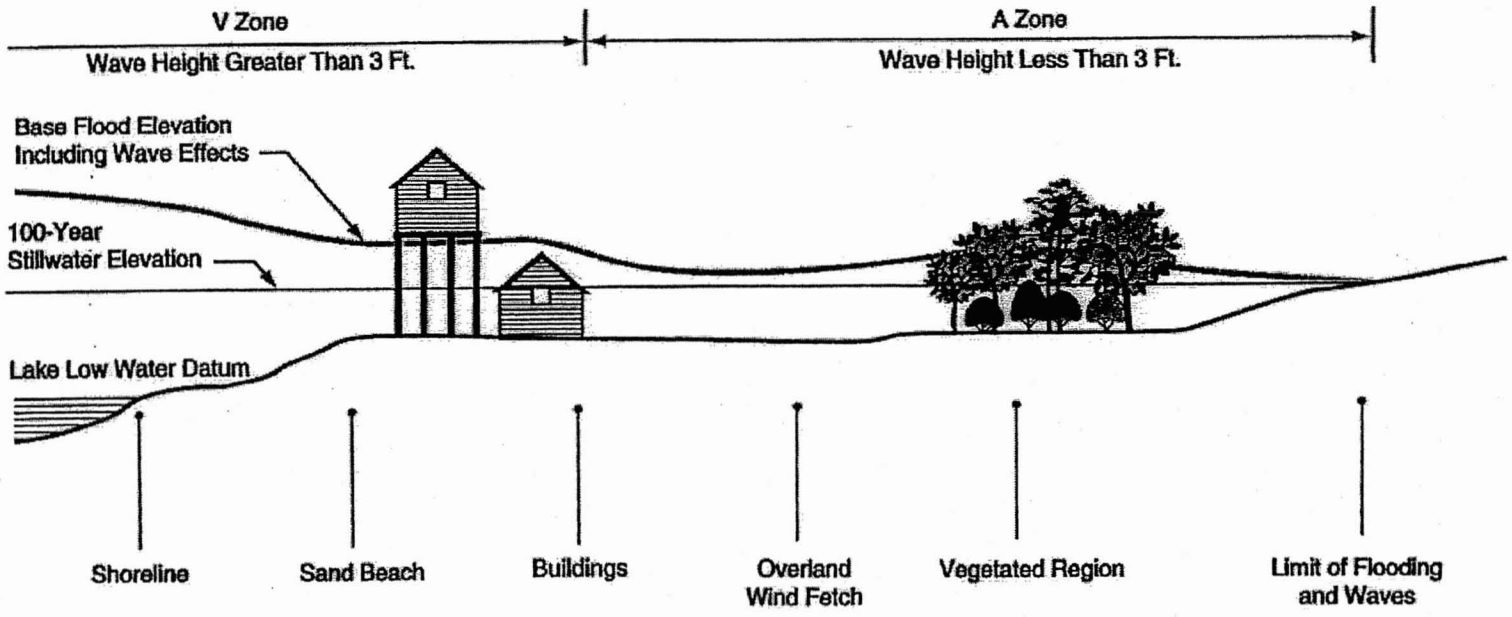


Figure D-44. Schematic Wave Effects along a Coastal Transect.

D.3.6.1 Simplified Wave Height Analysis

The potential usefulness of the simplified wave analysis method for treating 1-percent-annual-chance flood waves is suggested by certain aspects of the Great Lakes situation: the relatively low windspeeds, reducing the intensity of wave regeneration; the relatively simple eroded geometries, which are generally featureless lakeward of the ultimate flood barrier; the absence of barrier islands and back bays so that another flood source or elevation is seldom encountered; and the typical narrowness of the Coastal High Hazard Area. This method would not be appropriate where the transect includes coastal wetlands, other land cover providing appreciable flow resistance, or an extensive lowland area liable to flooding. Before any wave analysis, there must be confirmation that sizable waves likely propagate towards shore during the local 1-percent-annual-chance flood.

All elements of this treatment are extracted from the basic NAS methodology (Dawdy & Maloney, 980; FEMA, February 1981; NAS, 1977), with wave heights entirely regulated by local water depth. The estimated flood elevation (Z) is defined by wave action accompanying the flood, with the majority of the waveform in the crest above the 1-percent-annual-chance SWEL (S):

$$Z = S + 0.7\,H \tag{3}$$

where H is the local controlling wave height. A bound to H is given by wave breaking in shallow water, with the upper limit

$$H_* = 0.78\,d \tag{4}$$

where local water depth (d) equals (S-G), G being ground elevation. Combining these relations, local ground elevation constrains the flood elevation to an upper limit of

$$Z_* = S + 0.55\,d \tag{5}$$

Equation (4) implies that a minimum water depth of 3.85 feet is required for the 3-foot wave height characterizing a V Zone.

An obstruction on the transect may conveniently be treated as a thin barrier if flooding occurs to the same S on each side. Wave transmission is assumed to occur only if the barrier top elevation (C) is below S plus one-half the incident wave height (H_i). Transmitted wave height is

$$H_t = 0.5\,H_i + B \tag{6}$$

where B = ½[0.78 (S-C)] if the barrier is submerged, but B=[(S-C)] otherwise; the upper limit of $H_t = H_i$ occurs when H_i is less than [0.78 (S-C)], requiring that H_i is not depth-limited. Transmitted wave height beyond the barrier remains limited by ground elevation on the landward side of the barrier (G_t), through Equation (2), just as incident wave height is limited by

ground elevation on the lakeward side (G_i). With engineering judgment, wave obstructions other than walls might be represented by proper choices of G_i, C, and G_t in this procedure.

Figure D-45 presents an idealized numerical example demonstrating estimated wave heights, flood elevations, and flood zones. Note that varying elevations of depth-limited wave crests mirror the ground slopes.

[February 2002]

D.3.6.2 Use of WHAFIS 3.0 GL Model

Careful preparation and input of required site data are necessary in using WHAFIS. Like the other coastal treatments, the WHAFIS model considers the study area by representative transects. For WHAFIS, transects must be defined considering major topographic, vegetative, and cultural features. The transect, referenced to NGVD29, begins at the local elevation of Low Water Datum (Table D-13) and proceeds landward until either the ground elevation exceeds the SWEL or another flooding source is encountered.

Fundamental specifications for WHAFIS input include the 1-percent-annual-chance flood SWEL and a description of waves existing at the transect start. The wave description provides for an overwater fetch length, an initial significant wave height, or an initial period of dominant waves. In most Great Lakes applications, the wave period should be the input description, because that parameter is readily available from information about offshore waves (see Subsection D.3.2.6).

The Mapping Partner shall locate transects on the work maps and plot the transect ground profile from the topographic data, adjusted for erosion. The Mapping Partner shall ensure that each transect has all the input data identified on the profile plot for ease of input coding. The Mapping Partner also shall identify the location, height, and width of elongated manmade structures and show them as part of the ground profile, after confirming the structure's stability under forces of the 1-percent-annual-chance flood (see Subsection D.3.3).

Buildings are specified on the transect as rows perpendicular to the transect. Because buildings are not always situated in perfect rows, the Mapping Partner shall exercise judgment to determine which buildings can be represented by a single row. The required input value for each row of buildings is the ratio of open space to total space. This is simply the sum of distances between buildings in a row, divided by the total length of that row.

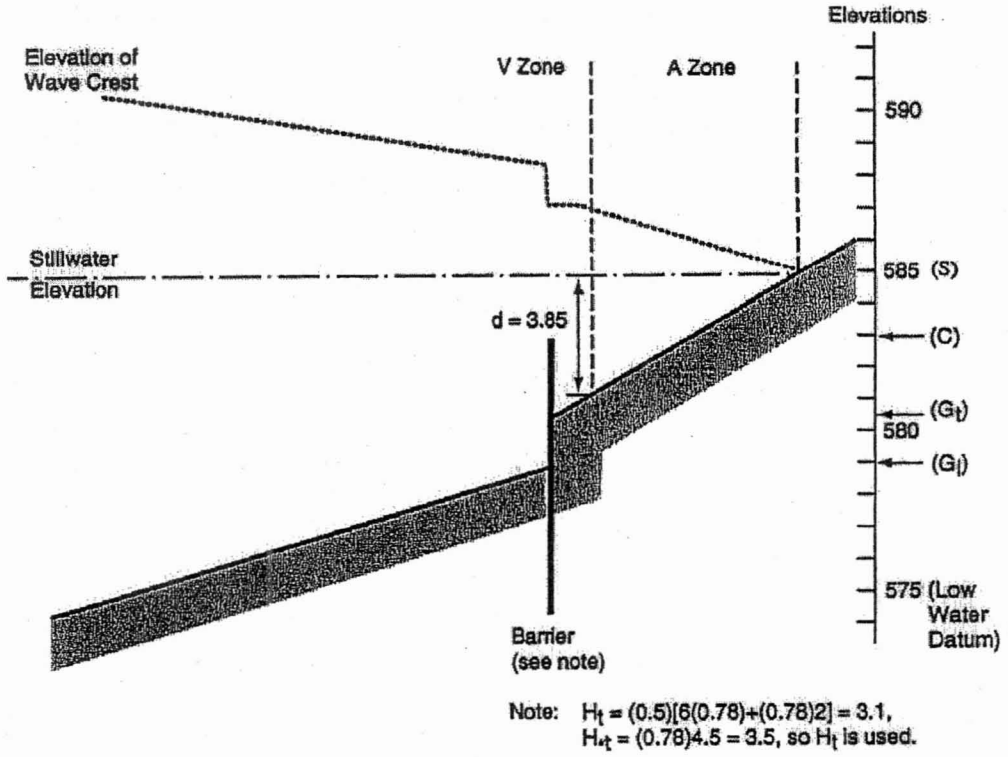


Figure D-45. Schematic Example of Simplified Wave Height Analysis Regulated by Local Water Depth, with All Indicated Quantities in Feet.

The first row or two of buildings along the shoreline is not always to be considered as obstructions. During a 1-percent-annual-chance flood, it is sometimes appropriate to assume that if they are not elevated on pilings, these buildings will be destroyed before the peak of the flood occurs. If they are elevated, the waves should propagate under the structures with minimal reduction in height. The Mapping Partner shall contact local officials to obtain typical construction methods and the lowest elevations of structure.

The WHAFIS program has two routines for vegetation: one for rigid vegetation that can be represented by an equivalent "stand" of equally spaced circular cylinders (NAS, 1977) and one for marsh vegetation that is flexible and oscillates with wave action (FEMA, 1984). For either type, considerable care is required in selecting representative parameters and in ruling out that the vegetation will be intentionally removed or that effects during a storm would be markedly reduced through erosion, uprooting, or breakage.

For the areas of rigid vegetation located on the transect, the required input values are the drag coefficient, CD; mean wetted height, h; mean effective diameter, D; and mean horizontal spacing, b. The value of CD should vary between 0.35 and 1.0, with 1.0 being used in most cases of wide vegetated areas. When the vegetation is in a single stand, a value of 0.35 should be used. Representative values for h, D, and b can be obtained from stereoscopic aerial photographs or by field surveys. Various guides for terrain analysis can provide procedures for estimating these values from aerial photographs. Table D-19 provide a useful procedure developed from Terrain Analysis Procedural Guide for Vegetation (Messmore, Vogel, & Pearson, 1979).

For marsh vegetation, a more complicated specification is required for completeness, and the eight parameters used to describe the attenuation properties of a specific vegetation type are explained in Table D-20.

WHAFIS includes considerable basic information on eight common types of seacoast marsh plants listed in Table D-21 (FEMA, 1984; FEMA, 1989), but among these, apparently only the *Juncus* species are likely to occur in the freshwater marshes on the Great Lakes. For vegetation not listed in Table D-21, the Mapping Partner shall input the geometrical parameters to WHAFIS.

At lakeshore elevations that are seldom flooded and thus are important for the 1-percent-annual-chance flood, a great diversity of wetland vegetation can occur along with upland vegetation species. Prevalent marsh plants at relatively high elevations (Levels Reference Study Board) may include combinations of grasses (*Phalaris arundinacea, Calamagrostis canadensis*), sedges (*Carex lacustris, C. rostrata, C. stricta, C. lasiocarpa*), rushes (*Juncus canadensis, J. effusus*), or cattails (*Typha* varieties). The Mapping Partner shall specify each existing type of vegetation s, along with its fractional coverage in any sizable patch; a patch of at least 10,000 square feet (0.09 hectare) can affect wave heights appreciably.

Table D-19. Procedure for Vegetation Analysis Using Stereoscopic Aerial Photographs.

1. Using the parallax bar or wedge, determine the height of three representative trees and compute the average height, h.

2. Locate three representative tree crowns, measure the diameters, and compute the average crown diameter, CD.

3. Determine the type of vegetation and calculate the stem diameter, D, using the following formulae:

Southern Pines	D (inches) = 5 + 0.5 CD (feet)
Eastern Hardwoods, Northern Pines and Others	D (inches) = 0.75 CD (feet)

4. Based on the scale of the aerial photographs, determine the diameter of a circle containing 0.08 hectares using Table 4. Place the circle on the photograph, over a representative area of trees, and count the number of trees, n, in the circle. A magnifier may be needed. More than one area can be counted and an average used for n. Calculate the number of trees per hectare, N, using the following formula:

$$N = \frac{n}{0.08}$$

5. Determine the horizontal spacing between trees using the following formula:

$$b \text{ (feet)} = 3.28 \left(\frac{12732}{N} \right) - \frac{D \text{ (inches)}}{12}$$

Table D-19. Procedure for Vegetation Analysis Using Stereoscopic Aerial Photographs (Cont.)

CIRCLE DIAMETERS
.08 HECTARE AREA, (1/5 ACRE)
(800 Square Meters, 8712 Square Feet)

PHOTO SCALE	.08 HECTARE CIRCLE	CIRCLE DIAMETER INCHES	MILLIMETERS
1:5,000		.253	6.38
1:6,000		.211	5.32
1:7,000		.1805	4.56
1:8,000		.158	3.99
1:9,000		.140	3.55
1:10,000		.126	3.192
1:11,000		.115	2.90
1:12,000		.105	2.66
1:13,000		.092	2.46
1:14,000		.090	2.28
1:15,000		.084	2.13
1:16,000		.079	1.99
1:17,000		.074	1.88
1:18,000		.070	1.77
1:19,000		.067	1.68
1:20,000		.063	1.60
1:21,000		.060	1.52
1:22,000		.057	1.45
1:23,000		.055	1.39
1:24,000		.053	1.33
1:25,000		.051	1.28

Table D-20. Marsh Plant Parameters

PARAMETER	EXPLANATION
C_D	Effective drag coefficient. Includes effects of plant flexure and modification of the flow velocity distribution. Default value is 0.1, usually appropriate for marsh plants without strong evidence to the contrary.
F_{cov}	Fraction of coverage. A default value is calculated by the program so that each plant type in the transect is represented equally, and the sum of the coverage for the plant types is equal to 1.0.
h	Unflexed stem height (feet). The stem height does not include the flowering head of the plant, the inflorescence.
N	Number density. Expressed as plants per square foot. The relationship to the average spacing between plants, b, can be expressed as $N = 1/b^2$.
D_1	Base stem diameter (inches). Default value may be determined from stem height and regression equations built into the program.
D_2	Mid stem diameter (inches). Default value may be determined from plant type and base stem diameter.
D_3	Top stem diameter (inches), at the base of the inflorescence. Default value may be determined from plant type and base stem diameter.
CA_b	Ratio of the total frontal area of the cylindrical portion of the leaves to the frontal area of the stem below the inflorescence. Default value may be determined from the plant type.

Table D-21. Abbreviations of Marsh Plant Types Used in WHAFIS

SPECIES OR SUBSPECIES	ABBREVIATION
Cladium jamaicense (saw grass)	CLAD
Distichlis spicata (salt grass)	DIST
Juncus gerardi (black grass)	JUNM
Juncus roemerianus (black needlerush)	JUNR
Spartina alterniflora (medium saltmeadow cordgrass)	SALM
Spartina alterniflora (tall saltmeadow cordgrass)	SALT
Spartina cynosuroides (big cordgrass)	SCYN
Spartina patens (saltmeadow grass)	SPAT

[February 2002]

D.3.6.3 Input Coding

After all the necessary input data have been identified on the transect, the Mapping Partner shall divide the transect into continuous segments, each representing a single open fetch or obstruction. Fetches are flooded areas with no obstructions, such as dunes, manmade barriers, buildings, and vegetation. The Mapping Partner shall subdivide fetches at points where the ground elevation abruptly changes and in the transition area of changing SWELs. The Mapping

Partner shall subdivide obstructions at the transect's seaward edge to more accurately model the wave dissipation. Rigid vegetation is to have two to three seaward segments extending 10 to 50 feet, and the first two or three rows of buildings are to have a segment for each row. Marsh vegetation will be subdivided by the WHAFIS model, and thus segmented input is not necessary.

The Mapping Partner shall enter the necessary data using 11 line types, including the Title line. The ten remaining lines each describe a certain type of fetch or obstruction, listed as follows:

- The IE (Initial Elevation) line describes the initial overwater fetch and the initial SWELs.
- The IF (Inland Fetch) and OF (Overwater Fetch) lines define the endpoint stationing and elevation of inland and overwater fetches, respectively.
- Obstructions are categorized either as buildings (BU line), rigid vegetation (VE line), marsh vegetation (VH and MG lines), dunes and other natural or manmade elongated barriers (DU line), or areas where the ground elevation is greater than the 1-percent-annual-chance SWEL (AS line).
- The ET (End of Transect) line enters no data but indicates the end of the input data.

Each line has an alphanumeric field describing the type of input for that line, followed by ten numeric fields describing the parameters.

To ensure proper modeling, the Mapping Partner shall enter all segments of each transect either as fetches or obstructions, with one input line required for each fetch or obstruction segment. The first two columns of each line identify the type of fetch or obstruction. The remaining 78 columns consist of one field of six columns followed by nine fields of eight columns. The Mapping Partner shall right-justify the numbers in any data field only if no decimal point is used. Decimal points are permitted but not required. The end point of one fetch or obstruction is the beginning of the next. The first two numeric fields of each line are used to read in the stationing (measured in feet from the beginning of transect) and elevation (in feet) of the end point. The last two fields used on each line are for entering new SWELs. An interpolation is performed within a transect segment starting at the closest station with an input SWEL. This interpolation uses the new SWEL input at the end point of the segment and the SWEL input at a previous segment. If these fields are blank or zero, the SWELs remain unchanged.

The input data requirements are summarized below for each line type. The Title line must be the first line, followed by the IE line, followed by any combination of the various fetch and obstruction lines. The ET line must be the last card entered for the transect. A blank line must follow to signify the end of the run. If multiple transects are being run, the Title line for the next transect will follow the blank line. All units are in feet unless otherwise specified.

TITLE Line (Title)

This line is required and must be the first input line.

DATA FIELD	COLUMNS	CONTENTS OF DATA FIELDS
0	1-2	Blank
1-10	3-80	Title information centered about column 40

IE Line (Initial Elevations)

This line is required and must be the second input line. This line is used to begin a transect at the shoreline and compute the wave height arising through the overwater fetch.

DATA FIELD	COLUMNS	CONTENTS OF DATA FIELDS
0	1-2	IE
1	3-8	Stationing of end point of initial overwater fetch in feet (zero at beginning of transect)
2	9-16	Ground elevation at end point in feet (usually Low Water Datum at beginning of transect)
3	17-24	Overwater fetch length (miles), if wave condition is to be calculated. Values of 24 miles or greater yield identical results.
4	25-32	10-percent-annual-chance SWEL in feet
5	33-40	1-percent-annual-chance SWEL in feet
6	41-48	Initial wave height; a blank or zero causes a default to a calculated wave height
7	49-56	Initial wave period (seconds); a blank or zero causes a default to a calculated wave period. The period is usually the most convenient wave specification for Great Lakes cases.
8-10	57-80	Not used

AS Line (Above Surge)

This line is used to identify the end point of an area with ground elevation greater than the 1-percent-annual-chance SWEL (such as a high dune or land mass). It is used when the ground surface temporarily rises above the 1-percent-annual-chance SWEL. The line immediately preceding the AS line must enter the stationing and elevation of the point at which the ground elevation first equals the 1-percent-annual-chance SWEL. The SWEL on the leeward side may be different from the SWEL on the windward side. The ground elevation entered on the AS line must equal the SWEL that applies to the leeward side of the land mass. The computer calculations will be terminated if a ground elevation greater than the 1-percent-annual-chance SWEL is encountered.

DATA FIELD	COLUMNS	CONTENTS OF DATA FIELDS
0	1-2	AS
1	3-8	Stationing at end point in feet of area above 1-percent-annual-chance SWEL
2	9-16	Ground elevation in feet at end point
3	17-24	A blank or zero indicates no change to the 10-percent-annual-chance SWEL; otherwise new 10-percent-annual-chance SWEL
4	25-32	A blank or zero indicates no change to the 1-percent-annual-chance SWEL; otherwise new 1-percent-annual-chance SWEL
5-10	33-80	Not used

BU Line (Buildings)

This line enters information needed to compute wave dissipation at each group of buildings.

DATA FIELD	COLUMNS	CONTENTS OF DATA FIELDS
0	1-2	BU
1	3-8	Stationing of end point in feet of group of buildings
2	9-16	Ground elevation at end point in feet
3	17-24	Ratio of open space between buildings to total transverse width of developed area
4	25-32	Number of rows of buildings
5	33-40	A blank or zero indicates no change to 10-percent-annual-chance SWEL; otherwise new 10-percent-annual-chance SWEL
6	41-48	A blank or zero indicates no change to 1-percent-annual-chance SWEL; otherwise new 1-percent-annual-chance SWEL
7-10	49-80	Not used

DU Line (Dune)

This line enters information necessary to compute wave dissipation at substantial sand dunes and other natural or manmade elongated barriers (e.g., levees, seawalls).

DATA FIELD	COLUMNS	CONTENTS OF DATA FIELDS
0	1-2	DU
1	3-8	Stationing at top of dune or barrier in feet
2	9-16	Elevation at top of dune or barrier in feet
3	17-24	A blank or zero indicates a dune or other natural barrier; any other number indicates a seawall or other manmade barrier
4	25-32	A blank or zero indicates no change to 10-percent-annual-chance SWEL; otherwise new 10-percent-annual-chance SWEL
5	33-40	A blank or zero indicates no change to 1-percent-annual-chance SWEL;

DATA FIELD	COLUMNS	CONTENTS OF DATA FIELDS
		otherwise new 1-percent-annual-chance SWEL
6-10	41-80	Not used

IF Line (Inland Fetch)

This line enters the parameters necessary to compute wave regeneration through inland fetches and over shallow inland waterbodies. The IF regeneration is computed using overland wind speed of 30 mph for Great Lakes floods.

DATA FIELD	COLUMNS	CONTENTS OF DATA FIELDS
0	1-2	IF
1	3-8	Stationing at end point of fetch in feet
2	9-16	Ground elevation at end point in feet
3	17-24	A blank or zero indicates no change to 10-percent-annual-chance SWEL; otherwise new 10-percent-annual-chance SWEL
4	25-32	A blank or zero indicates no change to 1-percent-annual-chance SWEL; otherwise new 1-percent-annual-chance SWEL
5-10	33-80	Not used

OF Line (Overwater Fetch)

This line enters the parameters necessary to compute wave regeneration over large bodies of water (i.e., large lakes, bays) using overwater wind speed of 40 mph for Great Lakes floods. If an inland waterbody is sheltered and has a depth of ten feet or less, the IF line calling for overland wind speeds should be used.

DATA FIELD	COLUMNS	CONTENTS OF DATA FIELDS
0	1-2	OF
1	3-8	Stationing at end point of fetch in feet
2	9-16	Ground elevation at end point in feet
3	17-24	A blank or zero indicates no change to the 10-percent-annual-chance SWEL; otherwise new 10-percent-annual-chance SWEL
4	25-32	A blank or zero indicates no change to 1-percent-annual-chance SWEL; otherwise new 1-percent-annual-chance SWEL
5-10	33-80	Not used

VE Line (Vegetation)

This line enters parameters necessary to compute wave dissipation due to rigid vegetation stands.

DATA FIELD	COLUMNS	CONTENTS OF DATA FIELDS
0	1-2	VE
1	3-8	Stationing at end point of vegetation in feet
2	9-16	Ground elevation at end point in feet
3	17-24	Mean effective diameter of equivalent circular cylinder in feet
4	25-32	Average actual height of vegetation in feet
5	33-40	Average horizontal spacing between plants in feet
6	41-48	Drag coefficient; a blank or zero causes a default to 1.0
7	49-56	A blank or zero indicates no change to 10-percent-annual-chance SWEL; otherwise new 10-percent-annual-chance SWEL
8	57-64	A blank or zero indicates no change to 1-percent-annual-chance SWEL; otherwise new 1-percent-annual-chance SWEL
9-10	65-80	Not used

VH Line (Vegetation Header for Marsh Grass)

Marsh grass is often part of a plant community that may consist of several plant types. The VH line is used to enter data that apply to all plant types modeled in the transect segment. To enter data for each plant type, MG lines for each plant type must follow the VH line.

DATA FIELD	COLUMNS	CONTENTS OF DATA FIELDS
0	1-2	VH
1	3-8	Stationing at end point of marsh vegetation segment in feet
2	9-16	Ground elevation at end point in feet
3	17-24	Reg_p, number of the primary seacoast region for default plant parameters. Leave blank for Great Lakes computations.
4	25-32	Wt_p, weighting factor for the primary seacoast region. Not applicable for Great Lakes analyses.
5	33-40	Reg_s, number of secondary seacoast region. Not applicable for Great Lakes analyses.
6	41-48	N_{pl}, number of plant types; range is 1 to 10, inclusive. One MG line is required for each plant type.
7	49-56	A blank or zero indicates no change to the 10-percent-annual-chance SWEL; otherwise new 10-percent-annual-chance SWEL
8	57-64	A blank or zero indicates no change to the 1-percent-annual-chance SWEL; otherwise new 1-percent-annual-chance SWEL
9	65-72	Not used
10	73-80	This field is for overriding the default method of averaging flood hazard factors in A Zones; if 1 in column 80, averaging process begins or ends at end of vegetation segment; otherwise, default averaging method is used

MG Line (Marsh Grass)

This line is used to enter data for a particular plant type. The first MG line must be preceded by a VH line. For the common seacoast marsh grasses listed in Table D-21, potentially useful default values are supplied in Table D-22. If a plant type not listed in the table is used, then appropriate data must be developed for Fields 2-9.

DATA FIELD	COLUMNS	CONTENTS OF DATA FIELDS
0	1-2	MG
1	5-8	Marsh plant type abbreviation (see Table 10)
2	9-16	C_D, effective drag Coefficient; default value is 0.1
3	17-24	F_{cov}, decimal fraction of vegetated area to be covered by this plant type; a blank or zero causes a default to be calculated so that each plant type is represented equally
4	25-32	h, mean unflexed height of stem (feet); for marsh plants, the inflorescence is not included
5	33-40	N, number of plants per square foot
6	41-48	D_1, base stem diameter (inches)
7	49-56	D_2, mid stem diameter (inches)
8	57-64	D_3, top stem diameter (inches)
9	65-72	CA_b, ratio of the total frontal area of cylindrical part of leaves to frontal area of main stem
10	73-80	Not used

ET Line (End of Transect)

This line is required and must be the last input card because it identifies the end of input for the transect.

DATA FIELD	COLUMNS	CONTENTS OF DATA FIELDS
0	1-2	ET
3-10	3-80	Not used

Table D-12. Significant Marsh Plant Types in Each Seacoast Region and WHAFIS Default Regional Plant Parameter Data

REGION NO.	1	2	3	4	5	6	7	8
REGION NAME:	**NORTH ATLANTIC**	**MID-ATLANTIC**	**SOUTH ATLANTIC**	**SOUTH FLORIDA**	**NORTHEASTERN GULF**	**DELTA PLAIN**	**CHENIER PLAIN**	**SOUTH TEXAS**
CLAD	---	---	---	7.50(+) 0.0656 6	6.00(2) 0.0260 6	---	---	---
DIST	---	0.78(1) 0.0039 211	1.00(1) 0.038 243	1.00(+) 0.0038 248	--- ---	1.08(4) 0.0035 102	1.08(+) 0.0035 102	---
JUNM	1.23(1) 0.0042 300	1.23(+) 0.0042 300	---	---	---	---	---	---
JUNR	---	2.95(+) 0.0095 147	2.95(+) 0.0095 147	---	2.95(3) 0.0095 147	3.00(4) 0.0106 83	2.95(+) 0.0095 147	---
SALM	1.39(1) 0.0184 45	1.06(1) 0.0103 36	1.63(1) 0.0141 12	1.63(+) 0.0141 12	---	1.67(4) 0.0141 21	2.62(5) 0.0211 16	---
SALT	1.86(1) 0.0175 37	2.21(1) 0.0169 18	3.20(1) 0.0183 10	3.20(+) 0.0183 10	---	3.20(4) 0.0183 10	3.20(+) 0.0183 10	---
SCYN	---	---	8.29(+) 0.0492 6	---	---	4.00(4) 0.0267 7	---	---
SPAT	1.03(1) 0.0025 409	0.85(1) 0.0019 327	1.65(1) 0.0019 236	---	2.58(2) 0.0026 236	1.88(4) 0.0016 333	1.88(+) 0.0019 333	---

Data arranged in vertical triplets:

h, stem height below inflorescence, in feet
D, base diameter, in feet
N, number density, in inverse square feet

Parenthetical references indicate data source:

1 = Hardisky and Reimold, 1977
2 = Monte, August 1983
3 = Kruczynski, Subrahmanyam, Drake, 1978
4 = Hopkinson, Gosselink, Parrondo, 1980, Diameters extrapolated
5 = Turner and Gosselink, 1975, Diameters extrapolated
+ = Extrapolated Data
--- = Insignificant amounts of this plant type in the region

D.3.6.4 Error Messages

While using the WHAFIS program, the Mapping Partner may encounter the error messages listed below.

- "AS card ground elevation less than SWEL, should use other type card, job dumped."

  Only use AS (above surge) line when the ground elevation is above the SWEL. Can otherwise use IF, OF, BU, DU, VE, or VH.

- "Ground elevation greater than surge elevation encountered, job dumped."

  If ground elevation is above surge elevation, AS card should be used.

- "Average depth less than or equal to zero, job dumped."

  The water depth must be greater than zero or a wave height cannot be computed. Check the SWEL and the ground elevation if point of job dump is not the last point along the transect profile.

- "The above card contains illegal data in the first 2 columns."

  Check input data for incorrect values or input within wrong columns. Aside from the title line, the first two columns in each line should contain the card identifiers.

- "Transmitted wave height at last fetch or obstruction = _____ which exceeds 0.5."

  Code the transect profile up to the inland limit where ground elevation intersects the SWEL so that wave height should decrease to zero. If the scope of work ends at the corporate limits before the ground elevation meets the SWEL, this message can be ignored.

- "Array dimensions exceeded. Job dumped."

  Size of the array is limited and the number of input parameters has exceeded the array. Check the number of input parameters at the location where the job dumped.

- "Invalid data in field 1 of IF card," etc.

  Check input data to make sure that data are in correct columns.

- "Wave period less than or equal to zero in subroutine fetch. Abort run."

  Either a fetch length or a wave period must be input for the program to run properly. Check input data.

- "Invalid data in field 3 or field 5 of VH card."
  Check input data.
- "Invalid data in field 4 of VH card."

  Check input data.

- "Invalid data in field 3 of MG card."

Check input data. The fraction of vegetated area covered by the stated plant type should be a decimal number between 0.0 and 1.0.

- "Missing MG card or incorrect data in field 6 of VH card."

  A MG card must always follow the VH card. Field 6 of the VH card pertains to the number of plant types, and one MG card is required for each plant type.

- "Invalid input data."

  Check input data for invalid characters, such as an O instead of a zero. Check to be sure that all data are in their correct columns.

- "Fcov was found to be negative for plant type = _____."

  Check input data to be sure that the decimal fraction of the vegetated area covered by the plant type is not negative.

- "Ncov is .LE. zero in Sub.Lookup when it should be .GT. zero. Abort run."

  Check input for number of plants covering the area.

- "The first card is not an IE card, this transect is aborted. Continued to next transect."

  The first card after the title line must always be an IE card. Check input data.

- "**** The surge elevation at this station (stationing ____), which is ____ card, is less than the ground elevation. The interpolation process is continued. *** Please double check the surge and ground elevations in the vicinity of this station!!!!!!"

  The surge elevation should not be below the ground elevation. If the interpolated surge elevation is interpolated below the ground elevation, insert additional cards to specify surge and ground elevations and use an AS card if necessary.

- "Interpolation line cuts off more than two portions of high ground ridge. This transect is aborted, re-assign 1-percent-annual-chance elevations at high ground stations."

  When the interpolated value falls below the ground elevation, insert additional cards to better model the area and set the SWEL equal to the ground elevation where appropriate. Insert AS cards as necessary.

- "**** Unreasonable high ground elevation at station ____ which is ____ card. This transect is aborted, continued to next transect. **** Double check the surge and ground elevations in the vicinity of this station. If the ground elevations are correct, either assign a higher surge elevation or use AS cards."

  Add additional input data as necessary to better define the ground elevation and surge elevation in this area.

[February 2002]

D.3.6.5 Output Description

The output of the program provides all the data necessary for plotting the BFEs and flood insurance risk zones along the transect. The output is in six parts:

Part 1 - Input

This is a printout showing all input data lines and the parameters assigned to each line, both manually and by default. This is followed by a more detailed printout with column headings for each input data line. When VH and MG Lines are used, a separate insert will be printed directly beneath the MG Line showing any default values supplied by the computer.

Part 2 - Controlling Wave Heights, Spectral Peak Wave Period, and Wave Crest Elevations

This is a list of the calculated controlling wave heights, spectral wave peak periods, and wave crest elevations at the end point of each fetch and obstruction of the input, and at calculation points generated between the input stations.

Part 3 - Location of Areas Above 1-Percent-Annual-Chance Surge

This is a list of the locations of areas where the ground elevation is greater than the 1-percent-annual-chance stillwater (surge) elevation. Only areas identified by AS lines are listed.

Part 4 - Location of Surge Elevations

This is a list of the 10- and 1-percent-annual-chance stillwater (surge) elevations and the stationing of the points where each set of SWELs first becomes fully effective.

Part 5 - Location of V Zones

This is a list of the locations of the V/A Zone boundary and locations of the V Zone areas relative to these boundaries. The stationing is given for each V/A Zone boundary. The locations of the V Zone areas in relation to these boundaries are given as windward or leeward of the boundary.

Part 6 - Numbered A Zones and V Zones

This is a list of the zone data needed to delineate the flood hazard boundaries on the FIRM. The location of a flood zone boundary and the wave crest elevation at that boundary are given on the left. Between the boundary listings are the zone designations and FHFs. Under FEMA's Map Initiatives Procedure guidelines, all numbered V and A Zones should be changed to VE and AE Zones, respectively (elevations will not change), and the FHFs can be ignored (FEMA, 1991). When the same zone and elevation are repeated in the list, they should be treated as a single zone.

[February 2002]

D.3.7 Mapping of Flood Elevations and Zones

This subsection discusses procedures for reviewing the initial model results and identifying flood insurance risk zones, and provides guidance for depicting the analysis on the FIRM.

[February 2002]

D.3.7.1 Review and Evaluation of Basic Results

The results of the technical analyses performed for the FIS or map revision determine the special flood hazards shown on the FIRM. The coastal hazards mapped on the FIRM depict the effects of erosion on overland wave propagation, the impact of steep beach slopes and bluffs on wave runup elevation, and the areas subject to high velocity wave hazards (V Zones). Because the FIRM is used for floodplain management and flood insurance determination, the Mapping Partner shall ensure the SFHAs are mapped with as much accuracy as possible.

With the results of the various analyses at hand, the Mapping Partner shall place flood elevations and zones on the work map or up-to-date topographic survey map, after first reviewed them for their consistency with the terrain and conditions they represent and with historical data. In using the models, it is possible to forget that the transects represent real shorelines of sandy beaches, rocky or cohesive bluffs, wetlands, etc., being subjected to extremely high water, waves, and winds. The Mapping Partner shall review the results of the analyses to determine if they are a reasonable representation of the coastal areas being modeled.

Although historical data from a storm closely approximating the base (1-percent-annual-chance) flood are seldom available, flood data for less intense storms will still indicate, at a minimum, what areas should be in flood zones. For instance, if a storm produced an extreme flood that caused structural damage to houses 100 feet from the shoreline, yet the flood was below the 1-percent-annual-chance flood SWEL, a reasonable Zone VE width would be at least 100 feet. Similarly, houses more than 100 feet from the shoreline that are flooded but not structurally damaged by the same storm must be at least in a Zone AE, AH, or AO. If the analyses of the 1-percent-annual-chance flood produce flood zones and elevations indicating lesser hazards than those recorded for a more common storm, the Mapping Partner shall reevaluate the analyses. There may be an explanation for the inconsistency (other than an error in the input data); for instance, a new coastal structure may act to reduce flood hazards locally or a big storm may have significantly altered the terrain. A field check should be undertaken to determine whether such an explanation exists.

If no explanation for the inconsistency is apparent, the Mapping Partner shall examine the data input to the models including checking that the SWELs, wave heights, wave periods, and fetch lengths were input correctly and are consistent with the historical data. A further field check could examine whether buildings or structures modeled would be destroyed by the storm or whether the buildings are on pilings above the flooding.

The Mapping Partner also shall evaluate the results of the erosion assessment by comparing the eroded profile to past effects, whether in the form of profiles, photographs, or simply

descriptions. A general idea of what happened previously can be sufficient. Judgment and experience must be used to project previous storm effects to the 1-percent-annual-chance flood conditions and to ensure that the eroded profile is consistent with previous events.

The main point emphasized here is that the results are not to be blindly accepted. Many uncertainties and variables in coastal processes may occur during an extreme flood, and many possible adjustments to methodologies for treating such an event may be appropriate. The validity of any model is demonstrated by its success in reproducing recorded events. Therefore, the model results must be in basic agreement with past flooding patterns and results, and historical data must be used to evaluate these results.

[February 2002]

D.3.7.2 Identification of Flood Insurance Risk Zones

Interpretation and accurate delineations of the hazards on the maps are the final critical elements in a coastal flood hazard study. The transect used in the wave elevation determination and the resulting wave analyses, whether for wave height or wave runup, is the tool by which the results can be mapped. Mapping Partner shall identify the flood zones and BFEs should be identified on each of the transect plots before transferring the information and delineating the hazard zones and BFEs on the work maps. It should be noted that because of changes in the NFIP in 1988 that redefined the Coastal High Hazard Area and incorporated wave runup hazards, Part 6 of the WHAFIS output, discussed in Section D.3.6, is no longer used to plot zones on the work maps.

It is important to understand the interrelationship of the three key elements in determining the flood hazard zone and BFE. These elements are the existing transect ground profile, the eroded transect ground profile, and the wave envelope. The existing transect ground profile may be modified by the presence of erosion forces along the shoreline, if appropriate, in which case the flood hazard zone depicted by the transect and wave analyses results may not appear to reflect the topography shown for existing conditions with ground elevations higher than the BFE. The eroded transect ground profile, developed using treatment described in Subsection D.3.4, must be used in the wave analyses described in Subsections D.3.5 and D.3.6. The BFEs and the topography shown on the work maps may differ from those produced by the erosion treatments for a shoreline reach and the wave analyses. This is because the topography of the work maps does not reflect the erosion of the shoreline determined as part of the coastal FIS or map revision request. To clarify areas where these discrepancies exist, the Mapping Partner shall provide a description of the areas subject to erosion treatments either in the coastal FIS Report or in the supporting engineering report for a map revision request.

The wave envelope is the most important of the three elements for identifying the flood hazard zone. The wave envelope is a combination of representative wave runup elevation and the wave crest profile determined by the wave results computed using the WHAFIS program. The wave crest profile is plotted on the final transect ground profile (with or without the effects of erosion) based on the results computed and shown in Part 2 of the WHAFIS output. For wave runup elevation results, a horizontal line is extended seaward from the computed runup elevation to its intersection with the wave crest profile. This determines the wave envelope profile for the

results combined from the WHAFIS wave height analysis and the RUNUP 2.0 wave runup analysis, as shown in Figure D-46. If the runup elevation is greater than the maximum wave crest elevation, the wave envelope will be a horizontal line at the runup elevation. Conversely, if the wave runup is negligible or was not modeled because of coastal processes and shoreline conditions that prevent significant runup from occurring, the wave crest profile alone will become the wave envelope.

Before transferring the established wave envelope information from each transect onto the work maps, it is important to understand the NFIP coastal flood zones and how to determine their location along the transect plot. The descriptions are as follows:

Zone VE - Coastal High Hazard Areas where wave action and/or high velocity water can cause structural damage in the base (1-percent-annual-chance) flood. The three criteria for determining a Zone VE area are: (1) the area where 3 foot or greater wave height could occur (this is the area where the WHAFIS wave crest profile is 2.1 feet or more above the SWEL), (2) the area where the eroded ground profile is 3 feet or more below the representative runup elevation, and (3) the primary frontal dune, by definition. Subdivided into elevation zones with BFEs assigned.

Zone AE - Areas of inundation by the base (1-percent-annual-chance) flood, including wave heights less than 3 feet and runup elevations less than 3 feet above the ground. Also subdivided into elevation zones with BFEs assigned.

Zone AH - Areas of shallow flooding or ponding, with water depth equal to 3 feet or less. Usually not subdivided, but a BFE is assigned.

Zone AO - Areas of "sheet-flow" shallow flooding where overtopping water flows into another flooding source. Assigned with 1-, 2-, or 3-foot depth of flooding.

Zone X - Areas above base (1-percent-annual-chance) flood inundation. On the FIRM, shaded Zone X is inundated by the 0.2-percent annual chance flood, unshaded Zone X is above 0.2-percent annual chance flood.

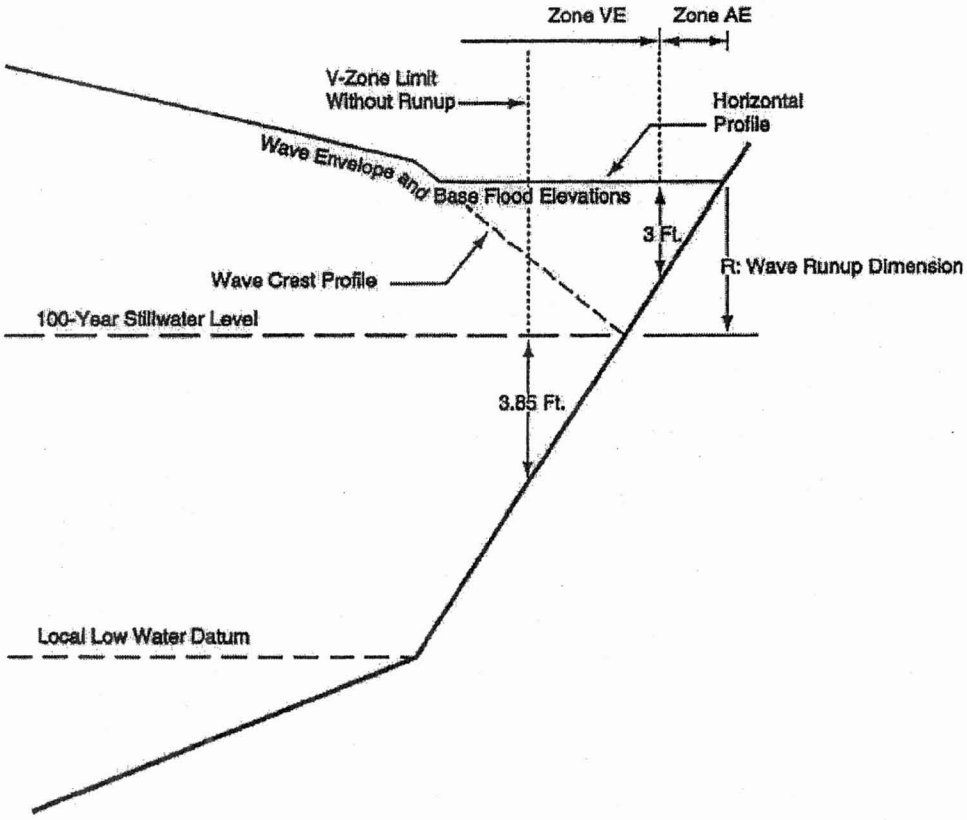


Figure D-46. Wave Envelope Resulting from Combination of Nearshore Crest Elevations and Shore Runup Elevation.

The first step in identifying the flood insurance risk zones on the transect is locating the inland extent of the VE Zone, also known as the VE/AE boundary. Once the Mapping Partner has identified the VE Zone limits for each of the three criteria described above, the Mapping Partner shall place the VE/AE boundary at the location that is furthest landward. The AE Zone will extend from the VE Zone limit to the inland limit of the 1-percent-annual-chance flood inundation, which is a ground elevation equal to the representative runup elevation, or the 1-percent-annual-chance SWEL if runup is negligible or not included in the wave analyses. Additional areas of shallow flooding or ponding for the 1-percent-annual-chance flood event can be designated as Zone AH or Zone AO. All areas above the 1-percent-annual-chance flood inundation are Zone X.

The Mapping Partner shall then subdivide the AE and VE Zones into elevation zones with whole-foot BFEs assigned. Ideally, to help in floodplain management and insurance determinations for buildings and property, the Mapping Partner shall establish an elevation zone for every BFE in the wave envelope. However, the FIRM scale may limit the number of zones that can be mapped. For the FIRM to be legible, there must be a minimum width for the zones. For coastal areas, the minimum zone width is 0.2 inch. For identifying elevation zones on the transect, the minimum width is 0.2 times the final FIRM scale; for example, 80 feet for a FIRM at a scale of 1 inch equals 400 feet, 100 feet for a FIRM at a scale of 1 inch equals 500 feet.

The Mapping Partner shall not subdivide the horizontal runup portion of the wave envelope, if any; the runup elevation, rounded to the nearest whole foot, is the BFE. However, the Mapping Partner shall subdivide the WHAFIS wave crest profile. Generally, the VE Zone is subdivided first. Initially, the Mapping Partner shall mark the location of all the elevation zone boundaries on the transect. Because whole-foot BFEs are being used, these must always be at the location of the half-foot elevation on the envelope.

The Mapping Partner shall combine elevation zones that do not meet the minimum width criterion with an adjacent zone or zones to yield an elevation zone that is wider than the minimum. The BFE for this combined zone is a weighted average of the combined zones. Often in subdividing VE Zones, the maximum BFE is located just inside the mapped shoreline, and the remainder of the VE Zone is then subdivided into minimum width elevation zones.

The Mapping Partner shall subdivide the AE Zone, if it is wide enough, in the same manner. If the total AE Zone is less than the minimum width, the lowest elevation VE Zone is usually assigned to that area. This situation typically occurs for steep or rapidly rising ground profiles, and it is not unreasonable to designate the entire inundated area as a VE Zone.

Relatively low areas inland of the AE Zone may be subject to shallow flooding or ponding of flood water and designated as AH or AO Zone. Such designations can be relatively common landward of coastal structures and dunes, where wave overtopping occurs.

Identifying appropriate zones and elevations may require particular care for dunes, given that the entire primary frontal dune is defined as Coastal High Hazard Area. Although the analyses may have determined a dune will not completely erode and wave action should stop at the retreated

duneface with only overtopping possibly propagating inland, the entire dune is still designated as a VE Zone. The BFE at the duneface is assigned for the remainder of the dune.

It may seem unusual to use a BFE that is lower than the ground elevation, although this is actually fairly common. Most of the BFEs for areas where the dune was assumed to be eroded are also below existing ground elevations. In these cases, it is the VE Zone designation that is most important to the NFIP; current regulations require structures to be built on pilings and prohibit alterations to the dune.

[February 2002]

D.3.7.3 Mapping Procedures

The final work maps prepared from the results of the coastal FIS or map revision request will be used to produce a new or revised FIRM for the affected community. The work map is essentially the base map selected for the study area, as described in Subsection D.3.2, and the depiction and delineation of the coastal flood hazards that reflect the results of the wave elevation determinations and flood zones established for each respective area. The Mapping Partner shall seta the work map up with contour lines, buildings, structures, vegetation, and transects used in the wave analyses clearly and accurately located.

The Mapping Partner shall transfer the flood zones and wave elevations identified on the transects to the work maps and interpolate the boundaries between the transects. The interpolation of the results at the transects and between the transects for the results of the wave height and wave runup analyses involves judgment and skill in reading the topographic and land cover information shown on the work maps. The time and effort put forth to determine the wave elevations will be negated if the results cannot be properly delineated on the work maps and shown on the FIRM. Because roads are the only fixed physical features shown on the FIRM, it is very important that other features and the flood zone boundaries are properly located on the work maps in relation to the centerline of the roads as they will appear on the FIRM. Other important considerations for mapping the results of the coastal FIS or map revision request discussed below include shoreline fluctuations, flood zone widths, interpolation of the transitions between zones for the represented transects, and the depiction and delineation of the Zone X shaded special flood hazard areas in areas subject to wave runup hazard.

An important but potentially ambiguous map feature is the depicted shoreline in the study area. Great Lakes shorelines are subject to large position changes, given shore erosion or accretion along with the considerable range in mean lake levels. The shoreline location may vary among the transects analyzed because of historical erosion or accretion not shown or accounted for on existing maps, but some clearly designated shoreline should be used for the work maps. For Great Lakes studies, the Mapping Partner shall ensure the depicted shoreline corresponds to the land intercept of Low Water Datum, as given in Table D-12 and usually shown on USGS maps. (It is customary to delineate flood zones only landward of the shoreline.)

The Mapping Partner shall transfer the identified elevation zones for each transect to the work maps, locating the boundaries along the transect line so that boundary lines can be interpolated

between transects, assuring that the boundaries are marked at the correct location. Because of the erosion assumptions, the location of the elevation 0.0 NGVD shoreline changes on the transect but not the work maps. The transect profile is used to determine the location of the zone change in relation to a physical feature, such as a ground contour, road, the back side of a row of houses, 50 feet into a vegetated area, etc. The boundary line along this feature for the area represented by that transect is then delineated.

The Mapping Partner shall check the widths of the zones being delineated carefully; if they narrow to less than 0.2 inch, they should be tapered to an end. Likewise, if an averaged elevation zone becomes much wider, it may be possible to break it into two elevation zones, both wider than 0.2 inch. Consideration of the final map scale of the FIRM to be produced from the work maps will help in determining how the zones should be combined and averaged.

One of the more difficult steps in delineating coastal flood zones and elevations is the interpolation and transition between transect results. Good judgment and an understanding of typical flooding patterns are the best tools for this job. The first step is to locate on the work maps any area of transition that is not exactly represented by either transect. The next step is to delineate the flood boundaries for each transect up to this area. Then consideration should be given to how a transition can be made across this area to connect matching zones, and still have the boundaries follow logical physical features. If there are other transects that are similar to this area, they could give an indication of flooding. Sometimes the elevation zones for the two contiguous transects are not the same; thus, some zones may have to be tapered to an end, or enlarged and divided in the transition area.

Communities with significant flooding hazards from wave runup may have one transect representing more than one area because the areas have similar shore slopes. In this case, the different areas are identified, and the results of the typical transect delineated in each area. Transition zones may be necessary between areas with high runup elevations to avoid large differences in BFEs and to smooth the change in flood boundaries. These zones, which should be fairly short, should cover the shore segment with a slope not exactly typical of either area. The transition elevation is determined by examining runup transects with similar slopes and using good judgment. Transition zones should not be used if there is a very abrupt change in topography, such as is found at the end of a structure.

Lastly, Mapping Partner shall map the Zone X (shaded) areas. Areas below the 0.2-percent annual chance SWEL and not covered by any other flood zone are designated Zone X shaded and shown on the FIRM. Often the maximum runup elevation is higher than the 0.2-percent annual chance elevation; thus, there will be no shaded Zone X in that area. The Mapping Partner shall designate all other areas as Zone X without any shading.

These *Guidelines* were compiled to give guidance in the preparation of coastal FISs and map revision requests. The collection of accurate and representative data, the correct application of the models, the evaluation and comparison of the results to historical data, and the proper delineation of flood elevations and zones will produce a FIRM that is both technically correct and directly usable for the intended purposes.

During all steps of the study, especially the mapping, the final product and its purposes should be remembered: the FIRM is used to determine flood insurance premiums and regulate building standards.

Because flood elevations are rounded to the nearest whole foot, there is no reason for spending hours to resolve a minor elevation difference. Also, because structures or proposed structures must be located on the FIRM, an attempt should be made whenever possible to smooth the boundary lines and to follow a fixed feature such as a road. In preparing the FIS, not only must the mapped results be technically correct, but the FIRM must be easy for the local insurance agent, building inspector, or permit officer to use.

Additional criteria and submittal requirements are documented in the Certification forms for Study Contractors (SC-1) and Application/Certification form 5 (MT-2) for map revision requests.

[February 2002]

D.3.8 Required Documentation

The Mapping Partner shall fully document the coastal flood hazard determination for each affected community. Because FIS Reports and FIRMs form the basis of Federal, State, and local regulatory and statutory enforcement mechanisms and are subject to administrative appeal and litigation, Mapping Partners shall ensure that all technical processes and decisions are recorded and documented. The FIS Report may not contain all the documentation that would be needed for a response in the event that the study results are questioned. Therefore, the Mapping Partner shall prepare an engineering report for each study. This report will provide detailed data needed by FEMA or the community to reconstruct or defend on technical grounds the study results. The minimum information required for the engineering report are summarized below.

Basic Data.

In this section, the Mapping Partner shall include all contacts made to obtain data for the study. All basic data used must be fully referenced and, if possible, reproduced in the report. All historical flood information must be documented in this section, even if the Mapping Partner did not use the information in quantitative analyses.

Transects

Each transect must be plotted separately and show the erosion assessment, input data for wave models, wave envelope, and zone determination.

Model Input and Output

The Mapping Partner shall provide computer printout listings for input and output data for both the Wave Runup and Wave Height Models for all the transects. These listings must be keyed to the transect location map and transect plots.

Study File

During the course of the study, the Mapping Partner shall maintain a file containing records of all coordination, activities, and decisions. This is especially important where nonstandard approaches were used and engineering judgment played a significant role. The Mapping Partner shall ensure this file meets the requirements for a Technical Support Data Notebook as documented in Appendix M of these Guidelines.

[February 2002]

D.3.9 Open Coast Flood Elevations and Wave Information

As discussed in Subsection D.3.2, the draft of "Basic Analyses of Wave Action and Erosion with Extreme Floods on Great Lakes Shores" (Dewberry & Davis, 1995) concluded from historical evidence that extreme floods were usually accompanied by the local 1/2-year wave condition on Lake Ontario, or by the 3-year wave condition on Lakes Erie, Huron, Michigan, and Superior. Examples of appropriate wave conditions derived for numerous sites on each of the Great Lakes are presented in Figures D-47 through D-56 and in Tables D-23 through D-27.

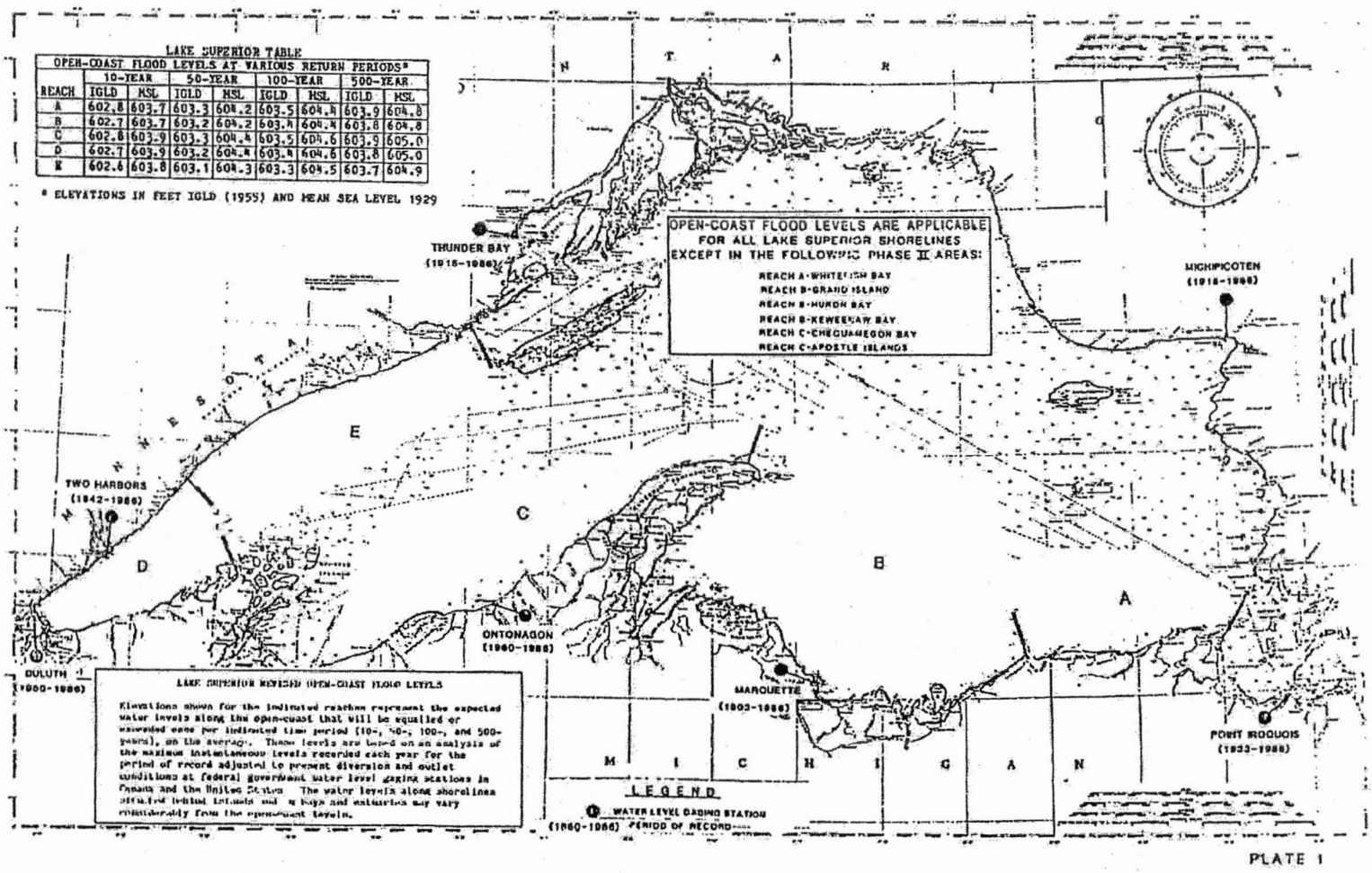


Figure D-47. Lake Superior Table and Map of Open Coast Flood Levels (USACE, 1988).

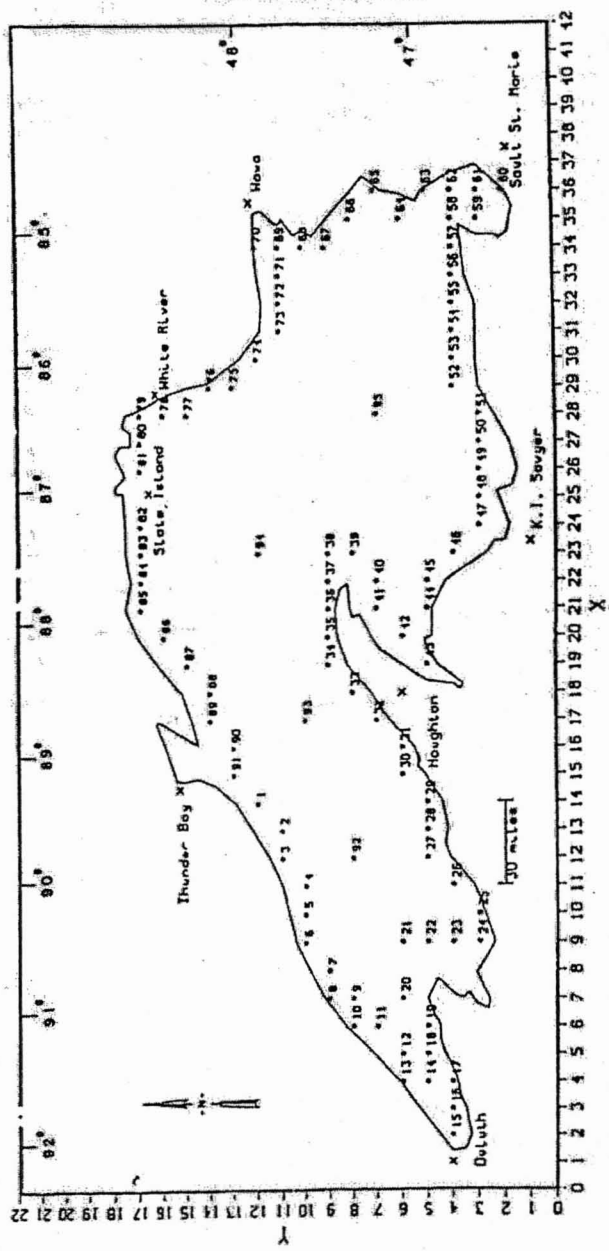


Figure D-48. Station Location Map for Lake Superior Wave Information Stations.

Table D-23. Three-Year Wave Conditions as Hindcast for Selected Nearshore Sites on Lake Superior

HINDCAST SITE ID	WAVE HEIGHT (METERS)	WAVE PERIOD (SECONDS)
SUPER-05	6.0	10.0
SUPER-13	5.8	10.0
SUPER-15	3.7	7.1
SUPER-23	4.3	--
SUPER-29	5.0	9.1
SUPER-35	5.9	--
SUPER-42	5.2	--
SUPER-47	7.7	11.1
SUPER-54	6.2	--
SUPER-60	4.5	7.7

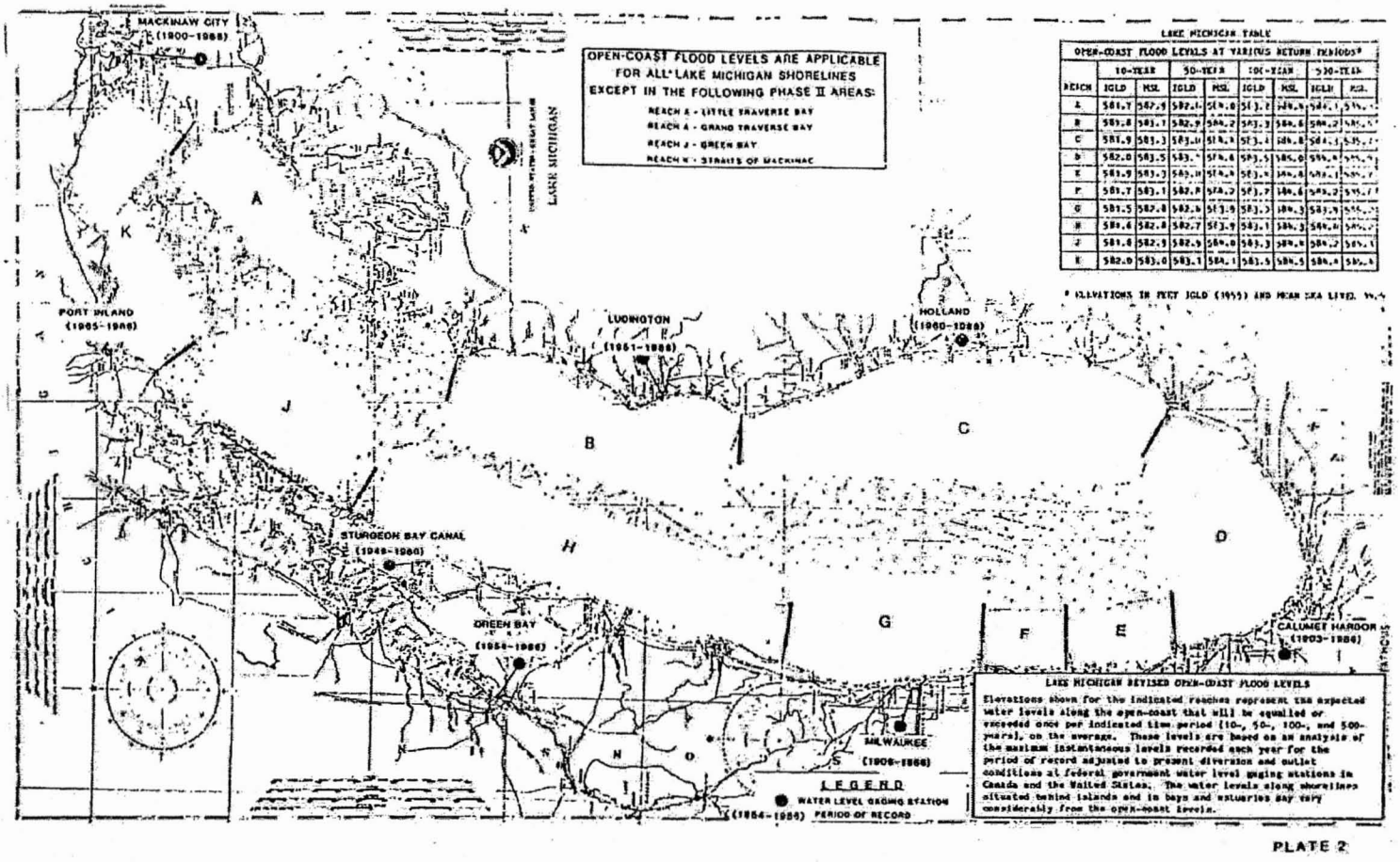


Figure D-49. Lake Michigan Table and Map of Open Coast Flood Levels (USACE, April 1988).

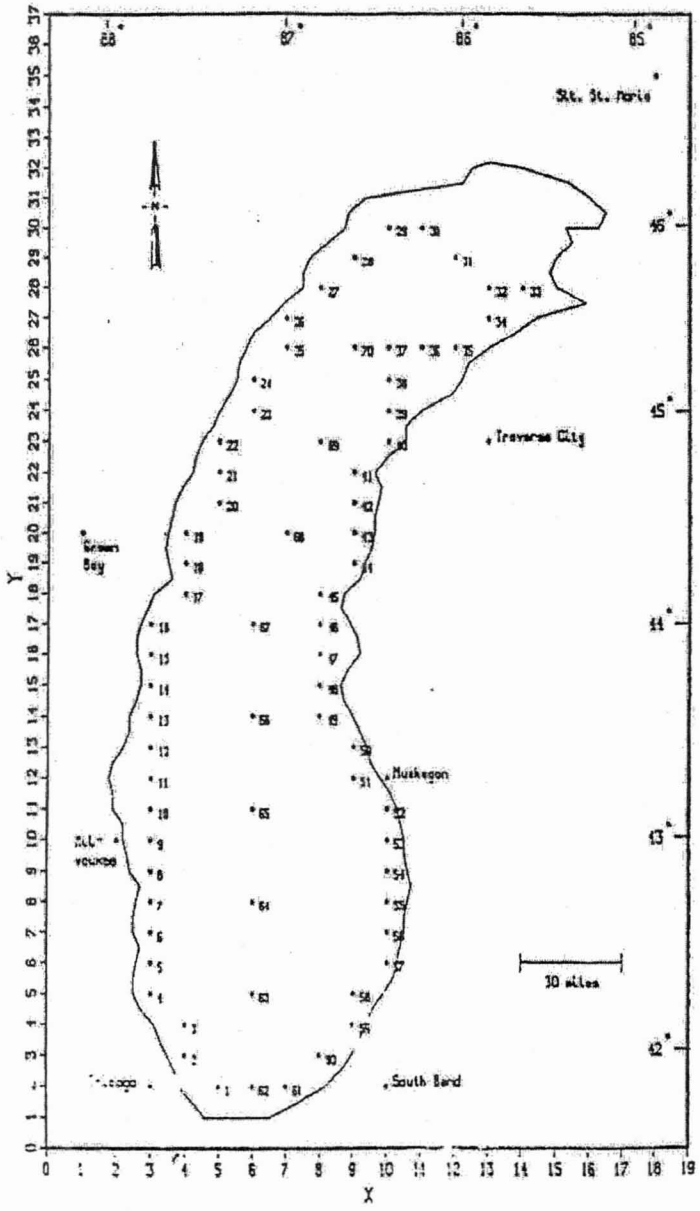
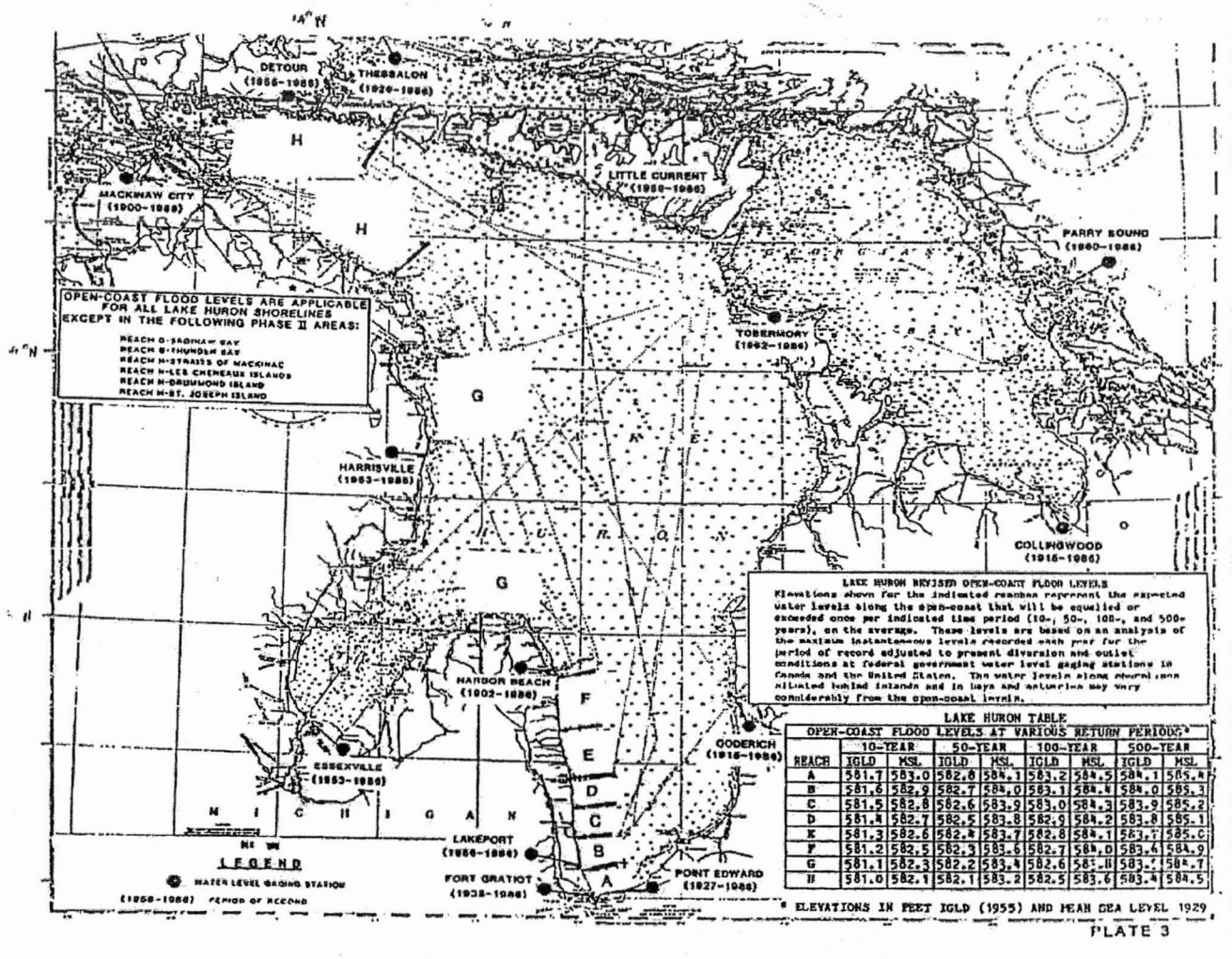


Figure D-50. Station Location Map for Lake Michigan Wave Information Stations.

Table D-24. Three-Year Wave Conditions as Hindcast for Selected Nearshore Sites on Lake Michigan

HINDCAST SITE ID	WAVE HEIGHT (METERS)	WAVE PERIOD (SECONDS)
MICH-01	4.4	9.1
MICH-03	4.6	9.1
MICH-09	4.7	8.3
MICH-14	3.9	--
MICH-19	4.0	8.3
MICH-22	3.7	7.7
MICH-26	3.3	8.3
MICH-30	3.4	8.0
MICH-34	3.7	--
MICH-41	4.1	--
MICH-46	4.7	9.1
MICH-48	5.2	9.1
MICH-54	5.2	9.1
MICH-60	4.5	8.3



LAKE HURON TABLE

OPEN-COAST FLOOD LEVELS AT VARIOUS RETURN PERIODS*

REACH	10-YEAR		50-YEAR		100-YEAR		500-YEAR	
	IGLD	MSL	IGLD	MSL	IGLD	MSL	IGLD	MSL
A	581.7	583.0	582.8	584.1	583.2	584.5	584.1	585.4
B	581.6	582.9	582.7	584.0	583.1	584.4	584.0	585.3
C	581.5	582.8	582.6	583.9	583.0	584.3	583.9	585.2
D	581.4	582.7	582.5	583.8	582.9	584.2	583.8	585.1
E	581.3	582.6	582.4	583.7	582.8	584.1	583.7	585.0
F	581.2	582.5	582.3	583.6	582.7	584.0	583.6	584.9
G	581.1	582.3	582.2	583.4	582.6	583.8	583.4	584.7
H	581.0	582.1	582.1	583.2	582.5	583.6	583.4	584.5

* ELEVATIONS IN FEET IGLD (1955) AND MEAN SEA LEVEL 1929

Figure D-51. Lake Huron Table and Map of Open Coast Flood Levels (USACE, 1988).

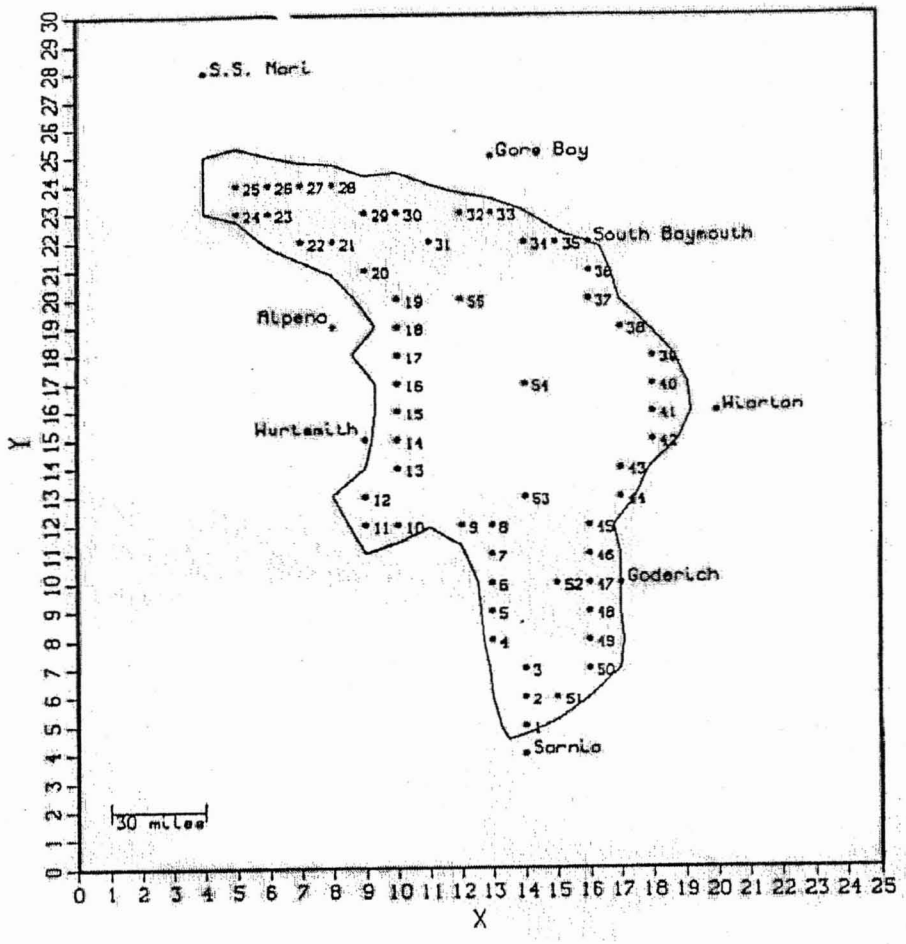


Figure D-52. Station Location Map for Lake Huron Wave Information Stations.

Table D-25. Three-Year Wave Conditions as Hindcast for Selected Nearshore Sites on Lake Huron

HINDCAST SITE ID	WAVE HEIGHT (METERS)	WAVE PERIOD (SECONDS)
HURON-01	6.1	9.1
HURON-02	6.2	10.0
HURON-07	5.6	9.1
HURON-11	6.3	9.1
HURON-12	6.2	9.5
HURON-15	6.1	9.1
HURON-20	5.0	--
HURON-25	4.1	7.7
HURON-26	4.3	9.1

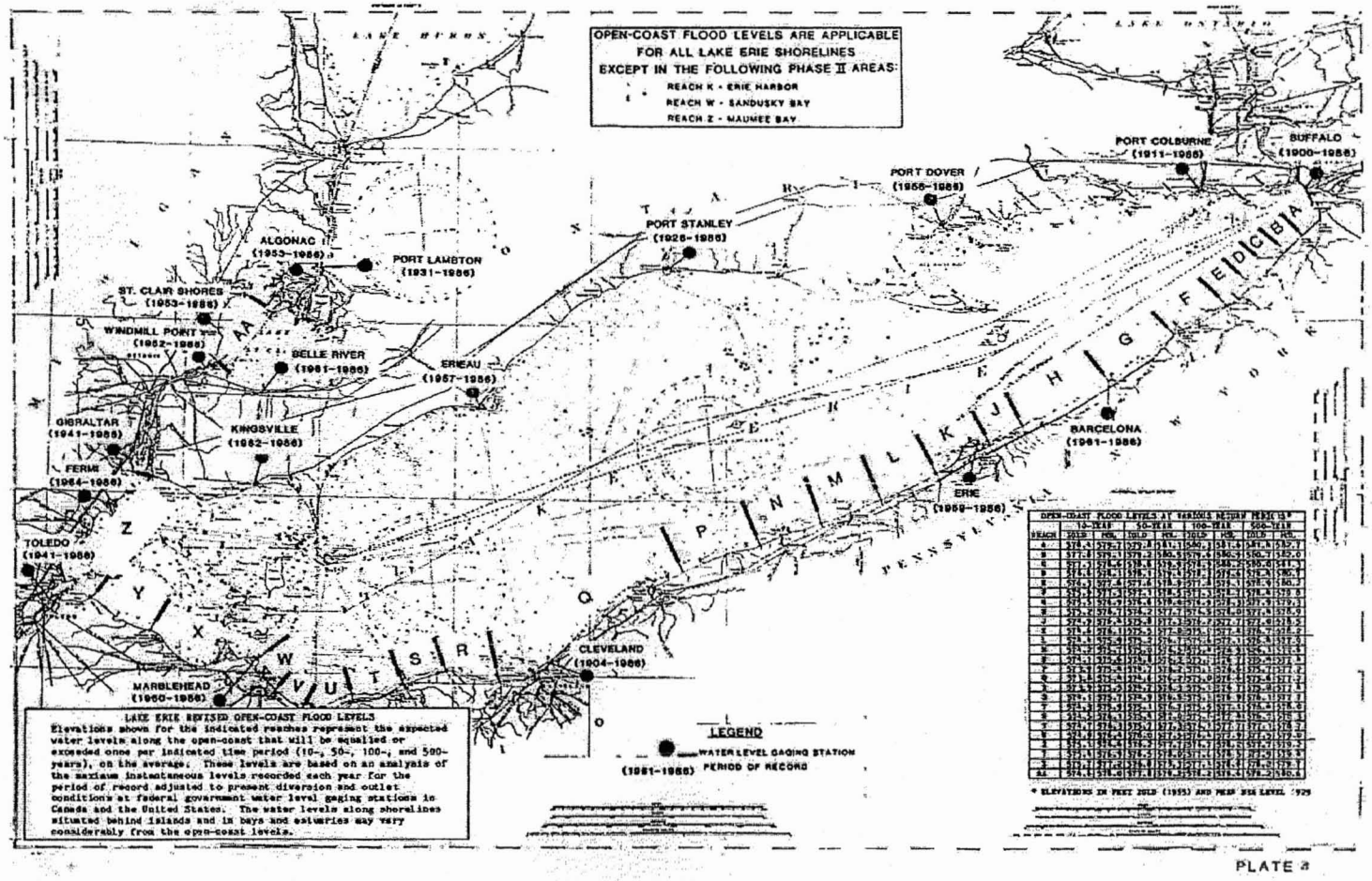


Figure D-53. Lake Erie Table and Map of Open Coast Flood Levels (USACE, 1988).

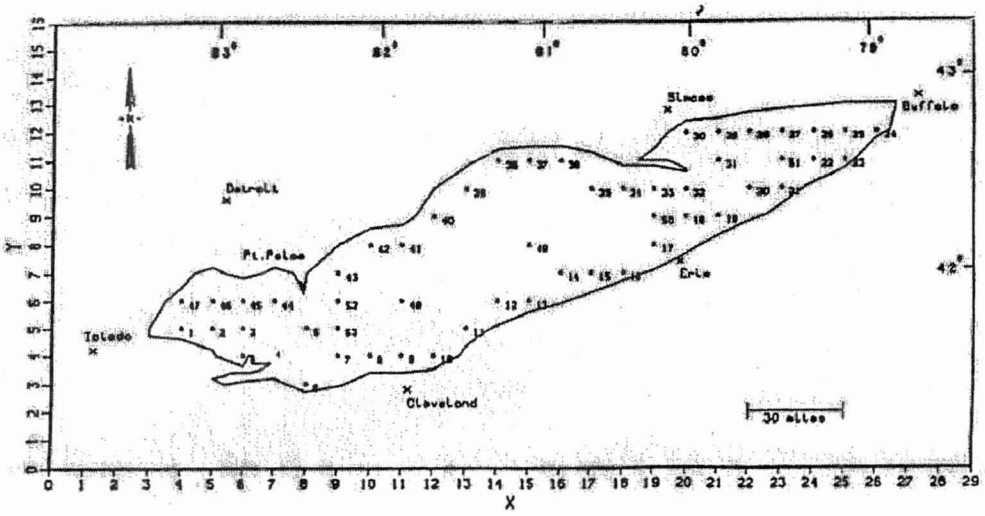
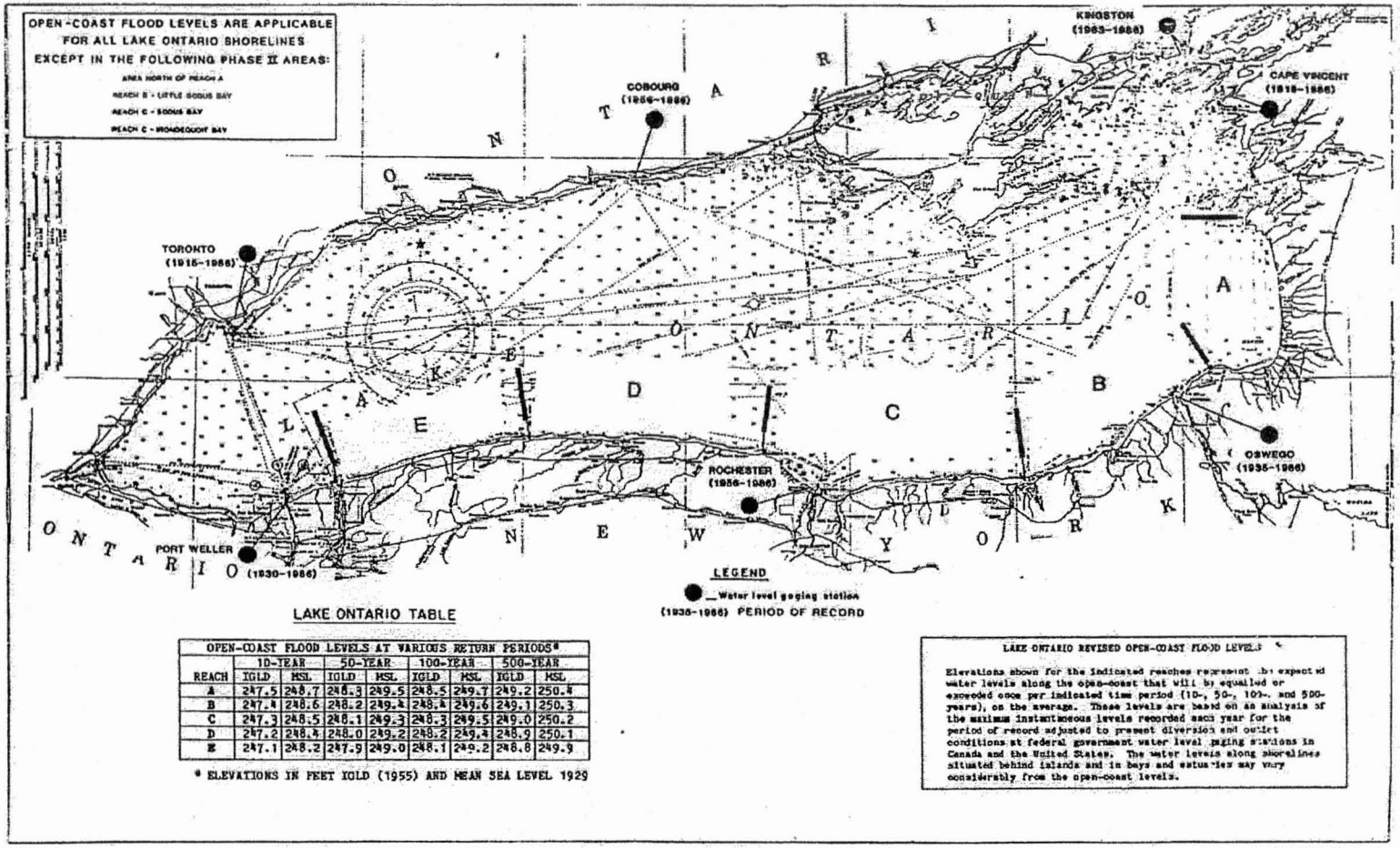


Figure D-54. Station Location Map for Lake Erie Wave Information Stations.

Table D-26. Three-Year Wave Conditions as Hindcast for Selected Nearshore Sites on Lake Erie

HINDCAST SITE ID	WAVE HEIGHT (METERS)	WAVE PERIOD (SECONDS)
ERIE-01	2.0	6.2
ERIE-04	1.9	6.2
ERIE-07	3.3	--
ERIE-10	3.6	7.7
ERIE-12	4.0	8.3
ERIE-15	4.2	--
ERIE-18	4.6	9.1
ERIE-21	4.9	9.1
ERIE-24	4.2	9.1
ERIE-47	1.8	5.6



LAKE ONTARIO TABLE

OPEN-COAST FLOOD LEVELS AT VARIOUS RETURN PERIODS*

REACH	10-YEAR		50-YEAR		100-YEAR		500-YEAR	
	IGLD	MSL	IGLD	MSL	IGLD	MSL	IGLD	MSL
A	247.5	248.7	248.3	249.5	248.5	249.7	249.2	250.4
B	247.4	248.6	248.2	249.4	248.4	249.6	249.1	250.3
C	247.3	248.5	248.1	249.3	248.3	249.5	249.0	250.2
D	247.2	248.4	248.0	249.2	248.2	249.4	248.9	250.1
E	247.1	248.2	247.9	249.0	248.1	249.2	248.8	249.9

* ELEVATIONS IN FEET IGLD (1955) AND MEAN SEA LEVEL 1929

LAKE ONTARIO REVISED OPEN-COAST FLOOD LEVELS

Elevations shown for the indicated reaches represent the expected water levels along the open-coast that will be equalled or exceeded once per indicated time period (10-, 50-, 100-, and 500-years), on the average. These levels are based on an analysis of the maximum instantaneous levels recorded each year for the period of record adjusted to present diversion and outlet conditions at federal government water level gaging stations in Canada and the United States. The water levels along shorelines situated behind islands and in bays and estuaries may vary considerably from the open-coast levels.

Figure D-55. Lake Ontario Table and Map of Open Coast Flood Levels (USACE, 1988).

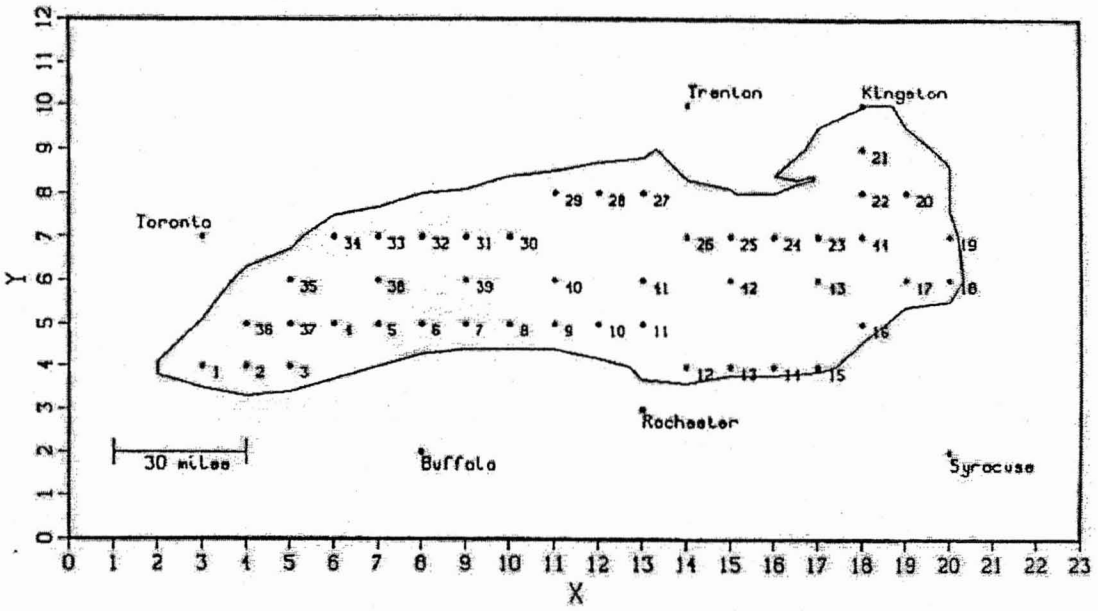


Figure D-56. Station Location Map for Lake Ontario Wave Information Stations.

Table D-27. One-Half-Year Wave Conditions as Hindcast for Selected Nearshore Sites on Lake Ontario

HINDCAST SITE ID	WAVE HEIGHT (METERS)	WAVE PERIOD (SECONDS)
ONT-04	2.7	--
ONT-06	2.9	6.7
ONT-07	3.0	7.1
ONT-11	3.2	7.1
ONT-14	2.6	--
ONT-17	3.2	7.1
ONT-21	2.4	5.9

[February 2002]

D.4 Wave Elevation Determination and V Zone Mapping: Pacific Ocean

No FEMA guidance documents have been published for Pacific Ocean coastal flood studies. Guidance is to be developed based on existing methodologies recommended by FEMA and coastal states for coastal analyses in the Pacific Ocean. Mapping Partners that are undertaking a flood hazard analysis of a Pacific coast site should consult with the FEMA RPO for that area.

[February 2002]

D.5 Erosion Hazard Study, Identification, and Mapping

No FEMA guidance documents have been published for erosion hazard studies and mapping. Guidance is to be developed based on new or existing methodologies recommended by FEMA and coastal states for erosion hazard studies and mapping in all coastal areas.

[February 2002]

D.6 References

Abel, C. E., Tracy, B. A., Vincent, C. L., & Jensen, R. E. (1989). Hurricane Hindcast Methodology and Wave Statistics for Atlantic and Gulf Hurricanes from 1956-1975. WIS Report 19. Coastal Engineering Research Center. Vicksburg, Mississippi.

Birkemeier, W. A., Kraus, N. C., Scheffner, N., & Knowles, S. C. (1987). U.S. Army Corps of Engineers, Coastal Engineering Research Center, Technical Report CERC-87-8. Feasibility Study of Quantitative Erosion Models for Use by FEMA in the Prediction of Coastal Flooding. Vicksburg, Mississippi

Cox, J. C. & Machemehl, J. (1986). "Overland Bore Propagation Due to an Overtopping Wave." Journal of Waterway, Port, Coastal and Ocean Engineering, Vol. 112, pp. 161-163.

Dawdy, David & Maloney, M. David. (1980). Method of estimating on-shore propagation of storm waves. Geophysical Research Letters. Vol. 7. (pp. 845-847).

de Waal, J. P. & van der Meer, J. W. (1992). Wave Runup and Overtopping on Coastal Structures. Proceedings 23rd Coastal Engineering Conference, pp. 1758-1771.

Delft Hydraulics Laboratory. (1983). Wave Runup and Overtopping at Dunes During Extreme Storm Surge Report M1819, Part II. (in Dutch). Delft, The Netherlands.

Dewberry & Davis. (1990). Investigation and Improvement of the Capabilities of the FEMA Wave Runup Model (Technical Documentation for RUNUP 2.0), Report and Computer Program. Fairfax, Virginia.

Dewberry & Davis. (1991). Technical Documentation for RUNUP 2.0. Report and computer program, Fairfax, Virginia

Dewberry & Davis. (1995). Basic Analyses of Wave Action and Erosion with Extreme Floods on Great Lakes Shores, draft prepared for Federal Emergency Management Agency. Fairfax, Virginia.

Driver, D. B., Reinhard, R. D., & Hubertz, J. M. (1991). Hindcast Wave Information for the Great Lakes: Lake Erie, WIS Report 22, USACE, Coastal Engineering Research Center. Vicksburg, Mississippi.

Driver, D. B., Reinhard, R. D., & Hubertz, J. M. (1992). Hindcast Wave Information for the Great Lakes: Lake Superior, WIS Report 23, USACE, Coastal Engineering Research Center. Vicksburg, Mississippi.

Federal Emergency Management Agency. (January 1981). Computer Program for Determining Wave Height Elevations for Flood Insurance Studies, revised. Washington, D.C.

Federal Emergency Management Agency. (February 1981). Users Manual for Wave Height Analysis, revised. Washington, D.C.

Federal Emergency Management Agency. (1984). Procedures for Applying Marsh Grass Methodology. Washington, D.C.

Federal Emergency Management Agency. (1986). Assessment of Current Procedures Used for the Identification of Coastal High Hazard Areas (V Zones). Washington, D.C.

Federal Emergency Management Agency. (September 1988). Wave Height Analysis for Flood Insurance Studies (Technical Documentation for WHAFIS Program Version 3.0). Washington, D.C.

Federal Emergency Management Agency. (August 1988). Coastal Flooding Hurricane Storm Surge Model, Volumes 1, 2, and 3. Washington, D.C.

Federal Emergency Management Agency. (November 1988). Basis of Erosion Assessment Procedures for Coastal Flood Insurance Studies. Washington, D.C.

Federal Emergency Management Agency, Federal Insurance Administration. (1989). *Guidelines and Specifications for Wave Elevation Determination and V Zone Mapping*, Third draft report. Washington, D.C.

Federal Emergency Management Agency. (1990). "Memorandum on Criteria for Evaluating Coastal Flood Protection Structures for National Flood Insurance Program Purposes." Washington, DC, dated April 23, 1990.

Federal Emergency Management Agency, Federal Insurance Administration. (1991). *Guidelines for Great Lakes Wave Runup Computation and Mapping*. Washington, D.C.

Federal Emergency Management Agency, Federal Insurance Administration. (August 1994). Basic Analyses of Wave Action and Erosion with Extreme Floods on Great Lakes Shores, draft report. Washington, D.C.

Federal Emergency Management Agency. (1994). *Guidelines and Specifications for Flood Hazard Mapping at Coastal Sites on the Great Lakes*, draft. Washington, D.C.

Federal Emergency Management Agency, Federal Insurance Administration. (1995.) *Guidelines and Specifications for Wave Elevation Determination and V Zone Mapping*, final report. Washington, D.C.

French, J. (1982). Memorandum on Special Computation Procedure Developed for Wave Runup Analysis for Casco Bay, FIS - Maine, 9700-153. Camp Dresser & McKee.

Gadd, P. E., Potter, R. E., Safaie, B. & Resio, D. (1984). Wave Runup and Overtopping: A Review and Recommendations. OTC 4674. Proceedings 1984 Offshore Technology Conference, pp. 239-248.

Gilhousen, D. B., Meindl, E. A., Changery, M. J., Franks, P. L., Burgin, M. G., & McKittrick, D. A. (1990). Climatic Summaries for NDBC Buoys and Stations: Update 1. National Data Buoy Center, National Space Technology Laboratory. Mississippi.

Goda, Yoshima. (1985). Random Seas and Design of Maritime Structures. University of Tokyo Press. Japan.

Hardisky, M.A. & Reimold, R. J. (1977). Nondestructive Assessment of Salt Marsh Plant Biomass, unpublished report. University of Georgia: Athens, Georgia.

Hopkinson, C. W., Gosselink, J. G., & Parrondo, R. T. (1980). Production of Coastal Louisiana Marsh Plants Calculated from Phenometric Techniques. Ecology, 61(5), 1091-1098.

Ho, F. P., Su, J. C., Hanevich, K. L., Smith, R. J., & Richards, F. P. (1987). Hurricane Climatology for the Atlantic and Gulf Coasts of the United States. NOAA Technical Report NWS 38. National Weather Service. Silver Spring, Maryland.

Hubertz, J. M., Driver, D. B., & Reinhard, R. D. (1991). Hindcast Wave Information for the Great Lakes: Lake Michigan, WIS Report 24, USACE, Coastal Engineering Research Center. Vicksburg, Mississippi.

Hubertz, J. M., Brooks, R. M., Brandon, W. A., & Tracy, B. A. (1993). Hindcast Wave Information for the U.S. Atlantic Coast. WIS Report 30. Coastal Engineering Research Center. Vicksburg, Mississippi.

Hydraulics Research Station. (1980). Design of Seawalls Allowing for Wave Overtopping. Report no. ex. 924. Wallingford, United Kingdom.

Jensen, R. E., Hubertz, J. M., Thompson, E. F., Reinhard, R. D., Borup, B. J., Brandon, W. A., Payne, J. B., Brooks, R. M., & McAneny, D. S. (1992). Southern California Hindcast Wave Information. WIS Report 20. Coastal Engineering Research Center. Vicksburg, Mississippi.

Knutson, P. L. & Woodhouse, W. W. Jr. (1983). Shore Stabilization with Salt Marsh Vegetation. Special Report 9. Coastal Engineering Research Center. Fort Belvoir, Virginia.

Kruczynski, W. L., Subrahmanyam, C. B., & Drake, S. H. (1978). Studies on the Plant Community of a North Florida Salt Marsh: Part I: Primary Production. Bulletin of Marine Science. 28(2), 316-334.

Leenknecht, D. A., Szuwalski, A., & Sherlock, A. R. (1992). Automated Coastal Engineering System, Version 1.07. Coastal Engineering Research Center. Vicksburg, Mississippi.

Levels Reference Study Board. (1993). Levels Reference Study: Great Lakes - St. Lawrence River Basin. Annex 2 to report submitted to International Joint Commission. Ottawa, Ontario/Washington, D.C.

Messmore, J. A., Vogel, T. C., & Pearson, A. R. (1979). U.S. Army Corps of Engineers, Engineer Topographic Laboratories. Terrain Analysis Procedural Guide for Vegetation. ETL-0178. Fort Belvoir, Virginia.

Monte, J. A. (1983). Field Data from the Florida Panhandle, unpublished report. Greenhorne & O'Mara, Inc. Greenbelt, Maryland.

Nagai, S. & Takada, A. (1972). Relations Between the Runup and Overtopping of Waves. Proceedings 13th Coastal Engineering Conference, pp. 1975-1992.

National Academy of Sciences. (1977). Methodology for Calculating Wave Action Effects Associated with Storm Surges. Washington, D.C.

Owen, M. W. (1980). Design of Seawalls Allowing for Wave Overtopping. Report Ex. 924. Hydraulics Research Station. Wallingford, United Kingdom.

Reinhard, R. D., Driver, D. B., Hubertz, J. M. (1991). Hindcast Wave Information for the Great Lakes: Lake Huron, WIS Report 26, USACE, Coastal Engineering Research Center. Vicksburg, Mississippi.

Saville, T., Jr. (1958). Wave Runup on Composite Slopes. Proceedings of the Sixth Conference on Coastal Engineering. ASCE. Council on Wave Research.

Stoa, P. N. (1978). Reanalysis of Wave Runup on Structures and Beaches. Technical Paper 78-2. Coastal Engineering Research Center. Fort Belvoir, Virginia.

Stone & Webster Engineering Corporation. (1978). Development and Verification of a Synthetic Northeaster Model for Coastal Flood Analysis. Boston, Massachusetts.

Stone & Webster Engineering Corporation. (1981). Manual for Wave Runup Analysis, Coastal Flood Insurance Studies. Boston, Massachusetts.

Suhayda, J. N. (1984). Attenuation of Storm Waves Over Muddy Bottom Sediments. Baton Rouge, Louisiana.

Thompson, E. F. (1977). Wave Climate at Selected Locations Along U.S. Coasts. Technical Report 77-1. Coastal Engineering Research Center. Fort Belvoir, Virginia.

Turner, R. E. & Gosselink, J. G. (1975). A Note on Standing Crops of Spartina alterniflora in Texas and Florida. Contributions in Marine Science, University of Texas.

U.S. Army Corps of Engineers, Galveston District. (1973). General Guidelines for Identifying Coastal High Hazard Zone, Flood Insurance Study - Texas Gulf Coast Case Study. Galveston, Texas.

U.S. Army Corps of Engineers, Galveston District. (1975). Guidelines for Identifying Coastal High Hazard Zones. Galveston, Texas.

U.S. Army Corps of Engineers, Coastal Engineering Research Center. (1984). Shore Protection Manual, Volumes I and II, 4th Edition, Washington, D.C.

U.S. Army Corps of Engineers, Detroit District. (1988). Revised Report on Great Lakes Open-Coast Flood Levels, Phase I/Phase II. Detroit, Michigan.

U.S. Army Corps of Engineers, Detroit District. (June 1989). Great Lakes Wave Runup Methodology Study. Detroit, Michigan.

U.S. Army Corps of Engineers, Detroit District. (September 1989). Saginaw Bay Flood Levels Report, Detroit, Michigan.

U.S. Army Corps of Engineers, Coastal Engineering Research Center. (1992). Automated Coastal Engineering System Version 1.07. Computer Programs and Documentation. Vicksburg, Mississippi.

Vellinga, P. (1986). Beach and Dune Erosion During Storm Surges. Communication No. 372. Delft Hydraulics Laboratory. Delft University of Technology. Delft, The Netherlands.

Walton, T. L., Jr., Ahrens, J. P., Truitt, C. L., & Dean, R. G. (1989). Criteria for Evaluating Coastal Flood-Protection Structures. Technical Report CERC-89-15. U.S. Army Corps of Engineers, Coastal Engineering Research Center. Vicksburg, Mississippi.

Williams, P. (1983). Interoffice Correspondence on Wave Runup Methodology, Massachusetts and Rhode Island Flood Insurance Studies. PRC Harris, Inc.

[February 2002]

Map MODERNIZATION

Federal Emergency Management Agency

FEMA's Flood Hazard Mapping Program

Guidelines and Specifications *for* Flood Hazard Mapping Partners

Appendix E: Guidance for Shallow Flooding Analyses and Mapping

FEDERAL EMERGENCY MANAGEMENT AGENCY

www.fema.gov/mit/tsd/dl_cgs.htm

FINAL

February 2002

Appendix E

Guidance for Shallow Flooding Analyses and Mapping

E.1 Introduction

Different types of shallow flooding commonly occur throughout the United States. Types of flows that result in shallow flooding include the following:

- Unconfined flows over broad, relatively low relief areas, such as alluvial plains;
- Intermittent flows in arid regions that have not developed a system of well-defined channels;
- Overbank flows that remain unconfined, such as on delta formations;
- Overland flow in urban areas; and
- Flows collecting in depressions to form ponding areas.

The procedures described in this Appendix are applicable to flows for which the effects of sediment on the flow regime can be ignored. Procedures for analyzing alluvial fan flooding, which considers sediment transport, are provided in Appendix G.

For purposes of the National Flood Insurance Program (NFIP), shallow flooding is defined as that with a depth limited to 3.0 feet or less where no defined channel exists.

[February 2002]

E.2 Study Scope

Given the current state of the art for determining shallow flooding hazards and the prohibitive cost of making these determinations, Mapping Partners shall follow certain parameters to limit the amount of area studied in detail for shallow flooding hazard determinations. Drainage area size is to be considered in determining whether shallow flooding hazards are analyzed using detailed or approximate methods. Mapping Partners generally shall not study flooding conditions resulting from drainage areas of less than 1.0 square mile using detailed study methods. Using approximate-study methods to identify flood hazards and delineate floodplain boundaries (described in more detail later in this Appendix) generally is sufficient. Flooding from sources with drainage areas less than 1.0 square mile is considered to be a local drainage problem.

Depths of flooding determined from the detailed study of shallow flooding hazards need be computed only to the nearest whole foot.

Detailed study is to be limited to only those areas that have a history of destructive flooding or that have a significant potential for damage to future development, and where expected 1-percent-annual-chance flood depths are 1.0 foot or greater.

[February 2002]

E.3 Applicable Flood Insurance Risk Zones

The flood insurance risk zones shown on the Flood Insurance Rate Map (FIRM) that are relevant to areas susceptible to shallow flooding are listed and described below.

Zone A — Zone A is the flood insurance risk zone that corresponds to the 1-percent-annual-chance floodplains that are determined by approximate-study methods. Because detailed hydraulic analyses are not performed for such areas, no 1-percent-annual-chance flood elevations or depths are shown within this zone on the FIRM.

Zone A0 — Zone A0 is the flood insurance risk zone that corresponds to the areas of 1-percent-annual-chance shallow flooding (usually sheet flow on sloping terrain) where average depths are between 1.0 and 3.0 feet. Average whole-foot depths derived from the detailed hydraulic analyses are shown within this zone on the FIRM.

Zone AH — Zone AH is the flood insurance risk zone that corresponds to the areas of 1-percent-annual-chance shallow flooding (usually areas of ponding) where average depths are between 1.0 and 3.0 feet. Whole-foot Base Flood Elevations (BFEs) derived from the detailed hydraulic analyses are shown within this zone on the FIRM.

Zone X — Zone X is the flood insurance risk zone that corresponds to areas outside the 0.2-percent-annual chance floodplain, areas within the 0.2-percent-annual-chance floodplain, areas of 1-percent-annual-chance flooding where average depths are less than 1.0 foot, areas of 1-percent-annual-chance flooding where the contributing drainage area is less than 1.0 square mile, and areas protected from the 1-percent-annual-chance flood of the main flooding source by levees. No 1-percent-annual-chance flood elevations or depths are shown within this zone on the FIRM.

Areas designated as Zones A, AO, and AH shall be shaded as 1-percent-annual-chance floodplains. Mapping Partners shall shade as 0.2-percent-annual-chance floodplains those areas designated Zone X that: are within the 0.2-percent-annual-chance floodplain; represent areas of 1-percent-annual-chance flood hazards with average depths of less than 1.0 foot or where the contributing drainage area is less than 1.0 square mile; or represent areas protected from the 1-percent-annual-chance flood of the main flooding source by levees. Areas designated Zone X that are outside the 0.2-percent-annual-chance floodplain shall not be shaded. Specifications for the screens to be used are listed in Appendix K.

[February 2002]

E.4 Shallow Flooding Classifications and Descriptions

Shallow flooding can occur as the result of several meteorological and watershed conditions. However, two broad classifications of shallow flooding into which almost all individual cases can be assigned—ponding and sheet runoff—have been determined to be sufficient for purposes of the NFIP.

[February 2002]

E.4.1 Ponding

Ponding is the result of runoff or flows collecting in a depression that may have no outlet, subterranean outlets, rim outlets, or manmade outlets such as culverts or pumping stations. Impoundments behind manmade obstructions (e.g., levees, road fills, railroad grades, canal banks, or similar structures) are included in this type of shallow flooding as long as they are not backwater from a defined channel or do not exceed 3.0 feet in depth.

[February 2002]

E.4.2 Sheet Runoff

Sheet runoff is the broad, relatively unconfined downslope movement of water across sloping terrain that results from many sources, including intense rainfall and/or snowmelt, overflow from a channel that crosses a drainage divide, and overflow from a perched channel onto deltas or plains of lower elevation. Generally, sheet runoff enters a channel or drainage system that intersects its flow, but occasionally it dissipates before reaching a channel. Sheet runoff is typical in areas of low topographic relief and poorly established drainage systems.

[February 2002]

E.5 Study Procedures

The general guidelines cited herein are applicable to all areas of shallow flooding. They are indicative of the general approach taken to the study of shallow flooding problems in order to fulfill the requirements of the NFIP.

The Mapping Partner performing the study shall average small-scale topographic variations across inundated areas in determining depths to keep the effort and results commensurate with the obtainable accuracy of shallow flooding study methods.

The Mapping Partner shall extend the flood insurance risk zone designations across the entire inundated area without separate designation of Zone X areas at the edges of Zones AO or AH. Thus, the Mapping Partner shall use Zone X areas only when the average depth across the entire inundated area is less than 1.0 foot. The Mapping Partner shall not use a Zone AO at the edge of a Zone AE where the depth is less than or equal to 3.0 feet.

Shallow flooding is often characterized by highly unpredictable flow direction because of low relief or shifting channels and debris loads. Where such conditions exist, the Mapping Partner shall delineate the entire area susceptible to this unpredictable flow as an area of equal risk.

The Mapping Partner shall ignore small-scale topographic relief that is not evident on existing topographic mapping and that might lead to "islands" of one flood insurance risk zone within larger areas of another. When this situation occurs, FEMA will issue Letters of Map Amendment to individual property owners as necessary.

Shallow flooding areas are to be designated as either Zone AH or Zone AO depending on the relative accuracy with which flood elevations or depths can be determined. Mapping Partners shall delineate ponding areas with a constant 1-percent-annual-chance flood elevation as Zone AH with a whole-foot BFE on the work map. Mapping Partners shall delineate areas of sheet runoff as Zone A0 with average flooding depths above the ground surface, rounded to the nearest whole foot, indicated on the work map. However, where the slope of the water surface is extremely low and uniform BFEs can be established for large land areas, Zone AH with a BFE is preferred.

The Mapping Partner shall not calculate the 10-, 2-, or 0.2-percent-annual-chance flood elevations, delineate 0.2-percent-annual-chance floodplain boundaries or regulatory floodways, or develop Flood Profiles in shallow flooding areas. If these items can be readily determined, the Mapping Partner shall not use shallow flooding procedures.

The Mapping Partner shall assess historical information, local citizen reports, existing physical features, and previous reports discovered during the bibliography search for information on possible flooding conditions. Where any information shows possible local flooding depths, or other hazards more severe than those determined by the study procedures in these Guidelines, that information and reference must be included in the FIS Report to fully alert community officials, citizens, and other users to the potential hazard.

[February 2002]

E.5.1 Approximate Study Methods

For areas of expected shallow flood hazard that have no significant development pressure for the near future, the Mapping Partner performing a study shall use approximate study methods.

Normally, only the designation Zone A is to be used in these areas, with two possible exceptions. In many areas of 1-percent-annual-chance shallow flooding, average flood depths can often be readily determined to be below 1.0 foot by simple and inexpensive methods. In this situation, with a very limited study, shallow flooding areas may be designated as Zone X. The Mapping Partner shall also use Zone X whenever the contributing drainage area causing shallow flooding is less than 1.0 square mile and there is no history of destructive flooding or no significant potential to damage future development.

[February 2002]

E.5.2 Detailed Study Methods: Ponding

Areas of ponding can be identified through historic data on past flooding, local inquiries, examination of topographic maps, and field reconnaissance. The Mapping Partner performing the study shall determine inflow to, and outflow from, the ponding area and calculate the storage volume and elevations using a simple reservoir routing analysis. Hydrographs, empirical formulas, and design equations for culverts and other manmade structures are to be considered. Determination of stage-storage relationships requires some topographic information. Wherever adequate contour interval mapping is available, the Mapping Partner shall determine storage volumes directly from those maps. Otherwise, the Mapping Partner shall survey a limited number of cross sections to determine storage volumes. The number of cross sections needed will depend on the size of the ponding area, but usually one along the major axis and two perpendicular to that axis will be sufficient.

Where volumes of inflow to ponding areas are sufficient to fill the available storage volume behind low dikes or other large, uniform obstructions, their crest elevation will determine the elevation of flooding in the ponding area. Such areas can usually be delineated based on field reconnaissance, in conjunction with an examination of topographic maps, without detailed calculations or field surveys.

Based on the findings from the detailed study, the Mapping Partner shall establish one BFE for each ponding area; this BFE will appear under the Zone AH designation on the FIRM.

[February 2002]

E.5.3 Detailed Study Methods: Sheet Runoff

Areas of sheet runoff can be identified from historic data and local inquiries, supplemented by field reconnaissance and examination of topographic maps and aerial photographs. However, the lack of adequate data (e.g., small-interval contour mapping) and costly analytical methods pose problems for detailed study of these areas.

Sheet runoff typically takes place across broad areas of low relief. This makes it likely that sheet runoff depths will be less than 1.0 foot. For flood insurance purposes, once a determination has been made that flooding depths are less than 1.0 foot, the area is to be designated as Zone X and more detailed analysis is not required. In certain situations, however, sheet runoff depths may average more than 1.0 foot. Such may be the case, for instance, when the channel capacity of a perched stream is exceeded, as on a delta formation. The Mapping Partner shall identify those areas where depths averaging more than 1.0 foot could occur and then undertake a more detailed analysis of these areas. In the unlikely occurrence of sheet runoff with an average depth of more than 3.0 feet, the Mapping Partner shall contact the Regional Project Officer for guidance. The Mapping Partner shall select the specific methods to be used in the detailed analysis; however, normal depth calculations are usually used, with effective-flow areas established using available topographic information, historical information, and engineering judgment. Losses through ground infiltration normally are not to be considered.

The Mapping Partner shall determine the 1-percent-annual-chance flood discharge at the head of a sheet flow area by an appropriate method. In the absence of a permanent manmade channel or large-scale topographic features to restrict its flow, the Mapping Partner shall route this discharge uniformly across the entire area susceptible to sheet flow. The Mapping Partner shall obtain cross section and slope information to determine average flood depths across the area. Whenever small-interval contour mapping exists, the Mapping Partner shall develop cross sections directly from those maps; otherwise, the Mapping Partner shall take a limited number of cross sections across the area to determine average flood depths. Cross sections are to be maintained perpendicular to flow over the surface.

Methods of determining what areas to include in a particular shallow flooding area can vary significantly based on the available data, type of study, and analysis used. Typically, average flood depths from representative cross sections taken from available topographic information are used in selecting a reach. Generally, the average flow depth at a cross section in a shallow flooding (Zone AO) area is obtained by dividing the flow area with the water-surface top width. A weighted average of all the average flow depths at all cross sections within a selected reach length would be used to define the extent of shallow flooding zones. For NFIP mapping purposes, areas of shallow flooding with average depths of 1.0 foot or less are designated as Zone X. Areas of shallow flooding with average depths between 1.0 and 1.5 feet are designated as Zone AO (DEPTH 1'); between 1.5 and 2.5 feet, Zone AO (DEPTH 2'); between 2.5 and 3.0 feet, Zone AO (DEPTH 3'). Only after the average depth for a selected reach is determined would that value, for NFIP mapping purposes, be rounded to the nearest whole foot.

In urban areas, sheet runoff is affected by buildings, sewer and drainage systems, and street design. In many cases, storm sewer and street systems are intended to carry the total discharges of only relatively frequent floods. Less frequent floods, including the 1-percent-annual-chance flood, will often result in shallow flooding as the capacity of designed drainage networks is exceeded. Such problems, if amenable to detailed study at all, are exceedingly costly to analyze. Because such areas are already developed, improved drainage systems may be the only short-term solution to the problem. Analysis of local drainage problems is considered beyond the scope of these Guidelines. Therefore, the Mapping Partner shall rely on historic data and the reports of local engineers and

residents to identify such areas, and use field reconnaissance and engineering judgment to delineate them.

The procedures outlined in this Appendix are adequate to determine areas susceptible to sheet flow flooding, but they may not indicate the severity of the possible local hazard. The Mapping Partner shall include any available information - reports of local residents, historical data, and especially photographs of past floods - in the FIS Report to document velocity, depth, debris, and shifting channel hazards that may exist.

[February 2002]

E.5.4 Deliverable Products

The Mapping Partner performing a study shall submit the following information to the Mapping Partner preparing the FIS Report and FIRM:

- A description of the cause of shallow flooding and the method used to determine its extent;
- A determination of the discharge at the head of the sheet flow area or the discharge hydrograph or the runoff volume at the ponded area;
- A topographic map with a suitable scale showing the location of the cross sections or the ponded area;
- A stage-storage relationship of the ponded area or the normal depth computations at the cross sections, the average depth at each cross section, and weighted depth for selected reaches for sheet flow areas;
- A map with a suitable scale showing the Zone AH with BFE and/or Zone AO with computed weighted average depths; and
- Any other available information, including reports of local residents, historical data, and photographs of past floods.

[February 2002]

Map MODERNIZATION

Federal Emergency Management Agency

FEMA's Flood Hazard Mapping Program

Guidelines and Specifications *for* Flood Hazard Mapping Partners

Appendix F: Guidance for Ice-Jam Analyses and Mapping

FEDERAL EMERGENCY MANAGEMENT AGENCY

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Appendix F

Guidance for Ice-Jam Flooding Analyses and Mapping

F.1 Introduction

An ice jam may be defined as an accumulation of ice in a river, stream, or other flooding source that reduces the cross-sectional area available to carry the flow and increases the water-surface elevation. Ice usually accumulates at a natural or manmade obstruction or a relatively sudden change in channel slope, alignment, or cross-section shape or depth. Ice jams are common in locations where the channel slope changes from relatively steep to mild, and where a tributary stream enters a large river. Ice jams often cause considerable increases in upstream water-surface elevation, and the flooding often occurs quite rapidly after the jam forms.

In the northern United States, where rivers can develop relatively thick ice covers during the winter, ice jams can contribute significantly to flood hazards. Although flow discharges may be low relative to free flow flood, the stages of ice jam flooding may be among the highest on the record. Ice jams typically occur repeatedly in the same locations and ice jam flooding tends to be local and highly site specific.

In areas likely to be selected for a detailed study by the Federal Emergency Management Agency (FEMA) or one of FEMA's Mapping Partners, historical documentation usually will indicate if ice-jam-caused flooding is a significant factor warranting consideration. In regions of the United States where ice jams are typical, the Mapping Partner that performs a detailed study shall investigate historical floods for evidence of ice-jam contribution as part of the study reconnaissance effort.

[February 2002]

F.2 Ice Jam Types

Ice jams have been classified in numerous ways by various investigators. In the U.S. Army Cold Regions Research and Engineering Laboratory Technical Note entitled "Methodology for Ice Jam Analysis" (1980), ice jams were classified as freezeup-, breakup-, floating-, or grounded-type jams. Each type is discussed in more detail in Subsections F.2.1 through F.2.4.

Additional information on the characteristics of ice jams is provided by the National Research Council of Canada in Chapter 10 of *Hydrology of Floods in Canada—A Guide to Planning and Design* (National Research Council of Canada, 1989), and by the U.S. Army Corps of Engineers in Engineering Pamphlet 1110-2-11, *Engineering and Design Ice Jam Flooding: Causes and Possible Solutions* (U.S. Army Corps of Engineers, 1994).

[February 2002]

F.2.1 Freezeup-Type Jams

Freezeup-type jams are associated with the formation and accumulation of frazil ice, which eventually forms a continuous ice cover. Freezeup jams typically occur during early winter to midwinter. The Mapping Partner that performs the detailed study usually will not be required to address freezeup-type jams in performing a detailed study for National Flood Insurance Program (NFIP) purposes because freezeup-type jams are not associated with large discharge events. However, the Mapping Partner shall be aware of possible exceptions.

[February 2002]

F.2.2 Breakup-Type Jams

Breakup-type jams are frequently associated with rapid increases in runoff and rises in river stage, resulting from rainfall and/or snowmelt. Breakup-type jams usually occur in the late winter or early spring. Because of the large volumes of ice that may be involved and the greater discharges associated with them, breakup-type jams are predominant in ice-jam-caused flooding. Therefore, breakup-type jams are the type that the Mapping Partner that performs the detailed study will typically need to investigate.

[February 2002]

F.2.3 Floating-Type Jams

Floating-type jams are considered to be those where the ice is not grounded to the channel bottom and significant flow takes place beneath the ice cover. Floating-type jams are typical of deeper rivers. Because floating-type jams can cause significant backwater effects, the Mapping Partner that performs the detailed study must address them as part of the study.

F.2.4 Grounded-Type Jams

Grounded-type jams are characterized by an ice cover that is partially grounded to the bed of the channel, with most of the flow being diverted into the overbank and floodplain areas. Grounded-type jams are typical of shallow, confined stream sections. Because grounded-type jams can cause significant backwater effects, the Mapping Partner that performs the detailed study must address them as part of the study.\

[February 2002]

F.3 Reconnaissance

When the Mapping Partner that performs the detailed study determines that ice jamming has historically resulted in flooding within the community under study, the Mapping Partner shall intensify the reconnaissance effort. Through the intensified reconnaissance effort, the Mapping Partner will be able to acquire as much data as possible concerning ice-jam events in the community, on the streams being studied, and in the region. Such data shall include, but not be limited to, locations of ice jams, dimensions, ice volumes, causes, associated river stages and discharges, frequency of occurrence, lateral and upstream extent of flooding, season of occurrence, and other contributing or correlative factors.

The Mapping Partner that performs the detailed study also shall investigate the nature of ice jamming common to the site; that is, whether freezeup- or breakup-type jams are typical and whether grounded- or floating-type jams are typical. Because very limited documented data are usually available, the Mapping Partner that performs the detailed study shall investigate all possible sources of information, including:

- Photographs;
- Local residents;
- Newspapers;
- Community officials; and
- State and Federal agencies.

During the field reconnaissance, the Mapping Partner that performs the detailed study also shall investigate physical evidence of ice jams, such as high-water marks, damage to structures, or scars on trees, that may provide useful data for the analysis.

[February 2002]

F.4 Analysis Approaches

Different methods may be used for establishing flood elevations in areas subject to ice-jam flooding, depending on the availability of data and the nature of the ice-jamming phenomena that occur at the site of interest. The methods outlined herein are applicable primarily to stationary-type ice jams that occur during periods of ice breakup. These types of jams historically have resulted in major flooding in certain regions of the United States. When conditions warrant alternate analytical methods, the Mapping Partner that performs the detailed study must seek approval of the alternate methods from the FEMA Regional Project Officer before proceeding.

The approaches in Subsections F.4.1 and F.4.2 are based on the development of stage-frequency relationships for two different populations (ice-jam flood stages and free-flow flood stages), which are then combined into a single composite frequency curve for flood stages at a site under study. Depending on the availability of ice-jam stage information, ice-jam stage-frequency relationships may be determined directly or indirectly as discussed in Subsections F.4.1 and F.4.2. For NFIP purposes, the direct method is preferred where sufficient data are available.

[February 2002]

F.4.1 Direct Approach

If sufficient data exist at the site of interest, the Mapping Partner that performs the detailed study shall establish an ice-jam stage-frequency distribution directly by analyzing the historical ice-stage data. This approach is preferred where ice-jam stages are available for three or more significant events (i.e., overbank flooding) that span more than a 25-year period of record and where hydraulic conditions have not changed appreciably since those events.

Limited data on historical ice-jam stages are usually available at ungaged locations, and the Mapping Partner that performs the detailed study may obtain these data from a variety of sources, including:

- Community officials,
- Resident recollections,
- Newspaper accounts,
- High-water marks,
- Tree damage or scars,
- Vegetation trim lines, and
- Disturbed bank material.

If historical records of stage are sufficient, the Mapping Partner that performs the detailed study may use the graphical frequency analysis method to compute plotting positions and fit a frequency curve on probability paper. Because of their simplicity, FEMA recommends using the Weibull plotting positions for this purpose. However, the Mapping Partner shall be aware that any extrapolation beyond the range of observed data is risky when the graphical frequency analysis is performed, because the ice-affected stages are primarily governed by the regime of ice and its interaction with channel geometry. Additional guidance on graphical frequency analysis and the use of exceedance thresholds for ice-jam flooding is provided in *Hydrology of Floods in Canada—A Guide to Planning and Design* (National Research Council of Canada, 1989).

If the study/restudy reach includes a gaging station where historical ice jams have occurred, the Mapping Partner that performs the detailed study shall perform a stage-frequency analysis using the stage data at the gaging station. The Mapping Partner shall obtain the stage data necessary for this analysis from streamflow records published by the U.S. Geological Survey and other agencies.

The annual-maximum stage can occur as the result of either a free-flow event or an ice-jam event. For the ice-jam events, the annual-maximum peak stage can occur at a different time than the annual-maximum peak discharge.

If detailed data are available, the Mapping Partner that performs the detailed study may follow two approaches for the direct analysis of stage data: (1) annual-event series and (2) annual-maximum series. The Mapping Partner shall use the annual-event series approach when data are available for both the maximum peak stage during the ice-jam season and the maximum peak stage during the free-flow season for each year (two values per year). The Mapping Partner shall use the annual-maximum series approach when only data for the annual-maximum peak stages are available for each year.

In both approaches, the Mapping Partner that performs the detailed study shall develop separate frequency curves for the ice-jam events and the free-flow events and then combine them to determine the percent chance that a given stage will be exceeded in a year. Weibull plotting positions are preferred for determining the individual stage-frequency curves. However, when there are more than 10 years of ice-jam or free-flow stages, the Mapping Partner may fit a frequency distribution such as the log-Pearson Type III to the stage data or their logarithms to help define or extend the stage-frequency curve based on plotting positions. An example of analyzing both annual-event and annual-maximum series is given in "Discussion of Techniques for Analysis of Ice-Jam Flooding" (Thomas, Crockett, and Johnson, 1998).

[February 2002]

F.4.1.1 Annual-Event Series

To develop the annual-event series, the Mapping Partner that performs the detailed study shall develop peak stages for the ice-jam season and for the free-flow season for each year of record. However, most often, the available data will not be sufficient to develop the annual-event series. In many years, only a single peak stage is reported. To develop the annual-event series for these

years, the Mapping Partner must either estimate the peak stage for the missing season or, preferably, determine the peak stage through a search of the historical stage records. FEMA does not recommend estimating the peak stage because this approach introduces uncertainty in the analysis, particularly when estimating the missing ice-jam stages. Even though a search of historical stage records is usually time consuming, the Mapping Partner that performs the detailed study shall use this approach for developing the complete annual-event series.

For the annual-event series, stage-frequency curves are computed for each season and combined using the following equation:

$$P(s) = P(si) + P(sq) - P(si) * P(sq) \qquad (1)$$

where

P(s) = Probability of the annual-maximum stage exceeding a given stage "s" in any year, by either type of event

P(si) = Probability of the annual-maximum stage exceeding a given stage "s" in the ice-jam season (not all events in the ice-jam season will necessarily be affected by backwater from ice)

P(sq) = Probability of the annual-maximum stage exceeding a given stage "s" in the free-flow season

P(si) * P(sq) = Joint probability of the annual-maximum stage exceeding a given stage "s" in any year from both types of events

For the annual-event analysis, the Mapping Partner that performs the detailed study shall determine a peak stage for each season each year and combine the seasonal frequency curves assuming the two populations are independent of one another. Use of Equation 1 is not appropriate if the two populations are not independent, if it is impossible to compile an annual-event series, or if it is impossible to segregate the peak stages into populations based on distinct hydrologic causes. When these conditions cannot be met, the Mapping Partner that performs the detailed study shall recommend and receive approval for an alternate approach that uses only the annual maximum peak stages in the frequency analysis.

[February 2002]

F.4.1.2 Annual-Maximum Series

In the annual-maximum series, the Mapping Partner that performs the detailed study identifies the annual peak stage in each year of record as resulting from either an ice-jam or free-flow event. The Mapping Partner that performs the detailed study shall then develop a stage-frequency curve using all annual-maximum stages that are ice-jam events and a separate stage-frequency curve using all the annual-maximum stages that are free-flow events. Each frequency curve is called a "conditional-frequency curve."

The ice-jam conditional-frequency curve is "conditioned" in the sense that only annual-maximum peak stages that are ice-jam-related are used in the frequency analysis. To obtain the probability of an ice-jam event exceeding a given stage "s" in any year, the Mapping Partner that performs the detailed study shall multiply the exceedance probabilities from the conditional-frequency curve by the fraction of time that ice-jam events produce annual-maximum peak stages.

The free-flow conditional-frequency curve is "conditioned" in the sense that only annual-maximum peak stages that are free-flow events are used in the frequency analysis. To obtain the probability of a free-flow event exceeding a given stage "s" in any year, the Mapping Partner that performs the detailed study shall multiply the exceedance probabilities from the conditional-frequency by the fraction of time that free-flow events produce annual-maximum peak stages.

The Mapping Partner that performs the detailed study shall then combine the seasonal-frequency curves combined to obtain the probability of the annual-maximum stage exceeding a given stage "s" in any year due to either a free-flow or an ice-jam related event. For the annual-maximum series, the Mapping Partner that performs the detailed study shall compute the stage-frequency curves for each season and combine them using the following equation:

$$P(s) = (P(s) \mid s = \text{free-flow event}) * P(s = \text{free-flow event}) + (P(s) \mid s = \text{ice-jam event}) * P(s = \text{ice-jam event}) \quad (2)$$

where

P(s)= Probability of the annual-maximum stage exceeding a given stage "s" in any year, by either type of event

(P(s) | s = free-flow event) = The conditional probability of the annual-maximum stage exceeding a given stage "s" in any year, when only free-flow events that are annual-maximum peak stages are used in the analysis

(P(s = free-flow event) = The fraction of years for which the annual-maximum peak stage was a free-flow event

(P(s) | s = free-flow event) * P(s = free- flow event) = The joint probability of the annual-maximum stage exceeding a given stage "s" in any year and the seasonal free-flow event is an annual maximum

(P(s) | s = ice-jam event) = The conditional probability of the annual-maximum stage exceeding a given stage "s" in any year, when only ice-jam events that are annual-maximum peak stages are used in the analysis

P(s= ice-jam event) = The fraction of years for which the annual-maximum peak stage was an ice-jam event

(P(s) | s = ice-jam event) * P(s = ice-jam event) = The joint probability of the annual-maximum stage exceeding a given stage "s" in any year and the seasonal ice-jam event is an annual maximum

[February 2002]

F.4.1.3 Summary

Equations 1 and 2 provide two different approaches for combining stage-frequency curves when stage data are directly available, when stage data are determined by the indirect approach described in Subsection F.4.2, or for a combination of the two approaches. For example, the Mapping Partner that performs the detailed study may use Equation 1 where limited historical stage data are available for ice-jam analysis and where the stage data for free-flow conditions are determined using the indirect approach. The Mapping Partner may estimate the probability of the annual-maximum stage exceeding a given stage "s" in any year from an ice-jam event (P(si)) from limited stage data such as three events occurring over at least a 25-year period.

As discussed earlier in this appendix, the Mapping Partner that performs the detailed study should perform a graphical analysis using Weibull plotting positions, and combine the probability (P(si) with the free-flow probabilities (P(sq)) using Equation 1. The Mapping Partner should determine the free-flow probabilities (P(sq)) using discharge-frequency analysis for the free-flow season and standard hydraulic modeling procedures as described in Subsection F.4.2.

Equation 2 is more convenient for directly computing stage-frequency curves for study/restudy reaches where detailed information is available, such as at gaging stations. This approach requires the fraction of time that annual-maximum stages are caused by either ice-jam or free-flow events and uses just the annual-maximum stages for the two types of events. This information is usually not available or easy to determine for ungaged locations.

The Mapping Partner that performs the detailed study shall use the direct approach rather than the indirect approach as discussed below because the joint probabilities of various hydrologic and hydraulic factors (e.g., discharges, ice volumes, ice thickness) are inherently included in the frequency analysis. However, available data are often not sufficient for direct analysis or when hydraulic conditions in the study/restudy reach are different from gaging stations located upstream or downstream of the reach. In those instances, the Mapping Partner that performs the detailed study shall use the indirect approach.

[February 2002]

F.4.2 Indirect Approach

F.4.2.1 Assumptions

The Mapping Partner that performs the detailed study may use the indirect approach to ice-jam stage-frequency analysis where available data are insufficient to establish a stage-frequency distribution directly. This approach makes use of the following assumptions:

- Ice-jam stage frequency is a function of ice-jam season-discharge frequency.
- Ice jams are of the breakup type.
- Ice jams are of the stationary type.
- For all ice jams, the ice thickness will be given by the equilibrium relationship developed in "Formation of Ice Covers and Ice Jams in Rivers" (Pariset, Hauser, and Gagnon, 1966).
- For all ice jams, the stage-discharge relationship will be determined by adjusting the standard step-backwater technique for flow under an ice cover of equilibrium thickness.
- For grounded-type jams, the stage-discharge relationship at the point of ice-jam formation will be that resulting from complete or nearly complete blockage of the normal channel, with flow being carried in the overbank floodplain areas.

[February 2002]

F.4.2.2 General Procedures

To apply the indirect approach, the Mapping Partner that performs the detailed study shall use the procedures discussed below.

The Mapping Partner that performs the detailed study shall establish a free-flow stage-frequency distribution for each cross section by using standard backwater modeling to establish stage-discharge relationships. Usually, the four standard (10-, 2-, 1-, and 0.2-percent-annual-chance) discharges will provide sufficient points for establishing the stage-frequency curve for each cross section on normal probability paper.

The Mapping Partner that performs the detailed study shall separate the water year into an "ice-jam season" and a "free-flow season" based on the historical occurrence of ice jams in the region and, in particular, in the stream under study. The season shall encompass the period when breakup-type ice jams normally occur and will likely vary with the latitude and elevation of the stream being studied. Ice jams tend to be associated with one of the seasonal peak flows because ice jams typically form during rises in river stage that break up the ice sheet.

Where peak flow data are available at gaging stations, the Mapping Partner that performs the detailed study shall perform discharge-frequency analyses for the ice-jam and free-flow seasons

using procedures described in Bulletin 17B (Interagency Advisory Committee on Water Data, 1982). If the logarithms of the peak-flow data do not fit a log-Pearson Type III distribution, then the Mapping Partner may use other frequency distributions or the appropriate plotting position formulas for this purpose. The reasons for deviating from Bulletin 17B procedures shall be documented.

For ungaged streams, the Mapping Partner that performs the detailed study shall establish seasonal discharge-frequency relations by performing a regional analysis of seasonal flows for the gaged streams in the region. Usually, the establishment of regional seasonal discharge-drainage-area relations will be sufficient for this purpose.

The Mapping Partner that performs the detailed study shall then use standard hydraulic techniques to establish corresponding stage-frequency curves for each cross section in the reach where ice jams are to be considered. Usually, the analyses of the standard percent chance of exceedance used in a FEMA flood study (i.e., 10-, 2-, 1- and 0.2-percent-annual-chance) will be sufficient to establish the stage-frequency curves. For ice-jam analysis, this is typically accomplished using the ice-cover option in the U.S. Army Corps of Engineers (USACE) HEC-2 hydraulic program or the USACE HEC-RAS computer program. For additional information on the ice-cover option in the HEC-2 program, the Mapping Partner that performs the detailed study should refer to "Analysis of Flow in Ice Covered Streams Using Computer Program HEC-2" (USACE, 1979) on the use of this option.

These options take into account the hydraulic aspects of flow under ice, such as a reduction in flow area, increased wetted perimeter, and ice roughness. The inputs required to use this option include the following:

- Normal HEC-2 or HEC-RAS input;
- Thickness of the ice in the channel and overbanks
- Manning's "n" value for the underside of the ice cover, and
- Specific gravity of the ice.

The recommended ranges for "n" values are from 0.015 to 0.045 for unbroken ice and from 0.04 to 0.07 for ice jams. The specific gravity of normal ice is approximately 0.92 and is the recommended value for this analysis.

Where major floods are caused by ice jams, the assumption of equilibrium ice thickness is probably reasonable because sufficient upstream conditions exist to generate the ice volumes needed. Unless there is strong evidence to the contrary, the ice thickness used in the analysis shall be the approximate equilibrium thickness as defined in "Formation of Ice Covers and Ice Jams in Rivers" (Pariset, Hauser, and Gagnon, 1966). Where equilibrium ice thickness is not appropriate, the Mapping Partner that performs the detailed study shall provide written justification for the thickness used in the analysis.

The Mapping Partner that performs the detailed study shall calibrate for floating-type jams by assuming equilibrium ice thickness at the location where the ice-jam stage-frequency curve is needed and use a combination of discharge, equilibrium ice thickness, and roughness that would correspond to that stage. The Mapping Partner shall calibrate grounded-type jams by assuming complete blockage of the main channel at the point of obstruction, with equilibrium ice thickness, discharge, and roughness that would correspond to that stage. This will permit the Mapping Partner to use the ice cover option in the HEC-2 or HEC-RAS computer programs to estimate corresponding ice-jam stages upstream or downstream of the point where historical data are available.

The Mapping Partner that performs the detailed study shall document that grounded-type ice jams have occurred historically before grounded-type jam behavior is assumed. Grounded-type jams may occur at confined sections, such as bridges, and at shallow sections. The hydraulic analysis assumes that a high percentage of the normal flow area of the channel (or bridge) is obstructed and that most of the flow is in the overbank areas.

At the point of obstruction, the Mapping Partner that performs the detailed study shall use an actual or hypothetical bridge section to permit the special bridge routine to facilitate the analysis. The Mapping Partner shall then adjust the low chord of the bridge (HEC-2 variable ELLC) and the net flow area (HEC-2 variable BAREA) to achieve different degrees of blockage of the main channel.

The Mapping Partner that performs the detailed study shall normally assume between 95- and 100-percent blockage of the main channel unless sufficient evidence exists to support another assumption. In that case, the Mapping Partner shall document and justify the alternative. Upstream from the site of grounding, the Mapping Partner shall assume the equilibrium ice thickness, as computed according to the Pariset formulation (Pariset, Hauser, and Gagnon, 1966), unless alternative thicknesses can be justified.

The Mapping Partner that performs the detailed study shall establish a stage-frequency curve for the ice-jam and the free-flow events by plotting the stages from the HEC-2 or HEC-RAS analyses at each cross section. The Mapping Partner shall plot stages for the 10-, 2-, 1- and 0.2-percent-annual-chance floods on normal (or log-normal) probability paper and draw smooth curves through these points.

Not every flood event during the ice-jam season is affected by ice. If sufficient ice-jam data are available, then the Mapping Partner that performs the detailed study shall incorporate the fraction of time that ice-jam season peak stages are affected by ice in the analysis. If the discharge-frequency relation in the ice-jam season is independent of ice conditions, then the 10-, 2-, 1- and 0.2-percent-annual-chance flood discharges are essentially the same for those years when ice jams occur and when they do not occur.

Under these conditions, the Mapping Partner shall develop water-surface profiles for ice-affected and free-flow conditions in the ice-jam season. A modified version of Equation 1 for combining the stage-frequency curves is as follows:

$$P(s) = [P(sw)*P(si=\text{ice-jam event}) + P(so)*P(si=\text{free-flow event})] + P(sq) - [(P(sw)*P(si=\text{ice-jam event}) + P(so)*P(si=\text{free-flow event})) * P(sq)] \quad (3)$$

where P(s) and P(sq) are as defined in Equation 1

P(sw) = Probability of exceeding a given stage "s" in the ice-jam season developed using the discharge-frequency relationship for the ice-jam season and ice-affected hydraulic conditions

P(si=ice-jam event) = Fraction of years during the ice-jam season that peak stages are affected by ice jams

P(so) = Probability of exceeding a given stage "s" in the ice-jam season developed using the discharge-frequency relationship for the ice-jam season and free-flow hydraulic conditions

P(si=free-flow event) = Fraction of years during the ice-jam season that peak stages are free-flow events

The assumption in Equation 3 is that the conditional distribution of peak discharges for the ice-jam season is the same for ice-affected and free-flow conditions. If ice jams only occur when peak discharges are large or, conversely, if large peak discharges do not occur under free-flow conditions, Equation 3 is not applicable.

[February 2002]

F.4.2.3 Summary

For the indirect approach, the Mapping Partner that performs the detailed study shall obtain the composite stage-frequency curve for the various percent-chance-exceedance floods at each cross section. This shall be done by combining the free-flow and ice-jam stage-frequency curves using Equations 1, 2, or 3, depending on the available data and analysis procedures used in establishing the discharge-frequency relationship. The various conditions are summarized below.

If the discharge-frequency analysis was performed using the annual-event approach (two discharge values per year), the Mapping Partner that performs the detailed study shall use Equation 1 to combine the ice-jam and free-flow stage-frequency curves. Equation 1 also applies for combining the stage-frequency curves if regional seasonal discharge-drainage-area relations are used to determine the discharge-frequency curves. Seasonal discharge-frequency curves developed in this manner represent the probabilities of the annual-maximum discharge exceeding a given discharge value during either the ice-jam or free-flow season. These exceedance probabilities are not conditioned or related to the fraction of time that the annual-

maximum discharges are either ice-jam or free-flow events; therefore, the conditional-frequency approach of Equation 2 is not appropriate.

If the Mapping Partner that performs the detailed study based the discharge-frequency estimates of the 10-, 2-, 1- and 0.2-percent-annual-chance floods solely on annual-maximum discharge events, then the Mapping Partner shall use Equation 2 for combining the stage-frequency curves. This implies that the discharge-frequency curves used for this analysis are based on either ice-jam or free-flow annual-maximum discharges and that these frequency curves have NOT been adjusted for the fraction of time that the ice-jam or free-flow events are annual maximums.

If the discharge-frequency relationship during the ice-jam season is the same under ice-affected and free-flow conditions and sufficient ice-jam data are available, the Mapping Partner that performs the detailed study shall use Equation 3 to account for the fraction of time that the peak stages in the ice-jam season are actually affected by backwater from ice.

[February 2002]

F.5 Presentation of Results

Requirements for presenting the results of the ice-jam analyses in the Flood Insurance Study (FIS) report and on the Flood Insurance Rate Map (FIRM) are presented in Subsections F.5.1 and F.5.2.

[February 2002]

F.5.1 Flood Insurance Study Report

The information the Mapping Partner that performs the detailed study shall submit the information summarized in Subsections F.5.1.1, F.5.1.2, and F.5.1.3 for inclusion in the FIS report. The Mapping Partner that prepares the Preliminary and Final versions of the FIS report shall, at the direction of FEMA, include this information either in the main body of the FIS report or as an additional subsection at the end of the FIS report. (For additional information on formats for FIS reports, see Appendix J of these Guidelines.)

[February 2002]

F.5.1.1 Information To Be Included in Text

The Mapping Partner that performs the detailed study shall submit the information summarized below for inclusion in the text.

- The Mapping Partner that performs the detailed study shall provide a discussion of historic ice jams.
- The Mapping Partner that performs the detailed study shall provide a discussion of any discharge-frequency analysis for the ice-jam season, if used, and the statistical treatment of stage-frequency analysis for the ice-jam and non-ice-jam events. In this discussion, the Mapping Partner that performs the detailed study shall reference the historical data used in the analyses along with its source and how it was used.
- The Mapping Partner that performs the detailed study shall provide a discussion of how free-flow and ice-jam stages were computed and whether stages were computed directly from stage-frequency analyses or indirectly analyzed. The Mapping Partner that performs the detailed study shall include the following topics in this discussion:

  1. Approximate channel blockage and ice thickness assumed, if used;
  2. The relationship of the computed ice-jam stages to historic floods;

3. An example of stage-frequency curves for combined floods for the point of obstruction, or a representative cross section within the community if the former is outside the corporate or county limits; and

4. An explanation that regulatory floodways were computed only for free-flow conditions.

[February 2002]

F.5.1.2 Information To Be Included in Tables

The Mapping Partner that performs the detailed study shall submit the information summarized below for inclusion in the data tables that appear in the FIS report.

- The Mapping Partner that performs the detailed study shall submit information for the Summary of Discharges Table that is based on an analysis of the full year and footnote the table to that effect.

- The Mapping Partner that performs the detailed study shall submit information for the "Regulatory" column of the Floodway Data Table using the 1-percent-annual-chance (100-year) flood elevations established from the composite ice-jam and free-flow season stage-frequency curves and footnoted the table to that effect. All other columns in the Floodway Data Table shall be based on the 1-percent-annual-chance (100-year) floodflow conditions.

[February 2002]

F.5.1.3 Flood Profiles

The Mapping Partner that performs the detailed study shall submit Flood Profiles that are based on the elevations established from the composite ice-jam and free-flow stage-frequency analysis.

[February 2002]

F.5.2 Maps

The Mapping Partner that performs the detailed study and the Mapping Partner that prepares the Preliminary and Final versions of the FIRM for FEMA shall ensure the information shown on the FIRM is based on the elevations established from the composite ice-jam and free-flow stage-frequency analyses performed at each cross section. The Mapping Partners also shall ensure that the regulatory floodways are established and plotted based on the 1-percent-annual-chance (100-year) flood discharges and hydraulics assuming free-flow conditions.

The Mapping Partner that performs the detailed study may indicate the lateral extent of a major historic ice jam on the work map if it is well documented, does not hamper interpretation, and is appropriately annotated as such.

F.6 References

Interagency Advisory Committee on Water Data, Office of Water Data Coordination, Hydrology Subcommittee, Bulletin No. 17B, "Guidelines for Determining Flood Flow Frequency," September 1981, Revised March 1982.

National Research Council of Canada, *Hydrology of Floods in Canada—A Guide to Planning and Design*, Ottawa, Ontario, 1989.

Pariset, E., R. Hausser, and A. Gagnon, "Formation of Ice Covers and Ice Jams in Rivers," *Journal of the Hydraulics Division, American Society of Civil Engineers*, November 1966.

Thomas, W.O., Jr., K. L. Crockett, and A. A. Johnson, "Discussion of Techniques for Analysis of Ice-Jam Flooding," *Association of State Floodplain Managers, Proceedings of the 22nd Annual Conference*, Milwaukee, Wisconsin, May 18-22, 1998, pp. 457-464.

U.S. Department of the Army, Cold Regions Research and Engineering Laboratory, Technical Note, "Methodology for Ice Jam Analysis," D.J. Calkins, October 1980.

U.S. Department of the Army, Corps of Engineers, Engineering Pamphlet 1110-2-11, *Engineering and Design of Ice Jam Flooding: Causes and Possible Solutions*, November 1994.

U.S. Department of the Army, Corps of Engineers, Hydrologic Engineering Center, "Analysis of Flow in Ice Covered Streams Using Computer Program HEC-2," Davis, California, February 1979.

[February 2002]

Map MODERNIZATION

Federal Emergency Management Agency

FEMA's Flood Hazard Mapping Program

Guidelines and Specifications *for* Flood Hazard Mapping Partners

Appendix G: Guidance for Alluvial Fan Flooding Analyses and Mapping

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February 2002

Appendix G

Guidance for Alluvial Fan Flooding Analyses and Mapping

G.1 Introduction

Alluvial fans, and flooding on alluvial fans, show great diversity because of variations in climate, fan history, rates and styles of tectonism, source area lithology, vegetation, and land use. Acknowledging this diversity, the Federal Emergency Management Agency (FEMA) developed an approach that considers site-specific conditions in the identification and mapping of flood hazards on alluvial fans. This approach, summarized herein, was first documented in Guidelines for Determining Flood Hazards on Alluvial Fans.

Investigation and analysis of the site-specific conditions may require knowledge in various disciplines, such as geomorphology, soil science, hydrology, and hydraulic engineering. Although the scope of study may constrain the degree of site-specific consideration undertaken, field inspections of the alluvial fan must be conducted.

As defined in Section 59.1 of the National Flood Insurance Program (NFIP) regulations, the current (1999) definition of "Alluvial Fan Flooding" means flooding that occurs on the surface of an alluvial fan or similar landform, originates at the apex, and is characterized by high-velocity flows; active processes of erosion, sediment transport, and deposition; and unpredictable flowpaths.

FEMA will revise the current definition under Section 59.1 to be consistent with the approach described in this Appendix and specifically to eliminate reference to "similar landforms." The process described in this Appendix is intended for flooding only on alluvial fans as described below.

As interim guidance in the determination of "similar landform," unless the landform under investigation meets the three criteria under Stage 1 for composition, morphology, and location, the landform is not considered to be "similar."

This Appendix provides guidance for the identification and mapping of flood hazards occurring on alluvial fans, irrespective of the level of fan forming activity. The term ***alluvial fan flooding*** encompasses both ***active alluvial fan flooding*** and ***inactive alluvial fan flooding***. Each type of alluvial fan flooding is described below.

Active alluvial fan flooding occurs only on alluvial fans and is characterized by flow path uncertainty so great that this uncertainty cannot be set aside in realistic assessments of flood risk or in the reliable mitigation of the hazard.

An active alluvial fan flooding hazard is indicated by the following three related criteria:

1. Flow path uncertainty below the hydrographic apex;

2. Abrupt deposition and ensuing erosion of sediment as a stream or debris flow loses its ability to carry material eroded from a steeper, upstream source area; and

3. An environment where the combination of sediment availability, slope, and topography creates an ultrahazardous condition for which elevation on fill will not reliably mitigate the risk.

Inactive alluvial fan flooding is similar to traditional riverine flood hazards, but occurs only on alluvial fans. Inactive alluvial fan flooding is characterized by flow paths with a higher degree of certainty in realistic assessments of flood risk or in the reliable mitigation of the hazard. Unlike active alluvial fan flooding hazards, an inactive alluvial fan flooding hazard is characterized by relatively stable flow paths. However, like areas of active alluvial fan flooding, inactive alluvial fan flooding may be subject to sediment deposition and erosion, but to a degree that does not cause flow path instability and uncertainty.

An alluvial fan may exhibit both active and inactive alluvial fan flooding hazards. The hazards may vary spatially or vary at the same location, contingent on the level of floodflow discharge. Spatially, for example, upstream inactive portions of the alluvial fan may distribute floodflow to active areas at the distal part of the alluvial fan. Hazards may vary at the same location, for example, with a flow path that may be stable for lower flows, but become unstable at higher flows.

An example of an alluvial fan that exhibits both active and inactive alluvial fan flooding is depicted in Figure G-1. In this example, the area between the topographic apex and the hydrographic apex (apex definitions will be discussed below) would be considered *inactive alluvial fan flooding* because this reach is characterized by a stable, entrenched channel which can convey the 1-percent-annual-chance (100-year) flood discharge without overbank flooding. The area below the hydrographic apex would be considered *active alluvial fan flooding* because this area is characterized by flow path uncertainty, abrupt deposition, and ensuing erosion of sediment as the channel loses its competence to carry material eroded from a steeper, entrenched upstream source area.

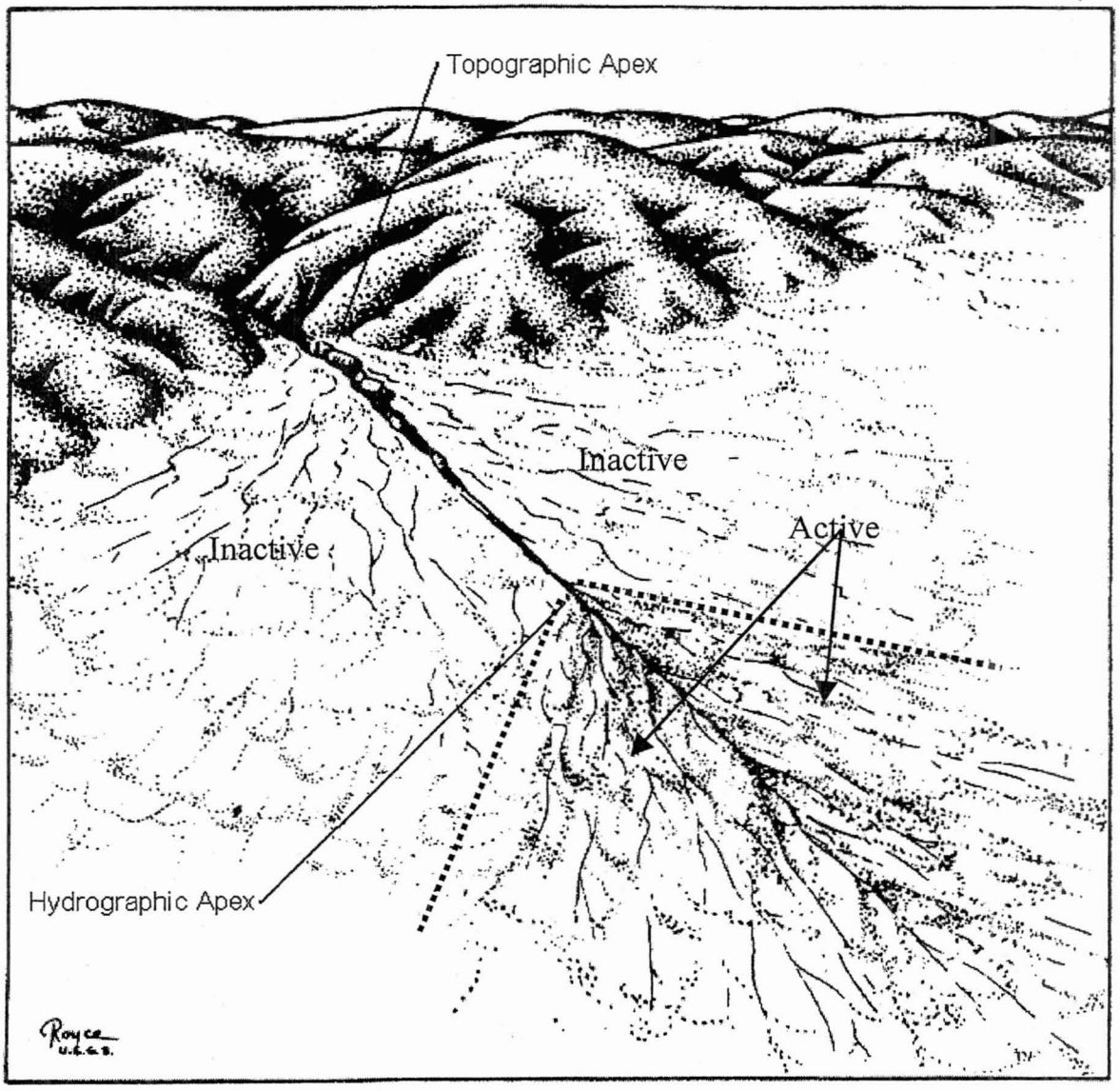

Figure G-1. Alluvial Fan With Entrenched Channel Leading To Active Deposition at Distal Part of the Fan. Original Published as Figure 3-2 in *Alluvial Fan Flooding* (National Research Council, 1996). Reproduced with Permission From the National Research Council; Annotations Added by FEMA.

[February 2002]

G.2 Analysis Approach

Through the approach for alluvial fan flooding identification and mapping documented herein, FEMA seeks to identify whether (1) the area under study is an alluvial fan and (2) which portions of this area, if any, are characterized by or subject to active alluvial fan flooding. After these steps, various methods unique to different situations can be employed to analyze and define the 100-year flood within the areas of alluvial fan flooding identified on the alluvial fan. Thus, the approach for the identification and mapping of alluvial fan flooding can be divided into three stages.

- Stage 1—Recognizing and characterizing alluvial fan landforms;
- Stage 2—Defining the nature of the alluvial fan environment and identifying active and inactive areas of the fan; and
- Stage 3—Defining and characterizing the 100-year flood within the defined areas.

Each of these stages is described in detail in this Appendix. Additional information also can be found in a National Research Council report entitled *Alluvial Fan Flooding* (National Research Council, 1996)

Each stage must be addressed and thoroughly documented during the analysis process. Because each stage builds on the previous stage and because of the complexity of many alluvial fans, the Mapping Partner who undertakes the analysis and mapping of alluvial fan flooding must coordinate closely with the FEMA Regional Project Officer (RPO) and FEMA Headquarters (HQ) from the onset of the study. The progression of the process is shown in Figure G-2.

Progression through each of the stages results in a procedure that narrows or divides the problem to smaller and smaller areas. In Stage 1, the landform on which the flooding occurs must be characterized. If the location of study is an alluvial fan, the Mapping Partner proceeds to Stage 2 to identify which parts of the alluvial fan are active or inactive. Finally, in Stage 3, the Mapping Partner performing the analysis must use various methods to define and analyze the 100-year flood within each identified area of alluvial fan flooding. Progression through these stages requires a variety of maps and photographs, as well as a significant amount of field work and analysis to fully understand the flood hazard. The Mapping Partner may need to consult with geologists, geomorphologists, and/or soil scientists during each stage.

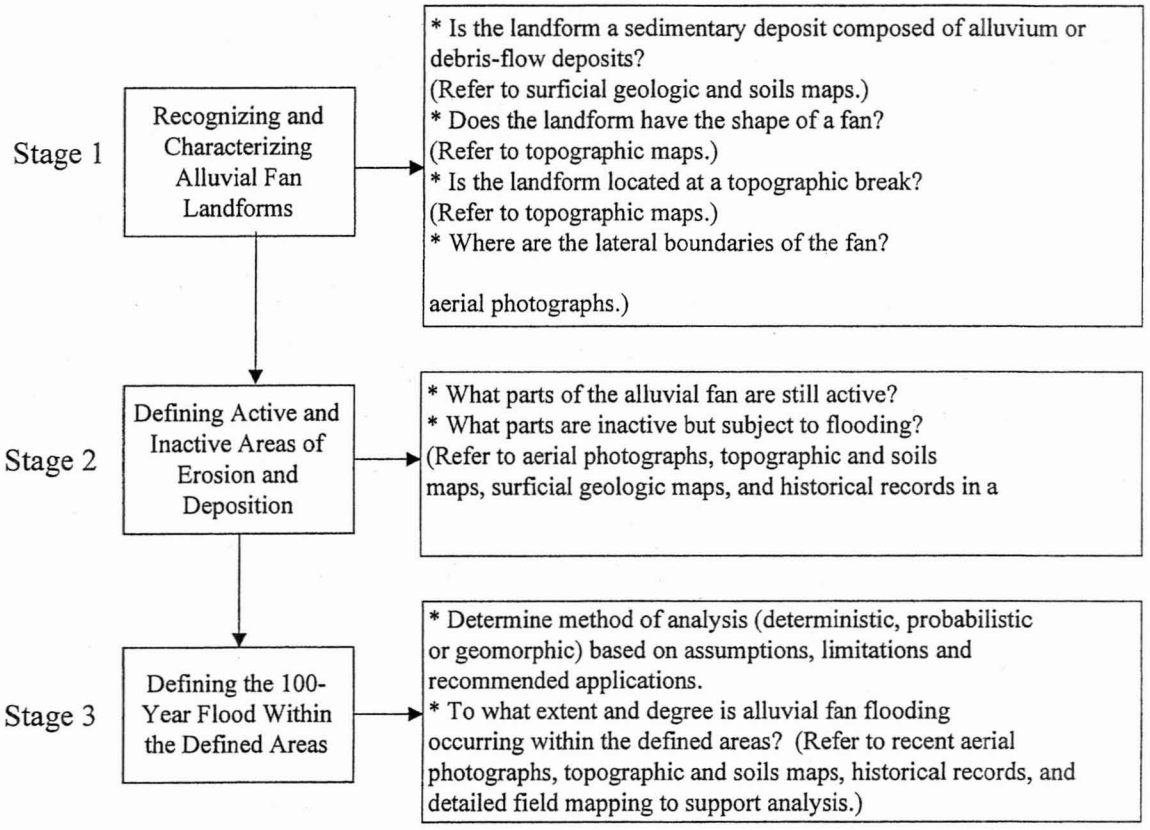

Figure G-2. Three Stages of the Process To Identify and Map Alluvial Fan Flooding. Original Published in National Research Council, 1996, Figure 3-1; Amended by FEMA.

[February 2002]

G.2.1 Stage 1: Recognizing and Characterizing Alluvial Fan Landforms

As defined in this Appendix, alluvial fan flooding occurs only on alluvial fans. Therefore, the first stage of the process is to determine whether the landform in question is an alluvial fan. If, after following the guidelines in this subsection, the Mapping Partner concludes that the landform is not an alluvial fan, then the methods described in this Appendix are not intended for, or necessarily applicable to, the landform in question.

An alluvial fan is a sedimentary deposit located at a topographic break such as the base of a mountain front, escarpment, or valley side, that is composed of streamflow and/or debris flow sediments and has the shape of a fan, either fully or partially extended. These characteristics can be categorized by composition, morphology, and location as discussed in Subsections G.2.1.1, G.2.1.2, and G.2.1.3.

[February 2002]

G.2.1.1 Composition

Alluvial fans are landforms constructed from deposits of alluvial sediments or debris flow materials. These deposits, "alluvium", are an accumulation of loose, unconsolidated to weakly consolidated sediments. Alluvium refers to sediments transported by either streamflow or debris flows. Geologic maps and field reconnaissance can be used to determine whether the landform is composed of alluvium.

[February 2002]

G.2.1.2 Morphology

Alluvial fans are landforms that have the shape of a fan, either partly or fully extended. Flow paths may radiate outward to the perimeter of the fan; however, drainage may exhibit a range of patterns such as dendritic, anastomosing, and distributary. Topographic maps and aerial photos can be used to assess this criterion.

[February 2002]

G.2.1.3 Location

Alluvial fan landforms are located at a topographic break where long-term channel migration and sediment accumulation become markedly less confined than upstream of the break. This locus of increased channel migration and sedimentation is referred to as the alluvial fan apex.

The topographic apex is at the extreme upstream extent of the alluvial fan landform. The hydrographic apex is the highest point on the alluvial fan where there exists physical evidence of channel bifurcation and/or significant flow outside the defined channel; its location may be either coincidental with, or at a point downstream of, the topographic apex as seen in Figure G-1.

The hydrographic apex may depend on the discharge and may vary with the magnitude of the flooding event.

[February 2002]

G.2.1.4 Defining the Toe and Lateral Boundaries of an Alluvial Fan

The distal terminus, or ***toe***, of an alluvial fan commonly is defined by:

- A stream that intersects the fan and transports deposits away from the fan;
- A playa lake;
- An alluvial plain; and
- Smoother, gentler slopes of the piedmont plain.

Such boundaries can often be identified on topographic maps by changes in contour lines or identified on aerial photographs or by field inspection as changes in vegetation as a result of sediment changes or increased water table depth.

Lateral boundaries of alluvial fans are the edges of deposited and reworked alluvial materials. The lateral boundary of a single alluvial fan typically is a trough, channel, or swale formed at the lateral limits of deposition. The lateral boundary also may be a confining mountainside.

Lateral boundaries of single alluvial fans can often be identified as a contact of distinct differences between light-colored, freshly abraded, alluvial deposits and darker-colored, weathered deposits with well-developed soils on piedmont plains. Care should be taken to ensure that the contact is not simply a divide between older and more recent deposits of the alluvial fan.

The lateral boundaries of alluvial fans that coalesce with adjacent alluvial fans are generally less distinct than those of single alluvial fans. These lateral boundaries may be marked by a topographic trough or ridge. It is sometimes possible to distinguish between surfaces of adjacent alluvial fans based on different source-basin rock types. Defining the lateral boundaries of coalescing fans will likely require additional fieldwork, use of surficial geologic and soils maps, and consultation with a geomorphologist or soil scientist.

[February 2002]

G.2.2 Stage 2: Defining Active and Inactive Areas

During Stage 1, the Mapping Partner conducting the analysis identified whether the landform in question is an alluvial fan. During Stage 2, the Mapping Partner will seek to delineate areas of the alluvial fan that are active or inactive in the deposition, erosion, and unstable flow path flooding that builds alluvial fans. The activities in Stage 2 have been designed to narrow the

area of concern for Stage 3, which is the specific identification of the extent of the 100-year flood.

Although active alluvial fan flooding has occurred on all parts of an alluvial fan at some time in the geologic past in order to construct the landform itself, this does not mean that all parts are equally susceptible to active alluvial fan flooding now. Also, flooding may be occurring on inactive areas of the alluvial fan.

In most of the United States, it is possible to identify parts of alluvial fans that were actively constructed during the Pleistocene epoch (approximately 2 million to 10,000 years ago) and parts that have been active (i.e., flooded) during the Holocene epoch (the past 10,000 years). The reason that this broad distinction generally is possible is that the two epochs were identified and defined on the basis of climatic conditions. The Holocene epoch is a time of interglacial warm conditions, whereas the Pleistocene epoch was marked by repeated full glacial, cool conditions alternating with warm interglacials like that of the Holocene epoch. As a result of these climatic differences, flooding and sedimentation occurred at different rates and magnitudes during the Pleistocene and Holocene epochs. The impacts of these climatic changes on alluvial fan formation can be inferred from geologic, geomorphic, and soil data.

A change in the rate of tectonic uplift along a mountain front can also result in abandonment of parts of alluvial fans. For example, a decrease in the rate of uplift at a mountain front relative to the alluvial fan could result in stream channel downcutting at the mountain front/alluvial fan apex over a period of time. As a consequence, the upper part of the fan would become entrenched, and the active area of deposition would shift downfan.

[February 2002]

G.2.2.1 Identification of Active Areas

The term *active* refers to that portion of an alluvial fan where deposition, erosion, and unstable flow paths are possible. If flooding and deposition have occurred on a part of an alluvial fan in the past 100 years, clearly that part of the fan can be considered to be active. This conclusion may be supported by historic records, photographs, time-sequence aerial photography, and engineering and geomorphic information. If flooding and deposition have occurred on a part of an alluvial fan in the past 1,000 years, for example, that part of the fan may be subject to future alluvial fan flooding. This conclusion may only be supported by geomorphic information, however. It becomes more difficult to determine whether a part of the fan that has not experienced sedimentation for more than 1,000 years actually is active, that is, that there is some likelihood of flooding and sedimentation under the present climate conditions.

Because there is no clear analytical technique for making such projections of the estimates of the spatial extent of inundation, Stage 2 analysis involves systematically applied judgment and the combination of hydraulic computations and qualitative interpretations of geologic evidence concerning the recent history and probable future evolution of channel forms, as well as flooding and sedimentation processes. It must be kept in mind, however, that the intent of Stage 2 is to narrow the area of concern with regard to active deposition, erosion, and unstable flow paths over a period of time generally exceeding 100 years. Therefore, the combination of engineering

and geomorphic analyses, both qualitative and quantitative, provide an indication of the approximate spatial extent of possible inundation over a relatively long time period (i.e., several thousand years). During Stage 3, the Mapping Partner that performs the detailed study shall will determine the floodplain limits associated with the 1-percent-annual-chance (100-year) flood.

[February 2002]

G.2.2.2 Identification of Inactive Areas

For a given area of the alluvial fan, if the situations described in Subsection G.2.2.1 do not exist, then the area is considered inactive and not subject to the deposition, erosion, and unstable flow path flooding that builds alluvial fans. Inactive areas may be subject to flooding though, most notably within entrenched channels.

Evidence of inactive areas may include armoring along the margin of the area bordering active areas, older vegetation, and the lack of change in flow paths viewed over the aerial photographic record. This evidence, though, does not preclude the area from possibly being classified as an active area as a result of changes in, or conditions within, adjacent active areas.

Older alluvial fan surfaces are considered active if any of the following are true:

- The recently active sedimentation zone is migrating into the older surface.
- The elevation difference between the recently active sedimentation zone and the older surface is small relative to flood, deposition, and debris depths conceivable in the current regime of climate, hydrology, or land use in the source area.
- Upstream of the site, there is an opportunity for avulsions that could lead channels or sheet floods across the older surface.

[February 2002]

G.2.2.3 Identification Process

Once a relative time period is chosen (e.g., <1,000 years) to help evaluate the active areas of an alluvial fan, the analyst must determine relative ages for the morphologic features on the alluvial fan. Indicators of land surface age for Stage 2 are based on relative age indicators. Absolute (numerical) dating techniques, such as radiocarbon dating, are generally beyond the scope of many studies.

Detailed soils and surficial geological maps, when available, provide useful delineation of soil types and surface ages. An examination of the historical record of flooding and deposition can enhance the information gained from the soils map. Aerial photographs from different years can be used to identify sites of deposition. Field examination of morphologic features on the alluvial fan surface, particularly noting evidence of human activity (recent or archaeological) or weathering characteristics such as desert pavement, rock varnish, B-horizon development in the

soil profile, calcic-horizon development, and pitting and rilling of clasts may also provide relative age information.

Density and type of vegetation can provide useful clues to the age of an alluvial fan surface area. Texture and composition of the sediment, in addition to the water-holding capacity, relate to the surface vegetation. Fresh alluvial deposits contain little organic carbon or clay and, as a result, do not promote vegetation growth. Vegetation is limited on older surfaces because they receive only direct rain, are often erosional, and can be less fertile (carbonate soil cropping out at the surface, for example). Intermediate-age surfaces (middle to late Holocene) contain the most dense and diverse vegetation.

Use and interpretation of diagnostic vegetation, like the use and interpretation of desert pavement, varnish, or soil properties, are generally specific to the individual fan in question. Within a geographic region, however, surface characteristics of alluvial fans may be correlated from one fan to another.

Detailed topographic maps (i.e., 2-foot contour interval) are instrumental in identifying potential avulsion areas and in delineating the boundaries of areas subject to different flood, deposition and debris flow depths. Topographic maps also can be used to identify older alluvial surfaces within active zones that are not subject to flooding.

Areas of question noted during the analysis of maps and aerial photographs should be closely examined during the field inspection. All flow paths should be walked to verify the active and inactive areas that have been delineated. Stage 2 is complete when the analyst has defined and delineated all active and inactive areas of deposition, erosion, and unstable flow path flooding, as well as adjacent inactive fan areas. All inactive areas with stable flow path flooding and all active areas may be considered floodprone, but through Stage 2, the degree to which these areas are floodprone is not yet known. **The delineated floodprone areas of Stage 2 should approximate the largest possible extent of the 100-year flood.**

[February 2002]

G.2.2.4 Types of Alluvial Fan Flooding

Several types of flooding occur on alluvial fans. The most common ones are described in this subsection.

Flooding Along Stable Channels

A deeply entrenched channel or network of channels often is subject to inactive alluvial fan flooding. This type of flooding usually occurs within distributary flow systems that were formed during climatic or tectonic conditions different from the present. This flooding can occur at the head of the alluvial fan but become unstable downstream. Conversely, unstable channels can become stable in the downstream direction; this can occur because of headcutting into the toe as a result of changing hydraulic conditions downstream from the toe. Human intervention, directly by channel modification or indirectly by land-use change, can create stable channels.

Sheetflow

Some parts of alluvial fans are characterized by sheetflow, which is the flow of water as broad sheets that are completely unconfined by any channel boundaries. Sheetflow might occur where flow departs from a confined channel and no new channel is formed. It might also occur where several shallow, distributary channels join together near the toe of a fan and the gradient of the fan is so low that the flows merge into a broad sheet. Because such sheetflows can carry high concentrations of sediment in shallow water and follow unpredictable flow paths, they are classified as active alluvial fan flooding.

Sheetflows generally occur on downslope parts of fans, where channel depths are low and the boundaries of channels become indiscernible. They are also more common at distal locations because of the likelihood of fine-grained sediments and shallow groundwater; during prolonged rainfall, the ground can become saturated, resulting in extensive sheet flooding as runoff arrives from upslope. Fine-grained sediments can aggravate the likelihood of sheetflow because some clay minerals swell when wet, forming an impermeable surface at the beginning of a rainstorm.

Debris Flow

Some parts of alluvial fans are characterized by debris flows, flows with a very high concentration of sediment in relation to water. Debris flows pose hazards that are very different from those of sheetflows or water flows in channels. Identifying those parts of alluvial fans where debris flow deposition might occur requires the examination of deposits from past flows. Debris flow deposits can be distinguished from fluvial deposits by differences in morphology, depositional relief, stratigraphy, and clast fabric. Exposures in channel banks can be examined and can be supplemented with shallow trenches in different deposits.

Unstable Flow Path Flooding

Active areas of an alluvial fan will generally be characterized by unstable and uncertain flow path flooding. This type of flooding usually creates a single channel just below the apex, but splits into multiple channels as it proceeds down the alluvial fan. These channels are subject to deposition and bank or bottom erosion that cause channel migration, avulsion, and the formation of new channels. Areas subject to this type of flooding are characterized by shallow, braided or distributary, sand- to gravel-bed channels. Recently formed channels may have less established vegetation, such as trees, than older channels in the same general area.

[February 2002]

G.2.3 Stage 3: Defining the 100-Year Flood Within Defined Areas

FEMA uses the 100-year flood, the flood having a 1-percent chance of being exceeded in any given year, to delineate Special Flood Hazard Areas (SFHAs) on NFIP maps. In the preceding discussion of Stages 1 and 2, methods of identifying alluvial fan landforms and areas of active and inactive deposition, erosion, and unstable flow path flooding were described. During Stage 3, the Mapping Partner that performs the detailed study will determine the severity and will delineate the extent of the 1-percent-annual-chance (100-year) flood within any floodprone area identified during Stage 2.

The broad spectrum of alluvial fan landforms and types of flooding illustrates, as previously discussed, the futility of developing a "cookbook" method to apply to all fans in all geographic areas. The analysis of the flood hazards on alluvial fans therefore requires a flexible approach that is based on site-specific evaluations. Several methods for quantifying the 100-year flood are presented in the following sections and are summarized in Table G-1. Not all methods are appropriate for all situations. The assumptions and limitations of each should be carefully considered in deciding which methods to apply to particular areas of an alluvial fan.

Sample maps resulting from the application of some of the available methods are included as Figures G-5 through G-13 at the end of this Appendix.

[February 2002]

Table G-1. Methods for Defining the 1-Percent-Annual Chance (100-Year) Flood Within Floodprone Areas Defined During Stage 2

METHOD	ASSUMPTIONS	LIMITATIONS	RECOMMENDED APPLICATIONS	FIGURE NUMBER
Risk-Based Analysis	Refer to *Guidelines for Risk and Uncertainty Analysis in Water Resources Planning* (USACE, 1992).			
FAN Computer Program	Flooding in rectangular channel; critical depth, erosion of rectangular channel banks until the change in width divided by the change in depth equals –200; the probability density function of a discharge occurring at the apex is log-Pearson Type III; the frequency of flood events for various recurrence intervals, i.e., 2-year through 500-year, can be adequately defined; equal probability along contour arcs (random flow paths); (also provides for multiple channels at normal depth, assuming total width is 3.8 times the single-channel width)	Fluvial (as opposed to debris flow) formed fan, unstable flow paths	Highly active, conical fans	G-5
Sheetflow	Broad, unconfined, shallow flooding	Not for use in areas of undulating terrain	Shallow flooding across uniformly sloping surfaces	G-6
Hydraulic Analytical Methods	Stable flow path, uncertainty is to a degree that may be disregarded	Not for use with active alluvial fan flooding	Entrenched stable channel networks, constructed channels, urbanized areas	G-7 and G-13
Geomorphic Data, Post-Flood Hazard Verification, and Historical Information	Relies primarily on qualitative information, post-flood verification, historical data, and interpretive studies	Approximate method	Alluvial fans with little or no urbanization	G-8 and G-9
Composite Methods	As identified in the sections referring to the methods being applied	Must integrate multiple methods into one result	Floodprone areas that contain unique physical features in some locations or have areas varying in levels of erosion and migration activity	G-10, G-11, and G-12

G.2.3.1 Risk-Based Analysis

The U.S Army Corps of Engineers provided a framework that may be used to analyze flood hazards on alluvial fans using the principles of risk-based analysis in *Guidelines for Risk and Uncertainty Analysis in Water Resources Planning* (U.S Army Corps of Engineers, 1992). This method uses the total probability equation that will be discussed in detail in Subsection G.2.3.2. The degree of uncertainty associated with a prediction of a given flood scenario is assessed by bringing to bear evidence derived from geomorphologic and other studies. This method tracks the effects of the error associated with a calculation to provide a confidence band in ensuing predictions of flood-hazard severity.

[February 2002]

G.2.3.2 Analysis Using FAN Computer Program

Assumptions, limitations, and recommended applications for the FAN Computer program are as follows:

- Assumptions: flooding in rectangular channel; critical depth; erosion of rectangular channel banks until the change in width divided by the change in depth equals -200; the probability density function of a discharge occurring at the apex is log-Pearson Type III; the frequency of flood events for various recurrence intervals, i.e., 2-year through 500-year, can be adequately defined; equal probability along contour arcs (random flow paths); also provides for multiple channels at normal depth, assuming total width is 3.8 times the single channel width

- Limitations: fluvial (as opposed to debris flow) formed fan, unstable flow paths

- Recommended Applications: highly active, conical fans

The FAN computer program provides one method of analyzing the flood hazards on alluvial fans. The methodology used by the FAN program defines the risk of inundation at any particular location by applying the definition of the 1-percent-annual-chance (100-year) flood through the theorem of total probability. The methodology itself is broader than the use within the FAN program. Let **H** be a random variable denoting the occurrence of flooding at a particular location. That is:

$$\mathbf{H} = \begin{cases} 1 \text{ if the location is inundated} \\ 0 \text{ if the location is not inundated} \end{cases}$$

Then the probability of the location being inundated by a flood above a given magnitude, say q_0, is:

$$P\left[\boldsymbol{H}=1 \bigcap \boldsymbol{Q} > q_0\right] = \int_{q_0}^{\infty} P_{H|Q}(1,q) f_Q(q) dq \qquad (1)$$

where

$\boldsymbol{Q}$ = random variable denoting the magnitude of the flood

$P_{H|Q}(1,q)$ = conditional probability that the location will be inundated, given that a flood of magnitude q is occurring

$f_Q(q)$ = probability density function (PDF) defining the likelihood that a flood of a magnitude between q and q+dq will occur in any given year

Equation (1) only defines whether a location is within an SFHA and does so in terms of the parameter q_0. For riverine flooding, q_0 represents an elevation, and $P_{H|Q}(1,q)$ is 1 if the elevation of the location is less than q_0 and 0 if it is greater than q_0. At a given location (point on a cross section), there is a one-to-one relationship between the discharge being conveyed by the stream and the elevation of the surface of the floodwater (i.e., the rating curve for the cross section). For riverine flooding, solving Equation (1) reduces to defining the discharge-frequency relationship for the reach of the stream under consideration (hence the notation q_0 to denote magnitude).

As in riverine analysis, the PDF describing frequency of the magnitude of flooding for alluvial fan flooding is taken to be the discharge-frequency relationship of the contributing drainage basin. Unlike riverine analysis, $P_{H|Q}(1,q)$ does not simplify to 0 or 1, because there is uncertainty in the flow path. The FAN program provides energy depths and velocities relating to discharge for use in defining the flood hazard.

The FAN program uses the assumptions outlined below. Where noted with an asterisk (*), these assumptions may be adjusted for observed field conditions; however, the FAN program does not readily accommodate these adjustments.

This method's assumptions are as follows. Floods on alluvial fans are at liberty to expend energy to create the most efficient path to convey the water and sediment load. That path is shallow and approximately rectangular in cross section. Energy is expended through sediment movement until the minimum energy possible is reached. In short, the reasoning is that a flood flows at critical depth and is confined to a rectangular path. The flow path would not widen indefinitely but, instead, would reach a point where it would stabilize. From empirical data, of which there are very little, that point is taken to be where the rate of change of topwidth per change in depth (dW/dd) is –200 (* may be adjusted).

The reasoning leads to the one-to-one relationships:

$$d = 0.106\ q^{1/5} \qquad (2)$$

$$v = 1.506\ q^{1/5}$$

(3)where

d = specific energy in feet

v = velocity in feet per second

q = discharge in cubic feet per second (cfs)

The conditional probability in Equation (1) accounts for the uncertainty in the path of a flood with a given magnitude. Even if the path of the flood can be predicted with reasonable certainty, the magnitude of the flood at a particular location may not be so certain, as deposition or scour in shallow channels may greatly affect the direction of flow at channel splits. Many alluvial fans exhibit a channel network. The capacities of the individual channels as well as the capacities of the networks in aggregate vary from almost negligible to more than the 100-year flood discharge. The treatment of the uncertainty in a given discharge being exceeded at a particular location given the discharge somewhere else [$P_{H|Q}(1,q)$] varies.

The least complex treatment (used in the FAN program) follows from the reasoning that the topography of the area is the result of deposition that occurred during the past. If that process continues, then, over the long term, the probability of every point on a contour being inundated is the same. That is, $P_{H|Q}(1,q)$ is uniformly distributed and, for a given point, is approximately the width of the flood path divided by the width (the "contour width") of the area subject to flooding at the elevation of that point (* may be adjusted). This method assumes that all areas of the alluvial fan are subject to flooding and that there is a fixed relationship between flooding depth and discharge.

In general, these assumptions apply when there is absolute uncertainty regarding how floods will occur. Thus, for the FAN program, under the simple conditions,

$$P_{H|Q}(1,q) = \frac{w(q)}{W_{fan}} = \frac{9.408\ q^{2/5}}{W_{fan}} \qquad (4)$$

where

$w(q)$ = width of the path conveying q cfs

W_{fan} = contour width

The contour width, W_{fan} , is shown in Figure G-3. The resulting flood insurance risk zones are depicted in Figure G-4. The functional form of Equation (4) is a consequence of the reasoning

leading to Equations (2) and (3) and is presented here for demonstrative purposes, not as the only form possible.

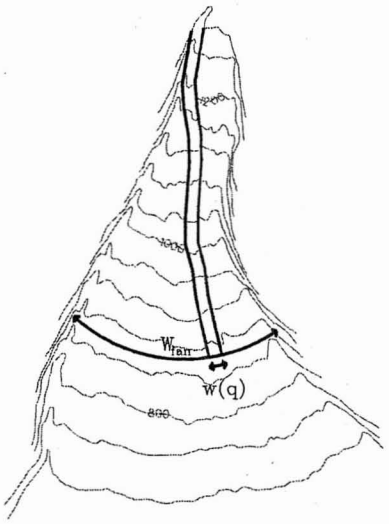

Figure G-3. Fan and Single-Channel Widths

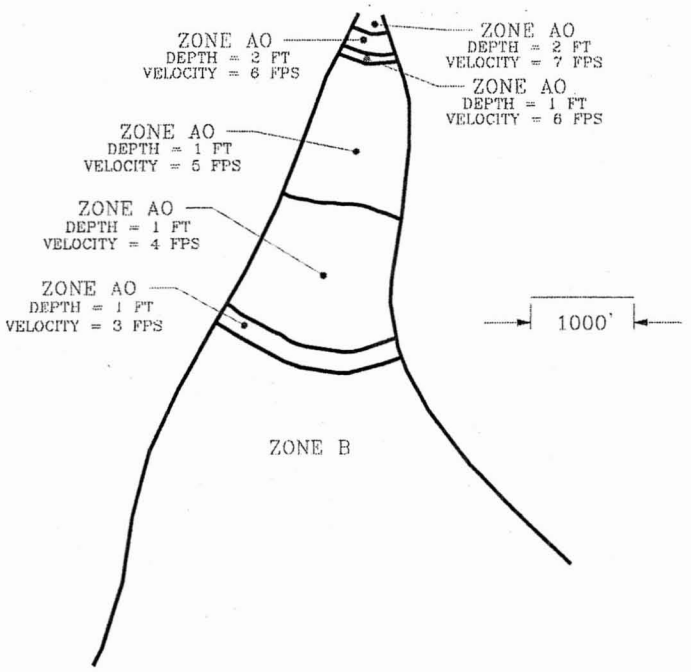

Figure G-4. Flood Insurance Risk Zones Respective to Figure G-3

The FAN program provides for the situation where flows are near normal depth in multiple channels. Program output includes results for this situation in addition to the single channel at critical depth. The results are then applied based on observed field conditions. More

information is provided in *FAN: An Alluvial Fan Flooding Computer Program User's Manual and Program Disk* (FEMA, 1990).

[February 2002]

G.2.3.3 Sheetflow Analysis Method

Assumptions, limitations, and recommended applications for the sheetflow analysis method are as follows:

- Assumptions: broad, unconfined, shallow flooding
- Limitations: not for use in areas of undulating terrain
- Recommended Applications: shallow flooding across uniformly sloping surfaces

Guidance on the analysis and mapping of shallow flooding is provided in Appendix E of these Guidelines. Although Appendix E indicates that Mapping Partners are not to use the procedures in that Appendix for the analysis of alluvial fan flooding, the approach established by this Appendix enables the use of those methods described in Appendix E, except for highly active conical fans that are studied using the FAN program.

[February 2002]

G.2.3.4 Hydraulic Analytical Methods

Assumptions, limitations, and recommended applications for hydraulic analytical methods are as follows:

- Assumptions: stable flow path, uncertainty is to a degree that may be disregarded
- Limitations: not for use with active alluvial fan flooding
- Recommended Applications: entrenched stable channels and channel networks, constructed channels, urbanized areas

For inactive, yet floodprone areas, the Mapping Partner that performs the alluvial fan analysis may use "riverine" hydraulic analytical methods. Where flow paths are stable and flow is reasonably confined, standard hydraulic engineering methods, such as backwater computations, may be used to define the elevation (or depth), velocity, and extent of the 1-percent-annual-chance (100-year) flood. Hydraulic methods may also be used for stable channel networks when applicable. For example, relict alluvial fans or inactive fans with stable channels, as determined by a geomorphic analysis, may be subject to flow splits throughout the distributary system that exists. Hydraulic modeling can generally handle split-flow analyses through stream junctions of this type.

In general, for stable channels on alluvial fans, physically based methods that consider site processes and hydraulics, such as channel geometry, grade and roughness, and channel bank and

bed material are preferred. Where precise computations of water-surface profiles using energy and momentum based methods may not be feasible based on the scope of the study, the use of normal depth calculations for definition of approximate floodplain boundaries for the 1-percent-annual-chance (100-year) flood may be warranted.

Appendix C of these Guidelines provides guidance for hydraulic analytical methods. Several methods applicable to conditions found on alluvial fans are described. These methods include two-dimensional water-surface models, modeling techniques of streams with supercritical flow regimes, and split-flow analysis.

Two-dimensional models may be appropriate for determining flood hazards on an alluvial fan. Different two-dimensional models may be particularly useful in the analysis and modeling of some or all of the following situations: flows that contain a high amount of sediment, unconfined flows, split flows, mud/debris flows, and complex urban flooding. For use in defining flood hazards for the NFIP, all hydraulic models must meet the conditions of Paragraph 65.6 (a) (6) of the NFIP regulations.

One-dimensional sediment transport models or the methods described in Section G.3 are also useful for the analysis of conditions on alluvial fans.

[February 2002]

G.2.3.5 Analysis Using Geomorphic Data, Post-Flood Hazard Verification, and Historical Information

Assumptions, limitations, and recommended applications for alluvial fan flooding analyses performed using geomorphic, post-flood hazard verification, and historical information are as follows:

- Assumptions: relies primarily on qualitative information, post-flood hazard verification, historical data, and interpretive studies
- Limitations: approximate method
- Recommended Applications: alluvial fans with little or no urbanization

The geomorphic approach is for active alluvial fans where deposition, erosion, and unstable flow paths are possible. Traditional engineering methods, as described in Subsection G.2.3.4, generally are inappropriate for areas with these hydraulic characteristics. Probabilistic methods, as described in Subsection G.2.3.2 and contained in the FAN computer program, also contain inherent limiting assumptions that may not adequately represent field conditions and may not be applicable to many active alluvial fans.

In some situations, the Mapping Partner may use the information collected during Stage 2 to delineate an approximate floodplain on an alluvial fan. In situations where geomorphic field investigations, coupled with historical documentation, and documentation of hydrologic and

hydraulic characteristics of flood event(s) (post-flood hazard verification) are available, an approximate flood hazard delineation is possible.

By combining quantitative data on an actual flood event, historical information and photographs of other flood events, time-sequence aerial photography documenting recent activity or inactivity, and field investigation of the morphologic characteristics and relative ages of the fan, an approximate (Zone A) flood hazard delineation may be warranted.

For many alluvial fans, the various flood indicators (Stage 2 information) provide limited or partial information. Because the flood assessment of active alluvial fans is more uncertain than more traditional flood assessment, the Mapping Partner that perform the analysis must document all assumptions and limitations well and consider these assumptions and limitations in the overall evaluation.

[February 2002]

G.2.3.6 Analysis Using Composite Methods

Assumptions, limitations, and recommended applications for alluvial fan flooding analyses performed using composite methods are as follows:

- Assumptions: as identified in the sections referring to the methods being applied
- Limitations: must integrate multiple methods into one result
- Recommended Applications: floodprone areas that contain unique physical features in some locations or have areas varying in levels of erosion and migration activity

Site-specific conditions on alluvial fans may lend themselves to the use of multiple or combined methods previously described for the determination of flood hazards. For example, in areas that contain manmade conveyance channels or deeply entrenched stable channels, the Mapping Partner can combine the results of traditional hydraulic computer programs with methods for analyzing active areas. The Mapping Partner that performs the analysis must coordinate with the FEMA RPO and with FEMA HQ staff during the development of the study plan.

[February 2002]

G.3 Additional Information on Sediment Transport

This section regarding sediment transport is included as supplemental information for the analysis of alluvial fans. Sediment transport analyses are generally required for alluvial fan studies and revisions.

The boundaries of the stream channel are usually soil material with a given resistance to erosion. Bed material can range from large boulders to very fine clay particles. In general terms, sediment can be cohesive, including clay, silt, and mixtures, or noncohesive, including sand, gravel, and larger particles. Transport of noncohesive materials is strongly dependent on particle size. The entire size distribution of the material is needed to ascertain its erodibility. The bond between particles in cohesive soil dictates its resistance to erosion and is far more important than size distribution. However, size becomes important once the material has been eroded and is transported by the flow.

An important sediment transport process is the development of an armor layer in beds containing gravel and cobbles. Water flowing over the mixture of sand and coarser material lifts the smaller grains and leaves an upper layer or armor of large particles. This armor protects the underlying sediment from further erosion and controls the subsequent behavior of sediment transport. A flood event of large magnitude can disturb the protective layer, and the armoring process will start again.

Sediment transport exerts substantial control over morphology and channel geometric configuration. An indicator of this influence is the sediment transport rate, which is the rate at which material moves in the stream as quantified in units of weight per unit time. The transport rate is closely dependent on the water discharge.

Two classification systems are used describe the sediment load in a stream. The first classification system divides the load into ***bed load*** and ***suspended load***. The ***bed load*** is that portion of the sediment that moves along the bottom by sliding, rolling, or saltation. The ***suspended load*** is comprised of all of the material carried in suspension.

The second classification system divides the sediment load into ***wash load*** and ***bed-material load***. The ***wash load*** is comprised of very fine materials, clay and silt, rarely found in the bed. The wash load does not depend on the carrying capacity of the stream but on the amount supplied by the watershed. The ***bed-material load*** is comprised of all of the material found in the bed. Some of it will move very close to the bottom, but some may be found in suspension.

Quantification of sediment transport is fraught with uncertainty because of the complexity of the phenomenon and its inherent spatial and temporal variability. Existing mathematical representations have relied heavily on experimental results. The available sediment transport formulas have been grouped according to the approach used to derive them. Three major approaches have been used: shear stress, power, and parametric. Formulas also can be grouped according to the component of the total load they attempt to quantify: bed load, suspended load, or bed-material load. Table G-2 summarizes some of the more commonly used formulas; however, it is not intended to be a complete listing.

Despite the intense efforts expended in the development of these formulas, evaluation against field data indicates that they commonly overpredict or underpredict sediment loads by orders of magnitude of actual measured sediment transport rates. This discrepancy is likely a result of imperfect knowledge of the physics of sediment transport and also of the extensive variability and heterogeneity in hydrologic and geologic factors.

For these reasons, no one formula is better than the others. Mapping Partners must select a sediment transport formula based on how well the conditions of the problem at hand match the assumptions underlying the formula. If possible, Mapping Partners should verify the applicability of the formula with site-specific field data.

Table G-2. Sediment Transport Formulas and Classifications

		Sediment Transport Formula										
Criteria	**Grouping**	**DuBoys (1879)**	**Shields (1936)**	**Einstein Bed Load(1950)**	**Einstein Suspended Load (1950)**	**Meyer-Peter-Muller (1948)**	**Einstein-Brown (1950)**	**Parker *et al.* (1982)**	**Engelund-Hansen (1967)**	**Ackers-White (1973)**	**Yang (1972)**	**Colby (1964)**
Approach	Shear Stress	X	X	X		X	X	X				
	Power								X	X	X	
	Parametric											X
Load Component	Bed Load	X	X	X		X	X	X				
	Suspended Load				X							
	Bed-Material Load								X	X	X	X

[February 2002]

G.4 References

Chang, H. H., *Fluvial Processes in River Engineering,* New York: John Wiley & Sons, 1988.

Dawdy, D.R., "Flood Frequency Estimates on Alluvial Fans," *Journal of the Hydraulics Division, ASCE, Proceedings*, Vol. 105, No. HYII, pp. 1407-1413, November 1979.

Federal Emergency Management Agency, *FAN: An Alluvial Fan Flooding Computer Program User's Manual and Program Disk*, September 1990.

Gomez, B., and M. Church, "An assessment of bed load sediment transport formulae for gravel bed rivers," *Water Resources Research*, Vol. 25, No. 6, p. 1161-1186, 1989.

National Research Council, *Alluvial Fan Flooding*, National Academy Press, Washington, D.C., 1996.

Simons, Li & Associates, Inc., *Design Manual for Engineering Analysis of Fluvial Systems*, prepared for Arizona Department of Water Resources, Tucson, Arizona, 1985.

U.S. Department of the Army, Corps of Engineers, *Guidelines for Risk and Uncertainty Analysis in Water Resources Planning,* Report 92-R-1, Fort Belvoir, Virginia, 1992.

Yang, C. T., and S. Wan, "Comparison of selected bed-material formulas," *ASCE Journal of Hydraulic Engineering*, Vol. 117, p. 973-989, 1991.

[February 2002]

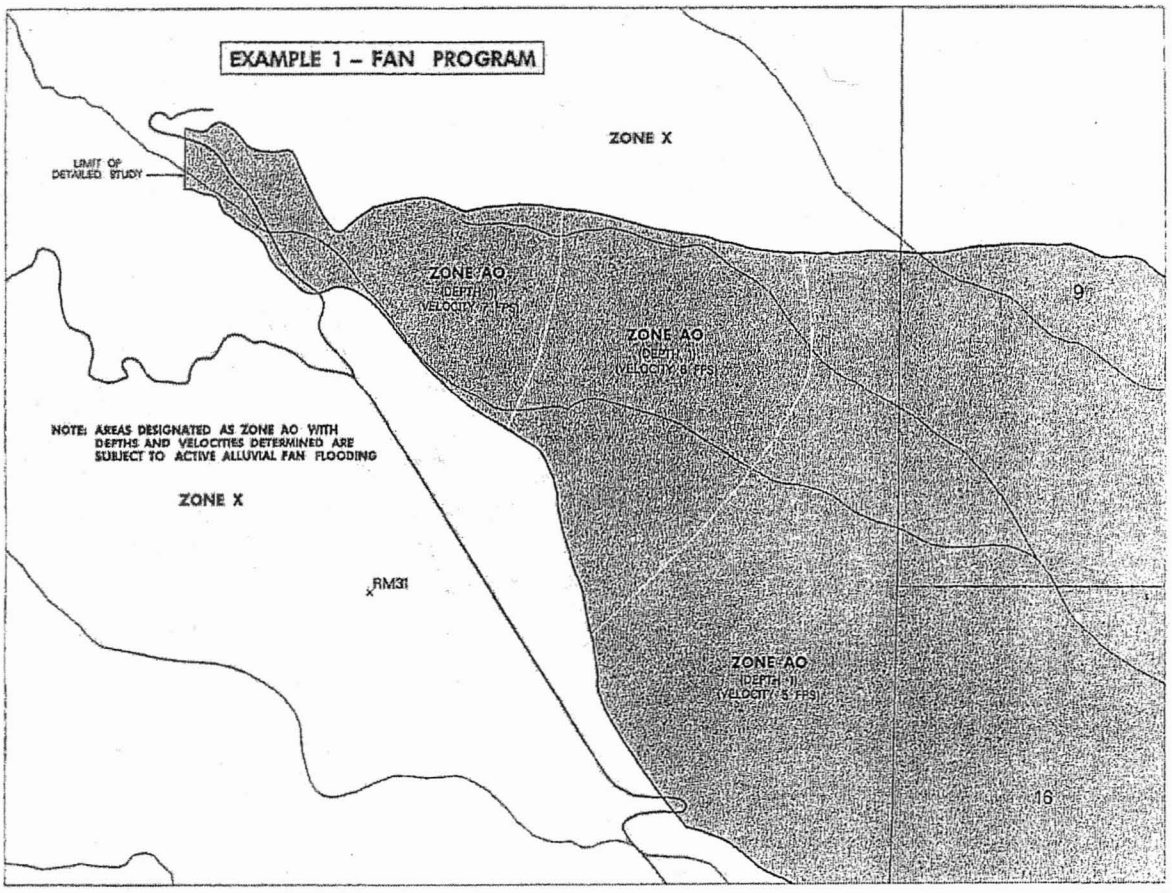

Figure G-5. Sample Map Generated From Alluvial Fan Analysis Using FAN Computer Program.

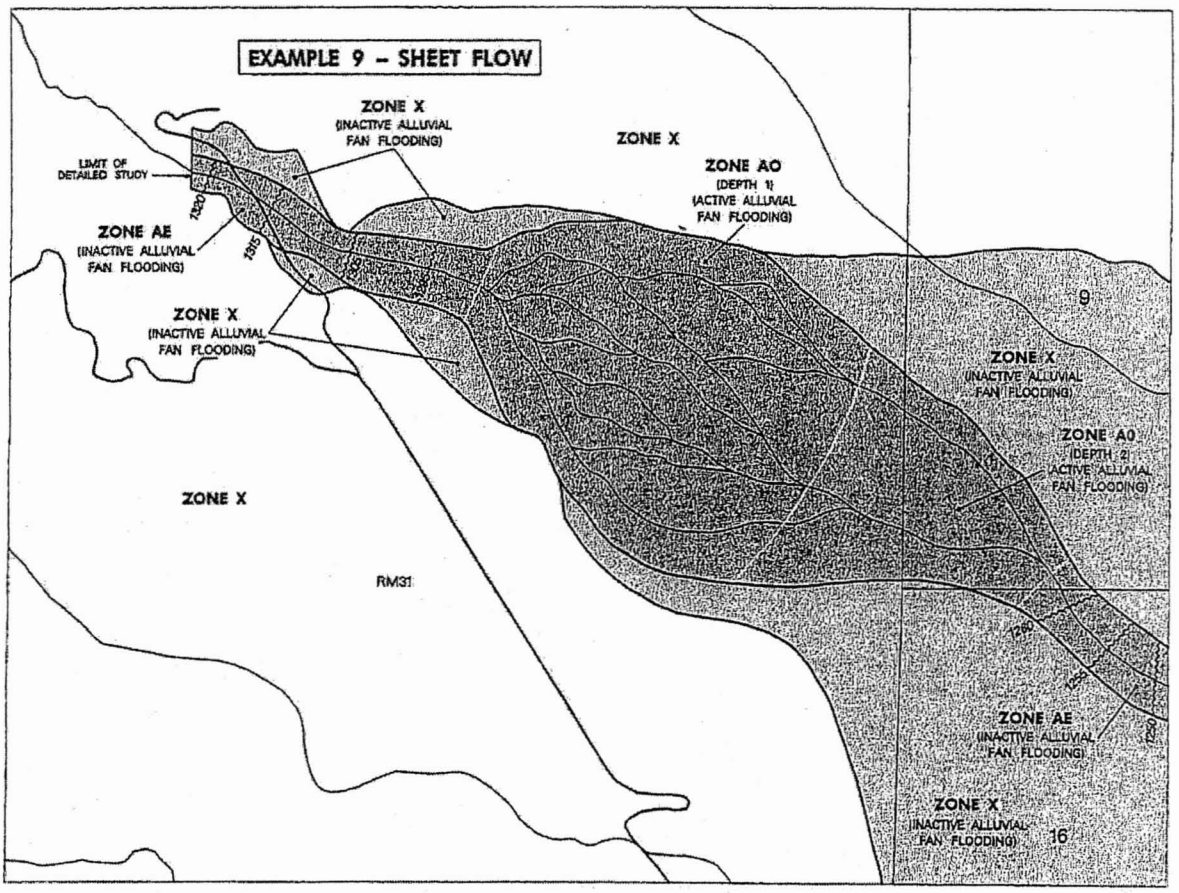

Figure G-6. Sample Map Generated From Alluvial Fan Analysis Using Sheetflow Analysis Methods.

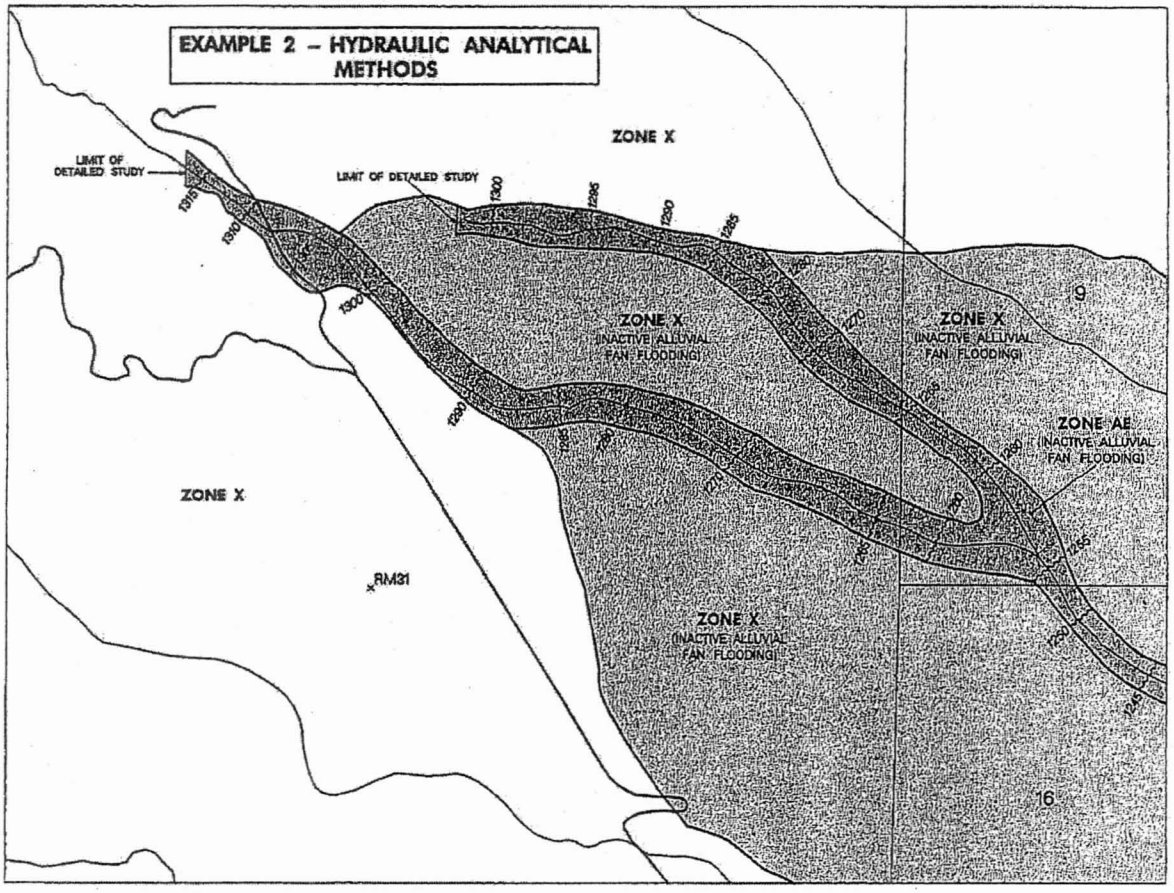

Figure G-7. Sample Map Generated From Alluvial Fan Analysis Using Hydraulic Analytical Methods.

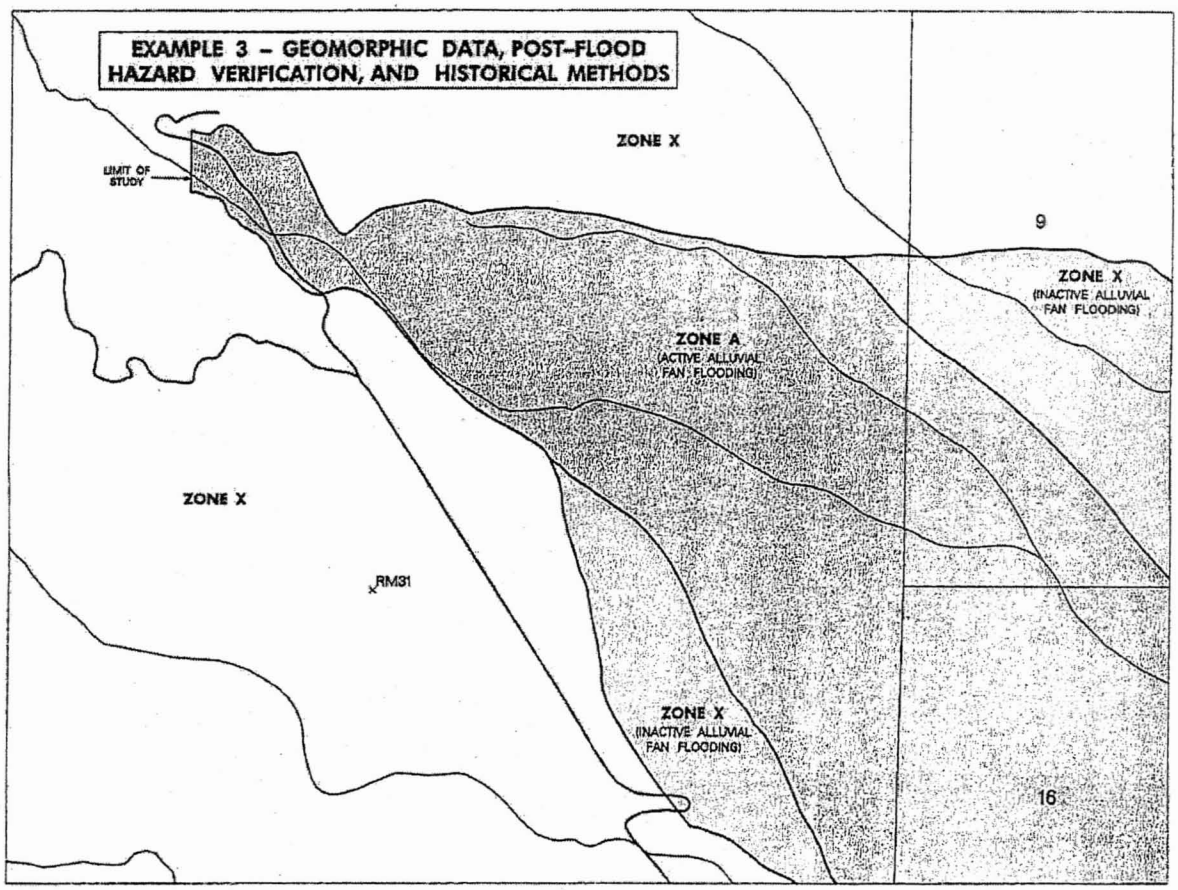

Figure G-8. Sample Map Generated From Alluvial Fan Analysis Using Geomorphic Data, Post-Flood Hazard Verification Data, and Historic Information.

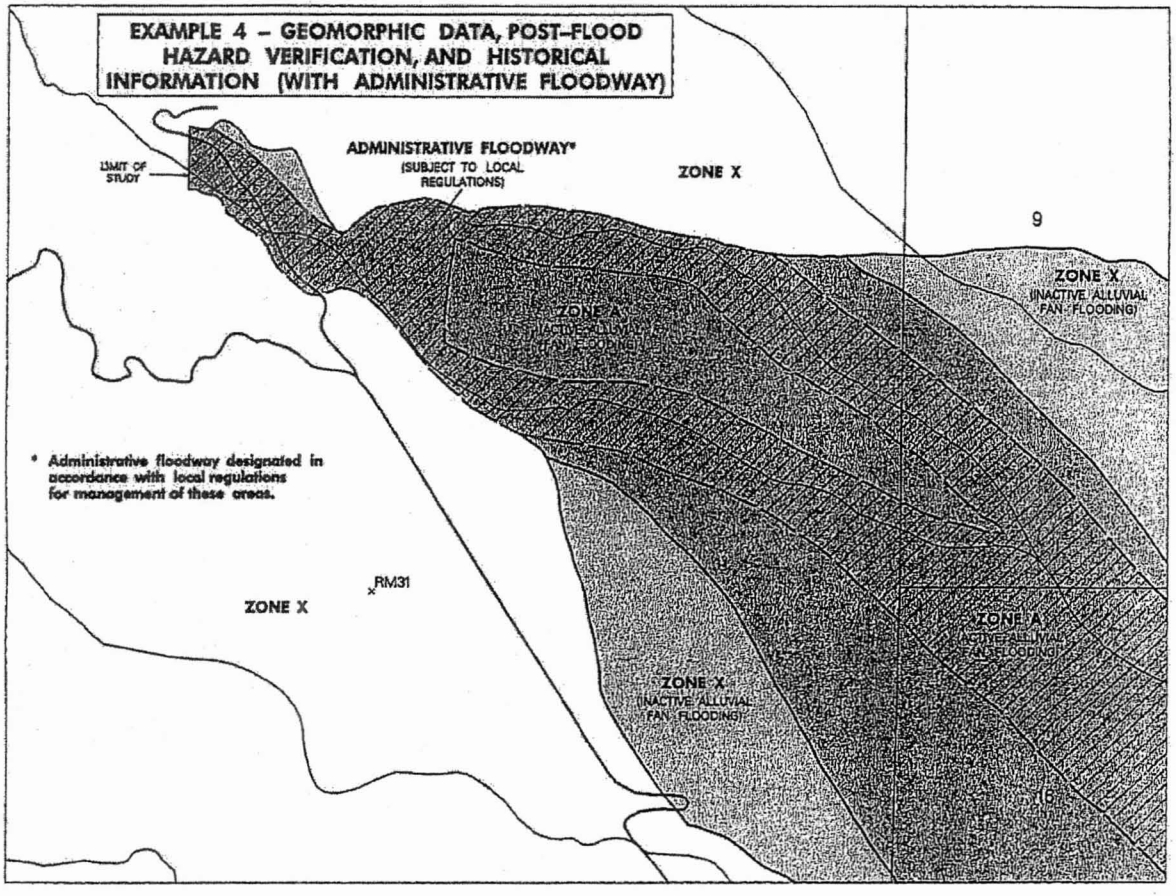

Figure G-9. Sample Map Generated From Alluvial Fan Analysis Using Geomorphic Data, Post-Flood Hazard Verification, and Historic Information (Administrative Floodway Shown).

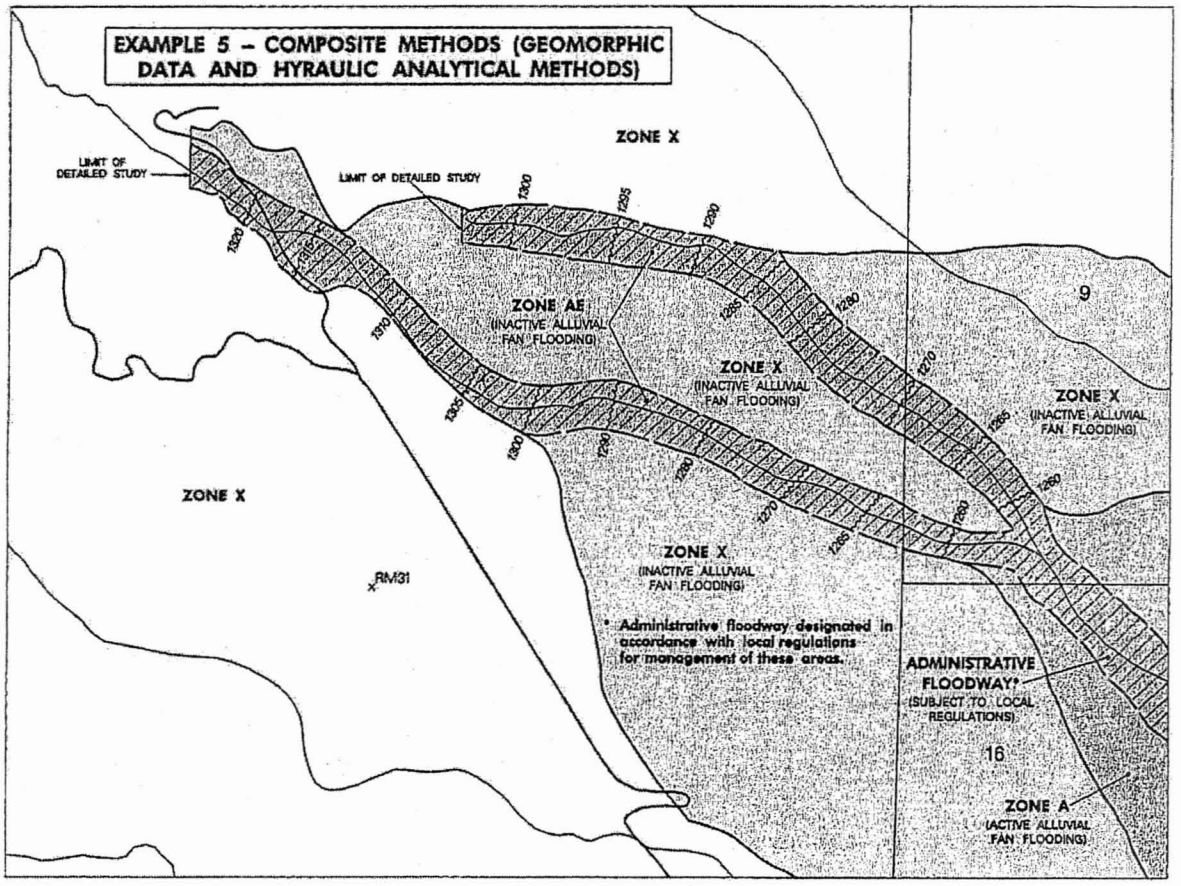

Figure G-10. Sample Map Generated From Alluvial Fan Analysis Using Composite Methods (Geomorphic Data and Hydraulic Analytical Methods).

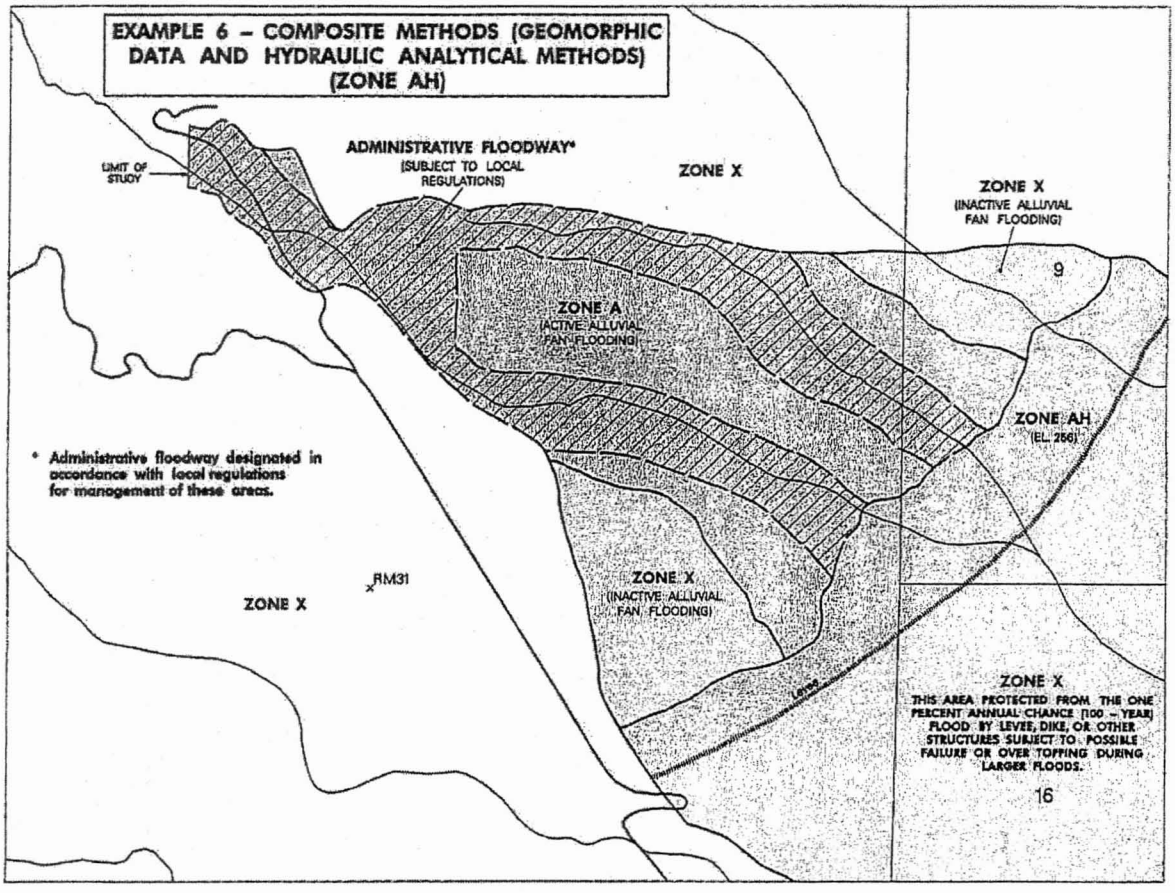

Figure G-11. Sample Map Generated From Alluvial Fan Analysis Using Composite Methods (Geomorphic Data and Hydraulic Analytical Methods); Zone AH Shown.

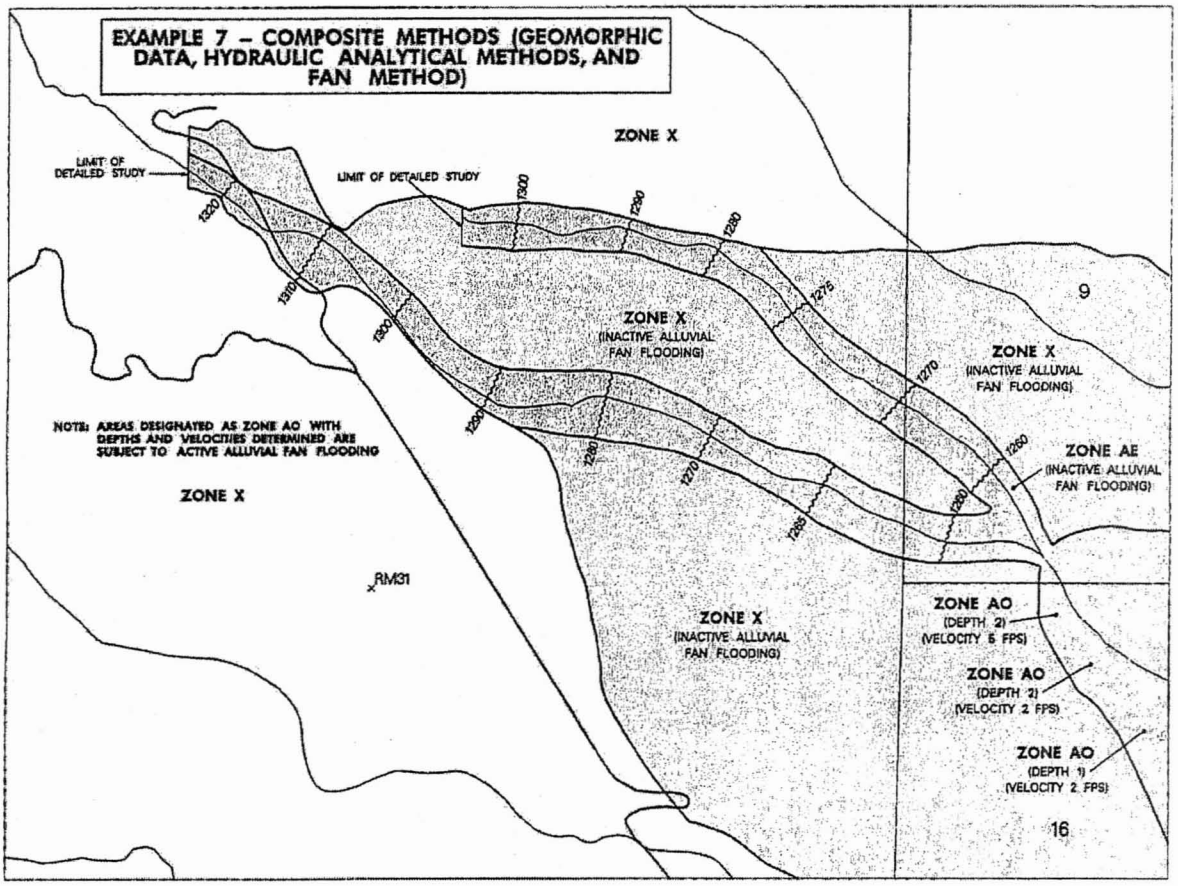

Figure G-12. Sample Map Generated From Analysis Using Composite Methods (Geomorphic Data, Hydraulic Analytical Methods, and FAN Computer Program).

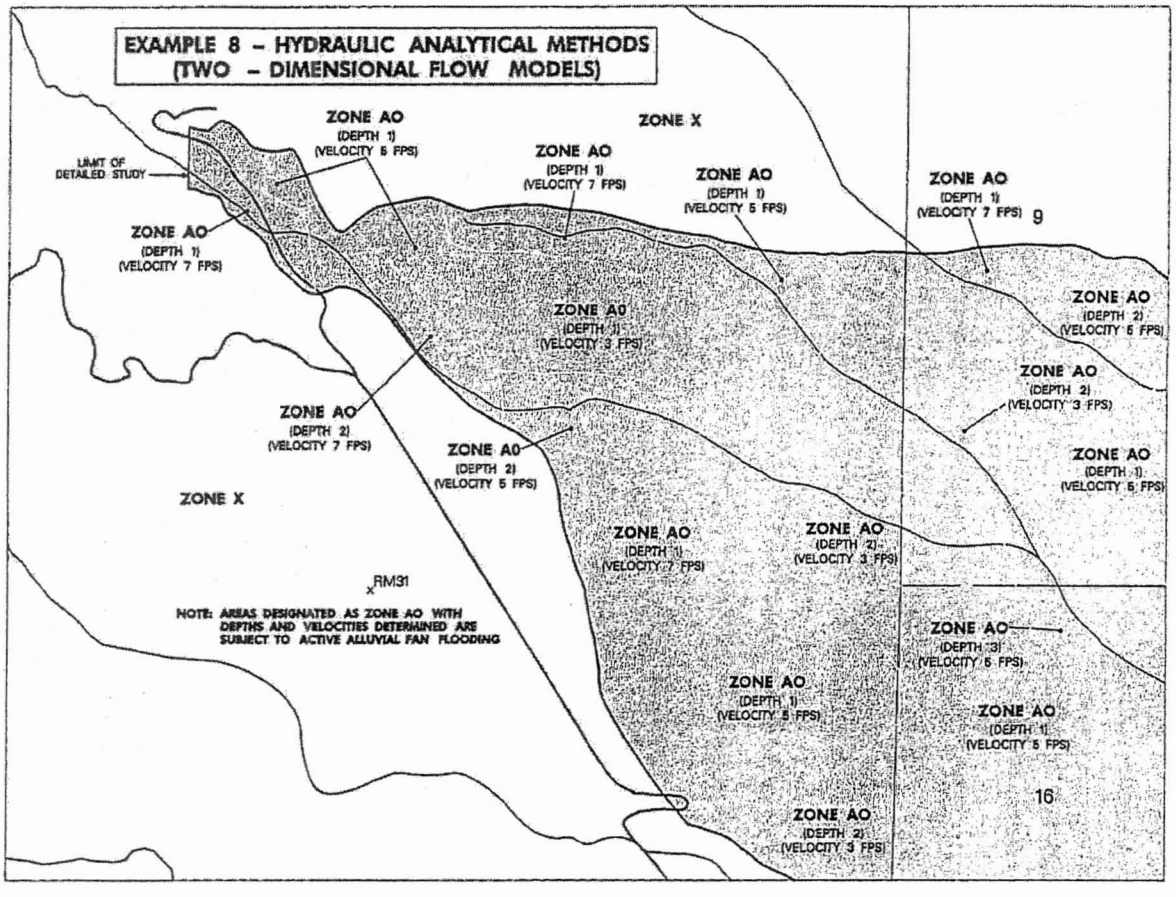

Figure G-13. Sample Map Generated From Alluvial Fan Analysis Using Hydraulic Analytical Methods (Two-Dimensional Flow Model).

[February 2002]

Map MODERNIZATION

Federal Emergency Management Agency

FEMA's Flood Hazard Mapping Program

Guidelines and Specifications *for* Flood Hazard Mapping Partners

Appendix H: Guidance for Evaluating Flood Protection Systems

FEDERAL EMERGENCY MANAGEMENT AGENCY

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February 2002

Appendix H

Guidance for Mapping of Areas Protected by Levee Systems

H.1 Introduction

This Appendix describes the Federal Emergency Management Agency (FEMA) requirements and procedures for evaluating earthen levee systems and mapping the areas affected by those systems. Procedures for evaluating concrete dikes, floodwalls, seawalls, and other structures are not covered herein and shall be coordinated with and approved by the FEMA Regional Project Officer (RPO) or the Project Officer (PO) at FEMA Headquarters (HQ). Mapping Partners also must contact the RPO or PO to obtain the appropriate criteria for analyzing agricultural levees.

Specific guidance for the evaluation of coastal structures and the mapping of areas affected by these structures is contained in Appendix D of these Guidelines.

[February 2002]

H.2 Levee System Components and Terminology

A levee system usually consists of a main levee, tie back levees, a gravity outlet, and pumps. Some levee systems may also include pressure conduits, closure structures, ring levees, setback levees, sublevees, and spur levees. The most common components are defined below.

- *Levees*: Manmade structure, usually earthen embankments, designed and constructed in accordance with sound engineering practices to contain, control, or divert the flow of water so as to provide protection from temporary flooding.

- *Levee system*: A flood protection system which consists of a levee, or levees, and associated structures, such as closure and drainage devices, which are constructed and operated in accordance with sound engineering practices.

- *Main and tributary levees*: Levees that lie along a main stream and its tributaries, respectively.

- *Tie back levees*: Levees that extend from the main levee along a river, lake, or coast to a bluff line (high ground) and are part of the line-of-protection.

- *Ring levees*: Levees that completely encircle or "ring" an area subject to inundation from all directions.

- *Setback levees*: Levees that are built landward of existing levees, usually because the existing levees have suffered distress or are in some way being endangered, as by river migration.

- *Sublevees*: Levees built for the purpose of under-seepage control. Sublevees encircle areas behind the main levee which are subject, during high-water stages, to high uplift pressures and possibly the development of sand boils. They normally tie into the main levee, thus providing a basin that can be flooded during high-water stages, thereby counterbalancing excess head beneath the top stratum within the basin. Sublevees are rarely employed as the use of relief wells or seepage berms make them unnecessary except in emergencies.

- *Berms*: Horizontal strips or shelves of material built contiguous to the base of either side of levee embankments for the purpose of providing protection from underseepage and erosion, therefore increasing stability of the embankment, or reducing seepage. Berms can be located on either side of levees, depending upon the berms' purpose.

- *Spur levees*: Levees that project from the main levee and serve to protect the main levee from the erosive action of stream currents. Spur levees are not true levees but training dikes.

- *Dikes*. Embankments constructed of earth or other suitable materials to protect land from overflows or to regulate water.

- *Floodwalls*: Cconcrete walls constructed adjacent to streams for the purpose of preventing flooding of property on the landside of the wall; normally constructed in lieu of or to supplement levees where the land required for levee construction is more expensive or not available.

- *Lines-of-protection*: Locations of levees or walls that prevent floodwaters from entering an area.

- *Pressure conduits*: Closed conduits designed to convey interior flows through the line-of–protection under internal pressure. The inlet to a pressure conduit that discharges interior flows by force of gravity must be at a higher elevation than the river stage against which it functions. Some pressure conduits may serve as discharge conduits from pumping stations.

- *Pumping stations*: Pumps located at or near the line-of-protection to discharge interior flows over or through the levees or floodwalls (or through pressure lines) when free outflow through gravity outlets is prevented by high exterior stages.

- *Gravity outlets*: Culverts, conduits, or other similar conveyance openings through the line-of-protection that permit discharge of interior floodwaters through the line-of-protection by gravity when the exterior stages are relatively low. Gravity outlets are equipped with gates to prevent river flows from entering the protected area during time of high exterior stages.

- *Closure devices*: Any movable and essentially watertight barriers, used in flood periods to close an opening in a levee, securing but not increasing the levees' design level of protection.

- *Stop logs*: Logs, planks, cut timber, steel, or concrete beams fitting into end guides between walls or piers to close openings in levees, floodwalls, dams, or other hydraulic structures; the logs usually being handled or placed one at a time.

- *Street gates*: Closure gates used during flood periods to close roadway openings through levees or floodwalls.

The diagrams in Figure H-1 provide plan view and sectional view schematics of a standard levee system.

[February 2002]

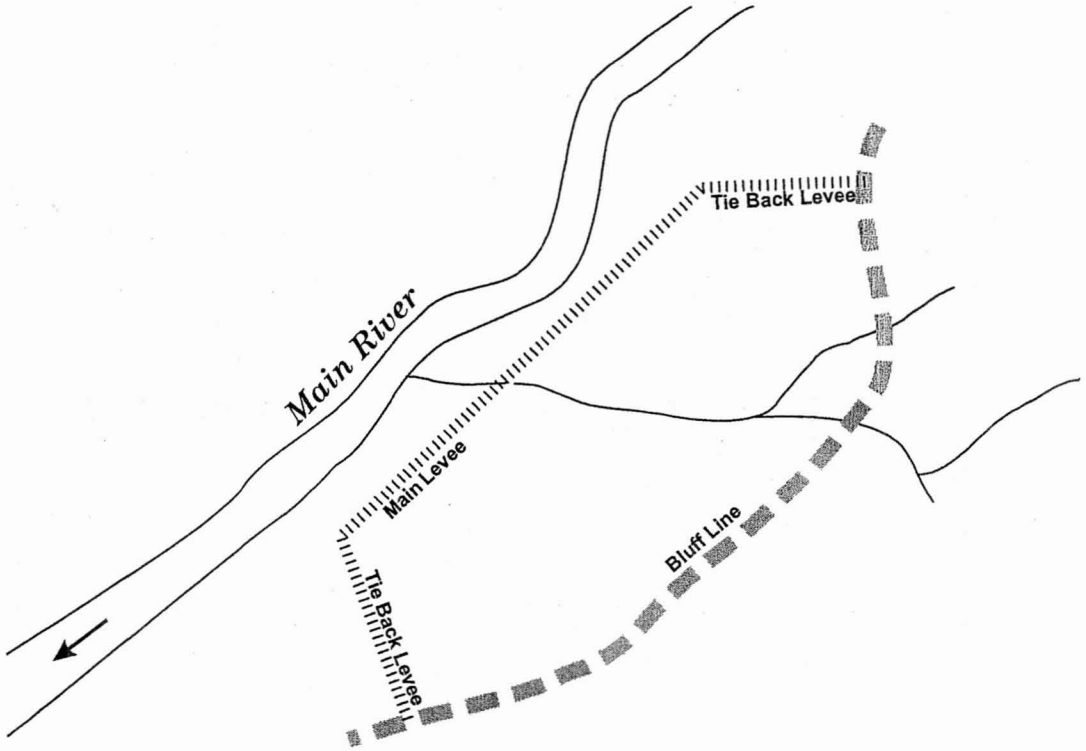
H.3 Levee System Evaluation Criteria

In evaluating the ability of levee systems to provide protection from the 1-percent-annual-chance flood, the criteria outlined in Section 65.10 of the NFIP regulations and the step-by-step procedures as summarized on the following pages should be used. The Mapping Partner should always initiate analyses by evaluating the levee's freeboard and maintenance plan and should only proceed with further analyses if these requirements are met.

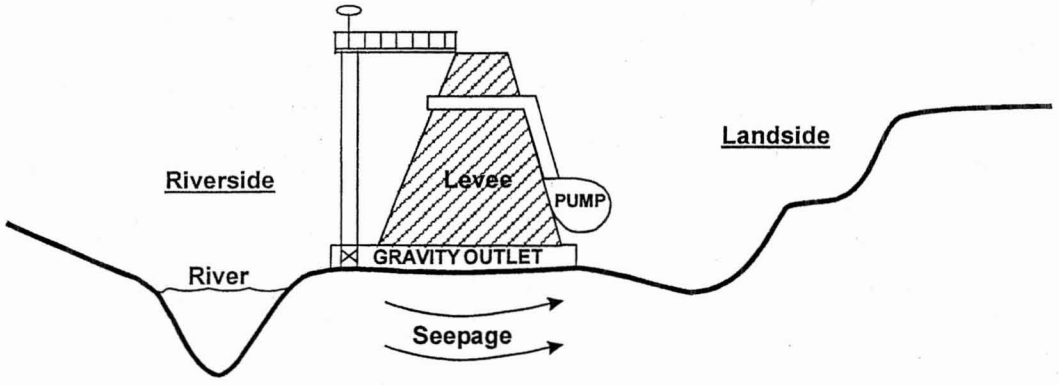
1. Freeboard. A minimum levee freeboard of 3 feet shall be necessary, with an additional 1 foot of freeboard within 100 feet of either side of structures within the levee or wherever the flow is constricted, such as at bridges. An additional 0.5 foot above this minimum is also required at the upstream end, tapering to the minimum at the downstream end of the levee. The criteria concerning freeboard are detailed in Paragraph 65.10(b)(1) of the NFIP regulations.

2. Structural Design Analyses. The Mapping Partner shall review the structural analyses which address closures, embankment protection, embankment and foundation stability, and settlement. The structural analyses must meet the criteria detailed in Paragraphs 65.10(b)(2),(3),(4) and (5) of the NFIP regulations.

3. Interior Drainage. Where credit will be given to levees providing protection from the 1-percent-annual-chance flood, the adequacy of interior drainage systems shall be evaluated. Interior drainage systems associated with levee systems usually include storage areas, gravity outlets, pumping stations, or a combination thereof. These drainage systems will be recognized by FEMA as providing flood protection only if the criteria outlined in Paragraphs 65.10 (b)(6) and (c)(2) of the NFIP regulations are met.



PLAN VIEW SCHEMATIC



SECTIONAL VIEW SCHEMATIC

Figure H-1. Plan View and Sectional View Schematics of Standard Levee System

4. Operations. In general, levee evaluation shall not consider human intervention (e.g., capping of levees by sandbagging, earthfill, or flashboards) for the purpose of increasing a levee's design level of protection during an imminent flood. Only in exceptional cases where no practicable alternative exists and technical justification is provided will FEMA permit sandbagging to satisfy freeboard requirements. The Mapping Partner shall coordinate all such cases with FEMA RPO. Human intervention will normally only be accepted for the operation of closure structures (e.g., gates or stoplogs) and manual back-up for pumping stations in a levee system designed to provide at least 1-percent-annual-chance flood protection, including adequate freeboard as described earlier. Where levee closures and/or pumping stations are involved, an officially adopted operations plan must be submitted that meets all the criteria set forth in Paragraphs 65.10(c)(1) and (2) of the NFIP regulations.

5. Maintenance. For a levee system to be recognized as providing protection from the 1-percent-annual-chance flood, the system must be maintained in accordance with an officially adopted maintenance plan, and a copy of this plan must be provided to FEMA by the owner of the levee system. The specific requirements of the maintenance plan are detailed in Paragraph 65.10(d) of the NFIP regulations. Note that a governmental agency must assume ultimate responsibility for maintenance plans.

6. Certification Requirements. All levee systems must be certified in accordance with Paragraph 65.10(e) of the NFIP regulations.

7. Exception Procedures. FEMA will accept certification from another Federal agency that an existing levee system is designed and constructed to provide protection against the 1-percent-annual-chance flood in lieu of the requirements outlined in Paragraphs 65.10(b)(1) through (7) of the NFIP regulations. Under certain circumstances, FEMA may also grant exceptions to the above requirements or approve alternate analysis techniques.

[February 2002]

H.4 Criteria for Crediting Levee Systems on FIRMs

The Mapping Partner responsible for performing the hydrologic and hydraulic analyses shall follow the steps listed below in determining a levee system's ability to provide protection from the 1-percent-annual-chance flood. The final decision concerning the creditability of the levee system must be made by the RPO before the Mapping Partner proceeds with further hydraulic analyses.

1. The Mapping Partner shall identify the levee system to be studied, including all "levee elements" (e.g., main levee, tieback levee, railroad or highway embankment), interior drainage elements and any other elements required to form a stand-alone flood-control structure.

2. The Mapping Partner shall determine the ownership of each system element via telephone contact with community officials and/or appropriate State and Federal agencies.

3. The Mapping Partner shall determine the status of all system elements, as presently reflected on the effective FIRM (i.e., credited or uncredited, detailed or approximate study).

4. The Mapping Partner shall obtain from the system element owner, operator (i.e., local, State, or Federal agency; or private individual or corporation), and/or the appropriate FEMA data repository, all available supporting documentation, including but not limited to "as-built" plans; survey data; geotechnical reports; structural analyses; interior drainage analyses; inspection reports; and operation and maintenance plans.

5. The Mapping Partner shall obtain written confirmation of any previous certification by the agency responsible for design and construction that the levee system or elements thereof are Federal projects that provide protection from the 1-percent-annual-chance flood, when appropriate.

6. The Mapping Partner shall make an individual inventory of data received for the levee system.

7. The Mapping Partner shall perform hydraulic analyses of the 10-, 2-, 1- and 0.2-percent-annual-chance floods, assuming the levee system to be in place if these water-surface profiles are not available. Otherwise, assess the available computations for present-day application and modify, if necessary.

8. The Mapping Partner shall use available "as-built" levee profiles or topographic data and the 1-percent-annual-chance water-surface profile obtained from the hydraulic analysis conducted with the levee in place to make a determination of the available freeboard of each system element.

9. The Mapping Partner shall contact the RPO immediately if any element of a levee system is found to provide less than the required freeboard and notify him or her of the level of freeboard deficiency identified. Based on this discussion and the availability of other design data, the RPO may request more detailed surveys of the levee profile or that a risk analysis be performed on uncertainties related to elements of levee design.

10. The Mapping Partner shall review the available operation and maintenance plans to determine whether the plans conform with the requirements of Section 65.10 (c) and (d) and document in writing to the RPO any noted deficiencies. The RPO will provide guidance on any supplemental investigations necessary to ascertain the adequacy of operation and maintenance plans.

11. The Mapping Partner shall summarize the results and conclusions of the above-mentioned levee investigation in a final letter report to the RPO and include as attachments and/or references all correspondence and reports of telephone conversations among the Mapping Partner, the RPO, local, State, and Federal entities, and levee owners; inventories of available data; and field inspection reports and photographs.

12. The Mapping Partner shall summarize the actions taken in the investigation, the ownership of each system element, and the outcome of the investigation in the draft of the FIS Report, under the section headed "Local Flood Protection Measures."

[February 2002]

H.5 Review Responsibilities

This section addresses the independent review responsibilities of the Mapping Partner responsible for preparing the Preliminary FIS report and FIRM (hereinafter referred to as reviewing Mapping Partner).

The reviewing Mapping Partner shall verify that all levees and structures intended to serve as levees for their effect on the 1-percent-annual-chance flood have been properly analyzed. The Mapping Partner shall conduct this review to ensure that all minimum design criteria requirements have been met before any levee system receives recognition on the NFIP map as providing protection from the 1-percent-annual-chance flood. . The Mapping Partner shall document any deviations or exceptions fully and ensure a technical basis for exceptions is provided. This independent review shall assess the conclusions reached by the Mapping Partner performing the hydrologic and hydraulic review and shall facilitate establishing appropriate flood risk zone determinations for the FIRM, and does not constitute a determination as to how a structure or system will perform during a flood event.

[February 2002]

H.5.1 Review Criteria

The reviewing Mapping Partner shall conduct this review to ensure that the analysis was performed in accordance with the requirements detailed in Sections H.3 and H.4 of these Guidelines and in conformance with Section 65.10 of the NFIP regulations.

FEMA will not consider privately owned, operated, or maintained levee systems as providing protection from the 1-percent-annual-chance flood unless local ordinances or State statutes mandate operation and maintenance. Levee systems for which a community, State, or Federal agency has responsibility for operation and maintenance will be considered by FEMA if they meet, and continue to meet, minimum design, operation, and maintenance standards. These standards must be consistent with the level of protection sought through the comprehensive floodplain management criteria established in Section 60.3 of the NFIP regulations.

The minimum design requirements for both riverine and coastal levees that must be met, and therefore must be reviewed by the reviewing Mapping Partner, fall into the following categories: freeboard, closures, embankment protection, embankment and foundation stability, settlement, interior drainage, and other design criteria (as required by FEMA). The reviewing Mapping Partner shall review the detailed engineering analyses to be performed under each category to ensure that they comply with Paragraph 65.10(b) of the NFIP regulations. The level of effort to be expended by the reviewing Mapping Partner in reviewing levee structural design criteria shall be decided by the PO at FEMA HQ or his/her designee on a community-by-community basis.

For a levee to be recognized on the FIRM as providing protection from the 1-percent-annual-chance flood, the operation plans must comply with FEMA regulations as outlined in Paragraph

65.10(c) of the NFIP regulations. When required, the reviewing Mapping Partner shall review the plans to ensure compliance with FEMA regulations, particularly in the areas of closures and interior drainage systems.

The final criterion for levee certification is a functional maintenance plan that complies with Paragraph 65.10(d) of the NFIP regulations. The reviewing Mapping Partner shall review the plans to ensure that, at a minimum, they specify the maintenance activities to be performed, the frequency of performance, and the person(s) by name or title responsible for the performance.

It should be noted, however, that FEMA will accept certification from another Federal agency that an existing levee system is designed and constructed to provide base flood protection in lieu of the requirements outlined in Paragraphs 65.10(b)(1) through (b)(7) of the NFIP regulations. In addition, under certain circumstances, FEMA may also grant exceptions to the above requirements or approve alternative analysis techniques on a case-by-case basis.

[February 2002]

H.5.2 Levee Inventory

In addition, to the review responsibilities detailed above, the reviewing Mapping Partner shall ensure that all levees that have been identified and evaluated are documented and inventoried in accordance with the guidance provided in Volume 3, Subsection 3.2.7.3, of these Guidelines, which includes the requirements to prepare a Levee Inventory Data Entry Form to support the Credited Structures Inventory System.

[February 2002]

H.6 Floodplain Mapping and Flood Profiles

If the levee satisfies the appropriate aforementioned requirements, as verified by the RPO, the protected area (landward side of the levee) will be designated as Zone X or the appropriate zone determined by the interior drainage analysis such as Zone AH. If an interior drainage analysis does not exist or has been determined to be insufficient in the levee investigation, the Mapping Partner shall coordinate internal zone designations with the RPO.

If the subject levee does not meet the requirements stated in Section 65.10 of the NFIP regulations, as verified by the RPO, the 1-percent-annual-chance flood elevations will be recomputed as if the levee did not exist. None of the subject levee will be recognized as providing 1-percent-annual-chance flood protection unless there are portions of the levee system that can meet requirements of Section 65.10 of the NFIP regulations independent of the remaining levee system. The 1-percent-annual-chance flood levels on the unprotected side of the levee will be equal to the 1-percent-annual-chance water-surface elevations computed with the levees in place.

If the 1-percent-annual-chance flood level, with the levee in place, is higher than the top of the levee, the computed 1-percent-annual-chance flood levels shall be used on the river side of the levee. The 1-percent-annual-chance flood levels shall then be recomputed for the landward side of the unrecognized levee as if the levee did not exist.

If water-surface elevations of the 10-, 2-, and 0.2-percent-annual-chance floods are higher than the top-of-levee elevations, those elevations shall also be considered equal to the top-of-levee elevations on the unprotected side. If those elevations are lower than the top-of-levee elevations, they will be shown as computed on the Flood Profile. Further analyses for the conditions without the levees shall not be made for frequency floods less than the 1-percent-annual-chance flood.

For the levees that do not satisfy the minimum requirements, a maximum of five Flood Profiles might be drawn on the profile sheet representing the 10-, 2-, and 1-percent-annual-chance floods with levee elevations, and the 1- and 0.2-percent-annual-chance floods without levee elevations.

If the "with levee" base (1-percent-annual-chance) flood elevations (BFEs) are higher than the "without levee" BFEs, the FIRM should show a line running along the levee centerline, separating the areas of different BFEs. Otherwise, only "without levee" BFEs will be shown.

The regulatory floodway widths shall be computed for the "without levee" condition if the levees do not meet the requirements of Section 65.10 of the NFIP regulations. The equal conveyance reduction method is to be used. The "Regulatory" column in the Floodway Data Table will include two BFEs, representing "river side" and "land side" conditions, if the former elevation is higher than the latter elevation. Otherwise, "without levee" BFEs are to be shown. At a tributary's confluence with the main stream, BFEs from the main stream are to be shown as the

regulatory elevations if they are higher than the "river side" or "land side" BFEs of the tributary.

The above procedures for the determination of elevations and regulatory floodways also shall be applied to the conditions where levees exist on both sides of the stream. If levees exist on both sides of a stream, the evaluation of levee systems shall consider the possibility of simultaneous levee failure, failure of only the left side, and failure of only the right side. Simultaneous levee failure shall be considered for both elevation and regulatory floodway computations.

Regulatory floodway boundaries are to be delineated at the landside toe of mainline and tributary levees that are recognized as providing 1-percent-annual-chance flood protection on a FIRM. Thus, the community's floodplain management ordinance must prohibit encroachment on the levee, which could jeopardize the levee's integrity or effectiveness. It may also be appropriate to place regulatory floodways at levees providing a lower level of protection if encroachment on the river side of the levee is of concern to the community. The Mapping Partner that is performing the analysis shall consult with community officials and the RPO to resolve this situation.

For levee systems where an area of land may be totally or partially surrounded by levees or where two or more flooding sources join that have levees on both sides of the stream, the Mapping Partner that is performing the analysis shall contact the RPO before proceeding with any analyses for levee failures. For these complex situations, the flood hazard in the area that would have been protected by the non-failed levee(s) should be based on selection of failure scenarios that yield the highest BFE or flood hazard.

[February 2002]

H.7 Flood Control Restoration Zones

When the Mapping Partner evaluating a flood protection system determines that a community is in the process of restoring the flood protection system to provide protection from the 1-percent-annual-chance (100-year) flood, that Mapping Partner shall follow the procedures outlined in Section 65.14 of the NFIP regulations and obtain the information required by FEMA. If the criteria of Section 65.14 are met, the Mapping Partner shall coordinate with the RPO or the PO at FEMA HQ to determine whether the FIRM should designate the temporary flood hazard areas as a flood control restoration zone (Zone AR). The Mapping Partner also shall coordinate with the RPO or the PO at FEMA HQ to determine whether SFHAs shown on the effective FIRM shall be designated as "dual" flood insurance rate zones (i.e., Zone AR/AE, Zone AR/AH, Zone AR/AO, Zone AR/A).

When the Mapping Partner evaluating a flood protection system determines that a restoration project has been completed and all required certifications and evidence have been submitted, that Mapping Partner shall coordinate with the RPO or the PO at FEMA HQ to determine whether the flood control restoration zone designation should be revised to Zone A99. The criteria outlined in Paragraph 65.14(h) of the NFIP regulations shall be the basis for this determination.

[February 2002]

Map MODERNIZATION

Federal Emergency Management Agency

FEMA's Flood Hazard Mapping Program

Guidelines and Specifications *for* Flood Hazard Mapping Partners

Appendix I: Scoping Guidance and Tools

FEDERAL EMERGENCY MANAGEMENT AGENCY

www.fema.gov/mit/tsd/dl_cgs.htm

FINAL

February 2002

Appendix I

Project Scoping Toolbox

This Appendix provides a variety of tools to assist the Federal Emergency Management Agency (FEMA) Lead and other Project Team members during the Project Scoping phase of a Flood Map Project. Project Team members shall use the "toolbox" of templates, checklists, and forms presented in this Appendix to record activities throughout the Project Scoping phase.

Detailed information on the Project Scoping phase is provided in Volume 1, Section 1.3 of these Guidelines. As discussed in Volume 1, Section 1.3 of these Guidelines, the activities completed during the Project Scoping phase are grouped into those that take place before, during, and after a Scoping Meeting, as follows:

- Pre-Scoping Meeting activities;
- Scoping Meeting activities; and
- Post-Scoping Meeting activities.

[February 2002]

I.1 Pre-Scoping Meeting Activities

The templates, checklists, and forms that the FEMA Lead and other Project Team members shall use to record activities before the Project Scoping Meeting are summarized in Subsections I.1.1 through I.1.8.

[February 2002]

I.1.1 Initial Community Contact – Record of Communication Template

FEMA designed the Initial Community Contact—Record of Communication Template, shown on page I-2, to record the activities involved with planning the initial community contact and recording the topics covered during telephone call(s) with the community. If more than one community is contacted, the FEMA Lead or other assigned FEMA staff shall prepare a separate form for each community.

Community/Mapping Project:	
Date:	**Case No.:**
Recorder:	
Name of Community Contact:	
Agency/Organization	
Telephone Number:	
E-Mail Address:	
Facsimile Number:	
Topics To Cover:	
• Purpose of the Mapping Project {Insert notes.}	
• Community's Perception of Mapping Needs {Insert notes.}	
• Target Schedule for Completing the Project {Insert notes.}	
• Possibility of Community Contributing as a Cooperative Technical Partner {Insert notes.}	
• Other Discussion Topics {Insert notes.}	
• Community's Engineering, Planning, and GIS Capabilities - How advanced are they? - Where do they reside in the community's organization? {Insert notes.}	

[February 2002]

I.1.2 Project Management Plan Template

FEMA designed the Project Management Plan Template, shown on pages I-4 to I-10, to record activities associated with the preliminary Project Management Plan, such as establishing specific project protocols and management objectives for the entire Project. After the Project Management Team has been formed, each team member will be provided with a copy of the preliminary Project Management Plan. The Project Management Plan is a "living" document that the Project Management Team shall update, with information added when necessary, as a Flood Map Project progresses.

[February 2002]

Project Management Plan

{Insert Name of Project}

Prepared by:

{Insert Name(s) of Author(s)}

{Insert Initial Date}

{Insert Revision Date}

{Insert Revision Date}

{Insert Revision Date}

Project Management Team Contact Information

Project Management Team Member	Organization	Contact Information	
{Insert name of FEMA Lead.}	{Insert organization or agency.}	Phone:	
		Fax:	
		E-mail:	
{Insert team member's role in this project.}			
{Insert name FEMA HQ Engineer.}	{Insert organization or agency.}	Phone:	
		Fax:	
		E-mail:	
{Insert team member's role in this project.}			
{Insert name of MCC Representative.}	{Insert organization or agency.}	Phone:	
		Fax:	
		E-mail:	
{Insert team member's role in this project.}			

Project Team Contact Information

Project Team Member	Organization	Contact Information	
{Insert name and address.}	{Insert organization or agency.}	Phone:	
		Fax:	
		E-mail:	
{Insert team member's role in this project.}			
{Insert name and address.}	{Insert organization or agency.}	Phone:	
		Fax:	
		E-mail:	
{Insert team member's role in this project.}			
{Insert name and address.}	{Insert organization or agency.}	Phone:	
		Fax:	
		E-mail:	
{Insert team member's role in this project.}			
{Insert name and address.}	{Insert organization or agency.}	Phone:	
		Fax:	
		E-mail:	
{Insert team member's role in this project.}			
{Insert name and address.}	{Insert organization or agency.}	Phone:	
		Fax:	
		E-mail:	
{Insert team member's role in this project.}			
{Insert name and address.}	{Insert organization or agency.}	Phone:	
		Fax:	
		E-mail:	
{Insert team member's role in this project.}			
{Insert name and address.}	{Insert organization or agency.}	Phone:	
		Fax:	
		E-mail:	
{Insert team member's role in this project.}			

Introduction

The general objectives for this Mapping Project are to:

Use this table to list or describe the overall objectives of the project (check all that apply).	
	Convert map panels (revised and unrevised) to digital format.
	Update the {floodplain and/or floodway} for the subject flooding source to reflect new {hydrologic and/or hydraulic} conditions (e.g., recent development, new flood control structures, changes in stream morphology, etc.).
	Incorporate previously unmapped or revised map features, such as [{specify; e.g., new roads, elevation reference marks, corporate boundaries, LOMCs, etc.}]
	Create new FIRMS for previously unmapped areas.
	Perform a detailed study of a previously approximately studied or unstudied area.
	Other primary objectives. {Add any other primary objectives.}

The remainder of this Project Management Plan establishes project coordination protocols and outlines the general management activities required to meet these objectives.

1. Description of Mapping Project

{Provide a brief description of the project area.}

2. Communication Protocols

{List and/or describe communication protocols between and among Project Management Team and Project Team Members; e.g., MICS, e-mail, project-specific Web site. Note: Insist on consistent and clear documentation methods for all project communications.}

3. Milestones and Reporting Requirements

The major milestones and intermediate milestones are identified in the table below. Fill in the major milestones first; this will help provide a schedule and framework. As the project progresses, fill in the intermediate milestones. (Major milestones are shaded gray.)

	Milestones	Target Date	Completion Date
Pre-Scoping Meeting Activities	Form Project Management Team		
	Initial Community Contact		
	Prepare Preliminary Project Management Plan		
	Initial Project Conference Call with Community		
	Form Project Team		
	Complete Research		
	Draft Scope of Project		
	Draft Scope of Project Conference Call		
	Distribute Background Information		
Scoping Meeting	**Hold Scoping Meeting**		
Post-Scoping Meeting Activities	Document Scoping Meeting		
	Develop SOW and Distribute to Project Team Members		
	Project Team Members Submit T&C Estimates		
	Update MNUSS		
	Issue Task Orders and Notice to Proceed		

	Milestones	Target Date	Completion Date
Flood Data Update	**Acquire Necessary Topographic and Field Data**		
	Independent QA/QC		
	Complete Hydrologic Analyses		
	Independent QA/QC		
	Complete Hydraulic Analyses		
	Independent QA/QC		
	Complete Digital Floodplain Mapping		
	Independent QA/QC		
Digital Conversion	Acquire Base Map		
	DFIRM Production (non-revised areas)		
	Merge Effective and Updated Information		
	Issue Preliminary FIS and FIRM		
Post-Preliminary Processing	Hold Final Meeting		
	Initiate 90-Day Appeal Period		
	Issue Letter of Final Determination		
	Final DFIRM Distributed		

4. Outreach Strategy

{Describe outreach strategy to be implemented for the project; e.g., press releases, targeted mailings, Congressional briefings, public affairs, Television/Radio, or "Letters to the Editor" from FEMA Director. Note that guidance on performing this outreach is currently under development by the FEMA Technical Services Division, Program Outreach Branch.}

5. Other On-Going and Related Activities or Projects

{List all on-going and related activities or projects. Describe how activity or project relates and/or ties in with the project.}

6. Quality Assurance Approach and/or Requirements

{Describe quality assurance approach and/or requirements for this project; e.g., FMPCC performs independent review of H&H analyses by CTP. Include a description of the roles and responsibilities of the various Project Team members in quality assurance.}

7. Retention and Maintenance of Records

{Describe procedures to be followed for retention and maintenance of all records and data related to this project.}

8. Project Completion Activities

Project Completion Activity	Completion Date
{Insert all Project Completion Activities; e.g., Updating MNUSS, Finalizing Vouchers, Holding Final Meeting. Note: Insert new table row for each activity.}	{Insert Date.}

[February 2002]

I.1.3 Initial Project Conference Call Agenda/Meeting Minutes Template

FEMA designed the Initial Project Conference Call Agenda/Meeting Minutes Template, shown on page I-12 to document the agenda and results of the initial Project conference call to the community (ies). If more than one call is conducted, the FEMA Lead or other assigned FEMA staff shall use a separate form for each community.

[February 2002]

Community/Mapping Project:	
Date:	**Case No.:**
FEMA Lead:	
Participants:	
1.	**6.**
2.	**7.**
3.	**8.**
4.	**9.**
5.	**10.**

Agenda Items	**Estimated Time**
1. Introduce Project Management Team	
{Insert notes.}	
2. Provide overview of proposed project, including: • Purpose of project; • Potential flooding sources that have been identified so far (including limits of project); and • Why community/flooding sources were chosen for project.	
{Insert notes.}	
3. Discuss community's assessment of flood mapping needs	
{Insert notes.}	
4. Discuss potential data sources (e.g., digital base maps, on-going projects, and data collection efforts)	
{Insert notes.}	
5. Identify other key players (e.g., regional or State agencies)	
{Insert notes.}	
6. Discuss community's capabilities and interest in becoming a CTP	
{Insert notes.}	
7. Other topics of discussion	
{Insert notes.}	
8. Outline schedule of future activities	
{Insert notes.}	
9. Summary/Action Items	
{Insert notes.}	

I.1.4 Effective Map and Report Summary Template

FEMA designed the Effective Map and Report Summary Template, shown on pages I-14 to I-18, for the assigned Project Team member to use in recording the results of research of effective information. As discussed in Volume 1, Subsection 1.3.2.6 of these Guidelines, findings from a search of the FEMA library storage facility for effective Flood Insurance Rate Map (FIRM) panels and Flood Insurance Study (FIS) reports and other flood hazard data or existing study data and the results of other research are to be documented on this template.

[February 2002]

Effective Map and Report Summary

{Insert Name of Project}

{Insert Community Name - Complete Separate Summary for Each Community.}

{Insert Date}

Prepared by:

{Insert Name(s) of Author(s)}

Introduction

{Insert paragraph describing the purpose of this Effective FIRM Summary document. If more than one community is involved in the project, provide a summary for each.}

1. Library Research

A. General Effective FIS Information

Date of the Effective FIRM: {Insert date}

Number of effective FIRM panels: {Insert number of panels and list by number; e.g., 99009C0025D}

Format of the effective FIRM (check all that apply):

- ❑ Manual
- ❑ Digital
- ❑ Countywide
- ❑ Map Initiatives

Type of flooding (check all that apply): ❑ Riverine ❑ Coastal ❑ Alluvial

(Attach effective FIRM, FIS, and/or FHBM.)

B. Base Map Information

Provide the following for the base map(s) used for the effective FIRM.

Base Map Source	Date	Scale
{Insert base map source}	{Insert date}	{Insert scale}

C. Summary of Map Actions

Letters of Map Change				
The LOMRs and LOMAs listed below have been issued and are currently effective.				
LOMC Type	Case No.	Effective Date	Project Identifier	Panel

D. Summary of Flood Control Structures

{Provide an inventory of effective flood control structures (levees/dams) and their certification status.}

{Provide any relevant information on file regarding post-disaster investigations in the proposed study area.}

E. Flooding Source: {Insert name of flooding source; use one "Flooding Source" table for each flooding source studied in detail.}

H&H	Method	Date	Digital Copy Available?	Reach Limits
Hydrology			❑ Yes ❑ No	
Hydraulics			❑ Yes ❑ No	

Topographic Source for Floodplain Delineation	{Insert Topographic Source.}
Data Source for Cross Section Data	{Insert Data Source.}

2. MNUSS Research Summary

A. Flood Data Update Needs

List Need Type(s): {Insert type of need.}

B. Map Maintenance Needs

List Need Type(s): {Insert type of need.}

(Attach a printout of the MNUSS Community Need Reports.)

3. Map Needs Assessment Results

Was a separate Map Needs Assessment done? ❑ Yes ❑ No

If so, when? {Insert date of Map Needs Assessment.}

Why? {Insert description of why the needs assessment was done.}

Summary of Map Needs Assessment Findings:

{Provide a summary of the findings of the map needs assessment.}

(Attach completed Map Needs Assessment Form.)

4. Attachments

- Scoping Map
- Relevant future file information
- MNUSS Community Need Reports:
- Map Needs Assessment Form, if completed
- Effective FIRM panels
- FIS report

[February 2002]

I.1.5 Available Data Inventory Template

FEMA designed the Available Data Inventory Template, shown on pages I-20 to I-28, to record the results of research of all available data including, but not limited to, available base map information, topographic data, flood hazard data and hydrologic and hydraulic information and data. The assigned Project Team member shall use this template to document the agencies contacted, date, name of person contacted, telephone number, and the result of the research.

[February 2002]

Available Data Inventory

{Insert Name of Project}

{Insert Date}

Prepared by:

{Insert Name(s) of Author(s)}

This checklist is used to inventory base map, topographic, and hydrologic and hydraulic data, and floodplain mapping information and data available or currently underway that may be useful for this project. (Also, use the "Effective FIRM Summary" and the "Potential Obstacles to Project Completion Checklist.")

Use the checklist below to help solicit the information you will need to answer the key questions.

Base Map Information

Are U.S. Geological Survey (USGS) Digital Orthophoto Quadrangles (DOQs) available for this community or county? ❑ Yes ❑ No

{Insert notes.}

What community base map data are available? From whom?

{Insert notes.}

What is the source of the base map data and how were the data created?

{Insert notes.}

Are the owners of the data willing to allow FEMA to release the base map data to the public with the DFIRMs? ❑ Yes ❑ No

If you checked "No," to the above question you do not need to complete the rest of the Base Map Information section of this checklist.

Contact Information for Data Source	
Name:	
Organization:	
Telephone No.:	
E-Mail Address:	
Facsimile No.:	

{Insert notes.}

If the base map data are in vector format and the owner is not willing to release the data, will the owner allow FEMA to make a raster image of the vector base map data and release that? ❑ Yes ❑ No

{Insert notes.}

Base Map Information (Continued)

Do the data cover the entire community or county being restudied (not just the streams being studied)? ❑ Yes ❑ No

{Insert notes.}

Are the data available now? If not, what is the projected completion date? ❑ Yes ❑ No

{Insert notes.}

What is the accuracy or resolution of each data set or type?

{Insert notes.}

When were the base map data created, last updated, or reviewed for update needs?

Created	Last Updated	Reviewed
{Insert date.}	{Insert date.}	{Insert date.}

{Insert notes.}

Is the base map in the process of being revised? If yes, what is being done and when will it be completed? ❑ Yes ❑ No

{Insert notes.}

What projection, horizontal datum, and vertical datum were used for the base map data sets?

Projection	Horizontal Datum	Vertical Datum
{Insert notes.}	{Insert notes.}	{Insert notes.}

In what file format(s) are the data available?

{Insert notes.}

How are the data tiled?

{Insert notes.}

Is a data dictionary or metadata available? ❑ Yes ❑ No

{Insert notes.}

Base Map Information (Continued)

What feature types do the base map data sets contain? (Check all that apply.)

- ☐ Roads
  - ☐ Centerlines
  - ☐ Edge of pavement
  - ☐ Right of way
  - ☐ Digital orthophotos

  {Insert notes.}
- ☐ Road Names
  - ☐ Stored as attributes in database
  - ☐ Placed as graphic elements for plotting. At what scale(s)?

  {Insert notes.}
- ☐ Railroads/railroad names

  {Insert notes.}
- ☐ Airports

  {Insert notes.}
- ☐ Rivers, streams, lakes, shorelines, coastline

  {Insert notes.}
- ☐ Are political boundaries (corporate, county, extraterritorial, etc.) current? ☐ Yes ☐ No

  {Insert notes.}
- ☐ Parks, military reservations, Native American lands

  {Insert notes.}
- ☐ Range, township, section lines

  {Insert notes.}
- ☐ Building footprints

  {Insert notes.}
- ☐ Parcels

  {Insert notes.}

Base Map Information (Continued)

❑ Bridges

{Insert notes.}

❑ Flood control structures (e.g., culverts, levees, dams, weirs, floodwalls, jetties, etc.)

{Insert notes.}

❑ What bench marks, Elevation Reference Marks (ERMs), or other vertical control data are available for the community, county, or study area?

{Insert notes.}

Topographic Information

What elevation data are available?

{Insert notes.}

What is the source of the topographic data (how were the data created)?

{Insert notes.}

Do the data cover the floodplains for the flooding sources in the entire community or county being restudied? ❑ Yes ❑ No

{Insert notes.}

Are the data available now? If not, what is the projected completion date? ❑ Yes ❑ No

{Insert notes.}

What is the accuracy or resolution of the topographic data?

{Insert notes.}

When were the topographic data created, last updated, or reviewed for update needs?

Created	Last Updated	Reviewed
{Insert date.}	{Insert date.}	{Insert date.}

{Insert notes.}

Topographic Information (Continued)

What projection, horizontal datum, and vertical datum were used for the topographic data?

Projection	Horizontal Datum	Vertical Datum
{Insert notes.}	{Insert notes.}	{Insert notes.}

{Insert notes.}

In what format(s) are the data available?

{Insert notes.}

Contours	Digital Elevation Model (DEM)	Digital Terrain Model (DTM)	Triangulated Irregular Network (TIN)
{Insert contour interval.}	{Insert horizontal and vertical resolutions.}	{Insert notes.}	{Insert notes.}

{Insert notes.}

Flood Hazard Data

Are digital flood hazard data available? If so, from whom? ☐ Yes ☐ No

{Insert notes.}

Have flood hazard data that have been converted to digital format been compared to the effective FIRMs to ensure that base map to flood hazard relationships have been preserved? ☐ Yes ☐ No

{Insert notes.}

What was the source of the digital flood hazard data and how were the data created?

{Insert notes.}

Do any new data tie in to the existing effective information? ☐ Yes ☐ No

{Insert notes.}

Do the data cover the entire community or county being restudied? ☐ Yes ☐ No

{Insert notes.}

Flood Hazard Data (Continued)

Are the data available now? If not, what is the projected completion date? ❑ Yes ❑ No

{Insert notes.}

What is the accuracy or resolution of each data set or type?

{Insert notes.}

When were the data created, last updated, or reviewed for update needs?

{Insert notes.}

Created	Last Updated	Reviewed
{Insert date.}	{Insert date.}	{Insert date.}

{Insert notes.}

Are Letters of Map Change (LOMCs) included in any digital data sets? ❑ Yes ❑ No

{Insert notes.}

What projection, horizontal datum, and vertical datum were used for the flood hazard data sets?

{Insert notes.}

Projection	Horizontal Datum	Vertical Datum
{Insert notes.}	{Insert notes.}	{Insert notes.}

In what file format(s) are the data available?

{Insert notes.}

How are the data tiled?

{Insert notes.}

Is a data dictionary or metadata available? ❑ Yes ❑ No

{Insert notes.}

Have flood hazard data that have been converted to digital format been compared to the effective FIRMs to ensure that base map to flood hazard relationships have been preserved? ❑ Yes ❑ No

{Insert notes.}

Flood Hazard Data (Continued)

What feature types do the flood hazard data sets contain? (Check all that apply.)

- ☐ 1% annual chance flood hazard areas

  {Insert notes.}

- ☐ 0.2% annual chance flood hazard areas

  {Insert notes.}

- ☐ Floodways

  {Insert notes.}

- ☐ Coastal Barrier Resources System areas

  {Insert notes.}

- ☐ Alluvial fans

  {Insert notes.}

- ☐ Base flood elevations, velocities, or depths

  {Insert notes.}

- ☐ Cross sections

  {Insert notes.}

- ☐ Elevation Reference Marks (ERMs)

  {Insert notes.}

- ☐ LOMCs

  {Insert notes.}

- ☐ Are data for other flood frequencies available? ☐ Yes ☐ No

  {Insert notes.}

Do the flood hazard boundaries need to be fitted to newer or more detailed stream locations and/or topography than was previously used for the existing FIRM? ☐ Yes ☐ No

{Insert notes.}

Are new hydrologic and hydraulic models available? If so, please describe them. ☐ Yes ☐ No

{Insert notes.}

Do hydrologic and hydraulic models need inclusion? ☐ Yes ☐ No

{Insert notes.}

Flood Hazard Data (Continued)

Were the hydrologic and hydraulic data developed using automated modeling and mapping techniques? If so, describe them. ❑ Yes ❑ No

{Insert notes.}

Are digital files containing data needed for hydrologic or hydraulic modeling (e.g., land use or soils) available? ❑ Yes ❑ No

{Insert notes.}

Are supplemental data (e.g., photographs, etc.) available? ❑ Yes ❑ No

{Insert notes.}

Are supplemental data in digital format? ❑ Yes ❑ No

{Insert notes.}

Are there levees in this community? ❑ Yes ❑ No

{Insert notes.}

If levees are present, do they provide protection from the 1% annual chance flood event? ❑ Yes ❑ No

{Insert notes.}

Is U.S. Army Corps of Engineers certification available for these levees? ❑ Yes ❑ No

{Insert notes.}

Do the coastal analyses reflect primary frontal dunes? ❑ Yes ❑ No

{Insert notes.}

Do the coastal analyses reflect wave heights? ❑ Yes ❑ No

{Insert notes.}

Does the community maintain hydrologic and hydraulic analyses that reflect future conditions? ❑ Yes ❑ No

{Insert notes.}

Are other hazard data available? If yes, what are they? ❑ Yes ❑ No

{Insert notes.}

Are elevation certificates for floodprone structures available in a database or other electronic format? ❑ Yes ❑ No

{Insert notes.}

I.1.6 Potential Obstacles to Project Completion Checklist Template

FEMA designed the Potential Obstacles to Project Completion Checklist Template, shown on pages I-30 to I-35, to record identified potential obstacles to the completion of a Flood Map Project, as well as to record creative solutions and/or alternatives to minimize or avoid potential obstacles. The assigned Project Team member shall check the type of obstacle identified, and then fill in the necessary information. The checklist is a "living" document that the assigned Project Team member shall update throughout the entire lifecycle of the Project, when necessary.

[February 2002]

Community Name	{Insert Community Name.}
Project Management Team	{List Project Management Team Members.}
Date Created	{Insert checklist completion date.}
Date Revised	{Insert checklist revision date.}
Date Revised	{Insert checklist revision date.}
Date Revised	{Insert checklist revision date.}

☐ **Unable to Adequately Address Needs with Available Funding**

Minimum Project Needs

- {Insert needs.}

Estimated Funding Required

- {Provide estimated funding level required.}

Possible Solutions or Alternatives

- {List and/or discuss possible solutions or alternatives.}

Comments: {Insert additional comments.}

Resolution

- {Describe the resolution for this issue.}

Can the project proceed? ☐ Yes ☐ No

☐ **Base Map Availability**

☐ USGS DOQ not available

☐ Local base map not available

☐ Local base map does not meet FEMA's minimum specifications. Explain why:

(For additional information, visit FEMA' Web site at www.fema.gov/mit/tsd and view "Guidance Information for Base Map Specifications for New Digital Flood Insurance Rate Map Product." The following minimum standards must be met for FEMA to use community-supplied base map data rather than USGS DOQs for DFIRM production. Check those that apply to this project.)

☐ Resolution

☐ Horizontal Accuracy

☐ Horizontal Reference System

☐ Data Sources

☐ Currency

☐ Coverage

☐ Availability

☐ Restrictions on Use

☐ Contents

☐ Thematic Separation of Data

☐ File Format

❑ Data Structure ❑ Metadata
Comments: {Insert notes.}
Possible Solutions or Alternatives • {List and/or discuss possible solutions or alternatives for base map availability issues.}
Resolution • {Describe the resolution for this issue.}
Can the project proceed? ❑ Yes ❑ No

❑ **Hydrologic or Hydraulic Issues**

Hydrologic & Hydraulic Issues • {List and/or discuss any hydrologic & hydraulic issues that could threaten the success of the project.}
Possible Solutions or Alternatives • {List and/or discuss possible solutions or alternatives for each hydrologic & hydraulic issue.}
Comments: {Insert additional comments.}
Resolution • {Describe the resolution for this issue.}
Can the project proceed? ❑ Yes ❑ No

❑ **Community Concerns**
Community Needs, Concerns, and/or Preferences • {List and/or describe any community needs, concerns, and/or preferences.}
Other Potential Community-Related Obstacles • {Discuss and/or describe any other obstacles posed by the community.}
Possible Solutions or Alternatives • {List and/or discuss possible solutions or alternatives to community-related issues.}
Comments: {Insert additional comments.}
Resolution • {Describe the resolution for this issue.}
Can the project proceed? ❑ Yes ❑ No

❑ **Reliance on Other Studies or Data**
Relationship to the Proposed Flood Project • {Describe how the dependent on-going study or studies tie in with the proposed flood mapping project.} • {Describe if, how, and why the dependent on-going study or studies could delay the proposed flood mapping project.} • {Describe data that will not be available within the project's scheduling constraints; e.g., topographic mapping.}

Possible Solutions
• {List and/or discuss possible solutions or ways to work around this obstacle. For example, if the dependent on-going study or studies are a source of data for the proposed mapping project, are there alternative sources of data?}
Comments: {Insert additional comments.}
Resolution • {Describe the resolution for this issue.}
Can the project proceed? ❑ Yes ❑ No

❑

Project Priority
Change in Priority • {List any possible changes in the priority for this project.}
Needs Update • {Discuss any updates to the needs that may affect the priority.}
Possible Solutions or Alternatives • {Describe appropriate course of action should priorities change.}
Comments: {Insert additional comments.}
Resolution • {Describe the resolution for this issue.}
Can the project proceed? ❑ Yes ❑ No

❑ **Other Considerations**
Federal/State/Non-Governmental Organizations • {Describe and/or discuss any politically motivated considerations that could delay/impede the project.}
Programmatic • {Describe and/or discuss any programmatic considerations that could delay/impede the project.}
Disaster-Related • {Describe and/or discuss any disaster-related issues or considerations that could delay/impede the project.}
Legal • {Describe and/or discuss any legal considerations that could delay/impede the project.}
Other • {Describe and/or discuss any additional considerations that could delay/impede the project.}
Possible Solutions or Alternatives • {Describe any possible solutions or alternatives.}
Comments: {Insert additional comments.}
Resolution • {Describe the resolution for this issue.}
Can the project proceed? ❑ Yes ❑ No

I.1.7 Draft Scope of Project Template

FEMA designed the Draft Scope of Project Template, shown on pages I-37 to I-41, to record the elements of the draft Scope of Project. The draft Scope of Project is based on mapping needs determined during the Mapping Needs Assessment Phase of the Flood Map Project and/or the research portion of the Scooping Phase of the Flood Map Project. The draft Scope of Project is a "living" document that the FEMA Lead and other Project Team members shall update, when necessary.

[February 2002]

Scope of Project

{Insert Name of Project}

{Insert Date}

{Insert Revision Date}

{Insert Revision Date}

{Insert Revision Date}

{Insert Revision Date}

{Insert Name(s) of Author(s)}

Introduction

{Insert paragraph describing the purpose of this project. The purpose statement should include a summary of the research and outreach activities completed. Note in the purpose statement that the project is subject to change due to community priorities and funding availability.}

1. Needs List

Mapping Need	Need Type	Source of Need
{Insert brief summary of need; e.g., "Restudy of Mill Brook" or "Convert Maps to DFIRM." Add new table row for each need.}	{Insert either "Flood Data Update" or "Map Maintenance."}	{Explain how the need was identified; e.g., community, MAPPING PARTNER Research, etc.}

2. DFIRM Production

Check all that apply:

☐ Countywide ☐ Community-based

☐ Incorporate LOMCs

☐ Effective Information for Non-Revised Flooding Sources will be digitized

A. Proposed Paneling Scheme

{Describe and discuss the proposed paneling scheme for this project. Attach an index.}

B. Base Map

{Indicate the sources for base maps to be used for the project.}

Source	Date	Scale	Contour Interval	Coverage
{Insert source of base map. Note: Add table row for each source.}	{Insert date.}	{Insert scale.}	{Insert contour interval.}	{Describe coverage.}

{Additional comments}

C. Option Choices

- ☐ Resolve external mismatches
- ☐ Incorporate Physical Map Revision or Existing Data Studies
- ☐ Fit existing FIS profiles to newer topographic data
- ☐ Expand database to include:
  - {List what will be included in expanded database.}
- ☐ Fit Zone As to newer topo
- ☐ Map unmapped communities
- ☐ Convert to North American Vertical Datum of 1988
- ☐ Convert to metric
- ☐ Add supplemental images:

  {Examples: Scanned Documents, Engineering Study Data Package, Technical Support Data Notebook, etc.}

- ☐ Replace ERMs with National Geodetic Survey benchmarks
- ☐ Include future conditions mapping
- ☐ Include erosion mapping
- ☐ Include other hazards:

  {Specify other hazards.}
- ☐ Other community options:

  {Specify other community options.}

3. Description of Project Area (Add flooding source tables as needed)

Flooding Source: (Insert Name}

Hazard Identification Method		Data Collection	
Hydrology	Hydraulics	Field Surveys for Cross Sections and Structures	Topographic Data (Include Scale and Contour Interval)

Flooding Source: (Insert Name}

Hazard Identification Method		Data Collection	
Hydrology	Hydraulics	Field Surveys for Cross Sections and Structures	Topographic Data (Include Scale and Contour Interval)

I.1.8 Draft Scope of Project Conference Call/Agenda Meeting Minutes Template

FEMA designed the Draft Scope of Project Conference Call/Agenda Meeting Minutes Template, shown on pages I-43 and I-44, to record the results of the conference call that the FEMA Lead will hold with the community once research has been completed and the draft Scope of Project has been prepared. If more than one conference call is conducted or more than one community is contacted, the FEMA Lead or other assigned FEMA staff shall prepare a separate form for each call.

[February 2002]

Community/Mapping Project:		
Date:	**Case No.:**	
FEMA Lead:		
Participants:		
1.	6.	
2.	7.	
3.	8.	
4.	9.	
5.	10.	
Agenda Items		**Estimated Time:**
1. Introductions/Roll-Call		
{Insert notes.}		
2. Overview of Agenda for Conference Call		
{Insert notes.}		
3. Summary of Research Methods		
{Review how the draft Scope of Project was developed.}		
4. Discuss Draft Scope of Project: • Flooding sources to be studied • Flood hazard identification methods to be used • Data collection needs and methods • Proposed paneling scheme • Base map • DFIRM options • Digital Conversion of Existing Data		
{Insert notes.}		

Agenda Items	Estimated Time:
5. Schedule Scoping Meeting and Identify Attendees	
{Insert notes.}	
6. Summary of Action Items	
{Insert notes.}	

I.2 Scoping Meeting Activities

The templates, checklists, and forms that the FEMA Lead and other Project Team members shall use to record activities during the Project Scoping Meeting are summarized in Subsections I.2.1 through I.2.8.

[February 2002]

I.2.1 Scoping Meeting Item Checklist Template

FEMA designed the Scoping Meeting Item Checklist Template, shown on pages I-46 to I-48, for the FEMA Lead to use in recording what items the individual Project team members must bring to the Scoping Meeting. The FEMA Lead or other designated FEMA staff shall complete this checklist before the Scoping Meeting is held.

[February 2002]

The following items are considered essential for the Scoping Meeting:

Item	Responsible Team Member
FIS Report(s)	
FIRM Panel(s)	
USGS Quad(s)	
Best Available Community Base Map(s)	
Effective FIRM Summary	
Available Data Inventory	
Scoping Map	
Draft Scope of Project	
Scoping Meeting Agenda/Minutes Form and Other Relevant Scoping Meeting Tools	

Bring the following items, if available:

Available	Item	Responsible Team Member
❑ Yes ❑ No	Aerial Photographs and/or DOQQ Images	
❑ Yes ❑ No	Aerial Topography	
❑ Yes ❑ No	Pertinent Reports/Studies/Plans (e.g., Federal Agency Reports or Master Drainage Plans)	
❑ Yes ❑ No		
❑ Yes ❑ No		
❑ Yes ❑ No		
❑ Yes ❑ No		
❑ Yes ❑ No		
❑ Yes ❑ No		
❑ Yes ❑ No		
❑ Yes ❑ No		
❑ Yes ❑ No		
❑ Yes ❑ No		
❑ Yes ❑ No		
❑ Yes ❑ No		
❑ Yes ❑ No		
❑ Yes ❑ No		
❑ Yes ❑ No		

The following community resources should also be available for the Scoping Meeting:

Available	Item	Responsible Team Member
❑ Yes ❑ No	Community Master Plan(s)	
❑ Yes ❑ No	As-Built Plans	
❑ Yes ❑ No	Drainage Master Plans	
❑ Yes ❑ No	Street Maps	
❑ Yes ❑ No	Zoning Maps	
❑ Yes ❑ No	Floodplain Ordinance(s)	
❑ Yes ❑ No		
❑ Yes ❑ No		
❑ Yes ❑ No		
❑ Yes ❑ No		
❑ Yes ❑ No		
❑ Yes ❑ No		
❑ Yes ❑ No		
❑ Yes ❑ No		
❑ Yes ❑ No		
❑ Yes ❑ No		
❑ Yes ❑ No		
❑ Yes ❑ No		

[February 2002]

I.2.2 Document Transmittal Letter Template

FEMA designed the Document Transmittal Letter Template, shown on pages I-50 and I-51, for the FEMA Lead, FEMA Assistance Officer (AO), or FEMA Contracting Officer (CO) to use in distributing the Scoping Meeting Item Checklist and background information on the Flood Map Project to all individuals that will attend the Scoping Meeting.

[February 2002]

Federal Emergency Management Agency
Region {Insert Regional Office Number}

{Date}

{Name of Community Official}
{Community Official's Title}
{Address 1}
{Address 2}
{Community, State ZIP code}

Dear {Name of Community Official}:

We have scheduled your community's Flood Mapping Project Scoping Meeting for {INSERT DATE OF SCOPING MEETING}. The meeting will be held at {INSERT TIME AND LOCATION OF MEETING}. Details regarding attendees, how you can prepare for the meeting, and what you will need to bring are listed below.

Flood Mapping Project:	{Insert the name of the Flood Mapping Project.}
Case Number:	{Insert Case Number.}
FEMA Lead:	{Name of FEMA Lead}
Attendees:	{Insert names of all attendees.}

The following are attachments to this letter:

- Scoping Meeting Agenda
- Revised Draft Scope of Project
- Project Management Plan

The Project Management Team will bring the following items:

- {Add items, as necessary.}

Your community has agreed to provide the following for the Flood Mapping Project Scoping Meeting:

- As-Built Construction Plans:
- Development Proposals
- Topographic Mapping
- Community Master Plan
- Street Maps
- Zoning Maps
- Floodplain Ordinances

We look forward to working with the community officials of {INSERT NAME OF COMMUNITY} to ensure that the goals of this Flood Mapping Project are met. This will allow {INSERT NAME OF COMMUNITY} to administer effective floodplain management programs. If you have any questions, please do not hesitate to contact the Director, Mitigation Division of the FEMA Region {Region Number} Office, at {Telephone}, or {Name of FEMA HQ Engineer} at our Headquarters Office in Washington, D.C., at {Telephone}, or by facsimile at {Fax Number}.

Sincerely,

{INSERT NAME AND TITLE OF FEMA LEAD AND/OR CONTRACTING OFFICER}

cc: {FEMA HQ Engineer}, FEMA Headquarters

{OTHER PROJECT TEAM MEMBERS, AS NECESSARY}

Attachments

I.2.3 Scoping Meeting Attendance Sheet Template

FEMA designed the Scoping Meeting Attendance Sheet Template, shown on page I-53, for the FEMA Lead or other designated FEMA staff to use in recording the name, title, organization/affiliation, and contact information for the Project Team members and other individuals that attend the Scoping Meeting.

[February 2002]

Community/Mapping Project:				
Date/Time:		**Case No.:**		
FEMA Lead:		**Location of Meeting:**		
Name	**Title**	**Organization/ Affiliation**	**Telephone/Fax**	**E-Mail Address**
			(P) (F)	
			(P) (F)	
			(P) (F)	
			(P) (F)	
			(P) (F)	
			(P) (F)	

I.2.4 Scoping Meeting Agenda/Meeting Minutes Template

FEMA designed the Scoping Meeting Agenda/Meeting Minutes Template, shown on page I-55, for the FEMA Lead or other designated FEMA staff to use in documenting the agenda and results of the Scoping Meeting. The estimated times listed in the template are simply a guideline to assist in running the meeting.

[February 2002]

Scoping Meeting Agenda/Meeting Minutes

Community/Mapping Project:	
Date/Time:	**Case No.:**
FEMA Lead:	**Location of Meeting:**
Participants:	
1.	6.
2.	7.
3.	8.
4.	9.
5.	10.

Agenda Items	Estimated Time
Introduction/Sign-In Sheet	10 minutes
{Insert notes.}	
Overview of Scoping Meeting Agenda	5 minutes
{Insert notes.}	
National Flood Insurance Program Overview	10 minutes
{Insert notes.}	
Needs List Development	15 to 45 minutes
{Insert notes.}	
Scope of Project Refinement	30 to 45 minutes
{Insert notes.}	
Community and Partner Agreement Discussion	15 minutes
{Insert notes.}	
Summary of Action Items	5 minutes
{Insert notes.}	
Total Time:	**1¾ to 2½ hours**

I.2.5 Task Assignment and Scheduling Worksheet Template

FEMA designed the Task Assignment and Scheduling Worksheet Template, shown on page I-57, to document task assignments made at the Scoping Meeting to Project Team members and to develop a schedule for the Flood Map Project. The assigned Project Team member that records this information shall refer to the Flood Map Project Process flowchart in Subsection I.2.6 and mark any components that will not be included as not applicable under the column entitled "Responsible Entity."

[February 2002]

Task Assignment and Scheduling Worksheet

Case No. _____

(See also the Flood Map Project Process flowchart.
Mark any components that will not be included as "N/A" under "Responsible Entity.")

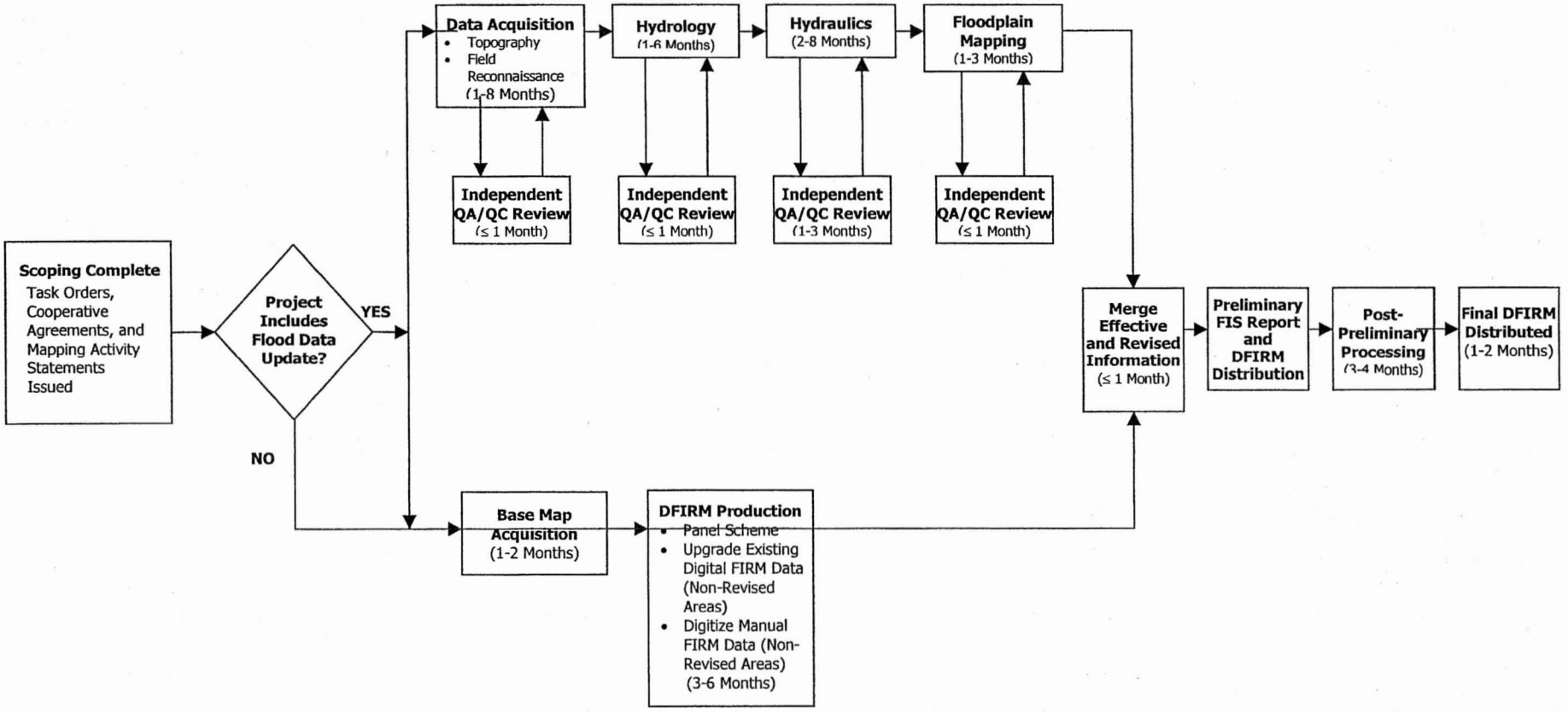
Community/Flood Map Project:			
Map Project Component	**Responsible Partner**	**Target Due Date**	**Typical Timeframe**
Field Surveys and Reconnaissance			1-8 months
Topographic Data Development			1-8 months
Independent QA/QC Review of Topographic Data			≤ 1 month
Hydrologic Analyses			1-6 months
Independent QA/QC Review of Hydrologic Analyses			≤ 1 month
Hydraulic Analyses			2-8 months
Independent QA/QC Review of Hydraulic Analyses			1-3 months
Floodplain Mapping (Revised Areas)			1-3 months
Independent QA/QC Review of Floodplain Mapping (Revised Areas)			≤ 1 month
Base Map Acquisition			1-2 months
DFIRM Production (Non-Revised Areas)			3-6 months
DFIRM Production (Merge Effective and Revised Information)			≤ 1 month
Application of DFIRM Graphics and Database Specifications			≤ 1 month
Independent QA/QC Review of Final DFIRM Product			≤ 1 month
Preliminary DFIRM and FIS Report Distribution			≤ 1 week
Post-Preliminary Processing			3-4 months
Final DFIRM and FIS Report Distribution			1-2 months

I.2.6 Flood Map Project Process Flowchart

FEMA designed the Flood Map Project Process flowchart, shown on page I-59, as a tool that the FEMA Lead and all Project Team members shall use for developing the Flood Map Project schedule at the Scoping Meeting.

[February 2002]

Flood Map Project Process



Note: Many of these steps can be conducted concurrently. Initiation of most steps is not necessarily contingent on the completion of previous steps.

I.2.7 Community Partner Memorandum of Agreement Template

FEMA designed the Community Partner Memorandum of Agreement Template, shown on pages I-62 and I-63, to assist the FEMA Lead and/or AO in developing an agreement between FEMA and a community that will participate in a Flood Map Project. FEMA and the community will sign this Agreement when a community will be contributing work or base map data, but will not be participating in the Cooperating Technical Partners initiative.

If the community will not be participating in the Project by contributing work or data, FEMA will sign a Community Partner Memorandum of Agreement with the community to:

- Document the good faith efforts to collaboratively assess the community's needs;
- Develop an appropriate Scope of Project; and
- Develop and publicize the updated map that results from the Flood Map Project.

[February 2002]

Federal Emergency Management Agency
Community Partner Memorandum of Agreement

AGREEMENT is made on {Insert Date}, by these parties: {Insert name(s) of community and/or partner(s)} and the Federal Emergency Management Agency (FEMA).

BECAUSE the National Flood Insurance Program (NFIP), established by the National Flood Insurance Act of 1968, has several purposes, the most significant being:

- To better indemnify individuals from losses through the availability of flood insurance;
- To reduce future flood damages through community floodplain management regulations; and
- To reduce costs for disaster assistance and flood control.

BECAUSE a critical component of this program is the identification and mapping of the nation's floodplains to create a broad-based awareness of the flood hazard and to provide the data necessary for community floodplain management programs and to actuarially rate flood insurance;

BECAUSE FEMA administers the NFIP and is authorized by §1360 of the National Flood Insurance Act of 1968, as amended (42 U.S.C. 4101), to establish and update flood-risk zone data in floodplain areas. Further, in the identification of flood-prone areas, FEMA is authorized to consult with, receive information from, and enter into agreements or other arrangements with the head of any State, regional, or local agency in order to identify these floodplain areas;

BECAUSE FEMA encourages strong Federal, State, regional, and local partnerships for the purposes of reducing flood losses and disaster assistance; and FEMA and its State, regional, and local partners have determined that it is advantageous to encourage and formalize greater cooperation in the flood hazard identification and mapping processes;

BECAUSE {Insert name(s) of community and/or partner(s)} participates in the NFIP {indicate if the community or partner shares flood protection and/or floodplain management responsibilities with communities that participate in the NFIP}, and {Insert name(s) of community and/or partner(s) or representatives of NFIP participating community}, {Insert has or have} been deemed by FEMA to be in good standing in the NFIP; and

BECAUSE {Insert name(s) of community and/or partner(s)} {Insert has or have} expressed a desire to cooperate with FEMA in the flood hazard identification process and have worked with FEMA to identify and prioritize {Insert name(s) of community and/or partner(s). Note name is possessive here.} flood mapping needs and develop a scope of study to produce an updated, digital flood map.

NOW, THEREFORE, it is mutually agreed that the parties enter into this agreement to work together to produce an updated, digital flood map for {Insert name(s) of community and/or partner(s)}.

Community Authorized Representative	Date
Community Authorized Representative (Printed)	Date
FEMA Authorized Representative	Date
FEMA Authorized Representative (Printed)	Date

[February 2002]

I.2.8 Cooperating Technical Partners Memorandum of Agreement Template

FEMA designed the Cooperating Technical Partners Partnership Agreement Template, shown on pages I-65, I-66, and I-67, to assist the FEMA Lead and/or AO in developing an agreement with a community, regional agency, or State agency that chooses to participate in the Cooperating Technical Partners initiative. Additional information on the Cooperating Technical Partners initiative may be found on the FEMA Flood Hazard Mapping website at www.fema.gov/mit/tsd/CTP_main.htm.

This Partnership Agreement is a broad statement of principle, emphasizing the value of the National Flood Insurance Program's three components of insurance, floodplain management, and mapping. Through this Partnership Agreement, FEMA and the community, regional agency, or State agency acknowledge the fundamental importance of flood hazard identification in the successful reduction of future flood losses and commit to the flood hazard identification effort.

[February 2002]

Federal Emergency Management Agency
Cooperating Technical Partners
Partnership Agreement

AGREEMENT is made on {Insert Date}, by these parties: {Insert name(s) of community and/or partner(s)} and the Federal Emergency Management Agency (FEMA).

BECAUSE the National Flood Insurance Program (NFIP), established by the National Flood Insurance Act of 1968, has several purposes, the most significant being:

- To better indemnify individuals from losses through the availability of flood insurance;
- To reduce future flood damages through community floodplain management regulations; and
- To reduce costs for disaster assistance and flood control.

BECAUSE a critical component of the NFIP is the identification and mapping of the nation's floodplains to create a broad-based awareness of the flood hazard and to provide the data necessary for community floodplain management programs and to actuarially rate flood insurance;

BECAUSE FEMA administers the NFIP and is authorized by §1360 of the National Flood Insurance Act of 1968, as amended (42 U.S.C. 4101), to establish and update flood-risk zone data in floodplain areas. Further, in the identification of flood-prone areas, FEMA is authorized to consult with, receive information from, and enter into agreements or other arrangements with the head of any State, regional, or local agency in order to identify these floodplain areas;

BECAUSE FEMA encourages strong Federal, State, regional, and local partnerships for the purposes of reducing flood losses and disaster assistance; and FEMA and its State, regional, and local partners have determined that it is advantageous to encourage and formalize greater cooperation in the flood hazard identification and mapping processes;

BECAUSE {Insert name(s) of community and/or partner(s)} participates in the NFIP {indicate if the community or partner shares flood protection and/or floodplain management responsibilities with communities that participate in the NFIP}, and {Insert name(s) of community and/or partner(s) or representatives of NFIP participating community}, {Insert has or have} been deemed by FEMA to be in good standing in the NFIP; and

BECAUSE {Insert name(s) of community and/or partner(s)} {Insert has or have} expressed a desire to cooperate with FEMA in the flood hazard identification process and have worked with FEMA to identify and prioritize {Insert name(s) of community and/or partner(s). Note name is possessive here.} flood mapping needs and develop a scope of study to produce an updated, digital flood map; and

BECAUSE {Insert name(s) of community and/or partner(s)} {Insert has or have} expressed a desire to perform certain functions in the flood hazard identification process and {Insert has or have} provided evidence that it {Insert has or have} sufficient technical capability and will dedicate the resources necessary to perform those functions.

NOW, THEREFORE, It is mutually agreed that the parties enter into this Agreement to work together to produce an updated, digital flood map for {Insert name(s) of community and/or partner(s)}.

1. CONSULTATIONS

The parties shall consult with each other to fully integrate each other's contributions into flood hazard identification efforts. Questions regarding the execution of the agreement will be resolved by an implementation committee consisting of a FEMA representative and a representative of {Insert name(s) of community and/or partner(s)}. In States where statutory and/or regulatory requirements require State review and/or approval of new flood hazard data, a State representative will also serve on the implementation committee, as appropriate.

2. EVALUATION AND REPORTING

The parties shall annually review the partnership created by this Agreement to determine and document the activities undertaken to maintain accurate flood hazard data, and to revise the Agreement as necessary.

3. RESOURCE COMMITMENT

The parties agree to commit the appropriate human and available financial resources sufficient to coordinate effectively with all entities impacted by flood hazard identification efforts to implement this Agreement.

4. STANDARDS

Unless otherwise agreed to by the parties, all flood hazard identification activities will be accomplished in accordance with the standards documented in *Guidelines and Specifications for Flood Hazard Mapping Partners* , dated February 2002, and subsequent updates.

5. TERM

The respective duties, responsibilities, and commitments of the parties in this Agreement shall begin on the date this agreement is signed by the parties and may be periodically renewed, revised, or terminated at the option of any of the parties. The parties agree that a 60-day notice shall be given prior to the termination of this Agreement.

THEREFORE, each party has caused this Agreement to be executed by its duly authorized representatives on the date this Agreement is signed.

CTP Authorized Representative	Date
CTP Authorized Representative (Printed)	Date
FEMA Authorized Representative	Date
FEMA Authorized Representative (Printed)	Date
State Representative	Date
State Representative (Printed)	Date

(In States where statutory and/or regulatory requirements require State review and/or approval of new flood hazard data, the State must be a signatory to a community's Agreement.)

[February 2002]

I.3 Post-Scoping Meeting Activities

The templates, checklists, and forms that the FEMA Lead and other Project Team members shall use to record activities after the Project Scoping Meeting are summarized in Subsections I.3.1, I.3.2, and I.3.3.

[February 2002]

I.3.1 Statement of Work Template

FEMA designed the Statement of Work Template (pages I-70 to I-101) to assist the FEMA Lead in documenting task assignments and standards for a Flood Map Project. The FEMA Lead shall prepare one Statement of Work for an entire Flood Map Project, covering all of the following tasks that apply to that Flood Map Project:

- Task 1—Field Surveys and Reconnaissance;
- Task 2—Topographic Data Development;
- Task 3—Independent QA/QC Review of Topographic Data;
- Task 4—Hydrologic Analyses;
- Task 4A—Coastal Hazard Analyses
- Task 5—Independent QA/QC Review of Hydrologic Analyses;
- Task 5A—Independent QA/QC Review of Coastal Hazard Analyses;
- Task 6—Hydraulic Analyses;
- Task 7—Independent QA/QC Review of Hydraulic Analyses;
- Task 8—Floodplain Mapping (Detailed Riverine or Coastal Analysis);
- Task 8A—Floodplain Mapping (Redelineation Using Effective Flood Profiles and Updated Topographic Data);
- Task 8—Floodplain Mapping (Refinement or Creation of Zone A);

- Task 9—Independent QA/QC Review of Floodplain Mapping (Revised Areas);
- Task 10—Base Map Acquisition;
- Task 11—DFIRM Production (Non-Revised Areas);
- Task 12—DFIRM Production (Merge Effective and Revised Information);
- Task 13—Preliminary DFIRM and FIS Report Distribution;
- Task 14—Post-Preliminary Processing; and
- Task 15—Reporting

Using the template, the resulting Statement of Work shall clearly identify the responsible Project Team member assigned to complete each Project task and the standard that each Project Team member shall meet for completion of each task and delivery of final products. The matrix of standards in the "Applicable Standards" section of the template (page I-98), subject to change when these Guidelines are updated, is a guide. Mapping Partners are strongly encouraged to use the listed references to standards to identify key sections of these Guidelines applicable to the task, but not limit their familiarity with these Guidelines to those sections. Final decisions regarding the standards to be met shall be made by the FEMA Lead in consultation with the rest of the Project Management Team.

[February 2002]

Statement of Work

{Insert Name of Project}

{Insert Case Number}

{Insert Date}

Introduction

The purpose of this mapping project is to develop {new/updated} Flood Insurance Rate Maps (FIRMs) and Flood Insurance Study (FIS) for {insert name of community(ies) or county}. The FIS and FIRMs will be produced in {countywide or community-based} digital FIRM (DFIRM) format.

<Delete this text and the table below if the project includes only conversion of maps to DFIRM>Additionally, this project will include developing new and/or updated flood data, as summarized in the following table:

Flooding Source	Reach Limits	Hydrology	Hydraulics	Floodplain Mapping	Redelin-eation of SFHAs Using Effective Profiles	Refine/ Establish Zone As
{Insert name of flooding source}	{Insert reach limits}	{Check if applicable}	{Check if applicable}	{Check if applicable}	{Check if applicable}	{Check if applicable}

This project will be completed by {insert names of Mapping Partner that will participate in this project}. The tasks, and who they will be completed by, are described in the Scope of Work below.

Scope of Work

The following sections describe the specific tasks associated with this mapping project. Each task description identifies the responsible entity, the applicable standards, and resultant deliverables.

<Include only those tasks listed below that apply to this mapping project>

<If any of the tasks are assigned to more than one project team member, copy the applicable subsection and renumber it using subletters (e.g., hydraulic analysis of different flooding sources can be divided and designated as Task 6a and Task 6b).>

Tasks	Mapping Partner No. 1	Mapping Partner No. 2	Mapping Partner No.3
Task 1 – Field Surveys and Reconnaissance			
Task 2 – Topographic Data Development			
Task 3 – Independent QA/QC Review of Topographic Data			
Task 4 –Hydrologic Analyses			
Task 4A –Coastal Hazard Analyses			
Task 5–Independent QA/QC Review of Hydrologic Analyses			
Task 5A–Independent QA/QC Review of Coastal Hazard Analyses			
Task 6 – Hydraulic Analyses			
Task 7 – Independent QA/QC Review of Hydraulic Analyses			
Task 8 – Floodplain Mapping (Detailed Riverine or Coastal Analysis)			
Task 8A – Floodplain Mapping (Redelineation Using Effective Flood Profiles and Updated Topographic Data)			
Task 8B – Floodplain Mapping (Refinement or Creation of Zone A)			
Task 9 – Independent QA/QC Review of Floodplain Mapping (Revised Areas)			
Task 10 – Base Map Acquisition			
Task 11 – DFIRM Production (Non-Revised Areas)			
Task 11A – Independent QA/QC Review of DFIRM Production (Non-Revised Areas)			

Tasks	Mapping Partner No. 1	Mapping Partner No. 2	Mapping Partner No.3
Task 12 – DFIRM Production (Merge Revised and Non-Revised Information)			
Task 12A – Application of DFIRM Graphic and Database Specifications			
Task 12A – Independent QA/QC Review of DFIRM Product Meeting FEMA Graphic and Database Specifications			
Task 13 – Preliminary DFIRM and FIS Report Distribution			
Task 14 – Post-Preliminary Processing			
Task 15 – Reporting			

Task 1 - Field Surveys and Reconnaissance

Responsible Entity: {Insert name of Mapping Partner responsible for this task}

Scope: To supplement any field reconnaissance conducted during the scoping phase of this project, {insert responsible party} shall conduct a detailed field reconnaissance of the specific study area to determine conditions along the floodplain(s), types and numbers of hydraulic and/or flood control structures, apparent maintenance or lack thereof of existing hydraulic structures, locations of cross sections to be surveyed, and other parameters needed for the hydrologic and hydraulic analyses.

In addition to the initial field reconnaissance, this task includes conducting field surveys, including obtaining channel and floodplain cross-sections, identifying or establishing elevation reference marks (ERMs), and obtaining the physical dimensions of hydraulic and flood control structures. {Insert responsible party} is responsible for coordinating with other team members collecting topographic data under Task 2 of this Statement of Work (SOW).

<Add additional details regarding the scope of this task, as appropriate>

Standards: All work conducted under this task shall conform to the standards specified for this task in the "Applicable Standards" section of this SOW.

Deliverables: In accordance with the Technical Support Data Notebook (TSDN) format described in Task 15, {Insert responsible party} shall make the following products available to the FEMA Lead:

<Add, modify or delete deliverables below, as necessary>

- A report summarizing the findings of the field reconnaissance.
- Maps and drawings that provide the detailed survey results.
- Survey note book containing cross sections and structural data.

Task 2 - Topographic Data Development

Responsible Entity: {Insert name of Mapping Partner responsible for this task}

Scope: To supplement the field surveys conducted under Task 1 of this SOW, additional topographic data of the overbank areas of flooding sources will be obtained to delineate floodplain boundaries. Specifically, new topographic data will be generated for {insert flooding souce(s)} using {Insert method for collecting additional topopgrahic data}. {Insert responsible party} is responsible for coordinating with other team members conducting field surveys under Task 1 of this SOW.

<Optional paragraph if automated H&H is used>This task also consists of developing topographic maps and/or Digital Elevation Models (DEMs) for the subject flooding sources using the data collected in Task 1 and 2. In addition, {insert responsible party} will be responsible for addressing all concerns or questions regarding this Task raised during the independent QA/QC review (Task 3 of this SOW).

<Add additional details regarding the scope of this task, as appropriate>

Standards: All work conducted under this task shall conform to the standards specified for this task in the "Applicable Standards" section of this SOW.

Deliverables: Upon completion of topographic data collection and processing for {insert flooding sources}, this data will be submitted to {insert name of party responsible for QA/QC review of the topographic data} for independent review under Task 3 of this SOW. Data for the remaining flooding sources will be submitted for an independent QA/QC review at the completion of this task.

In accordance with the Technical Support Data Notebook (TSDN) format described in Task 15, {Insert responsible party} shall make the following products available to the FEMA Lead.

<Add, modify or delete deliverables below, as necessary>

- Hardcopy topographic maps.
- Completed Form No. 5 of *Revisions to National Flood Insurance Program Maps, Application/Certification Forms and Instructions* (MT-2).
- Report summarizing methodology and results.
- Triangular Irregular Network (TIN) data on CD-ROM.
- Checkpoint analyses to assess the accuracy of TIN data including Root Mean Square Error (RMSE) calculations to support vertical accuracy.
- Identification of remote sensing data voids and methods used to supplement data voids.
- NGS data sheets for Network Control Points (NCP) used to control remote sensing and ground surveys.

Task 3 - Independent Quality Assurance/Quality Control Review of Topographic Data

Responsible Entity: {Insert name of Mapping Partner responsible for this task}

Scope: {Insert responsible party} shall review the mapping data generated by {Insert party responsible for conducting the topographic information} under Task 2 of this SOW to ensure that this information is consistent with FEMA standards and standard engineering practice and are sufficient to revise the FIRM.

<Add additional details regarding the scope of this task, as appropriate>

Standards: All work conducted under this task shall conform to the standards specified for this task in the "Applicable Standards" section of this SOW.

Deliverables: In accordance with the TSDN format described in Task 15 of this SOW, {Insert responsible party} shall make the following products available to the FEMA Lead.

<Add, modify or delete deliverables below, as necessary>

- A Summary Report that describes the findings of the QA/QC review.
- Recommendations to resolve any problems that arise as a result of the QA/QC review.

Task 4 – Hydrologic Analyses

Responsible Entity: {Insert name of Mapping Partner responsible for this task}

Scope: Hydrologic analyses will be completed for approximately {insert number of square miles} square miles of drainage area for the flooding source(s) listed in the Introduction of this Statement of Work. The hydrologic methods used for this analysis will be {insert the hydrologic methods to be used. Include a table if multiple methods are used}. Peak flood discharges will be calculated for the {specify recurrence intervals} annual chance storms. These flood discharges will be the basis for subsequent hydraulic analyses of the subject flooding sources. In addition, {insert responsible party} will be responsible for addressing all concerns or questions regarding this Task raised during the independent QA/QC review (Task 5 of this SOW).

<Optional paragraph for GIS-based modeling> If GIS-based modeling is used, automated data processing and modeling algorithms will be documented and provided to FEMA to ensure they are consistent with the standards outlined above. Digital data sets (such as elevation, basin, or land use data) will be documented and provided to FEMA for approval prior to performing the analyses to ensure they meet minimum requirements. If non-commercial (i.e., custom-developed) software is used for the analysis, then full user documentation, technical algorithm documentation, and the software will be provided to FEMA for review prior to performing the scope of work.

Standards: All work conducted under this task shall conform to the standards specified for this task in the "Applicable Standards" section of this SOW.

Deliverables: Upon completion of hydrologic modeling for {Insert flooding sources; specifiy a subset of all flooding sources being analyzed}, the results will be submitted to {insert name of party responsible for QA/QC review of the hydrologic modeling} for independent review under Task 5 of this SOW. The results for the remaining flooding sources will be submitted for QA/QC review at the completion of this task.

In accordance with the TSDN format described in Task 15 of this SOW, {Insert responsible party} shall make the following products available to the FEMA Lead:

<Add, modify or delete deliverables below, as necessary>

- Digital copies of all hydrologic modeling (input and output) files for {specify recurrence intervals}.
- "Summary of Discharge" Table(s) for each subject flooding source.
- Appropriate Mapping Partner application/certification form for hydrology.
- All backup data used in the analysis.
- <Optional for GIS-based modeling> For GIS-based modeling, deliverables include all input and output data, intermediate data processing products, and GIS data layers.

Task 4A – Coastal Hazard Analyses

Responsible Entity: {Insert name of Mapping Partner responsible for this task}

Scope: Coastal analyses will be completed for approximately {Insert Number of Transects} transects along {Insert Number of Miles} miles of shoreline, including the following coastal flooding sources: {Insert names of flooding source(s) or reference attached list}. Analyses will include: {Insert all that apply to this activity (e.g., Stillwater Elevations (SWEL) determinations, wave setup, wave height analyses, erosion analyses and wave runup)}.In addition, {insert responsible party} will be responsible for addressing all concerns or questions regarding this Task raised during the QA/QC review (Task 5A of this SOW).

Standards: All work conducted under this task shall conform to the standards specified for this task in the "Applicable Standards" section of this SOW.

Deliverables: Upon completion of the analyses for {Insert flooding sources; specifiy a subset of all flooding sources being analyzed}, the results will be submitted to {insert name of party responsible for QA/QC review} for independent review under Task 5A. The results for the remaining flooding sources will be submitted for QA/QC review at the completion of this task.

In accordance with the TSDN format described in Task 15 of this SOW, {Insert responsible party} shall make the following products available to the FEMA Lead:

- Digital 1- and 0.2-percent-annual chance floodplain boundaries and hazard zones;
- Digital wave envelope profiles for each transect representing the 1-percent-annual-chance stillwater and wave crest elevations and ground profile conditions;
- Draft Flood Insurance Study (FIS) report materials;
- Draft work maps used to prepare digital floodplain boundaries and hazard zones with each transect located accordingly;
- Digital copies of all coastal modeling (input and output files); and
- Copies of any other supporting computations.

In addition to the TSDN, a coastal study technical documentation notebook with all backup data, description of methodology, and input and output files used in the analyses and mapping (see Appendix D of *Guidelines and Specifications for Flood Hazard Mapping Partners*).

Task 5 - Independent Quality Assurance/Quality Control Review of Hydrologic Analyses

Responsible Entity: {Insert name of Mapping Partner responsible for this task}

Scope: {Insert responsible party} shall review the technical, scientific, and other information submitted by {Insert party responsible for conducting the hydrologic analysis} under Task 4 of this SOW to ensure that the data and modeling are consistent with FEMA standards and standard engineering practice and are sufficient to revise the FIRM. This work will include, at a minimum, the following:

<Delete or add tasks below, as necessary>

- Review submittal for technical and regulatory adequacy, required information, application/certification forms, and supporting data and documentation. The technical review will focus on:
  - Use of acceptable models.
  - Use of appropriate methodology(ies) for area of study or restudy.
  - Correctly applied methodology(ies)/model(s), including Quality Control of input parameters.
  - Comparison with gage data and/or regression equations, if appropriate.
  - Comparison with discharges for contiguous reaches or flooding sources.
- Maintain records of all contacts, reviews, recommendations, and actions and make them readily available to FEMA.
- Maintain an archive of all data submitted for hydrologic modeling review.

Standards: All work conducted under this task shall conform to the standards specified for this task in the "Applicable Standards" section of this SOW.

Deliverables: In accordance with the TSDN format described in Task 15 of this SOW, {Insert responsible party} shall make the following products available to the FEMA Lead.

<Add, modify or delete deliverables below, as necessary>

- A Summary Report that describes the findings of the QA/QC review.
- Recommendations to resolve any problems that arise as a result of the QA/QC review.

Task 5A - Independent Quality Assurance/Quality Control Review of Coastal Hazard Analyses

Responsible Entity: {Insert name of Mapping Partner responsible for this task}

Scope: {Insert responsible party} shall review the technical, scientific, and other information submitted by {Insert party responsible for conducting the coastal hazard analysis} under Task 4A of this SOW to ensure that the data and modeling are consistent with FEMA standards and standard engineering practice and are sufficient to revise the FIRM. This work will include, at a minimum, the following:

<Delete or add tasks below, as necessary>

- Review submittal for technical and regulatory adequacy, required information, application/certification forms, and supporting data and documentation. The technical review will focus on:
  - Use of acceptable models;
  - Use of appropriate methodology(ies) for area of study or restudy; and
  - Correctly applied methodology(ies)/model(s), including Quality Control of input parameters.
- Maintain records of all contacts, reviews, recommendations, and actions and make them readily available to FEMA.
- Maintain an archive of all data submitted for review.

Standards: All work conducted under this task shall conform to the standards specified for this task in the "Applicable Standards" section of this SOW.

Deliverables: In accordance with the TSDN format described in Task 15 of this SOW, {Insert responsible party} shall make the following products available to the FEMA Lead.

<Add, modify or delete deliverables below, as necessary>

- A Summary Report that describes the findings of the independent QA/QC review.
- Recommendations to resolve any problems that arise as a result of the independent QA/QC review.

Task 6 – Hydraulic Analyses

Responsible Entity: {Insert name of Mapping Partner responsible for this task}

Scope: Hydraulic analyses will be completed for approximately {insert number of miles} miles of the flooding sources listed in the Introduction of this SOW. The modeling will include the {insert recurrence intervals} annual chance events based on peak discharges computed under Task 4 of this SOW. The hydraulic methods used for this analysis will include {insert the hydraulic methods to be used. Include a table if multiple methods are used.}. Cross section and field data collected under Task 1 of this SOW will be used to prepare the hydraulic analyses. The hydraulic analyses will be used to establish flood elevations and floodways for the subject flooding sources. In addition, {insert responsible party} will be responsible for addressing all concerns or questions regarding this task raised during the independent QA/QC review (Task 7 of this SOW).

<Optional paragraph for GIS-based modeling> Automated data processing and modeling algorithms for GIS-based modeling will be documented and provided to FEMA to ensure they are consistent with the standards outlined above. Digital data sets will be documented and provided to FEMA for approval prior to performing the analyses to ensure they meet minimum requirements. If non-commercial (i.e., custom-developed) software is used for the analysis, then full user documentation, technical algorithm documentation, and the software will be provided to FEMA for review prior to performing the scope of work.

<Add additional details regarding the scope, as appropriate>

Standards: All work conducted under this task shall conform to the standards specified for this task in the "Applicable Standards" section of this SOW.

Deliverables: Upon completion of hydraulic modeling for {Insert flooding sources; specifiy a subset of all flooding sources being analyzed.}, the results will be submitted to {insert name of party responsible for QA/QC review of the hydraulic modeling} for independent review under Task 7 of this SOW. The results for the remaining flooding sources will be submitted for a final QA/QC review at the completion of this task.

In accordance with the TSDN format described in Task 15 of this SOW, {Insert responsible party} shall make the following products available to the FEMA Lead:

<Add, modify or delete deliverables below, as necessary>

- Digital profiles of the 10-, 2-, 1- and 0.2-percent-annual-chance water-surface elevations representing existing conditions;
- Floodway Data Table(s) for each subject flooding source;
- Digital copies of all hydraulic modeling (input and output) files;
- All backup data used in the analysis.
- <Optional for GIS-based modeling> For GIS-based modeling, deliverables include all input and output data, intermediate data processing products, GIS data layers, and final products in the format of the DFIRM database structure.

Task 7 - Independent Quality Assurance/Quality Control Review of Hydraulic Analyses

Responsible Entity: {Insert name of Mapping Partner responsible for this task}

Scope: {Insert responsible party} shall review the technical, scientific, and other information submitted by {insert party responsible for conducting the hydraulic analysis} under Task 6 of this SOW to ensure that the data and modeling are consistent with FEMA standards and standard engineering practice and are sufficient to revise the FIRM. This work will include, at a minimum, the following:

<Delete or add tasks below, as necessary>

- Review submittal for technical and regulatory adequacy, required information, application/certification forms, and supporting data and documentation. The technical review will focus on
  - Use of acceptable models;
  - Starting water-surface elevations;
  - Cross-section geometry;
  - Manning's "n" values and expansion/contraction coefficients;
  - Bridge and culvert modeling;
  - Discharges;
  - Floodway methods; and
  - Tie-in to upstream and downstream non-revised Flood Profiles.
- When the HEC-2 or HEC-RAS model is used, the reviewer will utilize the CHECK-2 or CHECK-RAS programs to flag potential problems and focus review efforts.
- Maintain records of all contacts, reviews, recommendations, and actions and make them readily available to FEMA.
- Maintain an archive of all data submitted for hydraulic modeling review.

Standards: All work conducted under this task shall conform to the standards specified for this task in the "Applicable Standards" section of this SOW.

Deliverables: In accordance with the TSDN format described in Task 15 of this SOW, {Insert responsible party} shall make the following products available to the FEMA Lead.

<Add, modify or delete deliverables below, as necessary>

- A Summary Report that describes the findings of the independent QA/QC review.
- Recommendations to resolve any problems that arise as a result of the independent QA/QC review.

Task 8 - Floodplain Mapping (Detailed Riverine or Coastal Analysis)

Responsible Entity: {Insert name of Mapping Partner responsible for this task}

Scope: Digital floodplain boundaries and floodway boundaries (if required) will be delineated for the flooding sources listed in Tasks 4A and 6 of this SOW. The mapping will incorporate all revised modeling and newly acquired topographic information. The floodplain boundaries for the {insert recurrence intervals} recurrence intervals and a floodway (if required) will be delineated on a digital work map based on topographic data developed under Task 2 of this SOW. In addition, {insert responsible party} will be responsible for addressing all concerns or questions regarding this task raised during the QA/QC review (Task 9 of this SOW).

<Add additional details regarding the scope of this task, as appropriate>

Standards: All work conducted under this task shall conform to the standards specified for this task in the "Applicable Standards" section of this SOW.

Deliverables: Upon completion of floodplain mapping for {Insert flooding sources; specify a subset of all flooding sources being remapped}, the results will be submitted to {insert name of party responsible for QA/QC review of the hydrologic modeling} for independent review under Task 9 of this SOW. The mapping for the remaining flooding sources will be submitted for QA/QC review at the completion of this task.

In accordance with the TSDN format described in Task 15 of this SOW, {Insert responsible party} shall make the following products available to the FEMA Lead:

<Add, modify or delete deliverables below, as necessary>

- Digital work maps with the 1- and 0.2-percent-annual chance floodplain boundaries and floodway boundaries (if required) delineated. These maps should also include cross sections, BFEs, and flood insurance risk zone designation labels.
- <For Coastal Areas—delete if not for coastal area>Digital work map with the Coastal High Hazard Area (V Zone) delineated along {Indicate either Atlantic Ocean, Gulf of Mexico, Great Lakes, Pacific Ocean, or other.} shorelines. These maps should include transect locations, BFEs, and flood insurance risk zone designation labels.
- Any backup or supplemental information used in the mapping required for the independent QA/QC review (Task 9 of this SOW) is to be included.

Task 8A - Floodplain Mapping (Redelineation Using Effective Flood Profiles and Updated Topographic Data)

Responsible Entity: {Insert name of Mapping Partner responsible for this task}

Scope: Digital floodplain boundaries will be delineated for the flooding sources listed in the Introduction to this SOW. The mapping will incorporate newly acquired topographic information. The floodplain boundaries for the 1- and 0.2-percent-annual-chance floods will be delineated on a digital work map based on topographic data developed under Task 2 of this SOW. In addition, {insert responsible party} will be responsible for addressing all concerns or questions regarding this task raised during the independent QA/QC review (Task 9 of this SOW).

<Add additional details regarding the scope of this task, as appropriate>

Standards: All work conducted under this task shall conform to the standards specified for this task in the "Applicable Standards" section of this SOW.

Deliverables: Upon completion of floodplain mapping for {Insert flooding sources; specify a subset of all flooding sources being remapped}, the results will be submitted to {insert name of party responsible for QA/QC review of the hydrologic modeling} for independent review under Task 9 of this SOW. The mapping for the remaining flooding sources will be submitted for an independent QA/QC review at the completion of this task.

In accordance with the TSDN format described in Task 15 of this SOW, {Insert responsible party} shall make the following products available to the FEMA Lead:

<Add, modify or delete deliverables below, as necessary>

- Digital work maps with the 1- and 0.2-percent-annual chance floodplain boundaries and floodway boundaries (if delineated on the effective FIRM or FBFM) delineated. These maps should also include cross sections, BFEs, and flood insurance risk zone designation labels as shown on the FIRM and FBFM.

- <For Coastal Areas—delete if not for coastal area>Digital work map with the Coastal High Hazard Area (V Zone) delineated along {Indicate either Atlantic Ocean, Gulf of Mexico, Great Lakes, Pacific Ocean, or other.} shorelines. These maps should include transect locations, BFEs, and flood insurance risk zone designation labels.

Any backup or supplemental information used in the mapping required for the independent QA/QC review (Task 9 of this SOW) is to be included.

Task 8B - Floodplain Mapping (Refinement or Creation of Zone A)

Responsible Entity: {Insert name of Mapping Partner responsible for this task}

Scope: Digital floodplain boundaries will be delineated for the flooding sources listed in the Introduction to this SOW. The mapping will incorporate newly acquired topographic information. The floodplain boundaries for the 1-percent-annual-chance flood will be delineated on a digital work map based on topographic data developed under Task 2 of this SOW. In addition, {insert responsible party} will be responsible for addressing all concerns or questions regarding this task raised during the independent QA/QC review (Task 9 of this SOW).

<Add additional details regarding the scope of this task, as appropriate>

Standards: All work conducted under this task shall conform to the standards specified for this task in the "Applicable Standards" section of this SOW. {insert responsible party}may expand on the approaches for analyzing Zone A areas outlined in *Guidelines and Specifications for Flood Hazard Mapping Partners* and in FEMA 265, *Managing Floodplain Development in Approximate Zone A Areas* (April 1995), and/or develop new approaches. Such approaches must be coordinated with the FEMA Regional Project Officer before analysis and mapping begin.

Deliverables: Upon completion of floodplain mapping for {Insert flooding sources; specify a subset of all flooding sources being remapped}, the results will be submitted to {insert name of party responsible for QA/QC review of the hydrologic modeling} for independent review under Task 9 of this SOW. The mapping for the remaining flooding sources will be submitted for an independent QA/QC review at the completion of this task.

In accordance with the TSDN format described in Task 15 of this SOW, {Insert responsible party} shall make the following products available to the FEMA Lead:

<Add, modify or delete deliverables below, as necessary>

- Digital work maps with the 1-percent-annual chance floodplain boundaries delineated. These maps should include flood insurance risk zone designation (Zone A) labels.
- Written summary of the analysis methodologies used shall be included.
- <For Coastal Areas—delete if not for coastal area>Digital work map with the Coastal High Hazard Area (V Zone) delineated along {Indicate either Atlantic Ocean, Gulf of Mexico, Great Lakes, Pacific Ocean, or other.} shorelines. These maps must include flood insurance risk zone designation labels.
- Any backup or supplemental information, including supporting calculations and assumptions for any computed 1-percent-annual-chance water-surface elevations used in the mapping required for the independent QA/QC review (Task 9 of this SOW) is to be included. If computer models are used, input and output should be provided in both hardcopy and digital (CD-ROM, 3.5" diskette, or zip disk) format.
- If automated GIS-based models are applied, all input data, output data, intermediate data processing products, and GIS data layers shall be submitted.

Task 9 - Independent Quality Assurance/Quality Control Review of Floodplain Mapping (Revised Areas)

Responsible Entity: {Insert name of Mapping Partner responsible for this task}

Scope: {Insert responsible party} shall review the floodplain work maps submitted by {Insert party responsible for conducting the floodplain mapping} under Tasks 8, 8A, and 8B of this SOW to ensure that the results of the hydraulic analyses are accurately represented on the work maps. This work will include, at a minimum, the following:

<Add, modify or delete tasks below, as necessary>

- Cross sections were properly located and oriented on the work map and agree with the Floodway Data Table.
- The Base Flood Elevations (BFEs) shown on the work map are properly located and agree with the results of the hydraulic modeling.
- The floodway widths agree with the widths shown in the Floodway Data Table(s) and the results of the hydraulic modeling.
- The floodplain boundaries agree with the flood elevations shown in the Floodway Data Table(s) and the contour lines and other topographic information shown on the work maps.
- For coastal studies, setup and runup height elevations shown on the work map agree with those shown on the data table(s), and stillwater elevations are shown where coastal and riverine flooding studied in detail join.
- Zone designations are indicated properly.

Standards: All work conducted under this task shall conform to the standards specified for this task in the "Applicable Standards" section of this SOW.

Deliverables: In accordance with the TSDN format described in Task 15, {Insert responsible party} shall make the following products available to the FEMA Lead.

<Add, modify or delete deliverables below, as necessary>

- A Summary Report that describes the findings of the QA/QC review noting any deficiencies and providing recommendations to resolve them or agreeing with the mapping results.
- Recommendations to resolve any problems that arise as a result of the QA/QC review.
- An annotated work map with all questions and/or concerns indicated will be provided, if necessary.

Task 10 - Base Map Acquisition

Responsible Entity: {Insert name of Mapping Partner responsible for this task}

Scope: This task consists of obtaining the digital base map {specify which one} for the project, and includes the following activities:

<Add, modify or delete tasks below, as necessary>

- Obtain digital files (raster or vector) of the base map.
- Secure necessary permissions from the map source to allow FEMA's use and distribution of hardcopy and digital map products using the digital base map, free of charge.
- Certify that the digital data meets the minimum standards and specifications that FEMA requires for DFIRM production.
- Populate the DFIRM database with the information required by FEMA.

Standards: All work conducted under this task shall conform to the standards specified for this task in the "Applicable Standards" section of this SOW.

Deliverables: In accordance with the TSDN format described in Task 15, {Insert responsible party} shall make the following products available to the FEMA Lead.

<Add, modify or delete deliverables below, as necessary>

- Written certification that the digital data meet the minimum standards and specifications.
- Documentation that the digital base map can be used by FEMA.

Task 11 – Digital Flood Insurance Rate Map Production (Non-Revised Areas)

Responsible Entity: {Insert name of Mapping Partner responsible for this task}

Scope: For all flooding sources except those specified in the Introduction to this SO W (that will have updated flood data developed under Tasks 1 – 9), the effective FIRMs and Flood Boundary Floodway Maps (FBHMs) will be converted to digital format that conforms with FEMA DFIRM specifications. The base map acquired under Task 10 will be used for the conversion. The scope of this task covers the digitization of {insert number of panels} FIRM panels and {insert number of panels} FBFM panels. Letters of Map Change (LOMCs) issued since the current effective FIRM for each affected community will also be incorporated. The digital flood theme for the flooding sources specified in the Introduction will not be digitized as part of this task; rather, {insert name of responsbile party} will leave these as "holes" in the digital flood theme that will be filled in as part of Task 12 using digital flood data from Task 8.

<Add additional details regarding the scope of this task, as appropriate>

Standards: All work conducted under this task shall conform to the standards specified for this task in the "Applicable Standards" section of this SOW.

Deliverables: In accordance with the TSDN format described in Task 15, {Insert responsible party} shall make the following products available to the FEMA Lead.

<Add, modify or delete deliverables below, as necessary>

- DFIRM mapping files in one of the GIS file formats specified in FEMA's Digital Flood Insurance Rate Map (DFIRM) Specifications. These files should be provided on CD-ROM.
- DFIRM database files in one of the database formats specified in FEMA's Digital Flood Insurance Rate Map (DFIRM) Specifications. These files should also be provided on CD-ROM.
- Metadata files describing the DFIRM data should be provided. These files will include the required information and follow the examples shown in FEMA's Digital Flood Insurance Rate Map (DFIRM) Specifications.
- A complete set of plots of the DFIRM panels showing all detail at the scale(s) agreed upon in the "Scope of Project" will be provided.
- A Quality Assurance/Quality Control (QA/QC) report that includes a description and the results of all automated or manual quality assurance steps taken during the preparation of the DFIRMs will be provided.

Task 11A – Independent Quality Assurance/Quality Control Review of Digital Flood Insurance Rate Map Production (Non-Revised Areas)

Responsible Entity: {Insert name of Mapping Partner responsible for this task}

Scope: {Insert responsible party} shall review the DFIRM panels submitted by {Insert party responsible for producing DFIRM panels for non-revised (i.e., effective) areas} under Task 11 of this SOW to ensure that the new DFIRM panels accurately represent the information shown on the effective FIRMs and FBFMs for the area mapped. This work will include, at a minimum, checking the following:

<Add, modify or delete tasks below, as necessary>

- Cross sections were properly located and oriented as shown on the FIRM or FBFM.
- The BFEs are properly located and agree with the BFEs shown on the FIRM.
- The floodway widths agree with the widths shown on the FIRM or FBFM.
- The floodplain boundaries agree with the floodplain boundaries shown on the FIRM and the contour lines, other topographic information, and planimetric information shown on the DFIRM base.
- For coastal studies, setup and runup height elevations shown on the work map agree with those shown on the data table(s), and stillwater elevations are shown where coastal and riverine flooding studied in detail join.
- Zone designations are indicated properly.

Standards: All work conducted under this task shall conform to the standards specified for this task in the "Applicable Standards" section of this SOW.

Deliverables: In accordance with the TSDN format described in Task 15 of this SOW, {Insert responsible party} shall make the following products available to the FEMA Lead.

<Add, modify or delete deliverables below, as necessary>

- A Summary Report that describes the findings of the QA/QC review noting any deficiencies and providing recommendations to resolve them or agreeing with the mapping results;
- Recommendations to resolve any problems that arise as a result of the QA/QC review; and
- An annotated copy of the DFIRM with all questions and/or concerns indicated, if necessary.

Task 12 – Digital Flood Insurance Rate Map Production (Merge Revised and Non-Revised Information)

Responsible Entity: {Insert name of Mapping Partner responsible for this task}

Scope: Upon completion of the floodplain mapping tasks (Tasks 8, 8A, and/or 8B of this SOW) for the revised flooding sources and the DFIRM production for non-revised areas (Task 11 of this SOW), the digital floodplain data will be merged into a single, updated Digital FIRM. This work will include tying in Flood Profiles, floodplain boundaries and floodways with contiguous communities that were not studied as part of this SOW. {Insert name of responsible party} will be responsible for coordinating with those Mapping Partners conducting Tasks 8, 8A, 8B, and 11, as necessary, to resolve any potential tie-in issues.

<Add additional details regarding the scope of this task, as appropriate>

Standards: All work conducted under this task shall conform to the standards specified for this task in the "Applicable Standards" section of this SOW.

Deliverables: In accordance with the TSDN format described in Task 15 of this SOW, {Insert responsible party} shall make the following products available to the FEMA Lead.

<Add, modify or delete deliverables below, as necessary>

- DFIRM mapping files in one of the FEMA-approved GIS file formats. These files should be provided on CD-ROM.
- DFIRM database files in one of the FEMA-approved database formats. These files should also be provided on CD-ROM.
- Metadata files describing the DFIRM data are to be provided in FEMA-approved format.
- A complete set of plots of the DFIRM panels showing all detail at the scale(s) agreed upon in the "Scope of Project" shall be provided.
- A QA/QC report that includes a description and the results of all automated or manual QA/QC steps taken during the preparation of the DFIRMs shall be provided.

Task 12A – Application of Digital Flood Insurance Rate Map Graphics and Database Specifications

Responsible Entity: {Insert name of Mapping Partner responsible for this task}

Scope: Upon completion of the floodplain mapping tasks (Tasks 8, 8A, and/or 8B of this SOW) and DFIRM production tasks (Tasks 11 and 12 of this SOW), the DFIRM will be revised as appropriate to meet current FEMA graphic specifications. In addition, the DFIRM spatial database will be revised as appropriate to meet current FEMA database specifications. {Insert name of responsible party} will be responsible for coordinating with those Mapping Partners conducting Tasks 8, 8A, 8B, 11, and 12, as necessary, to resolve any problems.

<Add additional details regarding the scope of this task, as appropriate>

Standards: All work conducted under this task shall conform to the standards specified for this task in the "Applicable Standards" section of this SOW.

Deliverables: In accordance with the TSDN format described in Task 15 of this SOW, {Insert responsible party} shall make the following products available to the FEMA Lead.

<Add, modify or delete deliverables below, as necessary>

- DFIRM mapping files that meet FEMA specifications. These files should be provided on CD-ROM.
- DFIRM database files that meet FEMA specifications. These files should also be provided on CD-ROM.
- Metadata files that meet FEMA specifications.
- A complete set of plots of the DFIRM panels shall be prepared for the independent QA/QC review (Task 12B of this SOW).
- A QA/QC report that includes a description and the results of all automated or manual QA/QC steps taken during the preparation of the final DFIRMs shall be provided.

Task 12B – Independent Quality Assurance/Quality Control Review of Digital Flood Insurance Rate Map Product Meeting FEMA Graphics and Database Specifications

Responsible Entity: {Insert name of Mapping Partner responsible for this task}

Scope: Upon completion of the floodplain mapping tasks (Tasks 8, 8A, and/or 8B of this SOW) and DFIRM production tasks (Tasks 11 and 12 of this SOW), the DFIRM will be revised as appropriate to meet current FEMA graphic specifications. In addition, the DFIRM spatial database will be revised as appropriate to meet current FEMA database specifications. {Insert name of responsible party} will be responsible for coordinating with those Mapping Partners conducting Tasks 8, 8A, 8B, 11, and 12, as necessary, to resolve any problems.

<Add additional details regarding the scope of this task, as appropriate>

Standards: All work conducted under this task shall conform to the standards specified for this task in the "Applicable Standards" section of this SOW.

Deliverables: In accordance with the TSDN format described in Task 15 of this SOW, {Insert responsible party} shall make the following products available to the FEMA Lead.

<Add, modify or delete deliverables below, as necessary>

- A Summary Report that describes the findings of the QA/QC review noting any deficiencies and providing recommendations to resolve them or agreeing with the mapping results and the results of all automated or manual QA/QC steps taken during the independent QA/QC review;
- Recommendations to resolve any problems that arise as a result of the QA/QC review; and
- An annotated copy of the DFIRM with all questions and/or concerns indicated, if necessary.

Task 13 - Preliminary Digital Flood Insurance Rate Map and Flood Insurance Study Report Distribution

Responsible Entity: {Insert name of Mapping Partner responsible for this task}

Scope: This task consists of the final preparation, review and distribution of the preliminary FIRM and associated FIS report for community and public review and comment. The activities to be performed include:

<Add, modify or delete tasks below, as necessary>

- *FIS Report Preparation:* Unless instructed otherwise by FEMA, the revised FIS report will be prepared in the format of the existing FIS report. It will be revised to reflect current conditions, and include updated data tables and flood profiles. At a minimum, it will include the following: text; cover; vicinity map; tables; photographs (if available); profiles; floodway schematic; and, when necessary, transect schematic and transect location map.

- *QA/QC:* A final QA/QC review of the preliminary FIRMs and FIS report, including all data tables, flood profiles, and other components of the FIS, as appropriate, and the news release will be conducted. The QA/QC procedures will be consistent with the *Guidelines and Specifications for Flood Map Production Coordination Contractors (Final Draft)* referenced in the "Standards" subsection of this SOW.

- *Discrepancy Resolution:* The party conducting this task will be responsible for working with the party(ies) performing the other tasks of this project to resolve discrepancies identified during QA/QC.

- *Distribution of Preliminary DFIRM and FIS Report:* The Preliminary FIRM(s) and FIS report(s) will be distributed to the affected communities, State agencies, and others as appropriate.

- *News Release Preparation:* News release notifications of BFE changes will be prepared and submitted for QA/QC review (discussed below) before publication. The news release will summarize newly proposed BFEs, modifications to existing BFEs, and any changes to the community's floodplain management ordinances to be NFIP compliant.

- *Summary of Map Actions (SOMA) Preparation:* {insert name of responsible party} will prepare a Preliminary SOMA listing the Letters of Map Change that will be affected by the DFIRM.

- Standards: All work conducted under this task shall conform to the standards specified for this task in the "Applicable Standards" section of this SOW.

Deliverables: {Insert responsible party} shall make the following products available to the FEMA Lead.

<Add, modify or delete deliverables below, as necessary>

- {Insert number of sets to be printed} sets of printed Preliminary DFIRMs and revised FIS reports, including all updated data tables and Flood Profiles shall be mailed to the CEO and floodplain administrator of each community, the State NFIP Coordinator, the FEMA Regional Office, and others as directed by the FEMA Lead.

- Preliminary transmittal letters for each community receiving Preliminary copies of the DFIRM and FIS report shall be provided. These letters and any additional letters requested by the FEMA Lead or other FEMA staff shall be prepared in accordance with the current version of the FEMA *Document Control Procedures Manual.*

- Preliminary SOMA document prepared in accordance with FEMA requirements shall be provided.
- Revised DFIRM mapping files in the FEMA-approved format shall be provided on CD-ROM.
- Revised DFIRM database files in the FEMA-approved format shall be provided on CD-ROM.
- Revised metadata files in the FEMA-approved format shall be provided on CD-ROM.
- A QA/QC report that includes a description and the results of all automated or manual QA/QC steps taken during the preparation of the Preliminary DFIRM(s) and FIS report(s) shall be provided.

Task 14 - Post-Preliminary Processing

Responsible Entity: {Insert name of Mapping Partner responsible for this task}

Scope: This task consists of finalizing the FIRMs and FIS report after the preliminary FIS and FIRM have been issued for public review and comment. The activities to be performed include:

<Add, modify or delete tasks below, as necessary>

- *Initiation of Statutory 90-Day Appeal Period:* When required, upon completion of a 30-day community comment period and/or final coordination meeting with the community, {insert name of responsible Mapping Partner(s)} will arrange for and verify that a proposed BFE determination letter is sent to the community CEO(s) and floodplain administrator(s) for all affected communities, that a news release is published in prominent newspapers with local circulation within each affected community, and that a notice is published in the *Federal Register* in accordance with the current version of the FEMA *Guidelines and Specifications for Flood Hazard Mapping Partners* and *Document Control Procedures Manual.*

- *Resolving Appeals and Protests:* {insert name of responsible Mapping Partner(s)}will support FEMA in reviewing and resolving appeals and protests received during the 90-day appeal period. For each appeal and protest, the following activities will be conducted: initial processing of the submission, technical review of the appeal/protest, preparation of letters requesting additional supporting data, performing revised analyses, and preparing a proposed resolution for FEMA's review. {insert name of responsible Mapping Partner}will mail all associated correspondence upon authorization by FEMA.

- *Special Correspondence:* {insert name of responsible party(ies)} will support FEMA in responding to comments not received within the 90-day appeal period (referred to as "special correspondence"), including drafting responses for FEMA review. {insert name of responsible Mapping Partner}will also mail the final correspondence upon authorization by FEMA.

- *Revise FIRMs and FIS Report:* If necessary, {insert name of responsible Mapping Partner}will work with those parties responsible for preparing the DFIRM under Tasks 8, 8A, 8B, 11, and 12 of this SOW to revise the DFIRM(s) and FIS report(s) at the direction of the FEMA Lead and distribute Revised Preliminary copies of the DFIRM(s) and FIS reports, including data tables and Flood Profiles.

- *Letter of Final Determination:* {insert name of responsible Mapping Partner}k will work with FEMA to establish the effective date(s) for the DFIRM(s) and FIS report(s), and will prepare Letter(s) of Final Determination (LFDs) for FEMA review in accordance with the FEMA *Document Control Procedures Manual.*

- *GPO Processing:* {insert name of responsible Mapping Partner} will prepare final reproduction materials for the DFIRM(s) and FIS report(s) and provide these materials to FEMA. These materials will include camera-ready film negatives of the DFIRM(s) and paper copies of the FIS report(s) and profiles. In addition, the appropriate paperwork will be prepared and included with the FIRMs and FIS report, including the Transmittal Letter to the Community CEO, the Print Processing Worksheet, the Printing Requisition Form, and the Community Map Action Form.

- *Archiving Data:* {insert name of responsible Mapping Partner} will ensure the engineering backup data and related correspondence are packaged and stored properly in the library archives until they are transmitted to the Engineering Study Data Package Facility.

Standards: All work conducted under this task shall conform to the standards specified for this task in the "Applicable standards" section of this SOW.

Deliverables: In accordance with the requirements provided in the current version of the FEMA *Guidelines and Specifications for Flood Hazard Mapping Partners* and *Document Control Procedures Manaul* , {Insert responsible party} shall make the following products available to the FEMA Lead:

<Add, modify or delete deliverables below, as necessary>

- Documentation that the news release(s) was published in accordance with FEMA requirements;
- Documentation that the appropriate *Federal Register* notices were published in accordance with FEMA requirements;
- Draft LFD and associated backup data and information for FEMA review.
- Draft Special Correspondence and backup data and information for FEMA review.
- Appeal and Protest resolution letters, and all backup data and information for FEMA review.
- {Insert number of sets to be printed} sets of DFIRM negatives and printed FIS reports, including all updated data tables and Flood Profiles.
- Complete, organized Engineering Study Data Packages.

Task 15 - Reporting

All Project Team members for this project have reporting responsibilities for tasks included in this SOW. All Project Team members shall comply with the reporting requirements summarized in Volume 3 of *Guidelines and Specifications for Flood Hazard Mapping Partners*. In addition, the following reporting requirements shall be met:

- <Add reporting requirements, as appropriate>
- If any issues arise that could affect the completion of a task within the proposed scope or budget, the Mapping Partner that is responsible for that task must complete a Special Problem Report (SPR) as soon as possible after the issue is identified and submit it to the FEMA Lead. The SPR should describe the issue and propose possible resolutions.
- {Insert responsible party} will be responsible for collecting and maintaining a set of deliverables for all tasks and shall compile a comprehensive TSDN for the entire project.

All supporting documentation for the tasks in this SOW shall be submitted in the TSDN format in accordance with Appendix M of *Guidelines and Specifications for Flood Hazard Mapping Partners.*

Applicable Standards

The table on pages I-98, I-99, and I-100 summarizes the relevant standards that apply to each task described in this SOW.

Project Coordination

Throughout the project, all members of the Project Team will coordinate, as necessary, to ensure the products meet the technical and format specifications required and contain accurate, up-to-date information. Coordination activities will include:

<Add/delete/modify coordination activities, as necessary>

- Meetings, teleconferences, and videoconfernces with FEMA and other Project Team members {specify frequency or dates for meetings};
- Telephone conversations with FEMA and other Project Team members on a scheduled basis {specify schedule for calls} and an ad hoc basis, as required;
- Updates to FEMA status information systems; and
- E-mail, facsimile transmissions, and letters, as required.

Post-Submission Requirements

All Project Team members are responsible for assisting in the resolution of issues and questions raised prior to the DFIRM(s) becoming effective.

{Specify any post-submission requirements for each Project Team member.}

I.3.2 Time and Cost Estimate Template

FEMA designed the Time and Cost Estimate Template (pages I-103 to I-107) for Project Team members to use in preparing time and cost estimates for the Flood Map Project. Non-FEMA Project Team members shall develop time and cost estimates for assigned tasks. As part of the time and cost estimates, Project Team members also shall establish schedules for the assigned work. These schedules shall comply with the agreed-upon from the Scoping Meeting or changes shall be submitted to the FEMA Lead and the rest of the Project Team for approval.

[February 2002]

Time and Cost Estimate

Note that this form contains proprietary/privileged information and should be made available only to the FEMA Lead and/or FEMA Project Officer. Each member of the Project Management Team completes pertinent sections of the form for tasks assigned in the Project SOW and submits it to the FEMA Lead.

<table>
<tr><td colspan="2">1. Project Team Member:</td><td colspan="2">2. Community and/or County:</td></tr>
<tr><td>3. State:</td><td>4. Study Type:</td><td>5. Proposed Starting Date:</td><td>6. Completion Date:</td></tr>
<tr><td colspan="4">PLANNED WORK
PART I – DETAILED STUDY</td></tr>
<tr><td>7. Length of Stream(s):</td><td>8. Length of Coastline:</td><td>9. Community Area:</td><td>10. No. of Hydraulic Structures:</td></tr>
<tr><td colspan="2">11. No. of Valley Cross Sections:
Existing:_____ New:_____
Average Cost (New) $:_____</td><td colspan="2">12. Source(s):
Existing:_____
_____
_____</td></tr>
<tr><td colspan="4">PART II – APPROXIMATE STUDY</td></tr>
<tr><td>13. Length of Stream(s):</td><td colspan="3">14. Cost per Stream Mile $: _____
Estimated Cost $: _____</td></tr>
<tr><td colspan="4">PART III – MAPPING INFORMATION</td></tr>
<tr><td>15. No. of Revised Map Panels:_____</td><td>16. No. of Converted Map Panels:_____</td><td colspan="2">17. Base Map Source(s):_____
_____
_____</td></tr>
</table>

PART IV – SUMMARY OF COST ESTIMATE			
A. Labor Category (Fill in only for Assigned Tasks and mark others as "N/A.")	**Hourly Rate**	**Hours**	**Dollar Amount**
Task 1 – Field Surveys and Reconnaissance			
Task 2 – Topographic Data Development			
Task 3 – Independent QA/QC Review of Topographic Data			
Task 4 – Hydrologic Analyses			
Task 4A – Coastal Hazard Analyses			
Task 5 – Independent QA/QC Review of Hydrologic Analyses			
Task 5A – Independent QA/QC Review of Coastal Hazard Analyses			
Task 6 – Hydraulic Analyses			
Task 7 – Independent QA/QC Review of Hydraulic Analyses			
Task 8 – Floodplain Mapping (Detailed Riverine or Coastal Analysis)			
Task 8A – Floodplain Mapping (Redelineation Using Effective Profiles and Updated Topographic Data)			
Task 8B – Floodplain Mapping (Refinement or Creation of Zone A)			
Task 9 – Independent QA/QC Review of Floodplain Mapping (Revised Areas)			
Task 10 – Base Map Acquisition			
Task 11 – DFIRM Production (Non-Revised Areas)			
Task 11A– Independent QA/QC Review of DFIRM Production (Non-Revised Areas)			
Task 12 – DFIRM Production (Merge Revised and Non-Revised Information)			
Task 12A– Application of DFIRM Graphic and Database Specifications)			
Task 12B– Independent QA/QC Review of DFIRM Meeting Graphic and Database Specifications)			
Task 13 – Preliminary Map and Report Distribution			
Task 14 – Post-Preliminary Processing			
Task 15 – Reporting			

B. Burden			
Total Direct Labor Cost $	_____	x Rate _____ =	$ _____
C. Direct Material (Show Basis of Estimate)			$ _____
D. Travel MILEAGE Miles _____ x Rate $ _____ = $ _____ No. of Trips _____ PER DIEM No. of Days _____ x Rate $ _____ = $ _____			
E. Subcontractors (Separate cost basis justification for each attached)			$ _____
F. Other Direct Cost (Basis for estimate attached)			$ _____
G. General Administrative Cost			
Total Direct Labor Cost	$ _____	x Rate _____ =	$ _____
H. Fee (Where applicable)			$ _____
TOTAL ESTIMATED COSTS			$ _____
Remarks:			

PART V – PROJECT SCHEDULE (Fill in only for Assigned Tasks, Mark Others as "N/A.")			
Task Number	**Name**	**Start Date**	**End Date**
1	Field Surveys and Reconnaissance	December 31, 2002	December 31, 2002
2	Topographic Data Development		
3	Independent QA/QC Review of Topographic Data		
4	Hydrologic Analyses		
4A	Coastal Hazard Analyses		
5	Independent QA/QC Review of Hydrologic Analyses		
5A	Independent QA/QC Review of Coastal Hazard Analyses		
6	Hydraulic Analyses		
7	Independent QA/QC Review of Hydraulic Analyses		
8	Floodplain Mapping (Revised Areas)		
8A	Floodplain Mapping (Redelineation Using Effective Profiles and Updated Topographic Data)		
8B	Floodplain Mapping (Refinement or Creation of Zone A)		
9	Independent QA/QC Review of Floodplain Mapping (Revised Areas)		
10	Base Map Acquisition		
11	DFIRM Production (Non-Revised Areas)		
11A	Independent QA/QC Review of DFIRM Production (Non-Revised Areas)		
12	DFIRM Production (Merge Effective and Revised Information)		
12A	Application of DFIRM Graphic and Database Specifications		
12B	Independent QA/QC Review of DFIRM Meeting Graphic and Database Specifications)		

PART V – PROJECT SCHEDULE (Fill in only for Assigned Tasks, Mark Others as "N/A.")			
Task Number	**Name**	**Start Date**	**End Date**
13	Preliminary DFIRM and FIS Report Distribution		
14	Post-Preliminary Processing		
15	Reporting		
Name and Title of Person Preparing Estimate		Phone Number	Date

I.3.3 Notice to Proceed Letter Template

The FEMA AO or CO shall use the Notice to Proceed Letter Template (page I-109) to prepare the Notice to Proceed letter. The Notice to Proceed Letter distributes the final Scope of Work or Mapping Activity Statement to the Project Team members and notifies them to proceed accordingly.

[February 2002]

Federal Emergency Management Agency
{Insert Address of FEMA Office}

{Date}

{Name}
{Address2}
{Address3}
{Address4}
{Address5}

{Flood Mapping Project Title}
{Community(ies)}

{Salutation}:

With this letter, you are authorized to begin your portion of the work necessary to complete the {Insert Flood Mapping Project Title} for the above-referenced community(ies).

Enclosed is a final copy of the Project Management Plan for the project, which provides details on your portion of the work including the Statement of Work, Time- and Cost-Estimate, project time schedules, and project deliverables.

We look forward to working with your <choose one {Firm/Agency/Community--For CTPs} and the community officials of {Insert Name of Community}, as well as other {Insert Name of State} communities, to ensure that the goals of this Flood Mapping Project are met. This will allow {Insert Name of Community} to administer a more effective floodplain management program.

Sincerely,

{Insert Name of Contracting Officer and/or FEMA Lead}

{InsertTitle}

cc: {FEMA HQ Engineer}, FEMA Headquarters

{Insert Other Project Team Members, as necessary}

Enclosure

Task Number	Task Description	Guidelines Volume, Section/Subsection, and Appendix
1	Field Surveys and Reconnaissance	Volume 1, Sections 1.2, 1.3, 1.4 (specifically Subsection 1.4.2.1) Appendix A, Sections A.5, A.6, A.7, and A.8 Appendices B, C, and M
2	Topographic Data Development	Volume 1, Section 1.4 (specifically Subsection 1.4.2.1) Appendix A, Sections A.2 and A.3 Appendix M
3	Independent QA/QC Review of Topographic Data	Volume 1, Section 1.4 (specifically Subsections 1.4.1 and 1.4.2.1) Appendix A, Sections A.2, A.3, A.7 (specifically Subsection A.7.5), and A.8 (specifically Subsection A.8.6) Appendix M
4	Hydrologic Analyses	Volume 1, Section 1.4 (specifically Subsections 1.4.2.2 and 1.4.2.4) Appendix C, Sections C.1 and C.7 Appendices E, F, G, H, and M
4A	Coastal Hazard Analyses	Volume 1, Section 1.4 (specifically Subsection 1.4.2.2) Appendix A, Section A.4 Appendices B, D, and M
5	Independent QA/QC Review of Hydrologic Analyses	Volume 1, Section 1.4 (specifically Subsection 1.4.1) Appendix C, Section C.2 Appendices E, F, G, H, and M
5A	Independent QA/QC Review of Coastal Hazard Analyses	Volume 1, Section 1.4 (specifically Subsection 1.4.1) Appendix A, Section A.4 Appendices B, D, H, and M
6	Hydraulic Analyses	Volume 1, Section 1.4 (specifically Subsections 1.4.2.2 and 1.4.2.4) Appendix A, Section A.4 (specifically Subsection A.4.7) Appendix C, Sections C.3 and C.7 Appendices B, E, F, G, H, and M

Task Number	Task Description	Guidelines Volume, Section/Subsection, and Appendix
7	Independent QA/QC Review of Hydraulic Analyses	Volume 1, Section 1.4 (specifically Subsection 1.4.1) Appendix A, Section A.4 (specifically Subsection A.4.7) Appendix C, Section C.5 Appendices B, E, F, G, H, and M
8	Floodplain Mapping (Detailed Riverine or Coastal Analysis)	Volume 1, Section 1.4 (specifically Subsection 1.4.2.3) Appendix C, Sections C. 4 and C.6 Appendices K, L, and M
8A	Floodplain Mapping (Redelineation Using Effective Flood Profiles and Updated Topographic Data)	Volume 1, Section 1.4 (specifically Subsections 1.4.2.2 and 1.4.2.3) Appendices K. L, and M
8B	Floodplain Mapping (Refinement or Creation of Zone A)	Volume 1, Section 1.4 (specifically Subsection 1.4.2.3) Appendix C, Sections C.4 and C.6 Appendices K, L, and M
9	Independent QA/QC Review of Floodplain Mapping (Revised Areas)	Volume 1, Section 1.4 (specifically Subsections 1.4.1 and 1.4.2.3) Appendix C, Sections C.4 and C.6 Appendices D, K, L, and M
10	Base Map Acquisition and Preparation	Volume 1, Sections 1.3 (specifically Subsection 1.3.1.8) and 1.4 (specifically Subsection 1.4.3) Appendices A and B
11	DFIRM Production (Non-Revised Areas)	Volume 1, Section 1.4 (specifically Subsections 1.4.2.3 and 1.4.3.2) Appendices K, L, and M
11A	Independent QA/QC Review of DFIRM Production (Non-Revised Areas)	Volume 1, Section 1.4 (specifically Subsection 1.4.3) Appendices K, L, and M

Task Number	Task Description	Guidelines Volume, Section/Subsection, and Appendix
12	DFIRM Production (Merge Revised and Non-Revised Information)	Volume 1, Section 1.4 (specifically Subsections 1.4.2.3 and 1.4.3.3) Appendices K and L
12A	Application of DFIRM Graphic and Database Specifications	Volume 1, Section 1.4 (specifically Subsection 1.4.3) Appendices K and L
12B	Independent QA/QC Review of DFIRM Product Meeting FEMA Graphics and Database Specifications	Volume 1, Section 1.4 (specifically Subsection 1.4.3) Appendices K, L, and M
13	Preliminary DFIRM and FIS Report Distribution	Volume 1, Sections 1.4 (specifically Subsections 1.4.2 and 1.4.3) and 1.5 (specifically Subsection 1.5.1) Appendices J, K, L, and M
14	Post-Preliminary Processing	Volume 1, Section 1.5 Appendices J, K, L, and M
15	Reporting	Volume 3, Section 3.2

Map MODERNIZATION

Federal Emergency Management Agency

FEMA's Flood Hazard Mapping Program

Guidelines and Specifications *for* Flood Hazard Mapping Partners

Appendix J: Format and Specifications for Flood Insurance Study Reports

FEDERAL EMERGENCY MANAGEMENT AGENCY

www.fema.gov/mit/tsd/dl_cgs.htm

FINAL

February 2002

Appendix J

Format and Specifications for Flood Insurance Study Reports

The Federal Emergency Management Agency (FEMA) has established a concise, standardized format for the presentation of the facts, figures, and results of a Flood Map Project — the Flood Insurance Study (FIS) report. This Appendix includes guidance for the Mapping Partner that performed the detailed hydrologic and/or hydraulic analyses to follow in preparing and submitting content to be included in the FIS report. This Appendix also includes detailed FIS report preparation guidance for the Mapping Partner that reviews and processes the draft materials and prepares the Preliminary and Final versions of the FIS report, including submittal of the report to the FEMA Map Service Center (MSC). A sample, completed FIS report for a single community is included in Section J.4 for guidance.

J.1 Submittal Content for Flood Insurance Study Reports

The Mapping Partner that performed the detailed hydrologic and/or hydrologic analyses for the Flood Map Project (hereinafter referred to as the submitting Mapping Partner) shall submit only the information outlined below. Unless specifically requested to do so by the FEMA Lead for the Flood Map Project (usually, the Regional Project Officer or the Project Officer at FEMA Headquarters), the submitting Mapping Partner shall not draft a complete FIS report. The information submitted will be used by the Mapping Partner that reviews the draft materials provided by the submitting Mapping Partner and prepares the Preliminary and Final versions of the FIS report (hereinafter referred to as the processing Mapping Partner).

If FEMA published an effective FIS report for the community, the submitting Mapping Partner will not need to submit certain information. The submitting Mapping Partner is to limit the submitted information for each section to information pertinent to the current Flood Map Project and to those events that have occurred since the date of the effective FIS report (e.g. new population information, major flood event).

The processing Mapping Partner shall include the new information in the Preliminary and Final versions of the FIS report as discussed in Subsection J.2. The requirements to be followed by the submitting Mapping Partner are summarized in Subsections J.1.1 through J.1.7.

[February 2002]

J.1.1 Section 1.0, Introduction

For Subsection 1.1, Purpose of Study, the submitting Mapping Partner shall include the following information:

- Community name;
- County name; and
- State name.

For Section 1.2, Authority and Acknowledgments, the submitting Mapping Partner shall include the following information:

- Name(s) of Mapping Partner(s) that performed flood hazard analyses for Flood Map Project;
- Interagency Agreement Number or Contract Number;
- Completion date (month and year);
- Name and address of base map provider/agency; and
- Base map compilation source, scale, and date; coordinate system; projection; datum; any modifications to the base map source; and any restrictions on the release of base map data.

For Subsection 1.3, Coordination, the submitting Mapping Partner shall include the following information:

- Initial Consultation and Coordination Officer (CCO) meeting date, attendees, and agencies represented;
- Intermediate CCO meeting date, attendees, and agencies represented (if applicable); and
- Contacts made for purposes of acquiring information.

[February 2002]

J.1.2 Section 2.0, Area Studied

For Subsection 2.1, Scope of Study, the submitting Mapping Partner shall include the following information:

- Areas excluded from the study, as well as areas of extraterritorial jurisdiction;
- Names of flooding sources studied using detailed methods, listed in the same order as they appear in the Flood Profiles;
- Limits of detailed study for flooding sources studied partially using approximate methods;
- Names of Flooding sources studied by approximate methods; and
- Flooding sources on which the study was terminated, where the 1-percent-annual-chance floodplain permanently narrowed to less than 200 feet wide or for which the detailed study was ended where the drainage area was less than 1 square mile, when applicable.

For Subsection 2.2, Community Description, the submitting Mapping Partner shall include the following information:

- General description of the community's location within the county and state;
- Surrounding communities and their locations with respect to the subject community;
- Other nearby large cities and their locations relative to the community; and
- A brief description of the community.

The brief description may include population and census reference; patterns of residential and commercial development; the extent and nature of floodplain development; natural features that affect flood hazards in the community; and sufficient description of climatic, physiographic, and land use factors to support the discussion of flood problems that follows in Subsection 2.3.

For Subsection 2.3, Principal Flood Problems, the submitting Mapping Partner shall include the following information:

- Discharges and recurrence intervals of major floods;
- Locations (city and state) of all stream gages for studied streams;
- Any factors that aggravate flood problems; and

- Photographs of flooding, flood-control structures, and other flood-related subjects (with locations of photographs noted).

For Subsection 2.4, Flood Protection Measures, the submitting Mapping Partner shall include the following information:

- A description of all flood protection structures and floodplain management measures used to reduce potential flood damage;
- A description of all dams, including those affecting the community that lie outside the community;
- A description of dams within the community used for purposes other than flood control; and
- A description of levees and whether they meet the FEMA 3-foot freeboard requirement and any other provisions of Section 65.10 of the National Flood Insurance Program (NFIP) regulations.

In the description of levees, the submitting Mapping Partner shall identify any levees that have been certified by another Federal agency to provide flood protection, although they may not meet FEMA criteria, and the protected reaches.

[February 2002]

J.1.3 Section 3.0, Engineering Methods

For Subsection 3.1, Hydrologic Analyses, the submitting Mapping Partner shall include the following information:

- A description of the hydrologic analyses, including the computer model used, for all flooding sources studied using detailed methods;
- A Summary of Discharges Table, providing a summary of drainage area-peak discharge relationships for the streams studied by detailed methods; and
- A Summary of Stillwater Elevations Table, providing a summary of 10-percent-annual-chance (10-year), 2-percent-annual-chance (50-year), 1-percent-annual-chance (100-year), and 0.2-percent-annual-chance (500-year) flood elevations at all lakes and ponds studied using detailed methods and along streams in cases where elevations would create a flat profile along the studied reach.

For the Summary of Discharges Table, drainage areas for each stream are to be listed in descending order. Streams are to be listed in the same order as they appear in the Flood Profiles. A sample Summary of Discharges Table is provided in the sample report in Section J.4.

For the Summary of Stillwater Elevations Table, flooding sources are to be listed alphabetically; locations are to be listed from upstream to downstream. A sample Summary of Stillwater Elevations table is provided in the sample report in Section J.4..

For Subsection 3.2, Hydraulic Analyses, the submitting Mapping Partner shall include the following information:

- A description of the method used for developing cross sections for all streams studied by detailed methods;
- A description of the method used for determining the dimensions of hydraulic structures;
- A description of the method used for assigning channel roughness factors (Manning's "n") and the "n" values for all streams studied by detailed methods (channel and overbank areas);
- A description of the method used for obtaining water-surface elevations for all streams studied by detailed methods, including the computer model used;
- A description of the method used for obtaining starting water-surface elevations for all streams studied by detailed methods;
- A description of the method used for studying wave height and wave runup; lacustrine, ice jam, and alluvial fan flooding; and areas of shallow flooding (where applicable), including the computer model used;
- Transect Descriptions, when applicable, that includes the transect number, location, 1-percent-annual-chance stillwater elevation, and maximum 1-percent-annual-chance wave elevation;
- A description of the hydraulic analyses for approximate flooding sources, if performed;
- Transect Data Table, when applicable, that includes the flooding source (with the affected transects); 10-, 2-, 1-, and 0.2-percent-annual-chance stillwater elevations; zone designation; and Base Flood Elevation (BFE);
- Transect schematic, when applicable; and
- Transect Location Map, when applicable.

For Section 3.3, Vertical Datum, the submitting Mapping Partner shall include the vertical datum and releveling dates, if any, and the conversion factors, if any.

[February 2002]

J.1.4 Section 4.0, Floodplain Management Applications

For Subsection 4.1, Floodplain Boundaries, the submitting Mapping Partner shall include information on the following:

- All source maps used, including scale, contour interval, date of map, and type of map (e.g., topographic, compiled from aerial photographs) or information used to create the work map; and
- All maps or methods used to delineate floodplain boundaries for flooding sources studied by approximate methods.

For Subsection 4.2, Floodways, the submitting Mapping Partner shall include the following information when floodways are computed:

- Names of all streams for which regulatory floodway widths extend beyond the corporate or county limits;
- Names of all streams affected by backwater from other streams;
- A description of the method(s) used for computing regulatory floodway(s);
- Floodway Data Table;
- Floodway schematic;
- Reason(s) why regulatory floodways were not computed and delineated for certain streams or portions of streams; and
- A description of any unusual procedures, such as State-imposed or locally imposed surcharge limits of less than 1.0 foot for regulatory floodway.

[February 2002]

J.1.5 Section 5.0, Insurance Application

For Section 5.0, the submitting Mapping Partner does not need to submit any information, unless specifically directed to prepare a complete FIS report. Section 5.0 shall include the standard language that appears in the sample FIS report in Section J.5.

[February 2002]

J.1.6 Section 6.0, Flood Insurance Rate Map

For Section 6.0, the submitting Mapping Partner does not need to submit any information, unless specifically directed to prepare a complete FIS report. Section 6.0 shall include the standard language that appears in the sample FIS report in Section J.5.

[February 2002]

J.1.7 Section 7.0, Other Studies

For Section 7.0, the submitting Mapping Partner shall identify and reference all FEMA studies and restudies for contiguous communities and any other published reports or available data covering flooding sources in the community or county. All disagreements and discrepancies shall be noted and/or resolved.

[February 2002]

J.1.8 Section 8.0, Location of Data

For Section 8.0, the submitting Mapping Partner does not need to submit any information, unless specifically directed to prepare a complete FIS report. Section 8.0 shall include the standard language that appears in the sample FIS report in Section J.5 as well as the address for the FEMA RO for the state in which community is located.

[February 2002]

J.1.9 Section 9.0, Bibliography and References

For Section 9.0, the submitting Mapping Partner shall list references with complete information. For all references, the author or originating agency, title, date of publication or distribution, and place of publication (Washington, DC not needed for Federal agency publications) shall be included. For map references, the map scale and contour interval (as applicable) shall be included.

[February 2002]

J.1.10 Exhibit 1, Flood Profiles

For Exhibit 1, Flood Profiles, new Flood Profiles or revised Flood Profiles for all flooding sources studied by detailed methods are to be listed. See Subsection J.2.3.1 for Flood Profile specifications.

[February 2002]

J.2 Preparation of Flood Insurance Study Reports

The FIS report shall include cover, text, tables (as applicable), photographs (if available), floodway schematic (if applicable), transect schematic (if applicable), transect location map (if applicable), and Flood Profiles (if applicable). The processing Mapping Partner shall follow the specifications in this section in preparing Preliminary and Final versions of new and revised FIS reports. Requirements for format and text content, standard paragraphs and language, graphic specifications, and organization are summarized in the subsections that follow.

[February 2002]

J.2.1 Format and Text Content Specifications

The sample FIS report located in Section J.4 presents the overall format and sections required to produce an FIS report for final printing and is supplemented by Figures J-1 through J-15 at the end of this Appendix.

The content of the sample single-jurisdiction report is fictional. The sample presents an original report that has been revised twice by adding an additional section to the report. The sections, subsections, paragraphs and language required for every FIS report appear in bold-faced type. The language of the specific content within the sections can be used as guidance. The subsections below present the different formats of FIS reports and list the additions or changes to the sample report required for each.

Additional guidance and requirements for the Mapping Partner that prepares the FIS report in final form for FEMA (hereinafter referred to as the processing Mapping Partner) are provided below.

- The margins of all pages are to be approximately 1 inch to allow for binding of the printed FIS report.

- The final camera-ready text pages are to be typed, single-spaced, on 8-½" x 11", good-quality non-grain paper. Negatives of the text pages are not required for camera-ready deliverables submitted to the MSC for publication by the U.S. Government Printing Office (GPO).

- Most of the required tables may be typed as part of the text; hence, they require no graphics preparation. They may be produced in a landscape or portrait format, with preference given to the best presentation based on the size of the tables. The sample report in Section J.4 and Figures J-7 through J-15 at the end of this Appendix provide guidance on table presentation. In some cases, it may be appropriate for the processing Mapping Partner to use the same graphic format used for the effective FIS report materials for consistency of presentation.

- The format of Section 9.0, Bibliography and References, in the sample report is one method that may be used to present the references within the body of the FIS report and in Section 9.0. Other industry-accepted formats may be used as long as the application of the format is consistent within the FIS report. If an FIS report is revised or the FIS report is revised by Addendum (see Subsection J.2.1.6), the format used for the effective FIS report must be followed.

- The opening page of all FIS reports is the Notice to Flood Insurance Study Users. When the results of a Flood Map Project are issued in Preliminary form for community review, FIS reports are to include the following note at the bottom of that page if any unchanged components have been omitted from the Preliminary version of the FIS report:

  The Preliminary FIS report does not include unrevised Floodway Data Tables or unrevised Flood Profiles. These unrevised components will appear in the final FIS report.

  The processing Mapping Partner shall remove this note before the FIS report is submitted to the MSC for printing by GPO.

- If the vertical datum used for the Flood Map Project or map revision is North American Vertical Datum of 1988 (NAVD88) or if the vertical datum was changed from National Geodetic Vertical Datum of 1929 (NGVD29) to NAVD88, all FIS report components including, but not limited to, the Floodway Data Table and the Flood Profiles, must reflect the correct datum title.

[February 2002]

J.2.1.1 Map Initiatives Format

The FEMA Map Initiatives Format is used to present all flood hazard information on the Flood Insurance Rate Map (FIRM), including floodplain boundary delineations, floodway boundary delineations, zone labels, BFEs, and cross sections. When a FIRM is prepared in the Map Initiatives Format, some specific text changes shall be made to the FIS report. Guidance on when an FIS report is to be prepared in the Map Initiatives Format is provided below.

[February 2002]

First-Time Flood Insurance Study Report

The processing Mapping Partner shall use the Map Initiatives Format for a single-jurisdiction FIS report for a community that does not have an effective FIS report. The sample FIS report in Section J.4 (without the additional revisions section) presents the information requiremed for a first-time FIS report prepared in the Map Initiatives Format.

[February 2002]

Conversion of Standard Format to Map Initiatives Format

The processing Mapping Partner shall use the Map Initiatives Format also when converting the FIS report from the Standard Format; that is, to combine flood hazard and regulatory floodway data previously included on FIRMs and Flood Boundary and Floodway Maps (FBFMs) into a single FIRM format. Requirements concerning format and organization are provided below.

The processing Mapping Partner shall include the following information at the end of the Notice to Flood Insurance Study Users included in the sample report in Section J.4:

> **Selected Flood Insurance Rate Map panels for this community contain information that was previously shown separately on the corresponding Flood Boundary and Floodway Map panels (e.g., floodways, cross sections). In addition, former flood hazard zone designations have been changed as follows:**

Old Zone(s)	New Zone
A1 through A30	AE
V1 through V30	VE
B	X
C	X

The processing Mapping Partner shall complete and substitute the following paragraph for the first paragraph in Subsection 1.1 of the FIS report:

> **This Flood Insurance Study (FIS) report has been prepared to revise and update a previous FIS report/Flood Insurance Rate Map (FIRM) for the [Full Community Name]. This information will be used by [Community Name] to update existing floodplain regulations as part of the Regular Phase of the National Flood Insurance Program (NFIP). The information will also be used by local and regional planners to further promote sound land use and floodplain development.**

[February 2002]

J.2.1.2 Partial Map Initiatives Format

For some FIS reports, FEMA may direct the processing Mapping Partner to prepare the FIRM and FIS report in the Partial Map Initiatives Format. That is, FEMA may request that the processing Mapping Partner prepare only certain FIRM panels and certain portions of the FIS report in the Map Initiatives Format. Specific requirements for the format and organization of an FIS report prepared in the Partial Map Initiatives Format are provided below.

The processing Mapping Partner shall include the following information at the end of the standard Notice to Flood Insurance Study Users included in the sample report in Section J.4:

> **Selected Flood Insurance Rate Map panels for this community contain information that was previously shown separately on the corresponding Flood Boundary and Floodway Map panels (e.g., floodways and cross sections). In addition, former flood insurance risk zone designations have been changed as follows.**
>
> | Old Zone(s) | New Zone |
> |---|---|
> | A1-A30 | AE |
> | V1-V30 | VE |
> | B | X |
> | C | X |
>
> **Initial Effective Date:** **January 20, 1990**
>
> **Revised Dates:** **April 15, 1994 – to change Special Flood Hazard Areas, to change Base Flood Elevations, to change zone designations, and to add Special Flood Hazard Areas, dated May 13, 1990, from Fulton County, Pennsylvania.**
>
> **August 22, 1997**

This additional information for the Notice to Flood Insurance Study Users provides for the addition of the Reason for Revision with the revision dates. The processing Mapping Partner shall use the addition when room is limited on the FIRM panel. The most recent date represents the "current" revision, and the reasons for this revision are those that appear on the FIRM legend. See Appendix K of these Guidelines for a complete discussion of map dates in the legend.

[February 2002]

J.2.1.3 Countywide Format

The Countywide Format is used to present a unified study of flood hazards across community boundaries within a county. The processing Mapping Partner generally shall follow the sample report provided in Section J.4; however, several changes shall be made to the standard wording and tables. Those changes are presented below in the order of their appearance in the FIS report.

Subsection 1.1, Purpose of Study

The processing Mapping Partner shall complete and substitute the following paragraph for the first paragraph:

> **This Flood Insurance Study (FIS) revises and supersedes the FIS reports and/or Flood Insurance Rate Maps (FIRMs) [/Flood Boundary and Floodway Maps] in the geographic area of _____ County, State, including the [Complete Names of Incorporated Communities, in Alphabetical Order] and unincorporated areas of _____ County (hereinafter referred to collectively as _____ County), and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This study has developed flood risk data for various areas of the community that will be used to establish actuarial flood insurance rates. This information will also be used by _____ County to update existing floodplain regulations as part of the Regular Phase of the National Flood Insurance Program (NFIP), and by local and regional planners to further promote sound land use and floodplain development. Minimum floodplain management requirements for participation in the NFIP are set forth in the Code of Federal Regulations at 44 CFR, 60.3.**

Subsection 2.1, Scope of Study

The processing Mapping Partner shall complete and substitute the following sentence for the first sentence:

> **This FIS covers the geographic area of _____ County, [State].**

[February 2002]

Section 6.0, Flood Insurance Rate Map

The processing Mapping Partner shall complete and add the following paragraph at the end of the section:

> **The current FIRM presents flooding information for the entire geographic area of _____ County. Previously, separate Firms were prepared for each identified floodprone incorporated community and the unincorporated areas of the county. Historical data relating to the maps prepared for each community are presented in Table ___.**

The processing Mapping Partner also shall add a Community Map History Table in this section. Format and specifications for this table are presented in Figure J-15 at the end of this Appendix.

[February 2002]

J.2.1.4 Existing Data Studies and Existing Data Restudies

Existing Data Studies and Existing Data Restudies are processed when analyses that are conducted independently for purposes other than the NFIP are submitted to update flood hazards shown on NFIP maps. For Existing Data Studies and Existing Data Restudies, the processing Mapping Partner shall produce the FIS reports in the format provided in the sample report in Section J.4, with the name of the agency that is the source of data cited in Subsection 1.2 of the FIS report.

[February 2002]

J.2.1.5 Flood Insurance Study Report/Flood Insurance Rate Map Combinations

For small-scale Flood Map Projects and map revisions, especially those that include single-panel FIRMs, the FEMA RPO, PO or his/her designee may direct the processing Mapping Partner to print the FIS report directly on the FIRM panel. Additional information on this mapping format is provided in Appendix K. Interested parties may order an example of this format from the FEMA MSC by calling 1-800-358-9616.

[February 2002]

J.2.1.6 Revisions by Addendum

If FEMA directs the processing Mapping Partner to revise an FIS report but not reformat it, the processing Mapping Partner shall ensure that the format, organization, and content of the report follow that of the effective FIS report, with some exceptions. The processing Mapping Partner shall take the most cost-effective approach to updating the FIS report; the minimum work required is the creation of an addendum, or additional section, that shall be placed at the end of the FIS report. This section, Revisions Description, shall appear as Section 9.0 for reports prepared in Standard Format or as Section 10.0 for reports prepared in Map Initiatives Format.

The Revisions Description section is to provide information regarding the significant revisions that were made since the FIS report was last printed. The processing Mapping Partner shall include a subsection for each revision, and shall ensure that the subsections are numbered consecutively (e.g., 9.1, 9.2, for reports prepared in Standard Format; 10.1, 10.2, for reports prepared in Map Initiatives Format). Samples of the added section can be found in the sample report in Section J.4.

If the addendum format is used, the processing Mapping Partner shall include the information below in the "Notice to Flood Insurance Study Users" in addition to the information found in the sample FIS report. The processing Mapping Partner shall substitute Section 10.0 with Section 9.0 and Sections 1.0 through 9.0 with Sections 1.0 through 8.0 if the effective FIS report was prepared in the Standard Format.

This FIS report was revised on [add new effective date]. Users should refer to Section 10.0, Revisions Description, for further information. Section 10.0 is intended to present the most up-to-date information for specific portions of this FIS report. Therefore, users of this FIS report should be aware that the information presented in Section 10.0 supersedes information in Sections 1.0 through 9.0 of this FIS report.

[February 2002]

J.2.2 Graphic and Table Elements

The requirements for the graphic and table elements of an FIS report are summarized in Subsections J.2.2.1 through J.2.2.7. Graphic examples of report elements are provided in the sample report in Section J.4 and in Figures J-1 through J-5 at the end of this Appendix.

[February 2002]

J.2.2.1 Cover

The processing Mapping Partner shall use the existing cover of the FIS report if it was prepared according to the requirements below. If the processing Mapping Partner creates a new FIS report, the cover need not include the outline of the subject county and State. The processing Mapping Partner shall provide the final camera-ready cover on 9" x12" contact negative film.

The following are requirements for the presentation of the final FIS report cover:

- Where applicable, the effective date or revised date (matching that shown on the FIRM) is to be shown.
- The legal name of the community (e.g., City of _____, Township of _____), the County name, and the State name is to be shown. The legal name may be obtained by requesting a letterhead from the community.
- If the FIS report is to be printed in two or more volumes, a separate cover is to be prepared for each volume, indicating the appropriate number of the volume. See Figures J-1, J-2, and J-3 at the end of this Appendix for presentation requirements.
- Countywide FIS report covers are to include a list of the names and community identification numbers of the county and all incorporated communities, including non-floodprone communities.

[February 2002]

J.2.2.2 Vicinity Map

If the effective FIS report for a subject community includes a Vicinity Map, the processing Mapping Partner shall remove the Vicinity Map when preparing the revised FIS report. If a new FIS report is created, the processing Mapping Partner shall not create a Vicinity Map.

[February 2002]

J.2.2.3 Transect Location Map

For Flood Map Projects and map revisions that include wave height or wave runup analyses, the locations of transects used in the analyses are to be shown on a Transect Location Map. When a Transect Location Map is required, the processing Mapping Partner shall prepare the frame according to the specifications given in the sample FIS report in Section J.4. The processing Mapping Partner shall prepare the final Transect Location Map on 9" x 12" contact negative film.

[February 2002]

J.2.2.4 Flood Photographs

If flood photographs are to be used in the FIS report, the processing Mapping Partner shall submit the screened photographs set in their correct locations in the FIS report. The processing Mapping Partner may prepare the photographs in positive or negative camera-ready form.

[February 2002]

J.2.2.5 Schematics

The processing Mapping Partner shall include a floodway schematic and/or a transect schematic, when applicable. The processing Mapping Partner shall refer to the sample report in Section J.4 and to Figure J-5 at the end of this Appendix for requirements for the schematics.

[February 2002]

J.2.2.6 Floodway Data Table

A Floodway Data Table is to be created for each flooding source for which a regulatory floodway has been designated on the FIRM or FBFM. Floodway data are to be shown for each cross section shown on the FIRM or FBFM. Cross-section labels must be consistent with the FIRM, FBFM, and Flood Profiles. The water-surface elevations in the "Regulatory" column must be identical to the elevations shown on the Flood Profiles. The "Without Floodway" column must contain the natural 1-percent-annual-chance (100-year) water-surface elevations of streams computed without consideration of backwater from other flooding sources. These two columns will contain identical elevations except in confluence situations where regulatory elevations are determined by another flooding source.

Cross-section data may be shown for areas of backwater flooding; however, elevations in the "Without Floodway" column of the Floodway Data Table must be footnoted as follows:

> Elevation Computed Without Consideration of Backwater Effects From (Source of Flooding)

The words "Backwater Effects" are to be replaced with "Tidal Effects," "Overflow Effects," "Ice Jam Effects," or "Storm Surge Effects," to reference the appropriate flooding situation.

Where a rise in energy grade has been used to determine the regulatory floodway, the computed change in water-surface elevation must be shown, even though these changes may be small. When negative surcharges are encountered, the "Increase" column must be shown as 0.0, and the value in the "With Floodway" column must be the same as the value in the "Without Floodway" column. In general, when bridge cross-section data are included in the table, only the data for the cross section at the upstream face of the bridge is to be provided on the Floodway Data Table.

The regulatory floodway width values shown on the Floodway Data Table must be rounded to the nearest whole foot. When a part of a regulatory floodway is outside the corporate or county limits and the width within the corporate or county limits is not shown, the "Width" column must be footnoted as follows:

"This Width Extends Beyond the Corporate/County Limits."

When both the total width and the width within the corporate/county limits are known, the "width" column must be footnoted as follows:

"Width/Width Within Corporate (County) Limits."

The specifications for the Floodway Data Table are provided in the sample report in Section J.4.

[February 2002]

J.2.2.7 Flood Insurance Zone Data Table

For revised FIS reports that are kept in the Standard Format, flood insurance zone data are to be tabulated at the direction of the FEMA RPO, PO, or his/her designee. Flood insurance zone data are to be included in the appropriate format for each flooding source studied by detailed methods. However, backwater reaches of a tributary stream are not to be listed when the main stream has also been studied and zone data are listed for it in the table. The specifications for the Flood Insurance Zone Data Table are provided in Figure J-15.

In situations where the FIRM is being produced, in whole or in part, in the Map Initiatives Format, the processing Mapping Partner shall remove the Flood Insurance Zone Data Table from the FIS report.

[February 2002]

J.2.3 Flood Profiles

The processing Mapping Partner may use the Flood Profiles generated by the submitting Mapping Partner for final publication if they are technically accurate and legible and they meet the standards and requirements summarized in Subsection J.2.3.1

[February 2002]

J.2.3.1 Flood Profile Standards and Requirements

The submitting Mapping Partner and processing Mapping Partner shall ensure that the Flood Profiles meet the following standards and requirements:

- The Flood Profiles for each stream studied by detailed methods shall be drawn in a standard format, using the format, symbol, and type specifications shown on the Flood Profile in the sample report in Section J.4. If a main stream has backwater effects on a tributary stream, and the flood elevations computed for the main stream are revised, the Flood Profiles for the tributary stream shall be revised accordingly.

- Flood Profiles shall not be plotted for more than one flooding source on each panel, with one exception. When a main stream goes by one name to a point where it is formed by the confluence of two small tributary streams, one of the tributary streams shall be selected as a logical continuation of the main stream. The Flood Profile shall then continue, uninterrupted, up the tributary. The Flood Profile panel shall show both the stream names in the title block and indicate the point where the name change occurs. The main stream stationing and cross-section sequencing are to continue up the tributary stream. Each stream shall be treated separately in the text and tables. Flood Profiles shall be continuous for the entire stream length studied.

- When the Flood Profiles are prepared for the first time, or existing Flood Profiles are revised, the 10-, 2-, or 0.2-percent-annual-chance flood lines shall not be included. The water-surface profiles of the 1-percent-annual-chance flood and the channel bottom (streambed) or hydraulic base line only are to appear.

- Breaks in the Flood Profile shall not occur for stream segments passing through areas not included or where the stream and floodplains leave and return to the community. Flood Profiles are also required for those watercourse segments that may not lie within the community, but do contribute to the flood inundation within the community. Profile limits are to include areas where the stream has left the community, but flood inundation continues. The processing Mapping Partner shall label those limits that are located outside the community as "Limit of Flooding Affecting Community."

- On the Flood Profiles for tributary streams, the 1-percent-annual-chance flood backwater from the main watercourse or water body shall be labeled as "Backwater From (Main Stream Name)."

- All drawdowns shall be eliminated from the Flood Profiles.

- Any well-documented high-water marks of past major floods that are discovered during the reconnaissance shall be shown and referenced on the Flood Profiles.

Additional guidance regarding scale, cross sections, physical features, restudied streams, and reach and zone labels is provided in the subsections below.

[February 2002]

Scale

An elevation scale (vertical) of 1 inch equals 1, 2, 5, 10, or 20 feet is to be used. Use of non-whole-foot scales (e.g., 1 inch = 2.5 feet) shall be approved by the FEMA RPO, PO, or his/her designee. Elevations shall be shown on the left side of the grid at 1-inch intervals within the profile elevation range. Elevations need not be shown on the right side of the grid. The profile plots shall agree to within 1/20 inch of the 1-percent-annual-chance regulatory flood elevations provided in the Floodway Data Table.

The stream distance scale that is used shall be chosen so that the profile measures at least 3 inches in length and the average slope across the profile page does not exceed 35 degrees. When determining scales, the Mapping Partner shall consider the total number of Flood Profiles that will be created. A horizontal scale of 1 inch equals 100, 200, 400, 500, 1,000, or 2,000 feet is preferred. The horizontal scale shall be labeled at 1-inch intervals along the bottom edge of the grid and legend box.

The use of miles, and fractions thereof, is to be avoided except for major flooding sources where a reference system in miles has already been established. However, the units for any one flooding source shall be consistent. Stationing notation (i.e., 100 + 00) is to be converted into conventional feet measurement. Stationing is to be referenced from a physical location such as a confluence or structure. Corporate limits are only be used as a last resort for Flood Profile stationing.

Downstream elevations are to begin on the left edge of the grid. Stream distance is measured along the stream channel centerline or some other hydraulic base line as defined and delineated on the work maps submitted by the submitting Mapping Partner. Distance and elevation units used on a Flood Profile must be consistent with the units provided in the computer printout and with the units used on the Floodway Data Table.

[February 2002]

Cross Sections

Flood Profile cross sections must be plotted at distances that are consistent with tabular data and work map locations. Cross sections for each stream are to be labeled in alphabetical sequence, beginning at the downstream study limit. For each stream, the labels are to begin with A, B, C, and continue to Y, Z, AA, AB, ... AZ, BA, BB, BC, and so forth. Cross-section sequences must not be carried over from one stream to another unless the hydraulic model is continuous from one stream to another. Cross-section labels are to be shown within hexagonal shapes; when close spacing necessitates, hexagons are to be stacked, as shown on the sample Flood Profile in

the sample FIS report in Section J.4. The location of the cross section indicated by the placement of the hexagon must not deviate more than 0.05 inch from the location presented on the Floodway Data Table. For short stream segments that meander beyond the detailed study limits, and for stream segments for which no regulatory floodway is computed, selected sequentially labeled cross sections may be shown on the Flood Profile.

[February 2002]

Physical Features

All hydraulic structures, points of confluence, corporate limits, and other pertinent information must be indicated on the Flood Profiles. Points of confluence for entering tributaries are to be labeled as "Confluence with (Stream Name)."

For bridges, top of road (TOR), and low steel (LS) are to be represented by the conventional symbol, "I," where TOR is represented by the upper horizontal bar, LS by the lower bar, and the center of the structure by the vertical bar. For high-level bridges where the symbol cannot be shown on the Flood Profile, TOR and LS elevations are to be indicated.

For culverts, the symbol is to represent the overburden. The culvert pipe is assumed to be the open area between the streambed and the bottom of the overburden.

[February 2002]

Restudied Streams

In preparing Flood Profiles for restudied streams, the processing Mapping Partner shall maintain the existing format. For example, the processing Mapping Partner shall use the horizontal and vertical scales used in the effective FIS report. Stationing notation and datum reference must be consistent with effective Flood Profiles to perform any modifications in a cost-effective manner.

The processing Mapping Partner shall ensure that all Flood Profiles for restudied streams reflect 1-percent-annual-chance (100-year) flood elevations and reflect the streambed or hydraulic baseline. The processing Mapping Partner shall ensure that all structures reflected on the effective Flood Profiles as well as any new structures are depicted on the revised Flood Profile. All cross sections shown on the revised FIRM (or FBFM) and in the Floodway Data Table must be clearly reflected on the submitted profiles. The processing Mapping Partner shall obtain approval from the FEMA Lead for deviations from the effective Flood Profile format.

The processing Mapping Partner shall adjust the backwater area on Flood Profiles for tributaries that flow into a revised stream to reflect the revised elevations.

[February 2002]

Reach and Zone Labels

In situations where the FIRM is being produced, in whole or in part, in the Map Initiatives Format, the processing Mapping Partner shall remove reach and zone labels from all Flood Profiles.

[February 2002]

J.2.3.2 Flood Profile Production

Flood Profiles may be prepared digitally or manually; digital files are preferred. Additional guidance regarding digital and manual Flood Profile production is provided in the subsections that follow.

[February 2002]

Digital Flood Profile Production

Two software applications for profile creation are available for download, free of charge, from the FEMA website (http://www.fema.gov/mit/tsdfrm_soft.htm).

The first application is RASPLOT. Refer to the RASPLOT User's Manual, available for separate download, for guidance regarding its use.

The second application is FISPLOT. The FISPLOT program allows users to create drawing interchange format (*.DXF) files from HEC-2 input and output files. FISPLOT may later be enhanced so that it can generate Flood Profiles from other backwater computer models, such as WSPRO and WSP2.

The FISPLOT-generated *.DXF files can then be imported into AutoCAD® and all the appropriate FEMA symbols, such as bridge deck information, are displayed in an AutoCAD® drawing (*.DWG) file.

However, equivalent software may be used, provided that the output file produces a Flood Profile that meets the requirements above. Mapping partners should contact the RPO to discuss using alternative software platforms.

[February 2002]

Manual Flood Profile Production

Flood Profiles are to be neatly drawn and lettered on standard 11"x17", 10x10 to the inch grid, mylar profile sheets. At the submitting Mapping Partner's request, the FEMA Lead may provide assistance in obtaining blank standard mylar profile sheets. Use of non-standard profile sheets (i.e., continuous computer-generated profile sheets or paper copy vs. mylar) shall be coordinated and approved by the FEMA Lead. If the use of a continuous profile sheet is approved, the Mapping Partner shall ensure that the selected vertical scale would not necessitate replotting the

profiles; i.e., the Mapping Partner responsible for producing the final Flood Profile should be able to trace-draft the submitted continuous profile sheet onto standard 11"x17" mylar profile sheets.

[February 2002]

J.3 Volume Printing

The processing Mapping Partner shall ensure that the following requirements are met when appropriate:

- FIS reports exceeding 150 pages in length shall be subdivided into two or more volumes.
- No more than 100 pages shall be included in any volume of a multiple-volume FIS report.
- Where possible, reports shall be subdivided so that volumes begin and end at logical breakpoints; however, the number of volumes must be minimized.
- One listing, Tables of Contents, shall be prepared for all volumes.
- A copy of the complete Tables of Contents shall appear in each volume of the FIS report.

[February 2002]

J.4 Future-Conditions Flood Hazard Information

At the request of a community and with the approval of FEMA, FIS reports may include, for informational purposes, flood hazard information based on projected- or future-conditions hydrologic and hydraulic analyses. If community officials request that FEMA show the future-conditions flood hazard information in the FIS report, the future-conditions flood insurance risk zone shall be referenced in the FIS report. Although graphic specifications are flexible for the presentation of future-conditions flood hazard information, the zone label for the future-conditions flood insurance risk zone will be "Zone X (Future Base Flood)."

The future-conditions flood insurance risk zone shall be defined in the FIS report as follows:

> Zone X (Future Base Flood) is the flood insurance risk zone that corresponds to the 1-percent-annual-chance floodplains that are determined based on future-conditions hydrology. No BFEs or base flood depths are shown within this zone.

FEMA opted to use the Zone X (Future Base Flood) designation for the future-conditions flood hazard areas, in lieu of a new flood insurance risk zone designation, to minimize confusion by users of the FIRM that make determinations regarding Federal mandatory flood insurance purchase requirements. Those users now recognize that areas designated as Zone X (shaded) are floodprone, but that the mandatory flood insurance purchase requirement does not apply. Because the risk premium rates for buildings located in the future-conditions 1-percent-annual-chance (100-year) floodplain will be the rate comparable to other areas outside the SFHA, FEMA believes designating these areas as "Zone X (Future Base Flood)" will be sufficient distinction.

[February 2002]

J.5 Sample Flood Insurance Study Report

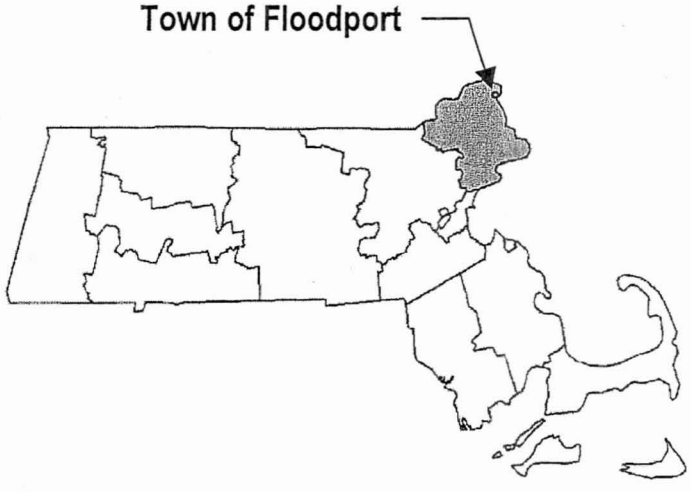
The following sample single-jurisdiction FIS report, for a fictional Massachusetts community, is in the final form to be submitted to the MSC for printing by GPO. The sample FIS report is for a community subject to both riverine flooding and coastal flooding (i.e., wave height and runup hazards). This FIS report has been prepared in the Map Initiatives format with an extra section added as an addendum at the end of the report.

The following sample FIS report is intended only as a graphic example of a report format; the content is not intended to be an authoritative example of an actual FIS report. The sections, subsections, paragraphs, and language required for every FIS report are presented in **bold-faced** type. The submitting Mapping Partner and processing Mapping Partner may use the language of the specific content within the sections and subsections for guidance.

[February 2002]

FLOOD INSURANCE STUDY

TOWN OF FLOODPORT, MASSACHUSETTS
FLOOD COUNTY



REVISED:
August 31, 2001

Federal Emergency Management Agency

COMMUNITY NUMBER - 259999

NOTICE TO
FLOOD INSURANCE STUDY USERS

Communities participating in the National Flood Insurance Program have established repositories of flood hazard data for floodplain management and flood insurance purposes. This Flood Insurance Study (FIS) report may not contain all data available within the Community Map Repository. Please contact the Community Map Repository for any additional data.

The Federal Emergency Management Agency (FEMA) may revise and republish part or all of this FIS report at any time. In addition, FEMA may revise part of this FIS report by the Letter of Map Revision process, which does not involve republication or redistribution of the FIS report. Therefore, users should consult with community officials and check the Community Map Repository to obtain the most current FIS report components.

This FIS report was revised on August 31, 2001. Users should refer to Section 10.0, Revisions Description, for further information. Section 10.0 is intended to present the most up-to-date information for specific portions of this FIS report. Therefore, users of this report should be aware that the information presented in Section 10.0 supersedes information in Sections 1.0 through 9.0 of this FIS report.

Effective Date: January 15, 1992

Revised Dates: November 11, 1992 (Flood Insurance Rate Map only)
December 3, 1996
August 31, 2001

TABLE OF CONTENTS

		Page
INTRODUCTION		1
1.1	**Purpose of Study**	1
1.2	**Authority and Acknowledgments**	1
1.3	**Coordination**	1
2.0	**AREA STUDIED**	2
2.1	**Scope of Study**	2
2.2	**Community Description**	2
2.3	**Principal Flood Problems**	5
2.4	**Flood Protection Measures**	5
3.0	**ENGINEERING METHODS**	6
3.1	**Hydrologic Analyses**	6
3.2	**Hydraulic Analyses**	10
4.0	**FLOODPLAIN MANAGEMENT APPLICATIONS**	16
4.1	**Floodplain Boundaries**	16
4.2	**Floodways**	17
5.0	**INSURANCE APPLICATION**	19
6.0	**FLOOD INSURANCE RATE MAP**	20
7.0	**OTHER STUDIES**	21
8.0	**LOCATION OF DATA**	21
9.0	**BIBLIOGRAPHY AND REFERENCES**	21

10.0 REVISIONS DESCRIPTION 22

10.1 First Revision (Revised December 3, 1996) 22

a. Acknowledgments 22

b. Scope 22

c. Other Studies 22

d. References and Bibliography 22

10.2 Second Revision (Revised August 31, 2001) 22

a. Acknowledgments 22

b. Coordination 22

c. Scope 22

d. Hydrologic and Hydraulic Analyses 22

e. Floodways 22

f. Other Studies 22

g. References and Bibliography 22

FIGURES

Figure 1 - Transect Location Map 3

Figure 2 - Floodway Schematic 19

TABLES

Table 1 - Summary of Discharges 7
Table 2 - Summary of Stillwater Elevations 9
Table 3 - Transect Descriptions 14
Table 4 - Transect Data 15
Table 5 - Floodway Data 21
Table 6 - Revised Summary of Discharges 28

EXHIBITS

Exhibit 1 - Flood Profiles
Rocky River ..... Panel 01P

Exhibit 2 - Flood Insurance Rate Map Index

Flood Insurance Rate Map

FLOOD INSURANCE STUDY

TOWN OF FLOODPORT, FLOOD COUNTY, MASSACHUSETTS

1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study investigates the existence and severity of flood hazards in the Town of Floodport, Flood County, Massachusetts, and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This study has developed flood risk data for various areas of the community that will be used to establish actuarial flood insurance rates and to assist the community in its efforts to promote sound floodplain management. Minimum floodplain management requirements for participation in the National Flood Insurance Program (NFIP) are set forth in the Code of Federal Regulations at 44 CFR, 60.3.

In some states or communities, floodplain management criteria or regulations may exist that are more restrictive or comprehensive than the minimum Federal requirements. In such cases, the more restrictive criteria take precedence and the State (or other jurisdictional agency) will be able to explain them.

1.2 Authority and Acknowledgments

The sources of authority for this Flood Insurance Study are the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973.

The hydrologic and hydraulic analyses for this study were performed by John Brown Engineering Corporation, **for the Federal Emergency Management Agency** (FEMA), under Contract No. H-1983. **This work was completed in** December 1985.

1.3 Coordination

The initial Consultation Coordination Officer (CCO) meeting was held on April 12, 1983, **and attended by representatives of FEMA,** the Town of Floodport, and the study contractor.

Coordination with Town officials and Federal, State, and regional agencies produced information pertaining to floodplain regulations, community maps, flood history, and other hydrologic data.

The U.S. Army Corps of Engineers (USACE) and the National Oceanic and Atmospheric Administration (NOAA) were contacted for data on tide elevations. Coordination with these agencies concerning coastal flood elevations was continued during the study. The Massachusetts Department of Public Works

(MDPW) was contacted for information on historic flooding and high-water marks. Vertical control data used to establish the network of elevation reference marks were provided by the MDPW, NOAA, U.S. Geological Survey (USGS), and U.S. Coast and Geodetic Survey.

An intermediate CCO meeting was held on February 14, 1984, and attended by representatives of FEMA, the community, and the study contractor. The purpose of this meeting was to present preliminary results of the study to the community.

The results of the study were reviewed at the final CCO meeting held on December 1, 1986, **and attended by representatives of FEMA**, the community, and the study contractor. **All problems raised at that meeting have been addressed.**

2.0 AREA STUDIED

2.1 Scope of Study

This FIS covers the incorporated **areas of the** Town of Floodport, Flood County, Massachusetts.

Riverine flooding on the Rocky River from approximately 100 feet downstream of U.S. Route 1 to the upstream corporate limits was studied by detailed methods. Tidal flooding from the Atlantic Ocean, including wave action, and the Merrimack River was also studied by detailed methods.

The areas studied by detailed methods were selected with priority given to all known flood hazard areas and areas of projected development or proposed construction through December 1990.

Keiths and Richards Creeks were studied by approximate methods for their lengths within the Town of Floodport.

Approximate analyses were used to study those areas having low development potential or minimal flood hazards. The scope and methods of study were proposed to, and agreed upon, by FEMA and the Town of Floodport.

2.2 Community Description

The Town of Floodport is located in northeastern Flood County, in northeastern Massachusetts, approximately 35 miles north of the City of Boston. It is bordered by the Atlantic Ocean to the east; the Town of Rowley to the south; the Towns of West Newbury, Groveland, and Georgetown to the west; and the City of Newburyport to the north.

Because of its proximity to the Atlantic Ocean, Floodport attracts both a permanent and transient population. According to the 1980 State census, the town had an estimated population of 4,239.

The population density in 1980 was 167 persons per square mile (Massachusetts Department of Commerce, 1980). Floodport is experiencing growth pressure, and coastal seasonal homes are being converted to year-round residences. It is estimated that the population of the town will increase approximately 51 percent by 1990 (New England River Basins Commission, 1975).

The total area contained within the corporate limits of Floodport is 25.4 square miles. Of the total area, only 8.4 percent is classified as urban land. The remaining land uses are as follows: forest, 34.6 percent; wetlands, 38.2 percent; agriculture and open land, 16.8 percent; mining and waste disposal, 0.3 percent; and recreation, 1.7 percent (Massachusetts Agricultural Experiment Station, 1974).

Development along the Floodport coast is primarily residential (permanent and seasonal) and recreational. The coast is characterized by the sand dunes of the barrier beach, Plum Island, which extends from the confluence of Plum Island Sound and the Ipswich River north to the Merrimack River. Residential development is located on the northern portion of Plum Island. The remainder of Plum Island, except Camp Sea Haven, is part of the Parker River National Wildlife Refuge. To the west of Plum Island is an extensive system of salt marshes associated with the Mill and Plum Island Rivers. The Plum Island River, a tidal creek, is a waterway for small boats between the Merrimack River and Plum Island Sound. Residential development is located west of the salt marshes, approximately 2 miles from the coast. Residential development is also located in the southwestern corner of town.

The coast is relatively flat, ranging from sea level to an approximate elevation of 30 feet. Inland, the topography is level, with an average elevation of 50 feet. Small hills, with elevations of 100 to 150 feet, are located in the southern and southwestern portions of town. The soils are predominantly wet throughout eastern and central Floodport. Northwestern Floodport has rough and stony soils. Floodport has a tidal shoreline of 48.3 miles (Massachusetts Department of Commerce, 1975).

The Rocky River and its tributaries drain most of the town. The river, which is 21 miles long and has a drainage area of approximately 35 square miles, has its headwaters in West Boxford and flows northeasterly until it joins Plum Island Sound in Floodport.

The climate of Floodport is variable. The average annual precipitation is approximately 43 inches; the average annual snowfall is approximately 47 inches. The Floodport area experiences no dry season. From June to September, rainfall usually occurs as showers or thunderstorms. The thunderstorms produce heavy, sometimes excessive, amounts of rain. Throughout the year, the heaviest gales

usually come from the northeast and east and are more common and severe during the winter. "Northeasters," as they are called, produce an abundance of rain and snow. The average annual temperature is approximately 51 °F; the mean temperatures for January and July are 28°F and 74.8°F, respectively (NOAA, 1976).

2.3 Principal Flood Problems

The low-lying coastal areas of the town adjacent to the Atlantic Ocean are subject to the periodic flooding and wave attack that accompanies storms such as northeasters. Hurricanes have not produced significant flooding in these areas. The majority of coastal storms cause damage only to low coastal roads, boats, beaches, and seawalls. Occasionally, a major storm accompanied by strong onshore winds and high tides results in surge and wave activity that causes extensive property damage and erosion.

Four of the more significant storms in the Floodport area were those of December 1901 and 1959 (approximately 160- and 15-year recurrence intervals, respectively) and February 1972 and 1978 (approximately 10- and 70-year recurrence intervals, respectively). These storms damaged harbors, marinas, and residential and commercial developments in the floodprone coastal areas.

In addition to flooding, serious shorefront erosion has occurred at Plum Island since the early 1880s, when the mouth of the Merrimack River was located approximately 0.5 mile south of its present position. Jetties, which were constructed at the turn of the century, had stabilized the entrance of the river at its present location and tended to create a buildup of the oceanfront shores on the northern end of the island.

However, since 1938, continuous recession of the shoreline has occurred, resulting primarily from severe storm surge and coincident wave action. During the severe storm that occurred on February 19, 1972, a wide fronting beach and backlying dunes were destroyed, and several cottages were damaged or destroyed. This storm made the island susceptible to further damage.

Riverine flooding has not generally been as severe as coastal flooding in the Floodport area. Extreme water levels on the Rocky River are primarily caused by runoff from heavy rainfall and snowmelt.

2.4 Flood Protection Measures

Present and future demands associated with the seasonal tourist industry will further intensify the pressure for development of floodprone coastal lands. However, the adoption of State and local development regulations concerning floodplain management will help alleviate storm-related losses (USACE, 1971).

No major structural flood protection measures exist or are planned for the Town of Floodport.

3.0 ENGINEERING METHODS

For the flooding sources studied by detailed methods in the community, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this study. Flood events of a magnitude that are expected to be equaled or exceeded once on the average during any 10-, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for floodplain management and for flood insurance rates. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10-, 2-, 1-, and 0.2-percent chance, respectively, of being equaled or exceeded during any year. Although the recurrence interval represents the long-term, average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than 1 year are considered. For example, the risk of having a flood that equals or exceeds the 1-percent- annual-chance (100-year) flood in any 50-year period is approximately 40 percent (4 in 10); for any 90-year period, the risk increases to approximately 60 percent (6 in 10). The analyses reported herein reflect flooding potentials based on conditions existing in the community at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish peak discharge-frequency relationships for each flooding source studied by detailed methods affecting the community.

Floodflow frequencies for the Rocky River were based on a statistical analysis of USGS gage data. These data were analyzed in accordance with criteria outlined in Bulletin 17B (Interagency Advisory Committee on Water Data, 1982). Discharge-frequency data were based on a USGS computer model (USGS, 1976). The model was run on November 20, 1983, using a systematic record of 32 years and a generalized skew coefficient; the input for, and assumptions of, the analysis were reviewed and accepted for use in this study.

Peak discharge-drainage area relationships for the Rocky River are shown in Table 1.

Table 1. Summary of Discharges

Flooding Source and Location	Drainage Area (square miles)	Peak Discharges (cubic feet per second) 10-Percent-Annual-Chance	2-Percent-Annual-Chance	1-Percent-Annual-Chance	0.2-Percent-Annual-Chance
Rocky River					
At U.S. Route 1	13.6	415	685	831	1,261

In New England, the flooding of low-lying coastal areas is caused primarily by storm surge generated by extratropical coastal storms called northeasters. Hurricanes also occasionally produce significant storm surge in New England, but they do not occur nearly as frequently as northeasters.

To calculate the storm surge and total storm tide elevations produced by historic storms, storm pressures and windfields were determined. A computer model was developed to simulate these fields based on several easily obtained storm parameters of northeasters. A detailed description of this model is presented in the report entitled "Development and Verification of a Synthetic Northeaster Model for Coastal Flood Analysis" (Stone and Webster Engineering Corporation, 1978). A different model was used to simulate the windfields and pressures of the hurricanes considered in this analysis (Stone and Webster Engineering Corporation, 1977). When coupled with a computer surge model, the storm tide along the shoreline could be calculated for each storm of interest.

NOAA synoptic weather charts were searched to determine the northeasters and hurricanes that could potentially produce significant flooding in the Floodport area (NOAA, 1978). Tidal records from tide gages in the New England area were examined to verify which historic storms produced high-water elevations. For the analysis of flood levels, 165 storms that occurred between 1942 and 1978 were considered.

The flood levels associated with historic storms were simulated using a modified version of the FEMA storm surge model (Tetra Tech, Inc., 1977, and Stone and Webster Engineering Corporation, 1978). Input to the model consisted of windfields and pressures generated either by the synthetic northeaster model or a hurricane-windfield-and-pressure-field model for each historic storm selected. The study area was modeled using a square grid of sufficient resolution to accurately represent the offshore bathymetry and shoreline configuration. The grid mesh covered an area from Cape Cod Bay to north of Portsmouth, New Hampshire, including Boston Harbor. Output from the model included the time history of storm-induced stillwater elevations for the communities in the study areas. The total stillwater elevation was calibrated using historic tide elevation data at Boston, Massachusetts, and Portsmouth, New Hampshire. Thus, the

historic storm-induced flood levels in Floodport could be simulated for each storm considered in the analysis.

The extent and frequency of coastal flooding were determined by conducting a frequency analysis of annual minimum tidal heights along the Atlantic coast at Floodport. Some historic storm-tide heights, consisting of both an astronomical tide and a storm-surge contribution, were determined by the mathematical simulation of historic northeasters and hurricanes described above; others, for which associated storm data were not available, were obtained by a correlation analysis using tide data from Boston or Portsmouth. The database at the Boston gage extended discontinuously from 1848 to 1978; the shorter record at Portsmouth was lengthened by a statistical correlation with data at Boston and Portland, Maine.

The annual maximums of these reproduced historic water elevations were fitted with a log-Pearson Type III distribution.

Elevations for floods of the selected recurrence intervals for the Atlantic Ocean and the Merrimack River are shown in Table 2.

Table 2. Summary of Stillwater Elevations

	Elevation (Feet)			
Flooding Source and Location	10-Percent-Annual-Chance	2-Percent-Annual-Chance	1-Percent-Annual-Chance	0.2-Percent-Annual-Chance
Atlantic Ocean				
Entire Shoreline Within Floodport	8.2	8.9	9.2	9.8
Rocky River				
Entire Shoreline Within Floodport	5.9	7.2	8.2	8.9

The analyses reported in this FIS report reflect the stillwater elevations due to tidal and wind setup effects. The effects of wave action were also considered in the determination of flood hazard areas. A detailed description of the methodology employed in this analysis can be found in the report entitled "Determination of Coastal Storm Tide Levels" (Stone and Webster Engineering Corporation, 1978). Coastal structures that are located above stillwater flood elevations can still be severely damaged by wave runup, wave-induced erosion, and wave-borne debris. For example, during a northeaster in February 1978, considerable damage along the Massachusetts coast was caused by wave activity, even though most of the damaged structures were above the high-water level (USACE, 1979).

The extent of wave runup past stillwater levels depends greatly on the wave conditions and local topography.

Wave heights and corresponding wave crest elevations were determined using the methodology developed by the National Academy of Sciences (NAS) (NAS, 1977). The wave runup was determined using the methodology developed for FEMA by Stone and Webster Engineering (Stone and Webster Engineering Corporation, 1981).

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of flooding from the sources studied were carried out to provide estimates of the elevations of floods of the selected recurrence intervals. Users should be aware that flood elevations shown on the Flood Insurance Rate Map (FIRM) represent rounded whole-foot elevations and may not exactly reflect the elevations shown on the Flood Profiles or in the Floodway Data Table in the FIS report. Flood elevations shown on the FIRM are primarily intended for flood insurance rating purposes. For construction and/or floodplain management purposes, users are cautioned to us the flood elevation data presented in this FIS report in conjunction with the data shown on the FIRM.

Cross sections for the backwater analyses were obtained from topographic maps compiled from aerial photographs (James W. Sewall Company, 1977). Below-water sections were obtained by field surveys. All bridges and culverts were surveyed to obtain elevation data and structural geometry.

Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles (Exhibit 1). For stream segments for which a floodway was computed (Section 4.2), selected cross-section locations are also shown on the FIRM (Exhibit 2).

Water-surface elevations for floods of the selected recurrence intervals were computed through use of the USACE HEC-2 step-backwater computer program (USACE, 1984). Starting water-surface elevations for the Rocky River were determined using critical depth.

Channel and overbank roughness factors (Manning's "n" values) used in the hydraulic computations were chosen by engineering judgment and were based on field observations of the stream and floodplain areas. The channel "n" values for the Rocky River ranged from 0.015 to 0.050, and the overbank "n" values ranged from 0.015 to 0.050.

The hydraulic analyses for this study were based on unobstructed flow. The flood elevations shown on the Flood Profiles (Exhibit 1) are thus considered valid only if hydraulic structures remain unobstructed, operate properly, and do not fail.

Hydraulic analyses, considering storm characteristics, the shoreline, and bathymetric characteristics of the tidal flooding source studied, were carried out

to provide estimates of the elevations of floods of the selected recurrence intervals along the shoreline.

Areas of coastline subject to significant wave attack are referred to as coastal high hazard zones USACE has established the 3-foot breaking wave as the criterion for identifying the limit of coastal high hazard zones (USACE, 1975). The 3-foot wave has been determined as the minimum size wave capable of causing major damage to conventional wood-frame or brick-veneer structures.

A wave height analysis was performed to determine wave heights and corresponding wave crest elevations for the areas inundated by tidal flooding. A wave runup analysis was performed to determine the height and extent of runup beyond the limit of tidal inundation. The results of these analyses were combined into a wave envelope, which was constructed by extending the maximum wave runup elevation seaward to its intersection with the wave crest profile.

The methodology for analyzing wave heights and corresponding wave crest elevations was developed by the NAS (NAS, 1977). The NAS methodology is based on three major concepts. First, a storm surge on the open coast is accompanied by waves. The maximum height of these waves is related to the depth of water by the following equation:

$$H_b = 0.78d$$

where H_b is the crest-to-trough height of the maximum or breaking wave and d is the stillwater depth. The elevation of the crest of an unimpeded wave is determined using the equation:

$$Zw = S^* + 0.7H^* = S^* + 0.55d$$

where Z_w is the wave crest elevation, $S*$ is the stillwater elevation at the site, and $H*$ is the wave height at the site. The 0.7 coefficient is the portion of the wave height that reaches above the stillwater elevation. H_b is the upper limit for $H*$.

The second major concept is that the breaking wave height may be diminished by dissipation of energy by natural or manmade obstructions. The wave height transmitted past a given obstruction is determined by the following equation:

$$Ht = Phi$$

where H_t is the transmitted wave height, B is a transmission coefficient ranging from 0.0 to 1.0, and H_i is the incident wave height. The coefficient is a function of the physical characteristics of the obstruction. Equations have been developed by the NAS to determine the transmission coefficient for vegetation, buildings,

natural barriers such as dunes, and manmade barriers such as breakwaters and seawalls (NAS, 1977).

The third major concept concerns unimpeded reaches between obstructions. New wave generation can result from wind action. This added energy is related to distance and mean depth over the unimpeded reach.

The methodology for analyzing wave runup was developed by Stone and Webster Engineering Corporation (Stone and Webster Engineering Corporation, 1981). The wave runup computer program operates using an ensemble of deepwater wave heights, H_i; the stillwater elevation, $S*$; a wave period, T_S; and the beach slope, m. For Floodport, wave heights range from 2 feet to 6 feet; the wave period is 4 seconds.

These concepts and equations were used to compute wave envelope elevations associated with the 1-percent-annual-chance storm surge. Accurate topographic, land-use, and land-cover data are required for the coastal analyses. Maps of the study area, prepared at a scale of 1:2,400 with a contour interval of 5 feet, were used for the topographic data (James W. Sewall Company, 1977). The land-use and land-cover data were obtained by field surveys.

Wave height and wave runup were computed along transects that were located perpendicular to the average mean shoreline. The transects were located with consideration given to the physical and cultural characteristics of the land so that they would closely represent conditions in their locality. Transects were located close together in areas of complex topography and dense development. In areas having more uniform characteristics, the transects were spaced at larger intervals. It was also necessary to locate transects in areas where unique flooding existed and in areas where computed wave heights varied significantly between adjacent transects. Figure 2 illustrates the location of the transects for the community. A listing of the transect locations and stillwater elevations, as well as the maximum wave crest (or wave runup) elevations, is provided in Table 3.

Along each transect, wave envelope elevations were computed considering the combined effects of changes in ground elevation, vegetation, and physical features. Between transects, elevations were interpolated using the previously cited topographic maps, land-use data, land-cover data, and engineering judgment to determine the areal extent of flooding. The results of the calculations are accurate until local topography, vegetation, or cultural development within the community undergoes any major changes. The results of this analysis are summarized in Table 4. Historic flood damage information was also used in the determination of floodprone areas along the Floodport shoreline (USGS, 1979).

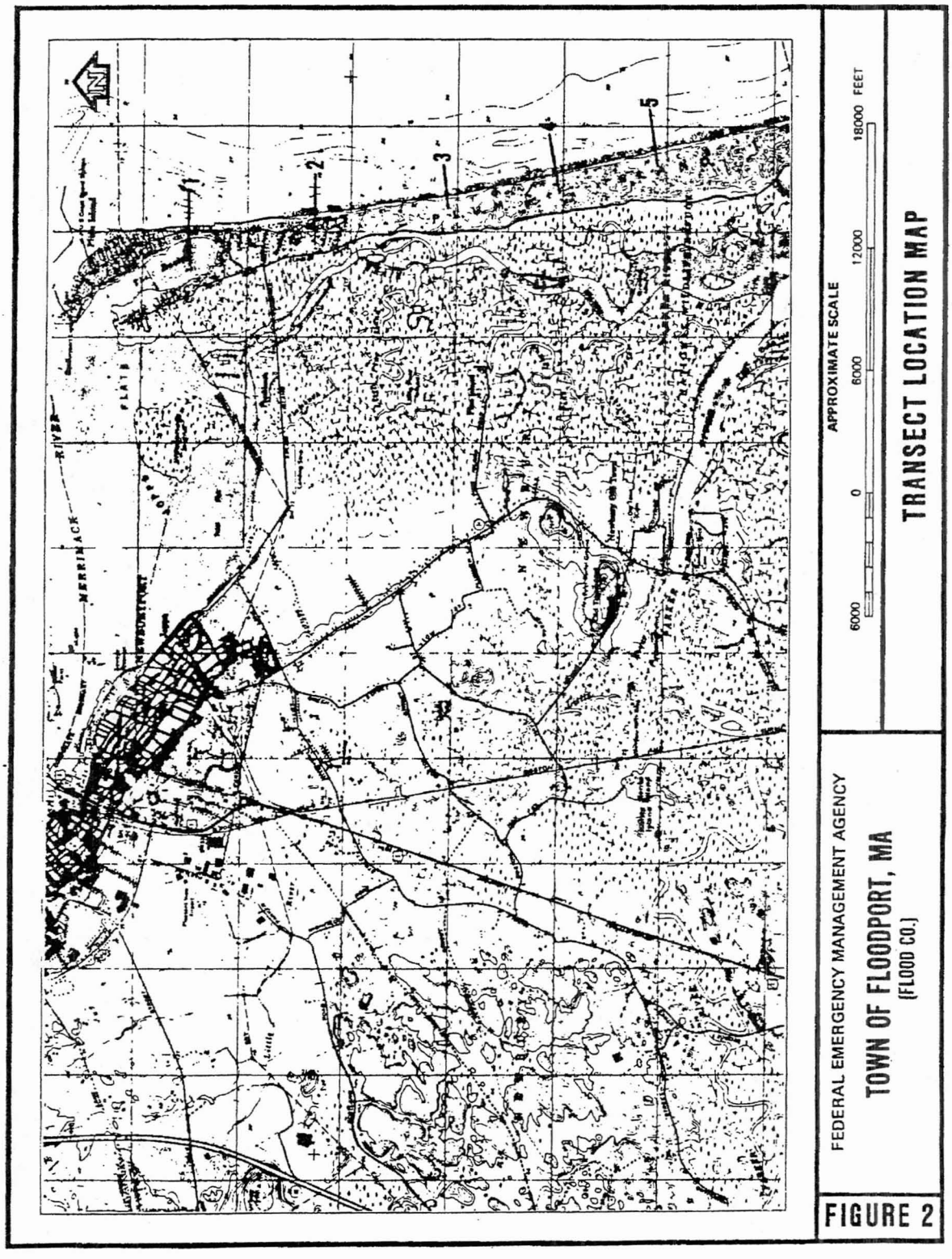

N
2
3
5
MERRIMACK
RIVER
PLAIN
APPROXIMATE SCALE
6000
0
6000
12000
18000 FEET
FEDERAL EMERGENCY MANAGEMENT AGENCY
TOWN OF FLOODPORT, MA
(FLOOD CO.)
TRANSECT LOCATION MAP
FIGURE 2

Table 3. Transect Descriptions

Transect	Location	1-Percent-Annual-Chance Flood Elevation (Feet) Stillwater	Maximum Wave[1]
1	From Plum Island Point south to Plum Island Turnpike, extended east	9.2 – 8.2	14[2]
2	From Plum Island Turnpike, extended east, to Perry Road, extended east	9.2	18[3]
3	From Perry Road, extended east, to Mason Street, extended east	9.3	14[2]
4	From Mason Street, extended east, to 8th Street, extended east	9.3	14[2]
5	From 8th Street extended east, to approximately 3,000 feet south of 1st Street	9.3	17[3]

[1]Due to map scale limitations, the maximum wave elevation is not shown on the Flood Insurance Rate Map
[2]Maximum wave height elevation
[3]Maximum wave runup elevation

Table 4. Transect Data

Flooding Source	Stillwater Flood Elevation (Feet) 10-Percent-Annual-Chance	2-Percent-Annual-Chance	1-Percent-Annual-Chance	0.2-Percent-Annual-Chance	Base Flood Elevation (Feet)[1]
Atlantic Ocean and Merrimack River	8.2	8.9	9.2	9.8	9.14
Transect 1	5.9	7.2	8.2	8.9	8-11
Atlantic Ocean					
Transect 2	8.2	8.9	9.2	9.8	9.18
Transect 3	8.3	9.0	9.3	10.0	9-14
Transect 4	8.3	9.0	9.3	10.0	9-14
Transect 5	8.3	9.0	9.3	10.0	9-17

[1]Due to map scale limitations, BFEs shown on the Flood Insurance Rate Map represent average elevations for the depicted Zones

3.3 Vertical Datum

All FIS reports and FIRMs are referenced to a specific vertical datum. The vertical datum provides a starting point against which flood, ground, and structure elevations can be referenced and compared. Until recently, the standard vertical datum in use for newly created or revised FIS reports and FIRMs was the National Geodetic Vertical Datum of 1929 (NGVD29). With the finalization of the North American Vertical Datum of 1988 (NAVD88), many FIS reports and FIRMs are being prepared using NAVD88 as the referenced vertical datum.

All flood elevations shown in this FIS report and on the FIRM are referenced to NAVD88. Structure and ground elevations in the community must, therefore, be referenced to NAVD88. It is important to note that adjacent communities may be referenced to NGVD29. This may result in differences in Base Flood Elevations (BFEs) across the corporate limits between the communities.

For more information on NAVD88, see the FEMA publication entitled *Converting the National Flood Insurance Program to the North American Vertical Datum of 1988* (FEMA, June 1992), or contact the Vertical Network Branch, National Geodetic Survey, Coast and Geodetic Survey, National Oceanic and Atmospheric Administration, Rockville, Maryland 20910 (Internet address http://www.ngs.noaa.gov).

Temporary vertical monuments are often established during the preparation of a flood hazard analysis for the purpose of establishing local vertical control. Although these monuments are not shown on the FIRM, they may be found in the Technical Support Data Notebook associated with the FIS report and FIRM for this community. Interested individuals may contact FEMA to access these data.

4.0 FLOODPLAIN MANAGEMENT APPLICATIONS

The NFIP encourages State and local governments to adopt sound floodplain management programs. Therefore, each FIS provides 1-percent-annual-chance (100-year) flood elevations and delineations of the 1- and 0.2-percent-annual-chance (500-year) floodplain boundaries and 1-percent-annual-chance floodway to assist communities in developing floodplain management measures. This information is presented on the FIRM and in many components of the FIS report, including Flood Profiles, Floodway Data Table and Summary of Stillwater Elevations Table. Users should reference the data presented in the FIS report as well as additional information that may be available at the local map repository before making flood elevation and/or floodplain boundary determinations.

4.1 Floodplain Boundaries

To provide a national standard without regional discrimination, the 1-percent-annual-chance (100-year) flood has been adopted by FEMA as the base flood for floodplain management purposes. The 0.2-percent-annual-chance (500-year) flood is employed to indicate additional areas of flood risk in the community. For each stream studied by detailed methods, the 1- and 0.2-percent-annual-chance floodplain boundaries have been delineated using the flood elevations determined at each cross section. Between cross sections, the boundaries were interpolated using topographic maps at a scale of 1:2,400, **with a contour interval of** 5 feet (James W. Sewall Company, 1977).

For tidal areas without wave action, the 1- and 0.2-percent-annual-chance floodplain boundaries were delineated using topographic maps at a scale of 1:2,400, with a contour interval of 5 feet (James W. Sewall Company, 1977). For the tidal areas with wave action, the floodplain boundaries were delineated using the elevations determined at each transect; between transects, the boundaries were interpolated using engineering judgment; land-cover data; and topographic maps at a scale of 1:2,400, with a contour interval of 5 feet (James W. Sewall Company, 1977). The 1-percent-annual-chance floodplain was divided into whole-foot elevation zones based on the average wave envelope elevation in that zone. Where the map scale did not permit these zones to be delineated at l-foot intervals, larger increments were used.

The 1- and 0.2-percent-annual-chance floodplain boundaries are shown on the FIRM (Exhibit 2). On this map, the 1-percent-annual-chance floodplain boundary corresponds to the boundary of the areas of special flood hazards (Zones A, AE, V, and VE); and the 0.2-percent-annual-chance floodplain boundary corresponds to the boundary of areas of moderate flood hazards. In cases where the 1- and 0.2-percent-annual-chance floodplain boundaries are close together, only the 1-percent-annual-chance floodplain boundary has been shown. Small areas within the floodplain boundaries may lie above the flood elevations but cannot be shown due to limitations of the map scale and/or lack of detailed topographic data.

For the streams studied by approximate methods, only the 1-percent-annual-chance floodplain boundary is shown on the FIRM (Exhibit 2).

4.2 Floodways

Encroachment on floodplains, such as structures and fill, reduces flood-carrying capacity, increases flood heights and velocities, and increases flood hazards in areas beyond the encroachment itself. One aspect of floodplain management involves balancing the economic gain from floodplain development against the resulting increase in flood hazard. For purposes of the NFIP, a floodway is used as a tool to assist local communities in this aspect of floodplain management. Under this concept, the area of the 1-

percent-annual-chance floodplain is divided into a floodway and a floodway fringe. The floodway is the channel of a stream, plus any adjacent floodplain areas, that must be kept free of encroachment so that the 1-percent-annual-chance flood can be carried without substantial increases in flood heights. Minimum Federal standards limit such increases to 1.0 foot, provided that hazardous velocities are not produced. The floodways in this study are presented to local agencies as minimum standards that can be adopted directly or that can be used as a basis for additional floodway studies.

The floodway presented in this FIS report and on the FIRM was computed for certain stream segments on the basis of equal conveyance reduction from each side of the floodplain. Floodway widths were computed at cross sections. Between cross sections, the floodway boundaries were interpolated. The results of the floodway computations have been tabulated for selected cross sections (Table 6). In cases where the floodway and 1-percent-annual-chance floodplain boundaries are either close together or collinear, only the floodway boundary has been shown.

Portions of the floodway for the Rocky River extend beyond the corporate limits.

The area between the floodway and 1-percent-annual-chance floodplain boundaries is termed the floodway fringe. The floodway fringe encompasses the portion of the floodplain that could be completely obstructed without increasing the water-surface elevation of the 1-percent-annual-chance flood more than 1.0 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to floodplain development are shown in Figure 2.

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
ROCKY RIVER								
A	11430	100	433	4.3	6.3	4.0[2]	4.3	0.3
B	11900	160	915	2.0	6.3	4.6[2]	5.3	0.7
C	12200	300	1190	1.6	6.3	5.6[2]	5.6	0.0
D	13100	300	1327	1.4	6.3	6.1[2]	6.1	0.0
E	14900	250	1280	1.3	7.3	7.3	7.6	0.3
F								
G								
H								
I								
J								
K								

[1]Feet above mouth
[2]Elevation computed without consideration of backwater effects from Cobb River
(What about cross sections F through K?)

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF FLOODPORT, MA
(FLOOD COUNTY)

FLOODWAY DATA

ROCKY RIVER

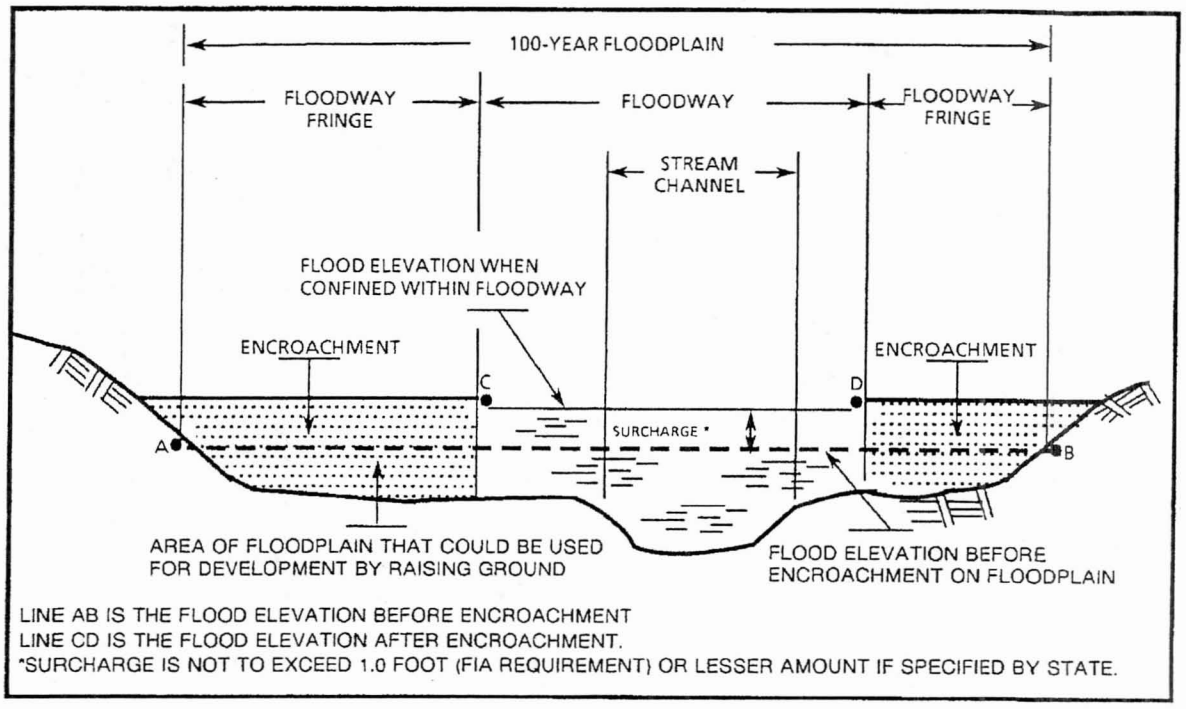


Figure 2. Floodway Schematic

5.0 INSURANCE APPLICATIONS

For flood insurance rating purposes, flood insurance zone designations are assigned to a community based on the results of the engineering analyses. These zones are as follows:

Zone A

Zone A is the flood insurance risk zone that corresponds to the 1-percent-annual-chance floodplains that are determined in the FIS by approximate methods. Because detailed hydraulic analyses are not performed for such areas, no BFEs or base flood depths are shown within this zone.

Zone AE

Zone AE is the flood insurance risk zone that corresponds to the 1-percent-annual-chance floodplains that are determined in the FIS by detailed methods. In most instances, whole-foot BFEs derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

Zone AH

Zone AH is the flood insurance risk zone that corresponds to the areas of 1-percent-annual-chance shallow flooding (usually areas of ponding) where average depths are between 1 and 3 feet. Whole-foot BFEs derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

Zone AO

Zone AO is the flood insurance risk zone that corresponds to the areas of 1-percent-annual-chance shallow flooding (usually sheet flow on sloping terrain) where average depths are between 1 and 3 feet. Average whole-foot base flood depths derived from the detailed hydraulic analyses are shown within this zone.

Zone AR

Zone AR is the flood insurance risk zone that corresponds to an area of special flood hazard formerly protected from the 1-percent-annual-chance flood event by a flood-control system that was subsequently decertified. Zone AR indicates that the former flood-control system is being restored to provide protection from the 1-percent-annual-chance or greater flood event.

Zone A99

Zone A99 is the flood insurance risk zone that corresponds to areas of the 1-percent-annual-chance floodplain that will be protected by a Federal flood protection system where construction has reached specified statutory milestones. No BFEs or depths are shown within this zone.

Zone V

Zone V is the flood insurance risk zone that corresponds to the 1-percent-annual-chance coastal floodplains that have additional hazards associated with storm waves. Because approximate hydraulic analyses are performed for such areas, no BFEs are shown within this zone.

Zone VE

Zone VE is the flood insurance risk zone that corresponds to the 1-percent-annual-chance coastal floodplains that have additional hazards associated with storm waves. Whole-foot BFEs derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

Zone X

Zone X is the flood insurance risk zone that corresponds to areas outside the 0.2-percent-annual-chance floodplain, areas within the 0.2-percent-annual-chance floodplain, areas of 1-percent-annual-chance flooding where average depths are less than 1 foot, areas of 1-percent-annual-chance flooding where the contributing drainage area is less than 1 square mile, and areas protected from the 1-percent-annual-chance flood by levees. No BFEs or base flood depths are shown within this zone.

Zone X (Future Base Flood)

Zone X (Future Base Flood) is the flood insurance risk zone that corresponds to the 1-percent-annual-chance floodplains that are determined based on future-conditions hydrology. No BFEs or base flood depths are shown within this zone.

Zone D

Zone D is the flood insurance risk zone that corresponds to unstudied areas where flood hazards are undetermined, but possible.

6.0 FLOOD INSURANCE RATE MAP

The FIRM is designed for flood insurance and floodplain management applications.

For flood insurance applications, the map designates flood insurance risk zones as described in Section 5.0 and, in the 1-percent-annual-chance floodplains that were studied by detailed methods, shows selected whole-foot BFEs or average depths. Insurance agents use the zones and BFEs in conjunction with information on structures and their contents to assign premium rates for flood insurance policies.

For floodplain management applications, the map shows by tints, screens, and symbols, the 1- and 0.2-percent-annual-chance floodplains, floodways, and the locations of selected cross sections used in the hydraulic analyses and floodway computations.

7.0 OTHER STUDIES

Using National Ocean Survey tide gage data (NOAA, 1984), the USACE has predicted 10-, 2-, 1-, and 0.2-percent-annual-chance flood levels at Boston, Massachusetts, and Portsmouth, New Hampshire . The USACE results compare favorably with flood levels determined in this study, considering the distance between Ipswich and the National Ocean Survey gaging stations.

FEMA has published FIS reports and FIRMs for the Towns of West Newbury (FEMA, 1979) and Georgetown (FEMA, 1978). The results presented in the FIS report and on the FIRM for the Town of Floodville are in exact agreement with the results for those towns.

An FIS for the Town of West Newburyport is in progress (FEMA, unpublished). The results of that study will be in exact agreement with the results of this study.

This FIS report either supersedes or is compatible with all previous studies on streams studied in this report and should be considered authoritative for purposes of the NFIP.

8.0 LOCATION OF DATA

Information concerning the pertinent data used in the preparation of this study can be obtained by contacting the Flood Insurance and Mitigation Division, Federal Emergency Management Agency, J. W. McCormack Post Office and Courthouse Building, Room 462, Boston, Massachusetts 02109.

9.0 BIBLIOGRAPHY AND REFERENCES

Commonwealth of Massachusetts, Department of Commerce, Profile of Floodport, Boston, Massachusetts, 1975.

Commonwealth of Massachusetts, Department of Commerce, Division of Census, Population-Area-Density, Boston, Massachusetts, 1980.

Federal Emergency Management Agency Flood Insurance Study, Town of West Newbury, Massachusetts, December 15, 1979.

Federal Emergency Management Agency, Flood Insurance Study, Town of Georgetown, Massachusetts, December 4, 1978.

Federal Emergency Management Agency, Flood Insurance Study, Town of Newburyport, Massachusetts, unpublished..

James W. Sewall Company, Topographic Maps, Scale 1:2,400, Contour Interval 5 Feet. Floodport, Massachusetts (1977).

Massachusetts Agricultural Experiment Station, Remote Sensing: 20 Years of Change in Essex County, Massachusetts, 1951-1971. William P. MacConnel, August 1974. .

National Academy of Sciences, Methodology for Calculating Wave Action Effects Associated with Storm Surges, 1977.

New England River Basins Commission, Report of the Southeastern New England Study. Boston, Massachusetts, December 1975.

Stone and Webster Engineering Corporation, Determination of Coastal Storm Tide Levels., Boston, Massachusetts, October 1978.

Stone and Webster Engineering Corporation, Manual for Wave Runup Analysis, Coastal Flood Insurance Studies, Boston, Massachusetts, November 1981.

Stone and Webster Engineering Corporation, Development and Verification of a Synthetic Northeaster Model for Coastal Flood Analysis, Boston, Massachusetts, October 1978.

Stone and Webster Engineering Corporation,. SWECO 7501-NP-A, Two-Dimensional Coastal Storm Surge Model. Boston, Massachusetts, July 1977.

Tetra Tech, Inc., for the Federal Emergency Management Agency, Coastal Flooding Handbook, Pasadena, California, May 1977.

U.S. Department of the Army, Corps of Engineers, Hydrologic Engineering Center, HEC-2 Water Surface Profiles, Generalized Computer Program. Davis, California, April 1984.

U.S. Department of the Army, Corps of Engineers, New England Division, "A Report on the Assessment of Flood Damage Resulting from the Storm of February 6-7, 1978, Along the Coastline from Orleans, Massachusetts, to New Castle, New Hampshire," Waltham, Massachusetts, February 1979.

U.S. Department of the Army, Corps of Engineers, Galveston District, Guidelines for Identifying Coastal High Hazard Zones, Galveston, Texas, June 1975.

U.S. Department of the Army, Corps of Engineers, New England Division, National Shoreline Study, Regional Inventory Report, North Atlantic Region, Volume 1, Waltham, Massachusetts, 1971.

U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Ocean Survey, Tide Table, 1931-1984, East Coast of North and South America, 1984.

U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Weather Service, Environment Data Service, Synoptic Weather Charts, 1978, 1976, 1972, 1970, 1969, 1968, 1967, 1966, 1962, 1961, 1960, 1959, 1958, 1957, 1954, 1953, 1950, 1944, 1940, 1931.

U.S. Department of Commerce, National Oceanic and Atmospheric Administration, United States Coast Pilot 1, Atlantic Coast, Eastport to Cape Cod, November 1976.

U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Hazard Boundary Map, Town of Floodport, Massachusetts, Scale 1:6,000, April 4, 1978.

U.S. Department of the Interior, Geological Survey, Computer Program E-431, Users Manual, Computer Applications for Step-Backwater and Floodway Analyses, James O. Shearman, 1976.

Interagency Advisory Committee on Water Data, Office of Water Data Coordination, Hydrology Subcommittee, Bulletin No. 17B, Guidelines for Determining Flood Flow Frequency. September 1981, revised March 1982.

U.S. Department of the Interior, Geological Survey, Water Resources Investigations 78-61, *Coastal Flood of February 7, 1978, in Maine, Massachusetts, and New Hampshire*, 1979.

10.0 REVISIONS DESCRIPTION

This section has been added to provide information regarding significant revisions made since the original FIS report and FIRM were printed. Future revisions may be made that do not result in the republishing of the FIS report. All users are advised to contact the Community Map Repository at the address below to obtain the most up-to-date flood hazard data.

Town of Floodport Engineering Department

101 Main Street, Suite 999

Floodport, MA

10.1 First Revision (Revised December 3, 1996)

a. Acknowledgments

The WHAFIS analyses for this revision was performed by Tackney & Associates, Inc. FEMA reviewed and accepted these data for purposes of this revision.

b. Scope

Based on better topographic and vegetation in formation, the wave height elevations for the three additional transects along the Atlantic Ocean, south of transect 22, were computed using the WHAFIS computer model (FEMA, 1981). The additional transects are shown on Figure 2, Transect Location Map, as transects 22A, 22B, and 22C, and are described in Table 2, Summary of Stillwater Elevations. Additionally, the zone designations and BFEs were changed as a result of a revised WHAFIS analysis and to agree with the FIRM for Seaside County (FEMA, 1986).

c. Other Studies

This revision is in agreement with the published FIS for Seaside County, Massachusetts (FEMA, 1986). This revision does not reflect information from any other contiguous community.

d. References and Bibliography

Federal Emergency Management Agency, Flood Insurance Study, Town of Georgetown, Massachusetts, June 1986

Federal Emergency Management Agency, Users Manual for Wave Height Analysis, Revised February 1981.

10.2 Second Revision (Revised August 31, 2001)

a. Acknowledgments

The hydrologic and hydraulic analyses for this revision were taken from a report titled "Floodplain Management Study, Shaw County, Massachusetts," prepared by the U.S. Soil Conservation Service (SCS) (SCS, 1984). FEMA reviewed and accepted these data for purposes of this revision.

b. Coordination

A final CCO meeting was held on September 4, 1999, to review the results of this revision.

c. Scope

This revision includes a revised detailed analysis of the Rocky River from its confluence with Big Creek to U.S. Route 1.

d. Hydrologic and Hydraulic Analyses

Revised flood discharges along the Rocky River were established by valley flood routings computed using the SCS TR-20 computer program (USCS, 1982). Peak drainage-discharge area relationships for the 10-, 2-, 1-, and 0.2-percent-annual-chance floods are shown in Table 7.

Table 7. Revised Summary of Discharges

		Peak Discharges (cubic feet per second)			
Flooding Source and Location	Drainage Area (square miles)	10-Percent-Annual-Chance	2-Percent-Annual-Chance	1-Percent-Annual-Chance	0.2-Percent-Annual-Chance
Rocky River					
At U.S. Route 1	13.6	420	690	850	1,298

e. Other Studies

The FIS for the Town of Watertown (FEMA, unpublished), in progress as of the date of this Revisions Description, agrees with this study.

f. Bibliography and References

Federal Emergency Management Agency, Flood Insurance Study, Town of Watertown, Massachusetts, unpublished.

U.S. Department of Agriculture, Soil Conservation Service, Floodplain Management Study. Shaw County, Massachusetts, 1984.

U.S. Department of Agriculture, Soil Conservation Service, Technical Release No. 20, Computer Program for Project Formulation, Hydrology, May 1982.

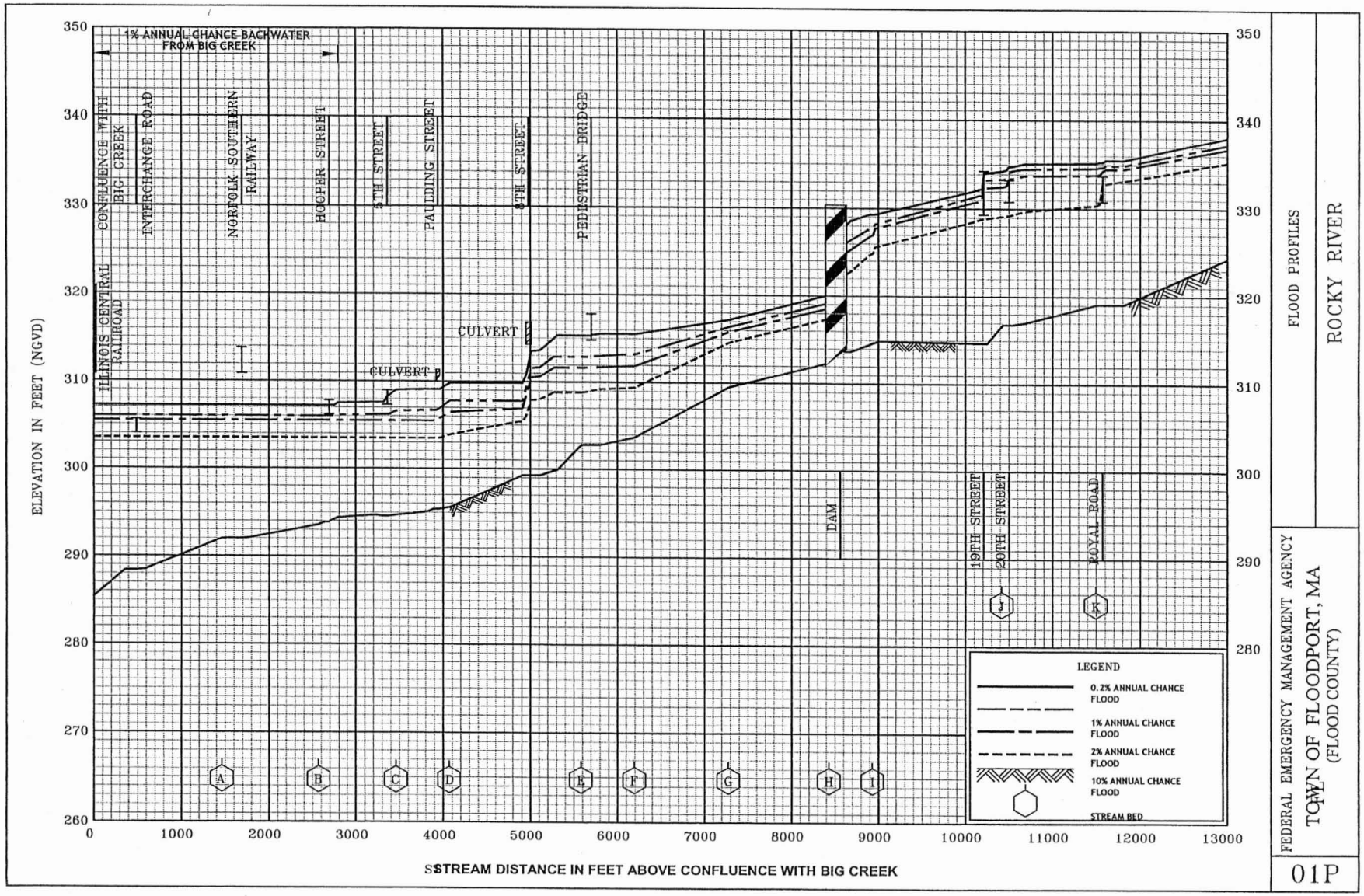

1% ANNUAL CHANCE BACKWATER FROM BIG CREEK
CONFLUENCE WITH BIG CREEK
INTERCHANGE ROAD
NORFOLK SOUTHERN RAILWAY
HOOPER STREET
5TH STREET
PAULDING STREET
8TH STREET
PEDESTRIAN BRIDGE
ILLINOIS CENTRAL RAILROAD
CULVERT
CULVERT P
DAM
19TH STREET
20TH STREET
ROYAL ROAD
ELEVATION IN FEET (NGVD)
STREAM DISTANCE IN FEET ABOVE CONFLUENCE WITH BIG CREEK
LEGEND
0.2% ANNUAL CHANCE FLOOD
1% ANNUAL CHANCE FLOOD
2% ANNUAL CHANCE FLOOD
10% ANNUAL CHANCE FLOOD
STREAM BED
FLOOD PROFILES
ROCKY RIVER
FEDERAL EMERGENCY MANAGEMENT AGENCY
TOWN OF FLOODPORT, MA
(FLOOD COUNTY)
01P

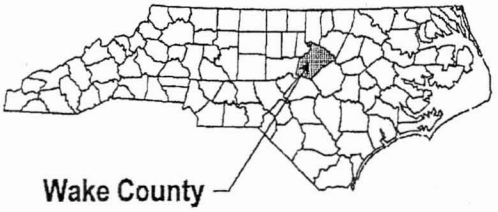
Figure J-1. Cover for Multiple-Volume Countywide Report

FLOOD INSURANCE STUDY

VOLUME 1 OF 6

WAKE COUNTY, NORTH CAROLINA AND INCORPORATED AREAS

COMMUNITY NAME	COMMUNITY NUMBER
APEX, TOWN OF	370467
CARY, TOWN OF	370238
FUQUAY-VARINA, TOWN OF	370239
GARNER, TOWN OF	370240
HOLLY SPRINGS, TOWN OF	370403
KNIGHTDALE, TOWN OF	370241
MORRISVILLE, TOWN OF	370242
RALEIGH, CITY OF	370243
ROLESVILLE, TOWN OF	370468
WAKE COUNTY (UNINCORPORATED AREAS)	370368
WAKE FOREST, TOWN OF	370244
WENDELL, TOWN OF	370245
ZEBULON, TOWN OF	370246



REVISED:
NOVEMBER 20, 1998

Federal Emergency Management Agency

Figure J-2. Cover for Multiple-Volume Non-Countywide Report

FLOOD INSURANCE STUDY

VOLUME 1 OF 3

GWINNETT COUNTY, GEORGIA
(UNINCORPORATED AREAS)

REVISED:
JULY 20, 1998

Federal Emergency Management Agency

COMMUNITY NUMBER - 130322

Figure J-3. Cover for Multiple-Volume Single-Jurisdiction Report

FLOOD INSURANCE STUDY

VOLUME 1 OF 2

CITY OF AUGUSTA, GEORGIA
RICHMOND COUNTY

REVISED:
MARCH 23, 1999

Federal Emergency Management Agency

COMMUNITY NUMBER - 130158

Figure J-4. Table of Contents for Multiple-Volume Countywide Report

TABLES OF CONTENTS

Table of Contents – Volume 1 – April 22, 1999

		Page
1.0	INTRODUCTION	1
1.1	Purpose of Study	1
1.2	Authority and Acknowledgments	2
1.3	Coordination	7
2.0	AREA STUDIED	8
2.1	Scope of Study	8
2.2	Community Description	18
2.3	Principal Flood Problems	19
2.4	Flood Protection Measures	21
3.0	ENGINEERING METHODS	23
3.1	Hydrologic Analyses	23
3.2	Hydraulic Analyses	40
4.0	FLOODPLAIN MANAGEMENT APPLICATIONS	48
4.1	Floodplain Boundaries	48
4.2	Floodways	49
5.0	INSURANCE APPLICATIONS	123
6.0	FLOOD INSURANCE RATE MAP	125
7.0	OTHER STUDIES	125
8.0	LOCATION OF DATA	130
9.0	BIBLIOGRAPHY AND REFERENCES	130

Table of Contents – Volume 1 – continued

Page

FIGURES

Figure 1 – Floodway Schematic 123

TABLES

Table 1 – Streams Studied by Detailed Methods 8, 10

Table 2 – Scope of Revision for August 2, 1995, Countywide FIS 12-14

Table 3 – Letters of Map Revision 15-17

Table 4 – Summary of Discharges 28-40

Table 5 – Summary of Roughness Coefficients 45-47

Table 6 – Floodway Data 51-122

Table 7 – Community Map History 126-128

EXHIBITS

Exhibit 1 – Flood Profiles

Alum Creek	Panels 01P-04P
Barbee Ditch	Panels 05P-07P
Barnes Ditch	Panels 08P-10P
Beem Ditch	Panels 11P-12P
Big Darby Creek	Panels 13P-17P
Big Run	Panels 18P-20P
Big Walnut Creek	Panels 21P-28P
Billingsley Ditch	Panels 29P-31P
Bishop Run	Panels 32P-33P

Table of Contents – Volume 2 – April 19, 1997

EXHIBITS - continued

Exhibit 1 – Flood Profiles - continued

Blacklick Creek	Panels 34P-50P
Blacklick Creek Lateral D	Panel 51P
Blacklick Creek Lateral G-B	Panel 52P
Blacklick Creek Lateral K	Panels 53P-54P
Blacklick Creek Tributary C	Panel 55P
Brown Run	Panels 56P-59P
Clover Groff Ditch	Panels 60P-62P
Coble-Bowman Ditch	Panels 63P-64P
Cosgray Ditch	Panels 65P-70P
Cramer Ditch	Panels 71P-75P
Dry Run	Panels 76P-79P
Blau Ditch	Panels 79P-81P
Dysar Ditch	Panel 82P
Early Run	Panels 83P-85P
French Run	Panels 86P-87P
French Run (Lateral G-A)	Panels 88P-89P

Table of Contents – Volume 2 – continued

EXHIBITS - continued

Exhibit 1 -	Flood Profiles – continued	
	Georges Creek	Panels 90P-92P
	Grant Run	Panels 93P-95P
	Orders & Wallace Ditch	Panel 95P
	Grove City Creek 1	Panel 96P
	Mulberry Run	Panels 96P-99P
	Grove City Creek 2	Panels 100P-101P
	West Water Run	Panel 101P
	Haines Ditch	Panel 102P
	Hamilton Ditch	Panels 103P-105P
	Hayden Run	Panels 106P-109P
	Faust County Ditch	Panel 109P
	Hellbranch Run	Panels 110P-112P
	McCoy Ditch	Panel 112P
	Indian Run	Panels 113P-114P
	North Fork Indian Run	Panels 114P-118P
	Lisle Ditch	Panel 119P
	Little Darby Creek	Panel 120P
	Little Walnut Creek	Panels 121P-125P
	Marsh Run	Panels 126P-127P
	Baumgardner Ditch	Panels 127P-128P
	Martin Grove Ditch	Panel 129P

Table of Contents – Volume 3 – April 21, 1999

EXHIBITS – continued

Exhibit 1 -	Flood Profiles – continued	
	Mason Run	Panels 130P-134P
	Molcomb Ditch	Panels 135P-140P
	Olentangy River	Panels 141P-143P
	Patzer Ditch	Panels 144P-145P
	Plum Run	Panels 146P-149P
	Plum Run Tributary	Panels 150P-152P
	Powell Ditch	Panel 153P
	Rhodes Ditch	Panel 154P
	Rocky Fork Ditch	Panels 155P-158P
	Scioto Big Run	Panels 159P-162P
	Scioto River	Panels 163P-169P
	Scioto River Divided Flow Reach	Panel 170P
	Snyder Run	Panels 171P-172P
	South Fork Dry Run	Panel 173P
	South Fork Georges Creek	Panels 174P-175P
	South Fork Indian Run	Panels 176P-186P
	Spring Run	Panels 187P-190P
	Sugar Run	Panels 192P-196P
	Swisher Creek	Panels 197P

Table of Contents – Volume 3 – continued

EXHIBITS – continued

Exhibit 1 -	Flood Profiles – continued	
	Sycamore Run	Panels 198P-199P
	Tri-County Ditch	Panel 200P
	Tudor Ditch	Panels 201P-205P
	Turkey Run	Panels 206P-207P
	Tussing-Bachman Ditch	Panels 208P-209P
	Bush Ditch	Panels 209P-210P
	Utzinger Ditch	Panel 211P
	Georges Creek Overland Flow	Panel 212P
Exhibit 2 -	Flood Insurance Rate Map Index	
	Flood Insurance Rate Map	

[1]Note to users: Flood Profile 191P was removed to reflect the removal of the Delaware County portion of the City of Westerville

Figure J-5. Digital Base Map Source Description Example

The hydrologic and hydraulic analyses for the August 2, 1995, countywide FIS were performed by Water Resources and Coastal Engineering, Inc., for FEMA, under Joint Venture Contract No. EMW-91-C-3360. The joint venture team consisted of Water Resources & Coastal Engineering,, Inc. and Geodyssey, Inc. That work was completed in September 1992.

For the July 16, 1997, revision, the hydrologic and hydraulic analyses for Tussing-Bachman Ditch, Bush Ditch, and Georges Creek Overland Flow were prepared by the ODNR Division of Water. These analyses were subsequently modified by Dewberry & Davis under a directive from FEMA. This work was completed in December 1995.

For this revision, the hydrologic and hydraulic analyses for the Olentangy River were taken from the Delaware County, Ohio and incorporated areas FIS (Reference 1). The analyses were prepared by Evans, Mechwart, Hambleton, and Tilton, Inc. under Contract No. EMW-94-C-4525, and subsequently modified by Dewberry & Davis under a directive from FEMA.

The digital base mapping information was provided by the Franklin County Auditor's Office, Division of Automated Mapping, 373 South High Street, 19th Floor, Columbus, Ohio, 43215-6310. Further information about the base mapping is available by contacting the Auditor's Office. These files were compiled by photogrammetric methods and meet or exceed National Map Accuracy Standards at the original compilation scale of 1"=100'. The coordinate system used for the production of this FIRM is Universal Transverse Mercatur, North American Datum of 1927, Clarke 1866 spheroid. Differences in the datum and spheroid used in the production of FIRMs for adjacent counties may result in slight positional differences in map features at the county boundaries. These differences do not affect the accuracy of information shown on this FIRM.

Figure J-6. CCO Meeting Dates for Pre-Countywide FISs Table

For this countywide FIS, Woodward-Clyde was contracted by FEMA to perform the coastal flood studies of the Florida Panhandle under Contract No. EMW-95-C-4678/TO043. The coastal 100-year stillwater elevations and analyses were revised by Dewberry & Davis, under subcontract to Woodward-Clyde. All work was completed in April 1998. Riverine analyses for this countywide FIS were compiled from previously effective FISs for Bay County and its incorporated communities (References 1 - 9).

The digital base map files were derived from U.S. Geological Survey (USGS) 1:24,000 scale Digital Line Graphs. These files were modified in and around the floodplains to match data previously compiled for the FIS of Bay County and its unincorporated communities.

The coordinate system used for the production of the digital FIRMs is Universal Transverse Mercator referenced to the North American Datum of 1927 and the Clarke 1866 spheroid.

1.3 Coordination

The purpose of an initial Consultation Coordination Officer's (CCO) meeting is to discuss the scope of the FIS. A final CCO meeting is held to review the results of the study.

The dates of the initial and final CCO meetings held for the incorporated communities within the boundaries of Bay County are shown in Table 1, "CCO Meeting Dates for Precountywide FISs."

TABLE 1 - CCO MEETING DATES FOR PRECOUNTYWIDE FISs

Community Name	Initial CCO Date	Final CCO Date
Bay County (Unincorporated Areas)	*	June 12, 1985
Callaway, City of	*	June 11, 1985
Cedar Grove, Town of	*	*
Lynn Haven, City of	*	June 11, 1985
Mexico Beach, Town of	*	June 12, 1985
Panama City, City of	*	June 12, 1985
Panama City Beach, City of	*	June 13, 1985
Parker, City of	*	June 6, 1985
Springfield, City of	*	May 17, 1979

*Data not available

Figure J-7. Streams Studied by Detailed Methods Table

TABLE 1 - STREAMS STUDIED BY DETAILED METHODS

Abrams Creek
Abrams Run
Baeder Run
Blair Mill Run
Blair Mill Run Tributary
Buckwalter Tributary
Colmar Tributary
Crow Creek
Davis Grove Tributary
Deep Creek
Dodsworth Run
Donny Brook Run
East Branch Perkiomen Creek
East Tributary Stony Creek
Erdenheim Run
Frog Run
Goshenhoppen Creek
Gulph Mills Creek
Gulph Mills Creek Tributary A
Gulph Mills Creek Tributary B
Hosensack Creek
Huntingdon Valley Creek
Indian Creek
Jenkintown Creek
Lansdale Tributary
Little Neshaminy Creek
Little Neshaminy Creek Tributary No. 1
Little Neshaminy Creek Tributary No. 2
Lodal Creek
Macoby Creek
Macoby Creek Branch
Manatawny Creek
Matsunk Creek
Meadow Brook
Middle Creek
Mill Creek
Mingo Creek
Mingo Creek Tributary No. 1
Minister Creek
Minister Creek Tributary
Neshaminy Creek Branch
North Branch Baeder Run
North Branch Zacharias Creek
North Hatfield Tributary
Oak Terrace Tributary
Oley Creek
Oreland Run
Park Creek
Pennypack Creek
Pennypack Creek Branch
Pennypack Creek Tributary No. 1
Perkiomen Creek
Pine Run
Plymouth Creek
Rapp Run
Rock Creek
Rose Valley Creek
Sanatoga Creek
Sandy Run
Sandy Run Tributary No. 1
Sawmill Run
Schlegel Run
Schuylkill River
Scioto Creek
Skippack Creek
Skippack Creek Tributary No. 1
Skippack Creek Tributary No. 2
Southampton Creek
Sprogels Run
St. Josephs Run
Stony Creek
Stony Creek Tributary
Stony Run
Swamp Creek
Tacony Creek
Tannery Run
Towamencin Creek No. 1
Towamencin Creek No. 2
Tributary to Oreland Run
Tributary No. 1 to Unionville Tributary
Trout Creek
Unami Creek
Unionville Tributary
Unnamed Creek A
Valley Creek
Vaughn Run
War Memorial Creek
West Branch Neshaminy Creek
West Branch Neshaminy Creek Tributary
West Branch Perkiomen Creek
West Branch Skippack Creek
West Branch Swamp Creek
West Branch Towamencin Creek
West Branch Towamencin Creek Tributary No. 3
Wissahickon Creek
Zacharias Creek

Figure J-8. Scope of Study Table

TABLE 3 - SCOPE OF STUDY

Stream	Limits of Detailed Study
Abrams Creek	From its confluence with the Schuylkill River to a point approximately 60 feet upstream of Brawnlee Road
Abrams Run	From its confluence with Crow Creek to a point approximately 420 feet upstream of Falcon Road
Crow Creek	From its confluence with the Schuylkill River to a point approximately 80 feet upstream of Croton Road
Frog Run	From Flint Hill Road to a point approximately 440 feet upstream of South Henderson Road
Gulph Mills Creek	From Holstein Road to a point approximately 330 feet upstream of Gypsy Road
Gulph Mills Creek Tributary A	From its confluence with Gulph Mills Creek to a point approximately 80 feet upstream of Arden Road
Gulph Mills Creek Tributary B	From its confluence with Gulph Mills Creek to a point approximately 65 feet upstream of Lantern Lane
Matsunk Creek	From its confluence with the Schuylkill River to a point approximately 620 feet upstream of Crooked Lane
Unnamed Creek A	From its confluence with Matsunk Creek to a point approximately 80 feet upstream of Flint Hill Road

The areas studied by detailed methods were selected with priority given to all known flood hazard areas and areas of projected development and proposed construction.

This countywide FIS also incorporates the determination of letters issued by FEMA resulting in map changes (Letter of Map Revision [LOMR], Special Response [SR], Letter of Map Amendment [LOMA]), as shown in Table 4, "Letters of Map Change."

TABLE 4 - LETTERS OF MAP CHANGE

Community	Flooding Source(s) and Project Identifier	Date Issued	Type
Borough of Collegeville	Donny Brook Run Updated hydrologic and hydraulic data for the Statford Avenue culvert	July 23, 1990	LOMR

Figure J-9. Stream Name Changes Table

Table 2, "Stream Name Changes," lists streams that have names in this countywide FIS other than those used in the previously printed FISs for the communities in which they are located.

TABLE 2 - STREAM NAME CHANGES

Community	Old Name	New Name
Township of Abington	Tributary No. 1	Sandy Run Tributary No. 1
Borough of Hatfield	Towamencin Creek	Towamencin Creek No. 2
Township of Hatfield	Tributary to Unionville Tributary	Tributary No. 1 to Unionville Tributary
Township of Horsham	Branch of Pennypack Creek	Pennypack Creek Branch
Borough of Lansdale	Branch of Neshaminy Creek	Neshaminy Creek Branch
Township of Limerick	Tributary No. 1 to Mingo Creek	Mingo Creek Tributary No. 1
Township of New Hanover	Tributary to Minister Creek	Minister Creek Tributary
Borough of Norristown	Tributary to Stony Creek	Stony Creek Tributary
Township of Skippack	Tributary 1 to Skippack Creek	Skippack Creek Tributary No. 1
Township of Towamencin	Towamencin Creek	Towamencin Creek No. 1
	Tributary No. 1 of Skippack Creek	Skippack Creek Tributary No. 2
	Tributary No. 3 of West Branch Towamencin Creek	West Branch Towamencin Creek Tributary No. 3
Township of Upper Merion	Abrams Run	Crow Creek
	Gulph Creek	Gulph Mills Creek
	Gulph Creek Branch	Gulph Mills Creek
Township of Upper Moreland	Tributary 1	Pennypack Creek Tributary No. 1

For the December 19, 1996, FIS, the Schuylkill River was restudied by detailed methods, including its backwater effects, for its entire length within the county.

For this revision, limits of detailed study for the newly studied streams are listed in Table 3, "Scope of Study."

Figure J-10. Historical Tide Gage Water Level Records Table

The coastal areas of Walton County are subject to flooding from tidal surges associated with hurricanes both along the Gulf of Mexico and inside Choctawhatchee Bay. Generally, the terrain inland along Choctawatchee Bay rises fairly rapidly and flooding from surges is restricted to only short distances inland of the bay shoreline.

Walton County has experienced flooding from several hurricanes since 1870. Reports of high water marks for the hurricanes of 1936 were 8.4 feet NGVD at Fort Walton Beach, Okaloosa County, and from 7 to 8 feet NGVD at Destin, in Okaloosa County. This compares with the GKY 100-year surge prediction of 2 to 7 feet NGVD. The prediction does not incorporate the effects of wind driven waves or the tidal influences of the heavenly bodies. In October 1995, Hurricane Opal produced high storm surge tides in Walton County. Hurricane Opal highwater marks along the Gulf of Mexico shoreline of Walton County were from 8 to 25 feet NGVD and in Choctawhatchee Bay from 6 to 7 feet NGVD. Present conclusions about recurrence coastal flood elevations rely heavily on historical evidence from the continuous tidal records identified in Table 1.

For this countywide FIS, in order to evaluate existing FIS coastal flood frequencies and revised 100-year stillwater elevations, historical tide gauge water level records for the Florida Panhandle region were used. These water level records are shown in Table 1.

TABLE 1 - HISTORICAL TIDE GAUGE WATER LEVEL RECORDS FOR FLORIDA PANHANDLE REGION

AGENCY and GAUGE I.D.	SITE NAME	LATITUDE	LONGITUDE	MEAN TIDE RANGE (FT)	PERIOD of RECORD
NOS 8728690	Apalachicola	29° 43.6' N	84° 58.9' W	1.11	1967-95
USACE 02359665	Panama City	30° 09'22" N	85° 38'12" W	1.33	1935-95
NOS 8729108	Panama City	30° 09.1' N	85° 40.0' W	1.24	1975-95
NOS 8729210	Panama City Beach	~ 30.2° N	~ 85.8° W	1.25	1989-94
USACE 02366990	Destin/East Pass	30° 23'20" N	86° 30'04" W	0.58	1957-94
NOS 8729681	Navarre Beach	30° 22.6' N	86° 51.9' W	0.74	1978-89
NOS 8729840	Pensacola	30° 24.2' N	87° 12.8' W	1.19	1923-95
USACE 02376083	Gulf Beach	30° 18'50" N	87° 25'40" W	0.83	1940-95

Brief notes on the history and damages caused by hurricanes are abstracted from reports by the U.S. Army Corps of Engineers (USACE) (References 6 and 7). Additional information on hurricane history and damages, particularly for recent storms, comes from papers published in the Monthly Weather Review. The following pages list the significant storms affecting the panhandle in this century. Damage figures are those determined for values at the time of the storm, and no attempt has been made to adjust these figures to present day values.

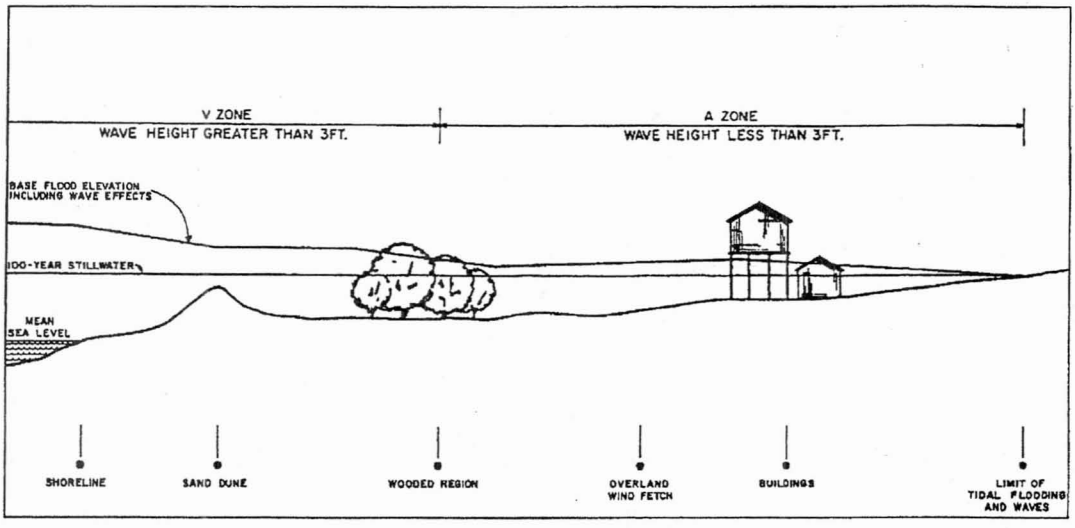
Figure J-11. Manning's "n" Values Table

The channel and overbank "n" values for all of the streams studied by detailed methods are shown in Table 6, "Manning's "n" Values."

TABLE 6 - MANNING'S "N" VALUES

Stream	Channel "n"	Overbank "n"
Abrams Creek	0.035-0.040	0.030-0.070
Abrams Run	0.013-0.035	0.035-0.050
Baeder Run	0.018-0.070	0.040-0.110
Blair Mill Run	0.032	0.060-0.087
Blair Mill Run Tributary	0.035-0.037	0.080-0.095
Buckwalter Tributary	0.040-0.045	0.050-0.120
Colmar Tributary	0.025-0.035	0.070
Crow Creek	0.035	0.030-0.050
Davis Grove Tributary	0.040-0.050	0.050-0.130
Deep Creek	0.035-0.045	0.050-0.080
Dodsworth Run	0.012-0.032	0.050
Donny Brook Run	0.012-0.050	0.030-0.125
East Branch Perkiomen Creek	0.013-0.090	0.033-0.125
East Tributary Stony Creek	0.045-0.050	0.055-0.085
Frog Run	0.035-0.040	0.020-0.050
Goshenhoppen Creek	0.035-0.040	0.060-0.080
Gulph Mills Creek	0.035-0.040	0.040-0.050
Gulph Mills Creek Tributary A	0.035	0.050
Gulph Mills Creek Tributary B	0.040	0.050
Hosensack Creek	0.035-0.040	0.035-0.080
Huntington Valley Creek	0.030-0.035	0.070-0.085
Indian Creek	0.030-0.040	0.050-0.125
Jenkintown Creek	0.050	0.130
Lansdale Tributary	0.020-0.035	0.060-0.075
Little Neshaminy Creek	0.030-0.050	0.050-0.110
Little Neshaminy Creek Tributary No. 1	0.045-0.060	0.075-0.120
Little Neshaminy Creek Tributary No. 2	0.025-0.050	0.060-0.120
Lodal Creek	0.040	0.055-0.080
Macoby Creek	0.030-0.045	0.030-0.090
Macoby Creek Branch	0.040	0.050-0.080
Manatawny Creek	0.035-0.040	0.050-0.090
Matsunk Creek	0.035-0.040	0.020-0.050
Meadow Brook	0.030-0.035	0.055-0.080
Middle Creek	0.032-0.055	0.030-0.120
Mill Creek	0.020-0.043	0.015-0.090
Mingo Creek	0.040	0.055-0.080
Mingo Creek Tributary No. 1	0.035-0.040	0.050-0.060

Figure J-12. Transect Schematic



TRANSECT SCHEMATIC Figure 3

TABLE 5 – TRANSECT DESCRIPTIONS

TRANSECT	LOCATION	ELEVATION (feet NGVD) 100-YEAR STILLWATER	ELEVATION (feet NGVD) MAXIMUM 100-YEAR WAVE CREST
1	At shoreline of Gulf of Mexico, in the unincorporated areas of Walton County, approximately 2.4 miles east of the Okaloosa/Walton County line.	10.5[1]	16.1
2	At shoreline of Gulf of Mexico, in the unincorporated areas of Walton County, south of Morris Lake.	10.5[1]	16.1
4	At shoreline of Gulf of Mexico, in the unincorporated areas of Walton County, approximately 1,200 feet southeast of intersection of County Route 30-A and Blue Mountain Road.	15[1]	16.1

[1]Includes wave setup of 2.5 feet.

COMMUNITY NAME	INITIAL IDENTIFICATION	FLOOD HAZARD BOUNDARY MAP REVISIONS DATE	FIRM EFFECTIVE DATE	FIRM REVISIONS DATE
Abington, Township of	March 2, 1973 May 28, 1976	None	September 30, 1977	January 2, 1991 March 3, 1992 December 19, 1996
Ambler, Borough of	May 31, 1974	April 30, 1976	November 2, 1977	August 18, 1992 December 19, 1996
Bridgeport, Borough of	January 16, 1974	December 13, 1976	January 3, 1979	December 19, 1996
Bryn Athyn, Borough of	December 20, 1974	None	February 17, 1982	May 15, 1991 December 19, 1996
Cheltenham, Township of	June 28, 1974	April 11, 1975	November 22, 1976	December 19, 1996
Collegeville, Borough of	November 22, 1974	None	February 15, 1980	December 19, 1996
Conshohocken, Borough of	March 22, 1974	None	December 15, 1977	December 19, 1996
Douglass, Township of	November 1, 1974	None	May 15, 1984	July 2, 1991 December 19, 1996
East Greenville, Borough of	November 15, 1974	None	July 25, 1976	December 19, 1996
East Norriton, Township of	June 28, 1974 July 9, 1976	None	September 30, 1977	December 19, 1996

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

MONTGOMERY COUNTY, PA
(ALL JURISDICTIONS)

COMMUNITY MAP HISTORY

Figure J-13. Community Map History Table

Map MODERNIZATION

Federal Emergency Management Agency

FEMA's Flood Hazard Mapping Program

Guidelines and Specifications *for* Flood Hazard Mapping Partners

Appendix K: Format and Specifications for Flood Insurance Rate Maps

FEDERAL EMERGENCY MANAGEMENT AGENCY

www.fema.gov/mit/tsd/dl_cgs.htm

FINAL

February 2002

Appendix K
Formats and Specifications for Flood Maps

Mapping Partners are to use this Appendix as a guide for the production and use of Flood Insurance Rate Maps (FIRMs). It sets forth specifications for the graphic elements that are shown on the FIRMs, including the mapping format representation, presentation of base map information, map frame sizing, legend, title block and notes to user appearance, and presentation of flood hazard information. It also addresses the specifications for the FIRM Map Index, Flood Boundary and Floodway Map (FBFM) Map Index and all Preliminary and Final map deliverables.

**NOTE: FEMA recognizes that not all Computer-Assisted Drafting and Design software support identical font styles. Therefore, the font specifications listed throughout this Appendix are to be used as a starting reference point only; any font herein that cannot be matched shall be emulated as closely as possible using True Type fonts, with consideration given to space constraints and the overall presentation of the finished product.*

[February 2002]

K.1 Mapping Methods and Formats

There are two methods of FIRM production- Digital and Manual. There are several distinct classifications of FIRM formats. These are Map Initiatives, Partial Map Initiatives, Countywide, Single-Jurisdiction, FIRM/Flood Insurance Study (FIS) Report Combination, and Standard (separate FIRM and FBFM). Many of these methods and formats can be mixed and interchanged, as with a Digital Partial Map Initiatives FIRM.

[February 2002]

K.1.1 Digital Method

The assigned Mapping Partner shall produce Digital FIRMs whenever possible for new FIRMs and for revisions of existing FIRMs. Manual (non-digital) techniques shall be employed in FIRM production only when it is more cost effective to do so and when there is not a specific request from the FEMA Regional office to convert the FIRM to digital format.

[February 2002]

K.1.2 Manual Method

The word "manual" refers to the standard color separation techniques primarily used in the 1970s, 1980s, and early 1990s for FIRM production. Other factors may also influence the conversion of a manual cartographic FIRM to a digital FIRM such as a community's ability and desire to use a digital product and the availability of digital base maps.

It is important to note that when processing the revision of an existing FIRM manually, the assigned Mapping Partner must maintain the appearance of the existing FIRM by emulating all fonts, line weights, line styles, and screens. The specifications found in the Guidelines and Specifications for Flood Map Production Coordination Contractors, Appendix B, dated February 17, 1999, shall serve as guidance. Additionally, Mapping Partners performing manual revisions shall remove Elevation Reference Marks shown on the panels and identify the locations of bench marks within the community. See Volume 1, Section 1.4 for a discussion of bench mark selection.

[February 2002]

K.1.3 Map Initiatives Format

The assigned Mapping Partner shall produce all FIRM creations and revisions in the Map Initiatives format whereby the information formerly shown separately on the FIRM and FBFM are combined and shown on the FIRM. The Map Repository address shall be added to the FIRM Index and in the legend of the panels that have been updated to the Map Initiatives format. If a full conversion to the Map Initiatives format cannot be justified, the Partial Map Initiatives format should be used.

[February 2002]

K.1.4 Partial Map Initiatives Format

The assigned Mapping Partner shall use the Partial Map Initiatives format for revisions of Standard format FIRMs that do not affect the majority of the FIRM panels. The Partial Map Initiatives format combines all flood hazard information to be shown on the revised FIRM panels, thereby eliminating specific FBFM panels. The Partial Map Initiatives format should only be chosen for a revision that is not large enough to justify converting the entire community FIRM to Map Initiatives or Countywide format. An example of this would be a 10-panel Standard format community FIRM requiring a revision of two panels. In this case, the assigned Mapping Partner would revise the two affected panels in the Map Initiatives format and eliminate the corresponding FBFM panels.

When the Partial Map Initiatives option is chosen, the assigned Mapping Partner shall include special paragraphs to explain the mixed format in the FIS Report. The specifics of this are detailed in Appendix J of these Guidelines. Because the Partial Map Initiatives format often requires the FBFM Index to be reprinted, this appendix includes notes to be used for FBFM Index revisions (see Section K.3.1). These notes explain the elimination of FBFM panels. As with Map Initiative format, the Map Repository Address shall be added to the FIRM panels and Index.

[February 2002]

K.1.5 Countywide Map Format

FIRMs will often be prepared in the FEMA Countywide format, whereby all jurisdictions within a given county are shown on one set of map panels. The assigned Mapping Partner shall prepare

new Countywide FIRMs in Map Initiatives format using digital production techniques. FEMA encourages the use of community- or county-supplied digital base maps for the production of countywide FIRMs; therefore, each base map supplied for this purpose will have its own unique specifications and appearance. The assigned Mapping Partner shall focus on the intent of the presentation and make every effort to conform to the standard base map specifications presented in Subsection K.4.1. A digital base map supplied by a community may contain unique graphic specifications, such as the portrayal of road centerlines or edge of pavement. The assigned Mapping Partner shall make changes to a digital base map only to facilitate map presentation, ease of use, or internal consistency in base map features; the assigned Mapping Partner shall coordinate these changes with the community that provided the data. Any significant deviations from the format presented in these Guidelines must be coordinated with the FEMA Lead or other designated FEMA staff.

There are several additional points to consider when creating a Countywide FIRM:

- Countywide mapping must provide seamless coverage within the entire county area. Any mismatches in floodplains, flood hazard information, base map information, etc., that previously existed between communities must be resolved.

- To ensure seamless coverage, portrayal of floodplains, Flood Profile and Floodway Data table information should be continuous for the length of the flooding sources. With that, the cross-section information must be re-lettered sequentially for the length of the detailed flooding sources.

[February 2002]

K.1.6 Multiple-County Communities

When processing a countywide FIRM that contains a multiple-county community, the assigned Mapping Partner shall select from one of the three options listed in order of preference- retain the subject community-based FIRM (and revise if necessary) as indicated in Option 1 below, or superseded the community-based FIRM as indicated in Options 2 or 3 below. Seamless mapping coverage between all affected jurisdictions must be obtained and that overlapping coverage and/or disclaimed flood hazard information shall be avoided.

Before a decision is made on the processing method which occurs during Project Scoping phase (see Volume 1, Section 1.3), the following questions must be answered:

- Does the subject community prefer to keep its community-based FIRM?

- In how many counties does the subject community lie?

- How are the multiple-county communities shown on the FIRMs of surrounding counties?

- What is the status of the surrounding counties relative to countywide processing?

- Does the subject community have full jurisdiction over its lands?

- How much of the subject community falls within the county that is being processed?
- What is the map scale of the existing community-based FIRM?
- How many panels would be added to the countywide FIRM in order to include the subject community in its entirety?

Once the questions above have been answered and all information has been obtained, the final decision regarding processing shall be made in consultation with the FEMA Project Officer. The three options discussed below ensure seamless mapping coverage for all jurisdictions, and prevent overlapping and/or duplicated flood hazard information from being shown on two separate FIRMs.

K.1.6.1 Processing Option 1

Under this option, the community-based FIRM would be retained as a separate map, and the community would be shown as an "Area Not Included" (no flood hazard or base map information shown) on the countywide FIRM being processed and on the FIRMs for all surrounding of the counties in which the subject community falls. If a Digital Orthophoto Quadrangle (DOQ) base map is used for the FIRM, the base map imagery will continue through the Area Not Included. When this option is chosen, a concurrent community-based FIRM revision must be processed, if required, to ensure that seamless coverage between the multiple-county community and its surrounding counties in which it is located will be maintained. Minor revisions of the FIRMs for adjacent counties to ensure that no overlaps or gaps in coverage exist.

[February 2002]

K.1.6.2 Processing Option 2

Under this option, the entire community is mapped on the new countywide FIRM. This option shall be used when the following criteria are met:

- The multiple-county community can be shown on the new countywide FIRM without substantially increasing the panel count; and
- At least 70% of the community area is located within the countywide FIRM being processed.

When Option 2 is chosen, the assigned Mapping Partner shall notify the FEMA Map Service Center (MSC) to supersede the community-based FIRM for the multiple-county community. The MSC must also be notified to include a notation in the Flood Map Status Information System that the subject multiple-county community is shown in its entirety on the new countywide FIRM. The adjacent counties will continue to show the subject multiple-county community as an Area Not Included on their FIRMs, even if their FIRMs are converted to the countywide format at a future date. This decision will be made on a case-by-case basis with the FEMA Project Officer.

[February 2002]

K.1.6.3 Processing Option 3

Apportion the multiple-county community such that it is shown on multiple countywide FIRMs. This option shall be used only when the following criteria are met:

- All adjacent counties in which the multiple-county community is located either already have Countywide FIRMs or will have in the near future; and

- The multiple-county community has been consulted and has not expressed significant concerns with being shown on more than one FIRM.

When Option 3 is chosen, if the processing of any of the contiguous countywide FIRMs that share the subject community are delayed (usually as a result of an appeal, protest, or other study complication), thereby making it impossible for all countywide FIRMs to become effective at the same time, the multiple-county community shall retain the community-based FIRM (see Option 1 above). In this situation, the assigned Mapping Partner must consult the FEMA Project Officer for a decision on how to proceed. Decisions will be made on a case-by-case basis, but must result in continuing and non-conflicting coverage for all land areas being mapped. Once all issues causing the delay are resolved, the assigned Mapping Partner can then proceed with the inclusion of the community into each countywide FIRM.

When Option 3 is chosen, the assigned Mapping Partner must notify the MSC to supersede the community-based FIRM for the multiple-county community.

[February 2002]

K.1.7 Single-Jurisdiction (Community-Based) Format

For single-jurisdiction FIRMs, all areas within a single community's jurisdiction are shown on one FIRM. The assigned Mapping Partner shall prepare a single-jurisdiction FIRMs when funding constraints or lack of suitable base map data prohibit full countywide mapping.

Many FIRM updates affect only a portion of a community (i.e., only a few map panels instead of the entire community). When this is the case, a decision must be made on whether to convert an entire manual FIRM to digital format during the revision or whether to process revisions manually. The decision shall be made with the following in mind:

- FEMA's goal is to convert its entire inventory of manual maps to a digital format.

- One of the primary benefits of digital mapping is that it will reduce the cost of future revisions.

- Many of the steps required to convert a study to digital format require nearly as much time for a partial digital study as for a full digital study, thus reducing costs in the long run.

Digital conversion of only the revised panels (partial digital conversion) is not the preferred option, but may be undertaken when funding constraints prohibit full digital conversion.

[February 2002]

K.1.8 Report/Map Combination Format

For small communities that are shown on single-jurisdiction FIRMs, a combination FIRM and FIS report may be created. This involves printing one FIRM panel as defined under the Map Initiates format described above containing all identified floodplains for the community as well as a condensed version of the FIS report. The use of this format should eliminate the requirement to create and print a separate FIS report. Space limitations will guide the decision on using this map format. At a minimum, the assigned Mapping Partner shall include the Flood Profiles, and Floodway Data and Summary of Flood Discharges tables on the FIRM. The assigned Mapping Partner shall also modify the FIRM Notes to Users to reference the map instead of the FIS report as the source of certain pertinent information. Examples of the notes and how they are modified are shown in Section K.7.1. The decision to create a combination FIRM and FIS report shall be made in consultation with a FEMA Project Officer.

[February 2002]

K.1.9 Standard Map Format

Unless specifically directed to do otherwise, the assigned Mapping Partner shall not produce new or revised FIRMs and FBFMs in the Standard format as separate FIRM and FBFM panels. All revisions should be processed in either one or a combination of the formats described above.

[February 2002]

K.2 Map Frames

Mapping Partners shall select frame sizes for Map Indexes and FIRM panels depending on whether the FIRM is being produced digitally or manually and whether the Index may be produced on 8 ½" x 11" paper.

[February 2002]

K.2.1 Z-fold Digital Frame Sizes

All Digital FIRMs, including most Map Indexes, shall be printed in map frames of the dimensions shown below:

- Trimmed paper size: Height 25.875 " x Width 36"
- Map border size: Height 25.082" x Width 34.880"
- Legend borders: Height 16.87" x Width 5.44"
- Notes to User borders: Height 15.15" x Width 5.44"
- Title Block box:
    - Overall dimensions: Height 7.85" x Width 4.40"
    - Striped side box: Height 7.225" x Width 1.10"
    - Title box: Height 7.225" x Width 3.30"
    - Striped upper box: Height 0.50" x Width 1.10"
    - Upper box: Height 0.50" x Width 3.30"

The map image size (the image inside the FIRM neatline) shall vary depending on the latitude of the community being mapped. Overedge areas may be included if they fit inside the map border.

Figure K-1 provides the dimensions of a Digital FIRM map frame.

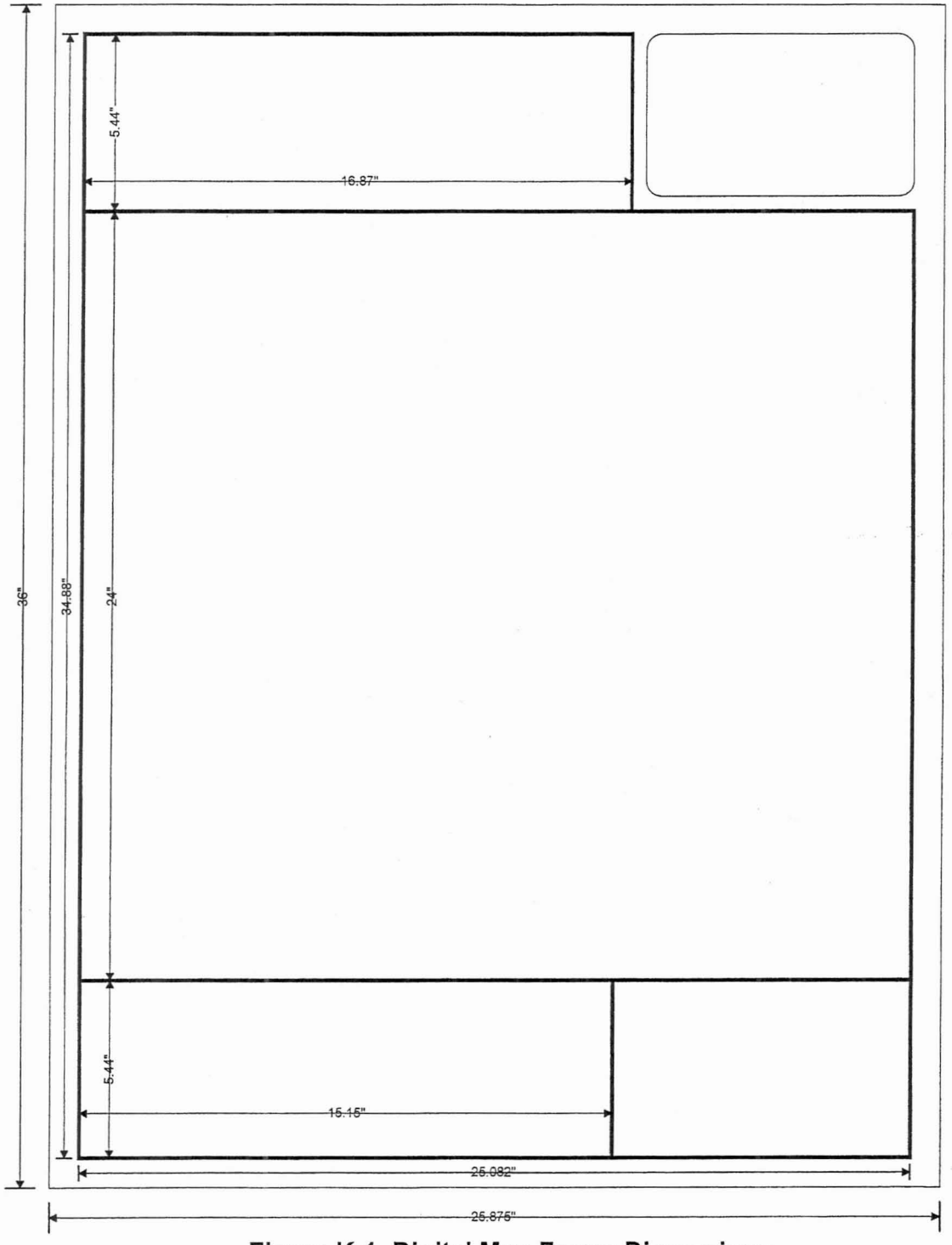


Figure K-1. Digital Map Frame Dimensions

[February 2002]

K.2.2 Z-fold Manual Frame Sizes

Manually-prepared FIRMs are printed in one of five map frame sizes, the dimensions of which are shown below. Refer to the diagram in Figure K.14-2 for additional Map Index dimensions.

A Frame	Trimmed paper size:	Height 25.79" x Width 18.76"
	Map neatline size:	Height 25.0" x Width 14.2"
B Frame	Trimmed paper size:	Height 25.79" x Width 22.33"
	Map neatline size:	Height 25.0" x Width 18.0"
C Frame	Trimmed paper size:	Height 25.79" x Width 26.28"
	Map neatline size:	Height 25.0" x Width 21.6"
D Frame	Trimmed paper size:	Height 25.79" x Width 29.03"
	Map neatline size:	Height 25.0" x Width 25.4"
E Frame	Trimmed paper size:	Height 25.79" x Width 37.52"
	Map neatline size:	Height 25.0" x Width 32.9"

Figure K-2 provides the dimensions of a Manual FIRM map frame.

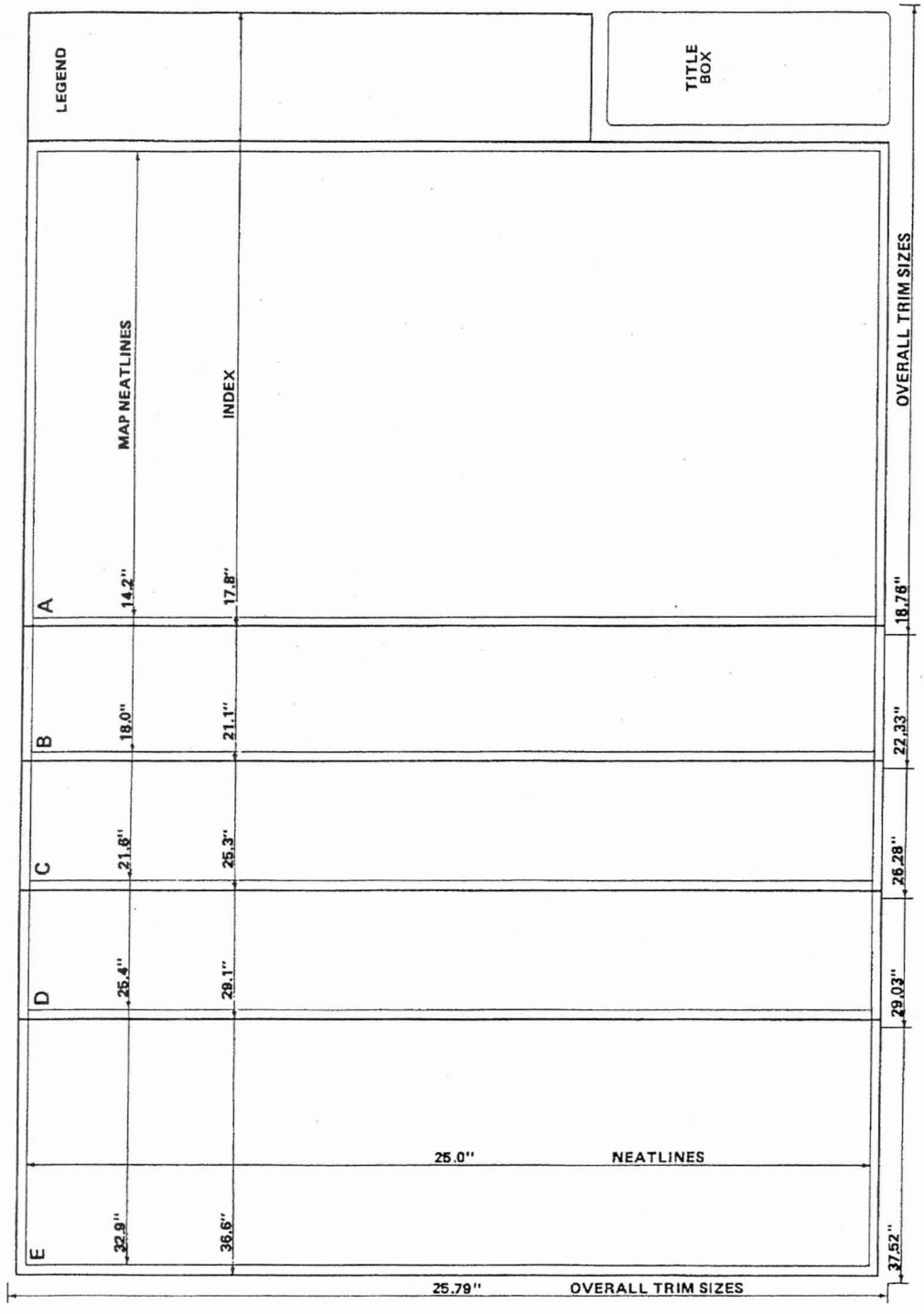


Figure K-2. Manual Map Frame Dimensions

[February 2002]

K.2.3 8½" x 11" Frames

Map Indexes for small communities with few map panels may be printed on 8½" x 11" paper. The dimensions of this map frame are shown below:

- Trimmed paper size: Height 8 ½ " x Width 11"
- Map border size: Height 7.5" x Width 10.0"
- Title Block box:
  - Overall dimensions: Height 6.00" x Width 3.30"
  - Striped side box: Height 5.60" x Width 0.78"
  - Title box: Height 5.60" x Width 2.50"
  - Striped upper box: Height 0.385" x Width 0.78"
  - Upper box: Height 0.385" x Width 2.50"

Section K.3 provides an example of an 8½" x 11" Map Index.

[February 2002]

K.3 Map Index

The assigned Mapping Partner shall produce a Map Index for every community that requires more than one printed map panel. Map Indexes may be prepared in an 8½" × 11" format for small- to medium-sized communities. When the panel count becomes large enough to render an 8½" × 11" Index unusable or illegible, a Z-fold Index is required. Z-fold Indexes must always be prepared for countywide FIRMs. Countywide FIRMs may require more than one Map Index sheet. A Map Index may be revised to include changes in community boundaries; the addition of map panels to the grid layout; the addition of roads, drainage lines, and other physical features; and revisions of dates and notes. When such revisions are necessary, the assigned Mapping Partner shall make these changes in a format consistent with that of the existing Map Index and according to the standards applied in the preparation of that Index.

When a new Map Index layout is necessary for a single-panel FIRM that must be expanded to a multiple-panel FIRM, or when an existing layout must be completely revised, the Assigned Mapping Partner shall prepare a new FIRM Map Index.

[February 2002]

K.3.1 Map Index Body Elements and Specifications

The entire jurisdictional area of the community, including corporate and Extraterritorial Jurisdictional (ETJ) limits, if appropriate, shall be divided into map panels, following standard grid layout procedures (see Section 1.4 of these Guidelines) . The Map Index shall have the same directional orientation as the individual map panels; for all digital FIRMs, north shall be oriented to the top of the page. Panel neatlines shall be accurately placed with respect to the community layout. The locations and names of major flooding sources, major roads, corporate limits, and selected railroads shall be shown to facilitate the orientation and location of the individual panels. Areas within the corporate limits that were not studied shall be labeled as such whenever the scale of the Map Index permits.

[February 2002]

K.3.1.1 Map Numbers

Each panel shown on the Map Index must contain a map number. The map number may be comprised of the Community Identification Number (CID), four-digit panel number, and suffix, or the countywide FIPS code, the letter "C", the four-digit panel number, and the suffix. The Map Index shall identify unprinted panels with asterisks and footnotes which define the reason(s) for the panel not being printed.

The appropriate reason(s) for the panel not being printed shall appear below the lower left corner of the grid layout. A listing of appropriate footnotes are listed in "Panel Not Printed" Footnotes table available later in this section.

Suffix changes shall be reflected both on the FIRM panel and the Map Index. The suffixes for unprinted panels should not change unless all panels are revised.

[February 2002]

K.3.1.2 Map Dates

The FIRM Map Index shall show the FIRM effective date in the title block. This date shall be designated in the title block as "Effective Date" (on the first FIRM for the subject jurisdiction or first countywide) or "Map Revised" (on FIRMs that have been revised at least once). When the preliminary copy of the Map Index is prepared, this date should be left blank. When the final copy of the Map Index is prepared, the date determined for the FIRM shall be added. Sample Map Index title blocks are shown in Section K.3.3. Similar type styles and sizes are acceptable, and may vary due to Map Index size limitations.

Map Indexes shall also list the effective date of each FIRM panel below the panel number on the Map Index to assist the user in determining current panel dates, as shown in Figure K-3.

17097C0159 B 06/20/97	17097C0159 B 06/20/97
17097C0159 A 09/04/94	17097C0159 A 09/04/94

Figure K-3. Panel Effective Dates on Map Index

When adding map dates under the panel numbers becomes problematic due to high levels of base map detail on the body of the Map Index, a second option is to list the dates of all printed panels in a separate FIRM Panel Dates table on the Map Index. When multiple Map Index panels exist, this table will list FIRM panels on a Map Index panel-specific basis. Figure K-4 shows a sample table with suggested font specifications.

10 Pt. Arial Bold CLC

FIRM Panel Dates For Printed Panels of Johnson County, FL (All Jurisdictions)					
Panel	Effective Date	Panel	Effective Date	Panel	Effective Date
0035 D	May 3, 2000	0145 D	May 3, 2000	0237 C	December 6, 1991
0039 E	July 7, 2001	0152 E	July 7, 2001	0242 B	January 8, 1988
0045 E	July 7, 2001	0155 E	July 7, 2001	0244 B	January 8, 1988
0053 D	May 3, 2000	0160 E	July 7, 2001	0252 D	May 3, 2000
0061 D	May 3, 2000	0164 B	January 8, 1988	0255 D	May 3, 2000
0062 D	May 3, 2000	0165 D	May 3, 2000	0256 D	May 3, 2000
0063 D	May 3, 2000	0166 B	January 8, 1988	0257 D	May 3, 2000
0064 D	May 3, 2000	0167 B	January 8, 1988	0258 D	May 3, 2000
0068 D	May 3, 2000	0168 B	January 8, 1988	0259 B	January 8, 1988
0086 C	December 6, 1991	0169 B	January 8, 1988	0261 B	January 8, 1988
0088 C	December 6, 1991	0176 D	May 3, 2000	0262 B	January 8, 1988
0090 C	December 6, 1991	0177 D	May 3, 2000	0263 B	January 8, 1988
0095 C	December 6, 1991	0178 D	May 3, 2000	0264 B	January 8, 1988
0110 D	May 3, 2000	0179 D	May 3, 2000	0267 B	January 8, 1988
0113 D	May 3, 2000	0181 D	May 3, 2000	0268 B	January 8, 1988
0114 D	May 3, 2000	0186 B	January 8, 1988	0269 B	January 8, 1988
0115 D	May 3, 2000	0201 C	December 6, 1991	0276 B	January 8, 1988
0119 D	May 3, 2000	0202 C	December 6, 1991	0277 B	January 8, 1988
0130 D	May 3, 2000	0204 D	May 3, 2000	0281 B	January 8, 1988

9 Pt. Arial CLC

Figure K-4 FIRM Panel Dates

[February 2002]

K.3.1.3 Panel Not Printed Footnotes

The following notes shall be added to the Map Index to identify why certain FIRM or FBFM panels are not printed.

Panel Not Printed Footnotes *Font specifications that cannot be matched may be approximated		
Example	Usage	Specification
PANEL NOT PRINTED – NO SPECIAL FLOOD HAZARD AREAS	This note is used to designate panels not printed because the entire panel area does not contain floodplain areas.	7-9 Pt. Arial CAPS

Panel Not Printed Footnotes *Font specifications that cannot be matched may be approximated		
Example	**Usage**	**Specification**
PANEL NOT PRINTED – AREA IN ZONE D	This note is used to indicate panels not printed because the panel area is entirely Zone D.	7-9 Pt. Arial CAPS
PANEL NOT PRINTED – AREA NOT INCLUDED	This note is used when the area of an entire panel is contained in an Area Not Included.	7-9 Pt. Arial CAPS
PANEL NOT PRINTED – OPEN WATER AREA	This note is used when an area of all water and no land is contained within the panel area.	7-9 Pt. Arial CAPS
PANEL NOT PRINTED – AREA ALL WITHIN ZONE AE (ELEVATION)	This note is used when the entire panel falls entirely within one flood hazard zone with one flood elevation. If the panel contains land area, this procedure shall only be used with the approval of a FEMA Project Officer, as normally any land areas on a FIRM with identified flood hazards should be printed. The elevation value is given in parentheses.	7-9 Pt. Arial CAPS
PANEL NOT PRINTED – AREA OUTSIDE CORPORATE / COUNTY BOUNDARY	This note is used to indicate paneled areas outside the subject jurisdiction.	7-9 Pt. Arial CAPS
PANEL NOT PRINTED - NO FLOODWAY DELINEATED; FOR FLOODPLAIN BOUNDARIES, SEE CORRESPONDING FLOOD INSURANCE RATE MAP PANEL PUBLISHED SEPARATELY	This note is used as a footnote on the FBFM Index to designate panels not printed because no floodway has been designated on that panel. Omit "published separately" if the FBFM Index is part of a Partial Map Initiatives publication. Omit "corresponding" if the FBFM paneling scheme is different from the FIRM.	7-9 Pt. Arial CAPS
PANEL NOT PRINTED – FLOODWAY DELINEATION SHOWN ON FLOOD INSURANCE RATE MAP	This note is used as a footnote on the FBFM Index to indicate that the floodway is now shown on the FIRM panel.	7-9 Pt. Arial CAPS

Panel Not Printed Footnotes *Font specifications that cannot be matched may be approximated		
Example	**Usage**	**Specification**
PANEL NOT PRINTED - AREA WITHIN *(community name)*, WHICH HAS A SEPARATELY PUBLISHED FLOOD INSURANCE RATE MAP; THE PORTION OF *(community name)* ON MAP NUMBER *(map number)* IS NOT WITHIN SPECIAL FLOOD HAZARD AREAS.	This note is used to indicate a panel that is partially within an Area Not Included and partially within an area that does not contain floodplains	7-9 Pt. Arial CAPS

[February 2002]

K.3.1.4 Index Body Notes

The following notes shall be used on the body of the Map Index, when appropriate. On a single-jurisdiction FIRM Index, the Map Repository address shall be shown above or in close proximity to the north arrow.

Index Body Notes *Font specifications that cannot be matched may be approximated		
Example	**Usage**	**Specification**
THIS AREA OF THE COMMUNITY NOT PRINTED – ALL IN OPEN WATER	This note is used on the body of the Map Index to indicate an unmapped area of the community that is entirely in open water.	7-9 Pt. Arial CAPS
THIS AREA OF THE COMMUNITY CONTAINS NO SPECIAL FLOOD HAZARD AREAS AND IS THEREFORE NOT PRINTED	This note is used on the body of the Map Index to indicate an area of the community that does not have floodplain areas and is not paneled.	7-9 Pt. Arial CAPS
MAP REPOSITORY (Maps available for reference only, not for distribution.) Manatee County Building Division Floodplain Section, 2nd Floor 1112 Manatee Avenue West Bradenton, Florida 34205	This is an example of a Map Repository listing for a single jurisdiction FIRM Index. The Map Repository is the location that the community has designated for storing its FIRM. The address is placed just above or in close proximity to the north arrow on the Map Index. The disclaimer, as stated, immediately follows the heading for the address.	**(Header)** 12 Pt. Arial CAPS with underscore and CLC **(Reference note, Community Name, and Address)** 10 Pt. Arial CAPS and CLC

Index Body Notes *Font specifications that cannot be matched may be approximated		
Example	**Usage**	**Specification**
NOTICE TO MAP USERS **FEMA maintains information about map features, such as street locations and names, in or near designated flood hazard areas. Requests to revise information in or near designated flood hazard areas may be provided to FEMA during the community review period, at the final Consultation Coordination Officer's meeting, or during the statutory 90-day appeal period. Approved requests for changes will be shown on the final printed FIRM.**	The following note must be added to all Preliminary FIRM Indexes and/or panel if panel is Only Panel Printed. It is also a standard paragraph in the transmittal letters to the communities. The note reminds the community to submit changes for street locations and names in or near the floodplains for incorporation into the final printed FIRM. The note does not appear on the final FIRM that is delivered to the Government Printing Office for printing. If the FIRM does not contain any Base Flood Elevations, the reference to the 90-day appeal period is omitted from the note.	**(Header)** 12-20 Pt. Arial Bold CAPS **(Reference note)** 12-20 Pt. Arial Bold CLC
– NOTE – DESIGNATED COASTAL BARRIERS ARE LOCATED ON PANELS 14, 18, 155[1], 161[1], 188, 304, 308, AND 309. [1]PANEL NOT PRINTED	This note is added above the Map Index north arrow for any community that contains Coastal Barrier units. All panels containing Coastal Barrier units and/or Otherwise Protected Areas, including panels that are not printed are listed. Non-printed panels are listed with a footnote.	10 Pt. Arial CAPS

Index Body Notes *Font specifications that cannot be matched may be approximated		
Example	**Usage**	**Specification**
MAP DATES This FIRM Index displays the map date for each FIRM panel at the time that this Index was printed. Because this Index may not be distributed to unaffected communities in subsequent revisions, users may determine the current map date for each FIRM panel by visiting the FEMA Map Service Center website at http://web1.msc.fema.gov, or by calling the Map Service Center at 1-800-358-9616. Communities annexing land on adjacent FIRM panels must obtain a current copy of the adjacent panel as well as the current FIRM Index. These may be ordered directly from the Map Service Center at the numbers listed above.	An inventory of NFIP panels is available through the Map Service Center website. Therefore, this note shall be placed on all countywide format FIRM Indexes above the FIRM Panel Dates table (if this option is chosen) or in a clear area of the FIRM Index (if the dates are shown within the individual map grids). If more than one FIRM Index is required to show the jurisdiction, this note is placed on each FIRM Index panel.	**(Header)** 10 Pt. Arial Bold CAPS with underscore **(Reference note)** 9 Pt. Arial CLC

[February 2002]

K.3.1.5 Flood Boundary and Floodway Map Index

FBFM Indexes shall be revised whenever the FIRM is prepared in the Partial Map Initiatives format. The Partial Map Initiatives format may be used for restudy or revision map action when it is determined that total conversion to Map Initiatives is not cost effective.

When the Partial Map Initiatives format is used, the FBFM panel(s) is superseded by the FIRM panel and the FBFM Index reflects this change. The appropriate "Panel Not Printed" footnote should be added to the Index for FBFM panels that are superseded by Partial Map Initiatives FIRM panels. See the table below for the proper wording of the "Panel Not Printed" footnote.

In addition to the "Panel Not Printed" footnote, a note shall be added to the body of the FBFM Index informing the user that the former FBFM panels have been superseded by the FIRM panels. See the table below for the proper wording of the note.

When preparing a revised FBFM Map Index, map dates may appear beneath each FBFM panel number within the map grid. The assigned Mapping Partner shall ensure that the remaining separately printed FBFM panels have the correct date under the panel number. Dates that appear on non-printed panels shall be removed.

The assigned Mapping Partner shall notify the MSC by memorandum or e-mail when Map Initiatives FIRM panels supercede Flood Boundary and Floodway Map panels.

[February 2002]

FBFM Index Body Notes *Font specifications that cannot be matched may be approximated		
Example	**Usage**	**Specification**
NOTE TO USER: **Floodways on Flood Boundary and Floodway Map panel(s)** *(list affected FBFM panel numbers)* **are shown on the corresponding Flood Insurance Rate Map panel(s).**	This note is used on the body of the FBFM Index in conjunction with the footnote to indicate that the FIRM has superseded the FBFM panel(s) when the floodway is now shown on the FIRM panel(s). Omit the word "corresponding" if the panel numbers are different the FIRM and FBFM.	20 Pt. Impact
NOTE TO USER: **PANEL(S)** *(list affected FBFM panel numbers)* **SHOULD BE USED FOR FLOODWAY INFORMATION ONLY. PLEASE REFER TO THE CORRESPONDING FLOOD INSURANCE RATE MAP PANELS FOR UP-TO-DATE 100- AND 500-YEAR FLOODPLAIN BOUNDARY INFORMATION.**	This note is used on the body of the FBFM Index when the floodplain boundaries have been modified but the floodway boundaries have remained the same and therefore, the FBFM panels were not revised.	20 Pt. Impact

K.3.1.6 Map Index Panel Element Graphic Specifications

The table below provides graphic specification standards for the depiction of information on Map Indexes. Note that separate specifications for 8½" x 11" Map Indexes appear in Subsection K.3.4.

Map Index Panel Elements *Font specifications that cannot be matched may be approximated		
Example	**Feature**	**Specification**
	North Arrow	Line weight .010" Width 1.20" Height 0.70"
	Major Road	Line weight .030"
CAPITAL STREET	Street, Road, Avenue Name	8 Pt. Arial CAPS
	Interstate Highway Symbol	Standard Interstate Route Shield Line weight .010" Size .200" x .200" to .400" x .480" 8 Pt. Arial Bold Narrow CAPS
	U.S. Highway Symbol	Standard U.S. Route Shield Line weight .010" Size .200" x .200" to .400" x .480" 8 Pt. Arial Bold Narrow CAPS
	State Highway Symbol	Circle Line weight .010" Diameter .200" to .280" 8 Pt. Arial Bold Narrow CAPS
	County Highway Symbol	Rectangle Line weight .010" Size .150" x .250" to .300" x .400" 8 Pt. Arial Bold Narrow CAPS
 CHESSIE SYSTEM *RAILROAD*	Railroad and Railroad Name	Line weight .015" Tie length .060", spacing .300" 8 Pt. Arial Italics CAPS
	Airport	Line weight .010"

Map Index Panel Elements *Font specifications that cannot be matched may be approximated		
Example	**Feature**	**Specification**
 Eighteen Mile Creek	River, Stream, Lake, or Other Hydrographic Feature and Feature Name	Line weight .008" to .010" 6 – 18 Pt. Times New Roman Bold Italics CLC
SHIP ISLAND	Small or Large Island	6 - 14 Pt. Arial CAPS
 ASSABET RIVER DAM	Major Dam and Dam Name	Line weight .010 8 Pt. Arial CAPS or CLC
	International, State, County Boundary	Line weight .030" Dashing: 1.500" .050" .150" .050" .150" .050" 1.500"
	Corporate, Extraterritorial Jurisdiction Boundary (Countywide)	Line weight .030" Color: 63% Gray No dashing
	Corporate, Extraterritorial Jurisdiction Boundary (Single jurisdiction)	Line weight .030" Dashing: 1.500" .050" .150" .050" 1.500"
CITY OF BLADES	Community Label	6 – 10 Pt. Times New Roman CAPS or CLC
 City of Lafayette (AREA NOT INCLUDED)	Area Not Included Note	Line weight .020" **(Community name)** 8-24 Pt. Times New Roman CAPS or CLC **(Note)** 8 – 11 Pt. Arial CAPS
FOREST BOUNDARY ROOSEVELT STATE FOREST	Forest, Park or Reservation Boundary, Boundary Label and Area Label (Large areas only)	**(Boundary Label)** 6-8 Pt. Arial CAPS **(Boundary)** Line weight .015" Dot diameter .030", spacing .400" **(Area Label)** 6-10 Pt. Times New Roman CAPS or CLC
1202300275 C **41050C0050 E**	FIRM Map Numbers	8 – 18 Pt. Arial Narrow Bold CAPS

Map Index Panel Elements *Font specifications that cannot be matched may be approximated		
Example	**Feature**	**Specification**
8/30/00	FIRM Panel Effective Dates	8 Pt. Arial Narrow CAPS

[February 2002]

K.3.2 Countywide Index

Countywide Map Index contains unique elements that enable the user to identify pertinent information for each individual community. These elements include a Listing of Communities table, a list of the Map Repositories, and multiple index sheets where applicable.

[February 2002]

K.3.2.1 Listing of Communities

The assigned Mapping Partner shall ensure that the Countywide Map Index contains a Listing of Communities table that lists, in alphabetical order and in tabular form, all jurisdictions included in the FIS. The table shall also list non-floodprone communities in the county, footnoted with an indication of their non-floodprone status. The listing shall not include communities that are labeled as Areas Not Included. Each community shall have its CID listed on the table in the "Community Number" column. Each panel showing any portion of a community, including non-printed panels shall be listed next to the community in the "Located on Panel(s)" column. Non-printed panels shall be footnoted as "Panel Not Printed."

Historical map dates shall be listed in the "Initial NFIP Map Date," "Initial FIRM Date," and "Most Recent FIRM Panel Date" columns. The Initial NFIP Map Date is the date of the community's first flood hazard map, which may be a Flood Hazard Boundary Map (FHBM), a combined FHBM/FIRM, or a FIRM. If the Initial NFIP Map Date does not correspond to the Initial Identification Date in the legend of the most recent map panel, a footnote shall be placed beneath the table to state the Initial Identification Date.

The Initial FIRM Date is the date of the community's first FIRM. The Most Recent FIRM Panel Date column shall list the last date on which a panel within that community was published. This date is added to clarify which communities are affected by the republication of the Map Index, since the Map Index is updated every time a panel within the county is republished. An example of a Listing of Communities table is shown in Figure K-5.

The following note shall be added above the north arrow of a countywide Map Index to clarify the meaning of the dates in the Listing of Communities table.

14 – 22 Pt. Arial CAPS with underscore

10 -12 Pt. Arial Narrow CAPS

LISTING OF COMMUNITIES

COMMUNITY NAME	COMMUNITY NUMBER	LOCATED ON PANEL(S)	INITIAL NFIP MAP DATE	INITIAL-FIRM DATE	MOST RECENT FIRM PANEL DATE
LAKE FOREST, CITY OF	170374	0169, 0188, 0190, 0257, 0259, 0276, 0277, 0278, 0279, 0285	FEBRUARY 1, 1974	FEBRUARY 18, 1981	SEPTEMBER 4, 1994
LAKE VILLA, VILLAGE OF	170375	0029, 0035, 0036, 0037, 0038, 0039, 0041	MAY 3, 1974	JULY 2, 1981	SEPTEMBER 4, 1994
LAKE ZURICH, VILLAGE OF	170376	0228, 0229, 0233, 0236, 0237, 0241	MARCH 29, 1974	JULY 5, 1983	JUNE 20, 1997
LIBERTYVILLE, VILLAGE OF	170377	0134, 0142, 0161, 0162, 0163, 0164, 0166, 0168, 0252	NOVEMBER 2, 1973	JANUARY 16, 1980	SEPTEMBER 4, 1994
LINCOLNSHIRE, VILLAGE OF	170378	0254, 0258, 0259, 0262, 0266, 0267	NOVEMBER 9, 1973	JULY 16, 1980	SEPTEMBER 4, 1994
LINDENHURST, VILLAGE OF	170379	0041, 0042, 0044	APRIL 5, 1974	JANUARY 2, 1980	SEPTEMBER 4, 1994
LONG GROVE, VILLAGE OF	170380	0144, 0231, 0232, 0233, 0234, 0241, 0242, 0251, 0253, 0254, 0261, 0263	APRIL 5, 1974	MAY 19, 1981	SEPTEMBER 4, 1994
METTAWA, VILLAGE OF	170381	0164, 0168, 0169, 0252, 0256, 0257	OCTOBER 18, 1974	MARCH 28, 1980	SEPTEMBER 4, 1994
MUNDELEIN, VILLAGE OF	170382	0139, 0142, 0143, 0144, 0161, 0163, 0232, 0251	JUNE 28, 1974	JULY 2, 1981	SEPTEMBER 4, 1994
NORTH BARRINGTON, VILLAGE OF	170383	0207, 0208, 0209, 0217, 0226, 0228, 0236	MARCH 22, 1974	OCTOBER 18, 1983	SEPTEMBER 4, 1994
NORTH CHICAGO, CITY OF	170384	0159, 0167, 0180, 0186, 0190	APRIL 5, 1974	DECEMBER 5, 1980	JUNE 20, 1997
OLD MILL CREEK, VILLAGE OF	170385	0055, 0061, 0062	AUGUST 30, 1974	AUGUST 1, 1980	SEPTEMBER 4, 1994
PARK CITY, CITY OF	170386	0156, 0157, 0159	MARCH 1, 1974	OCTOBER 15, 1981	SEPTEMBER 4, 1994
RIVERWOODS, VILLAGE OF	170387	0259, 0266, 0267, 0270, 0286	MARCH 1, 1974	AUGUST 15, 1980	SEPTEMBER 4, 1994
ROUND LAKE, VILLAGE OF	170388	0110, 0126, 0127, 0128, 0129	MARCH 29, 1974	AUGUST 1, 1980	SEPTEMBER 4, 1994
ROUND LAKE BEACH, VILLAGE OF	170389	0038, 0039, 0043, 0126, 0127, 0131	APRIL 5, 1974	AUGUST 1, 1980	SEPTEMBER 4, 1994
ROUND LAKE HEIGHTS, VILLAGE OF	170390	0038	MARCH 29, 1974	JANUARY 2, 1980	SEPTEMBER 4, 1994
ROUND LAKE PARK, VILLAGE OF	170391	0127, 0129, 0133, 0137, 0141, 0142	MARCH 29, 1974	JUNE 4, 1980	SEPTEMBER 4, 1994
THIRD LAKE, VILLAGE OF	170392	0044, 0132, 0155	SEPTEMBER 6, 1974	DECEMBER 25, 1981	JUNE 20, 1997
TOWER LAKES, VILLAGE OF	170393	0206, 0207	APRIL 5, 1974	MARCH 2, 1981	SEPTEMBER 4, 1994
VERNON HILLS, VILLAGE OF	170394	0163, 0164, 0251, 0252, 0253, 0254, 0256, 0258	FEBRUARY 4, 1977	AUGUST 1, 1980	SEPTEMBER 4, 1994
VOLO, VILLAGE OF	171042	0105, 0110, 0112, 0116, 0117	JANUARY 17, 1975	NOVEMBER 3, 1982	SEPTEMBER 4, 1994
WADSWORTH, VILLAGE OF	170395	0055, 0056, 0057, 0058, 0059, 0062, 0064, 0066, 0067, 0068	MARCH 1, 1974	FEBRUARY 4, 1981	SEPTEMBER 4, 1994
WAUCONDA, VILLAGE OF	170396	0116, 0117, 0118, 0119, 0140, 0207	APRIL 5, 1974	DECEMBER 1, 1981	SEPTEMBER 4, 1994
WAUKEGAN, CITY OF	170397	0066, 0067, 0068, 0069, 0086, 0087, 0088, 0089, 0095, 0154, 0156, 0157, 0158, 0159, 0166, 0177, 0180	MAY 10, 1974	JUNE 15, 1981	SEPTEMBER 4, 1994
WINTHROP HARBOR, VILLAGE OF	170398	0076, 0077, 0078, 0079, 0081	MARCH 8, 1974	DECEMBER 2, 1980	SEPTEMBER 4, 1994
ZION, CITY OF	170399	0057, 0059, 0076, 0077, 0078, 0079, 0081, 0085, 0086, 0087	MARCH 29, 1974	JANUARY 16, 1981	SEPTEMBER 4, 1994

8 - 10 Pt. Arial Narrow CAPS

Figure K-5 Listing of Communities Table

Listing of Communities Table Note *Font specifications that cannot be matched may be approximated		
Example	**Usage**	**Specification**
NOTICE Future revisions to this FIRM index will only be issued to communities that are located on FIRM panels being revised. This FIRM index therefore remains valid for FIRM panels dated [*date*] or earlier. Please refer to the "most recent FIRM panel date" column in the Listing of Communities table below to determine the most recent FIRM index date for each community.	This note is added to all countywide Map Indexes to inform map users that the Map Index may be republished in the future but not distributed to them unless they are affected by the revision. See Figure K.3.2-1 for an example of a Listing of Communities table referenced in this note.	**(Header)** 10 Pt. Arial Bold CAPS with underscore **(Reference note)** 9 Pt. Arial CLC

[February 2002]

K.3.2.2 Community Map Repository List

The assigned Mapping Partner shall ensure that Countywide Map Index contains a Community Map Repository list containing an alphabetical listing of the map repository address of each community that will receive a copy of the FIRM. The communities that are classified as Areas Not Included will not receive a copy of the FIRM and communities that are classified as non-floodprone will receive copies of the Map Index only. The Community Map Repository list shall be placed above or in close proximity to the north arrow. A sample Community Map Repository list is provided below.

Countywide Map Repositories Note *Font specifications that cannot be matched may be approximated		
Example	**Usage**	**Specification**
MAP REPOSITORIES (Maps available for reference only, not for distribution.) DAVIDSON COUNTY (UNINCORPORATED AREAS): Davidson County Government Center Planning Department 913 Greensboro Street Lexington, North Carolina 27293 DENTON, TOWN OF: Denton Town Hall 101 West Newsome Avenue Denton, North Carolina 27239 LEXINGTON, CITY OF: City of Lexington Community Development Department 31 West First Street Lexington, North Carolina 27292	This is an example of a Map Repository list for a countywide FIRM. The Map Repository is the location that the community has designated for storing its FIRM. The Map Repository address for each community included in the study is listed in alphabetical order on the body of the Map Index. If feasible, the list of addresses is placed just above the north arrow on the Map Index. The disclaimer, as stated, immediately follows the heading for the addresses.	**(Header)** 16-22 Pt. Arial Bold CAPS with underscore **(Reference note, Community Name, and Address)** 9-12 Pt. Arial CAPS and CLC

[February 2002]

K.3.2.3 Multiple Map Index Panels

FIRMs that are contained on one Map Index panel have the Map Number "IND0." It may sometimes be necessary to create multiple Map Index panels for large countywide FIRMs. In such cases, the Listing of Communities table and Community Map Repository list shall appear separately on a second Map Index sheet. Sometimes, it may also be necessary to split the image of the community itself onto multiple Map Index sheets. In such cases, a match line shall be added and labeled with a note that references the adjoining Map Index sheet. When multiple Map Index sheets are created, the Map Numbers of those sheets shall be IND1, IND2, etc., and an Index Locator Diagram shall be added to the Map Index, proportionate in size to other elements. Examples of an Index Locator Diagram are shown in Figures K-6 and K-7.

[February 2002]

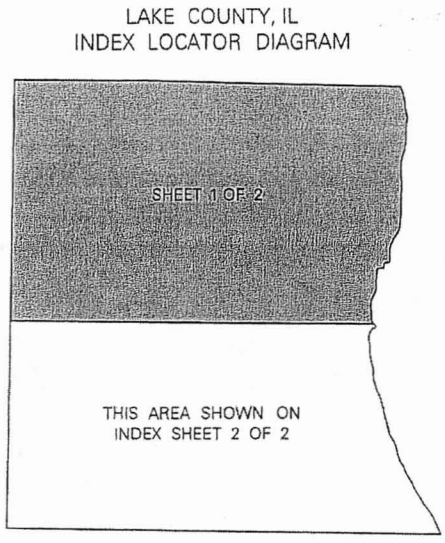


Figure K-6 Index Locator Diagram Sheet 1 of 2

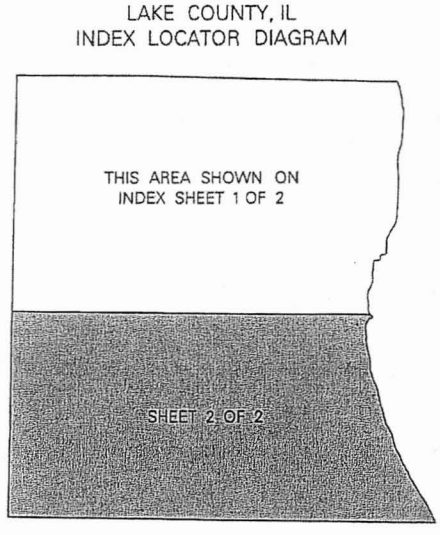


Figure K-7 Index Locator Diagram Sheet 2 of 2

K.3.3 Index Title Block

The Index title block must be similar in appearance to the FIRM title block, with the exception that it must contain a listing of all of the printed panels instead of community-specific information. The following pages contain examples of the following Map Index title blocks:

- Countywide DFIRM Index Title Block (Figure K-8);
- Countywide Multi-sheet DFIRM Index Title Block, Sheet 1 of 2 (Figure K-9);
- Countywide Multi-sheet DFIRM Index Title Block, Sheet 2 of 2 (Figure K-10);
- Single-Jurisdiction DFIRM Index Title Block (Figure K-11);
- Single-Jurisdiction Manual FIRM Index Title Block (Figure K-12); and
- Single-Jurisdiction Manual FBFM Index Title Block (Figure K-13).

Figure K-14, "Title Block Element Specifications," lists the specifications for the title block elements.

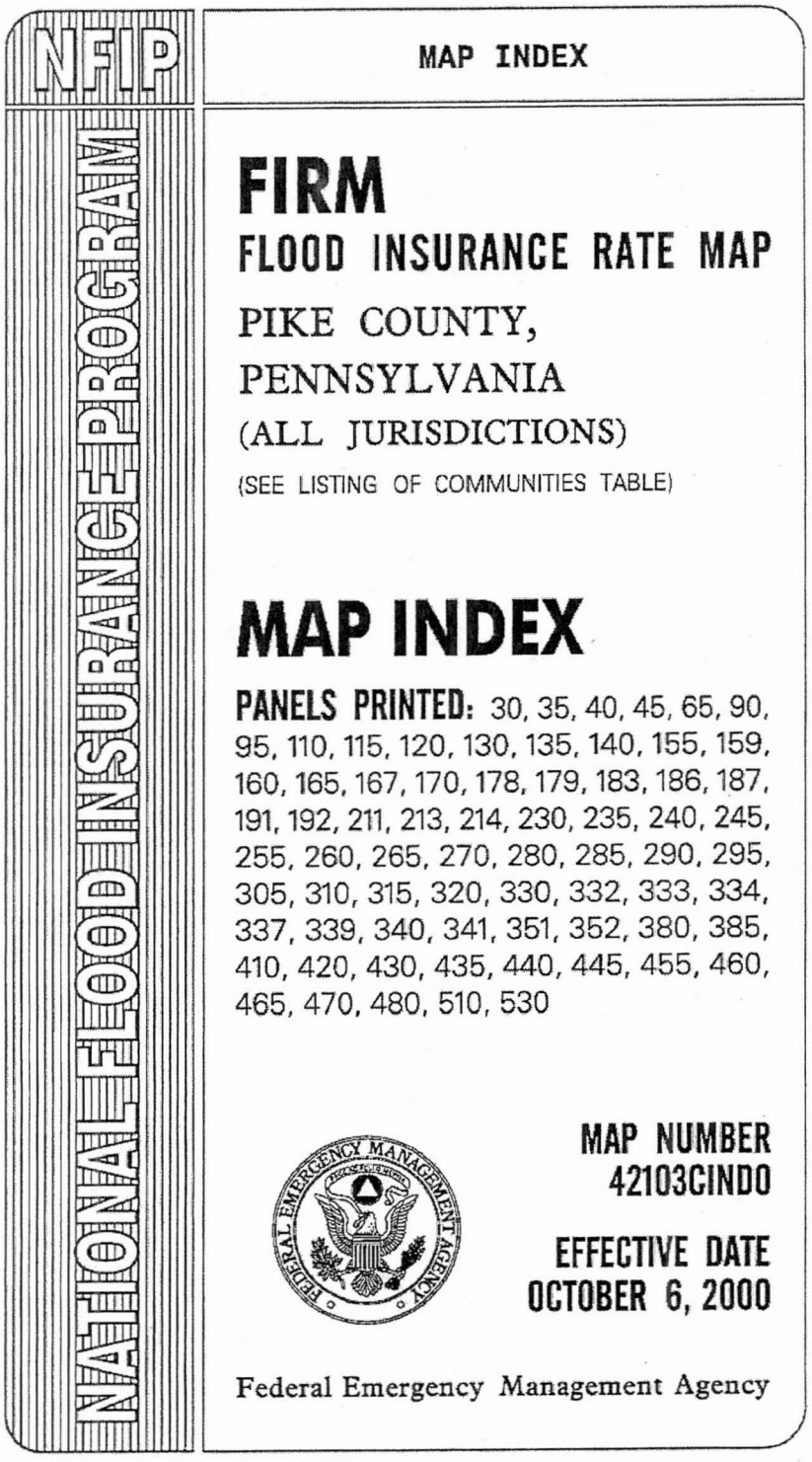


Figure K-8. Countywide DFIRM Index Title Block

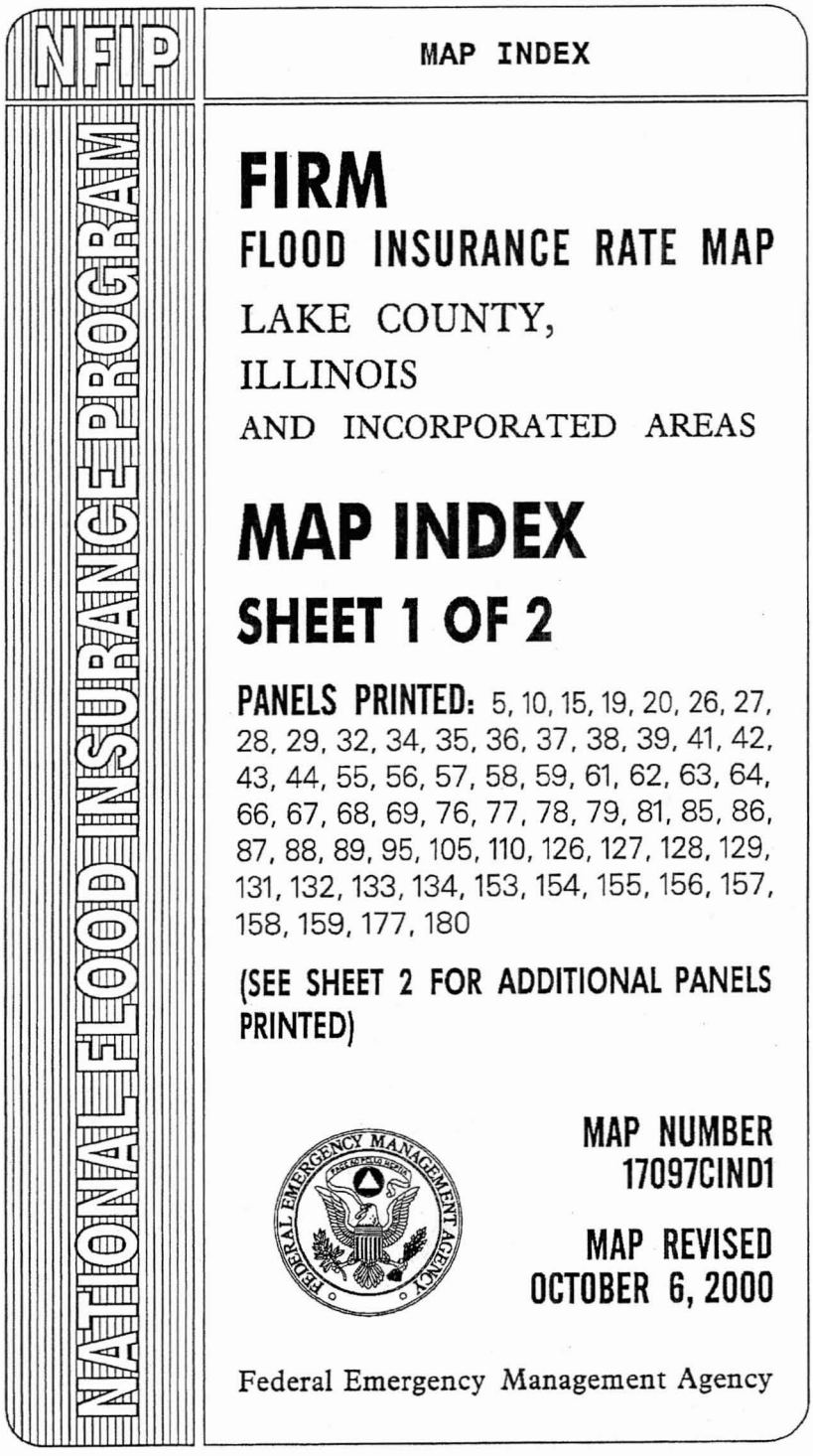


Figure K-9. Countywide Multi-sheet DFIRM Index Title Block, Sheet 1 of 2

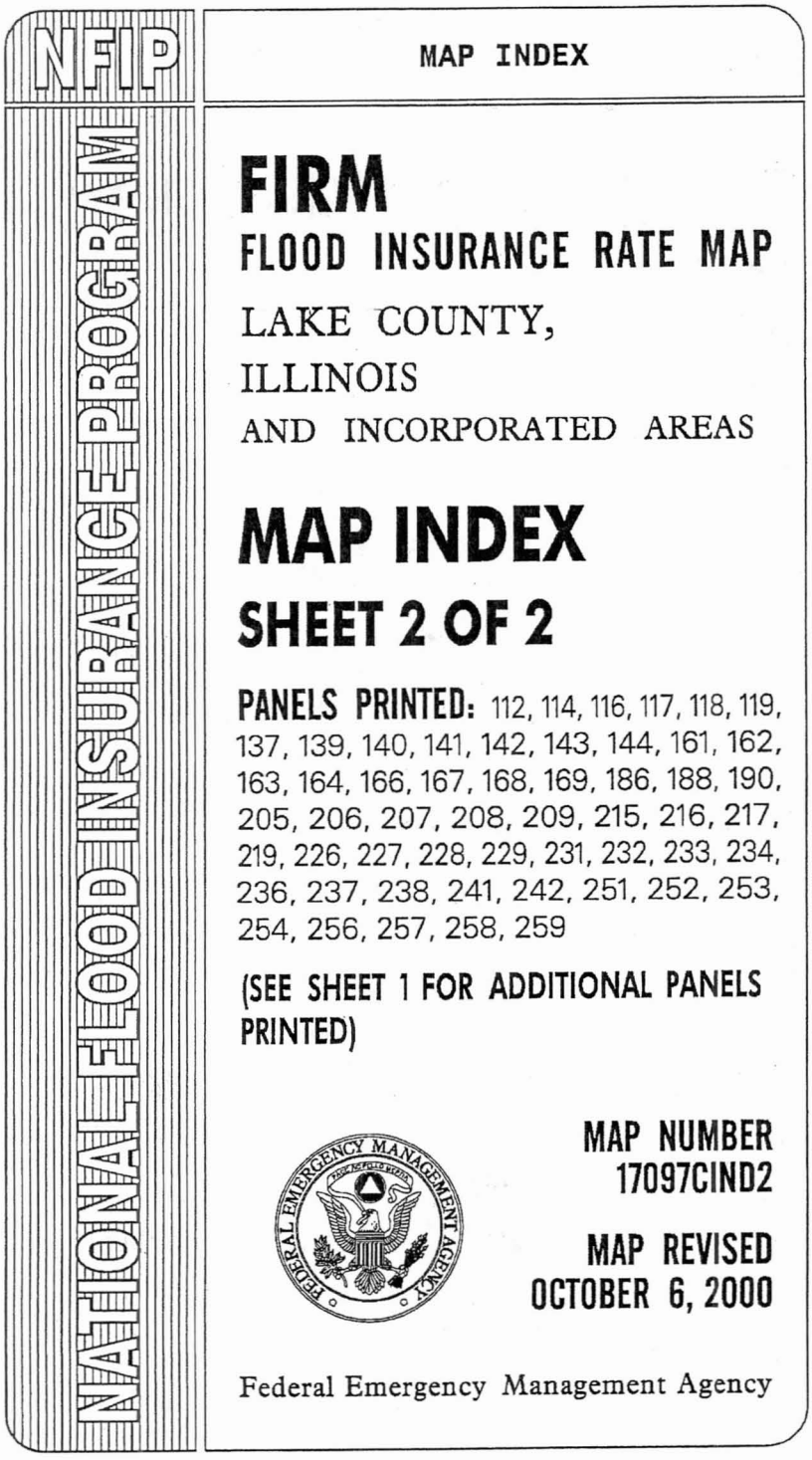


Figure K-10. Countywide Multi-sheet DFIRM Index Title Block, Sheet 2 of 2

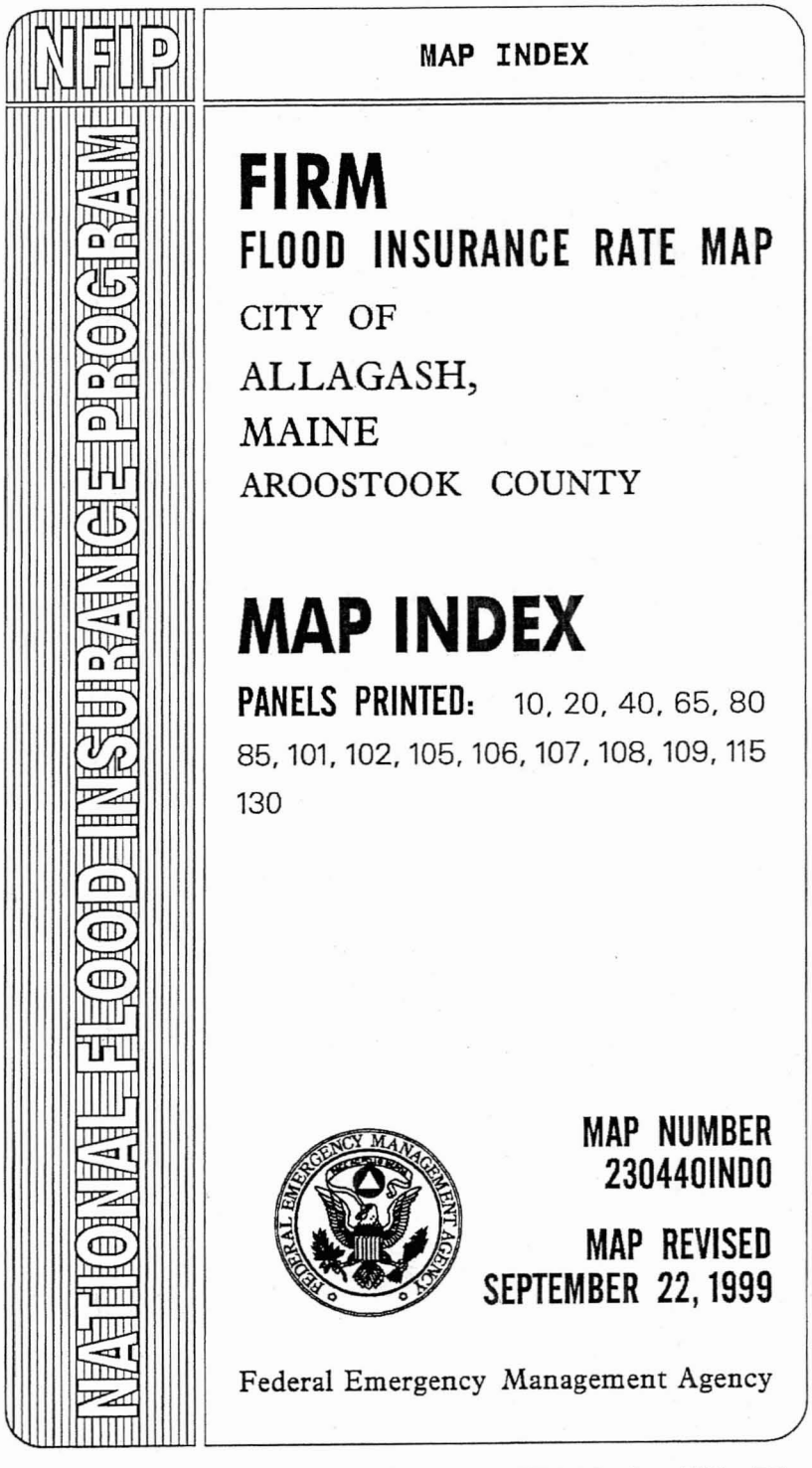


Figure K-11. Single-Jurisdiction DFIRM Index Title Block

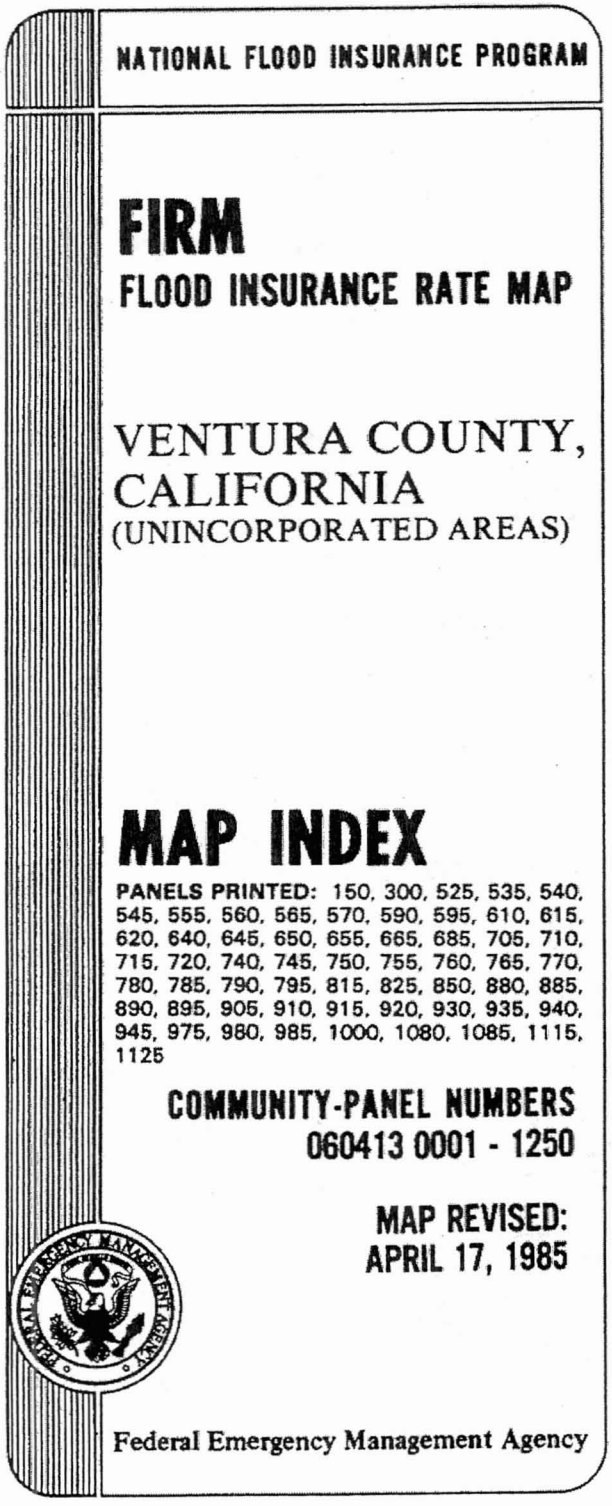


Figure K-12. Single-Jurisdiction Manual FIRM Index Title Block

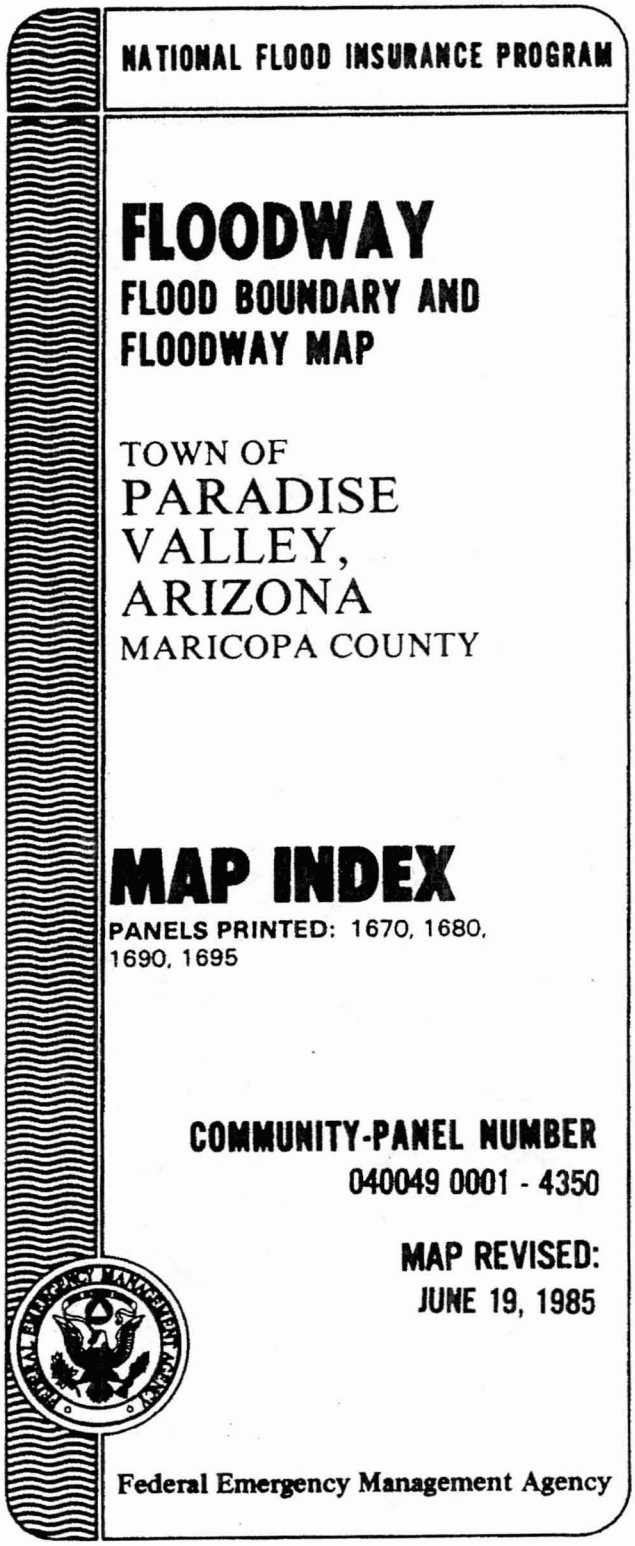


Figure K-13. Single-Jurisdiction Manual FBFM Index Title Block

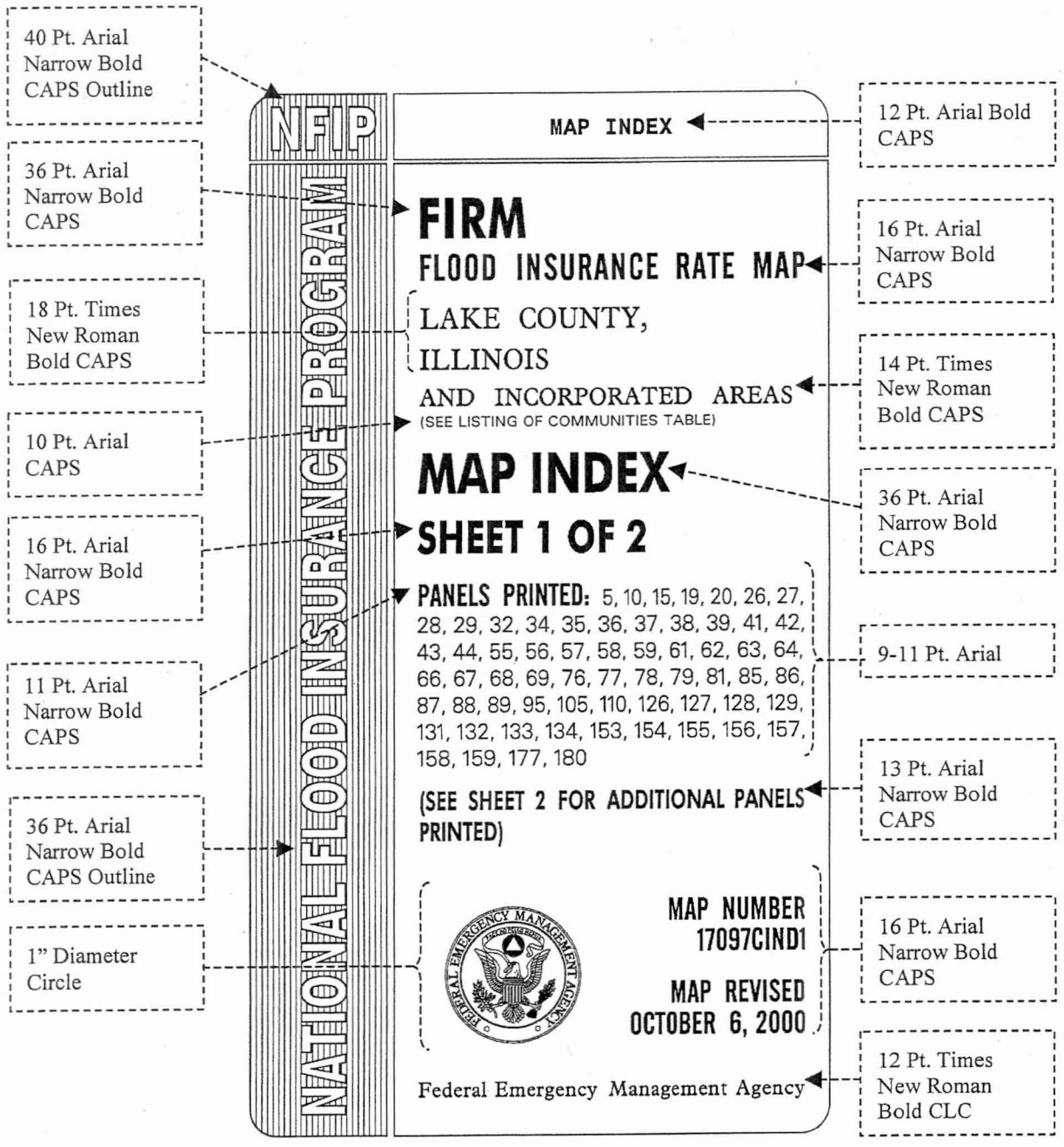


Figure K-14. Map Index Title Block Element Suggested Font Specifications

[February 2002]

K.3.4 8½"x11" Map Index

An example of an 8½" x 11 Map Index is presented in Figure K-15. As shown in Figure K-15, the specifications appear exactly as presented for the Z-fold Index but are at a smaller scale. Figure K-16 provides suggested font specifications for an 8½" x 11 Map Index. The table that follows Figure K-16 provides graphic specification standards for the depiction of information on 8½" x 11 Map Indexes.

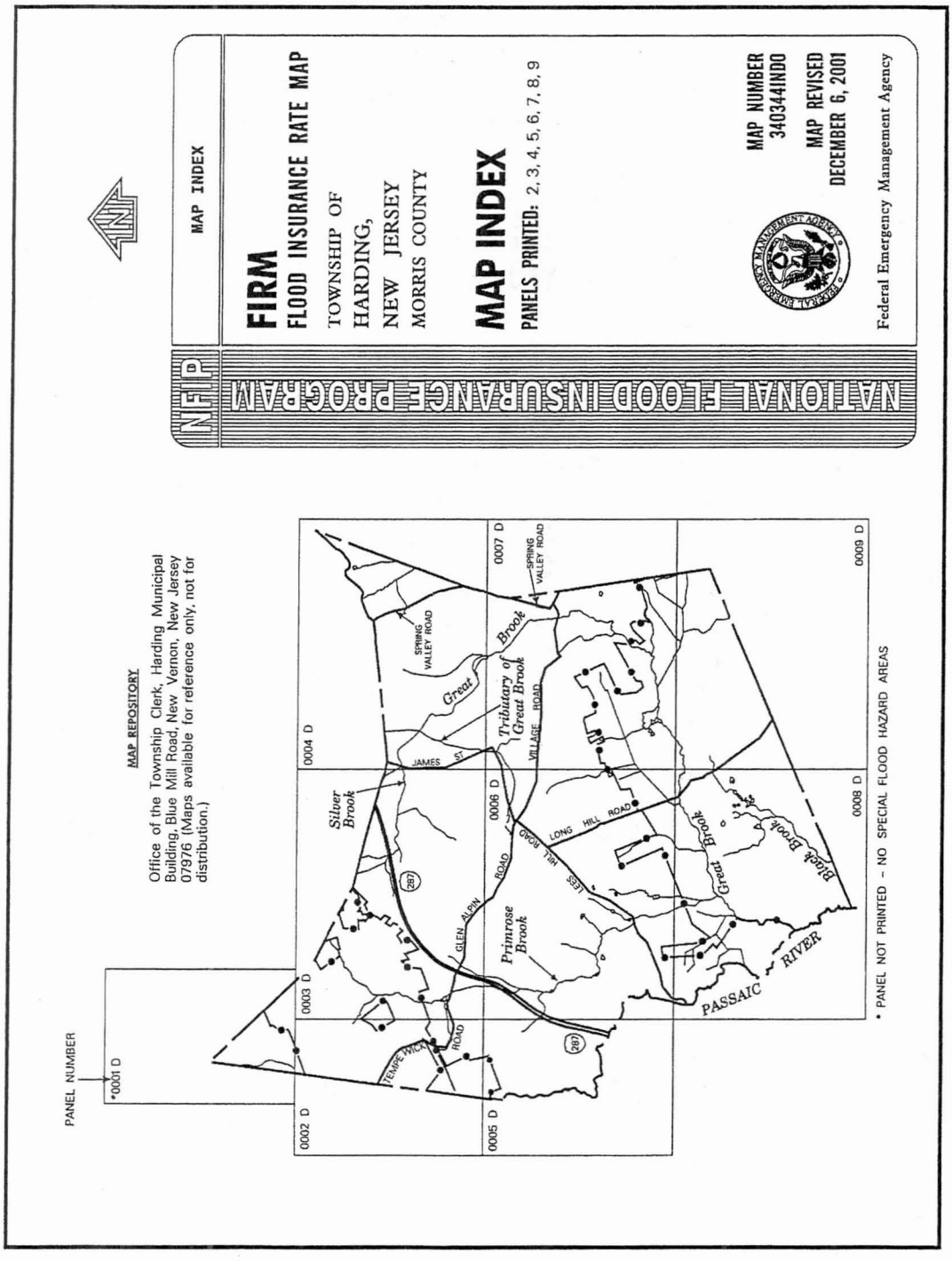


Figure K-15. Example of 8½" x 11" Map Index

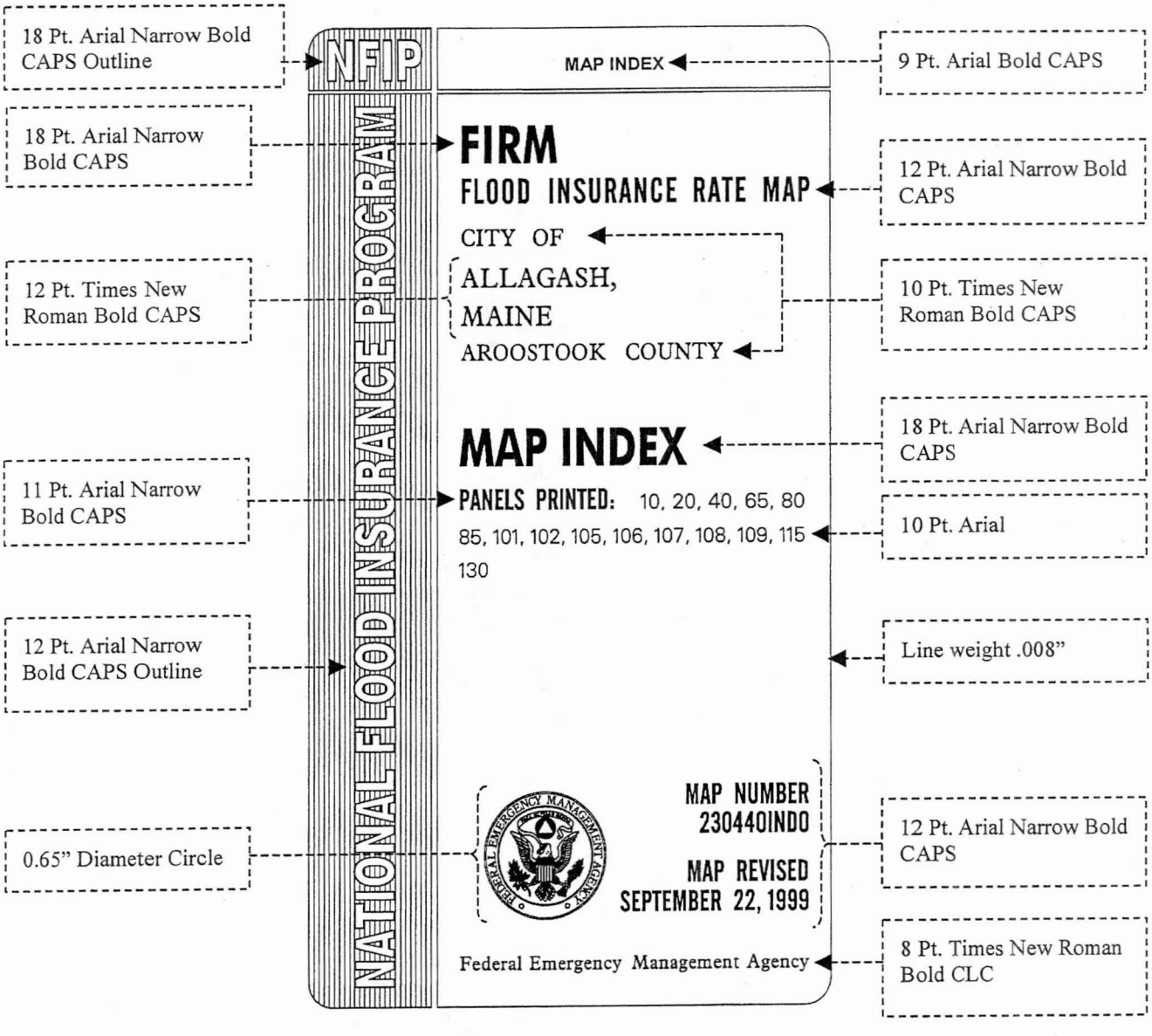


Figure K-16. Title Block for 8½" x 11" Map Index, with Suggested Font Specifications

8½" x 11" Map Index Elements *Font specifications that cannot be matched may be approximated		
Example	**Feature**	**Specification**
	North Arrow	Line weight .008" Width 0.675" Height 0.40"
	Major Road	Line weight .020"
CAPITAL STREET	Street, Road, Avenue Name	8 Pt. Arial CAPS
	Interstate Highway Symbol	Standard Interstate Route Shield Line weight .010" Size .200" x .200" to .400" x .480" 6 Pt. Arial Bold Narrow CAPS
	U.S. Highway Symbol	Standard U.S. Route Shield Line weight .010" Size .200" x .200" to .400" x .480" 6 Pt. Arial Bold Narrow CAPS
	State Highway Symbol	Circle Line weight .010" Diameter .200" to .280" 6 Pt. Arial Bold Narrow CAPS
	County Highway Symbol	Rectangle Line weight .010" Size .150" x .250" to .300" x .400" 6 Pt. Arial Bold Narrow CAPS
 CHESSIE SYSTEM RAILROAD	Railroad and Railroad Name	Line weight .008" Tie length .060", spacing .300" 6 Pt. Arial Italics CAPS
	Airport	Line weight .010"
 Eighteen Mile Creek	River, Stream, or Other Hydrographic Feature and Feature Name	Line weight .008" 6-10 Pt. Times New Roman Bold Italics CLC
SHIP ISLAND	Island	10 Pt. Arial CAPS

8½" x 11" Map Index Elements *Font specifications that cannot be matched may be approximated		
Example	**Feature**	**Specification**
 ASSABET RIVER DAM	Major Dam and Dam Name	Line weight .010 6 Pt. Arial CAPS or CLC
	International, State, County Boundary	Line weight .015" Dashing: .6" .05" .15" .05" .15" .05" .6"
	Corporate, Extraterritorial Boundary	Line weight .015" Dashing: .6" .05" .15" .05" .6"
CITY OF BLADES	Community Label	10 Pt. Times Roman CAPS
 City of Lafayette (AREA NOT INCLUDED)	Area Not Included Note	Line weight .015" **(Community name)** 6-10 Pt. Times New Roman CAPS or CLC **(Note)** 5-8 Pt. Arial CAPS
FOREST BOUNDARY ROOSEVELT STATE FOREST	Forest, Park or Reservation Boundary, Boundary Label and Area Label (Large areas only)	**(Boundary Label)** 6-8 Pt. Arial CAPS **(Boundary)** Line weight .015" Dot diameter .030", spacing .400" **(Area Label)** 6-10 Pt. Times New Roman CAPS or CLC
	FIRM Panel Neatline	Line weight .008"
0005 B	FIRM Map Numbers	8 Pt. Arial Narrow CAPS
8/30/00	FIRM Panel Effective Dates	8 Pt. Arial Narrow CAPS
MAP NUMBER	Map Number Label	8 Pt. Arial CAPS
– NOTE – DESIGNATED COASTAL BARRIERS ARE LOCATED ON PANELS 14, 18, 155[1], 161[1], 188, 304, 308, AND 309. [1]PANEL NOT PRINTED	This note is added near the Map Index north arrow for any community that contains Coastal Barrier units. All panels containing Coastal Barrier units and/or Otherwise Protected Areas, including panels that are not printed are listed. Non-printed panels are listed with a footnote.	8 Pt. Arial CAPS

8½" x 11" Map Index Elements *Font specifications that cannot be matched may be approximated		
Example	**Feature**	**Specification**
MAP REPOSITORY Office of the Township Clerk, Harding Municipal Building, Blue Mill Road, New Vernon, New Jersey 07976 (Maps available for reference only, not for distribution.)	This is an example of a Map Repository listing for a single jurisdiction FIRM Index. The Map Repository is the location that the community has designated for storing its FIRM. The address is placed just above or in close proximity to the north arrow on the Map Index. The disclaimer, as stated, immediately follows the address.	**(Header)** 9 Pt. Arial CAPS with underscore **(Reference note, Community Name, and Address)** 7 Pt. Arial CAPS and CLC
NOTICE TO MAP USERS **FEMA maintains information about map features, such as street locations and names, in or near designated flood hazard areas. Requests to revise information in or near designated flood hazard areas may be provided to FEMA during the community review period, at the final Consultation Coordination Officer's meeting, or during the statutory 90-day appeal period. Approved requests for changes will be shown on the final printed FIRM.**	The following note must be added to all Preliminary FIRM Indexes and/or panel if panel is Only Panel Printed. It is also a standard paragraph in the transmittal letters to the communities. The note reminds the community to submit changes for street locations and names in or near the floodplains for incorporation into the final printed FIRM. The note does not appear on the final FIRM that is delivered to the Government Printing Office for printing. If the FIRM does not contain any BFEs, the reference to the 90-day appeal period is omitted from the note.	**(Header)** 9 Pt. Arial Bold CAPS **(Reference note)** 9 Pt. Arial Bold CLC
*PANEL NOT PRINTED – NO SPECIAL FLOOD HAZARD AREAS	"Panel Not Printed" Notes	7-8 Pt. Arial CAPS

[February 2002]

K.4 Map Body

The body of the FIRM shall be comprised of base map information and flood hazard information, including any special notes needed for clarification, and, in applicable communities, areas designated as Coastal Barrier Resources System (CBRS) units where federal flood insurance is unavailable.

[February 2002]

K.4.1 Base Map

Base maps form the backdrop against which flood hazard information is viewed. Digital base maps also provide horizontal control for effective information compiled from existing FIRMs, FBFMs and FHBMs. Base maps cover the entire geographical area of a community and include planimetric data such as transportation features, hydrographic features, hydraulic structures, landforms, political boundaries. The printed FIRM shall not depict topographic (elevation) data such as contour lines. Base map features are employed by map users to locate properties and structures relative to the floodplains; therefore, the accuracy of the base maps used in the production of FIRMs is important to the overall precision of the FIRMs.

Once a base map has been accepted for use in FIRM production, the locations of features in the base map data files are used as is. To facilitate fitting data together from multiple sources, base map features from one source may be clipped where they meet those from another source. Small graphical mismatches between communities where roads or other features cross community boundaries must then be resolved. This processing should allow for the creation of seamless digital data files.

[February 2002]

K.4.1.1 Base Map Images

Whenever possible, the assigned Mapping Partner shall use DOQ images as they are received from the U.S. Geological Survey (USGS) or the community. The DOQ image shall cover the entire FIRM panel, even if some of the image falls outside the jurisdiction being studied. The assigned Mapping Partner shall not crop the image at the jurisdiction's boundary. However, no imagery shall be shown outside the FIRM panel neatline. On FIRM panels that are only partially covered by the studied jurisdiction, a note shall be added in areas outside the jurisdiction to clarify that flood hazards may exist outside the jurisdictional boundary. An example of the note is shown in Subsection K.4.3.

[February 2002]

Raster Images

Raster maps can be produced from digital data or they can result from the digital scanning of paper maps, map negatives, and aerial photographs, and/or from the orthorectification of those images so that they are accurately georeferenced with any distortions removed. Georeferencing

means that the map depicts the spherical earth projected as a plane map, normally with Universal Transverse Mercator (UTM) or State Plane coordinates, with or without tick marks or lines that depict parallels (lines of equal latitude) or meridians (lines of equal longitude). Human interpretation of scanned or imaged features shall be required to derive intelligence from raster maps. The most common form of raster image map is the digital orthophotos, especially the standard DOQs produced by the USGS.

Variations in tones between DOQ images are acceptable. If more than one DOQ image is included on a FIRM panel, lightening or darkening of individual images to balance tones is not necessary. Overall lightening of all DOQ images for a Flood Map Project using a single factor may be done so that flood hazard features can be clearly seen.

The assigned Mapping Partner shall portray updates to roads or other features that have occurred since the DOQs were produced as vectors on top of the DOQs. A note shall be added to the map to clarify significant additions as necessary.

The assigned Mapping Partner shall show vectors that depict studied flooding sources on top of the DOQs to clarify their locations. Vectors shall not be shown outside the Special Flood Hazard Areas (SFHAs) unless specifically authorized by the FEMA Project Officer.

[February 2002]

Vector Images

Vector base maps share to depict linear features (e.g., roads, railroads, streams) digitized as single-line centerlines or, alternatively, as dual lines showing the outer extremities of linear features (e.g., left and right banks of streams, curb lines on both sides of streets). Roadway right-of-ways or buffered road centerlines are not desirable because they do not depict a feature that can be physically located by users, who rely on the base map features for general orientation. Users often measure distances from road features in order to locate structures for insurance rating purposes. Road centerlines or edges of pavement are more suitable for this type of use. Vector maps must be digitized so that features are topologically correct. Then, a Geographic Information System (GIS) can automatically derive intelligence from the vector features and perform adjacency, proximity, and connectivity analyses.

[February 2002]

K.4.1.2 Base Map Features

The following are the types of base map features that the assigned Mapping Partner shall depict on the FIRM if they occur within the community:

- Transportation features, including roads, railroads, and airports shall be depicted. If digital orthophotos are supplied, these features must be clearly visible. Bridges that are included in the hydraulic models shall be included on the FIRM. Unimproved roads or trails (i.e., those travelways not intended for motorized vehicles or not usually used by motorized vehicles due to width or seasonal conditions) may be included, particularly if they cross the floodplains.

- Hydrographic features (e.g., streams, rivers, lakes, shorelines) shall be depicted.
- Hydraulic structures (e.g., levees, dams, weirs, floodwalls, jetties) shall be depicted.
- NGS bench marks shall be depicted.
- Political and other boundaries that identify corporate limits, extraterritorial jurisdictional areas, military lands, Native American lands, parks, forests, state gamelands, wildlife refuges, and similar areas shall be depicted.
- U.S. Public Land Survey System (PLSS) features, also known as range, township, and section lines, and their designators, shall be depicted.. Graphic and usage specifications for other horizontal reference grid systems are also included here; and
- Other features and notes shall be depicted.

The assigned Mapping Partner shall separately symbolize base map features that are not clearly visible on the DOQ due to their location within a floodplain. For example, a dam symbol should be outlined if it is not visible on the DOQ or if other floodplain features obscure it.

In general, the hierarchy of base map features is as follows: (1) political boundaries, (2) flood hazard areas, and (3) physical features such as shorelines. Coincident base map features are to be shown such that the heaviest or widest line is most prominent. For example, if a corporate boundary, a road, and a floodplain boundary are coincident, only the corporate boundary is to be shown.

The assigned Mapping Partner shall derive base map feature names from community-supplied files or hardcopy sources, current FIRM panels, U.S. Census Bureau Topologically Integrated Geographic Encoding and Reference System files, and/or other sources. All feature names that are available in digital format shall be shown on the FIRM. All feature labels on DOQ-based FIRMs shall be shown as black text with a white halo around the letters to enable the names to be clearly read against the intensity of the background image. Feature labels on non-DOQ FIRMs shall be shown as black text. Further graphic specifications are provided in the tables below, with separate paragraphs emphasizing information of particular importance.

Please note that the tables contain specifications for DOQ and non-DOQ base maps. In general, the non-DOQ-based examples also apply to FIRMs that are produced manually. Specific exceptions are individually noted. In general, bold type fonts surrounded by a white halo are used on DOQ-based FIRMs. Medium type fonts are used on non-DOQ-based FIRMs where the background allows them to show more clearly. All base map features and labels are shown on the FIRM in black unless otherwise noted.

[February 2002]

Roads

All primary roads, all roads located inside or within one inch of SFHA, and any road shown and labeled on a Flood Profile shall be labeled on the map. When space permits, secondary and

tertiary roads farther than one inch from SFHA shall be labeled. If a community supplies digital road labels beyond the stated minimums, these labels shall be shown on the FIRM, provided they meet the text placement standards and do not render the map unusable due to excessive clutter.

Road name labels shall be placed parallel to the road and spaced so that there is no more than one-half inch between each word in the road name. Additional road name labels shall be added for roads that traverse entire FIRM panels, or as necessary for clarity.

[February 2002]

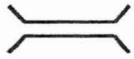
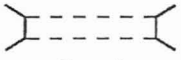
Railroads

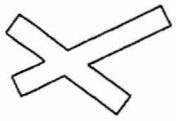
All railroads that traverse the community's mapped area shall be labeled. When available, the formal name taken from the sources defined above is to be used. The name shall be placed along the feature when feasible or leadered, if space is limited. If several different names for the same feature are available and would cause clutter and/or confusion, the generic term "Railroad" shall be used. If the generic name option is used, the formal name shown on the unrevised flood profiles shall not be changed.

[February 2002]

Base Map Features *Font specifications that cannot be matched may be approximated		
Transportation		
Example	**Feature**	**Specification**
	Primary Road	**(DOQ)** Line weight .020" **(Non-DOQ)** Line weight .015"
	Secondary Road	**(DOQ)** Line weight .017" **(Non-DOQ)** Line weight .010"
	Unimproved Road	Dash .05", space .010" **(DOQ)** Line weight .010" **(Non-DOQ)** Line weight .008"

Base Map Features *Font specifications that cannot be matched may be approximated		
Transportation		
Example	**Feature**	**Specification**
CAPITAL STREET CAPITAL STREET	Street, Road, Avenue Name	**(DOQ)** 8 Pt. Arial Bold CAPS **(Non-DOQ)** 8 Pt. Arial CAPS
Private Road *Unnamed Road*	Private Road, Unimproved Road, Unnamed Road Label	8 Pt. Arial Italics CLC
	Road Shown on Manual FIRM at 1"=700' and Larger Scale	Line weight .006" Lane width .088"
	Road Shown on Manual FIRM at 1"=800' to 1"=1,500' Scale	Line weight .004" Lane width .028"
	Road Shown on Manual FIRM at 1"=1,600' and Smaller Scale	Line weight .004" Lane width .014"
234	Interstate Highway Symbol	Standard Interstate Route Shield Size .200" x .200" to .400" x .480" 6 – 8 Pt. Arial Bold Narrow CAPS **(DOQ)** Line weight .010" **(Non-DOQ)** Line weight .008"
234	U.S. Highway Symbol	Standard U.S. Route Shield Size .200" x .200" to .400" x .480" 6 – 8 Pt. Arial Bold Narrow CAPS **(DOQ)** Line weight .010" **(Non-DOQ)** Line weight .008"
234	State Highway Symbol	Circle Diameter .200" to .280" 6 – 8 Pt. Arial Bold Narrow CAPS **(DOQ)** Line weight .010" **(Non-DOQ)** Line weight .008"

Base Map Features *Font specifications that cannot be matched may be approximated		
Transportation		
Example	**Feature**	**Specification**
234	County Highway Symbol	Rectangle Size .150" x .250" to .300" x .400" 6 – 8 Pt. Arial Bold Narrow CAPS **(DOQ)** Line weight .010" **(Non-DOQ)** Line weight .008"
 *Cornish Bridge*	Road or Railroad Bridge and Bridge Name	Line weight .010" Wing tick length .025", angle 45° 8 Pt. Arial Italics CLC
 Footbridge	Footbridge and Label	Wing tick length .025", angle 45° 8 Pt. Arial Italics CLC **(DOQ)** Line weight .010" **(Non-DOQ)** Line weight .008"
 *Tunnel*	Road or Railroad Tunnel and Label	Dash .050", space .010" Wing tick length .025", angle 45° 8 Pt. Arial Italics CLC **(DOQ)** Line weight .010" **(Non-DOQ)** Line weight .006" to .010"
 CHESSIE SYSTEM *RAILROAD*	Railroad and Name or Label	Tie length .060", spacing .300" - .500" 8 Pt. Arial Italics CAPS **(DOQ)** Line weight .010" **(Non-DOQ)** Line weight .006" to .010"
	Abandoned Railroad	Tie length .060", spacing .300" - .500" Dash .300", space .020" **(DOQ)** Line weight .010" **(Non-DOQ)** Line weight .006" to .010"

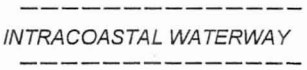
Base Map Features *Font specifications that cannot be matched may be approximated		
Transportation		
Example	**Feature**	**Specification**
----------	Dismantled Railroad, Old Railroad Grade	Dash .100", space .020" **(DOQ)** Line weight .010" **(Non-DOQ)** Line weight .006" to .010"
ABANDONED RAILROAD *Abandoned Railroad* *OLD RAILROAD GRADE* *Old Railroad Grade* *Dismantled Railroad*	Abandoned Railroad, Dismantled Railroad, Old Railroad Grade Labels	8 Pt. Arial Italics CAPS or CLC
---------- *Ferry*	Ferry and Label	Line weight .010" Dash .050", space .020" 8 Pt. Arial Italics CLC
 HAGERSTOWN AIRPORT	Airport and Airport Name	**(DOQ)** Line weight .017" **(Non-DOQ)** Line weight .010" 8 – 10 Pt. Arial CAPS
 HAGERSTOWN AIRFIELD *Airfield*	Airfield, Airfield Name, Airfield Label	Line weight .017" **(Name)** 8 – 10 Pt. Arial CAPS **(Label)** 8 Pt. Arial Italics CLC
 Landing Strip	Landing Strip and Label	Line weight .017" 8 Pt. Arial Italics CLC

Hydrographic Features

All hydrographic features (streams, lakes, ponds, bays, and oceans) that have an identified flood hazard associated with them shall be labeled. Stream name labels shall be placed parallel to the feature and spaced so that there is no more than one-half inch between each word in the stream name. Additional stream name labels may be added for streams that traverse entire FIRM panels, or as necessary for clarity. Large hydrographic features, such as oceans and lakes, shall

be labeled in larger type fonts or more than once on individual FIRM panels (as necessary for clarity).

[February 2002]

Base Map Features *Font specifications that cannot be matched may be approximated		
Hydrographic		
Example	**Feature**	**Specification**
	River, Stream, or Other Hydrographic Feature	**(DOQ)** Line weight .010" **(Non-DOQ)** Line weight .008"
Eighteen Mile Creek ***Utah Lake***	Name of River, Stream, or Other Hydrographic Feature	7 – 24 Pt. Times New Roman Bold Italics CLC
Unnamed Tributary ***Tributary No. 1***	Unnamed Stream, Unnamed Tributary Label	7 – 11 Pt. Times New Roman Bold Italics CLC
 Century Wash	Wash or Glacier and Name	Dash .050", space .010" 7 – 11 Pt. Times New Roman Bold Italics CLC **(DOQ)** Line weight .010" **(Non-DOQ)** Line weight .008"
 *INTRACOASTAL WATERWAY*	Intracoastal Waterway and Label	Line weight .010" Dash .070", space .020" 8 – 10 Pt. Arial Italic CAPS
Canal *Ditch* *Pond* *Wash* *Glacier* *Swamp* *Marsh* *Cranberry Bog*	Unnamed Hydrographic Feature Label	8 Pt. Arial Italics CLC

Hydraulic Structures

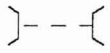
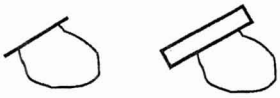
All hydraulic structures (dams, culverts, weirs, levees, and floodwalls) in or near identified floodplains (detailed or approximate) shall be labeled. The labels shall be placed near the structure and leadered in as appropriate. If no official name for the structure is available, the appropriate feature symbol and a label identifying the structure type (e.g., culvert) shall be added.

[February 2002]

Base Map Features

***Font specifications that cannot be matched may be approximated**

Hydraulic Structures

Example	Feature	Specification
 *Culvert* *Flume* *Penstock* *Aqueduct*	Culvert, Flume, Penstock, Aqueduct and Labels	Dash .050", space .010" Wing tick length .025", angle 45° 8 Pt. Arial Italics CLC **(DOQ)** Line weight .008" **(Non-DOQ)** Line weight .006" to .008"
 Levee	Levee and Levee Name or Label	Line weight .010" Length .060", space .010" 8 Pt. Arial Italics CLC
 *Assabet River Dam* *Dam* *ASSABET RIVER DAM* *DAM*	Dam or Weir and Name or Label	**(DOQ)** Line weight .017" 8 Pt. Arial CLC **(Non-DOQ)** Line weight .010" 8 Pt. Arial CAPS or CLC
 Pier *Sea Wall* *Dock* *Diversion Structure* *Flood Control Structure*	Pier, Dock, Jetty, Sea Wall, etc., and Labels	8 Pt. Arial Italics CLC **(DOQ)** Line weight .010" **(Non-DOQ)** Line weight .008" to .010"

Bench Marks

The assigned Mapping Partner shall show all qualifying bench marks within a given jurisdiction that are cataloged by the National Geodetic Survey (NGS) and entered in the National Spatial Reference System (NSRS) as First or Second Order Vertical, having a stability classification ranking of A, B, or C on the FIRM. The marks shall be identified by their NSRS Permanent Identifier (PID).

When local jurisdictions have established their own vertical monument network, these monuments may also be shown on the FIRM with the appropriate designations. The assigned Mapping Partner shall show local monuments on the FIRM only if the community has requested that they be included, the monuments meet the aforementioned inclusion criteria, and the community maintains the monuments and provides public access to information about the monuments such as their location, description, and elevation.

Refer to Volume 1, Section 1.4 for additional information on the criteria for showing bench marks on FIRMs.

Base Map Features

***Font specifications that cannot be matched may be approximated**

Bench Marks

Example	Feature	Specification
DX5510	Bench Mark	10 Pt. Arial CAPS Line Length .100" to .150" Angle 45° **(DOQ)** Line weight .017" **(Non-DOQ)** Line weight .010"

[February 2002]

Political Boundaries

All political boundaries shall be labeled with the appropriate jurisdiction name on each side of the boundary. The adjoining community's boundary label should be determined by the hierarchy of the areas being identified (e.g., City of Fairfield [if the community is within the same state], City of Fairfield, Wisconsin [if the community is in a different state], or Washington County, Wisconsin [if the county is in a different state]). If the community boundary is also a state boundary, the state name shall be shown in conjunction with the outside area's community name.

If there is not enough space along the boundary for a label because the jurisdiction area on the panel is small, the boundary itself shall not be labeled.

If a multiple-county community is shown in its entirety on a countywide FIRM, the county boundary that divides the community shall be labeled with the county names on each side. If the boundary is also a state boundary, the state names shall be shown. If the boundary labels do not fit inside the area of the multiple-county community, these labels shall be placed outside the community as close as possible to the community and leadered to the boundary. The corporate limits of a multiple-county community that lies in more than one county on a countywide FIRM should be labeled with the jurisdiction name on each side of the boundary. The corporate boundary outside the subject county should be labeled with the community label on the community side of the boundary and the adjacent community (incorporated or unincorporated) on the other side of the boundary.

When Extraterritorial Jurisdictional (ETJ) areas are significant for the purposes of the NFIP, they shall be shown on the FIRM. ETJ boundaries shall be are labeled on the ETJ side of the boundary with "*Community Name* Extraterritorial Jurisdiction Limits." If there are space constraints, the label may be shortened to "*Community Name* ETJ Limits."

Jurisdiction names and CIDs shall be placed near the center of the jurisdiction, if possible to label the area. For incorporated communities, the community type shall be followed by the name of the community (e.g., City of Smithville), and the CID placed immediately under the community name. For unincorporated county areas, the county name should be shown with "Unincorporated Areas" beneath it and the county CID should be placed immediately under that label.

The ETJ area shall be labeled with the community name, followed by the words "(Extraterritorial Jurisdiction)," and the CID number of the community exercising its extraterritorial jurisdiction authority.

[February 2002]

Other Boundaries

All areas governed by agencies other than those of the community being studied (military lands, Native American lands, parks, forests, state gamelands, wildlife refuges) shall be labeled with the official name at least once. If the area is large, additional labels should be added as needed. If the label does not fit inside the area, the label should be placed nearby and leadered into the area. The boundary of a park or other cultural feature should be labeled "PARK BOUNDARY" (or whatever the land use area boundary represents) along the outside, parallel to the boundary. If there is not enough space along the boundary, the boundary label may be omitted, but the area itself must always be labeled.

[February 2002]

Base Map Features *Font specifications that cannot be matched may be approximated		
Boundaries		
Example	**Feature**	**Specification**
VIRGINIA NORTH CAROLINA	International, State, County Boundary and Label	Dashing: 1.500" .050" .150" .050" .150" .050" 1.500" 10 Pt. Arial CAPS **(DOQ)** Line weight .030" **(Non-DOQ)** Line weight .020" to .030"
CITY OF SEAFORD SUSSEX COUNTY	Corporate, Extraterritorial Jurisdiction, Urban Growth Boundary and Label	Dashing: 1.500" .050" .150" .050" 1.500" 10 Pt. Arial CAPS **(DOQ)** Line weight .030" **(Non-DOQ)** Line weight .020" to .030"
City of Blades **100031**	Community Area Label and Community Identification Number	8 – 24 Pt. Times New Roman Bold CAPS or CLC
FOREST BOUNDARY ROOSEVELT STATE FOREST	Forest, Park or Reservation Boundary, Boundary Label and Area Label	**(Boundary Label)** 10 Pt. Arial CAPS **(Boundary)** Line weight .015" Dot diameter .030", spacing .400" **(Area Label)** 8-24 Pt. Times New Roman CAPS or CLC

Horizontal Reference Grids

The assigned Mapping Partner shall ensure that the FIRM contains a primary horizontal reference grid and secondary horizontal reference grid ticks to orient map readers to real-world coordinates; the latitude and longitude in degrees, minutes, and seconds shall be referenced at each of the four corners of the map panel; and the Universal Transverse Mercator (UTM) reference grid (or grid ticks) are included on the FIRM. Other reference grids (e.g., State Plane) may also be included. UTM, State Plane, and latitude/longitude reference grids or grid ticks shall be shown on the FIRM extending to the FIRM neatline.

[February 2002]

U.S. Public Land Survey System

U.S. Public Land Survey System (PLSS) features (i.e. range, township, and section lines) shall be shown on a digital FIRM if they are available in digital format and/or were shown on a previous FIRM. The assigned Mapping Partner shall avoid mix-and-match situations where only some FIRM panels in a given jurisdiction contain section information. If the selected base map for a Countywide FIRM does not include PLSS information, but some of the community-based FIRMs within the county showed this information previously, a concerted effort shall be made to ensure that the PLSS information is obtained and shown on the entire FIRM. The PLSS information shall meet the following specifications:

- Section numbers shall be placed in the center of the section (or portion of the section shown on the panel) parallel to the horizontal neatlines of the panel.
- Township lines shall be labeled at the left and right edges of the panel along both sides of the line.
- Range lines shall be labeled at the top and bottom edges of the panel along both sides of the line.
- Range, township, and section lines shall be terminated at the panel neatline and at the political boundaries of the subject community.

If the community being studied uses a PLSS grid, the primary grid shown on the FIRM shall be the PLSS. Otherwise, the primary horizontal reference grid shall be the same as the coordinate system of the digital data. For example, if the digital files are referenced to the UTM coordinate system, a UTM grid shall be shown on the map. If the digital files are referenced to the State Plane coordinate system, a State Plane grid of Northings and Eastings shall be shown on the map.

If the community being studied uses a PLSS grid, the secondary grid ticks shall be the same as the coordinate system of the digital data. When digital files are referenced to the UTM coordinate system, UTM grid ticks shall be shown as cross hairs within the body of the map and ticks along the edge. State Plane grid ticks are not required but may also be shown along the edges of the panel. When the digital files are referenced to the State Plane coordinate system, both UTM and State Plane grid ticks shall be required.

If the community does not use a PLSS grid, the secondary grid ticks shall be shown as cross hairs within the body of the map and ticks along the edge. When the primary grid is UTM, the secondary grid ticks shall be State Plane. When the primary grid is State Plane, the secondary grid ticks shall be UTM.

The grid interval shown on the FIRM shall not vary between panels within the same FIRM even if the panels are shown at different scales. Generally, a UTM grid interval of 1,000 meters and a State Plane grid interval of 5,000 feet shall be used.

Base Map Features *Font specifications that cannot be matched may be approximated		
Horizontal Reference Grids		
Example	**Feature**	**Specification**
_____	Range, Township, Section Line	**(DOQ)** Line weight .008" **(Non-DOQ)** Line weight .004" to .006"
R. 43 W. T. 22 N.	Range, Township Number	10 Pt. Arial CAPS
15 15 15 15 15	Section Number	8, 10, 14, 18, 24 Pt. Arial
_____	Horizontal Reference Grid	**(DOQ** Line weight .008" **(Non-DOQ)** Line weight .006"
—	Horizontal Reference Grid Ticks	Line weight .020" Length .300"
4276 000 M	Horizontal Reference Grid Coordinates (UTM)	10 Pt. Arial CAPS
365,000 FT	Horizontal Reference Grid Coordinates (State Plane)	10 Pt. Arial CAPS
80° 16' 52.5"	Corner Coordinates (Latitude, Longitude)	10 Pt. Arial CAPS

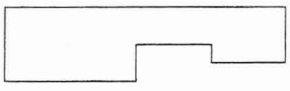
[February 2002]

Other Base Map Features and Notes

The following features and notes shall be added to the FIRM as needed.

Other Base Map Features and Notes

*Font specifications that cannot be matched may be approximated

Example	Feature/Usage	Specification
SHIP ISLAND	Name of Large Island	14 – 24 Pt. Arial CAPS
Green Island	Name of Small Island	8 – 11 Pt. Arial CAPS or CLC
Cape Cod	Name of Point, Cape, Neck	8 – 24 Pt. Arial CAPS or CLC
Lost Canyon	Name of Gulch, Canyon, Draw	8 – 10 Pt. Arial CAPS or CLC
CORPORATE LIMITS COINCIDENT WITH SHORELINE	This note is used when the corporate limits of a community or county boundary are coincident with a coastal shoreline. In these cases, only the shoreline is shown; the community boundary is not shown. See Section K.7 for coincident flood hazard features notes.	10 Pt. Arial CAPS
THIS AREA SHOWN AT A SCALE OF *(scale)* ON MAP NUMBER *(number)*	This note is used in the blank area of a breakout panel. The map number includes the 10-digit map number without the suffix. See Section K.1.4 for a discussion of map scales, map layout, and FIRM tiling.	24 Pt. Arial CAPS
 *BENTON COLLEGE*	Significant Outlined Landmark and Name	8 Pt. Arial Italics CAPS **(DOQ)** Line weight .010" **(Non-DOQ)** Line weight .008"

Other Base Map Features and Notes *Font specifications that cannot be matched may be approximated		
Example	**Feature/Usage**	**Specification**
● M1.5	River Mile Marker	Dot Diameter .030" to .090" 10 Pt. Arial CAPS
⊕	Gaging Station (shown if referenced in the hydrologic analysis)	Diameter .100"

[February 2002]

K.4.2 Flood Hazard Features

This subsection provides guidance for showing floodplains and regulatory floodways, flood insurance risk zone labels, Base Flood Elevations (BFEs), cross sections, limits of study, coastal transects, and other items needed to depict hydrologic and hydraulic analyses, and contains a table of their graphic specifications.

[February 2002]

K.4.2.1 Floodplains and Floodways

The 1-percent-annual-chance (100-year) and 0.2-percent-annual-chance (500-year) floodplain boundaries must be shown on the FIRM. The boundaries of Zone D areas must be shown unless they abut the 1-percent-annual-chance floodplain, in which case the 1-percent-annual-chance floodplain boundary shall take precedence.

Regulatory floodways shall be shown on the FIRM and, at cross-section locations, must agree with the values shown on the Floodway Data table in the FIS report within a maximum tolerance of five percent of the map scale or five percent of the distance, whichever is greater. When the 1-percent-annual-chance and regulatory floodway boundaries converge such that they become coincident, only the floodway boundary shall be shown.

The use of GIS and automated mapping techniques for the delineation of floodplain and floodway boundaries allows very small areas of flooding to be shown in the digital files. Mapping Partners must exercise some judgment in selecting which of these areas to show on the FIRM. Extremely small areas may be eliminated in some cases. However, in general, all 0.2-percent-annual-chance floodplain areas that are adjacent to 1-percent-annual-chance floodplain areas, no matter how thin, must be retained in the digital files.

[February 2002]

K.4.2.2 Flood Hazard Information Based on Future-Conditions Analyses

At the request of a community and with the approval of FEMA, FIRMs may include, for informational purposes, flood hazard areas based on projected- or future-conditions hydrologic and hydraulic analyses. If community officials request that FEMA show the future-conditions 1-percent-annual-chance floodplains on the FIRM, the future-conditions floodplains and flood insurance risk zone shall be shown on the FIRM and referenced in the accompanying FIS report. Although graphic specifications are flexible for the mapping of this flood insurance risk zone, the zone label will be "Zone X (Future Base Flood)." The future-conditions flood insurance risk zone shall be defined in the FIRM legend as follows:

> Zone X (Future Base Flood) is the flood insurance risk zone that corresponds to the 1-percent-annual-chance floodplains that are determined based on future-conditions hydrology. No BFEs or base flood depths are shown within this zone.

FEMA opted to use the Zone X (shaded) screen, in lieu of a new flood hazard zone designation, to depict the future-conditions 1-percent-annual-chance (100-year) floodplain to minimize confusion by users of the FIRM that make determinations regarding Federal mandatory flood insurance purchase requirements. Those users now recognize that areas designated as Zone X (shaded) are floodprone, but that the mandatory flood insurance purchase requirement does not apply. Because the risk premium rates for buildings located in the future-conditions 1-percent-annual-chance (100-year) floodplain will be the rate comparable to other areas outside the SFHA, FEMA believes designating these areas as "Zone X (Future Base Flood)" will be sufficient distinction.

[February 2002]

K.4.2.3 Zone Labels

All zone areas shall be labeled at least once with their appropriate flood zone and static elevation or depth, if appropriate. Zone labels should be repeated as necessary for clarity in large or complicated areas.

Very thin areas of 0.2-percent-annual-chance floodplain that border 1-percent-annual-chance floodplain areas shall be labeled where the areas become wide enough to be seen at the printed map scale.

In the 1-percent-annual-chance floodplains, the floodway fringe areas should not be considered separate areas requiring labels. One zone label should be sufficient for both the regulatory floodway and the floodway fringe.

When it is necessary to leader a label to isolated Zone X areas (shaded and unshaded) or clusters of Zone A areas, one label with two or more leaders may be used.

[February 2002]

K.4.2.4 Base Flood Elevations

BFEs of increasing elevation values shall be shown in floodplains as wavy lines perpendicular to the flow of the 1-percent-annual-chance flood. All BFEs should be labeled with an elevation value that is located above, below, or at the end of the line (i.e., where it meets the 1-percent-annual-chance floodplain boundary). If the BFE value cannot be placed within 0.1 inch of the BFE line, a leader line should be used to connect the BFE value to the BFE line. BFEs in floodplains with uniform elevations shall be shown as static (single) values. The value shall be placed below the zone label.

The basic intent of plotting BFEs on a FIRM is to represent the Flood Profile to within 0.5 foot of elevation tolerance. If BFEs are plotted correctly, the FIRM can be used to recreate the flood profile within 0.5 foot.

[February 2002]

K.4.2.5 Cross Sections

Cross sections shall be shown on the FIRM for all watercourses for which regulatory floodways have been determined. Cross-section locations and designations must correspond exactly to those shown on the Flood Profiles and in the Floodway Data tables presented in the FIS Report. The distances between cross sections and those between cross sections and physical features shown on the FIRM must agree with those shown on the Profiles within a maximum tolerance of 5 percent of the distance measured on the FIRM or FBFM.

[February 2002]

K.4.2.6 Cross-Section Labeling

Cross sections for each stream studied by detailed methods shall be labeled alphabetically from the downstream to the upstream limit of the study. At the request of a community and with the approval of the Project Officer, cross sections may also be labeled numerically. The typical numbering sequence is from the downstream to the upstream limit of study using the stream distance value at that location. Cross sections shall be labeled on the map with a hexagon at each end of the cross-section line. If there is not enough space to add a hexagon on each end, a hexagon may be placed on only one end. Cross-section hexagons shall be oriented so that the letter or number can be clearly read and is not upside down. If necessary to achieve this, the cross-section line should be trimmed or bent once it crosses the 0.2-percent-annual-chance boundary. Cross-section letters or numbers may follow the orientation of the hexagon or may be placed parallel to the bottom of the map sheet (0°).

Cross-section lines shall cross the entire floodplain (past the limits of the 0.2-percent-annual-chance whenever possible). If the cross-section line cannot exit either side of the floodplain on the panel, the hexagon should be placed in the middle of the cross-section line and the line removed behind the hexagon. All graphic adjustments to cross sections shall remain separate from modeled cross-section locations that are stored in the FIRM GIS files.

[February 2002]

K.4.2.7 Limit of Detailed Study and Limit of Study

Limit of Detailed Study labels shall be placed at the beginning and at the end of every area studied by detailed methods, when the terminus is indicated on the Flood Profile. Note that implied Limits of Detailed Study occur where the detailed study stops because of a stream confluence or when the stream exits the FIRM, and these situations should not be labeled on the FIRM. Also note that the same rules apply to Flood Profiles. A Limit of Detailed Study shall be depicted as a zone boundary and labeled as a Limit of Detailed Study when it divides areas of different zone designations (e.g., Zone AE from Zone A).

Limit of Study labels should be used whenever the study (approximate or detailed) ends abruptly and has no corresponding Flood Profile. This situation occurs most often along streams studied by approximate methods but can also occur on backwater arms of detailed studied streams.

[February 2002]

K.4.2.8 Coastal Transects

For coastal flood hazard studies, the assigned Mapping Partner shall perform an evaluation of the effects of waves accompanying the storm surge flood event on BFEs and hazard zones. The wave analyses performed shall be referenced in the FIS report and mapped on the FIRM. Wave transects shall be located with careful consideration of physical and cultural characteristics of the land so that they will closely represent conditions at those locations. Transect lines shall be delineated and labeled on the FIRM to identify the physical location of the wave transects described in the FIS Report.

The transect delineation on the FIRM should also help users to determine which wave transect analysis may influence or directly affect their property or area of interest. The wave effects mapped for any transect begin at the shoreline and end at the limits of 1-percent-annual-chance flood hazards, even though the actual transect line on the FIRM extends further seaward and landward of the flood hazard areas.

[February 2002]

K.4.2.9 Coastal Transect Labeling

Coastal transect numbers shall be placed in a circle on both ends of the transect line. If both ends of the line cannot be labeled due to space limitations, one label at either end or a label placed in the middle of the transect line with the line removed behind the circle should be sufficient. Transect numbers may follow the orientation of the transect line or may be placed parallel to the bottom of the map sheet (0°).

Transect numbering should generally proceed consecutively from north to south or west to east along a shoreline. New coastal transects inserted between existing transects should be numbered with an alphanumeric sequence (i.e., transects 5A and 5B might be inserted between existing transects 5 and 6).

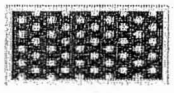
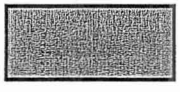
If constraints due to clutter limit the visibility of the transect lines on the FIRM, a Transect Location Map shall be used to portray the transects. Depending upon the coastal area to be shown, this map may be an 8 ½" x 11" page or 11"x17" foldout page placed in the FIS report. When a Transect Location Map is used, the FIRM GIS files include the transects in their correct geographic location relative to the other FIRM features. Refer to Appendix J for additional information on the Transect Location Map.

The table below provides examples of these flood hazard map features and their graphic portrayal on FIRMs. Two sets of examples, one for FIRMs that are DOQ-based and one for those that are non-DOQ-based are provided. In general, the non-DOQ-based examples also apply to FIRMs that are produced manually. Specific exceptions to this are individually noted. Color shall be used to distinguish certain flood hazard features on DOQ-based FIRMs. Bold type fonts surrounded by a white halo shall be used on DOQ-based FIRMs. Medium type fonts shall be used on non-DOQ-based FIRMs where the gray shading used for flood hazard areas allows them to show more clearly.

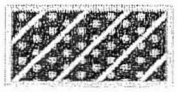
All flood hazard features shall be shown on the FIRM in black unless otherwise indicated.

Flood Hazard Features and Notes

*Font specifications that cannot be matched may be approximated

Example	Feature/Usage	Specification
(DOQ)  (Non-DOQ) 	1% annual chance Flood Hazard Area (Zones A, AE, AO, AH, AR, A99, V, and VE)	**(DOQ)** Area fill pattern Dot Diameter .020" Spacing .030" Offset between rows .025" Color: Cyan **(Non-DOQ)** 50% 133 lines per inch screen tint or equivalent area fill pattern
(DOQ) (Non-DOQ) 	1% annual chance Flood Hazard Boundary Line	**(DOQ)** Line weight .020" Color: Cyan **(Non-DOQ)** Line weight .015"

Flood Hazard Features and Notes *Font specifications that cannot be matched may be approximated		
Example	**Feature/Usage**	**Specification**
LIMIT OF STUDY LIMIT OF DETAILED STUDY **(DOQ)** **(Non-DOQ)**	The **Limit of Study** note is used to indicate the truncated terminus of a 1% annual chance floodplain of a stream or backwater area that has not been independently studied by detailed analyses (e.g., no flood profile is associated with this location). The **Limit of Detailed Study** note is used to indicate the terminus of a 1% annual chance floodplain of a stream that has been studied by detailed methods. The stream name may also be added to this note for clarity.	**(Label)** 8 Pt. Arial CAPS **(Line - DOQ)** Line weight .020" Color: Cyan **(Line – Non-DOQ)** Line weight .015" Color: Black
(DOQ) **(Non-DOQ)**	Boundary Dividing SFHAs of Different Elevations, Velocities, or Depths	Color: White **(DOQ)** Line weight .020" **(Non-DOQ)** Line weight .015"
(DOQ) **(Non-DOQ)**	0.2% annual chance Flood Hazard Area (shaded Zone X)	**(DOQ)** Area fill pattern Dots .020" diameter Spacing .030" Offset between rows .025" **(Non-DOQ)** 20% 133 lines per inch screen tint or equivalent area fill pattern
	0.2% annual chance Flood Hazard Boundary Line	**(DOQ)** Line weight .020" **(Non-DOQ)** Line weight .015"
	Areas Outside 1% or 0.2% annual chance Flood Hazard Areas (Zone X, D)	No screen or tint

Flood Hazard Features and Notes *Font specifications that cannot be matched may be approximated		
Example	**Feature/Usage**	**Specification**
	Zone D Boundary	Dash .500", space .050 **(DOQ)** Line weight .020" **(Non-DOQ)** Line weight .015"
(DOQ)  **(Non-DOQ)** 	Floodway Area	**(DOQ)** Area fill pattern Dots .020" diameter Spacing .030" Offset between rows .025" Color: Cyan Surprinted with diagonal hatching at 45° angle 10 lines per inch Line weight .010" Color: White **(Non-DOQ)** 50% 133 lines per inch screen tint or equivalent area fill pattern Surprinted with diagonal hatching at 45° 10 lines per inch, Line weight .004" to .010"
	Colorado River Floodway	Area fill pattern Diagonal cross-hatching at 45° and 135° angles 10 lines per inch Line weight .010"
(DOQ) **(Non-DOQ)** 	Floodway Boundary Line	Dash .375", space .050" **(DOQ)** Line weight .020" Color: Cyan **(Non-DOQ)** Line weight .015"

Flood Hazard Features and Notes *Font specifications that cannot be matched may be approximated		
Example	**Feature/Usage**	**Specification**
LIMIT OF FLOODWAY	The **Limit of Floodway** note is used to indicate the terminus of a floodway in an area where the detailed analysis extends beyond the end of the floodway.	**(Label)** 8 Pt. Arial CAPS Line Color: Black **(Line - DOQ)** Line weight .004" **(Line – Non-DOQ)** Line weight .004" to .006"
ZONE AE	Zone Designation	11 Pt. Arial Bold CAPS
(EL 10) (DEPTH 2') (VEL 15 FPS)	Static Base Flood Elevation, Depth, or Velocity	8 Pt. Arial CAPS
513	Base Flood Elevation Line	**(DOQ)** Line weight .017" **(Non-DOQ)** Line weight .010" to .030"
646	Base Flood Elevation Value	10 Pt. Arial Italics
A — A	Cross Section	Hexagon .200" across 10 Pt. Arial Bold CAPS **(DOQ)** Line weight .017" **(Non-DOQ)** Line weight .010"
23 - - - - - 23	Coastal Transect	10 Pt. Arial Bold CAPS Circle Diameter .200" Dash .050", space .010" **(DOQ)** Line weight .017" **(Non-DOQ)** Line weight .010"

Flood Hazard Features and Notes *Font specifications that cannot be matched may be approximated		
Example	**Feature/Usage**	**Specification**
	Arrowhead Leader	**(DOQ)** Line weight .010" **(Non-DOQ)** Line weight .006"
	Dot Leader	Dot Diameter .020" **(DOQ)** Line weight .010" **(Non-DOQ)** Line weight .006"
FLOODING EFFECTS FROM (*source name*)	This note is used: 1) where the detailed flooding source is physically located outside of the community and cannot be shown on the FIRM panels, 2) where the flooding source is located within the study area but is shown more than one full panel away from the floodplain to be labeled, or 3) in countywide studies where the flooding source is shown on a panel that a community will not receive.	10 Pt. Arial CAPS
FLOODWAY IN THIS AREA TOO NARROW TO SHOW TO SCALE; REFER TO FLOODWAY DATA TABLE	This note is used to indicate that map scale limitations do not allow the visible and accurate portrayal of the actual width of the floodway.	10 Pt. Arial CAPS
1% ANNUAL CHANCE FLOOD DISCHARGE CONTAINED IN CHANNEL **1% ANNUAL CHANCE FLOOD DISCHARGE CONTAINED IN CULVERT**	These notes are used to indicate where the 1% annual chance flood discharges do not overtop the channel banks or are completely contained within a culvert pipe. This area may be bordered by a 0.2% annual chance floodplain.	8 Pt. Arial Bold CAPS
0.2% ANNUAL CHANCE FLOOD DISCHARGE CONTAINED IN CHANNEL **0.2% ANNUAL CHANCE FLOOD DISCHARGE CONTAINED IN CULVERT**	These notes are used to indicate where both the 1% and 0.2% annual chance flood discharges do not overtop the channel banks or are completely contained within the culvert pipe.	8 Pt. Arial Bold CAPS

Flood Hazard Features and Notes *Font specifications that cannot be matched may be approximated		
Example	**Feature/Usage**	**Specification**
FLOODWAY CONTAINED IN CHANNEL FLOODWAY CONTAINED IN CULVERT	These notes are used to indicate where the floodway boundaries coincide with the banks of a channel or where the floodway is contained within a culvert pipe.	8 Pt. Arial Bold CAPS
THIS AREA PROTECTED FROM THE 1% ANNUAL CHANCE FLOOD BY LEVEE, DIKE OR OTHER STRUCTURE SUBJECT TO POSSIBLE FAILURE DURING LARGER FLOODS	This note is used to indicate that an area that has been shown as shaded Zone X on the landward side of the levee has an inherent flood risk in the event of a levee failure. In situations where there is a substantial area of 0.2% annual chance floodplain that exists in combination with the area protected from the 1% annual chance flood, the note below may be substituted.	8 Pt. Arial Bold CAPS
THIS AREA INCLUDES AREAS PROTECTED FROM THE 1% ANNUAL CHANCE FLOOD BY LEVEE, DIKE, OR OTHER STRUCTURE SUBJECT TO FAILURE DURING LARGER FLOODS	This note is normally used in combination with a dashed line to identify and differentiate the 0.2% annual chance floodplain area from the area that is protected from the 1% annual chance flood.	8 Pt. Arial Bold CAPS
COASTAL BASE FLOOD ELEVATIONS APPLY ONLY LANDWARD OF 0.0 FEET (*NGVD / NAVD*)	This note is used to indicate where a wave height analysis is in effect. The note varies according to the vertical datum used, and is placed on the map panel near the shoreline of the open body of water.	8 Pt. Arial Bold CAPS

Flood Hazard Features and Notes *Font specifications that cannot be matched may be approximated		
Example	**Feature/Usage**	**Specification**
FLOOD HAZARD INFORMATION IS NOT SHOWN ON THIS MAP IN AREAS OUTSIDE OF *[community/county name]*	This note is used on DOQ-based FIRM panels that are only partially covered by the studied jurisdiction. The note is added in areas outside the jurisdiction to clarify that flood hazards may exist outside the jurisdictional boundary but are not shown on this map. On a countywide study, if the area is adjacent to a dual/multiple-county community shown in its entirety, include both the community name and the name of the county (community name AND county name). This note shall not to be used in addition to or in place of Area Not Included labeling.	10 Pt. Arial CAPS
FLOOD HAZARD INFORMATION IS SHOWN WITHIN THE *[community name]* FOR INFORMATION ONLY. FOR FLOOD INSURANCE, REFER TO SEPARATELY PRINTED FLOOD INSURANCE RATE MAP FOR THE *[community name].*	This note is retained on countywide map panels, if applicable, to indicate that the named community is not included in the FIS because portions of it are also located within one or more other counties that currently are not in the countywide mapping format. This note should not be added to new countywide FIRMs because it corresponds to a method of handling multiple-county communities that is no longer used.	14 Pt. Arial CAPS

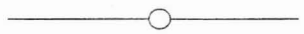
Flood Hazard Features and Notes *Font specifications that cannot be matched may be approximated		
Example	**Feature/Usage**	**Specification**
FLOOD INSURANCE INFORMATION ON THIS MAP APPLIES ONLY TO THE AREAS WITHIN THE CORPORATE LIMITS OF THE *[community name]*. SPECIAL FLOOD HAZARD AREAS ARE SHOWN OUTSIDE OF THE *[community name]* FOR PLANNING PURPOSES ONLY.	This note is used on a FIRM when a Standard Format FBFM panel that showed additional flood hazard information outside of the jurisdiction being studied is now being combined with the FIRM in Map Initiatives format. The flood hazard information outside the studied jurisdiction may be kept on the map at FEMA's discretion.	14 Pt. Arial CAPS

[February 2002]

K.4.3 Map Body Features and Notes

The following notes shall be added to the FIRM as needed to clarify flood hazard areas or features within the flood hazard areas, or to help locate related information on the FIRM.

Map Body Features and Notes *Font specifications that cannot be matched may be approximated		
Example	**Feature/Usage**	**Specification**
JOINS PANEL (*panel number*)	**Panel Neatline and Joins Panel note:** This note is used along each neatline of the map panel to indicate the number of the adjacent panel. The panel number includes only the 4-digit panel number and not the community number or the 5-digit FIPS code used for countywide FIRMs. In cases where more than one panel joins the subject panel (as is the case where a smaller scale panel abuts two larger scale panels), more than one "Joins Panel" note is shown along a single neatline.	**(Note)** 10 Pt. Arial CAPS **(Neatline - DOQ)** Line weight .010" **(Neatline - Non-DOQ)** Line weight .006"

Map Body Features and Notes *Font specifications that cannot be matched may be approximated		
Example	**Feature/Usage**	**Specification**
 STATE ENCROACHMENT LINE FLOWAGE EASEMENT BOUNDARY	These or similar notes are used to label the boundary of areas in which a community enforces more restrictive criteria for floodplain management than the minimum requirements of the NFIP.	**(Label)** 8 Pt. Arial CAPS **(State Encroachment Line)** Line weight .010" Circle diameter .060" **(Flowage Easement Boundary Line)** Line weight .010" to .020"
ZONE D BOUNDARY COINCIDENT WITH CORPORATE LIMITS	This is an example of a note that may be used to clarify coincident features. Roads that are coincident with other features generally do not need to be clarified by notes. See Section K.4.1.2 for an example of a coincident political boundary note.	10 Pt. Arial CAPS

Map Body Features and Notes *Font specifications that cannot be matched may be approximated		
Example	**Feature/Usage**	**Specification**
PROFILE BASE LINE	This note is used to identify a line on a map panel that indicates the modeled flow path of a stream when it does not coincide with the hydrographic feature shown on the map. The profile base line is used to represent channel distances as indicated on the Flood Profiles and Floodway Data tables. It is shown as a single line with one dash and labeled "Profile Base Line." A profile base line may be added to detailed studied streams for the following reasons: The hydraulic model reflects a more direct flow path than the channel configuration shown on the map. This is most often the case when the stream displays extensive meandering; An island splits the river shoreline. The profile base line is used to identify the main channel; A lake through which a stream flows is present, and the reservoir routing modeling method has been used to effect a continuous Flood Profile; or The flood flow path is undefined on the map but the flow path has been modeled.	**(Line label)** 8 Pt. Arial CAPS **(Line)** Line weight .010" Dashing: 1" .050" .100" .050" 1"

[February 2002]

K.4.4 Coastal Barrier Resources System Map Components

In cooperation with the U.S. Department of the Interior, FEMA transfers CBRS boundaries to FIRMs using Congressionally adopted CBRS source maps. FIRMs clearly depict the different CBRS areas and their effective dates with special map notes and symbologies. It should be noted that although FEMA shows CBRS areas on FIRMs, the U.S. Congress is the only entity that may authorize a revision to CBRS boundaries.

This Appendix uses the terms "Coastal Barriers" and "Coastal Barrier Resources System" units (CBRS). These terms are intended to be inclusive of all classifications of Coastal Barriers within the CBRS, including areas designated as Otherwise Protected Areas (OPAs). For additional information regarding the CBRS, see Volume 2, Section 2.2 of these Guidelines.

[February 2002]

K.4.4.1 Coastal Barrier Resources System Boundaries

The CBRS source maps show direct horizontal relationships between existing houses and the CBRS unit boundaries; these relationships must be maintained. Most often, the Coastal Barrier boundary has been delineated to keep existing homes out of the designated Coastal Barrier.

The CBRS source maps use thick lines to represent CBRS unit boundaries. Although standard cartographic practice is to follow the center of a boundary, if the boundary has a direct relationship with a linework feature (such as being against the edge of a road), that relationship must be maintained, even if it means the edge of the boundary line shown on the CBRS source map will be used.

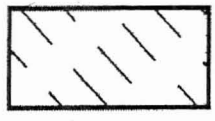
Boundary lines must be shown to differentiate between contiguous barriers of different classifications, because each CBRS classification carries a different insurance prohibition. All barriers must be labeled or identified by notes that identify the CBRS classification of each area.

[February 2002]

K.4.4.2 Map Screens for Coastal Barrier Resources System Areas

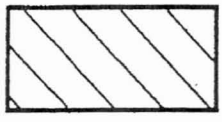
Although there are several different types of Coastal Barriers, there are only two unique map screens. Coastal Barriers shall be portrayed with the two map symbols shown below to differentiate between CBRS and OPA units, which contain differing prohibitions. The CBRS and OPA prohibition dates (i.e., the date that the CBRS or OPA area was originally designated) shall be shown within each separate CBRS and OPA unit to assist users in determining the proper insurance prohibition date for each unit.

CBRS unit

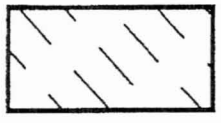


OPA unit

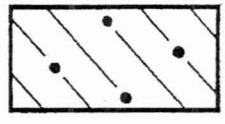
FIRMs prepared after 1991 and prior to November 2000 show three unique map screens to reflect the three classifications of CBRS units. The three screens are as follows:



1983
Coastal Barriers



1990 or later
Coastal Barriers



1991 or later
Otherwise Protected Areas

Because the official CBRS source maps may show CBRS boundaries open to the sea, CBRS screens should not be terminated at shorelines unless the shoreline is coincident with the CBRS or OPA boundary. The boundaries and screens shall extend into the open water to the edge of the SFHA screen unless the Coastal Barrier boundary is closed on the official CBRS map and includes areas beyond the limit of the SFHA screen.

[February 2002]

K.4.4.3 Coastal Barrier Notes for the Body of the FIRM

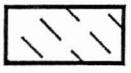
CBRS and OPA notes shall be located, whenever possible, on or near the land area, and shall not overprint existing base or floodplain features. When the note cannot be located on the land area because of space and clarity considerations, the note shall be placed in the open water within the CBRS or OPA screen, near the land area. When the note cannot be placed within the CBRS or OPA screen without creating overprints, the note shall be leadered to the land area.

CBRS Features and Notes

***Font specifications that cannot be matched may be approximated**

Example	Feature/Usage	Specification
FLOOD INSURANCE NOT AVAILABLE FOR STRUCTURES NEWLY BUILT OR SUBSTANTIALLY IMPROVED ON OR AFTER OCTOBER 1, 1983, IN DESIGNATED COASTAL BARRIERS.	This note identifies an area classified as a 1983 CBRS unit. An abbreviated note (see below) accompanied by a special Coastal Barrier Legend may be used instead. See Section K.5.1.1 for examples of the Coastal Barrier Legend.	7 Pt. Arial CAPS
FLOOD INSURANCE NOT AVAILABLE FOR NEW CONSTRUCTION OR SUBSTANTIALLY IMPROVED STRUCTURES ON OR AFTER (date), IN DESIGNATED COASTAL BARRIERS	This note identifies an area classified as a 1990 or later CBRS unit. An abbreviated note (see below) accompanied by a special Coastal Barrier Legend may be used instead. See Section K.5.1.1 for examples of the Coastal Barrier Legend.	7 Pt. Arial CAPS
FLOOD INSURANCE NOT AVAILABLE FOR STRUCTURES - NEWLY BUILT OR SUBSTANTIALLY IMPROVED ON OR AFTER (date) - NOT USED IN A MANNER CONSISTENT WITH THE PURPOSE OF THE OTHERWISE PROTECTED AREAS.	This note identifies an area classified as a 1991 or later Otherwise Protected Area. An abbreviated note (see below) accompanied by a special Coastal Barrier Legend may be used instead. See Section K.5.1.1 for examples of the Coastal Barrier Legend.	7 Pt. Arial CAPS
COASTAL BARRIER RESOURCES SYSTEM BOUNDARY COINCIDENT WITH CORPORATE LIMITS	This note is an example of one that may be used to clarify coincident features. See Section K.4.1.2 for an example of a coincident political boundary note.	10 Pt. Arial CAPS

CBRS Features and Notes *Font specifications that cannot be matched may be approximated		
Example	**Feature/Usage**	**Specification**
COASTAL BARRIER IDENTIFIED *(date)* **(SEE COASTAL BARRIER LEGEND)**	This is the abbreviated Coastal Barrier note for 1983 or 1990 or later Coastal Barriers. This note is used on all FIRM panels containing CBRS areas for a community with more than one different prohibition date. When this procedure is used, a special Coastal Barrier Legend is placed below the Notes to Users section of the FIRM border. This legend shows the entire CBRS map note for each classification of CBRS unit present on all of the FIRM panels in the community or county. See Section K.5.1.1 for examples of the Coastal Barrier Legend.	7 Pt. Verdana Bold CAPS
OTHERWISE PROTECTED AREA IDENTIFIED *(date)* **(SEE COASTAL BARRIER LEGEND)**	This is the abbreviated note for 1991or later Otherwise Protected Areas. This note is used on all FIRM panels containing CBRS areas for a community with more than one different prohibition date. When this procedure is used, a special Coastal Barrier Legend is placed below the Notes to Users section of the FIRM border. This legend shows the entire CBRS map note for each classification of OPA present on all of the FIRM panels in the community or county. See Section K.5.1.1 for examples of the Coastal Barrier Legend.	7 Pt. Verdana Bold CAPS
THIS AREA IS CONTAINED WITHIN THE COASTAL BARRIER RESOURCES SYSTEM	This note is used on FIRM panels when a Coastal Barrier overlaps an area of floodway.	10 Pt. Arial Bold CLC

CBRS Features and Notes *Font specifications that cannot be matched may be approximated		
Example	**Feature/Usage**	**Specification**
Comments or concerns regarding the Coastal Barrier Resources System or Otherwise Protected Area should be directed to the Coastal Barrier Coordinator at the U.S. Fish and Wildlife Service: (_ _ _) _ _ _-_ _ _ _.	This note refers map users to the Fish and Wildlife Service's Regional Coastal Barrier Coordinator. It is placed in the body of the FIRM panel close to the CBRS units. If the abbreviated Coastal Barrier notes and special Coastal Barrier Legend are used, this note appears below the Coastal Barrier Legend. See Section K.5.1.1 for examples of the Coastal Barrier Legend. The phone number is inserted into the above note as follows: **(413) 253-8657** CT, DE, MA, ME, MD, NJ, NY, RI, VA **(404) 679-7106** AL, FL, GA, LA, MS, NC, PR, SC, VI **(612) 713-5350** MI, MN, OH, WI **(505) 248-6454** TX	10 Pt. Tahoma Bold CLC
	Coastal Barrier Resources System Area	Area fill pattern Diagonal hatching at 135° angle 8 to 10 lines per inch Line weight .006" to .010"
	Otherwise Protected Area	Area fill pattern Broken diagonal hatching at 135° angle 8 to 10 lines per inch Line weight .006" to 010" Dash .130" to .150" space .750" to .850"
	Coastal Barrier Boundary	Dotted line Diameter .0875" spacing .0335"
	Coastal Barrier Boundary on Manual FIRM	Line weight .015"

[February 2002]

K.5 Map Legend

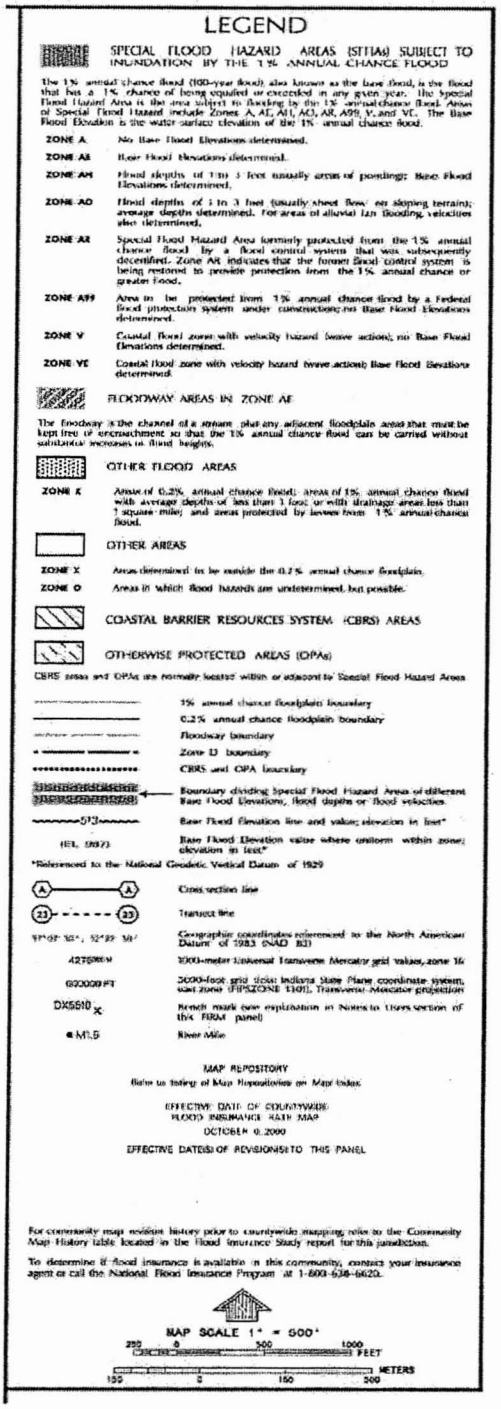
The map legend shall contain those items that are needed to assist the map user in interpreting map symbols, flood hazard screens, linework, flood hazard zone information, and other data within the body of the map. Planimetric data (such as railroads and political boundaries) shall not be included in the FIRM legend.

Most of the FIRM legend elements are standardized and do not vary. However, the content of the FIRM legend varies slightly based on the chosen base map, its coordinate system and horizontal datum, the vertical datum used for the study, community variables (e.g., map repository, previous FIRM editions), whether Coastal Barrier Resources System (CBRS) areas are included on the map, and the map scale.

The figures on the following pages contain examples of map legends for the following different types of FIRMs:

- Countywide DFIRM, DOQ Base Map (Figure K-17);
- Countywide DFIRM, Non-DOQ Base Map (Figure K-18);
- Single-Jurisdiction DFIRM, DOQ Base Map, Map Revised (Figure K-19);
- Single-Jurisdiction DFIRM, Non-DOQ Base Map, Effective Date (Figure K-20);
- Single-Jurisdiction DFIRM, Non-DOQ Base Map, Map Revised (Figure K-21);
- Single-Jurisdiction Manual FIRM, Map Initiatives Format, Map Revised (Figure K-22); and
- Single-Jurisdiction Manual FIRM, Standard Format (Figure K-23);.

Figure K-17.
Countywide DFIRM,
DOQ Base Map Legend



LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, A1, AO, AR, A99, V, and VE. The Base Flood Elevation is the water surface elevation of the 1% annual chance flood.

ZONE A — No Base Flood Elevations determined.

ZONE AE — Base Flood Elevations determined.

ZONE AH — Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.

ZONE AO — Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.

ZONE AR — Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.

ZONE A99 — Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.

ZONE V — Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.

ZONE VE — Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X — Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X — Areas determined to be outside the 0.2% annual chance floodplain.

ZONE D — Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas

1% annual chance floodplain boundary

0.2% annual chance floodplain boundary

Floodway boundary

Zone D boundary

CBRS and OPA boundary

Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.

513 — Base Flood Elevation line and value; elevation in feet*

(EL 987) — Base Flood Elevation value where uniform within zone; elevation in feet*

*Referenced to the National Geodetic Vertical Datum of 1929

A — A — Cross section line

23 — 23 — Transect line

97°07'30", 32°22'30" — Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)

4275000 — 1000-meter Universal Transverse Mercator grid values, zone 16

6000000 FT — 5000-foot grid ticks: Indiana State Plane coordinate system, west zone (FIPSZONE 1301), Transverse Mercator projection

DX5510 — Bench mark (see explanation in Notes to Users section of this FIRM panel)

M1.5 — River Mile

MAP REPOSITORY
Refer to listing of Map Repositories on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
OCTOBER 0, 2000

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

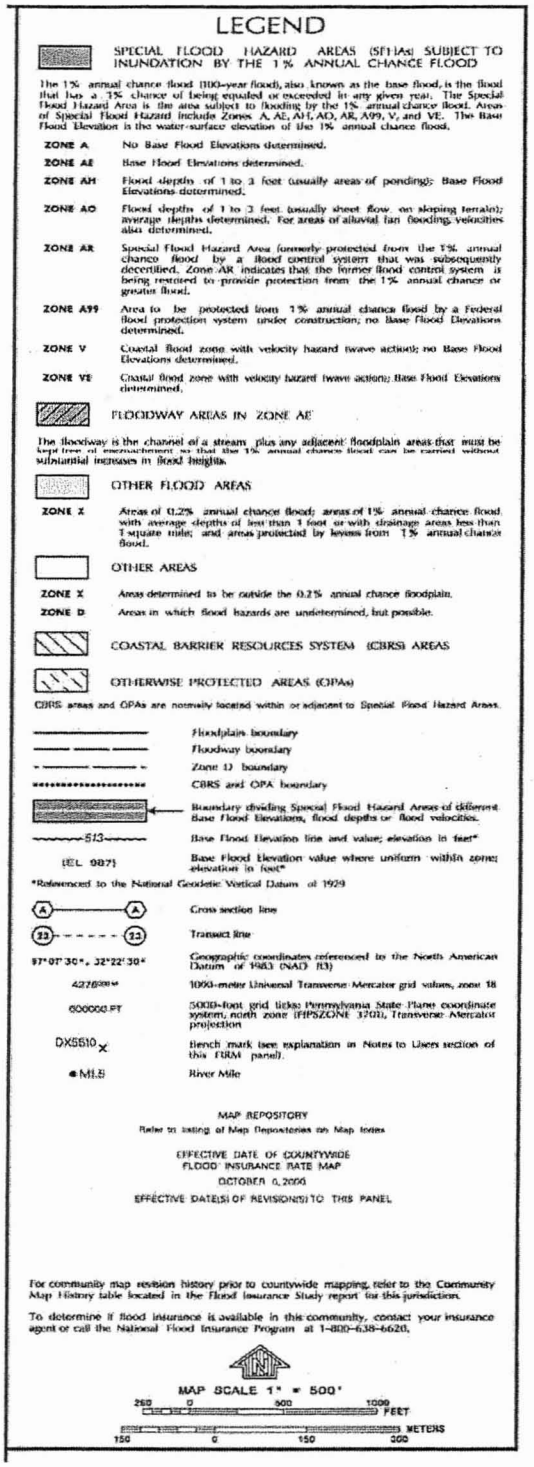
For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 500'

250 0 500 1000 FEET

150 0 150 300 METERS



LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A — No Base Flood Elevations determined.

ZONE AE — Base Flood Elevations determined.

ZONE AH — Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.

ZONE AO — Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.

ZONE AR — Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.

ZONE A99 — Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.

ZONE V — Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.

ZONE VE — Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X — Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X — Areas determined to be outside the 0.2% annual chance floodplain.

ZONE D — Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

Floodplain boundary

Floodway boundary

Zone D boundary

CBRS and OPA boundary

Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.

513 — Base Flood Elevation line and value; elevation in feet*

(EL 987) — Base Flood Elevation value where uniform within zone; elevation in feet*

*Referenced to the National Geodetic Vertical Datum of 1929

A — A — Cross section line

23 — 23 — Transect line

97°07'30", 32°22'30" — Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)

4276000 m — 1000-meter Universal Transverse Mercator grid values, zone 18

600000 FT — 5000-foot grid ticks: Pennsylvania State Plane coordinate system, north zone (FIPSZONE 3701), Transverse Mercator projection

DX5510 X — Bench mark (see explanation in Notes to Users section of this FIRM panel)

• M1.5 — River Mile

MAP REPOSITORY
Refer to listing of Map Repositories on Map Index

EFFECTIVE DATE OF COUNTYWIDE FLOOD INSURANCE RATE MAP
OCTOBER 6, 2000

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

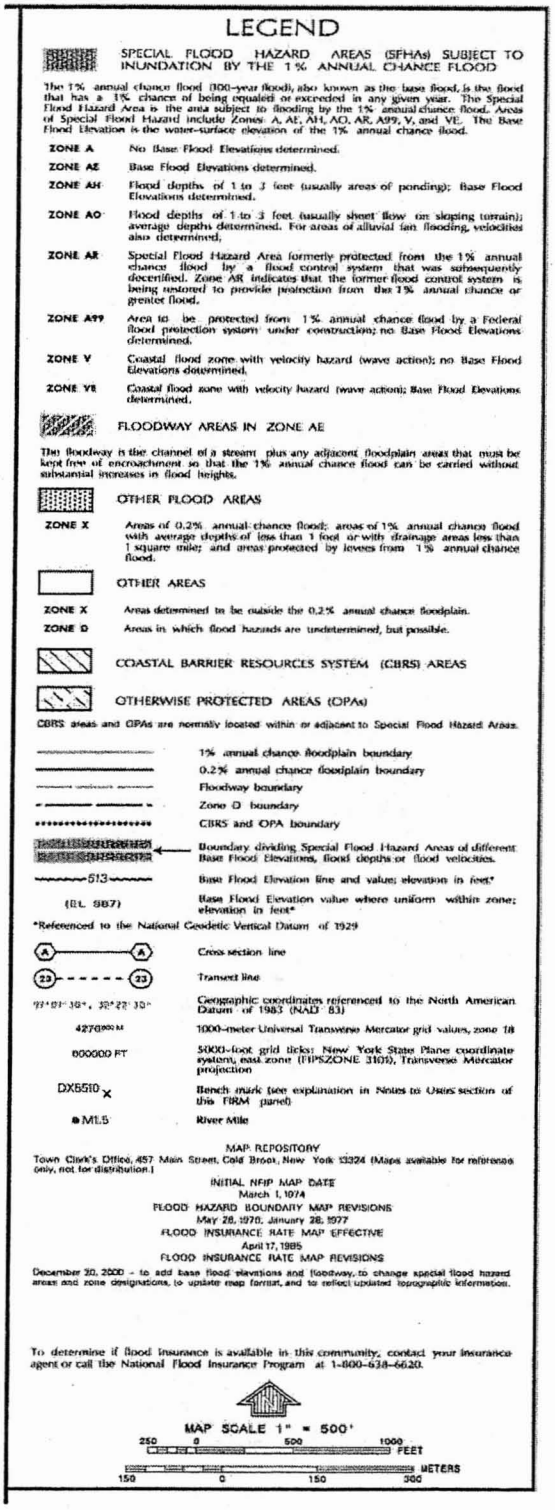
To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 500'

250 0 500 1000 FEET

150 0 150 300 METERS

Figure K-18. Countywide DFIRM, Non-DOQ Base Map Legend



LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A — No Base Flood Elevations determined.

ZONE AE — Base Flood Elevations determined.

ZONE AH — Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.

ZONE AO — Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.

ZONE AR — Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.

ZONE A99 — Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.

ZONE V — Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.

ZONE VE — Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X — Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X — Areas determined to be outside the 0.2% annual chance floodplain.

ZONE D — Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

1% annual chance floodplain boundary

0.2% annual chance floodplain boundary

Floodway boundary

Zone D boundary

CBRS and OPA boundary

Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.

513 — Base Flood Elevation line and value; elevation in feet*

(EL. 987) — Base Flood Elevation value where uniform within zone; elevation in feet*

*Referenced to the National Geodetic Vertical Datum of 1929

A — A — Cross section line

23 — 33 — Transect line

93°07'30", 32°22'30" — Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)

4276000 M — 1000-meter Universal Transverse Mercator grid values, zone 18

000000 FT — 5000-foot grid ticks: New York State Plane coordinate system, east zone (FIPSZONE 3101), Transverse Mercator projection

DX5510 × — Bench mark (see explanation in Notes to Users section of this FIRM panel)

• M1.5 — River Mile

MAP REPOSITORY

Town Clerk's Office, 457 Main Street, Cold Brook, New York 13324 (Maps available for reference only, not for distribution.)

INITIAL NFIP MAP DATE

March 1, 1974

FLOOD HAZARD BOUNDARY MAP REVISIONS

May 28, 1970; January 28, 1977

FLOOD INSURANCE RATE MAP EFFECTIVE

April 17, 1985

FLOOD INSURANCE RATE MAP REVISIONS

December 30, 2000 – to add base flood elevations and floodway, to change special flood hazard areas and zone designations, to update map format, and to reflect updated topographic information.

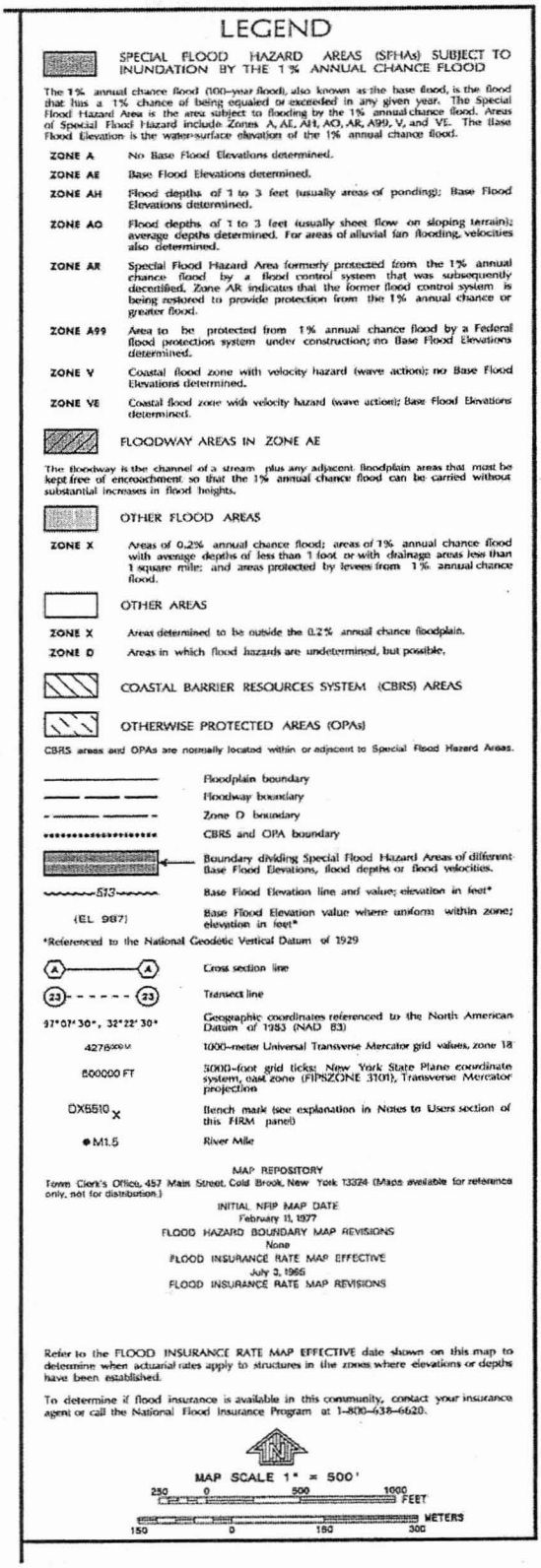
To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 500'

250 0 500 1000 FEET

150 0 150 300 METERS

Figure K-19. Single-Jurisdiction DFIRM, DOQ Base Map, Map Revised Legend



LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A — No Base Flood Elevations determined.

ZONE AE — Base Flood Elevations determined.

ZONE AH — Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.

ZONE AO — Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.

ZONE AR — Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.

ZONE A99 — Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.

ZONE V — Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.

ZONE VE — Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X — Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X — Areas determined to be outside the 0.2% annual chance floodplain.

ZONE D — Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

Floodplain boundary

Floodway boundary

Zone D boundary

CBRS and OPA boundary

Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.

513 — Base Flood Elevation line and value; elevation in feet*

(EL 987) — Base Flood Elevation value where uniform within zone; elevation in feet*

*Referenced to the National Geodetic Vertical Datum of 1929

A — A — Cross section line

23 — 23 — Transect line

97°07'30", 32°22'30" — Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)

4276000 M — 1000-meter Universal Transverse Mercator grid values, zone 18

500000 FT — 5000-foot grid ticks: New York State Plane coordinate system, east zone (FIPSZONE 3101), Transverse Mercator projection

DX5510 X — Bench mark (see explanation in Notes to Users section of this FIRM panel)

M1.5 — River Mile

MAP REPOSITORY

Town Clerk's Office, 457 Main Street, Cold Brook, New York 13324 (Maps available for reference only, not for distribution.)

INITIAL NFIP MAP DATE
February 11, 1977
FLOOD HAZARD BOUNDARY MAP REVISIONS
None
FLOOD INSURANCE RATE MAP EFFECTIVE
July 3, 1986
FLOOD INSURANCE RATE MAP REVISIONS

Refer to the FLOOD INSURANCE RATE MAP EFFECTIVE date shown on this map to determine when actuarial rates apply to structures in the zones where elevations or depths have been established.

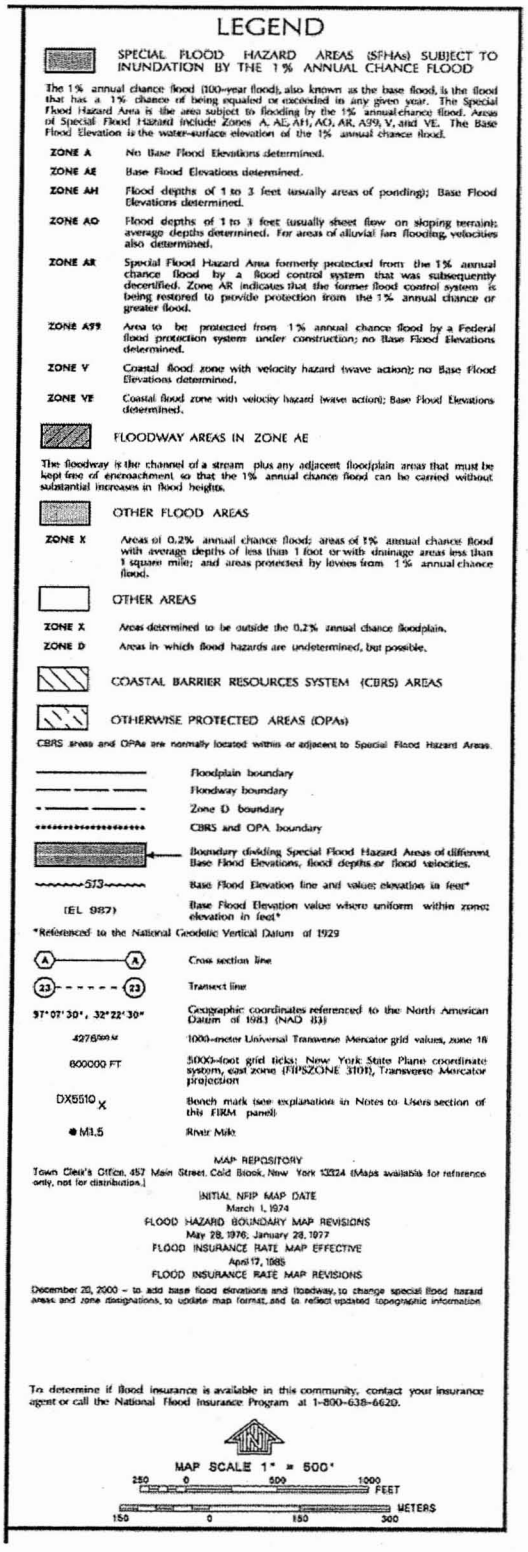
To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 500'

250 0 500 1000 FEET

150 0 150 300 METERS

Figure K-20. Single-Jurisdiction DFIRM, Non-DOQ Base Map



LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A — No Base Flood Elevations determined.

ZONE AE — Base Flood Elevations determined.

ZONE AH — Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.

ZONE AO — Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.

ZONE AR — Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.

ZONE A99 — Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.

ZONE V — Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.

ZONE VE — Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X — Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X — Areas determined to be outside the 0.2% annual chance floodplain.

ZONE D — Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

Floodplain boundary

Floodway boundary

Zone D boundary

CBRS and OPA boundary

Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.

513 — Base Flood Elevation line and value; elevation in feet*

(EL 987) — Base Flood Elevation value where uniform within zone; elevation in feet*

*Referenced to the National Geodetic Vertical Datum of 1929

Cross section line

Transect line

97°07'30", 32°22'30" — Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)

4276 — 1000-meter Universal Transverse Mercator grid values, zone 18

600000 FT — 5000-foot grid ticks: New York State Plane coordinate system, east zone (FIPSZONE 3101), Transverse Mercator projection

DX5510 X — Bench mark (see explanation in Notes to Users section of this FIRM panel)

M1.5 — River Mile

MAP REPOSITORY

Town Clerk's Office, 457 Main Street, Cold Brook, New York 13324 (Maps available for reference only, not for distribution.)

INITIAL NFIP MAP DATE

March 1, 1974

FLOOD HAZARD BOUNDARY MAP REVISIONS

May 28, 1976; January 28, 1977

FLOOD INSURANCE RATE MAP EFFECTIVE

April 17, 1985

FLOOD INSURANCE RATE MAP REVISIONS

December 20, 2000 – to add base flood elevations and floodway, to change special flood hazard areas and zone designations, to update map format, and to reflect updated topographic information.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 500'

250 0 500 1000 FEET

150 0 150 300 METERS

Figure K-21. Single-Jurisdiction DFIRM, Non-DOQ Base Map, Map Revised Legend

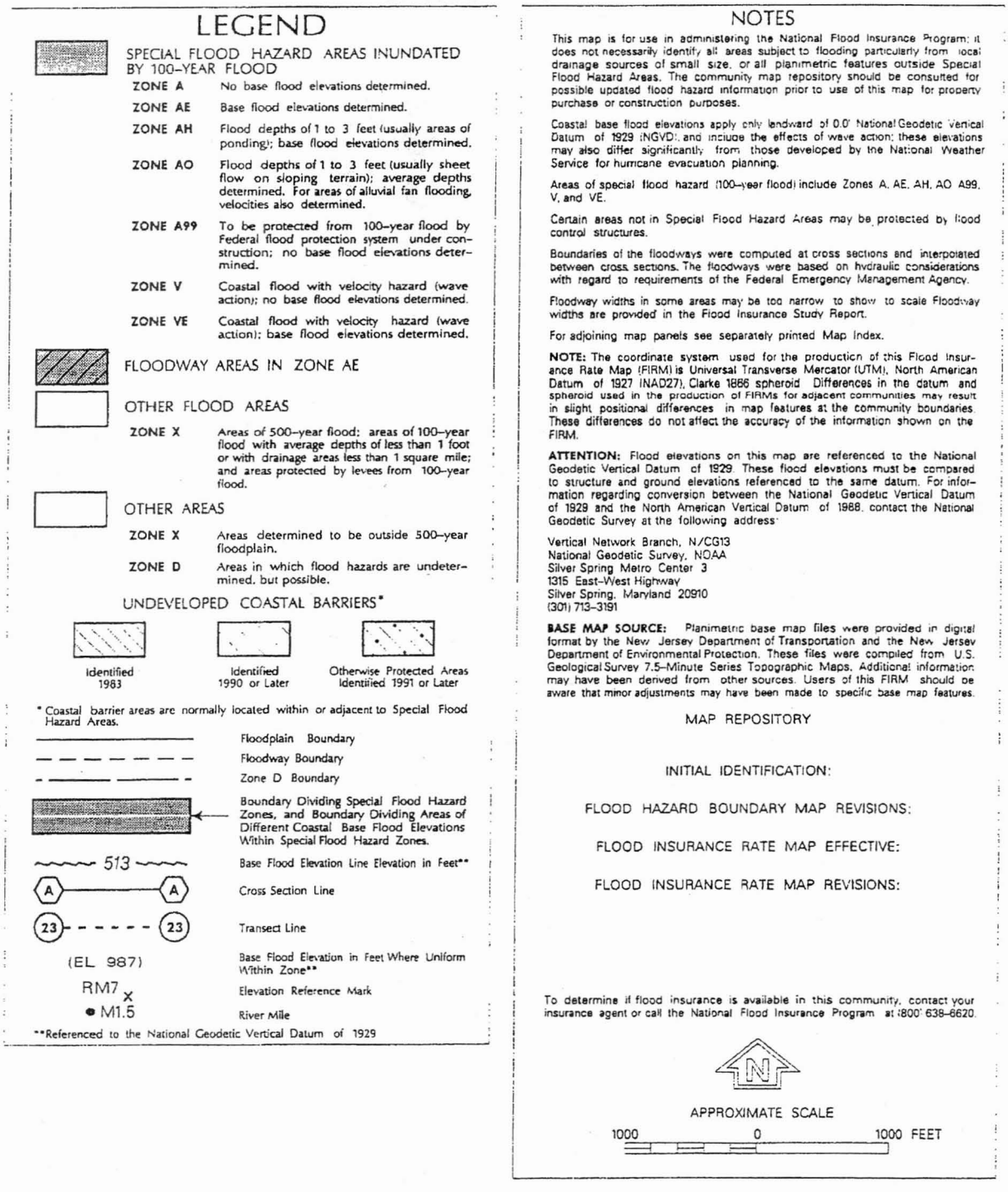
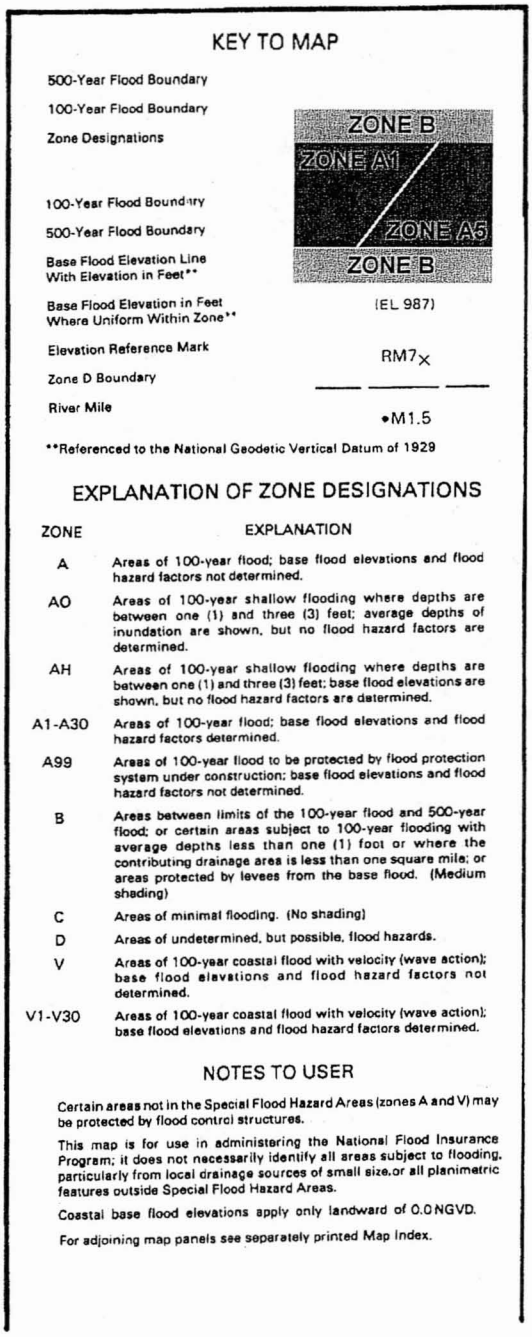


Figure K-22. Single-Jurisdiction Manual FIRM, Map Initiatives Format, Map Revised Legend



KEY TO MAP

500-Year Flood Boundary

100-Year Flood Boundary

Zone Designations

100-Year Flood Boundary

500-Year Flood Boundary

Base Flood Elevation Line With Elevation in Feet**

Base Flood Elevation in Feet Where Uniform Within Zone** (EL 987)

Elevation Reference Mark RM7×

Zone D Boundary

River Mile •M1.5

**Referenced to the National Geodetic Vertical Datum of 1929

EXPLANATION OF ZONE DESIGNATIONS

ZONE	EXPLANATION
A	Areas of 100-year flood; base flood elevations and flood hazard factors not determined.
AO	Areas of 100-year shallow flooding where depths are between one (1) and three (3) feet; average depths of inundation are shown, but no flood hazard factors are determined.
AH	Areas of 100-year shallow flooding where depths are between one (1) and three (3) feet; base flood elevations are shown, but no flood hazard factors are determined.
A1-A30	Areas of 100-year flood; base flood elevations and flood hazard factors determined.
A99	Areas of 100-year flood to be protected by flood protection system under construction; base flood elevations and flood hazard factors not determined.
B	Areas between limits of the 100-year flood and 500-year flood; or certain areas subject to 100-year flooding with average depths less than one (1) foot or where the contributing drainage area is less than one square mile; or areas protected by levees from the base flood. (Medium shading)
C	Areas of minimal flooding. (No shading)
D	Areas of undetermined, but possible, flood hazards.
V	Areas of 100-year coastal flood with velocity (wave action); base flood elevations and flood hazard factors not determined.
V1-V30	Areas of 100-year coastal flood with velocity (wave action); base flood elevations and flood hazard factors determined.

NOTES TO USER

Certain areas not in the Special Flood Hazard Areas (zones A and V) may be protected by flood control structures.

This map is for use in administering the National Flood Insurance Program; it does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size,or all planimetric features outside Special Flood Hazard Areas.

Coastal base flood elevations apply only landward of 0.0 NGVD.

For adjoining map panels see separately printed Map Index.

Figure K-23. Single-Jurisdiction Manual FIRM, Standard Format Legend

[February 2002]

K.5.1 Map Legend Components

The Map Legend provides the user with explanations of flood hazard feature representations as they are depicted on the FIRM or FBFM. The following components shall appear in the legend:

- Flood hazard area and CBRS area screen descriptions;
- Flood hazard zones descriptions;
- Floodplain, regulatory floodway, zone, and CBRS boundary descriptions;
- BFE and elevation labels, including a clear statement of the vertical datum used;
- Cross-section and transect labels;
- Geographic coordinate and primary and secondary horizontal reference grid labels, with notes stating the reference grids and projection used;
- Bench marks;
- River mile markers;
- Map repository notes;
- NFIP map dates;
- Map revision notes;
- General FIRM legend notes;
- North arrow; and
- Map scale.

Map Revision notes document the reasons for past and present FIRM revisions. The assigned Mapping Partner shall use one or more of the notes in the table below to explain why a panel was revised. Only one date is required when more than one note is used. All dates shall be written out in their entirety.

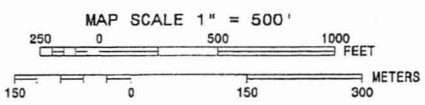
The map revision notes that are used for each FIRM revision shall be date-specific rather than panel-specific. All actions occurring on a specific date shall be combined into one map revision note and used on all panels for that particular revision. In addition, notes shall not be used on the first production of a countywide FIRM, even though these changes have occurred within the Flood Map Project that led to the countywide FIRM being developed.

Map Legend Features and Notes *Font specifications that cannot be matched may be approximated		
Example	**Feature/Usage**	**Specification**
LEGEND	Legend title	18 Pt. Verdana CAPS
SPECIAL FLOOD HAZARD AREAS SUBJECT TO....	Screen descriptions	10 Pt. Tahoma CAPS
ZONE AE	Zone labels	8 Pt. Arial Bold CAPS
Base Flood Elevations determined.	Zone and other map feature descriptions	8 Pt. Tahoma CLC
1% annual chance floodplain boundary	SFHA boundary description	8 Pt. Tahoma LC
MAP REPOSITORY Thomasville City Hall, 10 Salem Street, Thomasville, North Carolina 27360 (Maps available for reference only, not for distribution.)	This is an example of the Map Repository note used for single-jurisdiction or non-countywide FIRMs. The complete address of the map repository is included in the legend. The disclaimer, as stated, follows the address. Note that the Map Repository should be a street address and not a PO box.	8 Pt. Arial CAPS and CLC
MAP REPOSITORY Refer to listing of Map Repositories on Map Index	This note explains the location of the Map Repository note used for countywide maps. The map repository address for each community in the county is listed on the Map Index. See Section K.3.2 for an example of map repository listings used on the Map Index.	8 Pt. Arial CAPS and CLC
INITIAL IDENTIFICATION February 11, 1977 FLOOD HAZARD BOUNDARY MAP REVISIONS None FLOOD INSURANCE RATE MAP EFFECTIVE July 3, 1985 FLOOD INSURANCE RATE MAP REVISIONS December 20, 2000 – to add Base Flood Elevations, floodway, and Special Flood Hazard Areas; to change zone designations and Special Flood Hazard Areas; to update map format; and to reflect updated topographic information.	These headings and listings of NFIP map dates are used for manual single-jurisdiction studies. Historical map dates shall be listed in the FIRM legend for each printed panel. Dates may be supplied from various sources including the previous effective map. Standard map revision notes are provided below. See Section K.5.1.1 for standard Coastal Barrier revision notes.	8 Pt. Arial CAPS and CLC

Map Legend Features and Notes *Font specifications that cannot be matched may be approximated		
Example	**Feature/Usage**	**Specification**
INITIAL NFIP MAP DATE February 11, 1977 FLOOD HAZARD BOUNDARY MAP REVISIONS None FLOOD INSURANCE RATE MAP EFFECTIVE July 3, 1985 FLOOD INSURANCE RATE MAP REVISIONS December 20, 2000 – to add Base Flood Elevations, floodway, and Special Flood Hazard Areas; to change zone designations and Special Flood Hazard Areas; to update map format; and to reflect updated topographic information.	The Initial NFIP Map Date heading will be used on all digital single-jurisdiction studies.	8 Pt. Arial CAPS and CLC
EFFECTIVE DATE OF COUNTYWIDE FLOOD INSURANCE RATE MAP June 28, 1995 EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL August 23, 1999 – to update corporate limits, to change Base Flood Elevations and Special Flood Hazard Areas, to update map format, to add roads and road names, to incorporate previously issued Letters of Map Revision, and to modify Coastal Barrier Resources System units.	These headings and listings of NFIP map dates are used for countywide studies. See Appendix J for information on previous historical map dates for countywides.	8 Pt. Arial CAPS and CLC
January 31, 2001 - to update corporate limits	This note is used any time a revised FIRM shows a new corporate limit configuration. If an Area Not Included boundary is revised on the FIRM for the unincorporated areas of a county, this note specifically references the community (i.e., to update Town of Atlantic Beach corporate limits). An example date shown in italics has been placed in the note for clarity.	8 Pt. Arial CLC
(Date of revision) - to decrease Base Flood Elevations	This note is used any time existing BFEs have only been decreased.	8 Pt. Arial CLC
(Date of revision) - to increase Base Flood Elevations	This note is used any time existing BFEs have only been increased	8 Pt. Arial CLC
(Date of revision) - to change Base Flood Elevations	This note is used when BFEs are both increasing and decreasing.	8 Pt. Arial CLC

Map Legend Features and Notes *Font specifications that cannot be matched may be approximated		
Example	**Feature/Usage**	**Specification**
(Date of revision) - to add Base Flood Elevations	This note is used when BFEs are added to a new detailed A or V zone for an area previously unstudied or previously studied by approximate methods.	8 Pt. Arial CLC
(Date of revision) - to add Special Flood Hazard Areas	This note is used when new detailed or approximate 1% annual chance flooding is added to an area previously unstudied.	8 Pt. Arial CLC
(Date of revision) - to change Special Flood Hazard Areas	This note is used when the configuration of an existing SFHA is modified.	8 Pt. Arial CLC
(Date of revision) - to delete Special Flood Hazard Areas	This note is used when an SFHA is entirely removed from the FIRM.	8 Pt. Arial CLC
(Date of revision) - to change zone designations	This note is used when X (0.2% annual chance) zones are changed to X (no flooding) zones, or vice versa; when A zones are changed to X (0.2% annual chance) zones; and when A or V zones are changed to detailed zones (AE or VE zones).	8 Pt. Arial CLC
(Date of revision) - to update map format	This note is used when an 11" x 17" FIRM is remapped into a z-fold, when a FIRM and FBFM are combined into a FIRM (Map Initiatives or Partial Map Initiatives), or when the FIRM is being prepared using digital methods for the first time.	8 Pt. Arial CLC
(Date of revision) - to add roads and road names	This note is used when new roads and road names are added to the FIRM. "Update" instead of "add" is used when roads are moved or deleted, or when the names of roads change.	8 Pt. Arial CLC

Map Legend Features and Notes *Font specifications that cannot be matched may be approximated		
Example	**Feature/Usage**	**Specification**
(Date of revision) - to include the effects of wave action	This note is used when a coastal wave height analysis has been added for the first time to an existing "non-wave height" FIS. Please note that revision notes covering BFE and SFHA additions, deletions, changes or modifications are not necessary when this note is used to describe changes to the FIRM resulting from the addition of a wave height analysis.	8 Pt. Arial CLC
(Date of revision) – to update the effects of wave action	This note is used when a coastal wave height analysis has been revised.	8 Pt. Arial CLC
(Date of revision) - to incorporate Primary Frontal Dune analysis	This note is used when an FIS is revised to reflect the inland limit of the Primary Frontal Dune.	8 Pt. Arial CLC
(Date of revision) – to reflect revised shoreline	This note is used when all or part of the shoreline on a coastal FIRM has been revised.	8 Pt. Arial CLC
(Date of revision) - to reflect the effects of coastal erosion	This note is used when coastal erosion has been taken into account in the analysis.	8 Pt. Arial CLC
(Date of revision) - to add Special Flood Hazard Areas previously shown on (community name), (state) Flood Insurance Rate Map dated (date), (year)	This note is used when a FIRM revision incorporates the annexation of an area with special flood hazards that was previously shown on another community's FIRM.	8 Pt. Arial CLC
(Date of revision) - to incorporate previously issued Letters of Map Revision	This note is used when determinations made by Letter of Map Revision are incorporated into the revised FIRM.	8 Pt. Arial CLC
(Date of revision) - to reflect updated topographic information	This note is used when the FIRM revision is based, at least in part, on new topographic information.	8 Pt. Arial CLC
(Date of revision) - to incorporate previously issued Letters of Map Amendment	This note is used when determinations made by Letter of Map Amendment are incorporated into the revised FIRM.	8 Pt. Arial CLC

Map Legend Features and Notes *Font specifications that cannot be matched may be approximated		
Example	**Feature/Usage**	**Specification**
(Date of revision) - to add floodway	This note is used when floodway delineation has been added. This note is used only on Map Initiatives format FIRMs.	8 Pt. Arial CLC
(Date of revision) - to change floodway	This note is used when a floodway delineation change is the basis of the revision. This note is used only on Map Initiatives format FIRMs.	8 Pt. Arial CLC
(Date of revision) - to advance suffix	This note is used when the only change to the FIRM is to change the map number suffix. This note is used only with the approval of a FEMA Project Officer.	8 Pt. Arial CLC
For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study Report for this jurisdiction.	This note is shown only on countywide FIRMs.	8 Pt. Tahoma CLC
To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.	This note is shown on all FIRMs above the north arrow.	8 Pt. Tahoma CLC
Refer to the FLOOD INSURANCE RATE MAP EFFECTIVE date shown on this map to determine when actuarial rates apply to structures in the zones where elevations or depths have been established.	This note is shown only on single-jurisdiction FIRMs that are being published for the first time (i.e., FIRMs that show an effective date in the title block, not a map revised date).	8 Pt. Tahoma CAPS and CLC
	North arrow	Lineweight .010" Width .700" Height .400"
	The DFIRM scale bar includes references to both feet and meters and emulates the scale bar used by USGS on topographic quadrangles. The manual FIRM scale bar only includes the reference to feet. Note that this scale bar is not shown to actual size.	10 Pt. Arial Bold CAPS

[February 2002]

K.5.1.1 Coastal Barrier Resources System Map Revision Notes

The map revision notes pertaining to modifications to the Coastal Barrier Resources System are listed below. The Coastal Barrier revision notes matrix below provides guidance on the revision note to be used in the FIRM legend. The note used depends on whether CBRS areas and/or OPAs are being added to or removed from the community. Only one of the notes shown is used for any given community, so it must reflect the community as a whole. These revision notes are not panel-specific. They must reflect the action taken for the entire jurisdiction.

Coastal Barrier Revision Notes Matrix

Revision Note	Barrier Added	Barrier Removed[1]	OPA Added	OPA Removed[1]
To add Coastal Barrier Resources Areas	X			
To remove Coastal Barrier Resources Areas		X		
To modify Coastal Barrier Resources Areas	X	X		
To add Otherwise Protected Areas			X	
To remove Otherwise Protected Areas				X
To modify Otherwise Protected Areas			X	X
To add Coastal Barrier Resources Areas and Otherwise Protected Areas	X		X	
To add Coastal Barrier Resources Areas and to remove Otherwise Protected Areas	X			X
To add Coastal Barrier Resources Areas and to modify Otherwise Protected Areas	X		X	X
To remove Coastal Barrier Resources Areas and to add Otherwise Protected Areas		X	X	
To remove Coastal Barrier Resources Areas and Otherwise Protected Areas		X		X
To remove Coastal Barrier Resources Areas and to modify Otherwise Protected Areas		X	X	X
To modify Coastal Barrier Resources Areas and to add Otherwise Protected Areas	X	X	X	
To modify Coastal Barrier Resources Areas and to remove Otherwise Protected Areas	X	X		X
To modify Coastal Barrier Resources Areas and Otherwise Protected Areas	X	X	X	X

[1]This refers to any area, regardless of size, that has had the CBRS unit or OPA reduced in size in any area.

[February 2002]

K.5.1.2 Coastal Barrier Resource System Legend

The assigned Mapping Partner shall only use the Coastal Barrier Legend shown below when the abbreviated Coastal Barrier notes are used on the body of the FIRM and there is more than one note that applies to the entire community. It shall be placed under the Notes to Users portion of the frame in a separate frame area. These notes are the same as the non-abbreviated notes used on the body of the FIRM shown in Section K.4.4. These revision notes are not panel-specific.

They must reflect the action taken for the entire jurisdiction. A Coastal Barrier Legend example (Figure K-24) is provided below, followed by a table of the specifications for features and notes.

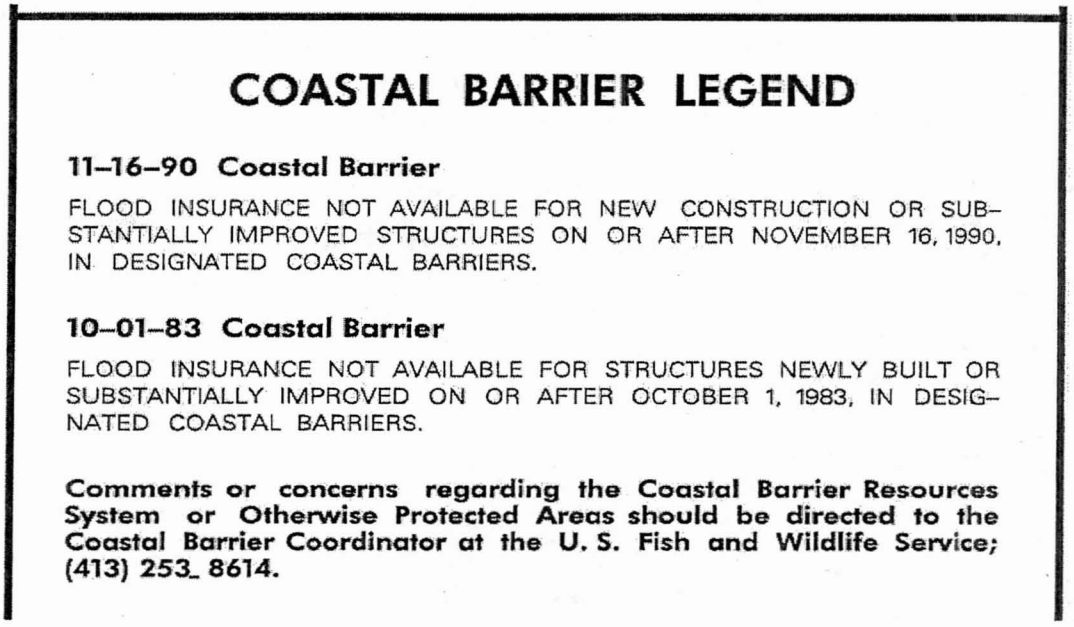


Figure K-24. Coastal Barrier Legend

Coastal Barrier Legend Features and Notes

*Font specifications that cannot be matched may be approximated

Example	Feature/Usage	Specification
COASTAL BARRIER LEGEND	Coastal Barrier legend title	18 Pt. Arial Bold CAPS
10-01-83 Coastal Barrier FLOOD INSURANCE NOT AVAILABLE FOR STRUCTURES NEWLY BUILT OR SUBSTANTIALLY IMPROVED ON OR AFTER OCTOBER 1, 1983, IN DESIGNATED COASTAL BARRIERS.	This note identifies an area classified as a 1983 Coastal Barrier. This note is placed in the Coastal Barrier Legend when the abbreviated version of this note is used on the body of the FIRM.	10 Pt. Arial Bold CLC 9 Pt. Arial CAPS

Coastal Barrier Legend Features and Notes *Font specifications that cannot be matched may be approximated		
Example	**Feature/Usage**	**Specification**
(_ _-_ _-_ _) Coastal Barrier FLOOD INSURANCE NOT AVAILABLE FOR NEW CONSTRUCTION OR SUBSTANTIALLY IMPROVED STRUCTURES ON OR AFTER (date), IN DESIGNATED COASTAL BARRIERS.	This note identifies an area classified as a 1990 or later Coastal Barrier. This note is placed in the Coastal Barrier Legend when the abbreviated version of this note is used on the body of the FIRM.	10 Pt. Arial Bold CLC 9 Pt. Arial CAPS
(_ _-_ _-_ _) Otherwise Protected Area FLOOD INSURANCE NOT AVAILABLE FOR STRUCTURES - NEWLY BUILT OR SUBSTANTIALLY IMPROVED ON OR AFTER (date) - NOT USED IN A MANNER CONSISTENT WITH THE PURPOSE OF THE OTHERWISE PROTECTED AREAS.	This note identifies an area classified as a 1991 or later Otherwise Protected Area. This note is placed in the Coastal Barrier Legend when the abbreviated version of this note is used on the body of the FIRM.	10 Pt. Arial Bold CLC 9 Pt. Arial CAPS
Comments or concerns regarding the Coastal Barrier Resources System or Otherwise Protected Areas should be directed to the Coastal Barrier Coordinator at the U.S. Fish and Wildlife Service; (_ _ _) _ _ _-_ _ _ _.	This note refers map users to the Fish and Wildlife Service's Regional Coastal Barrier Coordinator. If the abbreviated Coastal Barrier notes and special Coastal Barrier Legend are used, this note appears below the Coastal Barrier Legend. The phone number is inserted into the above note as follows: **(413) 253-8657** CT, DE, MA, ME, MD, NJ, NY, RI, VA **(404) 679-7106** AL, FL, GA, LA, MS, NC, PR, SC, VI **(612) 713-5350** MI, MN, OH, WI **(505) 248-6454** TX	10 Pt. Arial Bold CLC

[February 2002]

K.6 Map Title Block

The FIRM title block shall contain those items that identify the community and provide panel-specific information, including the map number and effective date of the FIRM panel. The community name must include, at a minimum, the community type (e.g., city, town, village), community name, and full state name. FIRMs for individual communities shall also include the name of the county, except in the cases of jurisdictions that are officially classified as "Independent." County FIRMs may include flood hazard information only for unincorporated areas administered directly by the county government, or for the entire geographic area within the county. "All Jurisdictions" FIRMs include flood hazard information for entire counties in which no separate county government exists; all land is administered by community agencies.

The title block shall include this community information, as in the following examples of community naming formats :

Town of
Adams,
Pennsylvania
Jefferson County

City of
Hampton,
Virginia
Independent City

Boone County,
Illinois
(Unincorporated Areas)

Carbon County,
Utah
And Incorporated Areas

Pike County,
Pennsylvania
(All Jurisdictions)

The following pages contain figures of sample title blocks for the following different types of FIRMs:

- Countywide DFIRM (Figure K-25);
- Countywide DFIRM with CBRS Areas (Figure K-26);
- Single-Jurisdiction Multi-Panel DFIRM (Figure K-27);
- Single-Jurisdiction DFIRM, Only Panel Printed (Figure K-28); and
- Single-Jurisdiction Manual FIRM (Figure K-29).

Font size and style specifications are provided in Figure K-30, "Title Block Element Specifications." Figures K-31 and K-32 provide important information concerning the title block content.

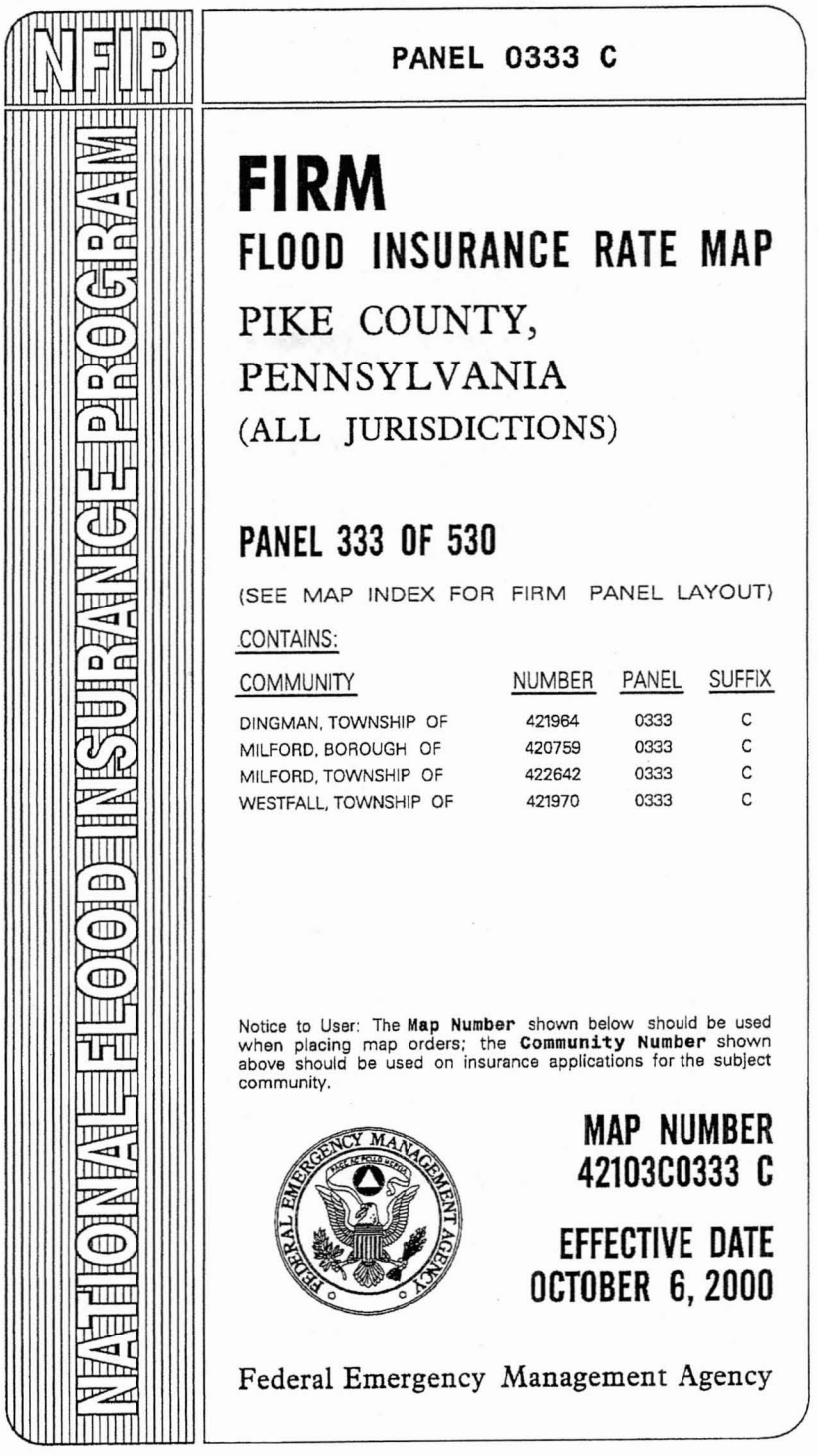


Figure K-25. Countywide DFIRM Title Block

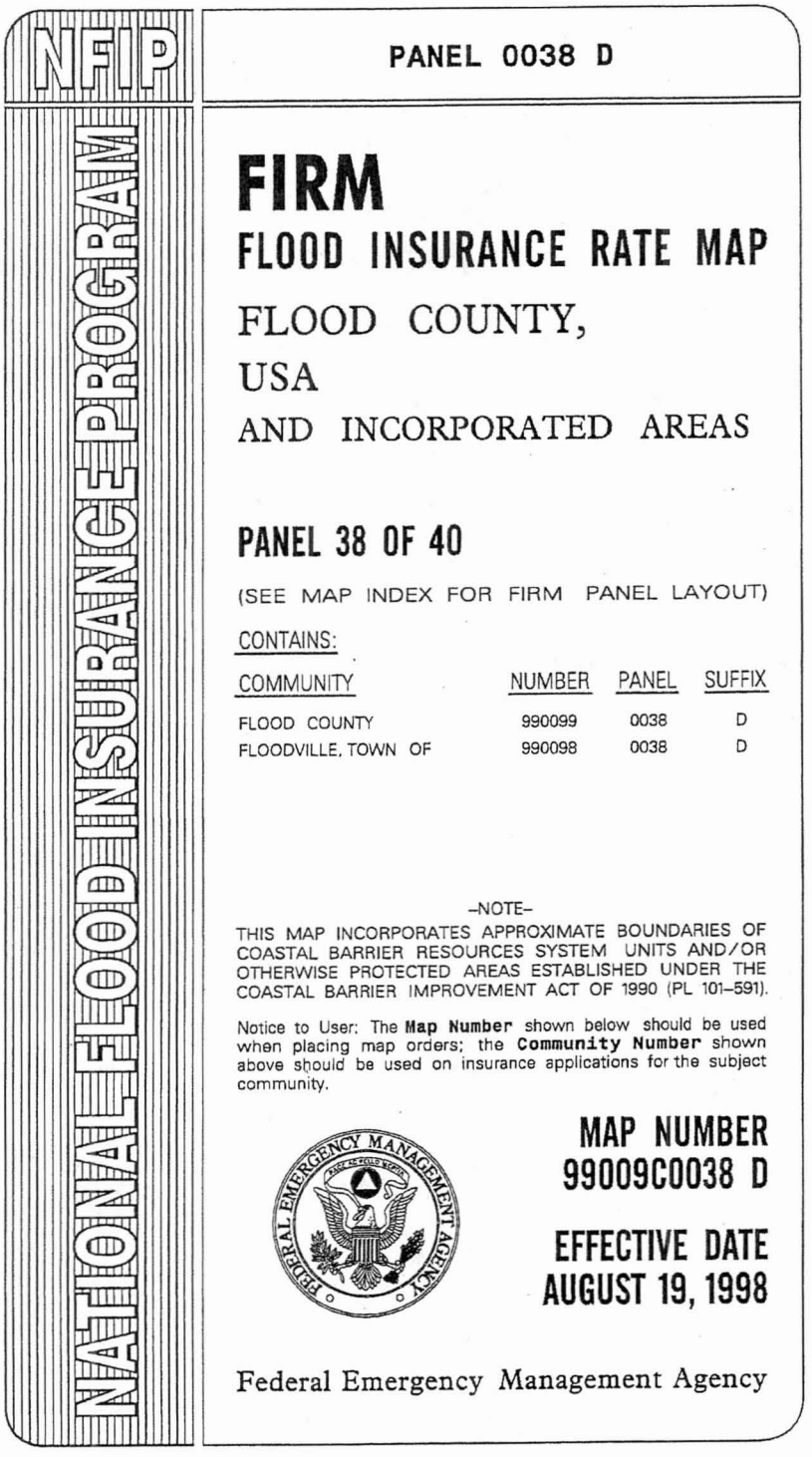


Figure K-26. Countywide DFIRM Title Block with CBRS Areas

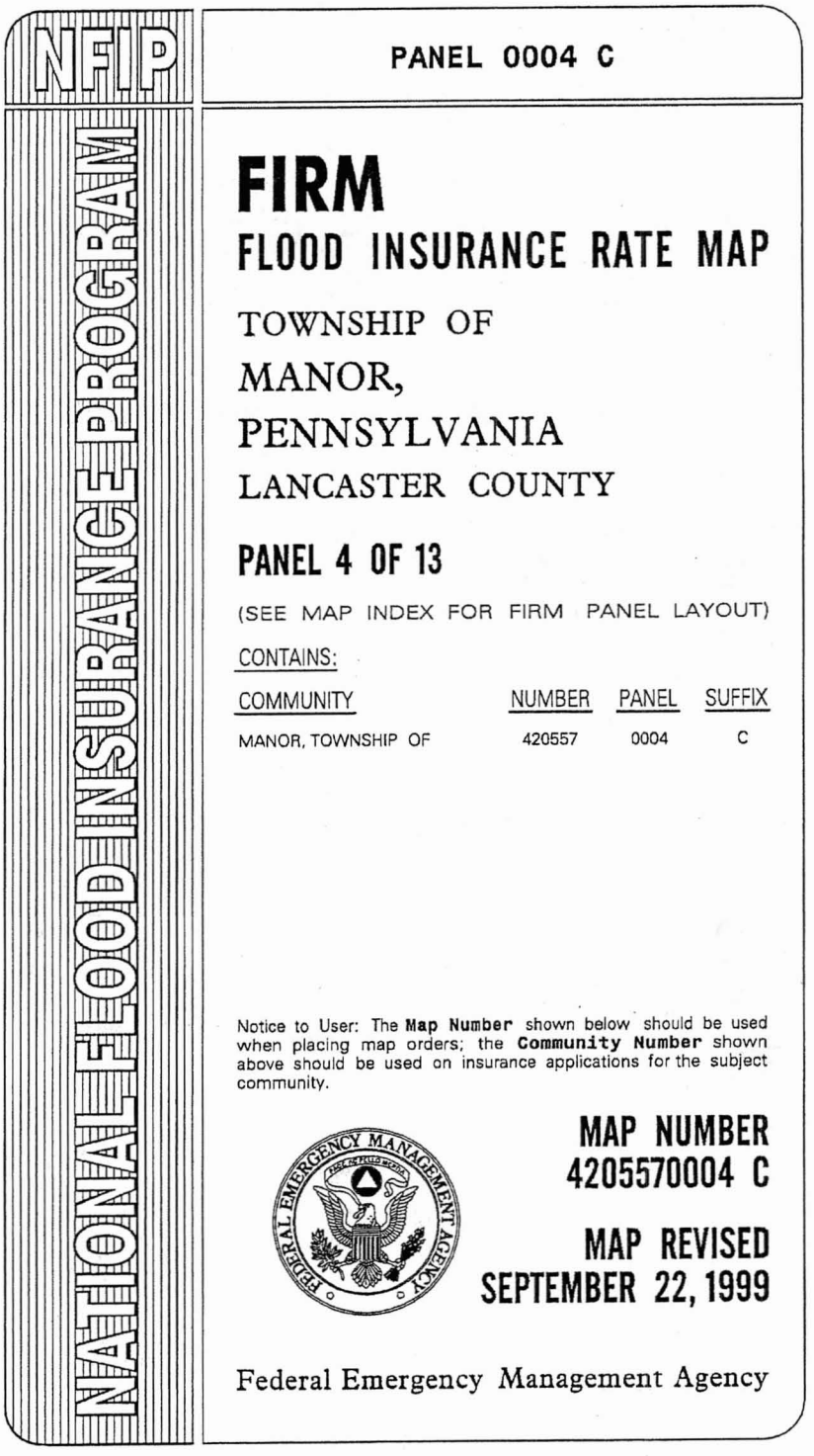


Figure K-27. Single-Jurisdiction Multi-Panel DFIRM Title Block

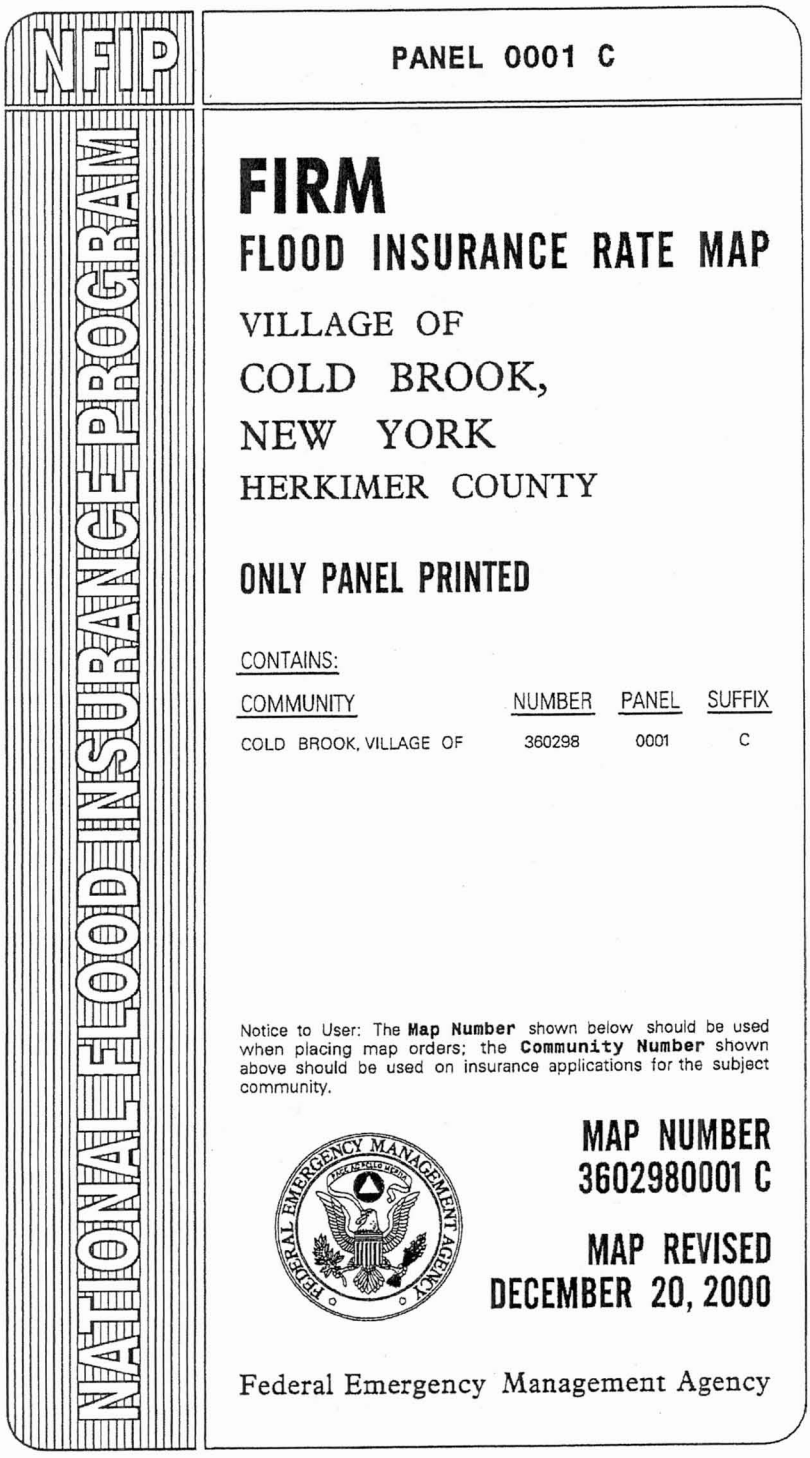


Figure K-28. Single-Jurisdiction DFIRM Title Block, Only Panel Printed

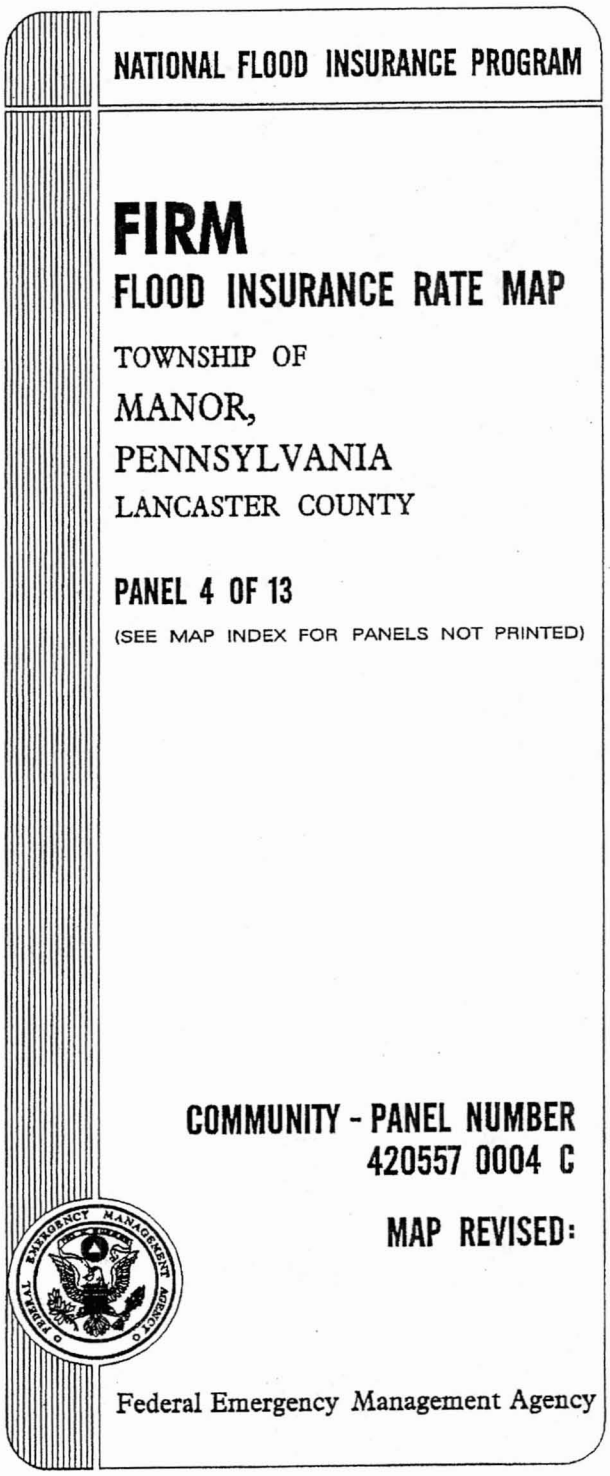


Figure K-29. Single-Jurisdiction Manual FIRM Title Block

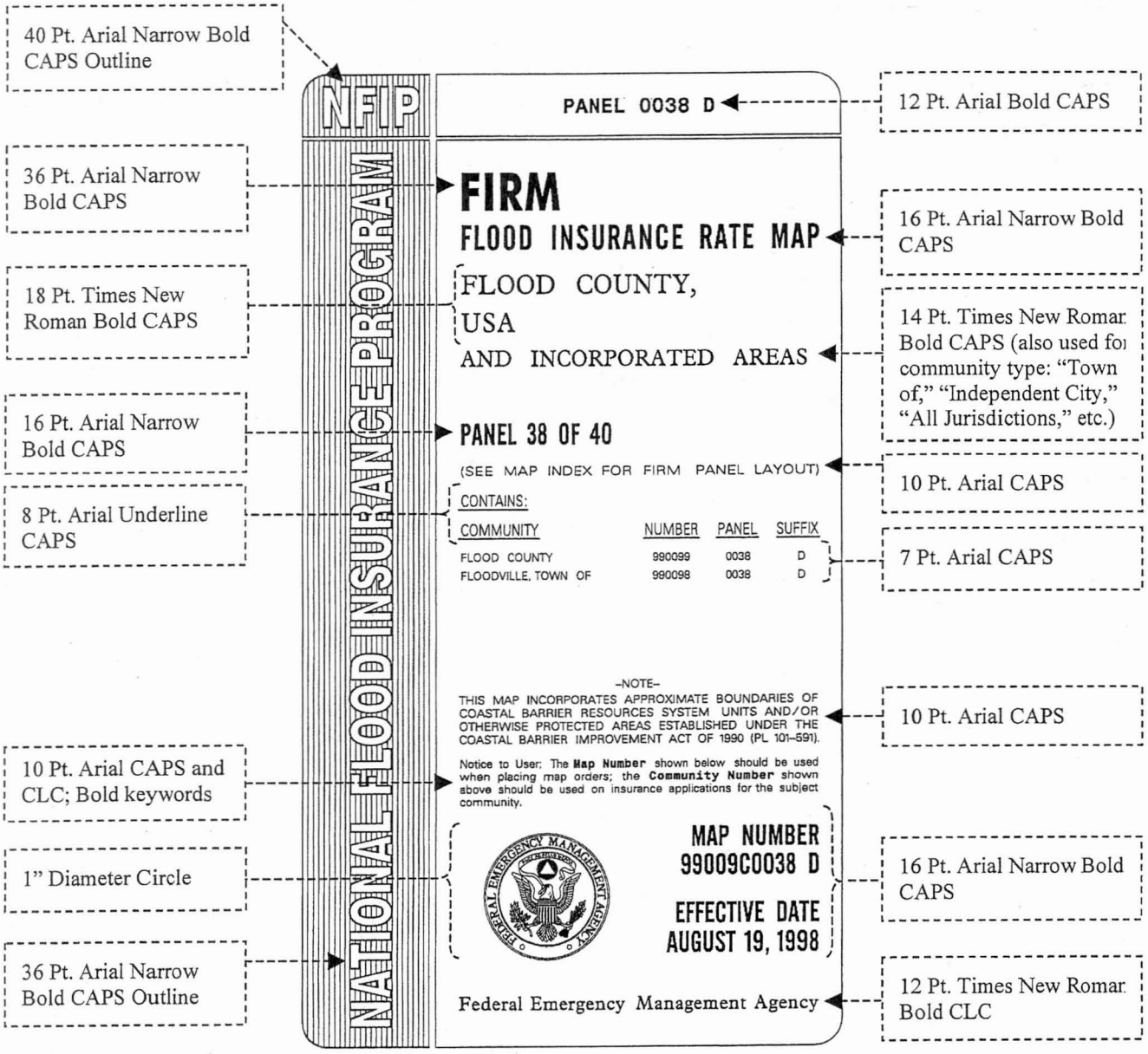
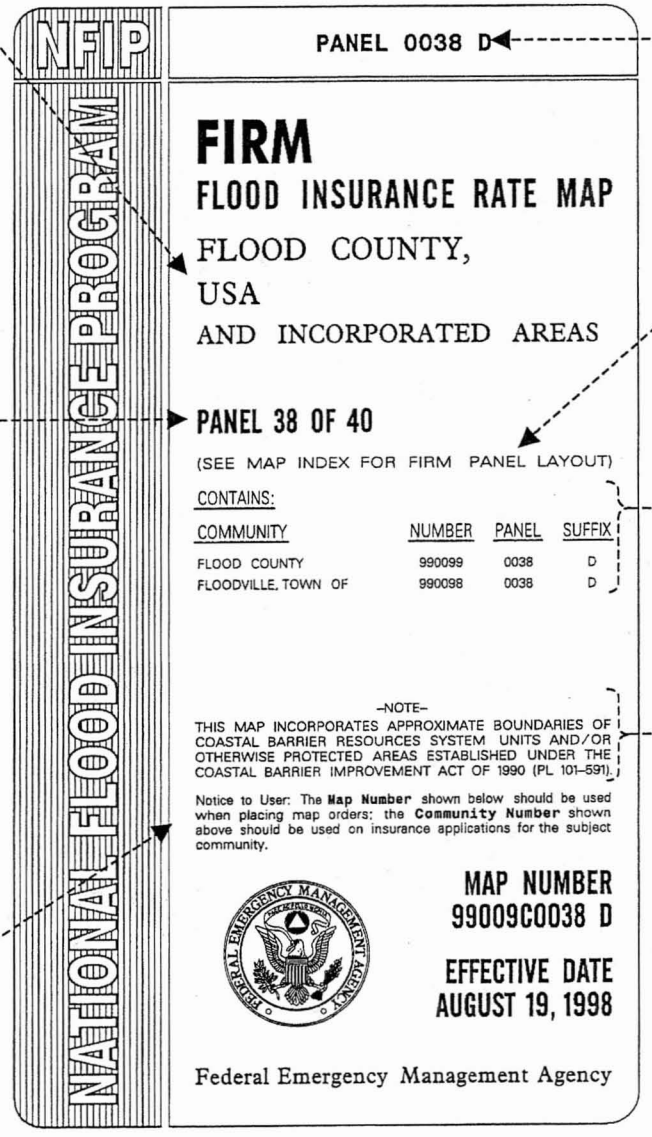


Figure K-30. Title Block Element Suggested Font Specifications

This example is based on a FIRM for a fictional community. When preparing title blocks, the state name is to be spelled out in full.

The FIRM panel number and the highest FIRM panel number in the series are included in the title blocks of multi-panel FIRMs. "Only Panel Printed" shall be used when the community may be shown on a single map sheet.

This note shall be placed on all FIRM title blocks to explain the use of the map number and the community number.



The FIRM panel number and suffix are included at the top of the FIRM title block to assist in locating FIRM panels for those users who store the maps upright in filing cabinets.

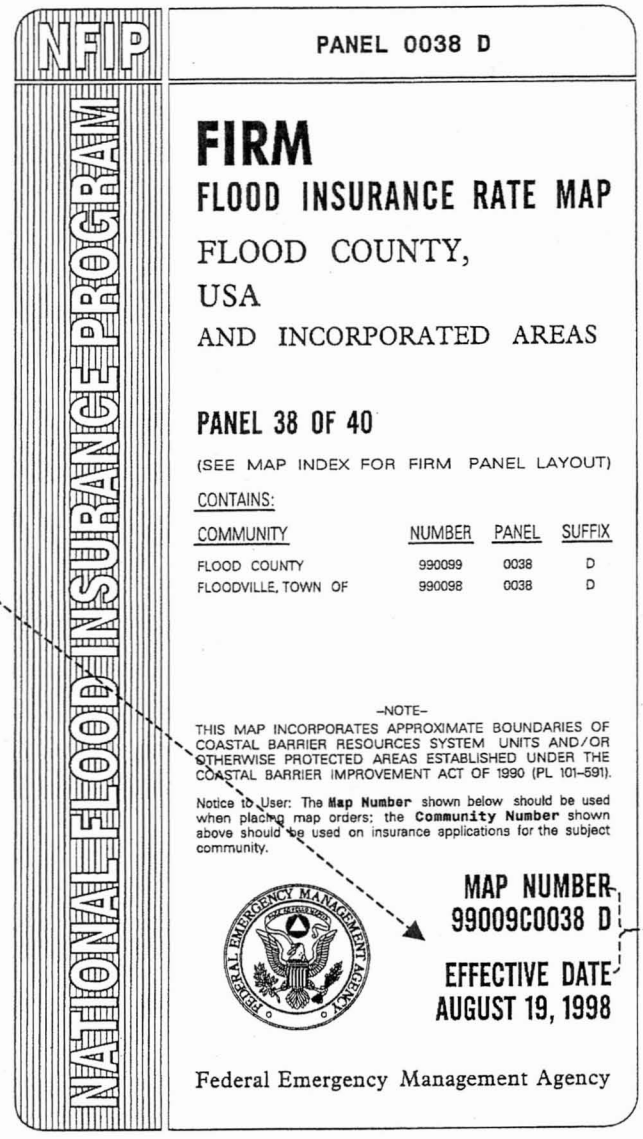
This note refers the map user to the index for an overview of the entire community. The note is omitted from "Only Panel Printed" FIRMs.

This list identifies the communities shown on the panel. Communities, including any county areas, are listed alphabetically.

The CBRS note used in this example must appear on every panel that contains a CBRS unit. If the map panel contains a CBRS or OPA unit established under an act subsequent to Public Law 101-591, the note shall be modified to include the applicable law, as in the example below:

THIS MAP INCORPORATES APPROXIMATE BOUNDARIES OF COASTAL BARRIER RESOURCES SYSTEM UNITS AND/OR OTHERWISE PROTECTED AREAS ESTABLISHED UNDER THE COASTAL BARRIER IMPROVEMENT ACT OF 1990 (PL 101-591) AND/OR THE WILD EXOTIC BIRD CONSERVATION ACT OF 1992 (PL 102-440).

Figure K-31. Title Block Element Usage Notes



The effective date shall be absent when a Preliminary FIRM is issued, and added when the final FIRM is published. On revised FIRMs, "Effective Date" shall be replaced with "Map Revised."

The Map Number is comprised of several components:

- either the 5-digit county FIPS code followed by "C" (on Countywide FIRMS) or the 6-digit community identification number;
- the 4-digit panel number;
- a space; and
- the map suffix.

The map suffix is used to track published editions of each FIRM panel. All panels within a study do not necessarily have the same map suffix if they were not all updated at the same time. When each new edition of a FIRM is prepared, the suffix for each revised FIRM panel is changed to the next letter in alphabetical sequence, with the letter "I" being skipped. For first-time Countywide FIRMs, the suffix will be the next letter following the highest suffix letter of any FIRM panel of all the jurisdictions included in the countywide. Likewise, any FIRM being revised to reflect a completely new panel layout will have suffixes one letter higher than the highest letter of any previously published panel.

Figure K-32. Title Block Element Usage Notes

K.7 Map Locator Diagram

Map Locator Diagrams serve the same function as a Map Index. The assigned Mapping Partner shall use the Map Locator Diagram only when one panel is printed and the entire community does not fit inside the panel neatlines (i.e., there are non-printed panels).

Figure K-33. Map Locator Diagram

The following guidelines shall be followed when preparing a Map Locator Diagram:

- The diagram shall be located in the title block, whenever possible.
- Because the Map Locator Diagram replaces the Map Index, the panels shall be numbered using four-digit panel numbers (for example, 0001) and include suffixes.
- Applicable Panel Not Printed notes, presented in Section K.3.1, shall be used to explain the non-printed panel(s).
- The panel that is printed shall be indicated with a screen.

[February 2002]

Map MODERNIZATION

Federal Emergency Management Agency

FEMA's Flood Hazard Mapping Program

Guidelines and Specifications *for* Flood Hazard Mapping Partners

Appendix L: Guidance for Preparing Draft Digital Data and DFIRM Database

FEDERAL EMERGENCY MANAGEMENT AGENCY

www.fema.gov/mit/tsd/dl_cgs.htm

FINAL

February 2002

Appendix L

Draft Digital Data and Digital Flood Insurance Rate Map Database Specifications

The purpose of this Appendix is to provide guidance and specifications to the Mapping Partner that prepares draft digital data for Digital Flood Insurance Rate Map (DFIRM) production and the Mapping Partner that prepares the Preliminary and Final DFIRM and databases for transfer to the Federal Emergency Management Agency (FEMA). For a particular Flood Map Project, the FEMA Lead may assign both tasks to one Mapping Partner or each task to a different Mapping Partners. This Appendix is not intended to specify in-process compilation or digitizing procedures but rather, to present specifications and requirements for output and deliverables.

[February 2002]

L.1 Digital Flood Insurance Rate Map Database Overview

The new FEMA Geographic Information System (GIS) databases will store the digital data used in the map production process, as well as the engineering backup data for floodplain studies. These databases will provide a standard, systematic method for FEMA to distribute comprehensive details of flood studies to the public and others in a digital format.

Preparing these data in digital format has significant advantages for ease of storage, records search, and distribution. But, the most significant advantage is that the data are designed to work within a GIS environment. The FEMA database can be used for automated analyses and map updates that are impractical and costly with paper products.

FEMA will collect as much data as possible in digital format, and archive the data in the GIS database format for each DFIRM created. For publication of these data, FEMA will provide a simplified version of the database for end users who are not interested in the complete engineering backup data. This Appendix describes the minimum acceptable draft digital data submittal requirements and the specifications for the simplified standard DFIRM database that FEMA will publish. The simplified version of the database is not intended to limit the scope of the GIS data collected and submitted to FEMA. In the future, FEMA plans to archive and make the complete engineering backup data package, or "enhanced database," available in GIS database format to interested users.

To facilitate the ease of use of the DFIRM database, FEMA will avoid the use of abbreviations and codes in the published data where feasible.

Where possible, all mapping and engineering data elements will be linked to physical geographic features that are georeferenced. A GIS has the ability to precisely overlay the mapping and engineering data. This approach supports a wide variety of existing and visionary FEMA engineering and mapping products, such as digital mapping; automated hydrologic and hydraulic modeling, automated mapping, web-based publishing, and direct links between modeling and mapping elements.

The DFIRM database is not intended to be used to produce an exact replica of the printed Flood Insurance Rate Map (FIRM). Instead, the DFIRM database is designed to allow a GIS user access to all of the information conveyed on the FIRM in a way that can best take advantage of the automated analysis capabilities of GIS. FEMA will provide a companion product in the form of a scanned or raster image of the hardcopy DFIRM that will allow users to reprint exact replicas of the whole FIRM or portions of the FIRM.

The DFIRM database will be designed to be usable in a standard Relational Database Management System (RDBMS), but will be software independent. Therefore, the products are defined as flat tables in public domain formats (e.g., ESRI Shapefiles, MapInfo MIF files). Users can import these formats into a wide variety of software packages. They manage GIS data in discrete files, generally organized by data theme. As a result, they do not support the inter table relationships and data integrity enforcement capabilities of an RDBMS. However, the data produced by FEMA will be designed, tested to follow these rules, and fully compatible with an RDBMS.

For Preliminary or Final DFIRMs, all of the tables in the DFIRM database are required if they apply to the DFIRM being created. Some tables, like those that depict coastal features, do not apply to every DFIRM. The Mapping Partner that creates the DFIRM shall ensure that all of the applicable tables in the DFIRM database have been completed and documented in the metadata. Generally, the DFIRM database for a new DFIRM will cover the entire jurisdiction. Detailed specifications for the Preliminary or Final DFIRM database are provided in Section L.3. A summary of the standard DFIRM database tables is provided in Table L-1.

Table L-1. DFIRM Database Table Summary

DFIRM Table Name	Table Type	Table Description
L_Comm_Info	Lookup	Information about each community on the DFIRM
L_Cst_Model	Lookup	Information about coastal engineering models reflected on the DFIRM
L_MT1_LOMC	Lookup	Information about LOMCs on the DFIRM
L_Pan_Revis	Lookup	Information about revisions to each FIRM panel
L_Pol_FHBM	Lookup	Information about revisions to FHBMs for each community
L_Riv_Model	Lookup	Information about non-coastal engineering models reflected on the DFIRM
L_Wtr_Nm	Lookup	Information about hydrographic features on the DFIRM
S_BFE	Spatial	Location and attributes for base flood elevations lines shown on DFIRM
S_CBRS	Spatial	Location and attributes for Coastal Barrier Resource System units on the DFIRM
S_Cst_Tsct_Ln	Spatial	Location and attributes for coastal transect lines shown on the DFIRM
S_DOQ_Index	Spatial	Location and attributes for orthophotography images used for the DFIRM
S_FIRM_Pan	Spatial	Location and attributes for DFIRM hardcopy map panels
S_Fld_Haz_Ar	Spatial	Location and attributes for flood insurance risk zones on the DFIRM
S_Fld_Haz_Ln	Spatial	Location and attributes for boundaries of flood insurance risk zones on the DFIRM
S_Gen_Struct	Spatial	Location and attributes for flood control structures shown on the DFIRM
S_Label_Ld	Spatial	Location and attributes for leader lines on transportation and hydrography labels shown on the DFIRM
S_Label_Pt	Spatial	Location and attributes for transportation and hydrography labels shown on the DFIRM
S_LOMR	Spatial	Location and attributes for LOMRs on the DFIRM
S_Perm_Bmk	Spatial	Location and attributes for benchmarks on the DFIRM
S_PLSS_Ar	Spatial	Location and attributes of sections, townships and ranges on the DFIRM
S_PLSS_Ln	Spatial	Location and attributes section lines, township lines and range lines on the DFIRM
S_Pol_Ar	Spatial	Location and attributes for political jurisdictions shown on the DFIRM
S_Pol_Ln	Spatial	Location and attributes for political boundaries shown on the DFIRM
S_Quad	Spatial	Location and attributes for USGS quadrangle maps covering the DFIRM area
S_Riv_Mrk	Spatial	Location and attributes for river mile markers shown on the DFIRM
L_Stn_Start	Lookup	Location and attributes for starting points for stream distance measurements
S_Trnsport_Ln	Spatial	Location and attributes for roads, railroads and other transportation features shown on the DFIRM
S_Wtr_Ar	Spatial	Location and attributes for hydrography features shown on DFIRM
S_Wtr_Ln	Spatial	Location and attributes for hydrography features shown on DFIRM
S_XS	Spatial	Location and attributes for cross-section lines in the area covered by the DFIRM
Study_Info	Non-spatial	General information about the DFIRM

Mapping Partners that are assigned other tasks for a Flood Map Project will normally produce draft study components and draft DFIRM digital data. For Mapping Partners

that create draft DFIRM digital data, not all the tables in the DFIRM database will apply. These Mapping Partners will often only submit data that cover the geographic area of their work. The tables that are applicable to a specific Flood Map Project will vary, depending on the specific scope of that activity. Table L-2 presents the DFIRM database tables that apply to specific components of a Flood Map Project. The scope of a particular project could include several of these activities and, therefore, all of the tables from each of the activities involved in the project will likely apply. Most Flood Map Projects will include the requirement of a digital base map that meets the requirements as outlined in Appendix K of these Guidelines.

Table L-2. Mapping Partner Activity Table

Digital FIRM Preparation	Digital FIRM Maintenance	Hydrologic and Hydraulic Analyses and Floodplain Mapping	Redelineation of Floodplain Boundaries Using Updated Topographic Data	Refinement of Approximate Zone A Boundaries	Digital Topographic Data Development	Coastal Hazard Analyses and Floodplain Mapping	Digital Base Map Development
L_Comm_Info	L_Comm_Info	L_Riv_Model	L_Riv_Model	L_Wtr_Nm	S_Perm_Bmk	L_Cst_Model	L_Wtr_Nm
L_Cst_Model	L_Cst_Model	L_Stn_Start	L_Stn_Start	S_Fld_Haz_Ar		L_Wtr_Nm	S_DOQ_Index
L_MT1_LOMC	L_MT1_LOMC	L_Wtr_Nm	L_Wtr_Nm	S_Fld_Haz_Ln		S_BFE	S_Gen_Struct
L_Pan_Revis	L_Pan_Revis	S_BFE	S_BFE	S_LOMR		S_CBRS	S_Label_Ld
L_Pol_FHBM	L_Pol_FHBM	S_Fld_Haz_Ar	S_Fld_Haz_Ar	S_Perm_Bmk		S_Cst_Tsct_Ln	S_Label_Pt
L_Riv_Model	L_Riv_Model	S_Fld_Haz_Ln	S_Fld_Haz_Ln	S_Wtr_Ar		S_Fld_Haz_Ar	S_Perm_Bmk
L_Stn_Start	L_Stn_Start	S_Gen_Struct	S_Gen_Struct	S_Wtr_Ln		S_Fld_Haz_Ln	S_PLSS_AR
L_Wtr_Nm	L_Wtr_Nm	S_LOMR	S_LOMR			S_Gen_Struct	S_PLSS_LN
S_BFE	S_BFE	S_Perm_Bmk	S_Perm_Bmk			S_LOMR	S_Pol_Ar
S_CBRS	S_CBRS	S_Riv_Mrk	S_Riv_Mrk			S_Perm_Bmk	S_Pol_Ln
S_Cst_Tsct_Ln	S_Cst_Tsct_Ln	S_Wtr_Ar	S_Wtr_Ar			S_Wtr_Ar	S_Quad
S_DOQ_Index	S_DOQ_Index	S_Wtr_Ln	S_Wtr_Ln			S_Wtr_Ln	S_Trnsport_Ln
S_FIRM_Pan	S_FIRM_Pan	S_XS	S_XS				S_Wtr_Ar
S_Fld_Haz_Ar	S_Fld_Haz_Ar						S_Wtr_Ln
S_Fld_Haz_Ln	S_Fld_Haz_Ln						
S_Gen_Struct	S_Gen_Struct						
S_Label_Ld	S_Label_Ld						
S_Label_Pt	S_Label_Pt						
S_LOMR	S_LOMR						
S_Perm_Bmk	S_Perm_Bmk						
S_PLSS_Ar	S_PLSS_Ar						
S_PLSS_Ln	S_PLSS_Ln						
S_Pol_Ar	S_Pol_Ar						
S_Pol_Ln	S_Pol_Ln						
S_Quad	S_Quad						
S_Riv_Mrk	S_Riv_Mrk						
S_Trnsport_Ln	S_Trnsport_Ln						
S_Wtr_Ar	S_Wtr_Ar						
S_Wtr_Ln	S_Wtr_Ln						
S_XS	S_XS						
Study_Info	Study_Info						

[February 2002]

L.1.1 Spatial Data and Tabular Data

The complete DFIRM database product is a GIS database made up of spatial data describing the location of features on the earth and tabular data that describe the attributes of these spatial features. The tables described in Sections L.4 and L.7 that begin with "S_" have a spatial component associated with them.

FEMA will distribute Preliminary and Final DFIRM databases to end users in GIS formats where the links between the spatial data and the attribute data are inherent in the data structure.

[February 2002]

L.1.2 Draft Digital Data Versus Preliminary and Final Digital Flood Insurance Rate Map Databases

To facilitate the submittal of digital flood hazard mapping data from all Mapping Partners, FEMA has established more flexible requirements for submitting draft DFIRM digital data than for Preliminary or Final DFIRM databases. Section L.2 provides options for submitting draft DFIRM spatial data in a Computer Assisted Drafting and Design (CADD) structure or a GIS structure.

Section L.2 also provides an option for the attribute table structure for DFIRMs that employs a more sophisticated relational structure. This option allows Mapping Partners that create draft DFIRM digital data to take advantage of relational database techniques to ensure data consistency and reduce database size. The Preliminary and Final DFIRM Databases have a simpler structure for ease of use by the general public. The primary difference between the draft table structure and the Preliminary and Final table structure is that domain tables are used in the draft structure and are not used in the Preliminary and Final structure.

The following discussion highlights the differences between the attribute table structure option available for draft DFIRM digital data and the attribute table structure for Preliminary and Final DFIRM Databases. Domain tables (tables in the database that begin with D_) were established to assist FEMA's Mapping Partners in the creation of the draft DFIRM database. These domain tables provide the Mapping Partner with valid or preferred attribute values for specific fields. A domain table also helps minimize entry differences by standardizing the value. For example, without domain tables, one user might enter "floodway" while another user might enter "FLDWY" while completing the FLOODWAY field in the S_Fld_Haz_Ar table. While both of these entries reflect the same idea, the inconsistency between the two forms makes it difficult to group similar features together. Using a domain table ensures that both users enter the same value (i.e., floodway) to describe the same feature. To capture local characteristics not included in the domain table, Mapping Partners also may add and use their own values in the domain table (e.g., a more restrictive locally regulated floodway could be added to the accepted domain values as "Local Floodway"). An example of a domain table is shown in Table L-3.

Table L-3. Sample Domain Table

FLDWAY_LID	FLOODWAY
1000	FLOODWAY
1010	COLORADO RIVER
1020	FLOODWAY CONTAINED IN CHANNEL
1030	FLOWAGE EASEMENT BOUNDARY
1040	STATE ENCROACHMENT
1050	AREA OF SPECIAL CONSIDERATION

Field names that end with "_LID" in the draft DFIRM specification (e.g., FLDWAY_LID) link to a domain table. The "_LID" field contains an integer that matches a value in the first field of the corresponding domain table. The second field of the domain table provides a more descriptive attribute value. In the Preliminary or Final DFIRM database the "_LID" field is replaced by the second field from the domain table (i.e., FLOODWAY). The attribute value stored in the Preliminary or Final DFIRM database is the descriptive attribute value, rather than an integer. The domain tables are not included in the Preliminary or Final DFIRM database. The Mapping Partner creating draft digital data and using domain tables to create the S_Fld_Haz_Ar table, will enter "1000" in that table as the FLDWAY_LID value. In this instance, "1000" stands for "FLOODWAY." When the Preliminary or Final DFIRM database is created, the FLDWAY_LID field becomes FLOODWAY, and the record value of "1000" becomes "FLOODWAY".

When creating the Preliminary or Final DFIRM database the assigned Mapping Partner shall treat the water name lookup table (L_Wtr_Nm) in the draft DFIRM digital data table structure option as a domain table. The surface water feature names stored in the lookup table to must be transferred related fields in other tables.

[February 2002]

L.2 Preparation of Draft Digital Data

L.2.1 General

If the Mapping Partner that creates the draft study components also produces the Preliminary Flood Insurance Study (FIS) report and FIRM, that Mapping Partner does not need to produce separate digital FIS data for the draft study components. Instead, the Mapping Partner will typically be responsible for creating a Preliminary or Final DFIRM database as described in Volume 1, Subsection 1.4.6.6 of these Guidelines and in Section L.3.

The main issues that the assigned Mapping Partner shall consider in the preparation of the digital data are:

- Coordination;
- Standards;
- Horizontal and Vertical Control;
- Data Structure;
- Quality Control;
- Deliverable Format; and
- Metadata.

The portability of the draft digital data is the primary consideration during the Project Scoping phase of a project. This is important because a variety of commercially available mapping and/or survey software packages with varying formats exist. FEMA applications that will use the Mapping Partner's digitally prepared mapping and survey data must be considered when "collecting" the information. To ensure compatibility, the assigned Mapping Partner shall capture the mapping features into a defined schema. The assigned Mapping Partner shall arrange the draft digital data within the draft DFIRM data files in such a manner that features are separated into a GIS table structure or a CADD layer/level and attribute structure. This Appendix provides standard schema for a Mapping Partner to follow that will eliminate the need to separate the spatial elements.

In addition, the digital data must be capable of being translated into a common spatial data exchange format. Normally, the specific data format and structure will be coordinated with the Project Team during the Project Scoping Meeting or immediately afterwards by technical staff.

A major aspect of GISs is horizontal and vertical position on the earth. Mapping data must be referenced to a standard coordinate system, employ a standard projection, and specify both the horizontal and the vertical datums used. These positional references are established prior to the field data collection and topographic mapping phase of the project. All planimetric and topographic features must be collected and referenced to this coordinate system and projection. See Appendix A of these Guidelines for a detailed discussion of aerial mapping and surveying specifications, which includes horizontal and vertical control for new mapping. Also see Appendix B of these Guidelines for a discussion of vertical datum selection and conversion.

Considerations for transfer of digital data also must include the file structure of the data, the transfer medium, the export/import device and the operating systems of the host and receiving systems (e.g., MS Windows, NT, UNIX).

[February 2002]

L.2.2 Coordination

The assigned Mapping Partner must coordinate with the FEMA Lead and other Project Team members before beginning a draft digital submittal. The coordination may occur during the Project Scoping Meeting (see Volume 1, Subsection 1.3.2 of these Guidelines) or during a separate meeting immediately afterward. This meeting should serve to coordinate the digital capture of the restudy data and facilitate the production of digitally generated FIRMs in a timely fashion. Data format is an important consideration to be discussed prior to data capture, as changing data format after the fact can be both time consuming and costly.

For most Flood Map Projects, the assigned Mapping Partner shall submit to FEMA a sample of the digital files being prepared when approximately 10 percent of the project has been completed. This will enable FEMA or another Mapping Partner selected by FEMA to review and comment on the digital data files, and will enable the submitting Mapping Partner to implement any modifications, if required, to the digital capture procedures at an early production stage.

A meeting between the Mapping Partner that produces the draft study components, FEMA, and the Mapping Partner that produces the Preliminary and Final DFIRM may be required at the interim submittal stage, for all parties to be familiar with any unique conditions in the data files.

Before beginning work to produce draft digital data, the assigned Mapping Partner shall coordinate with FEMA to determine if public domain software has been developed, and is available, for whatever hardware platform is chosen by the Mapping Partner for the digital work. Software may be available to assist in GIS table creation, data capture, data coding, layer/level assignment, quality control, and plotting.

[February 2002]

L.2.2.1 Data Sources

As specified in Volume 1, Section 1.3 of these Guidelines, a Mapping Partner must perform initial research to avoid duplication of effort during a Flood Map Project. This is especially critical for

digitally prepared study/restudy components because data collection is expensive. The assigned Mapping Partner shall identify and use existing digital data whenever possible, while still meeting required specifications and quality of work.

As part of the initial coordination effort, the Mapping Partner that produces the draft digital study/restudy components shall identify available digital data and obtain datasets and hardcopy plots as necessary for study/restudy areas. Potential sources of digital base map or floodplain boundary data may be State, county, or local government agencies responsible for GIS, planning agencies or real estate assessment agencies. Digital floodplain data also may be available from FEMA, if the area has been previously converted to digital format. Requirement for base maps are specified in Appendix K.

If existing data are available and used by the Mapping Partner that produces the draft digital study/restudy components, that Mapping Partner shall restructure the data to conform to one of the digitizing specification options listed below. If specific arrangements are made with the FEMA Lead—usually, either the FEMA Regional Project Officer or the Project Officer (PO) at FEMA Headquarters—to use another data schema, the assigned Mapping Partner shall provide complete documentation of the spatial data structure and attribute tables.

As part of data collection, coordination and submittal, the assigned Mapping Partner shall document the data sources, date of collection or digitizing, scale of digitizing, projections, coordinate systems, horizontal datum and vertical datum of all of the digital data used and submitted. For each data source used, the assigned Mapping Partner shall add a Source Citation entry to the DFIRM metadata file in the Lineage section under Data Quality. Within the metadata file, each data source is assigned a Source Citation Abbreviation as shown in Table L-4.

Table L-4. Source Citation Abbreviations

Source Citation Abbreviation	Use
BASE	For all base map sources (includes digital orthophotography, roads, railroads, airports, hydrography, U.S. Public Land Survey System (PLSS), political, military, park, forest and other lands)
FIRM	For features extracted from the existing FIRM
FHBM	For features extracted from the existing Flood Hazard Boundary Map (FHBM)
FBFM	For features extracted from the existing Flood Boundary and Floodway Map (FBFM)
LOMC	For information derived from a Letter of Map Change (LOMC)
FIS	For information taken from a previously published FIS report, including Floodway Table and Flood Profiles
STUDY	For information developed for the current Flood Map Project
TSDN	For any information taken from the Technical Support Data Notebook (TSDN) (used for existing backup information in FEMA's archives not published on previous FIRM)

Each source citation abbreviation for a distinct data source should be numbered (e.g., BASE1, BASE2, BASE3). All spatial tables in the standards below have a SOURCE_CIT field. This field should be populated with the Source Citation Abbreviation from the metadata file that applies to the related spatial feature.

[February 2002]

L.2.3 Standards

Maps and spatial data used for flood hazard analyses, floodplain boundary delineations, and FIRM compilation must meet all requirements specified in these Guidelines. The assigned Mapping Partner shall obtain or create these materials and submit these materials to FEMA, and shall ensure that the accuracy of the data in the submitted files, at a minimum, meets or exceeds FEMA's base map and FIS mapping information standards. The requirements for the flood hazard analyses, floodplain boundary delineations, and the base map are detailed in Volume 1, Section 1.4, Appendix A, and Appendix K of these Guidelines, respectively.

[February 2002]

L.2.4 Horizontal and Vertical Control

The assigned Mapping Partner shall create all digital data in a system that is capable of referencing the data to a geographic coordinate system and projection. The data must be in a State Plane coordinate system and associated projection or in the Universal Transverse Mercator (UTM) projection and coordinate system. The assigned Mapping Partner shall obtain approval for

variations from these two options from the FEMA Lead in advance. See Appendix K of these Guidelines for information on raster base maps in other projections and coordinate systems.

In the event that the county or other jurisdiction being mapped lies in more than one projection and coordinate system zone, the assigned Mapping Partner shall ensure that all digital data submitted are projected in the zone that contains the largest portion of the jurisdiction in a single zone. The assigned Mapping Partner shall not use multiple State Plane or UTM zones within a single submittal. The assigned Mapping Partner may compile data in another zone, particularly if this facilitates higher positional accuracy of the data, reproject the data to the chosen zone for the jurisdiction being mapped, and merge the reprojected data with the rest of the data.

The assigned Mapping Partner shall compile all horizontal information on either the North American Datum of 1927 (NAD27) (Clarke 1866 ellipsoid) or North American Datum of 1983 (NAD83) (Geodetic Reference System 1980 -- GRS 80 ellipsoid or revisions thereof). However, it is critical that horizontal datums not be mixed within a Flood Map Project. See Appendix A of these Guidelines for details on horizontal datum requirements.

The assigned Mapping Partner shall reference all vertical information to either the National Geodetic Vertical Datum of 1929 (NGVD29) or the North American Vertical Datum of 1988 (NAVD88). However, the NGVD29 must not mix vertical datums within a Flood Map Project. See Appendix B of these Guidelines for details.

[February 2002]

L.2.5 Digital Data Structure

Digital files must be prepared using a pre-defined system or schema that has been consistently used throughout. The layer/level or attribute assigned to a spatial element must be consistent and the information accessible to all users. The data must be organized in one of the data structures described in this Appendix and provided in one of the acceptable data formats unless specific arrangements are made with the FEMA PO.

[February 2002]

L.2.5.1 Tiling

FEMA requires that all digital data be in one single file or a series of thematic files that cover the entire geographic area being mapped instead of individual small tiles that cover limited geographic areas. The assigned Mapping Partner shall obtain approval for any variations to this requirement from the FEMA Lead.

[February 2002]

L.2.5.2 Topology

The assigned Mapping Partner shall ensure that vector data files must meet the following data structure requirements:

- Digitized linework must be collected at a reasonably fine line weight.
- Only simple linestrings or simple linear elements may be used for all linework.
- Line features must be continuous (no dashes, dots, patterns, or hatching).
- CADD files (e.g., MicroStation DGN files or AutoCAD DWG files) must not contain curves, B-splines, arcs or nested cells.
- CADD files must not contain annotation generated from a database; the annotation must be placed as text. GIS files (e.g. ArcInfo coverages or ArcView Shape files) may contain annotation and/or database attributes.
- Vectors may not cross other vectors within the same theme and all intersecting vectors must end at intersections.
- Area spatial features for a given theme must cover the entire study area without overlaps, under laps or sliver polygons between adjacent polygons.
- Files must be free of discontinuities such as overlapping lines, gaps, "turn backs," dangling lines and duplicate elements.
- Spatial files must not contain any linear or area patterns.
- Gaps or overshoots between features that should close must be eliminated.

Logical consistency describes certain node-line-area relationships internal to the digital data. The Node-line-area relationship requirements that the assigned Mapping Partner must meet include the following:

- Areas will be represented by closed polygons, without overshoots or undershoots.
- Unattributed polygons are not permitted, including "sliver" polygons that result from poor digitizing methods.
- Unnecessary nodes and vertices must be avoided.
- Vertices must be placed conservatively when designing features so that only the minimal number of vertices or nodes is used to create the desired shape with appropriate smoothness (e.g., a straight line will be defined with two nodes only).
- Lines must begin and end at nodes.
- Lines must connect to each other at nodes.
- Lines must not extend through nodes.

[February 2002]

L.2.5.3 Edgematching

The matching of features along the "edge" of a hardcopy map or tiles of digital data is critical in the creation of digital map products. Proper edgematching will ensure that a digital map product can be used as a seamless data layer in a GIS. As edges are digitized, features that cross the edge should snap together to form a seamless feature.

The assigned Mapping Partner shall ensure that all submitted digital data is tied into any existing digital data files so that a seamless transition is effected. The assigned Mapping Partner may produce new digital data to reflect new flood hazard information or to convert effective flood hazard information to digital format depending on the scope of the Flood Map Project. Hardcopy deliverables must reflect both the new digital data and any existing digital data previously prepared by FEMA. If no existing digital floodplain data are available from FEMA, deliverables must reflect the new digital data only. The assigned Mapping Partner must ensure that proper edgematching is performed at each step of the data creation process. If the Mapping Partner digitizes separate hardcopy sheets to produce the draft DFIRM data, the Mapping Partner must check that all features that cross the boundaries between separate sheets are smooth and continuous at the sheet boundaries. Likewise, the Mapping Partner must check that all features crossing jurisdiction boundaries are smooth and continuous at the jurisdiction boundary and that all features at the boundary of the draft DFIRM digital data submitted matches the contiguous information on the existing published FIRMs.

- The following are edgematching problems that the assigned Mapping Partner must avoid:
- **Disconnects.** Disconnects occur when the linework for features does not connect, either by being too short or too long at the source maps' edge.
- **Jogs**: Jogs occur when a common feature on adjoining maps does not line up seamlessly.
- **Missing Features**: Missing features are those that appear on one source map, but not on the adjacent map. The features may be missing from one map because of a variety of reasons, such as (1) different dates of the two maps; (2) an error in one map; (3) a difference in interpretation by the cartographers of the two maps; (4) differing scales of the two source maps, or (5) adjacent data not available.
- **Different Representation of Features**: Different representation of features occurs when features are represented differently on the source maps. For example, a road is a double line on one, and a single line on the other.

[February 2002]

L.2.5.4 Coincident Features

Coincident features are those that share the same location or boundary, such as a flood zone boundary and a floodwall. These coincident features must superimpose, vertex (shape point) for vertex, within the files. If not automated properly, it could appear that the flood zone ends before

the wall, leaving a strip of land on the waterside of the floodwall that is not in the flood zone. A lack of alignment can cause problems with digital files.

For a new DFIRM, the assigned Mapping Partner shall create coincident features by digitizing the graphic features only once. The assigned Mapping Partner shall create additional copies of coincident features by copying part of the first feature to create the relevant portion of the second, when necessary. This will ensure that the lines match perfectly.

In particular, the following pairs of tables have both area features and line features: S_Fld_Haz_Ln/S_Fld_Haz_Ar, S_Pol_Ln/S_Pol_Ar, and S_PLSS_Ln/S_PLSS_Ar. For these feature datasets, two tables are defined because they have attributes that apply to the entire area and attributes that apply to portions of the boundaries of these areas. However, the spatial elements that make up these features must be identical. All elements in the S_Fld_Haz_Ln table must match exactly with the boundaries of the elements in the S_Fld_Haz_Ar table. The same is true for the other two pairs of tables. For draft DFIRM digital data submitted in a spatial data format that supports both area and line attributes for the same spatial file, the assigned Mapping Partner shall submit a single spatial file with both sets of attributes.

[February 2002]

L.2.5.5 Precise Features

The position of horizontal control features of the DFIRM products will be based on published standards. The assigned Mapping Partner shall not re-digitize these control features, but rather the assigned Mapping Partner shall use the exact coordinates in the published standards. Candidate sources of control points include:

- U.S. Geological Survey 7.5-minute series quadrangle map corner coordinates;
- Coordinate grid; and
- Bench mark coordinates from the National Geodetic Survey or local control network.

[February 2002]

L.2.5.6 Data Compilation

Existing digital data may affect the choice of scale for data compilation. If base mapping is available at a scale greater than 1" = 400' (e.g. 1" = 200') the assigned Mapping Partner may choose to compile and digitize the revised data developed during the Flood Map Project at the base map scale.

FEMA's goal is to develop digital data that are as accurate as possible. In general, the most accurate data source must be relied upon to reference other features compiled onto the map. This may mean that, in some circumstances, floodplain boundary delineations made on very high-resolution topographic maps may appear slightly misplaced on a less accurate base map. However, if the base map meets FEMA standards, these differences should be very small. If application of

this approach creates significant visual problems with the floodplain boundary delineations on the base map selected, the assigned Mapping Partner shall resolve the issue with the FEMA Lead.

Likewise, when high accuracy data are collected for a Flood Map Project, it is FEMA's goal to maintain the accuracy of those data. For example, cross-section line features must correspond as closely as possible to the actual field survey locations. Often, the assigned Mapping Partner must graphically extend or reshape that end of a cross section for satisfactory cartographic display. When this is necessary, the Mapping Partner shall perform it as a graphic operation for hardcopy map production. The Mapping Partner shall not modify the digital spatial data that depict the true locations of the surveyed cross sections.

[February 2002]

L.2.5.7 Digitizing

All features must be digitized in their true positions as line strings or simple linear elements. Digitizing must be performed from stable base materials.

How well the registration control points line up to the map to be digitized is an important measurement when digitizing maps. The measurement of fit is sometimes called the Root Mean Square Error (RMSE). The RMSE value represents the amount of error between original and new coordinate locations calculated by the transformation process. The lower the RMSE, the better the fit. The RMSE must be no more than 0.003 inch.

[February 2002]

L.2.5.8 Base Map and Flood Hazard Data

Base map features are physical features like roads, railroads, rivers, lakes, levees, and bench marks, that map users may rely on to locate an area of interest on the FIRM. Flood hazard data are flood insurance risk zones, Base Flood Elevations (BFEs), cross-section locations, and hydraulic structures that depict the results of flood hazard analyses on the FIRM. Some physical features such as surface water features and hydraulic structures are used in the performance of the flood hazard analysis and may be grouped in either category. Table L-5 presents the features for the base map and the flood hazard data.

Table L-5. Base and Flood Hazard Data Tables

Base Map Tables	Flood Hazard Data Tables
L_Wtr_Nm	L_Comm_Info
S_DOQ_Index	L_Cst_Model
S_Gen_Struct	L_MT1_LOMC
S_Label_Ld	L_Pan_Revis
S_Label_Pt	L_Pol_FHBM
S_Perm_Bmk	L_Riv_Model
S_PLSS_Ar	L_Stn_Start
S_PLSS_Ln	S_BFE
S_Pol_Ar	S_CBRS
S_Pol_Ln	S_Cst_Tsct_Ln
S_Quad	S_FIRM_Pan
S_Trnsport_Ln	S_Fld_Haz_Ar
S_Wtr_Ar	S_Fld_Haz_Ln
S_Wtr_Ln	S_Gen_Struct
	S_LOMR
	S_Riv_Mrk
	S_XS
	Study_Info

The purpose of the base map is to present an accurate depiction of the relationship between the results of the flood hazard analyses and the physical features on the ground. Floodplain boundaries are typically delineated on a topographic map and may be subsequently transferred to the base map. The topographic and base map data may be derived from the same sources. The spatial accuracy of both the topographic and the digital base map is critical to maintaining the accuracy of the floodplain delineations.

The digital base map for a Flood Map Project is to be identified during the Project Scoping phase of the project. The assigned Mapping Partner shall use the digital base map in conjunction with the topographic data when preparing the floodplain boundary delineations. For a complete discussion of base maps, see Appendix K of these Guidelines.

For base map files, layers/levels or attributes are provided below for each data structure option. The Mapping Partner should insure that all Draft DFIRM Data files conform to the specifications below. An exception to this is preexisting base map files for transportation and water features, which may retain their normal structure. More detail is provided in the below table descriptions. The standard table formats included below should be used when new base map data creation is included in the Mapping Partner scope of work. If any data from the Mapping Partner are not in one of the structures below, the data must be separated by layers/levels or by attributes. If the base map data are not structured following one of the data schema listed below, detailed documentation of the data structure must be included.

The files produced by a the Mapping Partner that creates draft digital study/restudy components shall typically cover only the area that is revised as a result of the Flood Map Project.

[February 2002]

L.2.5.9 Computer Assisted Drafting and Design or Geographic Information System Preparation

A GIS database normally contains both spatial features and attribute records in the same file or in tables that can be easily related by the GIS system. A CADD system usually does not manage attribute records associated with each spatial feature as easily. As software evolves, there is less distinction between the two technologies. Users of these two systems still tend to apply these technologies in the traditional way. As a result, it is assumed that fundamentally different approaches will be used based on whether the Mapping Partner submits draft DFIRM data in CADD or GIS format. FEMA prefers to have DFIRM data submitted in GIS format. The CADD option is available for Mapping Partners who are unable to submit data in GIS format.

Mapping Partners that submit digital data in GIS format shall separate the spatial data into individual tables or files for each data theme created (e.g., roads are stored in a separate file from flood zones that are in a separate file from political boundaries). The Mapping Partner may store attribute data in the same GIS file as the associated spatial features, or in a parallel table structure in an RDBMS and linked to the spatial features by the primary key for each table. Both the spatial data and the attribute data must have the same primary key field.

Mapping Partners that submit data in CADD format shall store the spatial data in a single file with each data theme stored on a separate layer/level and identified by a color number within the file. See Subsection L.2.2.4.11 for detailed specifications. Each spatial feature in the CADD file must be attributed or tagged with a primary key that can be linked to the DFIRM attribute data for that feature. The Mapping Partner may store attribute data in the DFIRM table structure in an RDBMS or in individual data files in a standard database or spreadsheet format. Attribute data must be linked to the spatial features by the primary key for each table. Both the spatial data and the attribute data must have the same primary key field.

[February 2002]

L.2.5.10 Table Structure

Each DFIRM database table has a primary key field defined. This field is normally the table name followed by "_ID". The Mapping Partner that creates the digital data must populate these fields. Normally, the assigned Mapping Partner shall number the features in each table sequentially using this field; however, the assigned Mapping Partner may choose another method provided that the method is logical, documented, consistently implemented, and results in a unique ID value for each spatial feature.

Regardless of whether the draft DFIRM digital data is submitted in CADD or GIS format, the assigned Mapping Partner must submit all of the applicable DFIRM database attribute tables. Attribute data must be linked to the spatial features by the primary key for each table. Both the spatial data and the attribute data must have the same primary key field. The Mapping Partner may choose to follow either the table structure defined in Section L.4 for draft digital data, or the table structure in Section L.7 for Preliminary and Final DFIRM databases. Regardless of the table structure selected, the Mapping Partner shall ensure that the applicable fields use the appropriate values from the associated domain tables and that these values are treated consistently across all tables.

For a field that does not apply, the value must be Null (i.e. the field must be left empty, not set to zero). The Mapping Partner shall use the value zero only when an attribute has the specific value of zero. If a data format does not support null values (e.g. numeric fields in ARC/INFO Coverage format) then a value –9999 shall be used in place of null.

Because of production limitations and with approval from the FEMA Project Officer, the mapping partner may leave some fields blank that would otherwise be required by this specification. In this case, the mapping partner should insert the value "NP" for not populated.

Text fields must follow the capitalization standards that apply to the display of that information on the FIRM.

Date fields in the DFIRM database are stored in the native date format for the data format in which table is distributed. Not all of the database formats used for the DFIRM database support date values in the same way. The time of day is not stored or is set to zero depending on the structure of the date object in a particular data format. Where possible the output format of the date is set to YYYYMMDD.

In the detailed table documentation in Sections L.4 and L.7, each field name is followed by a letter code as follows:

- R – Required for all records.
- A – Required if applicable to the described spatial feature.

See Section L.4 for specific requirements for each table for draft digital data submittal.

[February 2002]

L.2.5.11 Spatial Files for Computer Assisted Drafting and Design Format

Mapping Partners that submit data in CADD format shall use the layer/level schema shown in Table L-6. No additional feature categories may be added to any layer/level. This ensures that data will not be miscoded in later processing steps or that time will not be spent separating features. To include feature categories that are not specified in the schema below (e.g., watersheds and sub-basins, land use classifications, building footprints), the Mapping Partner shall submit a second file containing these features and documentation of the layer/level schema.

The main purpose of this schema is to provide a logical separation of data themes by layer/level and color. The assigned Mapping Partner shall name each layer/level following the convention provided in Table L-6. The color numbers in the following schema are also important. The layer/level and color number are used to separate feature types. The actual color used is not important for the digital file. It is important that the correct color number is used. The correct colors, line weights, and other cartographic details for a particular feature on the finished FIRM are specified in Appendix K of these Guidelines. Depending on the software used to create the draft DFIRM digital data, the Mapping Partner that creates the Preliminary or Final DFIRM may be able to provide file templates and other tools to facilitate reproduction of the graphic specifications. Coordination should take place between the Mapping Partners and FEMA shortly after the Project Scoping Meeting. The layer/level and color requirements for CADD submittals of draft digital data are presented in Table L-6. See Appendix K for more detailed descriptions of these features and the Glossary for acronym definitions.

Table L-6. Layer/Level Schema Requirements

DESCRIPTION	LEVEL NUMBER	LEVEL NAME	COLOR
Flooding Elements			
Floodway Boundary	1	floodway	1
Colorado River Floodway	1	floodway	2
Area of Special Consideration	1	floodway	3
1% Flood Boundary	2	100-year	4
0.2% Flood Boundary	3	500-year	5
1%/0.2% Flood Boundary	4	100_500-year	6
1% Flood/Floodway Boundary	5	100_fldway	7
1%/0.2%/Floodway Boundary	6	100_500_fldway	8
Zone D Boundary	7	zoned	9
Zone Break	8	zonebreak	10
Limit of Floodway	9	limitfldway	11
Limit of Study	10	limitstudy	12
Limit of Detailed Study	11	lods	13
End of Spatial Extent	12	endspatial	14
BFE	13	bfe	15
Cross Section	14	xs_transect	16
Transect	14	xs_transect	17
Interpolated BFE	15	intbfe_intrxs	18
Intermediate Cross Section	15	intbfe_intrxs	19
Apparent Limit	16	applimit	20
Floodway Shape/Hatch	17	shapefldway	21
1% Flood Hazard Shapes	18	shape100	22
0.2% Flood Hazard Shapes	19	shape500	23
BFE Text	20	bfetxt	24
Cross Section Hexagon	21	xsectxt	25
Limit of Flooding Text	22	limittxt	26
Zone Text	23	zonetxt	27
Flowage Easement Line	24	flowage	28
State Encroachment Line	24	flowage	29
Hydro Elements			
Perennial River/Stream	25	hydro	30
Intermittent River/Stream	25	hydro	31
Shoreline/Coastline	25	hydro	32
Lake	25	hydro	33
Surface Water	25	hydro	34
Reservoir	25	hydro	35
Profile Base Line	25	hydro	36
Swamp	25	hydro	37
Channel	25	hydro	38
Channel Contains 1% Flood	25	hydro	39
Channel Contains 0.2% Flood	25	hydro	40
Ditch	25	hydro	41
Glacier	25	hydro	42

Hatchery	25	hydro	43
Race	25	hydro	44
Wash	25	hydro	45
Waterfall	25	hydro	46
Water Separation Line	25	hydro	47
Bog	25	hydro	48
Retention Pond	25	hydro	49
Tailings Pond	25	hydro	50
PBL	25	hydro	51
Water Feature Text	26	draintxt	52
Landform/Island Text	27	islandtxt	53
1000 Foot Marker & Text	28	rivermk	54
River Mile Marker & Text	28	rivermk	55
Structure Elements			
Weir	29	weir_dam	60
Dam	29	weir_dam	61
Levee	30	levee	62
Culvert	31	culvert	63
Culvert Contains 1% Flood	31	culvert	64
Culvert Contains 0.2% Flood	31	culvert	65
Headwalls/Wing walls	31	culvert	66
Bridges	32	bridge	67
Footbridge	32	bridge	68
Pier	33	other_struct	69
Dock	33	other_struct	70
Jetty	33	other_struct	71
Aqueduct	33	other_struct	72
Dike	33	other_struct	73
Fish Ladder	33	other_struct	74
Flume	33	other_struct	75
Gate	33	other_struct	76
Lock	33	other_struct	77
Penstock	33	other_struct	78
Seawall	33	other_struct	79
Structure Text	34	structxt	80
Cobra/OPA Elements			
Cobra Boundary	35	cobra	90
Otherwise Protected Areas	36	opa	91
Cobra Shapes	37	shapecobra	92
OPA Shapes	38	shapeopa	93
Cobra/OPA Notes	39	cobratxt	94
Political Elements			
Corporate Limits	40	corporate	100
Extraterritorial Boundary	40	corporate	101
Area Not Included	40	corporate	102
County Boundary	41	county	103
State Boundary	42	state_intl	104

International Boundary	42	state_intl	105
Political Boundary Text	43	polbdtxt	106
City/Borough/Township Name	44	polareatxt	107
Park Boundary	45	park	108
Forest Boundary	45	park	109
Reservation Boundary	45	park	110
Park/Forest/Reservation Text	46	parktxt	111
Urban Growth Boundary	47	other_juris	112
MUD Boundary	47	other_juris	113
LID Boundary	47	other_juris	114
Transportation Elements			
Primary Roads	48	majorrds	120
Secondary Roads	49	minorrds	121
Trail	50	other_rds	122
Undefined Roads	50	other_rds	123
Road Tunnel	50	other_rds	124
Ford	50	other_rds	125
Road Text	51	roadtxt	126
Route & Highway Symbols	51	roadtxt	127
Railroad	52	railroad	128
Abandoned Railroad	52	railroad	129
Undefined Railroad	52	railroad	130
Dismantled Railroad	52	railroad	131
Railroad Tunnel	52	railroad	132
Railroad Text	53	rrtxt	133
Airport/Landing Strip & Text	54	airport	134
Ferry	54	airport	135
Grid Elements			
FIRM Neatline	55	map_neatlines	140
Quad Neatline	55	map_neatlines	141
Quarter Section Lines	56	plss	142
Range Lines	56	plss	143
Township Lines	56	plss	144
Primary Grid & Labels	57	prigrid	145
Secondary Grid & Labels	58	secgrid	146
DOQ Neatline	63	nonplot	147
Misc Elements			
NGS Bench Marks	59	ngs	150
NGS Bench Mark Text	60	ngstxt	151
Gaging Station	61	gaging	152
Landmark	61	gaging	153
Misc Text & Notes	62	misctxt	154
LOMR Box	63	nonplot	155
Non-Plotted Level	63	nonplot	200+

[February 2002]

L.2.6 Quality Control

Digital files must be structured according to one of the pre-established schemas. This allows easy exchange of data between FEMA and Mapping Partners. Files must be free of duplicated elements and complex linestrings. The data must be horizontally controlled and referenced to the appropriate horizontal and vertical datums. All digitizing must be done carefully and in conformance with FEMA accuracy standards. For these reasons, the assigned Mapping Partner shall perform a thorough quality control (QC) review prior to submitting data to FEMA. FEMA will review the data provided by the Mapping Partner using automated and interactive techniques.

The following items must be included in the QC review of a verification plot to ensure that all deliverables meet minimum quality standards:

- All required features have been included.
- The data are correctly referenced to a State Plane or UTM grid coordinates.
- The correct datum has been used and is clearly indicated.
- All digitized linework is within 0.005 inch of its compiled location if digitizing is performed from a hardcopy manuscript. Plotted linework does not show gaps between plotted lines and compiled lines when plots and compilation manuscripts are overlaid.
- Character of features has been maintained (e.g., straight lines are straight; curves are curved).
- No obvious discontinuities exist (e.g., gaps, overshoots).
- Required labels (text) have been placed.
- All plotted data agree with the flood hazard analyses (e.g., regulatory floodway widths match) and cross-section labeling agrees with the appropriate computer model.
- Deliverable plots meet the requirements specified in Subsection L.2.2.6 for deliverables.
- Feature attributes are correct.
- Pseudo-nodes or shape points have been kept to the minimum required to maintain the correct character of the features.

[February 2002]

L.2.7 Deliverables

A complete draft DFIRM data submittal will include the following mapping items:

- Digital base map files and DFIRM database files;
- Digital Elevation Model (DEM) or Digital Terrain Model (DTM) if used;

- Work maps (plots);
- Map index; and
- Metadata file.

After completion of an internal QC review process, the Mapping Partner shall submit materials to FEMA in TSDN format. See Appendix M of these Guidelines for detailed requirements for the TSDN.

[February 2002]

L.2.7.1 Hardcopy Deliverables

Each submittal must include hardcopy copies of the work maps. For details on the format and content for work maps, see Volume 1, Section 1.4 of these Guidelines.
[February 2002]

L.2.7.2 Digital Deliverables

The digital data deliverables must clearly identify the data structure option that was used. To facilitate data processing, the assigned Mapping Partner shall submit Federal Geographic Data Committee (FGDC)-compliant metadata as specified in Subsection L.2.2.7. In addition, Mapping Partner shall completely fill out the checklist presented in Section L.5 and include it with any digital data submitted to FEMA. If Mapping Partner's system output capabilities do not fall within these categories, the Mapping Partner shall obtain approval for an exception to these requirements before submitting digital files to FEMA for review.

Raster Data

Digital orthophoto files may be submitted in Tagged Image File Format (.TIF), Georeferenced TIF (GeoTIF), Band Interleaved by Pixel (.BIP or .BIL), or Joint Photographic Experts Group (JPEG) format. Raster files must be accompanied by a file that provides coordinate information that will allow the images to be georeferenced (e.g., a tfw file).

Vector Data

Mapping Partners may submit vector data in the following file formats:

- ARC/INFO export file – E00;
- ArcView shape file – SHP;
- MicroStation design file – DGN;
- MapInfo interchange format – MIF;
- MapInfo native table format – TAB;
- AutoCAD drawing file – DWG;
- Drawing exchange format – DXF;
- Digital Line Graph – DLG; or
- Spatial Data Transfer Standard – SDTS.

Transfer Media

Mapping Partners must submit files on one of the following electronic media:

- CD-ROM (preferred);
- Zip disk;
- 8mm tape;
- 3 ½" diskette;
- Electronic transfer to File Transfer Protocol (FTP) site; or
- Electronic transfer by E-mail (for files under 2 MB).

As technology changes or in special situations, other media may be acceptable if coordinated with FEMA and the Mapping Partner receiving the data.

If a file compression utility was used, provide the utility to uncompress the files.

File Naming

Wherever possible, the assigned Mapping Partner shall use the table names from the DFIRM database specifications as the file names for draft DFIRM data files with an extension appropriate to the file format.

The draft DFIRM digital data files should be stored in a directory named for the state abbreviation, then named for the county (or county equivalent) or community covered by the FIS. Under each jurisdiction, there should be a separate directory for the standard DFIRM data files, a directory for digital orthophotos, if applicable, and a directory for any enhanced DFIRM database information

provided. All the files for each data format are stored together in a subdirectory named for the data format. For example, Montgomery County, Maryland, if submitted in ESRI Shapefile format would be stored as:

\MD\Montgomery_Co\DFIRM_DB\ArcShape\ - Directory contains all draft DFIRM data files in ESRI Shapefile format.

\MD\Montgomery_Co\DOQ\ - Directory contains all orthophoto files if used.

\MD\Montgomery_Co\Document\ - Directory containing metadata and a readme file.

\MD\Montgomery_Co\Enhanced_DB\ArcShape\ - Directory contains any enhanced DFIRM data files in ESRI Shapefile format.

For a single jurisdiction DFIRM, the structure would be the same, with the jurisdiction name instead of the county name. For example, for Dallas, Texas, the directory structure would begin with:

\TX\Dallas_City_Of\

Data Identification Requirements

Complete documentation of file names, sizes, and contents is required. All digital media submitted must be labeled with at least the following information:

- Mapping Partner name;
- Community name and state for which the FIS was prepared;
- The date the files were written to the media;
- Details that are necessary to read the media. (e.g., submittals on 8mm tape should include the tape writing format, density and command syntax used); and
- A brief description of contents.

The digital media must clearly identify the data structure used. If any variation from these specifications is used, the assigned Mapping Partner shall submit a comprehensive list of the level or attribute structure of the affected data. This particularly applies to base map data, which may often be in a non-standard data structure. The Mapping Partner also shall provide thorough documentation for these files.

[February 2002]

L.2.8 Metadata

To facilitate the use of these data and the transfer of data files between users, the assigned Mapping Partner shall prepare and submit a metadata file with all digital data submittals. Only one metadata

file is required for each Flood Map Project, however, in this one file, the assigned Mapping Partner must distinguish between the different origins of the various datasets included. The Metadata file shall follow the *Content Standard for Digital Geospatial Metadata (version 2.0)*, FGDC-STD-001-1998. Details of this standard are available at www.fgdc.gov. A sample metadata file for draft digital data is presented in Section L.6.

The metadata file must include a description of the source material from which the data were derived and the methods of derivation, including all transformations involved in producing the digital files. The description shall include the dates of the source material and the dates of ancillary information used for update. The date assigned to a source must reflect the date that the information corresponds to the ground. If the assigned Mapping Partner does not know this date, then the Mapping Partner may use a date of publication and indicate as such. Each data source in the metadata file must be assigned a Source Citation Abbreviation as described in Subsection L.2.2.1.

The assigned Mapping Partner shall describe any database created by merging information obtained from distinct sources in sufficient detail to identify the actual source for each element in the file.

Because not all DFIRM database tables are included in every draft DFIRM digital data submittal, the Overview Description Section of the Entity and Attribute Information of the metadata file must include a list of all DFIRM database tables included in the submittal.

An example of a metadata file for draft DFIRM digital data is presented in Section L.6 of this Appendix. Portions of the file that are double underlined typically vary with each Mapping Partner's submittal. In addition, the Mapping Partner should modify or replace any other portions of the metadata file to fully document the data submitted.

[February 2002]

L.3 Preparation of Preliminary and Final Digital Flood Insurance Rate Map Databases

L.3.1 General

FEMA's goal is to distribute consistent GIS versions of the flood hazard information for new DFIRMs. Therefore, Preliminary or Final DFIRM databases created by Mapping Partners must be consistent in file structure and in data format. The Mapping Partner that produces the draft DFIRM digital data must coordinate with the Mapping Partner that produces the Preliminary or Final DFIRM and the Preliminary or Final DFIRM database and ensure that the finished data meet applicable FEMA standards, include horizontal and vertical control, are documented properly, and conform with the standard data structure. The Mapping Partner that produces the Preliminary or Final DFIRM also must ensure that the Preliminary or Final DFIRM database meets FEMA specifications and that it is delivered to the FEMA Map Service Center in the proper formats.

[February 2002]

L.3.2 Coordination

One of the responsibilities of the Mapping Partner that produces the Preliminary or Final DFIRM database is to ensure that the Preliminary or Final DFIRM database is consistent. The Mapping Partner that produces the Preliminary or Final DFIRM database must assist FEMA with coordination of the draft DFIRM digital data submittal. The coordination may occur as part of the Project Scoping Meeting or as a separate meeting immediately afterward. This meeting must serve to coordinate the digital capture of the data and to facilitate the production of a digitally generated FIRM in a timely fashion. Data format is an important consideration to be discussed before data capture, as changing the data format after the fact can be both time consuming and costly.

The Mapping Partner that produces the draft DFIRM digital data shall submit to FEMA a sample of the digital files being prepared when the project is 10-percent complete. The Mapping Partner that produces the Preliminary or Final DFIRM database will assist FEMA to review the data files for any recommended modifications to digital capture procedures to be implemented by the Mapping Partner that produces the draft DFIRM digital data.

[February 2002]

L.3.2.1 Data Sources

As specified in Volume 1, Section 1.3 of these Guidelines, initial research must be performed to avoid duplication of effort. This is especially critical for digitally prepared Fuss because data capture is expensive. Existing digital data should be identified and used whenever possible, while still meeting required specifications and quality of work.

It is recommended that as part of the initial coordination effort, the Mapping Partner that produces the draft digital study components identify available digital data and obtain data sets and hardcopy plots as necessary for restudy areas. If the Mapping Partner producing the Preliminary or Final DFIRM finds that data required for Preliminary or Final DFIRM database are missing, additional data research may be required. If the Mapping Partner that produces the draft DFIRM digital data is unable to supply the missing data, potential sources of digital base map or floodplain boundary data include state, county, or local government agencies responsible for GIS and planning or real estate assessment agencies. Digital floodplain data also may be available from FEMA, if the mapping for the area has been converted to digital format.

If the Mapping Partner that produces the draft digital study components uses pre-existing data, the Mapping Partner shall restructure the data to conform with the spatial data and table structure requirements in Section L.7.

As part of data collection, coordination and submittal, the Mapping Partner that produces the draft DFIRM digital data must document the data sources, date of collection or digitizing, scale of digitizing, projections, coordinate systems, horizontal datum, and vertical datum of all digital data used and submitted. For each data source used, the Mapping Partner shall add a Source Citation entry to the DFIRM metadata file in the Lineage section under Data Quality. Within the metadata file, the Mapping Partner shall assign each data source a Source Citation Abbreviation. These abbreviations are presented above in Subsection L.2.2.1 in Table L-4:

The Mapping Partner that produces the draft DFIRM digital data shall number each source citation abbreviation for a distinct data source (e.g., BASE1, BASE2, BASE3). All spatial tables in the standards discussed in Subsection L.3.2.2 have a SOURCE_CIT field. The Mapping Partner that produces the draft DFIRM digital data shall populate the field with the Source Citation Abbreviation from the metadata file that applies to the related spatial feature.

[February 2002]

L.3.3 Standards

The Mapping Partner shall ensure that the Preliminary or Final DFIRM database conforms with the standards listed in this Appendix and Volume 1 and Appendices A, B, K of these Guidelines, as applicable.

[February 2002]

L.3.4 Horizontal and Vertical Control

The preferred projection, coordinate system and horizontal datum for the preliminary or final DFIRM Database spatial data is the UTM projection and coordinate system and referenced to NAD 1983. However, certain preliminary or final DFIRM Databases will be referenced to other projections and coordinate systems if the underlying base map data are orthophotos referenced to another projection and coordinate system. All digital data must be in a State Plane coordinate system and associated projection or the UTM projection and coordinate system. The Mapping Partner shall obtain approval from the FEMA Lead in advance for variations to these two options.

See Appendix A of these Guidelines for a discussion of horizontal datum and Volume 1, Subsection 1.4.2.2 for a discussion of raster base maps in other projections and coordinate systems.

In the event that the county or other jurisdiction being mapped lies in more than one UTM or State Plane Coordinate System zone, the assigned Mapping Partner must project all digital data submitted to the zone that contains the largest portion of the county or jurisdiction in a single zone. The assigned Mapping Partner shall not use multiple projection and coordinate system zones in the Preliminary or Final DFIRM database.

All vertical information must reference either NGVD29 or NAVD88. The assigned Mapping Partner must not mix vertical datums within a submittal. See Appendix B of these Guidelines for details.

[February 2002]

L.3.5 Data Structure

All Preliminary or Final DFIRM data must consistently follow the data structure described in Subsections L.2.3.

[February 2002]

L.3.5.1 Tiling

The assigned Mapping Partner shall submit all digital data in one single file or a series of thematic files that cover the entire geographic area being mapped and not in individual small tiles that cover limited geographic areas. Preliminary or Final DFIRM databases should normally cover an entire county (or county equivalent). In situations where countywide mapping is not practical, the DFIRM database must cover an entire community.

[February 2002]

L.3.5.2 Topology

Vector data files must meet the following data structure requirements:

- Vectors may not cross other vectors within the same theme and all intersecting vectors must end at intersections.
- Area spatial features for a given theme must cover the entire study area without overlaps, underlaps or sliver polygons between adjacent polygons.
- Files must be free of discontinuities such as overlapping lines, gaps, "turn backs," dangling lines and duplicate elements.
- Spatial files must not contain any linear or area patterns.
- Gaps or overshoots between features that should close must be eliminated.

Logical consistency describes certain node-line-area relationships internal to the digital data. Node-line-area relationship requirements include the following:

- Areas must be represented by closed polygons, without overshoots or undershoots.
- Uncoded polygons are not permitted, including "sliver" polygons that result from poor digitizing methods.
- Unnecessary nodes and vertices must be avoided. Vertices must be placed conservatively when designing features so that only the minimal number of vertices or nodes is used to create the desired shape with appropriate smoothness (e.g. a straight line will be defined with two nodes only).
- Lines must begin and end at nodes.
- Lines must connect to each other at nodes.
- Lines must not extend through nodes.

[February 2002]

L.3.5.3 Edgematching

Preliminary or Final DFIRM databases must meet the edgematching requirements described above in Subsection L.2.2.4.3.

[February 2002]

L.3.5.4 Coincident Features

Preliminary or Final DFIRM databases must meet the coincident feature requirements described above in Subsection L.2.2.4.4.

[February 2002]

L.3.5.5 Precise Features

Preliminary or Final DFIRM databases must meet the precise feature requirements described above in Subsection L.2.2.4.5.

[February 2002]

L.3.5.6 Data Compilation

FEMA's goal is to develop digital data that are as accurate as possible. In general, the most accurate data source must be relied upon to reference other features compiled onto the map. This may mean that, in limited circumstances, floodplain boundary delineations made on very high-

resolution topographic maps may appear slightly misplaced on a less accurate base map. However, if the base map meets FEMA standards, these differences should be very small. If this policy creates significant visual problems with the floodplain boundary delineations on the base map selected, the Mapping Partner shall resolve the issue with the FEMA Lead PO.

Likewise, when high-accuracy data are collected for a Flood Map Project, it is FEMA's goal to maintain the accuracy of those data. For example, cross-section line features must correspond as closely as possible to the actual field survey locations. Often, the Mapping Partner must graphically extend or reshape that end of a cross section for satisfactory cartographic display. When this is necessary, it must be performed as a graphic operation for hardcopy map production. The Mapping Partner will not modify the digital spatial data that depict the true locations of the surveyed cross sections.

[February 2002]

L.3.5.7 Digitizing

Preliminary or Final DFIRM databases must meet the digitizing requirements described above in Subsection L.2.2.4.7.

[February 2002]

L.3.5.8 Base Map and Flood Hazard Data

Base map features are physical features like roads, railroads, rivers, lakes, levees, political boundaries, and bench marks, that map users may rely on to locate an area of interest on the FIRM. Flood hazard data are flood insurance risk zones, BFEs, cross-section locations, and hydraulic structures that depict the results of flood hazard analyses on FIRM. Some physical features such as surface water features and hydraulic structures are used while performing the flood hazard analyses and may be grouped in either category. Table L-7 presents the features of the base map and the flood hazard data.

Table L-7. Base and Flood Hazard Data Tables

Base Map Tables	Flood Hazard Data Tables
L_Wtr_Nm	L_Comm_Info
S_DOQ_Index	L_Cst_Model
S_Gen_Struct	L_MT1_LOMC
S_Label_Ld	L_Pan_Revis
S_Label_Pt	L_Pol_FHBM
S_Perm_Bmk	L_Riv_Model
S_PLSS_Ar	L_Stn_Start
S_PLSS_Ln	S_BFE
S_Pol_Ar	S_CBRS
S_Pol_Ln	S_Cst_Tsct_Ln
S_Quad	S_FIRM_Pan
S_Trnsport_Ln	S_Fld_Haz_Ar
S_Wtr_Ar	S_Fld_Haz_Ln
S_Wtr_Ln	S_Gen_Struct
	S_LOMR
	S_Riv_Mrk
	S_XS
	Study_Info

The purpose of the base map is to present an accurate depiction of the results of the flood hazard analyses in relation to the physical features on the ground. The floodplain boundaries are typically delineated on a topographic map and may be subsequently transferred to the base map. The topographic and base map data may be derived from the same sources. The spatial accuracy of both the topographic and the digital base map is critical to maintaining the accuracy of the floodplain delineations.

The assigned Mapping Partner must ensure that all DFIRM database files conform to the required specifications with the exception of the base map files for transportation and water features. If pre-existing data are used by the Mapping Partner the tables presented in Section L.7, it is not necessary to restructure the files to meet the schema listed. This is discussed in more detail in the description of each of the tables in Section L.7. The data, however, must be structured logically. If the base map data are not structured following the standard data structure, the Mapping Partner must ensure that the tables that vary are documented in the Entity and Attribute section of the metadata file.

[February 2002]

L.3.5.9 Computer Assisted Drafting and Design or Geographic Information System Preparation

Preliminary or Final DFIRM databases must be produced in the standard GIS formats listed below. If the Draft DFIRM data were submitted as CADD format data, it is the responsibility of the

Mapping Partner that produces the Preliminary or Final DFIRM data to convert the data to GIS format.

[February 2002]

L.3.5.10 Table Structure

Mapping Partners must follow the attribute table structure presented in Section L.7. The attribute data must be stored directly in the ESRI Shapefile, ESRI ArcInfo Export File, or MapInfo Interchange Format table along with the associated spatial data. The attribute data must not be in an independent data file or relational database format. Lookup tables must be stored in dbf format, info format, or MIF format.

[February 2002]

L.3.5.11 Spatial Files

Mapping Partners must follow the table structure presented in Section L.7. All tables that begin with S_ are spatial files.

DFIRM database table has a primary key field defined. This field is normally the table name followed by "_ID". The Mapping Partner that creates the digital data must populate these fields. Normally features in each table will be numbered sequentially using this field, although the Mapping Partner may choose another method provided it is logical, documented, consistently implemented, and results in a unique ID value for each spatial feature.

For a field that does not apply, the value must be Null. The field must be empty. The Mapping Partner shall use the value zero only when an attribute has the specific value of zero. If a data format does not support null values (e.g. numeric fields in ARC/INFO Coverage format) then a value –9999 shall be used in place of null.

Because of production limitations and with approval from the FEMA Project Officer, the mapping partner may leave some fields blank that would otherwise be required by this specification. In this case, the mapping partner should insert the value "NP" for not populated.

Text fields must follow the capitalization standards that apply to the display of that information on the FIRM.

Date fields in the DFIRM database are stored in the native date format for the data format in which table is distributed. Not all of the database formats used for the DFIRM database support date values in the same way. The time of day is not stored or is set to zero depending on the structure of the date object in a particular data format. Where possible the output format of the date is set to YYYYMMDD.

In the table documentation in Section L.7, each field name is followed by a letter code as follows:

- R – Required for all records

- A – Required if applicable to spatial feature described

[February 2002]

L.3.6 Quality Control

The digital files must be structured following the standard DFIRM database schema. This allows easy exchange of these data between FEMA, Mapping Partners, and other flood hazard data users. All duplicated elements must be removed. The data must be horizontally controlled and referenced to the appropriate horizontal and vertical datum. All digitizing must be done carefully and in conformance with FEMA's accuracy standards. The assigned Mapping Partner must perform a thorough QC review before submitting data to FEMA. FEMA will review the data provided by the Mapping Partner using automated and interactive techniques.

The Mapping Partner must provide hardcopies of the Preliminary or Final effective DFIRM along with the DFIRM database for quality control review.

[February 2002]

L.3.7 Deliverables

A complete DFIRM database submittal will be comprised of the following items:

- DFIRM database transmittal form;
- Digital base map files and DFIRM database files in ESRI Shapefile, ESRI ArcInfo Export File, and MapInfo Interchange Format;
- Metadata file as an ASCII text file; and
- Applicable word processing version of the FIS report.

[February 2002]

L.3.7.1 Hardcopy Deliverables

The Mapping Partner must provide a transmittal form with the DFIRM database. The transmittal form shall document the scope of the submittal, including the files submitted, jurisdictions covered, etc.

[February 2002]

L.3.7.2 Digital Deliverables

The digital submittal from the Mapping Partner to FEMA must include the complete DFIRM database in ESRI Shapefile, ESRI ArcInfo Export File, and MapInfo Interchange Format. The

submittal also must include the metadata file, a raster version of each FIRM panel, and a PDF version of the FIS report.

When a Mapping Partner produces the Preliminary DFIRM database, only ESRI Shapefile format and a metadata file is required.

Transfer Media

The Mapping Partner must submit files to FEMA on one of the following electronic media:

- CD-ROM (preferred); or
- Electronic transfer to File Transfer Protocol (FTP) site.

As technology changes or in special situations, other media may be acceptable, but must be approved by the FEMA Lead.

File Naming

To name DFIRM Database files, the Mapping Partner must use the table names listed in Section L.7 as the file name with an extension appropriate to the file format.

The Mapping Partner must store the DFIRM database files be stored in a directory named for the state abbreviation, then named for the county (or county equivalent) or community covered by the DFIRM database. Under each jurisdiction, the Mapping Partner shall indicate a separate directory for the standard DFIRM database files, a directory for digital orthophotos, if applicable, and a directory for any enhanced DFIRM database information available. All the files for each data format are stored together in a subdirectory named for the data format. For example, Montgomery County, Maryland, would be stored as:

\MD\Montgomery_Co\DFIRM_DB\MapInfo\ - Directory contains all DFIRM database files in MapInfo MIF format.

\MD\Montgomery_Co\DFIRM_DB\ArcShape\ - Directory contains all DFIRM database files in ESRI Shapefile format.

\MD\Montgomery_Co\DFIRM_DB\ArcExport\ - Directory contains all DFIRM database files in ESRI Export format (if available).

\MD\Montgomery_Co\DOQ\ - Directory contains all orthophoto files if used.

\MD\Document\ - Directory containing metadata and a readme file.

\MD\Montgomery_Co\RFIRM\ - Directory contains raster images of FIRM panels.

\MD\Montgomery_Co\FIS\ - Directory contains PDF version of FIS report.

\MD\Montgomery_Co\Enhanced_DB\MapInfo\ - Directory contains all enhanced DFIRM database files in MapInfo MIF format.

\MD\Montgomery_Co\Enhanced_DB\ArcShape\ - Directory contains all enhanced DFIRM database files in ESRI Shapefile format.

\MD\Montgomery_Co\Enhanced_DB\ArcExport\ - Directory contains all enhanced DFIRM database files in ESRI Export format (if available).

For a single jurisdiction DFIRM, the structure would be the same, with the jurisdiction name instead of the county name. For example, for Dallas, Texas, the directory structure would begin with:

\TX\Dallas_City_Of\

Data Identification Requirements

Complete documentation of file names, sizes, and contents is required. The Mapping Partner shall label all digital media submitted to FEMA with at least the following information:

- Mapping Partner name;
- Community name and state affected by the Flood Map Project;
- Preliminary date or effective date of the DFIRM database; and
- Brief description of contents.

[February 2002]

L.3.8 Metadata

To facilitate the use of these data and the transfer of data files between users, a metadata file shall accompany all digital data submittals. Only one metadata file is required for each Flood Map Project. However, in this file, the assigned Mapping Partner must distinguish between the different origins of the various datasets included. The metadata file shall follow the *Content Standard for Digital Geospatial Metadata (version 2.0)*, FGDC-STD-001-1998. Details of this standard are available at www.fgdc.gov. A sample metadata file for Preliminary and Final DFIRM databases is presented in Section L.8 of this Appendix.

This metadata file must include a description of the source material from which the data were derived and the methods of derivation, including all transformations involved in producing the final digital files. The description must include the dates of the source material and the dates of ancillary information used for update. The date assigned to a source must reflect the date that the information corresponds to the ground. If the Mapping Partner does not know this date, the Mapping Partner may use a date of publication and indicate as such. For each data source in the metadata file, the Mapping Partner shall assign a Source Citation Abbreviation as described under Data Sources in Subsection L.2.2.1.

The Mapping Partner shall describe any database created by merging information obtained from distinct sources in sufficient detail to identify the actual source for each element in the file.

Because not all DFIRM Database tables are included in every standard DFIRM database, the Overview Description Section of the Entity and Attribute Information should include a list of all DFIRM Database tables included in the submittal.

An example of a metadata file for a DFIRM database is presented in Section L.8. Portions of the file that are double underlined typically vary with each DFIRM Database. In addition, the Mapping Partner must take care to modify or replace other portions of the metadata file to fully document the DFIRM database.

[February 2002]

L.4 Database Table Structure Requirements for Draft Digital Data

Table: S_BFE

The Base Flood Elevation (BFE) table is required for any digital data where BFE lines will be shown on the corresponding Flood Insurance Rate Map (FIRM). Normally, if there are any riverine AE zones, BFE lines are required.

The S_BFE table contains information about the BFEs within a study area. A spatial file with locational information also corresponds with this data table. BFE lines indicate the rounded whole-foot water-surface elevation of the 1-percent-annual-chance flood.

The spatial elements representing BFE features are lines extending from Special Flood Hazard Area (SFHA) boundary to SFHA boundary. The BFE lines will have no visible gaps or overshoots between the SFHA boundary and the end of the BFE line at the publication scale of the DFIRM. However, the ends of the BFE lines are not necessarily snapped precisely to the SFHA boundary. Each BFE is represented by a single line. While BFE lines are depicted as wavy lines on the hardcopy FIRM, they should be primarily straight lines in the spatial data, although they may bend consistent with procedures described in Volume 1 of these Guidelines.

The S_BFE table contains the following elements:

BFE_LN_ID	R Primary key for table lookup. Assigned by table creator.
ELEV	R Base Flood Elevation. The rounded, whole foot elevation of the 1-percent-annual-chance flood. This is the value of the BFE that is printed next to the BFE line on the FIRM.
UNIT_LID	R Unit Lookup Identification. A code that provides a link to a valid unit of measurement from the D_Units table. This unit indicates the measurement system used for the BFEs. Normally this would be feet.
V_DATM_LID	R Vertical Datum Lookup Identification. A code that provides a link to a valid vertical datum from the D_V_Datum table. The vertical datum indicates the reference surface from which the flood elevations are measured. Normally this would be North American Vertical Datum of 1988 for new studies.
SOURCE_CIT	R Source Citation. Abbreviation used in the metadata file when describing the source information for the S_BFE table.

Name	Type	Size
BFE_LN_ID	Text	11
ELEV	Single	4.2
UNIT_LID	Text	11
V_DATM_LID	Text	11
SOURCE_CIT	Text	11

Table: S_CBRS

This table is only required from Mapping Partners producing Preliminary and Final Digital Flood Insurance Rate Map (DFIRM) databases. This table only applies to coastal areas that have specially protected areas designated by Congress on Coastal Barrier Resources System (CBRS) maps. Authoritative CBRS boundary locations are shown on Fish and Wildlife Service maps. Normally these areas are already shown on existing Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps (FIRMs) for the area. CBRS areas have restrictions on insurance coverage after specified dates for new or substantially improved structures. See Appendix K of these Guidelines for more detailed information about CBRS areas.

The S_CBRS table contains information about the CBRS areas within the study area, if applicable. A spatial file with locational information also corresponds with this data table.

The spatial elements representing CBRS features are closed polygons. Each contiguous CBRS area of the same CBRS_TYP and same CBRS_DATE should be a single polygon.

The S_CBRS table contains the following elements.

CBRS_ID — R Primary key for table lookup. Assigned by table creator.

CBRS_LID — R CBRS Lookup Identification. A code that provides a link to a valid CBRS type codes found in the D_CBRS_Typ table. The type code provides details of the types of prohibitions that apply to the area. Normally this would be CBRS area or an Otherwise Protected Area (OPA).

CBRS_DATE — R Legislation Date on which restrictions for the CBRS area began. This should be indicated on the FIRM as a note or with a fill pattern indicated on the legend.

CBRS_TF — R This field is True if the area is a CBRS or an OPA.

SOURCE_CIT — R Source Citation. Abbreviation used in the metadata file when describing the source information for the S_CBRS table.

Name	Type	Size
CBRS_ID	Text	11
CBRS_LID	Text	11
CBRS_DATE	Date/Time	8
CBRS_TF	Text	1
SOURCE_CIT	Text	11

Table: S_Cst_Tsct_Ln

This table is required when the corresponding Flood Insurance Rate Map (FIRM) and/or Flood Insurance Study (FIS) will show coastal transect locations. Normally this is any area with a coastal study.

The S_Cst_Tsct_Ln table contains information about the Coastal Transect Lines within the study area, if applicable. The transect lines indicate the location that was used to provide representative topographic information for the coastal flood models used. A spatial file with locational information also corresponds with this data table.

The spatial elements representing coastal transects are lines generally extending from offshore all the way across the coastal floodplain. Each transect should be represented by a single line feature without the circles on each end shown on the hard copy map. The location and shape of the lines should depict as accurately as possible the position of the transect used.

The S_Cst_Tsct_Ln table contains the following elements.

TRAN_LN_ID — R Primary key for table lookup. Assigned by table creator.

TRAN_NO — R Transect number as shown on FIRM or in FIS. Each transect is normally numbered sequentially.

CST_MDL_ID — A Coastal Model Identification. This field is populated by a linking element to the L_Cst_Model table. The L_Cst_Model table contains detailed information about the coastal models that were used to determine the coastal flood hazard for the area of each individual transect line. This ID field should contain a number that matches the CST_MDL_ID field for a record in the L_Cst_Model. Multiple transects may link to a single record in the L_Cst_Model table. This field is not required for digital conversion of existing FISs. Significant additional research may be required to identify the model that applies for each transect. However, for new coastal studies, this field is required.

SOURCE_CIT — R Source Citation. Abbreviation used in the metadata file when describing the source information for the S_Cst_Tsct_Ln table.

Name	Type	Size
TRAN_LN_ID	Text	11
TRAN_NO	Text	4
CST_MDL_ID	Text	11
SOURCE_CIT	Text	11

Table: S_DOQ_Index

This table is required if digital orthophotography was used as the base map for the Flood Insurance Rate Map (FIRM).

The S_DOQ_Index table contains information about the digital orthophotography used as a base map for the study area. A spatial file with locational information also corresponds with this data table.

The spatial elements representing digital orthophotography index features are rectangular polygons. For standard U.S. Geological Survey Digital Orthophoto Quadrangles, polygons should match quarter-quad boundaries (excluding overedge). Otherwise, polygons should match the boundaries of the orthophotography used (excluding overedge if present).

The S_DOQ_Index table contains the following elements.

DOQ_ID — R Primary key for table lookup. Assigned by table creator.

FILENAME — R DOQ Filename. This filename should be assigned by either the digital orthophotography provider or the table creator. The filename should match the filename assigned by the primary distributor of the orthophotography used. This should be the complete filename including the file extension.

DOQ_DATE — R DOQ Date. This is the date that the digital orthophotography was flown.

SOURCE_CIT — R Source Citation. Abbreviation used in the metadata file when describing the source information for the S_DOQ_Index table.

Name	Type	Size
DOQ_ID	Text	11
FILENAME	Text	50
DOQ_DATE	Date/Time	8
SOURCE_CIT	Text	1

Table: S_FIRM_Pan

This table is required for all draft Digital Flood Insurance Rate Map (DFIRM) data.

The S_FIRM_Pan table contains information about the Flood Insurance Rate Map (FIRM) panel area. A spatial file with locational information also corresponds with this data table.

The spatial entities representing FIRM panels are polygons. The polygon for the FIRM panel corresponds to the geographic area where effective flood hazard information is depicted on the FIRM panel. Where a portion of the area within the FIRM panel neat line is outside the jurisdiction mapped by the FIRM, the panel boundary in the DFIRM spatial data should follow the boundary of the jurisdiction mapped by this FIRM. So for a single jurisdiction FIRM, the outermost panel boundaries would follow the community boundary. For a countywide FIRM, the outermost panel boundaries would follow the county boundary.

The S_FIRM_Pan table contains the following elements.

FIRM_ID	R Primary key for table lookup. Assigned by table creator.
ST_FIPS	R State FIPS. This is the two-digit code that corresponds to the State Federal Information Processing Standard (FIPS) code. This is a standard numbering system that is used by the Federal government. Defined in FIPS Pub 6-4. These two numbers correspond to the first two digits of the panel number.
PCOMM	R Community or County Identification Number. This is the 3rd through the 6th digits of the panel number. For community based maps this corresponds to the Federal Emergency Management Agency (FEMA) Community Identification number. For countywide maps this is the county (or county equivalent) FIPS code with a "C".
PANEL	R Panel Number. This is 7th through the 10th digits in the complete panel number. This is assigned by the scale of the map and the position within either the community or county. The panel number scheme is described in detail in Appendix K of these Guidelines.
SUFFIX	R Map Suffix. This is the final digit in the complete panel number. This is a letter suffix at the end of the panel number.
FIRM_PAN	R FIRM Panel Number. This is the complete FIRM panel number, which is made up of ST_FIPS, PCOMM, PANEL, and SUFFIX. This is the 11-digit FIRM panel number that is shown in the title block of the map.
PANEL_LID	R Panel Lookup Identification. A code that provides a link to the D_Panel_Typ table; this field will indicate if the maps are printed or not printed, community based, county wide, or an unmapped community.

EFF_DATE	A Effective Date. This is the effective date of the current map revision. This field is not populated until the FIRM effective date is established and the Final FIRM is ready for hardcopy production by FEMA. Then it is required.
SCALE_LID	R Map Scale Lookup Identification. A code that provides a link to a value in the D_Scale table, it is the denominator of the scale of the FIRM.
PNP_Reason	A Panel Not Printed Reason. If the FIRM panel is not printed, this is the reason. This could include 'All Zone X' or other reasons. See Appendix K for a listing of Panel Not Printed reasons that may be used. Only completed if the hardcopy panel is not printed by FEMA.
NW_LAT	R Northwest Latitude. This is the latitude of the northwest corner of the FIRM panel neat line. This value is in degrees, minutes, seconds (DDD MM SS.SSS). Normally this corresponds to U.S. Geological Survey (USGS) 7.5' quadrangle maps using North American Datum of 1983 (NAD83), or even subdivisions thereof. However this value should reflect the actual latitude if non-standard panel sizes are used.
NW_LONG	R Northwest Longitude. This is the longitude of the northwest corner of the FIRM panel. This value is in degrees, minutes, seconds (DDD MM SS.SSS). Normally this corresponds to USGS 7.5' quadrangle maps using NAD83, or even subdivisions thereof. However this value should reflect the actual longitude if non-standard panel sizes are used.
SE_LAT	R Southeast Latitude. This is the latitude of the southeast corner of the FIRM panel. This value is in degrees, minutes, seconds (DDD MM SS.SSS). Normally this corresponds to USGS 7.5' quadrangle maps using NAD83, or even subdivisions thereof. However, this value should reflect the actual latitude if non-standard panel sizes are used.
SE_LONG	R Southeast Longitude. This is the longitude of the southeast corner of the FIRM panel. This value is in degrees, minutes, seconds (DDD MM SS.SSS). Normally this corresponds to USGS 7.5' quadrangle maps using NAD83, or even subdivisions thereof. However this value should reflect the actual longitude if non-standard panel sizes are used.
SOURCE_CIT	R Source Citation. Abbreviation used in the metadata file when describing the source information for the S_FIRM_Pan table.

Name	Type	Size
FIRM_ID	Text	11
ST_FIPS	Text	2
PCOMM	Text	4
PANEL	Text	4
SUFFIX	Text	1
FIRM_PAN	Text	11
PANEL_LID	Text	11
EFF_DATE	Date/Time	8
SCALE_LID	Text	11
PNP_REASON	Text	50
NW_LAT	Text	15
NW_LONG	Text	15
SE_LAT	Text	15
SE_LONG	Text	15
SOURCE_CIT	Text	11

Table: S_Fld_Haz_Ar

This table is required for all draft Digital Flood Insurance Rate Map data.

The S_Fld_Haz_Ar table contains information about the flood hazards within the study area. A spatial file with locational information also corresponds with this data table. These zones are used by the federal Emergency Management Agency (FEMA) to designate the Special Flood Hazard Area (SFHA) and for insurance rating purposes. These data are the flood hazard areas that are or will be depicted on the Flood Insurance Rate Map (FIRM).

The spatial elements representing the flood zones are polygons. The entire area of the jurisdiction(s) mapped by the FIRM should have a corresponding flood zone polygon.

The S_Fld_Haz_Ar table contains the following elements.

FLD_AR_ID	R	Primary key for table lookup. Assigned by table creator.
ZONE_LID	R	Flood Zone Lookup Identification. This is a code that provides a link to a valid entry from the D_Zone table. This is the flood zone label/abbreviation for the area.
FLDWAY_LID	A	Floodway Lookup Identification. This is a code that provides a link to a valid entry from the D_Floodway table. Floodway areas are designated by FEMA and adopted by communities to provide an area that will remain free of development to moderate increases in flood heights due to encroachment on the floodplain. If the corresponding area is not designated as a floodway, this field is null.
SFHA_TF	R	Special Flood Hazard Area. If the area is within SFHA this field would be True. This field will be true for any area that is coded for any A or V zone flood areas. It should be false for any X or D zone flood areas.
STATIC_BFE	A	Static Base Flood Elevation. For areas of constant Base Flood Elevation (BFE), the BFE value is shown beneath the zone label rather than on a BFE line. In this situation the same BFE applies to the entire polygon. This is normally occurs in lakes or coastal zones. This field is only populated where a static BFE is shown on the FIRM.
V_DATM_LID	A	Vertical Datum Lookup Identification. A code that provides a link to a valid vertical datum from the D_V_Datum table. The vertical datum indicates the reference surface from which the flood elevations are measured. Normally this would be North American Vertical Datum of 1988 for new studies. This field is only populated if the STATIC_BFE is populated.

DEPTH — A Depth Value for Zone AO Areas. This is shown beneath the zone label on the FIRM. This field is only populated if a depth is shown on the FIRM.

UNIT_LID — A Unit Lookup Identification. A code that provides a link to a valid unit of measurement from the D_Units table. This unit indicates the measurement system used for the BFEs. Normally this would be feet. This field is only populated if the DEPTH or STATIC_BFE field is populated.

VELOCITY — A Velocity Measurement. This is shown beneath the zone label on the FIRM for alluvial fan areas (certain Zone AO areas). This value represents the velocity of the flood flow in this area. This field is only populated when a velocity is shown on the FIRM.

VEL_UNITS — A Unit of Measurement for the Velocity Attribute. This is shown in the legend where alluvial fans are present. This field is only populated if the VELOCITY field is populated.

AR_REVERT — A If the area is Zone AR, this field would hold the zone that the area would revert to if the AR zone were removed. This field is only populated if the corresponding area is Zone AR. Acceptable values for this field are listed in the D_Zone table.

BFE_REVERT — A If Zone is Zone AR, this field would hold that static base flood elevation for the reverted zone. This field is populated when Zone equals AR and the reverted zone has a static BFE.

SOURCE_CIT — R Source Citation. Abbreviation used in the metadata file when describing the source information for the S_Fld_Haz_Ar table.

Name	Type	Size
FLD_AR_ID	Text	11
ZONE_LID	Text	11
FLDWAY_LID	Text	11
SFHA_TF	Text	1
STATIC_BFE	Single	4.2
V_DATM_LID	Text	11
DEPTH	Single	4.2
UNIT_LID	Text	11
VELOCITY	Single	4.2
VEL_UNITS	Text	20
AR_REVERT	Text	6
BFE_REVERT	Single	4.2
SOURCE_CIT	Text	11

Table: S_Fld_Haz_Ln

This table is required for all draft Digital Flood Insurance Rate Map data.

The S_Fld_Haz_Ln table contains information about the flood hazard line features for the study area. A spatial file with locational information also corresponds with this data table.

The spatial elements representing the boundaries of the flood hazard areas depicted on the Flood Insurance Rate Map (FIRM) are lines.

The S_Fld_Haz_Ln table contains the following elements.

FLD_LN_ID — R Primary key for table lookup. Assigned by table creator.

LN_LID — R Line Lookup Identification. A code that provides a link to a valid entry from the D_Ln_Typ table. These line types describe the flood boundary and may be used to indicate how the feature should be depicted on the hardcopy FIRM.

SOURCE_CIT — R Source Citation. Abbreviation used in the metadata file when describing the source information for the S_Fld_Haz_Ln table.

Name	Type	Size
FLD_LN_ID	Text	11
LN_LID	Text	11
SOURCE_CIT	Text	11

Table: S_Gen_Struct

This table is required whenever hydraulic structures are shown in the flood profile. It is also required if levees are shown on the FIRM, channels containing the flooding are shown on the FIRM, or any other structure that impacts the area's flood risk is shown on the FIRM.

The S_Gen_Struct table contains information about the hydraulic structures within the study area. It should include all structures shown in the flood profiles. In addition, levees, sea walls, channels that contain flooding, and other significant flood control structures shown on the Flood Insurance Rate Map (FIRM) should be included. A spatial file with locational information also corresponds with this data table.

Spatial elements representing general structures are represented by lines. The lines should represent the primary characteristic of the structure. For example, bridges should be represented by the transportation centerline carried by the bridge. Dams should be represented by a line corresponding to the top of the dam. Levees should be represented by a line corresponding to the top of levee. A line corresponding to the centerline of the main barrel should represent a culvert.

The S_Gen_Struct table contains the following elements.

STRUCT_ID — R Primary key for table lookup. Assigned by table creator.

STRUCT_LID — R Structure Type Lookup Identification. A code that provides a link to a valid entry from the D_Struct_Typ table. This table contains entries for most major types of structures that would be found in hydraulic analyses.

STRUCT_NM — A Structure Name. This is the name of the feature and the name that will be shown on the hardcopy FIRM. It is blank if the structure is not named on FIRM and/or the name is unknown.

WTR_NM — R Surface Water Feature Name. This is the formal name of the surface water feature associated with the structure, as it will appear on the hardcopy FIRM.

SOURCE_CIT — R Source Citation. Abbreviation used in the metadata file when describing the source information for the S_Gen_Struct table.

Name	Type	Size
STRUCT_ID	Text	11
STRUCT_LID	Text	11
STRUCT_NM	Text	50
WTR_NM_LID	Text	11
SOURCE_CIT	Text	11

Table: S_Label_Ld

This table is required for Digital Flood Insurance Rate Map (DFIRM) data if any label leader lines are shown on the hardcopy FIRM.

The S_Label_Ld table contains information about leader lines that would connect labels to feature locations on base maps. The purpose of this table, along with the S_Label_Pt table is so that the DFIRM database can contain the names of roads and other physical features in or near the Special Flood Hazard Areas regardless of the type or structure of the base map used. A spatial file with locational information also corresponds with this data table.

The spatial entities representing label leaders will be lines.

The S_Label_Ld table contains the following element.

LEADER_ID R Primary key for table lookup. Assigned by table creator.

LABEL_LID R Label Type Lookup Identification. A code that provides a link to valid entries from the D_Label_Typ table. This type is a description of the planimetric features to which the labels and leaders are associated. For vector based maps, the labels and leaders will be associated with vector features in S_Trnsport_Ln, S_Wtr_Ar and S_Wtr_Ln. For maps with an ortho-photo base, the labels and leaders will be associated with DOQ water and transportation features. For maps that use both vector features and ortho-photos, all values may apply

Name	Type	Size
LEADER_ID	Text	11
LABEL_LID	Text	11

Table: S_Label_Pt

This table is required for all draft Digital Flood Insurance Rate Map (DFIRM) data.

The S_Label_Pt table contains information for text insertion point locations that would link labels to base map features. The purpose of this table, along with the S_Label_Ld table is so that the DFIRM database can contain the names of roads and other physical features in or near the Special Flood Hazard Areas (SFHAs) regardless of the type or structure of the base map used. A spatial file with locational information also corresponds with this data table.

The spatial entities representing labels are points. The point corresponds to the lower left corner of the label.

The S_Label_Pt table contains the following elements.

LABEL_ID R Primary key for table lookup. Assigned by table creator.

LABEL R Label for map feature.

LABEL_LID R Label Type Lookup Identification. A code that provides a link to valid entries from the D_Label_Typ table. This type is a description of the planimetric features to which the labels and leaders are associated. For vector based maps, the labels and leaders will be associated with vector features in S_Trnsport_Ln, S_Wtr_Ar and S_Wtr_Ln. For maps with an ortho-photo base, the labels and leaders will be associated with DOQ water and transportation features. For maps that use both vector features and ortho-photos, all values may apply.

DEGREES R The degrees of rotation required for the placement of a feature label onto a hard copy Flood Insurance Rate Map panel.

Name	Type	Size
LABEL_ID	Text	11
LABEL	Text	255
LABEL_LID	Text	11
DEGREES	Integer	4

Table: S_LOMR

This table is required when a Mapping Partner incorporates the results of effective Letters of Map Revision (LOMRs) into the draft Digital Flood Insurance Rate Map (DFIRM) data submitted to the Federal Emergency Management Agency (FEMA).

The S_LOMR table contains information about LOMR areas that are incorporated into the Flood Insurance Rate Map (FIRM). This table is planned as a mechanism for DFIRM producers to communicate areas of the DFIRM data that were affected by and updated to reflect the results of LOMRs. It is included in the draft DFIRM data submittal. It is not planned for distribution by FEMA once a complete map revision has incorporated these LOMRs into the effective FIRM panel. Therefore it is not included in the finished DFIRM data. A spatial file with locational information also corresponds with this data table.

The spatial entities representing LOMRs are polygons. The spatial information contains the bounding polygon for each LOMR area.

The S_LOMR table contains the following elements.

LOMR_ID — R Primary key for table lookup. Assigned by table creator.

EFF_DATE — R Effective Date of the LOMR.

CASE_NO — R Case Number. This is the case number of the LOMR that is assigned by FEMA. The case number is used to track the LOMR's supporting documentation. The case number should be entered without hyphens or other separators.

SCALE_LID — R Map Scale. A code that provides a link to a value in the D_Scale table. The linked value will contain the denominator of the effective scale of the LOMR.

SOURCE_CIT — R Source Citation. Abbreviation used in the metadata file when describing the source information for the S_LOMR table.

Name	Type	Size
LOMR_ID	Text	11
EFF_DATE	Date/Time	8
CASE_NO	Text	13
SCALE_LID	Text	11
SOURCE_CIT	Text	11

Table: S_Perm_Bmk

This table is required unless there are no National Geodetic Survey (NGS) or other bench marks that meet the minimum standard in the jurisdiction covered by the Flood Insurance Rate Map (FIRM).

The S_Perm_Bmk table contains information about Permanent Bench Marks that are associated with the study area. The bench marks shown in this file must meet the requirements specified in Subsection 1.4.1.4.1 of these Guidelines. A spatial file with locational information also corresponds with this data table.

The spatial entities representing bench marks are points. Generally, these points should be placed based on the coordinates in the NGS database. However, the horizontal coordinates maintained by the NGS for vertical bench marks are often not very precise because the users rely on the location descriptions to locate the bench marks. If the source of the horizontal coordinates used by the NGS is not precise, the data creator may adjust the position based on more accurate data.

The S_Perm_Bmk table contains the following elements.

BM_ID — R Primary key for table lookup. Assigned by table creator.

PID — R Permanent Identifier. This should be the NGS assigned or community assigned permanent identifier. It must be unique for each benchmark.

SOURCE_CIT — R Source Citation. Abbreviation used in the metadata file when describing the source information for the S_Perm_Bmk table.

Name	Type	Size
BM_ID	Text	11
PID	Text	11
SOURCE_CIT	Text	11

Table: S_PLSS_Ar

This table is required when U. S. Public Land Survey System (PLSS) areas are shown on the Flood Insurance Rate Map.

The S_PLSS_Ar table contains information about the PLSS areas that are associated within the study area. These include the attributes for the range, township, and section areas. A spatial file with locational information also corresponds with this data table.

The spatial elements representing the PLSS areas are polygons. Generally there is one polygon per section. The PLSS areas should cover the entire jurisdiction where sections are defined. The S_PLSS_Ar table contains the following elements.

PLSS_AR_ID — R Primary key for table lookup. Assigned by table creator.

RANGE — A Range Number. This is the range number assigned to the PLSS area shown. This attribute would also include the designation of E (east) or W (west) as part of the data. For example, 21W would be an acceptable value. This field is applicable whenever the SECT_NO does not equal zero.

TWP — A Township. This is the township number assigned to the PLSS area shown. This attribute would also include the designation of N (north) or S (south) as part of the data. For example, 14S would be an acceptable value. This field is applicable whenever the SECT_NO does not equal zero.

SECT_NO — R Section. This is the section number assigned to the PLSS area shown. Where no section number is defined, such as open water, the section number should be zero.

SOURCE_CIT — R Source Citation. Abbreviation used in the metadata file when describing the source information for the S_PLSS_Ar table.

Name	Type	Size
PLSS_AR_ID	Text	11
RANGE	Text	8
TWP	Text	8
SECT_NO	Text	4
SOURCE_CIT	Text	11

Table: S_PLSS_Ln

This table is required when U.S. Public Land Survey System (PLSS) areas are shown on the Flood Insurance Rate Map (FIRM).

The S_PLSS_Ln table contains information about the boundary lines for the PLSS that is associated with the study area, if applicable. This would include the attributes for the adjacent range and township areas. A spatial file with locational information also corresponds with this data table.

The spatial entities representing PLSS boundaries are lines.

The S_PLSS_Ln table contains the following elements.

PLSS_LN_ID	R	Primary key for table lookup. Assigned by table creator.
LN_LID	R	Line Lookup Identification. A code that provides a link to a valid entry from the D_Ln_Typ table. These line types describe the PLSS boundaries and may be used to indicate how the feature should be depicted on the hardcopy FIRM.
E_RANGE	A	East Range Number. This is the range number assigned to the PLSS area shown to the east of the line feature. This number is shown on the hardcopy FIRM. This attribute would also include the designation of E (east) or W (west) as part of the data. For example, 21W would be an acceptable value. Only populated for lines that divide one range from another.
W_RANGE	A	West Range Number. This is the range number assigned to the PLSS area shown to the west of the line feature. This number is shown on the hardcopy FIRM. This attribute would also include the designation of E (east) or W (west) as part of the data. For example, 21W would be an acceptable value. Only populated for lines that divide one range from another.
N_TWP	A	North Township. This is the township number assigned to the PLSS area shown to the north of the line feature. This number is shown on the hardcopy FIRM. This attribute would also include the designation of N (north) or S (south) as part of the data. For example, 14S would be an acceptable value. Only populated for lines that divide one township from another.
S_TWP	A	South Township. This is the township number assigned to the PLSS area shown to the south of the line feature. This number is shown on the hardcopy FIRM. This attribute would also include the designation of N (north) or S (south) as part of the data. For example, 14S would be an

acceptable value. Only populated for lines that divide one township from another.

SOURCE_CIT — R Source Citation. Abbreviation used in the metadata file when describing the source information for the S_PLSS_Ln table.

Name	Type	Size
PLSS_LN_ID	Text	11
LN_LID	Text	11
E_RANGE	Text	8
W_RANGE	Text	8
N_TWP	Text	8
S_TWP	Text	8
SOURCE_CIT	Text	11

Table: S_Pol_Ar

This table is required for all draft Digital Flood Insurance Rate Map data.

The S_Pol_Ar table contains information about the Political Areas within the study area. This would include the attributes for the political areas and other areas such as forests, parks, military lands, and Native American lands. For the National Flood Insurance Program (NFIP), it is important to know the jurisdiction that has land use authority over an area. Political jurisdictions individually agree to participate in the NFIP and availability of insurance, floodplain regulations, and insurance rates may vary by political jurisdiction. The political jurisdiction assigned to each area corresponds to the jurisdiction responsible for NFIP and floodplain management for that area. A spatial file with locational information also corresponds with this data table.

The spatial entities representing political areas are polygons.

The S_Pol_Ar table contains the following elements.

POL_AR_ID	R Primary key for table lookup. Assigned by table creator.
POL_Name1	R Political Area Name 1. This is the primary name of the area shown. For areas that have more than one name, this would be the primary name with subsequent names shown in fields below. This would correspond to the official name of this jurisdiction used by the Federal Emergency Management Agency (FEMA) within the NFIP. For unincorporated areas of a county, this should be the county name (e.g., Montgomery County).
POL_Name2	A Political Area Name 2. This is the secondary name of the area shown. Populated if there is a common name for an area other than the official jurisdiction name.
CO_FIPS	R County FIPS Code. This is the three-digit county Federal Information Processing Standard (FIPS) code. This is a standard numbering system that is used by the Federal government. Defined in FIPS Pub 6-4.
ST_FIPS	R State FIPS. This is the two-digit code that corresponds to the state FIPS code. This is a standard numbering system that is used by the Federal government. Defined in FIPS Pub 6-4. These two numbers correspond to the first two digits of the panel number.
COMM_NO	R Community identification number. This is the four-digit number assigned by FEMA to each community for tracking purposes under the NFIP. On newer Flood Insurance Rate Maps (FIRMs) the state FIPS and the Community Identification Number (CID) appear below the community name where it is shown in the body of the map. For single jurisdiction FIRMs, this is the 3rd through the 6th digits of the panel number. This number can be obtained from the community status book that can be viewed at www.fema.gov/msc.

CID — R Community Number. This is the six-digit community number assigned by FEMA. It is created by combining the state FIPS code with the CID.

ANI_TF — R Area Not Included True/False. This is a true/false field that contains information about the geographical area to determine if it is included in the FIRM or not. Areas Not Included fall within the extent of the map, but no flood risk information is shown on the FIRM. This is either because the area is mapped on another FEMA map or because the area is not mapped at all by FEMA.

COM_NFO_ID — A Community Information Identification. This attribute links to the table L_Comm_Info that contains information about the specific community. This table should contain a number that matches a corresponding number in the COM_NFO_ID field of the L_Comm_Info table. This field is populated for any jurisdiction that has a CID number issued by FEMA.

SOURCE_CIT — R Source Citation. Abbreviation used in the metadata file when describing the source information for the S_Pol_Ar table.

Name	Type	Size
POL_AR_ID	Text	11
POL_NAME1	Text	50
POL_NAME2	Text	50
CO_FIPS	Text	3
ST_FIPS	Text	2
CID	Text	4
COMM_NO	Text	6
ANI_TF	Text	1
COM_NFO_ID	Text	11
SOURCE_CIT	Text	11

Table: S_Pol_Ln

This table is required for all draft Digital Flood Insurance Rate Map data.

The S_Pol_Ln table contains information about the boundaries of Political Areas within the study area. This would include the attributes for the political areas and other areas such as forests, parks, military lands, and Native American lands. A spatial file with locational information also corresponds with this data table.

The spatial elements representing the boundaries of the political jurisdictions depicted on the Flood Insurance Rate Map (FIRM) are lines.

The S_Pol_Ln table contains the following elements.

POL_LN_ID R Primary key for table lookup. Assigned by table creator.

LN_LID R Line Lookup Identification. A code that provides a link to a valid entry from the D_Ln_Typ table. These line types describe the jurisdictional boundary and can be used to indicate how the feature should be depicted on the hardcopy FIRM.

SOURCE_CIT R Source Citation. Abbreviation used in the metadata file when describing the source information for the S_Pol_Ln table.

Name	Type	Size
POL_LN_ID	Text	11
LN_LID	Text	11
SOURCE_CIT	Text	11

Table: S_Quad

This table is required for all draft Digital Flood Insurance Rate Map data.

The S_Quad table contains information about the US Geological Survey (USGS) 7.5-Minute Series Topographic Quadrangle maps that cover the study area. While USGS 7.5-minute quadrangles do not meet the Federal Emergency Management Agency (FEMA) digital base map standards, they are often useful as a supplementary reference source. The quadrangle information is provided as a convenience to users who may want to cross-reference this map series. A spatial file with locational information also corresponds with this data table.

The spatial entities representing the USGS quadrangles are polygons. Each polygon corresponds to the neatline of a USGS map.

The S_Quad table contains the following elements.

QUAD_ID — R Primary key for table lookup. Assigned by table creator.

QUAD_NO — R Quad Number. This is the eight-digit USGS alphanumeric quadrangle identifier. The list of values for each state is published by USGS in the State Indexes to Topographic and Other Map Coverage. This item is composed of three components: the latitude, rounded down to the nearest whole degree, of the 7.5-minute quadrangle map sheet; the longitude, rounded down to the nearest whole degree, of the 7.5-minute quadrangle map sheet; and the alphanumeric map sheet identifier used by USGS (i.e., A1 through H8).

QUAD_NM — R Quad Name. This is the name of the quad that is assigned by USGS.

SOURCE_CIT — R Source Citation. Abbreviation used in the metadata file when describing the source information for S_Quad table.

Name	Type	Size
QUAD_ID	Text	11
QUAD_NO	Text	8
QUAD_NM	Text	50
SOURCE_CIT	Text	11

Table: S_Riv_Mrk

This table is required if the Flood Insurance Rate Map (FIRM) shows river distance marks.

The S_Riv_Mrk table contains information about the River Marks shown on the hardcopy FIRM if applicable. A spatial file with locational information also corresponds with this data table.

The spatial entities representing the river marks are points. The points are generally located along side of the river at regular intervals.

The S_Riv_Mrk table contains the following elements.

RIV_MRK_ID — R Primary key for table lookup. Assigned by table creator.

START_ID — R Start Identification. A code that provides a link to a point in the L_Stn_Start table at which the river mark distances start.

RIV_MRK_NO — R River Mark Number. This attribute usually represents the distance from a known point (identified by START_ID), such as the confluence with another river, to the current river mark. This is the value shown next to the river mark on the FIRM.

SOURCE_CIT — R Source Citation. Abbreviation used in the metadata file when describing the source information for the S_Riv_Mrk table.

Name	Type	Size
RIV_MRK_ID	Text	11
START_ID	Text	11
RIV_MRK_NO	Text	6
SOURCE_CIT	Text	11

Table: S_Trnsport_Ln

This table or an equivalent that is fully documented is required for all Digital Flood Insurance Rate Map databases that use a vector base map rather than orthophotos for the base map.

The S_Trnsport_Ln table contains information about the linear base map transportation features such as roads, railroads, and airports. A spatial file with locational information also corresponds with this data table.

The spatial entities representing linear transportation features are normally lines. However, if the available transportation data depict roads as polygons, this is acceptable also. In general, the transportation table structure is fairly flexible depending on the format of the data available for the map. The Federal Emergency Management Agency's (FEMA's) objective is to have spatially accurate base map data to which the flood hazard information is referenced. Users must be able to identify the names of roads, railroads and other major features in or near the Special Flood Hazard Areas (SFHAs). If these objectives are met, then almost any file structure is acceptable. Road centerlines or edge of pavement files are both acceptable, provided that they meet the FEMA base map standard. With some data structures, it may not be practical to assign feature names or other attributes to each spatial entity. While these attributes are desirable, FEMA recognizes that they may not always be easily available. This is acceptable because the S_Label_Pt and S_Label_Ld tables will identify the names of all of the important features in or near the SFHA.

The S_Trnsport_Ln table contains the following elements.

TRANS_ID	R Primary key for table lookup. Assigned by table creator.
TRANS_LID	R Transportation Lookup Identification. A code that provides a link to valid entries from the D_Trans_Typ table. These line types indicate how the feature should be depicted on the hardcopy Flood Insurance Rate Map.
RD_S_LID	R Road Status Lookup Identification. A code that provides a link to valid entries in the D_Rd_Stat table.
PREFIX	A Prefix of the Feature Name. Not all features will have an entry in this attribute. Valid entries might include N for a transportation feature named N Main Street.
FEAT_NM1	R Feature Name 1. This is the primary name of the feature. For areas that have more than one name, this would be the primary name with subsequent names shown in fields below.
NM_TYP	R Name Type. Transportation feature name type. Valid entries include items such as road, street, or avenue. Acceptable values for this field are listed in the D_Nm_Typ table.

SUFFIX — A Suffix of the Feature Name. Not all features will have an entry in this attribute. Valid entries might include NW for a transportation feature named Main Street NW.

FEAT_NM2 — A Feature Name 2. This is the secondary name of the feature.

FEAT_NM3 — A Feature Name 3. This is the tertiary name of the feature.

SOURCE_CIT — R Source Citation. Abbreviation used in the metadata file when describing the source information for the S_Trnsport_Ln table.

Name	Type	Size
TRANS_ID	Text	11
TRANS_LID	Text	11
RD_S_LID	Text	11
PREFIX	Text	50
FEAT_NM1	Text	100
NM_LID	Text	11
SUFFIX	Text	50
FEAT_NM2	Text	100
FEAT_NM3	Text	100
SOURCE_CIT	Text	11

Table: S_Wtr_Ar

This table is required for any Digital Flood Insurance Rate Map (DFIRM) database where vector surface water features are shown on the Flood Insurance Rate Map and some of these features are represented as polygons in the spatial data. Vector streams should always be shown with a vector base map. They may also be shown on orthophoto base maps.

The S_Wtr_Ar table contains information about surface water area features. A spatial file with locational information also corresponds with this data table.

The spatial elements representing surface water area features are polygons. Normally lakes, ponds and streams wide enough to show both channel banks will be represented as polygons. However, the main purpose of the S_Wtr_Ar table and the S_Wtr_Ln table are to provide a cartographic depiction of the surface water features for visual interpretation of the mapping data. As a result, the method for structuring surface water features as lines or polygons is very flexible. Surface water features may appear in either the S_Wtr_Ar table or the S_Wtr_Ln table or both. However, features that appear in both must match exactly. The hydrologic structure of the stream network will be represented by tables in the Enhanced DFIRM Database.

In general, the surface water table structure is fairly flexible depending on the format of the data available for the map. The Federal Emergency Management Agency's (FEMA's) objective is to have spatially accurate surface water feature data to which the flood hazard information is referenced. Users must be able to identify the names of flooding sources and other important surface water features. If these objectives are met, then almost any file structure is acceptable. Streams, rivers and lakes may be represented as either polygons or lines. With some data structures, it may not be practical to assign feature names or other attributes to each spatial entity. While these attributes are desirable, FEMA recognizes that they may not always be easily available. This is acceptable because the S_Label_Pt and S_Label_Ld tables will identify the names of flooding sources and other important surface water features.

The S_Wtr_Ar table contains the following elements.

WTR_AR_ID	R	Primary key for table lookup. Assigned by table creator.
WATER_LID	R	Surface Water Feature Lookup Identification. A code that provides a link to valid entries from the D_Wtr_Typ table. This type value describes the classification of the surface water feature. Valid entries include items such as lake, retention pond, and reservoir.
WTR_NM_LID	R	Surface Water Name Lookup Identification. A code that provides a link to the name of the surface water feature. The surface water feature name is taken from the table L_Wtr_Nm. This is a lookup table that is populated by the creator of the database.
SOURCE_CIT	R	Source Citation. Abbreviation used in the metadata file when describing the source information for the S_Wtr_Ar table.

Name	Type	Size
WTR_AR_ID	Text	11
WATER_LID	Text	11
WTR_NM_LID	Text	11
SOURCE_CIT	Text	11

Table: S_Wtr_Ln

This table is required for any Digital Flood Insurance Rate Map (DFIRM) database where vector surface water features are shown on the Flood Insurance Rate Map and some of these features are represented as lines in the spatial data. Vector streams should always be shown with a vector base map. They may also be shown on orthophoto base maps.

The S_Wtr_Ln table contains information about surface water linear features. A spatial file with locational information also corresponds with this data table.

The spatial elements representing surface water line features are lines. Normally stream centerlines will be represented as line features. However, the main purpose of the S_Wtr_Ar table and the S_Wtr_Ln table are to provide a cartographic depiction of the surface water features for visual interpretation of the mapping data. As a result, the method for structuring surface water features as lines or polygons is very flexible. Lake shorelines and stream channel banks used to show lakes and wide rivers are usually represented as polygons. However, they may be represented as lines based on the structure of the data received and the Mapping Partner's discretion. Surface water features may appear in either the S_Wtr_Ar table or the S_Wtr_Ln table or both. However, features that appear in both must match exactly. The hydrologic structure of the stream network will be represented by tables in the Enhanced DFIRM Database.

In general, the surface water table structure is fairly flexible depending on the format of the data available for the map. The Federal Emergency Management Agency's (FEMA's) objective is to have spatially accurate surface water feature data to which the flood hazard information is referenced. Users must be able to identify the names flooding sources and other important surface water features. If these objectives are met, then most any file structure is acceptable. Streams, rivers and lakes may be represented as polygons or lines. With some data structures, it may not be practical to assign feature names or other attributes to each spatial entity. While these attributes are desirable, FEMA recognizes that they may not always be easily available. This is acceptable because the S_Label_Pt and S_Label_Ld tables will identify the names of flooding sources and other important surface water features.

The S_Wtr_Ln table contains the following elements.

WTR_LN_ID	R	Primary key for table lookup. Assigned by table creator.
WATER_LID	R	Surface Water Feature Lookup Identification. A code that provides a link to valid entries from the D_Wtr_Typ table. The type value describes the kind of watercourse represented. Valid entries include items such as stream/river, channel, and shoreline/coastline.
CHAN_LID	R	Channel Lookup Identification. A code that provides a link to valid entries from the D_Chan_Rep table. This channel type value indicates whether a linear water feature is represented as a stream centerline or represented as channel bank locations. Valid entries include single or double.

WTR_NM_LID R Water Name Lookup Identification. A code that provides a link to the name of the water feature. The water feature name is taken from the table L_Wtr_Nm. This is a lookup table that is populated by the creator of the database.

SOURCE_CIT R Source Citation. Abbreviation used in the metadata file when describing the source information for the S_Wtr_Ln table.

Name	Type	Size
WTR_LN_ID	Text	11
WATER_LID	Text	11
CHAN_LID	Text	11
WTR_NM_LID	Text	11
SOURCE_CIT	Text	11

Table: S_XS

This table is required for any Digital Flood Insurance Rate Map database where cross sections are shown on the Flood Insurance Rate Map (FIRM). Normally any FIRM that has associated flood profiles has cross sections.

The S_XS table contains information about Cross Section lines. A spatial file with locational information also corresponds with this data table. These lines represent the locations of channel surveys performed for input into the hydraulic model used to calculate flood elevations. These locations are also shown on the Flood Profiles in the Flood Insurance Study (FIS) report and can be used to cross reference the Flood Profiles to the planimetric depiction of the flood hazards.

The spatial elements representing cross sections are lines generally extending from outside the floodplain, across the entire floodplain and out the other side. Each cross section should be represented by a single line feature without the hexagons shown on each end on the hardcopy map. The location and shape of the lines should depict as accurately as possible the position of the cross section used.

The S_XS table contains the following elements.

XS_LN_ID	R Primary key for table lookup. Assigned by table creator.
XS_LTR	A Cross-Section Letter. The letter that is assigned to the cross section on the hardcopy FIRM and in the FIS report. This attribute is blank if the cross section is not shown on the FIRM. For a digital conversion, only cross sections that are shown on the FIRM will be available.
XS_NO	A Cross-Section Number. This attribute is used for all cross sections that are created during the engineering analysis. This should be populated with the number sequence that the Mapping Partner who performs the engineering analysis uses. Each cross section should have a unique number. This attribute is not filled in for digital conversions.
START_ID	R Start Identification. This is a link to the station start table. The station start describes the origin for the measurements in the STREAM_STN field. This field should contain a number that links to a unique value in the START_ID field in the L_Stn_Start table.
STREAM_STN	R Stream Station. This is the measurement along the stream to the cross-section location. Normally this information is available in the Floodway Data table in the FIS report.
XS_LN_TYP	R Cross-Section Line Type. This attribute should contain 'LETTERED' for cross sections that are shown on the hardcopy FIRM. If the cross section will not be shown on the hardcopy FIRM, this attribute should contain 'NOT LETTERED' to indicate that the cross section is part of the backup data for the study, but is not shown on the FIRM.

WTR_NM_LID — R Surface Water Feature Name Lookup Identification. A code that provides a link to the name of the water feature associated with the cross section. The water feature name is taken from the table L_Wtr_Nm. This is a lookup table that is populated by the creator of the database.

WSEL_100 — R Water-Surface Elevation for the 1-Percent-Annual-Chance Flood Event. This is the precise elevation of the base flood calculated at this cross section. This elevation exactly matches the elevation of the base flood in the Flood Profiles and the Floodway Data table. This number is determined during the engineering analysis for the study. This value should match the regulatory column in the Floodway Data table in the FIS report or the elevation from the corresponding flood profile if no Floodway Data table is published.

RIV_MDL_ID — A River Model Identification. A code that provides a link to the riverine model table, L_Riv_Model. The L_Riv_Model table will identify the hydrologic and hydraulic models used to calculate the flood hazard at this cross section line. This ID field should contain a number that matches the RIV_MDL_ID field for a record in the L_Riv_Model table. The L_Riv_Model table documents model information for this cross section. Multiple cross sections may link to a single record in the L_Riv_Model table. This field is not required for digital conversion of existing FISs. Significant additional research may be required to identify the model that applies at a cross section. However, for new FISs, this field is required. .

SOURCE_CIT — R Source Citation. Abbreviation used in the metadata file when describing the source information for the S_XS table. Table:

Name	Type	Size
XS_LN_ID	Text	11
XS_LTR	Text	12
XS_NO	Text	12
START_ID	Text	11
STREAM_STN	Text	12
XS_LN_TYP	Text	20
WTR_NM_LID	Text	11
WSEL_100	Single	4.2
RIV_MDL_ID	Text	11
SOURCE_CIT	Text	11

Table: Study_Info

This table is required for all draft Digital Flood Insurance Rate Map data.

The Study_Info table contains details about the study such as the study name, datum, projection, etc. There is normally only one record in this table for each Flood Insurance Rate Map (FIRM).

The Study_Info table contains the following elements.

STD_NFO_ID	R Primary key for table lookup. Assigned by table creator.
STUDY_PRE	R Study Prefix. This is the prefix of the study name such as 'City of' or 'Town of'.
STUDY_NM	R Study Name. This attribute contains the main portion of the study name, which is shown in the title block of the hardcopy FIRM. For county-wide FIRMs, or FIRMs for the unincorporated portions of counties, the name should include the county or county equivalent descriptor (e.g. Washington County or Iberia Parish).
STATE_NM	R State Name. This attribute contains the state name for the study and is shown in the title block of the hardcopy FIRM.
CNTY_NM	R County Name. This is the county (or county equivalent) name that the study falls within. The name should include the county or county equivalent descriptor (e.g. Washington County or Iberia Parish). The county name is also shown in the title block section of the hardcopy FIRM.
JURIS_TYP	R Political Jurisdiction Type. This attribute contains entries such as 'Unincorporated Areas' or 'All Jurisdictions' or 'and Incorporated Areas' or it is left empty. If there are data in this attribute, it is also shown in the title block section of the hardcopy FIRM.
LG_PAN_NO	R Largest Panel Number. This is the highest panel number shown on the FIRM Index for the area mapped. This number is shown in the title block section of the hardcopy FIRM.
OPP_TF	R Only Panel Printed. This is a true/false field that is True only if the study has only one printed panel.
H_DATUM	R Horizontal Datum. Valid entries for this attribute include North American Datum of 1927 or North American Datum of 1983 (NAD83). This is the horizontal datum used for the printed FIRM. The horizontal datum describes the reference system on which the horizontal coordinate

information shown on the FIRM is based. NAD83 is the preferred horizontal datum.

V_DATM_LID — R Vertical datum Lookup Identification. A code that provides a link to valid vertical datum from the D_V_Datum table. This is the vertical datum of the printed FIRM. The vertical datum describes the reference surface from which elevation on the map is measured. Normally, this would be North American Vertical Datum of 1988 for new studies.

PROJECTION — R Map Projection used for hardcopy FIRM publication. The preferred projection is Universal Transverse Mercator (UTM). If a State Plane coordinate system and associated projection is used, this field should include the name of the projection, the state and the zone (e.g., Lambert Conformal Conic, Virginia North Zone).

PROJ_ZONE — A Projection Zone. When using many map projections and coordinate systems, there is a zone associated with the area. This field is populated based on the projection selected for the Final hardcopy map production. Applies if the projection used has a zone parameter such as UTM or state plane. The zone should be stated as the appropriate Federal Information Processing Standard zone or FIPSZONE.

CW_TF — R Countywide, true/false. This attribute is true if the hardcopy FIRM includes all incorporated areas and any unincorporated areas of the county.

CBRS_PHONE — A Coastal Barrier Resources System (CBRS) Phone number. This is the phone number for the contact person/office for the CBRS legislative area. Applies if the FIRM contains CBRS areas. Enter the phone number as a ten-digit numeric string without hyphens, parentheses or other separators.

CBRS_REG — A CBRS Coordinator's region. This attribute contains the Fish and Wildlife Service (FWS) region within which the FIRM is located. Applies if the FIRM contains CBRS areas.

RTROFT_TF — R Retrofit, True/False. The Retrofit attribute should be True if older study data is used with updated stream location data. If flood features were adjusted to fit new stream locations due to better base map information this attribute would be true.

Name	Type	Size
STD_NFO_ID	Text	11
STUDY_PRE	Text	20
STUDY_NM	Text	50
STATE_NM	Text	50
CNTY_NM	Text	50
JURIS_TYP	Text	50
LG_PAN_NO	Text	4
OPP_TF	Text	1
H_DATUM	Text	10
V_DATM_LID	Text	11
PROJECTION	Text	50
PROJ_ZONE	Text	4
CW_TF	Text	1
CBRS_PHONE	Text	15
CBRS_REG	Text	1
RTROFT_TF	Text	1

Table: L_Comm_Info

This table is required for all draft Digital Flood Insurance Rate Map data.

The L_Comm_Info table is a lookup table that contains community map repository details and map history information that is shown on the Flood Insurance Rate Map (FIRM) legend or index. There is normally one record in this table for each community mapped on the FIRM.

The L_Comm_Info table contains the following elements.

COM_NFO_ID	R Primary key for table lookup that links to the S_Pol_Ar table. Values in this field should match the values COM_NFO_ID field of the S_Pol_Ar table.
REPOS_ADR1	R First line of the mailing or street address for the map repository. The map repository is the office the community has designated as responsible for maintaining copies of all the flood hazard information the Federal Emergency Management Agency (FEMA) publishes for the community. The public may view copies of the current effective information at the map repository. This information is also displayed in the FIRM legend or index. For example, this line might read 'Division of Community and Economic Development'.
REPOS_ADR2	R Second line of the mailing or street address for the map repository. This information is also displayed in the FIRM legend or index. For example, this line might read '226 W. Fourth Street'.
REPOS_ADR3	A Third line of the mailing or street address for the map repository. This information is also displayed in the FIRM legend or index. For example, this line might read 'Suite 200'. Populated if address requires additional space.
REPOS_CITY	R City portion of the mailing or street address for the map repository. This information is also displayed in the FIRM legend or index. For example, this line might read 'Springfield'.
REPOS_ST	R State portion of the mailing or street address for the map repository. This information is also displayed in the FIRM legend or index. For example, this line might read 'IL'.
REPOS_ZIP	R ZIP Code portion of the mailing or street address for the map repository. This information is also displayed in the FIRM legend or index. For example, this line might read '62269'.
IN_ID_DAT	R Initial identification date for the community as shown on the FIRM legend, index, or Flood Insurance Study (FIS) report. This information can also be obtained from FEMA.

IN_NFIP_DT — R Initial date of the first National Flood Insurance Program map published by FEMA for this community. This can be obtained from the FIRM legend, index, or FIS report. This information can also be obtained from FEMA.

IN_FRM_DAT — R Initial date FIRM was created. This can be obtained from the FIRM legend, index, or FIS report. This information can also be obtained from FEMA.

RECENT_DAT — A Most recent panel date. This can be obtained from the FIRM Index or the FEMA Community Status book at www.fema.gov/msc. This field is only populated for final DFIRM Databases.

Name	Type	Size
COM_NFO_ID	Text	11
REPOS_ADR1	Text	50
REPOS_ADR2	Text	50
REPOS_ADR3	Text	50
REPOS_CITY	Text	50
REPOS_ST	Text	50
REPOS_ZIP	Text	9
IN_ID_DAT	Date/Time	8
IN_NFIP_DT	Date/Time	8
IN_FRM_DAT	Date/Time	8
RECENT_DAT	Date/Time	8

Table: L_Cst_Model

This table is completed if coastal engineering analysis was performed. It is required for new coastal studies It is not required for digital conversions of effective flood hazard information because considerable additional effort may be required to research the applicable models.

The L_Cst_Model table is a lookup table that contains information about the coastal models that were used during the engineering analysis.

The L_Cst_Model table contains the following elements.

CST_MDL_ID	R Primary key for table lookup that links to the S_Cst_Tsct_Ln table. Value in this field should match the values in the CST_MDL_ID field of the S_Cst_Tsct_Ln table.
WTR_NM_LID	R Surface Water Feature Name Lookup Identification. This is the name of the water feature that the model is associated with. The water feature name is taken from the table L_Wtr_Nm. This is a lookup table that is populated by the Mapping Partner that creates the database.
SURGE_LID	R Hurricane Surge Model Lookup Identification. This is the name or abbreviation of the Federal Emergency Management Agency (FEMA) approved hurricane surge model that is associated with the coastal model for the engineering analysis. The surge model information is taken from the table D_Surge_Mdl.
EFF_SURGE	R This is a yes/no field that indicates if this is the effective surge model for the area.
WAVE_LID	R Wave Height Model Lookup Identification. This is the name or abbreviation of the FEMA approved wave height model that was used with the coastal model for the engineering analysis. The wave height model information is taken from the table D_Wave_Mdl.
EFF_WAVE	R This is a yes/no field that indicates if this is the effective wave height model for the area.
RUNUP_LID	R Runup Model Lookup Identification. This is the name or abbreviation of the FEMA approved runup model that was used with the coastal model for the engineering analysis. The runup model information is taken from the table D_Runup_Mdl.
EFF_RUNUP	R This is a yes/no field that indicates if this is the effective runup model for the area.

SETUP_METH R Wave Setup Methodology. This information should detail the methodology used when setting up the wave models for the engineering analysis.

EFF_SETUP R This is a yes/no field that indicates if this is the effective wave setup methodology for the area.

EROS_TF R This is a true/false field to indicate if erosion treatment has been applied to the area.

EFF_EROS R This is a yes/no field that indicates if this is the effective erosion methodology for the area.

PFD_TF R This is a true/false field to indicate if primary frontal dune criteria were applied.

EFF_PFD R This is a yes/no field that indicates if this is the effective primary frontal dune methodology for the area.

SOURCE_CIT R Source Citation. Abbreviation used in the metadata file when describing the source information for the L_Cst_Model table.

Name	Type	Size
CST_MDL_ID	Text	11
WTR_NM_LID	Text	11
SURGE_LID	Text	11
EFF_SURGE	Text	1
WAVE_LID	Text	11
EFF_WAVE	Text	1
RUNUP_LID	Text	11
EFF_RUNUP	Text	1
SETUP_METH	Text	100
EFF_SETUP	Text	1
EROS_TF	Text	1
EFF_EROS	Text	1
PFD_TF	Text	1
EFF_PFD	Text	1
SOURCE_CIT	Text	11

Table: L_MT1_LOMC

The L_MT1_LOMC table is a lookup table that contains information about Letters of Map Change (LOMCs) for the area. LOMCs typically include property descriptions. Frequently, LOMCs are issued to show that specific locations are outside the Special Flood Hazard Areas (SFHAs). Generally, the amount of detail that can be shown on the map does not allow these areas to be shown explicitly on the Flood Insurance Rate Map (FIRM). Instead, this information is communicated in the form of a LOMC. For data published by the Federal Emergency Management Agency (FEMA), this table would only include letters of map amendment and letters of map revision based on fill that have been revalidated following the map revision. Revalidated LOMCs indicate that the information presented in the LOMC continues to be true regardless of the depiction of the area on the FIRM.

For LOMCs that appear on more than one map panel, multiple records will exist with the same case number, but different panel numbers.

The L_MT1_LOMC table contains the following elements.

LOMC_ID — R Primary key for table lookup. Assigned by table creator.

CASE_NO — R Case Number. This is the case number assigned by FEMA to the LOMC. This should be filled in for reference back to the complete LOMC materials. The case number should be entered without hyphens or other separators.

EFF_DATE — R Effective Date of the LOMC.

FIRM_PAN — R FIRM panel number that the LOMC is on. This is also a foreign key to the S_FIRM_Pan table. MT1 LOMCs can be matched to a specific FIRM panel by matching this field to the FIRM_PAN field of the S_FIRM_Pan table.

LOMC_STAT — R Status of the LOMC. Valid entries for this field include the following:

'superseded'

'revalidated'

'incorporated'

Only revalidated LOMCs are still in effect after a panel has been revised. All others should be superseded or incorporated into the new FIRM.

Name	Type	Size
LOMC_ID	Text	11
CASE_NO	Text	13
EFF_DATE	Date/Time	8
FIRM_PAN	Text	11
LOMC_STAT	Text	20

Table: L_Pan_Revis

This table does not apply for an initial Flood Insurance Rate Map (FIRM) or for a FIRM that has a completely new paneling scheme, such as a first time countywide FIRM. Otherwise, this table is required for all draft Digital Flood Insurance Rate Map data.

The L_Pan_Revis table is a lookup table that contains information about historic revisions to each FIRM panel.

For each FIRM panel that is being revised, there should be at least one record. There may also be multiple records for multiple revision dates for a particular FIRM panel and there may be multiple records for a single revision date if there are multiple revision notes for that date. Each FIRM panel may have a unique set of revision dates and revision codes. There should be one record for each FIRM_PAN, REVIS_DATE, REVIS_NOTE combination.

The L_Pan_Revis table contains the following elements.

FIRM_PAN — R FIRM Panel Number. The primary key for table lookup that links to the S_FIRM_Pan table. This should match a value in the FIRM_PAN field of the S_FIRM_Pan table. This is the complete FIRM panel number, which is made up of ST_FIPS, PCOMM, PANEL, and SUFFIX, which are found in S_FIRM_Pan table. The FIRM panel number is the 11-digit FIRM panel number that is shown in the title block of the map.

REVIS_DATE — R Revision Date. Effective date of revision to the FIRM panel. FIRM revision dates can be found in the FIRM legend or the Flood Insurance Study (FIS) report.

REVIS_NOTE — R Revision Note. Note describing the reason for the revision to the panel. This is shown under the effective date in the FIRM legend or in the FIS report. A list of standard revision notes appears in Appendix K of these Guidelines.

Name	Type	Size
FIRM_PAN	Text	11
REVIS_DATE	Date/Time	8
REVIS_NOTE	Text	255

Table: L_Pol_FHBM

This table does not apply if all communities on the FIRM never had revisions to their Flood Hazard Boundary Maps (FHBMs). Otherwise, this table is required for all Digital Flood Insurance Rate Map databases.

The L_Pol_FHBM table is a lookup table that contains a list of communities and FHBM revisions.

Each community may have different revision dates. Each revision date may have multiple revision notes.

The L_Pol_FHBM table contains the following elements.

COMM_NO — R Community Number, which is the primary key for table lookup, that links to the S_Pol_Ar table. The value in this field should match a value in the COMM_NO field of the S_Pol_Ar table. This is the six-digit community number assigned by FEMA. It is created by including the state Federal Information Processing Standard or FIPS code with the Community Identification Number.

FHBM_DATE — R FHBM revision date.

FHBM_NOTE — R FHBM revision note that describes the reason for the revision. FHBM revision notes are shown in the Flood Insurance Rate Map legend or in the Flood Insurance Study report. A list of standard revision notes is included in Appendix K of these Guidelines.

Name	Type	Size
COMM_NO	Text	6
FHBM_DATE	Date/Time	8
FHBM_NOTE	Text	255

Table: L_Riv_Model

This table is only completed if detailed engineering methods were used. It is required for new studies. However, because considerable additional effort may be required to research the applicable models, it is not required for digital conversions of effective flood hazard information.

The L_Riv_Model table is a lookup table that contains detailed information about the hydraulic and hydrologic models used in the engineering analysis for the area.

The L_Riv_Model table contains the following elements.

RIV_MDL_ID	R River Model Identification. The primary key for table lookup that links to the S_XS table. The value in this field should match the values in the RIV_MDL_ID field of the S_XS table.
WTR_NM_LID	R Surface Water Feature Name Lookup Identification. This is the name of the water feature that the models are associated with. Foreign key for table lookup that links to the L_Wtr_Nm table.
HYDRA_LID	R Hydraulic Model Lookup Identification. Foreign key for table lookup that links to the D_Hydra table.
EFF_HYDRA	R This is a yes/no field that indicates if this is the effective hydraulic model for the area.
HYDRA_DATE	R Hydraulic Model Run Date. This is the date that the hydraulic model was run.
HYDRO_LID	R Hydrologic Model Lookup Identification. Foreign key for table lookup that links to the D_Hydro table.
EFF_HYDRO	R This is a yes/no field that indicates if this is the effective hydrologic model for the area.
HYDRO_DATE	R Hydrologic Model Run Date. This is the date that the hydrologic model was run.
SOURCE_CIT	R Source Citation. Abbreviation used in the metadata file when describing the source information for the L_Riv_Model table.

Name	Type	Size
RIV_MDL_ID	Text	11
WTR_NM_LID	Text	11
HYDRA_LID	Text	11
EFF_HYDRA	Text	1
HYDRA_DATE	Date/Time	8
HYDRO_LID	Text	11
EFF_HYDRO	Text	1
HYDRO_DATE	Date/Time	8
SOURCE_CIT	Text	11

Table: L_Stn_Start

This table is required for any Digital Flood Insurance Rate Map database that has an S_XS table or S_Riv_Mrk table. Because of production limitations, it may be omitted at the direction of the FEMA Project Officer.

The L_Stn_Start table contains information about station starting locations. These locations indicate the reference point that was used as the origin for distance measurements along streams and rivers. This table is referenced by both the S_XS table that contains stream station information for cross section and by the S_Riv_Mrk table that contains river distance marker points.The location of the stationing start for a group of cross sections is normally referenced as a note on the Floodway Data table and on the Flood Profiles. Generally, all the cross sections for a particular reach are referenced to the same starting point.

The L_Stn_Start table contains the following elements.

START_ID — R Primary key for table lookup. Assigned by table creator. This field is the link that is used to reference cross section in the S_XS table or river marks in the S_Riv_Mrk table to the appropriate stationing starting point.

START_DESC — R Start Description. The description of the location of the station starting point. For example, the confluence with the Main Channel of the Big River.

SOURCE_CIT — R Source Citation. Abbreviation used in the metadata file when describing the source information for the L_Stn_Start table.

Name	Type	Size
START_ID	Text	11
START_DESC	Text	255
SOURCE_CIT	Text	11

Table: L_Wtr_Nm

The L_Wtr_Nm table is a lookup table that contains the name of the surface water feature shown on the Flood Insurance Rate Map (FIRM) and referenced throughout the database. This table is required if the draft Digital Flood Insurance Rate Map table structure is used.

The L_Wtr_Nm table contains the following elements.

WTR_NM_LID — R Surface Water Feature Name Lookup Identification. The primary key that links to the L_Cst_Model table, L_Riv_Model table, S_Gen_Struct table, S_Wtr_Ar table, S_Wtr_Ln table, and S_XS table. This value should match the value in the WTR_NM_LID field for related records in these tables.

WTR_NM — R Surface Water Feature Name. This is the formal name of the surface water feature, as it will appear on the hardcopy FIRM.

Name	Type	Size
WTR_NM_LID	Text	11
WTR_NM	Text	100

Table: D_CBRS_Typ

The D_CBRS_Typ table lists valid types of Coastal Barrier Resources System (CBRS) areas and contains the following elements.

CBRS_LID — Primary key for table lookup that links to the S_CBRS table.

CBRS_TYP — CBRS Type. The type code provides details of the types of prohibitions that apply to the area.

Valid entries are shown in the table below.

CBRS_LID	CBRS_TYP
1000	COASTAL BARRIER RESOURCES SYSTEM
1010	OTHERWISE PROTECTED AREA

Table: D_Chan_Rep

The D_Chan_Rep table lists valid channel representations and contains the following elements.

CHAN_LID — Primary key for table lookup that links to the S_Wtr_Ln table.

CHAN_REP — Channel Representation. Single means linear water features represented by a centerline. Double means linear water features represented by shorelines or channel banks.

Valid entries are shown in the table below.

CHAN_LID	CHAN_REP
1000	SINGLE
1010	DOUBLE

Table: D_Floodway

The D_Floodway table lists valid floodway representations and contains the following elements.

FLDWAY_LID — Primary key for table lookup that links to the S_Fld_Haz_Ar table.

FLOODWAY — Floodway Type. Floodway areas are designated by the Federal Emergency Management Agency to provide an area that must be kept free of encroachment so that the 1-percent-annual-chance flood event can be carried without substantial increase in flood heights. Normal floodway areas are 'floodway'. Special cases will have a note on the hardcopy Flood Insurance Rate Map.

Valid entries are shown in the table below.

FLDWAY_LID	FLOODWAY
1000	FLOODWAY
1010	COLORADO RIVER
1020	FLOODWAY CONTAINED IN CHANNEL
1030	FLOWAGE EASEMENT BOUNDARY
1040	STATE ENCROACHMENT
1050	AREA OF SPECIAL CONSIDERATION

Table: D_Hydra

The D_Hydra table lists valid hydraulic models and contains the following elements.

HYDRA_LID — Primary key for table lookup that links to the L_Riv_Model table.

HYDRA_MDL — Hydraulic Model. This is the name or abbreviation of the hydraulic model that was used for the engineering analysis. As the Federal Emergency Management Agency approves the use of new engineering models for use in developing Flood Insurance Rate Maps, this list can be expanded.

Valid entries are shown in the table below.

HYDRA_LID	HYDRA_MDL
1000	ADLCPR
1001	DAMBRK
1002	E431
1003	FEQ
1004	FEQUTL
1005	FESWMS
1006	FLDWY
1007	HEC-2
1008	HEC-RAS
1009	J635
1010	NETWORK
1011	SWMM
1012	TABS2
1013	UNET
1014	WSP-2
1015	WSPG
1016	WSPRO

Table: D_Hydro

The D_Hydro table lists valid hydrologic models and contains the following elements.

HYDRO_LID — Primary key for table lookup that links to the L_Riv_Model table.

HYDRO_MDL — Hydrologic Model. This is the name or abbreviation of the hydrologic model that was used for the engineering analysis. As the Federal Emergency Management Agency approves the use of new engineering models for use in developing Flood Insurance Rate Maps, this list can be expanded.

Valid entries are shown in the table below.

HYDRO_LID	HYDRO_MDL
2000	DR3M
2001	FAN
2002	HEC-1
2003	HEC-FFA
2004	HEC-IFH
2005	HEC-HMS
2006	HSPF
2007	HYMO
2008	PEAKFQ
2009	PSU-IV
2010	RATIONAL METHOD
2011	REGRESSION EQUATION
2012	TR-20
2013	TR-55

Table: D_Label_Typ

The D_Label_Typ table lists valid features to which the labels and leaders apply.

LABEL_LID — Primary key for table lookup that links to the S_Label_Pt and the S_Label_Ld table.

LABEL_TYPE — Label type. This is a description of the planimetric features to which the labels and leaders are associated. For vector based maps, the labels and leaders will be associated with vector features in S_Trnsport_Ln, S_Wtr_Ar and S_Wtr_Ln. For maps with an ortho-photo base, the labels and leaders will be associated with DOQ water and transportation features. For maps that use both vector features and ortho-photos, all values may apply.

Valid entries are shown in the table below.

LABEL_LID	LABEL_TYPE
2000	S_Trsnport_Ln
2001	S_Wtr_Ar
2002	S_Wtr_Ln
2003	DOQ-transportation
2004	DOQ-water

Table: D_Ln_Typ

The D_Ln_Typ table lists valid line types used to determine symbology and drawing order on the hardcopy Flood Insurance Rate Map and contains the following elements.

LN_LID	Primary key for table lookup that links to the S_Fld_Haz_Ln table, the S_PLSS_Ln table, and the S_Pol_Ln table. Values 1000 thru 1999 are reserved for political lines, values 2000 thru 2999 are reserved for flood hazard lines, and values 3000 thru 3999 are reserved for U.S. Public Lands Survey System (PLSS) lines.
LN_TYP	Line Type. This is the boundary line type such as a floodplain boundary line, political boundary line, or PLSS boundary line. NOTE: The symbol '%' is a reserved symbol in most software packages so the word 'percent' was abbreviated to 'pct'.

Some lines may have multiple values. For the S_Pol_Ln table, the following precedence should apply: INTERNATIONAL, STATE, COUNTY, CORPORATE, EXTRATERRITORIAL JURISDICTION, URBAN GROWTH BOUNDARY, MUNICIPAL URBAN DRAINAGE DISTRICT, LEVEE IMPROVEMENT DISTRICT, AREA NOT INCLUDED, RESERVATION, FOREST, PARK.

For the S_Fld_Haz_Ln table, the following precedence should apply: LIMIT OF DETAILED STUDY, LIMIT OF STUDY, LIMIT OF FLOODWAY, FLOODWAY, 1--ANNUAL-CHANCE FLOOD HAZARD, ZONE BREAK, 0.2 pct ANNUAL CHANCE FLOOD HAZARD, FLOWAGE EASEMENT BOUNDARY, STATE ENCHROACHMENT LINE.

For the S_PLSS_Ln table, the following precedence should apply: TOWNSHIP, RANGE, SECTION, QUARTER SECTION.

Valid entries are shown in the table below.

LN_LID	LN_TYP
1010	AREA NOT INCLUDED
1020	CORPORATE
1021	EXTRATERRITORIAL JURISDICTION
1030	COUNTY
1040	FOREST
1041	PARK
1042	RESERVATION
1050	INTERNATIONAL
1060	STATE
1070	URBAN GROWTH BOUNDARY
1080	MUNICIPAL URBAN DRAINAGE DISTRICT
1090	LEVEE IMPROVEMENT DISTRICT
2000	0.2 pct ANNUAL CHANCE FLOOD HAZARD
2001	1 pct ANNUAL CHANCE FLOOD HAZARD
2002	ZONE D
2030	APPARENT LIMIT
2031	LIMIT OF DETAILED STUDY
2032	LIMIT OF FLOODWAY
2033	LIMIT OF STUDY
2040	FLOODWAY
2050	FLOWAGE EASEMENT BOUNDARY
2051	STATE ENCROACHMENT LINE
2052	ZONE BREAK
3000	QUARTER SECTION
3010	RANGE
3020	TOWNSHIP
3030	SECTION
3040	MEANDER
9000	END OF SPATIAL EXTENT

Table: D_Nm_Typ

The D_Nm_Typ table lists valid transportation feature name types and contains the following elements.

NM_LID — Primary key for table lookup that links to the S_Trnsport_Ln table.

NM_TYP — Name Type. The transportation feature name type.

Valid entries are shown in the table below.

NM_LID	NM_TYP
1000	ALLEY
1001	ARCADE
1002	AVENIDA
1003	AVENUE
1004	BOULEVARD
1005	BYPASS
1006	CALLE
1007	CAUSEWAY
1008	CENTER
1009	CIRCLE
1010	COURT
1011	COVE
1012	CRESCENT
1013	CROSSING
1014	DRIVE
1015	ESTE
1016	EXPRESSO
1017	EXPRESSWAY
1018	FREEWAY
1019	HIGHWAY
1020	LANE
1021	LOOP

NM_LID	NM_TYP
1022	MOTORWAY
1023	NORTE
1024	OESTE
1025	PARKWAY
1026	PASEO
1027	PASS
1028	PATH
1029	PIKE
1030	PLACE
1031	PLAZA
1032	ROAD
1033	ROW
1034	RUE
1035	SQUARE
1036	STREET
1037	SUR
1038	TERRACE
1039	THROUGHWAY
1040	TRAFFICWAY
1041	TRAIL
1042	TURNPIKE
1043	WAY

Table: D_Panel_Typ

The D_Panel_Typ table lists valid Flood Insurance Rate Map (FIRM) panel types and contains the following elements.

PANEL_LID — Primary key for table lookup that links to the S_FIRM_Pan table.

PANEL_TYP — Panel Type. The type of FIRM panel that identifies whether the panel is printed or not printed and whether it is community based or countywide mapping.

Valid entries are shown in the table below.

PANEL_LID	PANEL_TYP
1000	COUNTYWIDE, PANEL PRINTED
1010	COUNTYWIDE, NOT PRINTED
1020	COMMUNITY BASED, PANEL PRINTED
1030	COMMUNITY BASED, NOT PRINTED
1040	UNMAPPED COMMUNITY

Table: D_Rd_Stat

The D_Rd_Stat table lists valid road status values and contains the following elements.

RD_S_LID Primary key for table lookup that links to the S_Trnsport_Ln table.

RD_STAT Road Status.

Valid entries are shown in the table below.

RD_S_LID	RD_STAT
1000	PAVED
1010	PROPOSED
1020	UNDER CONSTRUCTION
1030	UNIMPROVED

Table: D_Runup_Mdl

The D_Runup_Mdl table lists valid wave runup models that can be used for the engineering analysis and contains the following elements.

RUNUP_LID — Primary key for table lookup that links to the L_Cst_Model table.

RUNUP_MDL — Runup Model. This is the name or abbreviation of the runup model that was used for the engineering analysis. As the Federal Emergency Management Agency approves the use of new engineering models for use in developing Flood Insurance Rate Maps, this list can be expanded.

Valid entries are shown in the table below.

RUNUP_LID	RUNUP_MDL
1010	RUNUP
1020	ACES RUNUP
1030	GREAT LAKES WAVE RUNUP MODEL

Table: D_Scale

The D_Scale table lists valid Flood Insurance Rate Map (FIRM) scales, ratios, and contains the following elements.

SCALE_LID — Primary key for table lookup that links to the S_FIRM_Pan table and the S_LOMR table.

SCALE — Map Scale. This is the denominator of the FIRM scale or effective Letter of Map Revision scale as a ratio. For example, 24000 is the denominator for a 1" = 2000' map.

Valid entries are shown in the table below.

SCALE_LID	SCALE
1000	6000
1010	12000
1020	24000

Table: D_Struct_Typ

The D_Struct_Typ table lists valid structure types associated with general hydraulic structures and contains the following elements.

STRUCT_LID Primary key for table lookup that links to the S_Gen_Struct table.

STRUCT_TYP Structure Type. These are hydraulic structures within the study area.

Valid entries are listed in the table below.

STRUCT_LID	STRUCT_TYP
1000	AQUEDUCT
1001	BRIDGE
1002	CULVERT
1003	DAM
1004	DIKE
1005	DOCK
1006	FISH LADDER
1007	FOOTBRIDGE
1008	FLUME
1009	GATE
1010	JETTY
1011	LEVEE
1012	LOCK
1013	PENSTOCK
1014	PIER
1015	SEAWALL
1016	WEIR
1017	WING WALL

Table: D_Surge_Mdl

The D_Surge_Mdl table lists valid hurricane surge models that can be used during the engineering analysis and contains the following elements.

SURGE_LID — Primary key for table lookup that links to the L_Cst_Model table.

SURGE_MDL — Hurricane Surge Model. This is the name or abbreviation of the hurricane surge model that was used for the engineering analysis. As the Federal Emergency Management Agency approves the use of new engineering models for use in developing Flood Insurance Rate Maps, this list can be expanded.

Valid entries are listed in the table below.

SURGE_LID	SURGE_MDL
1010	FEMA SURGE
1020	NEW ENGLAND TIDE PROFILE
1030	NOREASTER SURGE MODEL

Table: D_Trans_Typ

The D_Trans_Typ table lists valid transportation feature types for base map features and contains the following elements.

TRANS_LID — Primary key for table lookup that links to the S_Trnsport_Ln table. Values 1000 thru 1999 are reserved for road types, values 2000 thru 2999 are reserved for railroads, values 3000 thru 3999 are reserved for airports, and values 4000 thru 4999 are reserved for water transportation.

TRANS_TYP — Transportation Feature Type.

Valid entries are listed in the table below.

TRANS_LID	TRANS_TYP
1000	UNDEFINED RD
1001	PRIMARY RD
1002	SECONDARY RD
1003	TRAIL
1010	RD TUNNEL
1020	FORD
2000	UNDEFINED RR
2001	ACTIVE RR
2002	ABANDONED RR
2003	DISMANTLED RR
2010	RR TUNNEL
3000	AIRPORT
4000	FERRY
4001	INTRACOASTAL WATERWAY

Table: D_Units

The D_Units table lists valid units of measurement throughout the database and contains the following elements.

UNIT_LID — Primary key for table lookup that links to the S_BFE table and the S_Fld_Haz_Ar table.

UNITS — Unit of Measurement. Varies depending on the variable that it is quantifying. The legend on the hardcopy Flood Insurance Rate Map should specify the units.

Valid entries are shown in the table below.

UNIT_LID	UNITS
1000	FEET
1010	METERS

Table: D_V_Datum

The D_V_Datum table lists valid vertical datums and contains the following elements.

V_DATM_LID — Primary key for table lookup that links to the S_BFE table, the S_Fld_Haz_Ar table, and the Study_Info table.

V_DATUM — Vertical Datum. North American Vertical Datum of 1988 (NAVD88) is preferred. However, older studies may have been prepared using the National Geodetic Vertical Datum of 1929 (NGVD29).

Valid entries are shown in the table below.

V_DATM_LID	V_DATUM
1000	MSL
1010	NAVD88
1020	NGVD29

Table: D_Water_Typ

The D_Water_Typ table lists valid water feature types and contains the following elements.

WATER_LID — Primary key for table lookup that links to the S_Wtr_Ar table and the S_Wtr_Ln table.

WATER_TYP — Surface Water Feature Type.

Valid entries are shown in the table below.

WATER_LID	WATER_TYP
5000	CHANNEL
5001	DITCH
5002	GLACIER
5003	GULCH
5004	HATCHERY
5005	PERENNIAL RIVER/STREAM
5006	RACE
5007	SHORELINE/COASTLINE
5008	WASH
5009	WATERFALL
5020	INTERMITTENT RIVER/STREAM
5021	PROFILE BASE LINE
5022	WATER SEPARATION LINE
6000	LAKE
6001	BOG
6002	RESERVOIR
6003	RETENTION POND
6004	SWAMP
6005	TAILINGS POND

Table: D_Wave_Mdl

The D_Wave_Mdl table lists valid wave height models used during the engineering analysis and contains the following elements.

WAVE_LID — Primary key for table lookup that links to the L_Cst_Model table.

WAVE_MDL — Wave Height Model. This is the name or abbreviation of the wave height model that was used for the engineering analysis. As the Federal Emergency Management Agency approves the use of new engineering models for use in developing Flood Insurance Rate Maps, this list can be expanded.

Valid entries are shown in the table below.

WAVE_LID	WAVE_MDL
1010	WHAFIS
1020	GREAT LAKES WHAFIS

Table: D_Zone

The D_Zone table lists valid Flood Insurance Rate Map (FIRM) flood zones and contains the following elements.

ZONE_LID	Primary key for table lookup that links to the S_Fld_Haz_Ar table.
FLD_ZONE	Flood Zone. This is the flood insurance risk zone designation. These zones are used by the Federal Emergency Management Agency (FEMA) to designate Special Flood Hazard Areas (SFHAs) and for insurance rating purposes. Some older FEMA FIRMs were prepared in the Standard format that uses Zones B, C and numbered A and V zones. Newer FIRMs use the Map Initiatives format where the B corresponds to 0.2 pct ANNUAL CHANCE FLOOD HAZARD; C corresponds to Zone X; numbered A zones (e.g., A1, A2, A3) correspond to Zone AE; and numbered V zones (e.g., V1, V2, V3) correspond to Zone VE. All Digital Flood Insurance Rate Maps (DFIRMs) should use the Map Initiatives zone designations. See Volume 1, Subsection 1.4.6.1.5 of these Guidelines for details on the flood insurance risk zones. (NOTE: The symbol '%' is a reserved symbol in most software packages so the word 'percent' was abbreviated to 'pct'.)

Valid entries are shown in the table below.

ZONE_LID	FLD_ZONE
1000	A
1001	AE
1002	AH
1003	AO
1004	AR
1005	1 pct FLOOD HAZARD CONTAINED IN CHANNEL
1006	
1007	1 pct FUTURE CONDITIONS
1008	A99
1009	V
1010	VE
2000	0.2 pct ANNUAL CHANCE FLOOD HAZARD
2001	0.2 pct ANNUAL CHANCE FLOOD HAZARD CONTAINED IN CHANNEL
2002	
3000	AREA NOT INCLUDED
4000	D
4001	X PROTECTED BY LEVEE
4002	X
5000	OPEN WATER

Where the 1-percent-annual-chance flood or the 0.2-percent-annual-chance flood is contained in a culvert or channel, a corresponding feature appears in the S_Fld_Haz_Ar table only if an SFHA or 0.2-percent-annual-chance flood zone is shown on the FIRM in this area. In general, these culverts and channels are to be represented in the general structure table regardless of how the flood insurance risk zones are depicted. So, if these structures are shown on the FIRM as a dashed line passing through a Zone X, no corresponding flood insurance risk zone is shown in S_Fld_Haz_Ar table in the DFIRM database. If a narrow SFHA or 0.2-percent-annual-chance flood zone is shown on the FIRM, then a narrow polygon must be included in the DFIRM database. If the width of this flood insurance risk zone is accurately known and represented in the spatial data, the normal flood insurance risk zone is applied. If the width of the flood insurance risk zone is not accurately known and represented because of scale limitations, then the zone is designated as 1-percent-annual-chance flood contained in channel or 0.2-percent-annual-chance flood contained in channel as appropriate.

[February 2002]

L.5 Federal Emergency Management Agency Digital Mapping Information Checklist

Federal Emergency Management Agency Digital Mapping Information Checklist

The following checklist is intended to solicit information basic information about the format of digital mapping data submitted to the Federal Emergency Management Agency (FEMA) for preparation of a Digital Flood Insurance Rate Map (DFIRM). Please note that metadata compliant with the Federal Geographic Data Committee's *Content Standard for Digital Geospatial Metadata* should be submitted also. This metadata must include the following information and further details about the data submitted.

Point of Contact:

Name and/or Title _____

Community/Agency _____

Department _____

Address _____

_____

Telephone _____

Fax _____

Email _____

Data Type:

Pertinent information includes the following:

Format:

- ❑ ArcInfo
- ❑ ArcView
- ❑ MapInfo
- ❑ Intergraph
- ❑ AutoCAD
- ❑ Digital Line Graph
- ❑ Other _____

- ❑ Digital Orthophoto
  - ❑ Black & white
  - ❑ Color
  - ❑ TIF
  - ❑ JPEG
  - ❑ Raw

- ❑ Scanned
  - ❑ Georeferenced? _____
  - ❑ Dots per inch _____
  - ❑ Black & white
  - ❑ Grey scale
  - ❑ Color

Source Information:

How and when were the data compiled? By whom? At what scale? Pertinent information includes the following:

- ❑ Photogrammetrically compiled
- ❑ Digitized from a hardcopy source
  - ❑ Parcel maps/Plat maps
  - ❑ USGS quadrangles
  - ❑ Orthophotos
  - ❑ Aerial photos
  - ❑ Other community map _____
  - ❑ Generated using coordinate geometry (COGO)
  - ❑ Scanned

Date of photography or source material _____

Scale of data creation _____

Agency or firm that produced the data _____

Date of creation (if incomplete, provide estimated completion date) _____

Projection, Datums, Accuracy:

What coordinate system and projection were used? What horizontal and vertical datums were used? What is the stated accuracy of the data?

Coordinate system/projection:

- ❑ State Plane
- ❑ UTM
- ❑ Geographic (latitude and longitude)
- ❑ Other _____

Units:

- ❑ Feet
- ❑ Meters
- ❑ Decimal degrees
- ❑ Degrees, minutes, seconds
- ❑ Other _____

Horizontal datum:

- ❑ NAD27, Clarke 1866 spheroid
- ❑ NAD83, GRS80 spheroid

Vertical datum:

- ❑ NGVD29
- ❑ NAVD88
- ❑ Other _____

Accuracy _____

Data Contents:

What features are contained in the data set(s)? Are feature names included? If so, are they available as attributes and/or graphic text (annotation)? Please provide file structure details in the form of metadata, a data dictionary, or a layer list in addition to this form

Roads

- ❑ Centerlines
- ❑ Edge of pavement
- ❑ Right of ways

❑ Road names

Scale(s) at which they were intended to be used _____

❑ Railroads

- ❑ Railroad names

❑ Airports

- ❑ Airport names

- ❑ Streams, lakes, other water bodies
  - ❑ Feature names
- ❑ Range & township/section lines and numbers
- ❑ Political boundaries
  - ❑ Area names
- ❑ Flood control structures (dams, weirs, jetties, culverts, etc.)
- ❑ Floodplain boundaries and/or other FIRM features
- ❑ Contours
  Contour interval _____
- ❑ DEM/DTM/TIN
- ❑ Building outlines
  Parcels

Transfer Media:

What options are there for transferring the data to other users? What are the platform options?

Media:

- ❑ CD-ROM
- ❑ 8mm tape
- ❑ 4mm tape
- ❑ Zip disk
- ❑ Diskettes
- ❑ Email
- ❑ Other _____

Platforms:

- ❑ UNIX
- ❑ PC
- ❑ NT

[February 2002]

L.6 Metadata Example for Draft Digital Data

DFIRM DATABASE, FLOOD COUNTY, USA

Identification_Information:
Citation:
Citation_Information:
Originator: FEMA Mapping Partner
Publication_Date: 20000505
Title: DIGITAL FLOOD INSURANCE RATE MAP DATABASE, FLOOD COUNTY, USA
Geospatial_Data_Presentation_Form: Vector and Raster Digital Data
Publication_Information:
Publication_Place: Washington, DC
Publisher: Federal Emergency Management Agency
Other_Citation_Details: Metadata_File_Name: DFIRM_DB.htm
Online Linkage: *www.fema.gov/msc*
Description:
Abstract:
The Digital Flood Insurance Rate Map (DFIRM) Database depicts flood risk information and supporting data used to develop the risk data. The primary risk classifications used are the 1-percent-annual-chance flood event, the 0.2-percent-annual-chance flood event, and areas of minimal flood risk. The DFIRM Database is derived from Flood Insurance Studies (FISs), previously published Flood Insurance Rate Maps (FIRMs), flood hazard analyses performed in support of the FISs and FIRMs, and new mapping data where available. The FISs and FIRMs are published by the Federal Emergency Management Agency (FEMA). The file is georeferenced to earth's surface using the UTM projection and coordinate system. The specifications for the horizontal control of DFIRM data files are consistent with those required for mapping at a scale of 1:12,000.
Purpose:
The FIRM is the basis for floodplain management, mitigation, and insurance activities for the National Flood Insurance Program (NFIP). Insurance applications include enforcement of the mandatory purchase requirement of the Flood Disaster Protection Act, which "... requires the purchase of flood insurance by property owners who are being assisted by Federal programs or by Federally supervised, regulated or insured agencies or institutions in the acquisition or improvement of land facilities located or to be located in identified areas having special flood hazards" (Section 2 (b) (4) of the Flood Disaster Protection Act of 1973). In addition to the identification of Special Flood Hazard Areas (SFHAs), the risk zones shown on the FIRMs are the basis for the establishment of premium rates for flood coverage offered through the NFIP.
The DFIRM Database presents the flood risk information depicted on the FIRM in a digital format suitable for use in electronic mapping applications. The DFIRM Database is a subset of the Digital FIS database that serves to archive the information collected during the FIS.
Time_Period_of_Content:
Time_Period_Information:
Single_Date/Time:
Calendar_Date: 19980701
Currentness_Reference: FIRM and FIS Effective date
Status:
Progress: Complete
Maintenance_and_Update_Frequency: Irregular
Spatial_Domain:
Bounding_Coordinates:
West_Bounding_Coordinate: -84.125
East_Bounding_Coordinate: -84.25

North_Bounding_Coordinate: 30.5
South_Bounding_Coordinate: 30.625
Keywords:
Theme:
Theme_Keyword_Thesaurus: None
Theme_Keyword: FEMA Flood Hazard Zone
Theme_Keyword: DFIRM Database
Theme_Keyword: DFIRM
Theme_Keyword: Special Flood Hazard Area
Theme_Keyword: Digital Flood Insurance Rate Map
Theme_Keyword: CBRS
Theme_Keyword: Coastal Barrier Resources System
Theme_Keyword: Riverine Flooding
Theme_Keyword: Coastal Flooding
Theme_Keyword: NFIP
Theme_Keyword: Base Flood Elevation
Theme_Keyword: SFHA
Theme_Keyword: Flood Insurance Rate Map
Theme_Keyword: FIRM
Theme_Keyword: Floodway

Place:
Place_Keyword_Thesaurus: None
Place_Keyword: FLOOD COUNTY
Place_Keyword: USA
Access_Constraints: None
Use_Constraints:

The hardcopy FIRM and DFIRM maps and the accompanying FISs are the official designation of SFHAs and Base Flood Elevations (BFEs) for the NFIP. For the purposes of the NFIP, changes to the flood risk information published by FEMA may only be performed by FEMA and through the mechanisms established in the NFIP regulations (44 CFR Parts 59-78).
These digital data are produced in conjunction with the hardcopy FIRMs and generally matches the hardcopy map exactly. However the hardcopy flood maps and flood profiles are the authoritative documents for the NFIP.
Acknowledgement of FEMA would be appreciated in products derived from these data.
Point_of_Contact:
Contact_Information:
Contact_Organization_Primary:
Contact_Organization: Mapping Partner Contact Name
Contact_Position: Mapping Partner Position
Contact_Address:
Address_Type: mailing address
Address: Mapping Partner Address
City: Mapping Partner City
State_or_Province: Mapping Partner State
Postal_Code: Mapping Partner Zip
Country: Mapping Partner Country
Contact_Voice_Telephone:
Mapping Partner Phone Number
Contact_Electronic_Mail_Address:
Mapping Partner Email
Native_Data_Set_Environment:
Description of Mapping Partner's digital mapping environment
Cross_Reference:
Citation_Information:

Originator: Federal Emergency Management Agency
Publication_Date: 19980701
Title: Flood Insurance Rate Map, FLOOD COUNTY, USA
Geospatial_Data_Presentation_Form: map
Publication_Information:
Publication_Place: Washington, DC
Publisher: Federal Emergency Management Agency
Cross_Reference:
Citation_Information:
Originator: Federal Emergency Management Agency
Publication_Date: 19980701
Title: Flood Insurance Study, FLOOD COUNTY, USA
Geospatial_Data_Presentation_Form: document
Publication_Information:
Publication_Place: Washington, DC
Publisher: Federal Emergency Management Agency
Cross_Reference:
Citation_Information:
Originator: Federal Emergency Management Agency
Publication_Date: 19980701
Title: Raster DFIRM, FLOOD COUNTY, USA
Geospatial_Data_Presentation_Form: raster digital data
Publication_Information:
Publication_Place: Washington, DC
Publisher: Federal Emergency Management Agency
Data_Quality_Information:
Attribute_Accuracy:
Attribute_Accuracy_Report:
The DFIRM Database consists of countywide vector files and associated attributes produced in conjunction with the hardcopy FEMA FIRMs. The published effective FIRM and DFIRM are issued as the official designation of the SFHAs. As such, they are adopted by local communities and form the basis for administration of the NFIP. For these purposes they are authoritative. Provisions exist in the regulations for public review, appeals and corrections of the flood risk information shown to better match real world conditions. As with any engineering analysis of this type, variation from the estimated flood heights and floodplain boundaries is possible. Details of FEMA's requirements for the FISs and flood mapping process that produces these data are available in the Guidelines and Specifications for Flood Hazard Mapping Partners. Attribute accuracy was tested by manual comparison of source graphics with hardcopy plots and a symbolized display on an interactive computer graphic system.
Independent quality control testing of FEMA's DFIRM database was also performed.
To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables contained within the FIS report that accompanies this DFIRM database. Users should be aware that BFEs shown in the S_BFE table represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be used in conjunction with the FIRM for purposes of construction and/or floodplain management. The 1-percent-annual-chance water-surface elevations shown in the S_XS table match the regulatory elevations shown in the FIS report.
Logical_Consistency_Report:
When FEMA revises an FIS, adjacent studies are checked to ensure agreement between flood elevations at the boundaries of the studies. Likewise, flood elevations at the confluence of streams studied independently are checked to ensure agreement at the confluence. The FIRM and the FIS are developed together and care is taken to ensure that the elevations and other features shown on the flood profiles in the FIS agree with the information shown on the FIRM. However, the elevations as shown on the FIRM are rounded whole-foot elevations. They must be shown so that a profile recreated from the elevations on the FIRM will match the FIS profiles within one half of one foot.

Completeness_Report:
The data contained in the DFIRM Database files reflect the content of the source materials. Features may have been eliminated or generalized on the source graphic, due to scale and legibility constraints. With new mapping, FEMA plans to maintain full detail in the spatial data it produces. However, older information is often transferred from existing maps where some generalization has taken place.
Flood risk data are developed for communities participating in the NFIP for use in insurance rating and for floodplain management. Flood hazard areas are determined using statistical analyses of records of river flow, storm tides, and rainfall, information obtained through consultation with the communities, floodplain topographic surveys, and hydrological and hydraulic analysis. Both detailed and approximate analyses are employed. Generally, detailed analyses are used to generate flood risk data only for developed or developing areas of communities. For areas where little or no development is expected to occur, FEMA uses approximate analyses to generate flood risk data. Typically, only drainage areas that are greater than one square mile are studied.
Positional_Accuracy:
Horizontal_Positional_Accuracy:
Horizontal_Positional_Accuracy_Report:
The DFIRM Database consists of countywide vector files and associated attributes produced in conjunction with the hard copy FEMA FIRMs. The published effective FIRM and DFIRM maps are issued as the official designation of the SFHAs. As such they are adopted by local communities and form the basis for administration of the NFIP. For these purposes they are authoritative. Provisions exist in the regulations for public review, appeals and corrections of the flood risk information shown to better match real world conditions. As with any engineering analysis of this type, variation from the estimated flood heights and floodplain boundaries is possible. Details of FEMA's requirements for the FISs and flood mapping process that produces these data are available in the Guidelines and Specifications for Flood Hazard Mapping Partners. Horizontal accuracy was tested by manual comparison of source graphics with hardcopy plots and a symbolized display on an interactive computer graphic system.
Independent quality control testing of FEMA's DFIRM database was also performed.
Vertical_Positional_Accuracy:
Vertical_Positional_Accuracy_Report:
The DFIRM Database consists of countywide vector files and associated attributes produced in conjunction with the hard copy FEMA FIRMs. The published effective FIRM and DFIRM maps are issued as the official designation of the SFHAs. As such they are adopted by local communities and form the basis for administration of the NFIP. For these purposes they are authoritative. Provisions exist in the regulations for public review, appeals and corrections of the flood risk information shown to better match real world conditions. As with any engineering analysis of this type, variation from the estimated flood heights and floodplain boundaries is possible. Details of FEMA's requirements for the FISs and flood mapping process that produces these data are available in the Guidelines and Specifications for Flood Hazard Mapping Partners. Vertical accuracy was tested by manual comparison of source graphics with hardcopy plots and a symbolized display on an interactive computer graphic system.

Independent quality control testing of FEMA's DFIRM database was also performed.
Source_Information:
Source_Citation:
Citation_Information:
Originator: Federal Emergency Management Agency
Publication_Date: 1987
Title:
Flood Insurance Study, FLOOD COUNTY USA (Unincorporated areas).
Geospatial_Data_Presentation_Form: map
Publication_Information:
Publication_Place: Washington, DC
Publisher: Federal Emergency Management Agency
Other_Citation_Details:
The hydrologic and hydraulic analyses for the FIS dated April 17, 1987, were prepared by the U.S. Army Corps of Engineers (USACE), Springfield District, for the Federal Emergency Management Agency

(FEMA), under Inter-Agency Agreement No. EMW-84-E-1506. That work was completed in December 1985. Denominator_of_Source_Scale: 2400-12000
Source_Scale_Denominator: 12,000
Type_of_Source_Media: paper
Source_Time_Period_of_Content:
Time_Period_Information:
Single_Date/Time:
Calendar_Date: 19870601
Source_Currentness_Reference: Effective Date
Source_Citation_Abbreviation: FIS1
Source_Contribution:
Spatial and attribute information, floodplain widths, BFEs, floodplain location.
Source_Information:
Source_Citation:
Citation_Information:
Originator:
Federal Emergency Management Agency
Publication_Date: 1987
Title: Flood Insurance Study, FLOODVILLE, Town of
Geospatial_Data_Presentation_Form: map
Publication_Information:
Publication_Place: Washington, DC
Publisher: Federal Emergency Management Agency
Other_Citation_Details:
The hydrologic and hydraulic analyses for the FIS report dated April 17, 1987, were prepared by the USACE, Springfield District, for the FEMA, under Inter-Agency Agreement No. EMW-84-E-1506, Project Order No. 1, Amendment No. 4. That work was completed in December 1985. Denominator_of_Source_Scale: 2400-12000
Source_Scale_Denominator: 12, 000
Type_of_Source_Media: paper
Source_Time_Period_of_Content:
Time_Period_Information:
Single_Date/Time:
Calendar_Date: 19870601
Source_Currentness_Reference: Effective Date
Source_Citation_Abbreviation: FIS2
Source_Contribution:
Spatial and attribute information, floodplain widths, BFEs, floodplain location.
Source_Information:
Source_Citation:
Citation_Information:
Originator: Federal Emergency Management Agency
Publication_Date: 1998
Title:
Flood Insurance Study Report, FLOOD COUNTY, USA and Incorporated areas.
Geospatial_Data_Presentation_Form: map
Publication_Information:
Publication_Place: Washington, DC
Publisher: Federal Emergency Management Agency
Other_Citation_Details:
For this countywide FIS, the hydrologic and hydraulic analyses were prepared by USACE for FEMA, under Inter-Agency Agreement No. EMW-94-C-0019. This work was completed in October 1995. Denominator_of_Source_Scale: 2400-12000
Source_Scale_Denominator: 12000
Type_of_Source_Media: paper
Source_Time_Period_of_Content:

Time_Period_Information:
Single_Date/Time:
Calendar_Date: 19980701
Source_Currentness_Reference: Effective Date
Source_Citation_Abbreviation: FIS3
Source_Contribution:
Spatial and attribute information, floodplain widths, BFEs, floodplain location.
Source_Information:
Source_Citation:
Citation_Information:
Originator:
Town of Floodville Stormwater Management Department, 126 Royal Oaks Drive, Suite 201, Floodville, USA 99150
Publication_Date: 1995
Title: Base map for Floodville, USA
Geospatial_Data_Presentation_Form: vector digital data
Publication_Information:
Publication_Place: Floodville, USA
Publisher: Town of Floodville Stormwater Management
Other_Citation_Details:
These files were photogrammetrically compiled at scales of 1"=200' (urban areas) and 1"=400' (rural areas) from aerial photographs.
Source_Scale_Denominator: 4, 800
Type_of_Source_Media: CD-ROM
Source_Time_Period_of_Content:
Time_Period_Information:
Single_Date/Time:
Calendar_Date: 19950301
Source_Currentness_Reference: ground conditions
Source_Citation_Abbreviation: BASE1
Source_Contribution:
Location of roads, railroads, bridges, streams and other physical features shown.
Source_Information:
Source_Citation:
Citation_Information:
Originator:
Flood County Geographic Information Systems Department, 1110 South Road, Suite 205, Floodville, USA 99150
Publication_Date: 1995
Title: Base map for Flood County, USA
Geospatial_Data_Presentation_Form: vector digital data
Publication_Information:
Publication_Place: Floodville, USA
Publisher: Flood County Geographic Information Systems Department
Other_Citation_Details:
These files were photogrammetrically compiled at scales of 1"=200' (urban areas) and 1"=400' (rural areas) from aerial photographs.
Source_Scale_Denominator: 4,800
Type_of_Source_Media: CD-ROM
Source_Time_Period_of_Content:
Time_Period_Information:
Single_Date/Time:
Calendar_Date: 19950301
Source_Currentness_Reference: ground conditions
Source_Citation_Abbreviation: BASE2
Source_Contribution:

Location of roads, railroads, bridges, streams and other physical features shown.
Source_Information:
Source_Citation:
Citation_Information:
Originator:
U.S. Geological Survey
Publication_Date: 1998
Title: Digital Orthophoto Quadrangle
Geospatial_Data_Presentation_Form: remote-sensing image
Publication_Information:
Publication_Place: Reston, VA
Publisher: U.S. Geological Survey
Other_Citation_Details: The digital orthophoto quadrangle (DOQ) is a 1-meter ground resolution, quarter-quadrangle (3.75-minutes of latitude by 3.75-minutes of longitude) image cast on the Universal Transverse Mercator Projection (UTM) on the North American Datum of 1983 (NAD83). The imagery is based on panchromatic black and white (or color infra-red) NAPP or NAPP-like photography.
Source_Scale_Denominator: 12,000
Type_of_Source_Media: CD-ROM
Source_Time_Period_of_Content:
Time_Period_Information:
Single_Date/Time:
Calendar_Date: 19970301
Source_Currentness_Reference: ground conditions
Source_Citation_Abbreviation: BASE3
Source_Contribution:
Location of roads, railroads, bridges, streams and other physical features shown.
Process_Step:
Process_Description:
The DFIRM Database is compiled in conjunction with the hard copy FIRM and the Final printed FIS report. The specifics of the hydrologic and hydraulic analyses performed are detailed in the FIS report. The results of these studies are submitted in digital format to FEMA. These data and unrevised data from effective FIRMs are compiled onto the base map used for DFIRM publication and checked for accuracy and compliance with FEMA standards.
Source_Used_Citation_Abbreviation: FIS1-FIS3, BASE1-BASE3
Process_Date: 1996
Spatial_Data_Organization_Information:
Direct_Spatial_Reference_Method: Vector and raster
Point_and_Vector_Object_Information:
SDTS_Terms_Description:
SDTS_Point_and_Vector_Object_Type: Point
SDTS_Terms_Description:
SDTS_Point_and_Vector_Object_Type: String
SDTS_Terms_Description:
SDTS_Point_and_Vector_Object_Type: GT-polygon composed of chains
Raster_Object_Information:
Raster_Object_Type: Pixel
Spatial_Reference_Information:
Horizontal_Coordinate_System_Definition:
Planar:
Grid_Coordinate_System:
Grid_Coordinate_System_Name: Universal Transverse Mercator
Universal_Transverse_Mercator:
UTM_Zone_Number: 16
Transverse_Mercator:
Scale_Factor_at_Central_Meridian: 0.9996
Longitude_of_Central_Meridian: -87.0

Latitude_of_Projection_Origin: 0.0
False_Easting: 500000
False_Northing: 0.0
Planar_Coordinate_Information:
Planar_Coordinate_Encoding_Method: Coordinate Pair
Coordinate_Representation:
Abscissa_Resolution: 0.061
Ordinate_Resolution: 0.061
Planar_Distance_Units: meters
Geodetic_Model:
Horizontal_Datum_Name: North American Datum 1983
Ellipsoid_Name: Geodetic Reference System 80
Semi-major_Axis: 6378206.4
Denominator_of_Flattening_Ratio: 294.98
Vertical_Coordinate_System_Definition:
Altitude_System_Definition:
Altitude_Datum_Name: National Geodetic Vertical Datum of 1929
Altitude_Resolution: 0.03
Altitude_Distance_Units: feet
Altitude_Encoding_Method:
Attribute Values
Entity_and_Attribute_Information:
Overview_Description:
Entity_and_Attribute_Overview:
The DFIRM Database is made up of several data themes containing both spatial and attribute information. These data together represent the current flood risk for the subject area as identified by FEMA. The attribute tables include SFHA locations, flood zone designations, BFEs, political entities, cross-section locations, FIRM panel information, and other data related to the NFIP.
Entity_and_Attribute_Detail_Citation:
Appendix L of FEMA's Guidelines and Specifications for FEMA Flood Hazard Mapping Partners contains a detailed description of each attribute code and a reference to other relevant information.
Entity_and_Attribute_Detail_Citation:
The following tables are included in this data set:
L_Riv_Model
S_BFE
S_Fld_Haz_Ar
S_Fld_Haz_Ln
S_Gen_Struct
S_LOMR
L_Stn_Start
S_Wtr_Ar
S_Wtr_Ln
S_XS
L_Wtr_Nm
S_DOQ_Index
S_Perm_Bmk
S_PLSS_AR
S_PLSS_LN
S_Pol_Ar
S_Pol_Ln
S_Quad
S_Label_Ld
S_Trnsport_Ln
S_Label_Pt
S_Wtr_Ar
S_Wtr_Ln

Distribution_Information:
Distributor:
Contact_Information:
Contact_Organization_Primary:
Contact_Organization: Mapping Partner Contact
Contact_Address:
Address_Type: mailing address
Address: Mapping Partner Address
City: Mapping Partner City
State_or_Province: Mapping Partner State
Postal_Code: Mapping Partner Zip Code
Country: Mapping Partner Country
Contact_Voice_Telephone: Mapping Partner Phone Number
Contact_Electronic_Mail_Address:
Mapping Partner Email Address
Contact_Instructions:
Details for Mapping Partner distribution of data
Distribution_Liability:
Mapping Partner Liability Disclaimer
Standard_Order_Process:
Non-digital_Form:
Information about hardcopy versions available
Fees: Contact Distributor
Standard_Order_Process:
Digital_Form:
Digital_Transfer_Information:
Format_Name: Mapping Partner Data Format
Format_Version_Number: 1
Digital_Transfer_Option:
Offline_Option:
Offline_Media: CD-ROM
Recording_Format: ISO 9660
Fees:
Contact Distributor
Metadata_Reference_Information:
Metadata_Date: 19980509
Metadata_Contact:
Contact_Information:
Contact_Organization_Primary:
Contact_Organization: Mapping Partner Contact
Contact_Position: Mapping Partner Position
Contact_Address:
Address_Type: mailing address
Address: Mapping Partner Address
City: Mapping Partner City
State_or_Province: Mapping Partner State
Postal_Code: Mapping Partner Zip Code
Country: Mapping Partner Country
Contact_Voice_Telephone: Mapping Partner Phone
Contact_Electronic_Mail_Address:
Mapping Partner Email Address
Metadata_Standard_Name: FGDC Content Standards for Digital Geospatial Metadata
Metadata_Standard_Version: FGDC-STD-001-1998

[February 2002]

L.7 Database Table Structure Requirements for Preliminary and Final Digital Flood Insurance Rate Map Databases

Table: S_BFE

The Base Flood Elevation (BFE) table is required for any digital data where BFE lines will be shown on the corresponding Flood Insurance Rate Map (FIRM). Normally if there are any riverine AE zones, BFE lines are required.

The S_BFE table contains information about the BFEs within a study area. A spatial file with locational information also corresponds with this data table. BFE lines indicate the rounded whole-foot water surface elevation of the 1-percent-annual-chance flood.

The spatial elements representing BFE features are lines extending from Special Flood Hazard Area (SFHA) boundary to SFHA boundary. The BFE lines will have no visible gaps or overshoots between the SFHA boundary and the end of the BFE line at the publication scale of the DFIRM. However, the ends of the BFE lines are not necessarily snapped precisely to the SFHA boundary. Each BFE is represented by a single line. While BFE lines are depicted as wavy lines on the hardcopy FIRM, they should be primarily straight lines in the spatial data, although they may bend consistent with procedures described in Volume 1 of these Guidelines.

The S_BFE table contains the following elements.

BFE_LN_ID	R Primary key for table lookup. Assigned by table creator.
ELEV	R BFE. The rounded, whole-foot elevation of the 1-percent-annual-chance flood. This is the value of the BFE that is printed next to the BFE line on the FIRM.
UNITS	R BFE Units. This unit indicates the measurement system used for the BFEs. Normally this would be feet. Acceptable values for this field are listed in the D_Units table.
V_DATUM	R Vertical Datum. The vertical datum indicates the reference surface from which the flood elevations are measured. Normally this would be North American Vertical Datum of 1988 for new studies. Acceptable values for this field are listed in the D_V_Datum table.
SOURCE_CIT	R Source Citation. Abbreviation used in the metadata file when describing the source information for the S_BFE table.

Name	Type	Size
BFE_LN_ID	Text	11
ELEV	Single	4.2
UNITS	Text	20
V_DATUM	Text	6
SOURCE_CIT	Text	11

Table: S_CBRS

This table only applies to coastal areas that have specially protected areas designated by Congress on Coastal Barrier Resources System (CBRS) maps. Authoritative CBRS boundary locations are shown on Fish and Wildlife Service maps. Normally these areas are already shown on existing Federal Emergency Management Agency (FEMA) maps for the area. CBRS areas have restrictions on insurance coverage after specified dates for new or substantially improved structures. See Appendix K of these Guidelines for more detailed information about CBRS areas.

The S_CBRS table contains information about the CBRS areas within the study area, if applicable. A spatial file with locational information also corresponds with this data table.

The spatial elements representing CBRS features are closed polygons. Each contiguous CBRS area of the same CBRS_TYP and same CBRS_DATE must be a single polygon.

The S_CBRS table contains the following elements.

CBRS_ID — R Primary key for table lookup. Assigned by table creator.

CBRS_TYP — R CBRS Type. The type code provides details of the types of prohibitions that apply to the area. Normally this would be a CBRS area or Otherwise Protected Area (OPA). Acceptable values for this field are listed in the D_CBRS_Type table.

CBRS_DATE — R Legislation Date on which restrictions for the CBRS area began. This must be indicated on the Flood Insurance Rate Map as a note or with a fill pattern indicated on the legend.

CBRS_TF — R This field is True if the area is a CBRS or an OPA.

SOURCE_CIT — R Source Citation. Abbreviation used in the metadata file when describing the source information for the S_CBRS table.

Name	Type	Size
CBRS_ID	Text	11
CBRS_TYP	Text	35
CBRS_DATE	Date/Time	8
CBRS_TF	Text	1
SOURCE_CIT	Text	11

Table: S_Cst_Tsct_Ln

This table is required when the corresponding Flood Insurance Rate Map (FIRM) and/or Flood Insurance Study (FIS) will show coastal transect locations. Normally this is any area with a coastal study.

The S_Cst_Tsct_Ln table contains information about the Coastal Transect Lines within the study area, if applicable. The transect lines indicate the location that was used to provide representative topographic information for the coastal flood models used. A spatial file with locational information also corresponds with this data table.

The spatial elements representing coastal transects are lines generally extending from offshore all the way across the coastal floodplain. Each transect should be represented by a single line feature without the circles on each end shown on the hard copy map. The location and shape of the lines must depict as accurately as possible the position of the transect used.

The S_Cst_Tsct_Ln table contains the following elements.

TRAN_LN_ID R Primary key for table lookup. Assigned by table creator.

TRAN_NO R Transect number as shown on FIRM or in FIS report. Each transect is normally numbered sequentially.

CST_MDL_ID A Coastal Model Identification. This field is populated by a linking element to the L_Cst_Model table. The L_Cst_Model table contains detailed information about the coastal models that were used to determine the coastal flood hazard for the area of this transect line. This ID field must contain a number that matches the CST_MDL_ID field for a record in the L_Cst_Model table that documents coastal model information for this transect. Multiple transects may link to a single record in the L_Cst_Model table. This field is not required for digital conversion of an existing FIS. Significant additional research may be required to identify the model that applies at a transect. However, for new coastal studies, this field must be populated.

SOURCE_CIT R Source Citation. Abbreviation used in the metadata file when describing the source information for the S_Cst_Tsct_Ln table.

Name	Type	Size
TRAN_LN_ID	Text	11
TRAN_NO	Text	4
CST_MDL_ID	Text	11
SOURCE_CIT	Text	11

Table: S_DOQ_Index

This table is required if digital orthophotography was used as the base map for the Flood Insurance Rate Map (FIRM).

The S_DOQ_Index table contains information about the digital orthophotography used as a base map for the study area. A spatial file with locational information also corresponds with this data table.

The spatial elements representing digital orthophotography index features are rectangular polygons. For standard U.S. Geological Survey Digital Ortho Quadrangles, polygons must match quarter-quad boundaries (excluding overedge). Otherwise, polygons must match the boundaries of the orthophotography used (excluding overedge if present).

The S_DOQ_Index table contains the following elements.

DOQ_ID — R Primary key for table lookup. Assigned by table creator.

FILENAME — R DOQ Filename. This filename must be assigned by the digital orthophotography provider or the table creator. The filename should match the filename assigned by the primary distributor of the orthophotography used. This must be the complete filename including the file extension.

DOQ_DATE — R Digital Orthophotography Date. This is the date that the orthophotography was flown.

SOURCE_CIT — R Source Citation. Abbreviation used in the metadata file when describing the source information for the S_DOQ_Index table.

Name	Type	Size
DOQ_ID	Text	11
FILENAME	Text	50
DOQ_DATE	Date/Time	8
SOURCE_CIT	Text	11

Table: S_FIRM_Pan

This table is required for all preliminary or final DFIRM databases.

The S_FIRM_Pan table contains information about the Flood Insurance Rate Map (FIRM) panel area. A spatial file with locational information also corresponds with this data table.

The spatial entities representing FIRM panels are polygons. The polygon for the FIRM panel corresponds to the geographic area where effective flood hazard information is depicted on the FIRM panel. Where a portion of the area within the FIRM panel neatline is outside the jurisdiction mapped by this FIRM, the panel boundary in the Digital Flood Insurance Rate Map spatial data must follow the boundary of the jurisdiction mapped by the FIRM. So for a single jurisdiction FIRM, the outermost panel boundaries would follow the community boundary. For a countywide FIRM, the outermost panel boundaries would follow the county boundary.

The S_FIRM_Pan table contains the following elements.

FIRM_ID	R Primary key for table lookup. Assigned by table creator.
ST_FIPS	R State FIPS. This is the two-digit code that corresponds to the state Federal Information Processing Standard (FIPS) code. This is a standard numbering system that is used by the Federal government. Defined in FIPS Pub 6-4. These two numbers correspond to the first two digits of the panel number.
PCOMM	R Community or County Identification Number. This is the 3rd through the 6th digits of the panel number. For community based maps this corresponds to the Federal Emergency Management Agency (FEMA) Community Identification number. For countywide maps this is the county (or county equivalent) FIPS code with a "C".
PANEL	R Panel Number. This is 7th through the 10th digits in the complete panel number. This is assigned by the scale of the map and the position within the community or county. The panel number scheme is described in detail in Appendix K of these Guidelines.
SUFFIX	R Map Suffix. This is the final digit in the complete panel number. This is a letter suffix at the end of the panel number.
FIRM_PAN	R FIRM Panel Number. This is the complete FIRM panel number, which is made up of ST_FIPS, PCOMM, PANEL, and SUFFIX. This is the 11-digit FIRM panel number that is shown in the title block of the map.
PANEL_TYP	R Panel Type. The type of FIRM panel that identifies whether the panel is printed or not printed and whether it is community based or countywide

	mapping. Acceptable values for this field are listed in the D_Panel_Typ table.
EFF_DATE	A Effective Date. This is the effective date of the current map revision. This field is not populated until the FIRM effective date is established and the Final FIRM is ready for hardcopy production by FEMA. Then it is required.
SCALE	R Map Scale. This is the denominator of the FIRM scale as a ratio. For example, 24000 is the denominator for a 1" = 2000' map. Acceptable values for this field are listed in the D_Scale table.
PNP_Reason	A Panel Not Printed Reason. This is the explanation of the reason for the FIRM panels that are not printed. See Appendix K of these Guidelines for a listing of Panel Not Printed reasons that may be used. Only completed if the hardcopy panel is not printed by FEMA.
NW_LAT	R Northwest Latitude. This is the latitude of the northwest corner of the FIRM panel neatline. This value is in degrees, minutes, seconds (DDD MM SS.SSS). Normally this corresponds to U.S. Geological Survey (USGS) 7.5' quadrangle maps using North American Datum of 1983 (NAD83), or even subdivisions thereof. However this value must reflect the actual latitude if non-standard panel sizes are used.
NW_LONG	R Northwest Longitude. This is the longitude of the northwest corner of the FIRM panel. This value is in degrees, minutes, seconds (DDD MM SS.SSS). Normally this corresponds to USGS 7.5' quadrangle maps using NAD83, or even subdivisions thereof. However this value must reflect the actual longitude if non-standard panel sizes are used.
SE_LAT	R Southeast Latitude. This is the latitude of the southeast corner of the FIRM panel. This value is in degrees, minutes, seconds (DDD MM SS.SSS). Normally this corresponds to USGS 7.5' quadrangle maps using NAD83, or even subdivisions thereof. However this value must reflect the actual latitude if non-standard panel sizes are used.
SE_LONG	R Southeast Longitude. This is the longitude of the southeast corner of the FIRM panel. This value is in degrees, minutes, seconds (DDD MM SS.SSS). Normally this corresponds to USGS 7.5' quadrangle maps using NAD83, or even subdivisions thereof. However this value must reflect the actual longitude if non-standard panel sizes are used.
SOURCE_CIT	R Source Citation. Abbreviation used in the metadata file when describing the source information for the S_FIRM_Pan table.

Name	Type	Size
FIRM_ID	Text	11
ST_FIPS	Text	2
PCOMM	Text	4
PANEL	Text	4
SUFFIX	Text	1
FIRM_PAN	Text	11
PANEL_TYP	Text	35
EFF_DATE	Date/Time	8
SCALE	Text	5
PNP_REASON	Text	50
NW_LAT	Text	15
NW_LONG	Text	15
SE_LAT	Text	15
SE_LONG	Text	15
SOURCE_CIT	Text	11

Table: S_Fld_Haz_Ar

This table is required for all preliminary or final DFIRM databases.

The S_Fld_Haz_Ar table contains information about the flood hazard within the study area. A spatial file with locational information also corresponds with this data table. These zones are used by the Federal Emergency Management Agency (FEMA) to designate the Special Flood Hazard Areas (SFHAs) and for insurance rating purposes. These data are the flood hazard areas that are or will be depicted on the Flood Insurance Rate Map (FIRM).

The spatial elements representing the flood zones are polygons. The entire area of the jurisdiction(s) mapped by the FIRM must have a corresponding flood zone polygon.

The S_Fld_Haz_Ar table contains the following elements.

FLD_AR_ID	R	Primary key for table lookup. Assigned by table creator.
FLD_ZONE	R	Flood Zone. This is a flood zone designation. These zones are used by FEMA to designate the SFHAs and for insurance rating purposes. NOTE: The symbol '%' is a reserved symbol in most software packages so the word 'percent' was abbreviated to 'pct'. Acceptable values for this field are listed in the D_Zone table.
FLOODWAY	A	Floodway Type. Floodway areas are designated by FEMA and adopted by communities to provide an area that will remain free of development to moderate increases in flood heights due to encroachment on the floodplain. Normal floodway areas are 'floodway'. Special cases will have a note on the hardcopy FIRM. If the corresponding area is not designated as a floodway, this field is null. Acceptable values for this field are listed in the D_Floodway table.
SFHA_TF	R	SFHA. If the area is within an SFHA this field would be True. This field will be true for any area that is coded for any A or V zone flood areas. It must be false for any X or D zone flood areas.
STATIC_BFE	A	Static Base Flood Elevation (BFE). For areas of constant base flood elevation, the BFE is shown beneath the zone label rather than on a BFE line. In this situation the same BFE applies to the entire polygon. This is normally occurs in lakes or coastal zones. This field is only populated where a static BFE is shown on the FIRM.
V_DATUM	A	Vertical Datum. The vertical datum indicates the reference surface from which the flood elevations are measured. Normally this would be North American Vertical Datum of 1988 for new studies. This field is only populated if the STATIC_BFE field is populated. Acceptable values for this field are listed in the D_V_Datum table.

DEPTH — A Depth Value for Zone AO Areas. This is shown beneath the zone label on the FIRM. This field is only populated if a depth is shown on the FIRM.

UNITS — A BFE Units. This unit indicates the measurement system used for the BFEs. Normally this would be feet. This field is only populated if the STATIC_BFE or DEPTH field is populated. Acceptable values for this field are listed in the D_Units table.

VELOCITY — A Velocity Measurement. For alluvial fan areas (certain Zone AO areas), this is shown beneath the zone label on the FIRM. This value represents the velocity of the flood flow in this area. This field is only populated when a velocity is shown on the FIRM.

VEL_UNITS — A Unit of Measurement for the Velocity Attribute. This is shown in the legend where alluvial fans are present. This field is only populated if the VELOCITY field is populated.

AR_REVERT — A If the area is Zone AR, this field would hold the zone that the area would revert to if the AR zone were removed. This field is only populated if the corresponding area is Zone AR. Acceptable values for this field are listed in the D_Zone table.

BFE_REVERT — A If Zone is Zone AR, this field would hold that static base flood elevation for the reverted zone. This field is populated when Zone equals AR and the reverted zone has a static BFE.

SOURCE_CIT — R Source Citation. Abbreviation used in the metadata file when describing the source information for the S_Fld_Haz_Ar table.

Name	Type	Size
FLD_AR_ID	Text	11
FLD_ZONE	Text	55
FLOODWAY	Text	30
SFHA_TF	Text	1
STATIC_BFE	Single	4.2
V_DATUM	Text	6
DEPTH	Single	4.2
UNITS	Text	20
VELOCITY	Single	4.2
VEL_UNITS	Text	20
AR_REVERT	Text	6
BFE_REVERT	Single	4.2
SOURCE_CIT	Text	11

Table: S_Fld_Haz_Ln

This table is required for all preliminary or final DFIRM databases.

The S_Fld_Haz_Ln table contains information about the flood hazard line features for the study area. A spatial file with locational information also corresponds with this data table.

The spatial elements representing the boundaries of the flood hazard areas depicted on the Flood Insurance Rate Map (FIRM) are lines.

The S_Fld_Haz_Ln table contains the following elements.

FLD_LN_ID — R Primary key for table lookup. Assigned by table creator.

LN_TYP — R Line Type. These line types describe the flood boundary and may be used to indicate how the feature must be depicted on the hardcopy FIRM. Acceptable values for this field are listed in the D_Ln_Typ table.

SOURCE_CIT — R Source Citation. Abbreviation used in the metadata file when describing the source information for the S_Fld_Haz_Ln table.

Name	Type	Size
FLD_LN_ID	Text	11
LN_TYP	Text	45
SOURCE_CIT	Text	11

Table: S_Gen_Struct

This table is required whenever hydraulic structures are shown in the flood profile. It is also required if levees are shown on the FIRM, channels containing the flooding are shown on the FIRM, or any other structure that impacts the area's flood risk is shown on the FIRM.

The S_Gen_Struct table contains information about the hydraulic structures within the study area. It must include all structures shown in the flood profiles. In addition, levees, sea walls, channels that contain flooding, and other significant flood control structures shown on the Flood Insurance Rate Map (FIRM) must be included. A spatial file with locational information also corresponds with this data table.

Spatial elements representing general structures are represented by lines. The lines must represent the primary characteristic of the structure. For example, bridges must be represented by the transportation centerline carried by the bridge. Dams must be represented by a line corresponding to the top of the dam. Levees must be represented by a line corresponding to the top of levee. A line corresponding to the centerline of the main barrel must represent a culvert.

The S_Gen_Struct table contains the following elements.

STRUCT_ID — R Primary key for table lookup. Assigned by table creator.

STRUCT_TYP — R Structure Type. Hydraulic structures within the study area. Acceptable values for this field are listed in the D_Struct_Typ table.

STRUCT_NM — A Structure Name. This is the name of the feature and the name that will be shown on the hardcopy FIRM. Blank if the structure is not named on FIRM and/or the name is unknown.

WTR_NM — R Surface Water Feature Name. This is the formal name of the surface water feature associated with the structure, as it will appear on the hardcopy FIRM.

SOURCE_CIT — R Source Citation. Abbreviation used in the metadata file when describing the source information for the S_Gen_Struct table.

Name	Type	Size
STRUCT_ID	Text	11
STRUCT_TYP	Text	15
STRUCT_NM	Text	50
WTR_NM	Text	100
SOURCE_CIT	Text	11

Table: S_Label_Ld

This table is required for Digital Flood Insurance Rate Map (DFIRM) data if any label leader lines are shown on the hardcopy FIRM.

The S_Label_Ld table contains information about leader lines that would connect labels to feature locations on base maps. The purpose of this table, along with the S_Label_Pt table is so that the Digital Flood Insurance Rate Map (DFIRM) database can contain the names of roads and other physical features in or near the Special Flood Hazard Areas regardless of the type or structure of the base map used. A spatial file with locational information also corresponds with this data table.

The spatial entities representing label leaders will be lines.

The S_Label_Ld table contains the following element.

LEADER_ID — R Primary key for table lookup. Assigned by table creator.

LABEL_TYPE — R Label type. This is a description of the planimetric features to which the labels and leaders are associated. For vector based maps, the labels and leaders will be associated with vector features in S_Trnsport_Ln, S_Wtr_Ar and S_Wtr_Ln. For maps with an ortho-photo base, the labels and leaders will be associated with DOQ water and transportation features. For maps that use both vector features and ortho-photos, all values may apply. Acceptable values for this field are listed in the D_Label_Typ table.

Name	Type	Size
LEADER_ID	Text	11
LABEL_TYPE	Text	20

Table: S_Label_Pt

This table is required for all preliminary or final DFIRM databases.

The S_Label_Pt table contains information for point locations that would link labels to base map features. The purpose of this table, along with the S_Label_Ld table is so that the Digital Flood Insurance Rate Map (DFIRM) database can contain the names of roads and other physical features in or near the Special Flood Hazard Areas (SFHAs) regardless of the type or structure of the base map used. A spatial file with locational information also corresponds with this data table.

The spatial entities representing labels are points. The point corresponds to the lower left corner of the label.

The S_Label_Pt table contains the following elements.

LABEL_ID R Primary key for table lookup. Assigned by table creator.

LABEL R Label for map Feature.

LABEL_TYPE R Label type. This is a description of the planimetric features to which the labels and leaders are associated. For vector based maps, the labels and leaders will be associated with vector features in S_Trnsport_Ln, S_Wtr_Ar and S_Wtr_Ln. For maps with an ortho-photo base, the labels and leaders will be associated with DOQ water and transportation features. For maps that use both vector features and ortho-photos, all values may apply. Acceptable values for this field are listed in the D_Label_Typ table.

DEGREES R The degrees of rotation required for the placement of a feature label onto a Flood Insurance Rate Map panel.

Name	Type	Size
LABEL_ID	Text	11
LABEL	Text	255
LABEL_TYPE	Text	20
DEGREES	Integer	4

Table: S_LOMR

This table is required when a Mapping Partner incorporates the results of effective Letters of Map Revision (LOMRs) into the draft Digital Flood Insurance Rate Map (DFIRM) data submitted to the Federal Emergency Management Agency (FEMA).

The S_LOMR table contains information about LOMR areas that are incorporated into the Flood Insurance Rate Map (FIRM). This table is planned as a mechanism for DFIRM producers to communicate areas of the DFIRM data that were updated to reflect the results of LOMRs. It is included in the draft DFIRM data submittal. It is not planned for distribution by FEMA once a complete map revision has incorporated these LOMRs into the effective FIRM panel. Therefore it is not included in the Preliminary or Final DFIRM data. A spatial file with locational information also corresponds with this data table.

The spatial entities representing LOMRs are polygons. The spatial information contains the bounding polygon for each LOMR area.

The S_LOMR table contains the following elements.

LOMR_ID R Primary key for table lookup. Assigned by table creator.

EFF_DATE R Effective Date of the LOMR.

CASE_NO R Case Number. This is the case number of the LOMR that is assigned by FEMA. The case number is used to track the LOMR's supporting documentation.

SCALE R Map Scale. This is the denominator of the effective LOMR scale as a ratio. For example, 24000 is the denominator for a 1" = 2000' map.

SOURCE_CIT R Source Citation. Abbreviation used in the metadata file when describing the source information for the S_LOMR table.

Name	Type	Size
LOMR_ID	Text	11
EFF_DATE	Date/Time	8
CASE_NO	Text	13
SCALE	Text	5
SOURCE_CIT	Text	11

Table: S_Perm_Bmk

This table is required unless there are no National Geodetic Survey (NGS) or other bench marks that meet the minimum standard in the jurisdiction covered by the Flood Insurance Rate Map (FIRM).

The S_Perm_Bmk table contains information about Permanent Bench Marks that are associated with the study area. The bench marks shown in this file must meet the requirements specified in Subsection 1.4.1.4.1. A spatial file with locational information also corresponds with this data table.

The spatial entities representing bench marks are points. Generally, the assigned Mapping must place these points based on the coordinates in the NGS database. However, the horizontal coordinates maintained by the NGS for vertical bench marks is often not very precise because the users usually rely on the location descriptions to locate the bench marks. If the source of the horizontal coordinates used by the NGS is not precise, the Mapping Partner may adjust the position based on better available data.

The S_Perm_Bmk table contains the following elements.

BM_ID — R Primary key for table lookup. Assigned by table creator.

PID — R Permanent Identifier. This must be the NGS assigned or community assigned permanent identifier. It must be unique for each benchmark.

SOURCE_CIT — R Source Citation. Abbreviation used in the metadata file when describing the source information for the S_Perm_Bmk table.

Name	Type	Size
BM_ID	Text	11
PID	Text	11
SOURCE_CIT	Text	11

Table: S_PLSS_Ar

This table is required when U.S. Public Land Survey System (PLSS) areas are shown on the Flood Insurance Rate Map.

The S_PLSS_Ar table contains information about PLSS areas that are associated with the study area, if applicable. This would include the attributes for the range, township, and section areas. A spatial file with locational information also corresponds with this data table.

The spatial elements representing the PLSS areas are polygons. Generally there is one polygon per section. The PLSS areas must cover the entire jurisdiction where sections are defined. The S_PLSS_Ar table contains the following elements.

PLSS_AR_ID — R Primary key for table lookup. Assigned by table creator.

RANGE — A Range Number. This is the range number assigned to the PLSS area shown. This attribute would also include the designation of E (east) or W (west) as part of the data. For example, 21W would be an acceptable value. This field is applicable whenever the SECT_NO does not equal zero.

TWP — A Township. This is the township number assigned to the PLSS area shown. This attribute would also include the designation of N (north) or S (south) as part of the data. For example, 14S would be an acceptable value. This field is applicable whenever the SECT_NO does not equal zero.

SECT_NO — R Section. This is the section number assigned to the PLSS area shown.

SOURCE_CIT — R Source Citation. Abbreviation used in the metadata file when describing the source information for the S_PLSS_Ar table.

Name	Type	Size
PLSS_AR_ID	Text	11
RANGE	Text	8
TWP	Text	8
SECT_NO	Text	4
SOURCE_CIT	Text	11

Table: S_PLSS_Ln

This table is required when U.S. Public Land Survey System (PLSS) areas are shown on the FIRM.

The S_PLSS_Ln table contains information about the boundary lines for the PLSS that is associated with the study area, if applicable. This would include the attributes for the adjacent range and township areas. A spatial file with locational information corresponds with this data table.

The spatial entities representing PLSS boundaries are lines.

The S_PLSS_Ln table contains the following elements.

PLSS_LN_ID	R	Primary key for table lookup. Assigned by table creator.
LN_TYP	R	Line Type. This describes the PLSS boundary and may be used to indicate how the feature must be depicted on the hardcopy Flood Insurance Rate Map (FIRM). Acceptable values for this field are listed in the D_Ln_Typ table.
E_RANGE	A	East Range Number. This is the range number assigned to the PLSS area shown to the east of the line feature. This number is shown on the hardcopy FIRM. This attribute would also include the designation of E (east) or W (west) as part of the data. For example, 21W would be an acceptable value. Only populated for lines that divide one range from another.
W_RANGE	A	West Range Number. This is the range number assigned to the PLSS area shown to the west of the line feature. This number is shown on the hardcopy FIRM. This attribute would also include the designation of E (east) or W (west) as part of the data. For example, 21W would be an acceptable value. Only populated for lines that divide one range from another.
N_TWP	A	North Township. This is the township number assigned to the PLSS area shown to the north of the line feature. This number is shown on the hardcopy FIRM. This attribute would also include the designation of N (north) or S (south) as part of the data. For example, 14S would be an acceptable value. Only populated for lines that divide one township from another.

S_TWP — A South Township. This is the township number assigned to the PLSS area shown to the south of the line feature. This number is shown on the hardcopy FIRM. This attribute would also include the designation of N (north) or S (south) as part of the data. For example, 14S would be an acceptable value. Only populated for lines that divide one township from another.

SOURCE_CIT — R Source Citation. Abbreviation used in the metadata file when describing the source information for the S_PLSS_Ln table.

Name	Type	Size
PLSS_LN_ID	Text	11
LN_TYP	Text	45
E_RANGE	Text	8
W_RANGE	Text	8
N_TWP	Text	8
S_TWP	Text	8
SOURCE_CIT	Text	11

Table: S_Pol_Ar

This table is required for all preliminary or final DFIRM databases.

The S_Pol_Ar table contains information about the Political Areas within the study area. This would include the attributes for the political areas and other areas such as forests, parks, military lands, and Native American lands. For the National Flood Insurance Program (NFIP), it is important to know the jurisdiction that has land use authority over an area. Political jurisdictions individually agree to participate in the NFIP and availability of insurance, floodplain regulations, and insurance rates may vary by political jurisdiction. The political jurisdiction assigned to each area corresponds to the jurisdiction responsible for NFIP and floodplain management for that area. A spatial file with locational information also corresponds with this data table.

The spatial entities representing political areas are polygons.

The S_Pol_Ar table contains the following elements.

POL_AR_ID	R Primary key for table lookup. Assigned by table creator.
POL_Name1	R Political Area Name 1. This is the primary name of the area shown. For areas that have more than one name, this would be the primary name with subsequent names shown in fields below. This would correspond to the official name of this jurisdiction used by the Federal Emergency Management Agency (FEMA) within the NFIP. For unincorporated areas of a county, this must be the county name (e.g., Montgomery County).
POL_Name2	A Political Area Name 2. This is the secondary name of the area shown. Populated if there is a common name for an area other than the official jurisdiction name.
CO_FIPS	R County Federal Information Processing Standard (FIPS) Code. This is the three-digit county FIPS code. This is a standard numbering system that is used by the Federal government. Defined in FIPS Pub 6-4.
ST_FIPS	R State FIPS. This is the two-digit code that corresponds to the state FIPS code. This is a standard numbering system that is used by the Federal government. Defined in FIPS Pub 6-4. These two numbers correspond to the first two digits of the panel number.
COMM_NO	R Community identification number. This is the four-digit number assigned by FEMA to each community for tracking purposes under the NFIP. On newer Flood Insurance Rate Maps (FIRMs) the state FIPS and the Community Identification Number (CID) appear below the community name where it is shown in the body of the map. For single jurisdiction FIRMs, this is the 3rd through the 6th digits of the panel number. This number can be obtained from the community status book that can be viewed at www.fema.gov/msc.

CID — R Community Number. This is the six-digit community number assigned by FEMA. It is created by combining the state FIPS code with the CID.

ANI_TF — R Area Not Included True/False. This is a true/false field that contains information about the geographical area to determine if it is included in the FIRM or not. Areas Not Included fall within the extent of the FIRM, but no flood risk information is shown on this map. This is either because the area is mapped on another FEMA map or because the area is not mapped at all by FEMA.

COM_NFO_ID — A Community Information Identification. This attribute links to the table L_Comm_Info that contains information about the specific community. This table must contain a number that matches a corresponding number in the COM_NFO_ID field of the L_Comm_Info. This field is populated for any jurisdiction that has a CID number issued by FEMA.

SOURCE_CIT — R Source Citation. Abbreviation used in the metadata file when describing the source information for the S_Pol_Ar table.

Name	Type	Size
POL_AR_ID	Text	11
POL_NAME1	Text	50
POL_NAME2	Text	50
CO_FIPS	Text	3
ST_FIPS	Text	2
CID	Text	4
COMM_NO	Text	6
ANI_TF	Text	1
COM_NFO_ID	Text	11
SOURCE_CIT	Text	11

Table: S_Pol_Ln

This table is required for all preliminary or final DFIRM databases.

The S_Pol_Ln table contains information about the boundaries of Political Areas within the study area. This would include the attributes for the political areas and other areas such as forests, parks, military lands, and Native American lands. A spatial file with locational information also corresponds with this data table.

The spatial elements representing the boundaries of the political jurisdictions depicted on the Flood Insurance Rate Map (FIRM) are lines.

The S_Pol_Ln table contains the following elements.

POL_LN_ID R Primary key for table lookup. Assigned by table creator.

LN_TYP R Line Type. This describes the jurisdictional boundary and can be used to indicate how the feature must be depicted on the hardcopy FIRM. Acceptable values for this field are listed in the D_Ln_Typ table.

SOURCE_CIT R Source Citation. Abbreviation used in the metadata file when describing the source information for the S_Pol_Ln table.

Name	Type	Size
POL_LN_ID	Text	11
LN_TYP	Text	45
SOURCE_CIT	Text	11

Table: S_Quad

This table is required for all preliminary or final DFIRM databases.

The S_Quad table contains information about the US Geological Survey (USGS) 7.5-Minute Series Topographic Quadrangle maps that cover the study area. While USGS quadrangles do not meet the Federal Emergency Management (FEMA) digital base map standards, they are often useful as a supplementary reference source. The quadrangle information is provided as a convenience to users who may want to cross-reference this map series. A spatial file with locational information also corresponds with this data table.

The spatial entities representing the USGS quadrangles are polygons. Each polygon corresponds to the neatline of a USGS map.

The S_Quad table contains the following elements.

QUAD_ID — R Primary key for table lookup. Assigned by table creator.

QUAD_NO — R Quad Number. This is the eight-digit USGS alphanumeric quadrangle identifier. The list of values for each state is published by USGS in the State Indexes to Topographic and Other Map Coverage. This item is composed of three components: the latitude, rounded down to the nearest whole degree, of the 7.5-minute quadrangle map sheet; the longitude, rounded down to the nearest whole degree, of the 7.5-minute quadrangle map sheet; and the alphanumeric map sheet identifier used by USGS (i.e., A1 through H8).

QUAD_NM — R Quad Name. This is the name of the quadrangle that is assigned by USGS.

SOURCE_CIT — R Source Citation. Abbreviation used in the metadata file when describing the source information for S_Quad table.

Name	Type	Size
QUAD_ID	Text	11
QUAD_NO	Text	8
QUAD_NM	Text	50
SOURCE_CIT	Text	11

Table: S_Riv_Mrk

This table is required if the Flood Insurance Rate Map (FIRM) shows river distance marks.

The S_Riv_Mrk table contains information about the River Marks shown on the hardcopy FIRM if applicable. A spatial file with locational information also corresponds with this data table.

The spatial entities representing the river marks are points. The points are generally located along side of the river at regular intervals.

The S_Riv_Mrk table contains the following elements.

RIV_MRK_ID — R Primary key for table lookup. Assigned by table creator.

START_ID — R Start Identification. A code that provides a link to a point in the L_Stn_Start table at which the river mark distances start.

RIV_MRK_NO — R River Mark Number. This attribute usually represents the distance from a known point (identified by START_ID), such as the confluence with another river, to the current river mark. This is the value shown next to the river mark on the FIRM.

SOURCE_CIT — R Source Citation. Abbreviation used in the metadata file when describing the source information for the S_Riv_Mrk table.

Name	Type	Size
RIV_MRK_ID	Text	11
START_ID	Text	11
RIV_MRK_NO	Text	6
SOURCE_CIT	Text	11

Table: S_Trnsport_Ln

This table or an equivalent that is fully documented is required for all Digital Flood Insurance Rate Map databases that use a vector base map rather than use orthophotos for the base map.

The S_Trnsport_Ln table contains information about the linear base map transportation features such as roads, railroads, and airports. A spatial file with locational information also corresponds with this data table.

The spatial entities representing linear transportation features are normally lines. However, if the available transportation data depict roads as polygons, polygon representation is acceptable. In general, the transportation table structure is fairly flexible depending on the format of the data available for the map. The Federal Emergency Agency's (FEMA's) objective is to have spatially accurate base map data to which the flood hazard information is referenced. Users must be able to identify the names of roads, railroads and other major features in or near the special flood hazard area. If these objectives are met, then almost any file structure is acceptable. Road centerlines or edge of pavement files are both acceptable, provided that they meet the FEMA base map standard. With some data structures, it may not be practical to assign feature names or other attributes to each spatial entity. While these attributes are desirable, FEMA recognizes that they may not always be easily available. This is acceptable because the S_Label_Pt and S_Label_Ld tables will identify the names of all of the important features in or near the SFHA.

The S_Trnsport_Ln table contains the following elements.

TRANS_ID	R Primary key for table lookup. Assigned by table creator.
TRANS_TYP	R Transportation Feature Type. These line types indicate how the feature must be depicted on the hardcopy Flood Insurance Rate Map. Acceptable values for this field are listed in the D_Trans_Typ table.
RD_STAT	R Road Status. Acceptable values for this field are listed in the D_Rd_Stat table.
PREFIX	A Prefix of the Feature Name. Not all features will have an entry in this attribute. Valid entries might include N for a transportation feature named N Main Street.
FEAT_NM1	R Feature Name 1. This is the primary name of the feature. For areas that have more than one name, this would be the primary name with subsequent names shown in fields below.
NM_TYP	R Name Type. Transportation feature name type. Valid entries include items such as road, street, or avenue. Acceptable values for this field are listed in the D_Nm_Typ table.

SUFFIX — A Suffix of the Feature Name. Not all features will have an entry in this attribute. Valid entries might include NW for a transportation feature named Main Street NW.

FEAT_NM2 — A Feature Name 2. This is the secondary name of the feature.

FEAT_NM3 — A Feature Name 3. This is the tertiary name of the feature.

SOURCE_CIT — R Source Citation. Abbreviation used in the metadata file when describing the source information for the S_Trnsport_Ln table.

Name	Type	Size
TRANS_ID	Text	11
TRANS_TYP	Text	50
RD_STAT	Text	20
PREFIX	Text	50
FEAT_NM1	Text	100
NM_TYP	Text	20
SUFFIX	Text	50
FEAT_NM2	Text	100
FEAT_NM3	Text	100
SOURCE_CIT	Text	11

Table: S_Wtr_Ar

This table is required for any Digital Flood Insurance Rate Map (DFIRM) database where vector surface water features are shown on the Flood Insurance Rate Map (FIRM) and some of these features are represented as polygons in the spatial data. Vector streams must always be shown with a vector base map. They may also be shown on orthophoto base maps.

The S_Wtr_Ar table contains information about surface water area features. A spatial file with locational information also corresponds with this data table.

The spatial elements representing surface water area features are polygons. Normally lakes, ponds and streams wide enough to show both channel banks will be represented as polygons. However, the main purpose of the S_Wtr_Ar table and the S_Wtr_Ln table are to provide a cartographic depiction of the surface water features for visual interpretation of the mapping data. As a result, the method for structuring surface water features as lines or polygons is very flexible. Surface water features may appear in either the S_Wtr_Ar table or the S_Wtr_Ln table or both. However, features that appear in both must match exactly. The hydrologic structure of the stream network will be represented by tables in the Enhanced DFIRM Database.

In general, the surface water table structure is fairly flexible depending on the format of the data available for the map. The Federal Emergency Management Agency's (FEMA's) objective is to have spatially accurate surface water feature data to which the flood hazard information is referenced. Users must be able to identify the names of flooding sources and other important surface water features. If these objectives are met, then almost any file structure is acceptable. Streams, rivers and lakes may be represented as either polygons or lines. With some data structures, it may not be practical to assign feature names or other attributes to each spatial entity. While these attributes are desirable, FEMA recognizes that they may not always be easily available. This is acceptable because the S_Label_Pt and S_Label_Ld tables will identify the names of flooding sources and other important surface water features.

The S_Wtr_Ar table contains the following elements.

WTR_AR_ID	R	Primary key for table lookup. Assigned by table creator.
WATER_TYP	R	Surface Water Feature Type. This type value describes the classification of the surface water feature. Valid entries include items such as lake, retention pond, and reservoir. Acceptable values for this field are listed in the D_Wtr_Typ table.
WTR_NM	R	Surface Water Feature Name. This is the formal name of the surface water feature, as it will appear on the hardcopy FIRM.
SOURCE_CIT	R	Source Citation. Abbreviation used in the metadata file when describing the source information for the S_Wtr_Ar table.

Name	Type	Size
WTR_AR_ID	Text	11
WATER_TYP	Text	25
WTR_NM	Text	100
SOURCE_CIT	Text	11

Table: S_Wtr_Ln

This table is required for any Digital Flood Insurance Rate Map (DFIRM) database where vector surface water features are shown on the Flood Insurance Rate Map (FIRM) and some of these features are represented as lines in the spatial data. Vector streams must always be shown with a vector base map. They may also be shown on orthophoto base maps.

The S_Wtr_Ln table contains information about surface water linear features. A spatial file with locational information also corresponds with this data table.

The spatial elements representing surface water line features are lines. Normally stream centerlines will be represented as line features. However, the main purpose of the S_Wtr_Ar table and the S_Wtr_Ln table is to provide a cartographic depiction of the surface water features for visual interpretation of the mapping data. As a result, the method for structuring surface water features as lines or polygons is very flexible. Lake shorelines and stream channel banks used to show lakes and wide rivers are usually represented as polygons. However, they may be represented as lines based on the structure of the data received and the Mapping Partner's discretion. Surface water features may appear in either the S_Wtr_Ar table or the S_Wtr_Ln table or both. However, features that appear in both must match exactly. The hydrologic structure of the stream network will be represented by tables in the Enhanced DFIRM Database.

In general, the surface water table structure is fairly flexible depending on the format of the data available for the map. The Federal Emergency Management Agency's (FEMA's) objective is to have spatially accurate surface water feature data to which the flood hazard information is referenced. Users must be able to identify the names flooding sources and other important surface water features. If these objectives are met, then most any file structure is acceptable. Streams, rivers and lakes may be represented as polygons or lines. With some data structures, it may not be practical to assign feature names or other attributes to each spatial entity. While these attributes are desirable, FEMA recognizes that they may not always be easily available. This is acceptable because the S_Label_Pt and S_Label_Ld tables will identify the names of flooding sources and other important surface water features.

The S_Wtr_Ln table contains the following elements.

WTR_LN_ID	R	Primary key for table lookup. Assigned by table creator.
WATER_TYP	R	Surface Water Feature Type. The type value describes the kind of watercourse represented. Valid entries include items such as stream/river, channel, and shoreline/coastline. Acceptable values for this field are listed in the D_Wtr_Typ table.
CHAN_REP	R	Channel Representation. Single means linear water features represented by a centerline. Double means linear water features represented by shorelines or channel banks. Acceptable values for this field are listed in the D_Chn_Rep table.

WTR_NM R Surface Water Feature Name. This is the formal name of the surface water feature, as it will appear on the hardcopy FIRM.

SOURCE_CIT R Source Citation. Abbreviation used in the metadata file when describing the source information for the S_Wtr_Ln table.

Name	Type	Size
WTR_LN_ID	Text	11
WATER_TYP	Text	25
CHAN_REP	Text	20
WTR_NM	Text	100
SOURCE_CIT	Text	11

Table: S_XS

This table is required for any Digital Flood Insurance Rate Map database where cross sections are shown on the Flood Insurance Rate Map (FIRM). Normally any FIRM that has associated flood profiles has cross sections.

The S_XS table contains information about Cross Section lines. A spatial file with locational information also corresponds with this data table. These lines represent the locations of channel surveys performed for input into the hydraulic model used to calculate flood elevations. These locations are also shown on the Flood Profiles in the Flood Insurance Study (FIS) report and can be used to cross reference the Flood Profiles to the planimetric depiction of the flood hazard.

The spatial elements representing cross sections are lines generally extending from outside the floodplain, across the entire floodplain, and out the other side of the floodplain. Each cross section must be represented by a single line feature without the hexagons shown on each end on the hardcopy FIRM. The location and shape of the lines must depict as accurately as possible the position of the cross section used.

The S_XS table contains the following elements.

XS_LN_ID	R Primary key for table lookup. Assigned by table creator.
XS_LTR	A Cross-Section Letter. The letter that is assigned to the cross section on the hardcopy FIRM and the FIS profiles. This attribute is blank if the cross section is not shown on the FIRM. For a digital conversion, only cross sections that are shown on the FIRM will be available.
XS_NO	A Cross-Section Number. This attribute is used for all cross sections that are created during the engineering analysis. This must be populated with the number sequence that the Mapping Partner who performs the engineering analysis uses. Each cross section must have a unique number. This attribute is not filled in for digital conversions.
START_ID	R Start Identification. This is a link to the station start table. The station start describes the origin for the measurements in the STREAM_STN field. This field must contain a number that links to a unique value in the START_ID field in the L_Stn_Start table.
STREAM_STN	R Stream Station. This is the measurement along the stream to the cross section location. Normally this information is available in the Floodway Data table in the FIS report.
XS_LN_TYP	R Cross-Section Line Type. This attribute must contain 'LETTERED' for cross sections that are shown on the hardcopy FIRM. If the cross section will not be shown on the hardcopy FIRM it must contain 'NOT LETTERED' to indicate that it is part of the backup data for the study.

WTR_NM — R Surface Water Feature Name. This is the formal name of the surface water feature, as it will appear on the hardcopy FIRM.

WSEL_100 — R Water-Surface Elevation for the 1-Percent-Annual-Chance Flood Event. This is the precise elevation of the base flood calculated at this cross section. This elevation exactly matches the elevation of the base flood in the flood profiles and the Floodway Data table. This number is determined during the engineering analysis for the study. This value must match the regulatory column in the Floodway Data table in the FIS report or the elevation from the corresponding flood profile if no Floodway Data table is published.

RIV_MDL_ID — A River Model Identification. A code that provides a link to the riverine model table, L_Riv_Model. The L_Riv_Model table will identify the hydrologic and hydraulic models used to calculate the flood hazard at this cross section line. This ID field must contain a number that matches the RIV_MDL_ID field for a record in the L_Riv_Model table. The L_Riv_Model table documents model information for this cross section. Multiple cross sections may link to a single record in the L_Riv_Model table. This field is not required for digital conversion of existing FISs. Significant additional research may be required to identify the model that applies at a cross section. However, for new studies, this field is required.

SOURCE_CIT — R Source Citation. Abbreviation used in the metadata file when describing the source information for the S_XS table.

Name	Type	Size
XS_LN_ID	Text	11
XS_LTR	Text	12
XS_NO	Text	12
START_ID	Text	11
STREAM_STN	Text	12
XS_LN_TYP	Text	20
WTR_NM	Text	100
WSEL_100	Single	4.2
RIV_MDL_ID	Text	11
SOURCE_CIT	Text	11

Table: Study_Info

This table is required for all preliminary or final DFIRM databases.

The Study_Info table contains details about the study such as the study name, datum, projection, etc. There is normally only one record in this table for each Flood Insurance Rate Map (FIRM).

The Study_Info table contains the following elements.

STD_NFO_ID	R Primary key for table lookup. Assigned by table creator.
STUDY_PRE	R Study Prefix. This is the prefix of the study name such as 'City of' or 'Town of'.
STUDY_NM	R Study Name. This attribute contains the main portion of the study name that is shown in the title block of the hardcopy FIRM. For county-wide FIRMs, or FIRMs for the unincorporated portions of counties, the name should include the county or county equivalent descriptor (e.g. Washington County or Iberia Parish).
STATE_NM	R State Name. This attribute contains the state name for the study and is shown in the title block of the hardcopy FIRM.
CNTY_NM	R County Name. This is the county name (or county equivalent) that the study falls within. The name should include the county or county equivalent descriptor (e.g. Washington County or Iberia Parish). The county name is also shown in the title block section of the hardcopy FIRM.
JURIS_TYP	R Political Jurisdiction Type. This attribute contains entries such as 'Unincorporated Areas,' 'All Jurisdictions,' 'and Incorporated Areas' or it is left empty. If there are data in this attribute, it is also shown in the title block section of the hardcopy FIRM.
LG_PAN_NO	R Largest Panel Number. This is the highest panel number shown on the FIRM Index for the area mapped. This number is shown in the title block section of the hardcopy FIRM.
OPP_TF	R Only Panel Printed. This is a true/false field that is True only if the study has only one printed panel.
H_DATUM	R Horizontal Datum. Valid entries for this attribute include North American Datum of 1927 or North American datum of 1983 (NAD83). This is the horizontal datum used for the printed FIRM. The horizontal datum describes the reference system on which the horizontal coordinate information shown on the FIRM is based. NAD83 is the preferred horizontal datum.

V_DATUM	R Vertical Datum. This is the vertical datum of the printed FIRM. The vertical datum describes the reference surface from which elevation on the map is measured. Normally this would be North American Vertical Datum of 1988 for new studies. Acceptable values for this field are listed in the D_V_Datum table.
PROJECTION	R Map Projection used for hardcopy FIRM publication. The preferred projection is Universal Transverse Mercator (UTM). If a State Plane coordinate system and associated projection is used, this field must include the name of the projection, the state and the zone (e.g., Lambert Conformal Conic, Virginia North Zone).
PROJ_ZONE	A Projection Zone. When using many map projections and coordinate systems, there is a zone associated with the area. This field is populated based on the projection selected for the Final hardcopy map production. Applies if the projection used has a zone parameter such as UTM or State Plane. The zone must be stated as the appropriate Federal Information Processing Standard zone or FIPSZONE.
CW_TF	R Countywide, true/false. This attribute is true if the hardcopy FIRM includes all incorporated areas and any unincorporated areas of the county.
CBRS_PHONE	A Coastal Barrier Resources System (CBRS) Phone number. This is the phone number for the contact person/office for the CBRS legislative area. Applies if the FIRM contains and CBRS areas. Enter the phone number as a ten-digit numeric string without hyphens, parentheses or other separators.
CBRS_REG	A CBRS Coordinator's region. This attribute contains the Fish and Wildlife Service region that contains the FIRM area. Applies if the FIRM contains CBRS areas.
RTROFT_TF	R Retrofit, True/False. The Retrofit attribute is True if old study data is used with updated stream locations. If flood features were adjusted to fit new stream locations due to better base map information this attribute would be true as well.

Name	Type	Size
STD_NFO_ID	Text	11
STUDY_PRE	Text	20
STUDY_NM	Text	50
STATE_NM	Text	50
CNTY_NM	Text	50
JURIS_TYP	Text	50
LG_PAN_NO	Text	4
OPP_TF	Text	1
H_DATUM	Text	10
V_DATUM	Text	6
PROJECTION	Text	50
PROJ_ZONE	Text	4
CW_TF	Text	1
CBRS_PHONE	Text	15
CBRS_REG	Text	1
RTROFT_TF	Text	1

Table: L_Comm_Info

This table is required for all preliminary or final DFIRM databases.

The L_Comm_Info table is a lookup table that contains community map repository details and map history information that is shown on the Flood Insurance Rate Map (FIRM) legend or index. There is normally one record in this table for each community mapped on the FIRM. The L_Comm_Info table contains the following elements.

COM_NFO_ID	R Primary key for table lookup that links to the S_Pol_Ar table. Value in this field must match the values COM_NFO_ID field of the S_Pol_Ar table.
REPOS_ADR1	R First line of the mailing or street address for the map repository. The map repository is the office the community has designated as responsible for maintaining copies of all the flood hazard information the Federal Emergency Management Agency (FEMA) publishes for the community. The public may view copies of the current effective information at the map repository. This information is also displayed in the FIRM legend or index. For example, this line might read 'Division of Community and Economic Development'.
REPOS_ADR2	R Second line of the mailing or street address for the map repository. This information is also displayed in the FIRM legend or index. For example, this line might read '226 W. Fourth Street'.
REPOS_ADR3	A Third line of the mailing or street address for the map repository. This information is also displayed in the FIRM legend or index. For example, this line might read 'Suite 200'. Populated if address requires additional space.
REPOS_CITY	R City portion of the mailing or street address for the map repository. This information is also displayed in the FIRM legend or index. For example, this line might read 'Springfield'.
REPOS_ST	R State portion of the mailing or street address for the map repository. This information is also displayed in the FIRM legend or index. For example, this line might read 'IL'.
REPOS_ZIP	R ZIP Code portion of the mailing or street address for the map repository. This information is also displayed in the FIRM legend or index. For example, this line might read '62269'.
IN_ID_DAT	R Initial identification date for the community as shown on the FIRM legend, index, or Flood Insurance Study (FIS) report. This information can also be obtained from FEMA.

IN_NFIP_DT R Initial date of the first National Flood Insurance Program map published by FEMA for this community. This can be obtained from the FIRM legend, index, or FIS report. This information can also be obtained from FEMA.

IN_FRM_DAT R Initial date FIRM was created. This can be obtained from the FIRM legend, index, or FIS report. This information can also be obtained from FEMA.

RECENT_DAT A Most recent panel date. This can be obtained from the FIRM Index or the FEMA Community Status book at www.fema.gov/msc. This field is only populated for final DFIRM Databases.

Name	Type	Size
COM_NFO_ID	Text	11
REPOS_ADR1	Text	50
REPOS_ADR2	Text	50
REPOS_ADR3	Text	50
REPOS_CITY	Text	50
REPOS_ST	Text	50
REPOS_ZIP	Text	9
IN_ID_DAT	Date/Time	8
IN_NFIP_DT	Date/Time	8
IN_FRM_DAT	Date/Time	8
RECENT_DAT	Date/Time	8

Table: L_Cst_Model

This table is only completed if coastal engineering analysis was performed. It is required for new coastal studies but not required for digital conversion of effective flood hazard information. Significant additional effort may be required to research the applicable models for digital conversions.

The L_Cst_Model table is a lookup table that contains information about the coastal models that were used during the engineering analysis.

The L_Cst_Model table contains the following elements.

CST_MDL_ID	R Primary key for table lookup that links to the S_Cst_Tsct_Ln table. Value in this field must match the values in the CST_MDL_ID field of the S_Cst_Tsct_Ln table.
WTR_NM	R Surface Water Feature Name. This is the formal name of the surface water feature, as it will appear on the hardcopy Flood Insurance Rate Map.
SURGE_MDL	R Hurricane Surge Model. This is the name or abbreviation of the Federal Emergency Management Agency (FEMA) approved hurricane surge model that is associated with the coastal model for the engineering analysis. Acceptable values for this field are listed in the D_Surge_Mdl table.
EFF_SURGE	R This is a yes/no field that indicates if this is the effective surge model for the area.
WAVE_MDL	R Wave Height Model. This is the name or abbreviation of the FEMA approved wave height model that was used with the coastal model for the engineering analysis. Acceptable values for this field are listed in the D_Wave_Mdl table.
EFF_WAVE	R This is a yes/no field that indicates if this is the effective wave height model for the area.
RUNUP_MDL	R Runup Model. This is the name or abbreviation of the FEMA approved runup model that was used with the coastal model for the engineering analysis. The runup model information is taken from the table D_Runup_Mdl. Acceptable values for this field are listed in the D_Runup_Mdl table.
EFF_RUNUP	R This is a yes/no field that indicates if this is the effective runup model for the area.

SETUP_METH R Wave Setup Methodology. This information must detail the methodology used when setting up the wave models for the engineering analysis.

EFF_SETUP R This is a yes/no field that indicates if this is the effective wave setup methodology for the area.

EROS_TF R This is a true/false field to indicate if erosion treatment has been applied to the area.

EFF_EROS R This is a yes/no field that indicates if this is the effective erosion methodology for the area.

PFD_TF R This is a true/false field to indicate if primary frontal dune criteria were applied.

EFF_PFD R This is a yes/no field that indicates if this is the effective primary frontal dune methodology for the area.

SOURCE_CIT R Source Citation. Abbreviation used in the metadata file when describing the source information for the L_Cst_Model table.

Name	Type	Size
CST_MDL_ID	Text	100
WTR_NM	Text	25
SURGE_MDL	Text	1
EFF_SURGE	Text	25
WAVE_MDL	Text	1
EFF_WAVE	Text	30
RUNUP_MDL	Text	1
EFF_RUNUP	Text	100
SETUP_METH	Text	1
EFF_SETUP	Text	1
EROS_TF	Text	1
EFF_EROS	Text	1
PFD_TF	Text	1

Table: L_MT1_LOMC

The L_MT1_LOMC table is a lookup table that contains information about Letters of Map Change (LOMC) for the area. LOMCs typically include property descriptions. Frequently, LOMCs are issued to show that specific locations are outside the Special Flood Hazard Areas. Generally, the amount of detail that can be shown on the map does not allow these areas to be shown explicitly on the Flood Insurance Rate Map (FIRM). Instead, this information is communicated in the form of a LOMC. For data published by the Federal Emergency Management Agency (FEMA), this table would only include letters of map amendment and letters of map revision based on fill that have been revalidated following the map revision. Revalidated LOMCs indicate that the information presented in the LOMC continues to be true regardless of the depiction of this area on the FIRM.

For LOMCs that appear on more than one map panel, multiple records will exist with the same case number, but different panel numbers.

The L_MT1_LOMC table contains the following elements.

LOMC_ID	R Primary key for table lookup. Assigned by table creator.
CASE_NO	R Case Number. This is the case number assigned by FEMA to the LOMC. This must be filled in for reference back to the complete LOMC materials. The case number must be entered without hyphens or other separators.
EFF_DATE	R Effective Date of the LOMC.
FIRM_PAN	R FIRM panel number that the LOMC is on. This is also a foreign key to the S_FIRM_Pan table. MT1 LOMCs can be matched to a specific FIRM panel by matching this field to the FIRM_PAN field of the S_FIRM_Pan table.
LOMC_STAT	R Status of the LOMC. Valid entries for this field include the following: 'superseded' 'revalidated' 'incorporated' Only revalidated LOMCs are still in effect after a panel has been revised. All others must be superseded or incorporated into the new FIRM. Therefore, a final DFIRM Database will only include revalidated LOMCs.

Name	Type	Size
LOMC_ID	Text	11
CASE_NO	Text	13
EFF_DATE	Date/Time	8
FIRM_PAN	Text	11
LOMC_STAT	Text	20

Table: L_Pan_Revis

This table will not apply for an initial Flood Insurance Rate Map (FIRM) or for a FIRM that has a completely new paneling scheme such as a first time countywide FIRM. Otherwise, this table is required for all Preliminary or Final Digital Flood Insurance Rate Map databases.

The L_Pan_Revis table is a lookup table that contains information about historic revisions to each FIRM panel.

For each FIRM panel that is being revised, there must be at least one record. There may also be multiple records for multiple revision dates for a particular panel and there may be multiple records for a single revision date if there are multiple revision notes for that date. Each FIRM panel may have a unique set of revision dates and revision codes. There must be one record for each FIRM_PAN, REVIS_DATE, REVIS_NOTE combination.

The L_Pan_Revis table contains the following elements.

FIRM_PAN — R FIRM Panel Number. The primary key for table lookup that links to the S_FIRM_Pan table. This must match a value in the FIRM_PAN field of the S_FIRM_Pan table. This is the complete FIRM panel number, which is made up of ST_FIPS, PCOMM, PANEL, and SUFFIX, which are found in S_FIRM_Pan table. The FIRM panel number is the 11-digit FIRM panel number that is shown in the title block of the map.

REVIS_DATE — R Revision Date. Effective date of revision to the FIRM panel. FIRM revision dates can be found in the FIRM legend or the Flood Insurance Study (FIS) report.

REVIS_NOTE — R Revision Note. Note describing the reason for the revision to the panel. This is shown under the effective date in the FIRM legend or in the FIS report. A list of standard revision notes appears in Appendix K of these Guidelines.

Name	Type	Size
FIRM_PAN	Text	11
REVIS_DATE	Date/Time	8
REVIS_NOTE	Text	255

Table: L_Pol_FHBM

This table will not apply if all communities on the Flood Insurance Rate Map (FIRM) never had revisions to their Flood Hazard Boundary Maps (FHBMs). Otherwise, this table is required for all Digital Flood Insurance Rate Map databases.

The L_Pol_FHBM table is a lookup table that contains a list of communities and FHBM revisions.

Each community may have different revision dates. Each revision date may have multiple revision notes.

The L_Pol_FHBM table contains the following elements.

COMM_NO — R Community Number, which is the primary key for table lookup, that links to the S_Pol_Ar table. The value in this field must match a value in the COMM_NO field of the S_Pol_Ar table. This is the six-digit community number assigned by the Federal Emergency Management Agency (FEMA). It is created by combining the state Federal Information Processing Standard code with the Community Identification Number.

FHBM_DATE — R FHBM revision date.

FHBM_NOTE — R FHBM revision note that describes the reason for the revision. FHBM revision notes are shown in the FIRM legend or Flood Insurance Study report. A list of standard revision notes appears in Appendix K of these Guidelines.

Name	Type	Size
COMM_NO	Text	6
FHBM_DATE	Date/Time	8
FHBM_NOTE	Text	255

Table: L_Riv_Model

This table is only completed if detailed engineering methods were used. It required for new studies but is not required for digital conversions of effective flood hazard information. Significant additional effort may be required to research the applicable models for digital conversions.

The L_Riv_Model table is a lookup table that contains detailed information about the hydraulic and hydrologic models used in the engineering analysis for the area.

The L_Riv_Model table contains the following elements.

RIV_MDL_ID	R River Model Identification. The primary key for table lookup that links to the S_XS table. The value in this field must match the values in the RIV_MDL_ID field of the S_XS table.
WTR_NM	R Surface Water Feature Name. This is the formal name of the surface water feature, as it will appear on the hardcopy Flood Insurance Rate Map.
HYDRA_MDL	R Hydraulic Model. This is the name or abbreviation of the hydraulic model that was used for the engineering analysis. Acceptable values for this field are listed in the D_Hydra table.
EFF_HYDRA	R This is a yes/no field that indicates if this is the effective hydraulic model for the area.
HYDRA_DATE	R Hydraulic Model Run Date. This is the date that the hydraulic model was run.
HYDRO_MDL	R Hydrologic Model. This is the name or abbreviation of the hydrologic model that was used for the engineering analysis. Acceptable values for this field are listed in the D_Hydro table.
EFF_HYDRO	R This is a yes/no field that indicates if this is the effective hydrologic model for the area.
HYDRO_DATE	R Hydrologic Model Run Date. This is the date that the hydrologic model was run.
SOURCE_CIT	R Source Citation. Abbreviation used in the metadata file when describing the source information for the L_Riv_Model table.

Name	Type	Size
RIV_MDL_ID	Text	11
WTR_NM	Text	100
HYDRA_MDL	Text	25
EFF_HYDRA	Text	1
HYDRA_DATE	Date/Time	8
HYDRO_MDL	Text	25
EFF_HYDRO	Text	1
HYDRO_DATE	Date/Time	8
SOURCE_CIT	Text	11

Table: L_Stn_Start

This table is required for any Digital Flood Insurance Rate Map database that has an S_XS table or S_Riv_Mrk table. Because of production limitations, it may be omitted at the direction of the FEMA Project Officer.

The L_Stn_Start table contains information about station starting locations. These locations indicate the reference point that was used as the origin for distance measurements along streams and rivers. This table is referenced by both the S_XS table that contains stream station information for cross section and by the S_Riv_Mrk table that contains river distance marker points.The location of the stationing start for a group of cross sections is normally referenced as a note on the Floodway Data table and on the Flood Profiles. Generally, all the cross sections for a particular reach are referenced to the same starting point.

The L_Stn_Start table contains the following elements.

START_ID R Primary key for table lookup. Assigned by table creator. This field is the link that is used to reference cross section in the S_XS table or river marks in the S_Riv_Mrk table to the appropriate stationing starting point.

START_DESC R Start Description. The description of the location of the station starting point. For example, the confluence with the Main Channel of the Big River.

SOURCE_CIT R Source Citation. Abbreviation used in the metadata file when describing the source information for the L_Stn_Start table.

Name	Type	Size
START_ID	Text	11
START_DESC	Text	255
SOURCE_CIT	Text	11

[February 2002]

L.8 Metadata Example for Preliminary and Final Digital Flood Insurance Rate Map Databases

DFIRM DATABASE, FLOOD COUNTY, USA

Identification_Information:
Citation:
Citation_Information:
Originator: Federal Emergency Management Agency
Publication_Date: 20000505
Title: DIGITAL FLOOD INSURANCE RATE MAP DATABASE, FLOOD COUNTY, USA
Geospatial_Data_Presentation_Form: Vector and Raster Digital Data
Publication_Information:
Publication_Place: Washington, DC
Publisher: Federal Emergency Management Agency
Other_Citation_Details: Metadata_File_Name: DFIRM_DB.htm
Online Linkage: www.fema.gov/msc
Description:
Abstract:
The Digital Flood Insurance Rate Map (DFIRM) Database depicts flood risk information and supporting data used to develop the risk data. The primary risk classifications used are the 1-percent-annual-chance flood event, the 0.2-percent-annual-chance flood event, and areas of minimal flood risk. The DFIRM Database is derived from Flood Insurance Studies (FISs), previously published Flood Insurance Rate Maps (FIRMs), flood hazard analyses performed in support of the FISs and FIRMs, and new mapping data, where available. The FISs and FIRMs are published by the Federal Emergency Management Agency (FEMA). The file is georeferenced to earth's surface using the UTM projection and coordinate system. The specifications for the horizontal control of DFIRM data files are consistent with those required for mapping at a scale of 1:12,000.
Purpose:
The FIRM is the basis for floodplain management, mitigation, and insurance activities for the National Flood Insurance Program (NFIP). Insurance applications include enforcement of the mandatory purchase requirement of the Flood Disaster Protection Act, which "... requires the purchase of flood insurance by property owners who are being assisted by Federal programs or by Federally supervised, regulated or insured agencies or institutions in the acquisition or improvement of land facilities located or to be located in identified areas having special flood hazards," Section 2 (b) (4) of the Flood Disaster Protection Act of 1973. In addition to the identification of Special Flood Hazard Areas (SFHAs), the risk zones shown on the FIRMs are the basis for the establishment of premium rates for flood coverage offered through the NFIP.
The DFIRM Database presents the flood risk information depicted on the FIRM in a digital format suitable for use in electronic mapping applications. The DFIRM database is a subset of the Digital FIS database that serves to archive the information collected during the FIS.
Time_Period_of_Content:
Time_Period_Information:
Single_Date/Time:
Calendar_Date: 19980701
Currentness_Reference: FIRM and FIS effective date
Status:
Progress: Complete
Maintenance_and_Update_Frequency: Irregular
Spatial_Domain:
Bounding_Coordinates:
West_Bounding_Coordinate: -84.125
East_Bounding_Coordinate: -84.25
North_Bounding_Coordinate: 30.5
South_Bounding_Coordinate: 30.625

Keywords:
Theme:
Theme_Keyword_Thesaurus: None
Theme_Keyword: FEMA Flood Hazard Zone
Theme_Keyword: DFIRM Database
Theme_Keyword: DFIRM
Theme_Keyword: Special Flood Hazard Area
Theme_Keyword: Digital Flood Insurance Rate Map
Theme_Keyword: CBRS
Theme_Keyword: Coastal Barrier Resources System
Theme_Keyword: Riverine Flooding
Theme_Keyword: Coastal Flooding
Theme_Keyword: NFIP
Theme_Keyword: Base Flood Elevation
Theme_Keyword: SFHA
Theme_Keyword: Flood Insurance Rate Map
Theme_Keyword: FIRM
Theme_Keyword: Floodway

Place:
Place_Keyword_Thesaurus: None
Place_Keyword: FLOOD COUNTY
Place_Keyword: USA
Access_Constraints: None
Use_Constraints:

The hardcopy FIRM and DFIRM and the accompanying FISs are the official designation of SFHAs and Base Flood Elevations (BFEs) for the NFIP. For the purposes of the NFIP, changes to the flood risk information published by FEMA may only be performed by FEMA and through the mechanisms established in the NFIP regulations (44 CFR Parts 59-78).
These digital data are produced in conjunction with the hardcopy FIRMs and generally matches the hardcopy map exactly. However the hardcopy flood maps and flood profiles are the authoritative documents for the NFIP.
Acknowledgement of FEMA would be appreciated in products derived from these data.
Point_of_Contact:
Contact_Information:
Contact_Organization_Primary:
Contact_Organization: Federal Emergency Management Agency
Contact_Position: Federal Insurance and Mitigation AdministrationContact_Address:
Address_Type: mailing address
Address: 500 C Street, S.W.
City: Washington
State_or_Province: District of Columbia
Postal_Code: 20472
Country: USA
Contact_Voice_Telephone:
1-800-358-9616
Contact_Electronic_Mail_Address: www.fema.gov/msc

Native_Data_Set_Environment:
Original data development environment varies. Finishing of the data is done using ESRI's ARC/INFO software.
Cross_Reference:
Citation_Information:
Originator: Federal Emergency Management Agency
Publication_Date: 19980701

Title: Flood Insurance Rate Map, FLOOD COUNTY, USA
Geospatial_Data_Presentation_Form: map
Publication_Information:
Publication_Place: Washington, DC
Publisher: Federal Emergency Management Agency
Cross_Reference:
Citation_Information:
Originator: Federal Emergency Management Agency
Publication_Date: 19980701
Title: Flood Insurance Study, FLOOD COUNTY, USA
Geospatial_Data_Presentation_Form: document
Publication_Information:
Publication_Place: Washington, DC
Publisher: Federal Emergency Management Agency
Cross_Reference:
Citation_Information:
Originator: Federal Emergency Management Agency
Publication_Date: *19980701*
Title: *Raster DFIRM, FLOOD COUNTY, USA*
Geospatial_Data_Presentation_Form: raster digital data
Publication_Information:
Publication_Place: Washington, DC
Publisher: Federal Emergency Management Agency
Data_Quality_Information:
Attribute_Accuracy:
Attribute_Accuracy_Report:
The DFIRM Database consists of countywide vector files and associated attributes produced in conjunction with the hard copy FEMAFIRM. The published effective FIRM and DFIRM maps are issued as the official designation of the SFHAs. As such they are adopted by local communities and form the basis for administration of the NFIP. For these purposes they are authoritative. Provisions exist in the regulations for public review, appeals and corrections of the flood risk information shown to better match real world conditions. As with any engineering analysis of this type, variation from the estimated flood heights and floodplain boundaries is possible. Details of FEMA's requirements for the FISs and flood mapping process that produces these data are available in the Guidelines and Specifications for Flood Hazard Mapping Partners. Attribute accuracy was tested by manual comparison of source graphics with hardcopy plots and a symbolized display on an interactive computer graphic system.
Independent quality control testing of FEMA's DFIRM database was also performed.
To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables contained within the FIS report that accompanies this DFIRM database. Users should be aware that BFEs shown in the S_BFE table represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report must be used in conjunction with the FIRM for purposes of construction and/or floodplain management. The 1-percent-annual-chance water-surface elevations shown in the S_XS table match the regulatory elevations shown in the FIS report.
Logical_Consistency_Report:
When FEMA revises an FIS, adjacent studies are checked to ensure agreement between flood elevations at the boundaries. Likewise flood elevations at the confluence of streams studied independently are checked to ensure agreement at the confluence. The FIRM and the FIS are developed together and care is taken to ensure that the elevations and other features shown on the flood profiles in the FIS agree with the information shown on the FIRM. However, the elevations as shown on the FIRM are rounded whole-foot elevations. They must be shown so that a profile recreated from the elevations on the FIRM will match the FIS profiles within one half of one foot.
Completeness_Report:

Data contained in the DFIRM Database files reflect the content of the source materials. Features may have been eliminated or generalized on the source graphic, due to scale and legibility constraints. With new mapping, FEMA plans to maintain full detail in the spatial data it produces. However, older information is often transferred from existing maps where some generalization has taken place.
Flood risk data are developed for communities participating in the NFIP for use in insurance rating and for floodplain management. Flood hazard areas are determined using statistical analyses of records of river flow, storm tides, and rainfall; information obtained through consultation with the communities; floodplain topographic surveys; and hydrological and hydraulic analysis. Both detailed and approximate analyses are employed. Generally, detailed analyses are used to generate flood risk data only for developed or developing areas of communities. For areas where little or no development is expected to occur, FEMA uses approximate analyses to generate flood risk data. Typically, only drainage areas that are greater than one square mile are studied.
Positional_Accuracy:
Horizontal_Positional_Accuracy:
Horizontal_Positional_Accuracy_Report:
The DFIRM Database consists of countywide vector files and associated attributes produced in conjunction with the hardcopy FEMA FIRM. The published effective FIRM and DFIRM are issued as the official designation of the SFHAs. As such they are adopted by local communities and form the basis for administration of the NFIP. For these purposes they are authoritative. Provisions exist in the regulations for public review, appeals and corrections of the flood risk information shown to better match real world conditions. As with any engineering analysis of this type, variation from the estimated flood heights and floodplain boundaries is possible. Details of FEMA's requirements for the FISs and flood mapping process that produces these data are available in the Guidelines and Specifications for Flood Hazard Mapping Partners. Horizontal accuracy was tested by manual comparison of source graphics with hardcopy plots and a symbolized display on an interactive computer graphic system.
Independent quality control testing of FEMA's DFIRM database was also performed.
Vertical_Positional_Accuracy:
Vertical_Positional_Accuracy_Report:
The DFIRM Database consists of countywide vector files and associated attributes produced in conjunction with the hardcopy FEMA FIRM. The published effective FIRM and DFIRM maps are issued as the official designation of the SFHAs. As such they are adopted by local communities and form the basis for administration of the NFIP. For these purposes they are authoritative. Provisions exist in the regulations for public review, appeals and corrections of the flood risk information shown to better match real world conditions. As with any engineering analysis of this type, variation from the estimated flood heights and floodplain boundaries is possible. Details of FEMA's requirements for the FISs and flood mapping process that produces these data are available in the Guidelines and Specifications for Flood Hazard Mapping Partners. Vertical accuracy was tested by manual comparison of source graphics with hardcopy plots and a symbolized display on an interactive computer graphic system.
Independent quality control testing of FEMA's DFIRM database was also performed.
Source_Information:
Source_Citation:
Citation_Information:
Originator: Federal Emergency Management Agency
Publication_Date: 1987
Title:
Flood Insurance Study, FLOOD COUNTY USA (Unincorporated areas).
Geospatial_Data_Presentation_Form: map
Publication_Information:
Publication_Place: Washington, DC
Publisher: Federal Emergency Management Agency
Other_Citation_Details:
The hydrologic and hydraulic analyses for the FIS dated April 17, 1987, were prepared by the U.S. Army Corps of Engineers (USACE), Springfield District, for the Federal Emergency Management Agency (FEMA), under Inter-Agency Agreement No. EMW-84-E-1506. That work was completed in December 1985. Denominator_of_Source_Scale: 2400-12000.
Source_Scale_Denominator: 12,000

Type_of_Source_Media: paper
Source_Time_Period_of_Content:
Time_Period_Information:
Single_Date/Time:
Calendar_Date: 19870601
Source_Currentness_Reference: Effective Date
Source_Citation_Abbreviation: FIS1
Source_Contribution:
Spatial and attribute information, floodplain widths, BFEs, floodplain location.
Source_Information:
Source_Citation:
Citation_Information:
Originator: Federal Emergency Management Agency
Publication_Date: 1987
Title: Flood Insurance Study, FLOODVILLE, Town of
Geospatial_Data_Presentation_Form: map
Publication_Information:
Publication_Place: Washington, DC
Publisher: Federal Emergency Management Agency
Other_Citation_Details:
The hydrologic and hydraulic analyses for the FIS report dated April 17, 1987, were prepared by the USACE, Springfield District, for the FEMA, under Inter-Agency Agreement No. EMW-84-E-1506, Project Order No. 1, Amendment No. 4. That work was completed in December 1985. Denominator_of_Source_Scale: 2400-12000.
Source_Scale_Denominator: 12,000
Type_of_Source_Media: paper
Source_Time_Period_of_Content:
Time_Period_Information:
Single_Date/Time:
Calendar_Date: 19870601
Source_Currentness_Reference: Effective Date
Source_Citation_Abbreviation: FIS2
Source_Contribution:
Spatial and attribute information, floodplain widths, BFEs, floodplain location.
Source_Information:
Source_Citation:
Citation_Information:
Originator: Federal Emergency Management Agency
Publication_Date: 1998
Title:
Flood Insurance Study Report, FLOOD COUNTY, USA and Incorporated areas.
Geospatial_Data_Presentation_Form: map
Publication_Information:
Publication_Place: Washington, DC
Publisher: Federal Emergency Management Agency
Other_Citation_Details:
For this countywide FIS, the hydrologic and hydraulic analyses were prepared by USACE for FEMA, under Inter-Agency Agreement No. EMW-94-C-0019. This work was completed in October 1995. Denominator_of_Source_Scale: 2400-12000.
Source_Scale_Denominator: 12000
Type_of_Source_Media: paper
Source_Time_Period_of_Content:
Time_Period_Information:
Single_Date/Time:
Calendar_Date: 19980701
Source_Currentness_Reference: Effective Date

Source_Citation_Abbreviation: FIS3
Source_Contribution:
Spatial and attribute information, floodplain widths, BFEs, floodplain location.
Source_Information:
Source_Citation:
Citation_Information:
Originator:
Town of Floodville Stormwater Management Department, 126 Royal Oaks Drive, Suite 201, Floodville, USA 99150
Publication_Date: 1995
Title: Base map for Floodville, USA
Geospatial_Data_Presentation_Form: vector digital data
Publication_Information:
Publication_Place: Floodville, USA
Publisher: Town of Floodville Stormwater Management
Other_Citation_Details:
These files were photogrammetrically compiled at scales of 1"=200' (urban areas) and 1"=400' (rural areas) from aerial photographs.
Source_Scale_Denominator: 4,800
Type_of_Source_Media: CD-ROM
Source_Time_Period_of_Content:
Time_Period_Information:
Single_Date/Time:
Calendar_Date: 19950301
Source_Currentness_Reference: ground conditions
Source_Citation_Abbreviation: BASE1
Source_Contribution:
Location of roads, railroads, bridges, streams and other physical features shown.
Source_Information:
Source_Citation:
Citation_Information:
Originator:
Flood County Geographic Information Systems Department, 1110 South Road, Suite 205, Floodville, USA 99150
Publication_Date: 1995
Title: Base map for Flood County, USA
Geospatial_Data_Presentation_Form: vector digital data
Publication_Information:
Publication_Place: Floodville, USA
Publisher: Flood County Geographic Information Systems Department
Other_Citation_Details:
These files were photogrammetrically compiled at scales of 1"=200' (urban areas) and 1"=400' (rural areas) from aerial photographs.
Source_Scale_Denominator: 4,800
Type_of_Source_Media: CD-ROM
Source_Time_Period_of_Content:
Time_Period_Information:
Single_Date/Time:
Calendar_Date: 19950301
Source_Currentness_Reference: ground conditions
Source_Citation_Abbreviation: BASE2
Source_Contribution:
Location of roads, railroads, bridges, streams and other physical features shown:
Source_Information:
Source_Citation:
Citation_Information:

Originator:
U.S. Geological Survey
Publication_Date: 1998
Title: Digital Orthophoto Quadrangle
Geospatial_Data_Presentation_Form: remote-sensing image
Publication_Information:
Publication_Place: Reston, VA
Publisher: U.S. Geological Survey
Other_Citation_Details: The digital orthophoto quadrangle (DOQ) is a 1-meter ground resolution, quarter-quadrangle (3.75-minutes of latitude by 3.75-minutes of longitude) image cast on the Universal Transverse Mercator Projection (UTM) on the North American Datum of 1983 (NAD83). The imagery is based on panchromatic black and white (or color infra-red) NAPP or NAPP-like photography.
Source_Scale_Denominator: 12,000
Type_of_Source_Media: CD-ROM
Source_Time_Period_of_Content:
Time_Period_Information:
Single_Date/Time:
Calendar_Date: 19970301
Source_Currentness_Reference: ground conditions
Source_Citation_Abbreviation: BASE3
Source_Contribution:
Location of roads, railroads, bridges, streams and other physical features shown:
Process_Step:
Process_Description:
The DFIRM Database is compiled in conjunction with the hardcopy FIRM and the final FIS report. The specifics of the hydrologic and hydraulic analyses performed are detailed in the FIS report. The results of these studies are submitted in digital format to FEMA. These data and unrevised data from effective FIRMs are compiled onto the base map used for DFIRM publication and checked for accuracy and compliance with FEMA standards.
Source_Used_Citation_Abbreviation: FIS1-FIS3, BASE1-BASE3
Process_Date: 1996
Spatial_Data_Organization_Information:
Direct_Spatial_Reference_Method: Vector and raster
Point_and_Vector_Object_Information:
SDTS_Terms_Description:
SDTS_Point_and_Vector_Object_Type: Point
SDTS_Terms_Description:
SDTS_Point_and_Vector_Object_Type: String
SDTS_Terms_Description:
SDTS_Point_and_Vector_Object_Type: GT-polygon composed of chains
Raster_Object_Information:
Raster_Object_Type: Pixel
Spatial_Reference_Information:
Horizontal_Coordinate_System_Definition:
Planar:
Grid_Coordinate_System:
Grid_Coordinate_System_Name: Universal Transverse Mercator
Universal_Transverse_Mercator:
UTM_Zone_Number: 16
Transverse_Mercator:
Scale_Factor_at_Central_Meridian: 0.9996
Longitude_of_Central_Meridian: -87.0
Latitude_of_Projection_Origin: 0.0
False_Easting: 500000
False_Northing: 0.0
Planar_Coordinate_Information:

Planar_Coordinate_Encoding_Method: Coordinate Pair
Coordinate_Representation:
Abscissa_Resolution: 0.061
Ordinate_Resolution: 0.061
Planar_Distance_Units: meters
Geodetic_Model:
Horizontal_Datum_Name: North American Datum 1983
Ellipsoid_Name: Geodetic Reference System 80
Semi-major_Axis: 6378206.4
Denominator_of_Flattening_Ratio: 294.98
Vertical_Coordinate_System_Definition:
Altitude_System_Definition:
Altitude_Datum_Name: North American Vertical Datum of 1988
Altitude_Resolution: 0.03
Altitude_Distance_Units: feet
Altitude_Encoding_Method:
Attribute Values
Entity_and_Attribute_Information:
Overview_Description:
Entity_and_Attribute_Overview:
The DFIRM Database is made up of several data themes containing both spatial and attribute information. These data together represent the current flood risk for the subject area as identified by FEMA. The attribute tables include SFHA locations, flood zone designations, BFEs, political entities, cross-section locations, FIRM panel information, and other data related to the NFIP.
Entity_and_Attribute_Detail_Citation:
Appendix L of FEMA's Guidelines and Specifications for FEMA Flood Hazard Mapping Partners contains a detailed description of each attribute code and a reference to other relevant information.
Entity_and_Attribute_Detail_Citation:
The following tables are included in this data set:
L_Riv_Model
S_BFE
S_Fld_Haz_Ar
S_Fld_Haz_Ln
S_Gen_Struct
S_LOMR
L_Stn_Start
S_Wtr_Ar
S_Wtr_Ln
S_XS
L_Wtr_Nm
S_DOQ_Index
S_Perm_Bmk
S_PLSS_AR
S_PLSS_LN
S_Pol_Ar
S_Pol_Ln
S_Quad
S_Label_Ld
S_Trnsport_Ln
S_Label_Pt
S_Wtr_Ar
S_Wtr_Ln
Distribution_Information:
Distributor:
Contact_Information:
Contact_Organization_Primary:

Contact_Organization: FEMA, Map Service Center
Contact_Address:
Address_Type: mailing address
Address: P.O. Box 1038
City: Jessup
State_or_Province: Maryland
Postal_Code: 20794-1038
Country: USA
Contact_Voice_Telephone: 1-800-358-9616
Contact_Electronic_Mail_Address: www.fema.gov/msc

Contact_Instructions:
Data requests must include the full name of the community or county and the FIRM panel number(s) or the 7.5- minute series quadrangle sheet area(s) covered by the request.
Distribution_Liability:
No warranty expressed or implied is made by FEMA regarding the utility of the data on any other system nor shall the act of distribution constitute any such warranty. FEMA will warrant the delivery of this product in a computer-readable format, and will offer appropriate adjustment of credit when the product is determined unreadable by correctly adjusted computer input peripherals, or when the physical medium is delivered in damaged condition. Requests for adjustment of credit must be made within 90 days from the date of this shipment from the ordering site.
Standard_Order_Process:
Non-digital_Form:
Printed DFIRMs that match this data set are available from FEMA at the Map Service Center, cited above.
Fees: Contact Distributor
Standard_Order_Process:
Digital_Form:
Digital_Transfer_Information:
Format_Name: ESRI Shapefile
Format_Version_Number: 1
Digital_Transfer_Option:
Offline_Option:
Offline_Media: CD-ROM
Recording_Format: ISO 9660
Digital_Form:
Digital_Transfer_Information:
Format_Name: MapInfo Interchange file (MIF)
Format_Version_Number: 1
Digital_Transfer_Option:
Offline_Option:
Offline_Media: CD-ROM
Recording_Format: ISO 9660
Digital_Form:
Digital_Transfer_Information:
Format_Name: ARCE
Format_Version_Number: 1
Digital_Transfer_Option:
Offline_Option:
Offline_Media: CD-ROM
Recording_Format: ISO 9660
Fees:
Contact Distributor
Metadata_Reference_Information:
Metadata_Date: 19980509
Metadata_Contact:
Contact_Information:

Contact_Organization_Primary:
Contact_Organization: Federal Emergency Management Agency
Contact_Position: Federal Insurance and Mitigation Administration
Contact_Address:
Address_Type: mailing address
Address: 500 C Street, S.W.
City: Washington
State_or_Province: District of Columbia
Postal_Code: 20472
Country: USA
Contact_Voice_Telephone: 1-800-358-9616
Contact_Electronic_Mail_Address: www.fema.gov/msc
Metadata_Standard_Name: FGDC Content Standards for Digital Geospatial Metadata
Metadata_Standard_Version: FGDC-STD-001-1998

[February 2002]

Map MODERNIZATION

Federal Emergency Management Agency

FEMA's Flood Hazard Mapping Program

Guidelines and Specifications *for* Flood Hazard Mapping Partners

Appendix M: Guidance for Preparing and Maintaining Technical and Administrative Support Data

FEDERAL EMERGENCY MANAGEMENT AGENCY

www.fema.gov/mit/tsd/dl_cgs.htm

FINAL

February 2002

Appendix M

Guidance for Preparing and Maintaining Technical and Administrative Support Data

This Appendix describes the requirements that the Federal Emergency Management Agency (FEMA) and its Flood Hazard Mapping Partners must meet for preparing, submitting, and maintaining the technical and administrative support data generated for the Flood Hazard Mapping Program. Specifically, this Appendix covers the requirements for the Technical Support Data Notebook (TSDN), which contains all of the support data for a community for which FEMA published a flood hazard map and all revisions to that flood hazard map. The requirements in this Appendix apply to data produced by FEMA Flood Hazard Mapping Partners and submitted to FEMA.

[February 2002]

M.1 Background

In May 1989, FEMA issued the first version of its *Guide for Preparing Technical Support Data Notebook*. A revised version of the Guide was published in January 1990. The Guide, when originally published, applied to FEMA-contracted studies and restudies and established procedures for the development and maintenance of the TSDN for each flood study prepared by FEMA's Study Contractors and Technical Evaluation Contractors.

Since that time, FEMA has expanded the requirement to include map revisions submitted by community officials under Part 65 of the National Flood Insurance Program (NFIP) regulations and to mapping activities completed by communities, regional agencies, and State agencies participating in the Cooperating Technical Partners (CTP) initiative. (Interested parties may obtain more information about the CTP initiative from the FEMA Flood Hazard Mapping Website at http://www.fema.gov/mit/tsd/ctp_main.)

This Appendix, which supersedes the January 1990 Guide, details the requirements that Mapping Partners must follow in preparing and submitting technical and administrative support data to FEMA in the TSDN format. This Appendix also details the requirements that FEMA and the Mapping Partners that are processing and managing the data—presently the Flood Map Production Coordination Contractors—shall meet in processing and managing the data in the TSDN format.

For special circumstances where guidance for a particular mapping activity is not provided by these Guidelines, the Mapping Partner that is preparing and submitting the data and the Mapping Partner that is processing and maintaining the data for FEMA shall resolve issues through consultation with the FEMA Lead for the Flood Map Project. The FEMA Lead for the Flood Map Project usually will be the FEMA Regional Project Officer (RPO) or the Project Officer (PO) at FEMA Headquarters.

[February 2002]

M.2 Preparation and Submittal Requirements

M.2.1 FEMA-Contracted Flood Map Projects

For FEMA-contracted Flood Map Projects (i.e., Flood Insurance Studies, Flood Insurance Restudies, Limited Map Maintenance Program project revisions, CTP-initiated map updates), the Mapping Partner that is preparing and submitting data (hereinafter referred to as the submitting Mapping Partner) shall organize deliverable materials in the TSDN format. The submitting Mapping Partner shall submit the deliverable materials to the Mapping Partner that processes and maintains the data (hereinafter referred to as the receiving Mapping Partner).

The TSDN must be divided into five major sections, each encompassing a separate category of information typically generated by the submitting Mapping Partner during the course of a Flood Map Project. These major sections are:

1. General Documentation (e.g., Special Problem Reports, telephone conversation records, meeting minutes/reports, and general correspondence);
2. Engineering Analyses;
3. Draft Flood Insurance Study (FIS) Report;
4. Mapping Information; and
5. Miscellaneous Reference Materials.

The requirements for the five sections of the TSDN are outlined in Subsections M.2.1.1 through M.2.1.5, respectively. The figures discussed in each subsection are presented at the end of this Appendix.

Materials that cannot be physically included in the TSDN because of size or volume must be bound and clearly labeled and identified as exhibits to the TSDN.

When submitting data, the submitting Mapping Partner shall prepare a transmittal letter to accompany the TSDN. The transmittal letter must identify the communities that are affected by the Flood Map Project and provide an inventory of all materials submitted.

The submitting Mapping Partner shall retain copies of pertinent data for use in responding to the following: (1) questions from FEMA or a Mapping Partner that is reviewing the results of a Flood Map Project, (2) protests and appeals submitted to FEMA during the 90-day appeal period: and (3) other concerns and issues that may develop during the processing of the study or restudy. The submitting Mapping Partner also shall ensure that a clearly labeled cover appears on each TSDN volume submitted. (See Figure M-1 for a sample.)

For each section of the TSDN, the submitting Mapping Partner shall ensure all information is neatly recorded on the required index sheet and annotated to indicate whether the product is one of several others and whether it pertains only to the appropriate community. The submitting Mapping Partner also shall ensure the materials submitted are complete and of original quality. If the submitting Mapping Partner submits hard copies of the index sheets, the sheets must be completed in pen or dark pencil.

[February 2002]

M.2.1.1 General Documentation

In the General Documentation section, the submitting Mapping Partner shall include all written documentation, filed in reverse chronological order, that pertains to the general processing of a Flood Map Project. This section shall provide a comprehensive chronology of all Special Problem Reports (SPRs), telephone conversation reports, meeting minutes/reports, and general correspondence developed during the performance of the Flood Map Project. Additional information about each type of material is provided below.

[February 2002]

Special Problem Reports

An SPR identifies any special problems/issues encountered by the submitting Mapping Partner during the performance of the flood hazard analyses. The SPR must include written documentation generated or received by the submitting Mapping Partner that pertains to specific problem identification and/or special processing requirements. The submitting Mapping Partner shall provide a summary of the SPR as shown in Figure M-2 and an index sheet that includes the date, title, and exhibit number for the SPR as shown in Figure M-3.

[February 2002]

Telephone Conversation Records

Telephone conversation records include all written records or verbal communication documented by the submitting Mapping Partner. The submitting Mapping Partner shall provide an index sheet (see Figure M-4) containing the date, the name of the individual contacted, and the name of the government agency or firm the contact represents.

[February 2002]

Meeting Minutes/Reports

Meeting minutes/reports include written summaries of discussions in meetings between the submitting Mapping Partner and other parties, including all agencies and firms. They typically include minutes of standard meetings, including the Project Scoping meeting and the initial and final Consultation Coordination Officer meetings held by FEMA.

The submitting Mapping Partner shall provide an index sheet (see Figure M-5) containing the date of the minutes/report, meeting date, and meeting type.

[February 2002]

General Correspondence

General correspondence is the written correspondence generated or received by the submitting Mapping Partner and may include letters; transmittals; memorandums; general status reports and queries; and internal communications, routing slips, and notes.

[February 2002]

M.2.1.2 Engineering Analyses

This section of the TSDN is to include all coastal, riverine or other flood hazard engineering support data that were developed during the performance of a flood hazard analysis. Such support data as cross-section and/or transect information, basin characteristics, hydrologic and hydraulic calculations, graphs, nomographs, profile and cross-section plots, and any other engineering support data would be included.

The submitting Mapping Partner shall ensure the following categories of data are included in this section of the TSDN as appropriate to each Flood Map Project:

- Riverine hydrologic and hydraulic analyses;
- Coastal flooding analyses;
- Ice-jam flooding analyses;
- Alluvial fan flooding analyses;
- Key to Cross-Section Labeling; and
- Key to Transect Labeling.

The requirements for each category are provided below.

[February 2002]

Hydrologic and Hydraulic Analyses

The purpose of this subsection of the TSDN is to provide FEMA with comprehensive documentation and supporting data for the hydrologic and hydraulic (H&H) analyses performed by the submitting Mapping Partner.

The submitting Mapping Partner shall ensure that the indexes and accompanying supporting data for the H&H analyses are included in this section of the TSDN and meet the following requirements:

- Data are arranged in alphabetical order according to the flooding source/stream name.

- Data are properly labeled to identify the submitting Mapping Partner and the name(s) of community(ies) and State.

- Information on the type of model used, date of analysis, and exhibit number(s) assigned to those analyses that cannot be physically included in the TSDN because of size or volume are included.

Blank sample copies of the Hydrologic Analyses Index and Hydraulic Analyses Index sheets are provided at the end of this Appendix as Figures M-6 and M-7.

The submitting Mapping Partner shall ensure that the following general requirements are met:

- Hydrologic support data developed for the Flood Map Project must be provided. Such data may include basin characteristics, normal depth calculations, log-Pearson Type III calculations, regional regression equation calculations, frequency-discharge curves, and other relevant data.

- Hydraulic support data and calculations for riverine and coastal flooding sources that were developed for the Flood Map Project must be provided. Such data may include cross-section information (i.e., area, velocity, elevation calculations); floodway analyses; transect and surge data; wave height information; cross-section plots; computer models, calculations, and execution runs; and any other relevant data.

- The input files and results of the H&H analyses must be delivered in both hard copy (paper) and soft copy (electronic) format.

- If paper copies of the computer models used or generated for the Flood Map Project are too large to include in the TSDN, those copies must be individually bound and labeled according to the community and flooding source to which they apply, properly identified by exhibit number, and listed on the index sheet.

- Copies of computer models on diskette or CD-ROM must be packaged in computer envelopes or binders, labeled properly, identified by exhibit number, and listed on the index sheet.

The submitting Mapping Partner shall ensure that photographic or mapping information that may have been used in the development of the models are **not** included in this section. Such information shall be included in the "Mapping Information" section of the TSDN, which is discussed in Subsection M.2.1.4.

[February 2002]

Key to Cross-Section Labeling and Key to Transect Labeling

The purpose of this subsection of the TSDN is to provide FEMA with comprehensive cross-referencing between field survey notes, draft report and map materials, riverine hydraulic analyses, coastal flooding analyses, and (if readily available) U.S. Environmental Protection Agency (EPA) Reach File Numbers. For each flooding source where a hydraulic analysis was

performed, the submitting Mapping Partner shall complete and maintain Key to Cross-Section Labeling or Key to Transect Labeling forms as applicable. In each Key, the Mapping Partner shall identify the cross-section and transect information developed.

Sample blank copies of the Key to Cross-Section Labeling and Key to Transect Labeling forms are presented in Figures M-8 and M-9, respectively, at the end of this Appendix.

[February 2002]

M.2.1.3 Draft Flood Insurance Study Report

The submitting Mapping Partner shall ensure that the "Draft Flood Insurance Study Report" section of the TSDN contains all relevant components for FEMA's technical review, processing, and publication of the FIS report, including the following:

- FIS report text;
- Summary of Flood Discharges, Summary of Stillwater Elevations, Transect Locations, Surge Elevations, and Floodway Data Tables as required;
- Flood Profiles;
- Certification statement of work accomplished; and
- Other relevant support data.

[February 2002]

M.2.1.4 Mapping Information

The submitting Mapping Partner shall ensure that all mapping and related information generated for the Flood Map Project is provided to FEMA in the "Mapping Information" section of the TSDN, including the following:

- Topographic maps;
- Work maps;
- Base maps;
- Aerial photographs;
- Soil and vegetation maps;
- U.S. Geological Survey topographic quadrangle maps;
- Flood Hazard Boundary Maps;

- Community maps; and
- All other maps (manual and digital).

In preparing the TSDN for submittal to FEMA, the submitting Mapping Partner shall:

- Ensure that all information is properly labeled with the correct Mapping Partner name, submittal date, and community name. This information must include the type of map, the date of the map, the number of map sheets, and the exhibit numbers assigned to those maps that cannot be included in the TSDN because of size limitations.
- List all supplemental materials, such as topographic maps and aerial photographs, with a concise explanation of how the final work maps were delineated.
- Ensure mapping information is included within the notebook or bound and labeled separately and identified by exhibit number.
- Ensure that all digital data submitted meet the requirements outlined in Appendix L for data format, structure, delivery media, and documentation.
- Prepare and complete the Mapping Information Index. (Figure M-10.) The Mapping Information Index sheet(s) will assist data users in identifying the mapping data and information generated during the Flood Map Project. These index sheets also will be used to reference the map data that, due to format, size, or other limitations, cannot be physically located within the TSDN itself.
- Identify and label as an exhibit all map data that, due to format, size, or other limitations, cannot be physically located within the TSDN.
- Write a brief narrative, using the form shown in Figure M-11, to explain any additional procedure used to create the final work maps (e.g., whether field inspection or spot surveying was done to enhance the accuracy of the final work maps).
- List all supplemental materials (e.g., topographic maps, aerial photographs) with an accompanying explanation of how those materials relate to the work maps.

If photogrammetric processes were used, FEMA may request that the submitting Mapping Partner provide the following in the Mapping Information section of the TSDN:

- Documentation for the most recent calibration of the aerial camera and stereoplotter(s);
- Details on the flying height and camera focal length;
- Estimated "C Factor(s)" of the stereoplotter(s) used on the project; and
- Aerial triangulation reports, which are described in Appendix A, Subsection A.7.2 of these Guidelines.

If Global Positioning System (GPS) surveys were performed as part of the Flood Map Project, the submitting Mapping Partner shall provide the GPS documentation described in Appendix A of these Guidelines. This includes data categorized by the National Oceanic and Atmospheric Administration as follows:

- B-file—Project information, station position information, survey measurements, occupation notes, and synchronization information;
- D-file—Station descriptions and/or recovery notes for all new and/or newly occupied stations;
- G-file—Differential coordinates, standard errors, correlations, and related information required for a least-squares adjustment of a GPS field project; and
- R-file—Files created by the GPS receiver that contain the phase data of each satellite observed and any other files created by the receiver that are necessary during processing.

[February 2002]

M.2.1.5 Miscellaneous Reference Materials

The submitting Mapping Partner shall include all other support materials developed or used during the Flood Map Project in the "Miscellaneous Reference Materials" section of the TSDN. The submitting Mapping Partner shall compile an inventory of all essential and nonessential data using the form shown in Figure M-12. The submitting Mapping Partner shall include such reference materials as field survey notes and notebook, watershed studies, site visit photographs, community population and demographic studies, tax base reports, and legal references in this section.

[February 2002]

M.2.2 Support Data Generated by Receiving Mapping Partner

There are two instances in which the receiving Mapping Partner must physically incorporate materials in the TSDN prepared by the submitting Mapping Partner. First, the receiving Mapping Partner shall complete the appropriate portion of the Key to Cross-Section Labeling and/or Key to Transect Labeling sheets contained in the TSDN.

During the processing of the draft and final report and map materials, FEMA may direct the receiving Mapping Partner to revise some of the technical support data included in the TSDN to correct discrepancies or errors in the original data supplied by the submitting Mapping Partner. In such cases, the receiving Mapping Partner shall mark the data determined to be in error as "VOID." The receiving Mapping Partner also shall remove the void data from the TSDN and insert the revised data. When adding revised data to the TSDN, the receiving Mapping Partner shall properly label and place the data in the correct section. The receiving Mapping Partner shall maintain the void data until processing of the report and map has been completed (i.e., when the new or revised FIS report and FIRM become effective); at that time, the receiving Mapping Partner shall discard the void data.

[February 2002]

M.2.3 Map Revisions Initiated by Community Officials

For map revisions initiated by community officials under Part 65 of the NFIP regulations, FEMA does not require the submitting Mapping Partner (i.e., the community or other revision requester) to submit supporting data in the TSDN format. However, FEMA strongly encourages the use of the TSDN format to ensure all supporting data are submitted and clearly labeled for future reference.

To support a Map Revision under Part 6a5 of the NFIP regulations, the submitting Mapping Partner shall submit the following materials:

- Correspondence from the requester, the community, and, where applicable, the State, or other interested parties;
- Technical support data, such as calculations, graphs, charts, technical reports, diskettes, and computer printouts containing both input and detailed output for hydrologic and/or hydraulic analyses;
- Project location;
- Topographic, survey, and tax mapping information;
- Aerial photographs;
- Design drawings; and

- Annotated copies of effective NFIP maps; Flood Profiles; and Summary of Discharges, Floodway Data, and Transect Location Tables.

In most cases, the submitting Mapping Partner for a map revision request shall follow the same organizational and reproducible quality standards discussed in Subsection M.2 for FEMA-contracted Flood Map Projects. Specifically, whenever possible, the receiving Mapping Partner (i.e., the Mapping Partner assigned to review and process the map revision request for FEMA) shall provide guidance to the submitting Mapping Partner. This guidance, either by issuing written directions or through telephone conversations, shall clarify proper labeling and data identification requirements, as well as requirements concerning the legibility of materials that must be reproduced.

To the extent possible, the receiving Mapping Partner shall review all submitted support data for compliance with FEMA requirements for the identification, labeling, completeness, and quality of the data.

[February 2002]

M.3 Processing and Maintenance Requirements

M.3.1 FEMA-Contracted Flood Map Projects

After receiving the draft submittal and TSDN from the submitting Mapping Partner, the receiving Mapping Partner shall perform a cursory review of the TSDN. The purpose of this cursory review is to ensure that all sections are complete and that all data are labeled in a neat, clear, and organized manner in accordance with the guidance in Section M.2.

The receiving Mapping Partner shall ensure that a completed index form is included for each section of the TSDN. If any information is missing, mislabeled, or not labeled, the receiving Mapping Partner shall contact the submitting Mapping Partner for clarification. If the receiving Mapping Partner determines during the initial review that the TSDN does not conform to the guidelines in Section M.2, the receiving Mapping Partner shall consult with the FEMA Lead (either the RPO or PO) to determine which Mapping Partner must revise the TSDN submittal to bring it into compliance with FEMA requirements.

When data are common to more than one community, the TSDN for each community must contain a complete copy of the shared data, or the location of the data must be cross-referenced to a form for each section and subsection of the TSDN. To maintain the integrity of the original TSDN submittal, the receiving Mapping Partner shall make copies of any data needed during the review of the draft materials and production of the report and map. The receiving Mapping Partner shall maintain the original data in the TSDN for eventual digital storage.

Additional guidance regarding the individual sections of the TSDN is provided in Subsections F.3.1.1 through F.3.1.4.

[February 2002]

M.3.1.1 Engineering Analyses

The receiving Mapping Partner shall verify that both paper copies and/or copies of computer models on diskette or CD-ROM are maintained with the TSDN. The receiving Mapping Partner shall store the electronic media to ensure their integrity and that they are readily accessible for retrieval and use in responding to both internal and external information requests.

The receiving Mapping Partner shall perform a cursory review to verify the following:

- The Key to Cross-Section Labeling and/or Key to Transect Labeling include comprehensive cross referencing among the field survey notes; draft report and map materials; hydraulic computer analysis; and, if readily available, EPA Reach File Numbers.
- The Key to Cross-Section Labeling and/or Key to Transect Labeling are complete.
- The information in each Key to Cross-Section Labeling and/or Key to Transect Labeling pertains to only one flooding source.
- The information in each Key to Cross-Section Labeling and Key to Transect Labeling is presented in order from the mouth or point farthest downstream to the point farthest upstream.

[February 2002]

M.3.1.2 Flood Insurance Study Report Data

The receiving Mapping Partner shall review the "Flood Insurance Study Report Data" section of the TSDN provided by the Mapping Partner to ensure the following:

- The draft FIS report section contains all relevant components prepared by the submitting Mapping Partner, including draft text, Flood Profiles, data tables, and certification statement of work accomplished.
- This section includes only the most up-to-date record copies of the draft FIS report.
- The draft materials in this section pertain only to the appropriate community.
- All materials in this section are legible; properly labeled; easily identified by community; complete; and of original, reproducible quality.

[February 2002]

M.3.1.3 Mapping Information

The receiving Mapping Partner shall review the "Mapping Information" section of the TSDN provided by the Mapping Partner to ensure the following:

- The section includes comprehensive mapping information relating to the processing of the Flood Map Project.
- The digital data included meet the requirements in Appendices K and L of these Guidelines.

- All materials in this section are legible; properly labeled; easily identified by community and flooding source; complete; and of original, reproducible quality.

[February 2002]

M.3.1.4 Miscellaneous Reference Materials

The receiving Mapping Partner shall verify that all materials included in this section of the TSDN are properly labeled and exhibit number(s) are assigned to those materials that cannot be included in the TSDN because of size or volume.

[February 2002]

M.3.2 Map Revisions Initiated by Community Officials

As an integral part of the overall process for supporting map revisions, the receiving Mapping Partner reviews technical, scientific, and other administrative support data prepared and submitted by a revision requester. The review typically consists of, but is not limited to, ensuring that all support data received are complete, technically adequate, in compliance with FEMA-specified guidelines and specifications, and NFIP regulations, and sufficient to support a given map revision request. Most technical support data generated by the revision requester are subject to the same engineering and mapping standards outlined for FEMA-contracted Flood Map Projects discussed earlier in these Guidelines.

When processing map revision cases, the receiving Mapping Partner generally develops support data during the review and evaluation of the revision request—including internal review information and correspondence with the requester, State agencies, FEMA, community officials, or other agencies—that must be archived and maintained. The remaining information generated by the receiving Mapping Partner pertains to the appeal period and/or related statutory requirements for the establishment or modification of Base Flood Elevations, as applicable.

For purposes of this Appendix, two separate phases of processing, wherein uniform guidelines and specifications are necessary for map revisions, have been identified:

- The **Review Processing Phase** includes activities of the receiving Mapping Partner associated with the initial identification, coordination, and technical review of a map revision case up to the resolution of that case.

- The **Post-Review Processing Phase** relates to those activities performed by the receiving Mapping Partner, after the case has been resolved, to close out the file and prepare the supporting information for active storage and eventual processing by the Engineering Study Data Package Facility (ESDPF) staff.

The Review Processing and Post-Review Processing Phases are discussed in more detail in Subsections M.3.2.1 and M.3.2.2, respectively.

[February 2002]

M.3.2.1 Review Processing Phase

The receiving Mapping Partner shall, to the extent possible, provide initial guidance to the submitting Mapping Partner regarding the preparation and submittal of technical support data for a map revision request. If the receiving Mapping Partner and submitting Mapping Partner discuss a request before data are submitted, the receiving Mapping Partner shall provide overall guidance concerning the submittal quality of the support data to facilitate eventual digital conversion of the data for permanent retention. The requester is required to submit only the essential or relevant data that fully support the FEMA requirements for proper evaluation of the map revision request. Once support data are received, the receiving Mapping Partner reviews the revision request and develops revision case files under the procedures outlined below.

Generally, the support data submitted by the requester and the data generated by the receiving Mapping Partner shall contain what will be defined as "essential data" and "nonessential data." Essential data are the support data that are critical to understanding or recreating conditions that resulted in a map revision or other resolution of the map revision request, which therefore must be maintained by FEMA. Nonessential data are data generated as part of the internal production process or for general, informational purposes only. Nonessential data are usually needed for temporary storage only (i.e., throughout the review and production process) and can be discarded once the case has been resolved or during the Post-Review Processing Phase.

The receiving Mapping Partner shall use judgment in determining what data are considered essential or nonessential. Because of the nature of map revision cases, specific guidance concerning the essential versus nonessential character of individual pieces of supporting information is not possible.

The guidance given in the following paragraphs are for typical revision cases and shall not be construed as inflexible. However, the receiving Mapping Partner shall also refrain from retaining materials that are clearly not critical to understanding or recreating conditions that pertain to the resolution of a map revision case. Examples of essential revision support materials include:

- All official correspondence, including resolution letters (e.g., Letters of Map Revision, denial letters) and enclosures transmitted with those letters;
- All materials stored in the Flood Elevation Determination Docket (FEDD);
- Hydrologic and hydraulic models, calculations or computer printouts;
- Summary tables;
- Technical reports; and
- Topographic maps, work maps, tax maps, survey plats, and aerial photographs (all sizes and formats).

For the revision case files, except for the FEDD file information, the receiving Mapping Partner shall:

- Ensure revision case file materials have a maximum size of 11″ × 17.″
- Separate materials that are larger than 11″ × 17″ and physically maintain those materials outside the revision case file.
- File essential data that are 11″ × 17″ or smaller as part of the revision case file, unless the data in question are in the form of a voluminous report.
- Prepare a cross-referenced listing of the essential data not included in the revision case file so that these data can be readily identified as part of the revision package. and maintain the listing within the revision case file.
- Ensure the contents of the revision case file are legible (printed, typed, or handwritten in dark ink or pencil) and of original copy quality for future digital conversion.
- Ensure the revision case file properly identifies the community name, requester name, and the date when data were prepared.
- Ensure the revision case file is in good whole condition without tears or missing segments.

The nonessential materials generally consist of the following: large blueline prints of mapping information (Preliminary or Revised Preliminary copies of maps), duplicate data, extraneous reports or unrelated support data, void or superseded data, internal memorandums, transmittals, and other internal processing information. Although these types of data must be maintained throughout the Review Processing Phase of a revision, they are not critical in recreating the results for the final revision determination and, therefore, would not be considered for digital conversion by FEMA at a future date.

[February 2002]

Standard-Size Revision Case File Items

For purposes of these Guidelines, the term "standard-size revision case file" refers to any file that consists of a legal- or letter-sized manila folder containing original general correspondence, mapping information, technical information, or data (excluding computer printouts for hydrologic and hydraulic models, and information stored as part of the FEDD file) that are no larger than 11″ × 17″. The receiving Mapping Partner shall file all documents, reports, mapping information, or other support data (including hydrologic and hydraulic computer printouts) larger than 11″ × 17″ separately, and shall include a listing of those oversized in the standard-size case file. The receiving Mapping Partner shall maintain the FEDD file, as applicable, as a separate entity. Like the case file, the materials in the FEDD file must be complete, concise (to the extent possible), and in reverse chronological order.

[February 2002]

Essential Revision Case File Items

Essential items shall constitute the scannable portion of the case file and shall be organized in reverse chronological order. Data pertaining to specific technical areas shall, if practical, be grouped together in the case file, in reverse chronological order whenever possible. The receiving Mapping Partner shall file the case file items deemed essential for future scanning on the right-hand side of the revision case file folder (i.e., the side with the filing label), using a two-pronged, Acco-style binder and retainer (or equivalent) at the top.

To facilitate proper identification of the data, the receiving Mapping Partner shall include the following information on the front or the inside cover of the revision case file:

- Community identification number;
- Community name, type (e.g., CTY, V, TWP, CO), and State;
- Requester's first initial and last name;
- Flooding sources;
- Affected map type and map panel number;
- Case resolution date (MM/DD/YY); and
- Identification number of receiving Mapping Partner.

In addition to the labeling on the file noted above, the receiving Mapping Partner shall place a summary listing of the essential materials pertinent to the revision case not physically included within the revision case file. The information on this listing shall include the title, date, map scale (if applicable), and a description of the contents of each essential item. The receiving Mapping Partner's case identification number shall be included at the top center of that page.

Because of the critical nature of the data contained in computer printouts, a second or separate listing of computer printouts supporting the revision case shall be placed behind the summary of essential materials not physically included in the revision case file. Generally, because of their size, computer printouts are filed separately from the revision case file, but they are a part of the essential items requirement. Again, this listing shall identify the various computer model runs (e.g., study/restudy conditions, existing conditions, proposed conditions), the dates of the runs, and the names of the flooding sources modeled for each run.

[February 2002]

Nonessential Revision Case File Items

The receiving Mapping Partner shall maintain nonessential standard-size items in the revision case file. The receiving Mapping Partner shall place nonessential items relevant to the processing of the map revision request, but not pertinent to the technical support data, on the left-hand side of the revision case file folder.

The receiving Mapping Partner shall attach the nonessential items to the top of the file folder using a two-pronged, Acco-style binder and retainer (or equivalent). The receiving Mapping Partner shall label the data as nonessential using a standard 8-1/2″ × 11″ form that reads "INTERNAL PROCESSING FORMS; DO NOT SCAN." The receiving Mapping Partner shall delete nonessential once the map revision request has been resolved.

[February 2002]

Oversized Revision Case File Items

The receiving Mapping Partner shall follow similar guidelines for maintaining essential oversized items, including:

- Computer printouts from hydrologic and hydraulic models;
- CD-ROMs or diskettes containing digital versions of hydrologic and hydraulic models, maps, and related data;
- Work, survey, plat, or tax maps;
- Construction drawings,
- Topographic or aerial photographic maps;
- Supplementary (bound) reports; and
- Transect maps.

The receiving Mapping Partner shall file such data in boxes or shelving appropriate for storing oversized documents. To facilitate future retrieval, the receiving Mapping Partner shall clearly label each oversized item with the appropriate community name, state name, requester name, and case number. The receiving Mapping Partner also shall develop a listing of the essential oversized items and shall file this listing in the standard size case file for cross-referencing.

ESDPF staff (except for the hydrologic or hydraulic computer models/printouts) generally will not scan the essential oversized items. Therefore, the receiving Mapping Partner shall maintain the oversized materials in hardcopy format. The receiving Mapping Partner shall archive essential computer models in their original format.

The receiving Mapping Partner shall maintain nonessential oversized items only until such time as the revision case has been resolved. The receiving Mapping Partner shall then discard these items.

[February 2002]

M.3.2.2 Post-Review Processing Phase

The receiving Mapping Partner shall store all of the essential revision case files and FEDD files as noted earlier in this Appendix for an indefinite period of time. The ESDPF staff will initiate the digital conversion of the revision case files and FEDD files, as applicable.

Once the ESDPF staff shall not call in revision case files or FEDD files for digital conversion until approximately 1 year after the resolution date. The delay in call-in time is to allow the receiving Mapping Partner to respond to inquiries pertaining to the revision case. The majority of such inquiries are received within 1 year after case resolution. Therefore, the risk of having the receiving Mapping Partner receive an inquiry while the revision case file is being converted to digital format should be minimal.

The receiving Mapping Partner has organized the revision case file, the FEDD file, and the oversized items into the proper standard size format during the Review Processing Phase. Therefore, the effort required for the receiving Mapping Partner at the time of call-in shall involve only retrieving the essential standard size case file and the FEDD file and transmitting them to the ESDPF. The receiving Mapping Partner shall not transmit oversized items (except for the hydrologic and hydraulic computer printouts) to the ESDPF because these materials will not be digitally converted, and the summary listing will be a part of the digital file.

As is done with the digital study and restudy support data files, the ESDPF staff shall return the revision case file to the receiving Mapping Partner on CD-ROM for future use in responding to data requests from all sources. The CD-ROM record will be supplemented by the oversized items retained by the receiving Mapping Partner in permanent hardcopy storage.

[February 2002]

TECHNICAL SUPPORT DATA NOTEBOOK

For

_____

(COMMUNITY NAME AND STATE)

FLOOD INSURANCE STUDY/ MAP REVISION

SUBMITTED BY: _____

DATE SUBMITTED: _____

Page_____ of _____

Submitted by: _____

SPECIAL PROBLEM REPORT (SPR) INDEX

_____

(COMMUNITY NAME, STATE)

FLOOD INSURANCE STUDY/ MAP REVISION

SPR DATE	SPR TITLE	EXHIBIT NO.

Figure M-2. Special Problem Report Index

SPECIAL PROBLEM REPORT

DATE: _____

CONTRACT/ AGREEMENT NUMBER: _____

COMMUNITY NAME : _____

SUBMITTED BY: _____

_____

PROBLEM AREA

TECHNICAL COORDINATION
UNRESOLVED
DISCRIPANCIES
UNREALISTIC SCHEDULE
OTHER

DETAILED EXPLANATION

PROPOSED SOLUTION

Figure M-3. Special Problem Report Form

Page_____ of _____

Submitted by: _____

CONTACT REPORTS INDEX

_____

(COMMUNITY NAME, STATE)

FLOOD INSURANCE STUDY/ MAP REVISION

CONTACT REPORT DATE	FIRM/AGENCY CONTACTED

Figure M-4. Contact Reports Index

Page ____of_____

Submitted by: _____

MEETING MINUTES / REPORTS INDEX

_____

(COMMUNITY NAME, STATE)

FLOOD INSURANCE STUDY/ MAP REVISION

MINUTES / REPORT DATE	MEETING DATE	MEETING TYPE

Figure M-5. Meeting Minutes Index

Page
_____of_____

Submitted by: _____

HYDROLOGIC ANALYSES INDEX

_____

(COMMUNITY NAME, STATE)

FLOOD INSURANCE STUDY/ MAP REVISION

NO. FLOODING SOURCE STREAM NAME	HYDROLOGIC METHOD/ MODEL USED	METHOD/ MODEL ANALYSIS DATE	EXHIBIT PAPER COPY	EXHIBIT FLOPPY DISKETTES

Figure M-6. Hydrologic Analyses Index

Page _____ of _____

Submitted by: _____

HYDRAULIC ANALYSES INDEX

_____

(COMMUNITY NAME, STATE)

FLOOD INSURANCE STUDY/ MAP REVISION

FLOODING SOURCE/ STREAM NAME	HYDRAULIC METHOD/ MODEL USED	METHOD / MODEL ANALYSIS DATE	EXHIBIT NO. PAPER COPY	EXHIBIT NO. FLOPPY DISKETTES

Figure M-7. Hydraulic Analyses Index

Page _____ of _____

Submitted by: _____

KEY TO CROSS SECTION LABELING

_____

(COMMUNITY NAME, STATE)

FLOOD INSURANCE STUDY/ MAP REVISION

PREFARED BY: _____ FLOODING SOURCE: _____

DATE PREPARED: _____ RUN DATE: _____

FIELD SURVEY SECTION NO.	CROSS SECTION LETTER IN DRAFT FIS REPORT	COMPUTER STATIONING

Figure M-8. Key To Cross Section Labeling

Page_____ of _____

KEY TO TRANSECT LABELING

_____

(COMMUNITY NAME AND STATE)

FLOOD INSURANCE STUDY/MAP REVISION

PREPARED BY: _____ _____

_____

DATE PREPARED: _____ FLOODING SOURCE: _____

RUN DATE: _____

REVIEWED BY: _____

WHAFIS VERSION: _____

DATE REVIEWED: _____

EPA REACH

FIEILD SURVEY TRANSECTION NO.	FIELD NO.	TRANSECT NO. IN FINAL FIS
TRANSECT No. DRAFT FIS		
_____ _____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____ _____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

[1]Erosion Considered [2]Wave Setup Considered [3] Wave onsidered

Figure M-9. Key To Transect Labeling

Page_____ of _____

Submitted By: _____

MAPPING INFORMATION INDEX

_____

(COMMUNITY NAME, STATE)

FLOOD INSURANCE STUDY/ MAP REVISION

TYPE OF MAP	MAP DATE	NO. OF SHEETS	EXHIBIT NO.

Figure M-10. Mapping Information Index

Page_____ of _____

Submitted By: _____

WORK MAP DELINEATION SUMMARY

_____

(COMMUNITY NAME, STATE)

FLOOD INSURANCE STUDY/MAP REVSION

Figure M-11. Work Map Delineation Summary

Page_____ of _____

Submitted By: _____

MISCELLANEOUS REFERENCE MATERIALS INDEX

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(COMMUNITY NAME, STATE)

FLOOD INSURANCE STUDY/ MAP REVISION

ITEM	ITEM DATE	EXHIBIT NO.

Figure M-12. Miscellaneous Reference Materials Index

Map MODERNIZATION

Federal Emergency Management Agency

FEMA's Flood Hazard Mapping Program

Guidelines and Specifications *for* Flood Hazard Mapping Partners

Glossary

FEDERAL EMERGENCY MANAGEMENT AGENCY

www.fema.gov/mit/tsd/dl_cgs.htm

FINAL

February 2002

Glossary of Terms

The terms listed below are used throughout this document and in other FEMA Flood Hazard Mapping Program documents.

0.2-Percent-Annual-Chance Flood—The flood that has a 0.2-percent chance of being equaled or exceeded in any given year.

1-Percent-Annual-Chance Flood— The flood that has a 1-percent chance of being equaled or exceeded in any given year.

2-Percent-Annual-Chance Flood—The flood that has a 2-percent chance of being equaled or exceeded in any given year.

10-Percent-Annual-Chance Flood—The flood that has a 10-percent chance of being equaled or exceeded in any given year.

10-Year Flood—See 10-Percent-Annual-Chance Flood.

50-Year Flood—See 2-Percent-Annual-Chance Flood.

100-Year Flood—See 1-Percent-Annual-Chance Flood.

500-Year Flood—See 0.2-Percent-Annual-Chance Flood

Accuracy—The degree of correctness attained in a measurement.

Alluvial Fan—The sedimentary deposit located at a topographic break, such as the base of a mountain front, escarpment, or valley side, that is composed of streamflow and/or debris flow sediments and has the shape of a fan, either fully or partially extended. These characteristics can be categorized by composition, morphology, and location.

Alluvial Fan Flooding—The flooding that occurs on an alluvial fan as defined above. The term *alluvial fan flooding* encompasses both active alluvial fan flooding and inactive alluvial fan flooding.

Alluvial Fan Flooding (Active)—Flooding that occurs only on alluvial fans and is characterized by flow path uncertainty so great that this uncertainty cannot be set aside in realistic assessments of flood risk or in the reliable mitigation of the hazard. An active alluvial fan flooding hazard is indicated by three related criteria: (1) flow path uncertainty

below the hydrographic apex; (2) abrupt deposition and ensuing erosion of sediment as a stream or debris flow loses its ability to carry material eroded from a steeper, upstream source area; and (3) an environment where the combination of sediment availability, slope, and topography creates an ultrahazardous condition for which elevation on fill will not reliably mitigate the risk.

Alluvial Fan Flooding (Inactive)—Flooding that is similar to traditional riverine flood hazards, but occurs only on alluvial fans. Inactive alluvial fan flooding is characterized by flow paths with a higher degree of certainty in realistic assessments of flood risk or in the reliable mitigation of the hazard. Unlike active alluvial fan flooding hazards, an inactive alluvial fan flooding hazard is characterized by relatively stable flow paths. However, like areas of active alluvial fan flooding, inactive alluvial fan flooding, may be subject to sediment deposition and erosion, but to a degree that does not cause flow path instability and uncertainty.

Alphanumeric Data—Data consisting of both letters and numbers, and possibly symbols such as punctuation marks.

American Standard Code for Information Interchange (ASCII)—A popular standard for the exchange of alphanumeric data.

Appeal—The formal objection to proposed or proposed modified Base Flood Elevations (BFEs), submitted by a community official or an owner or lessee of real property within the community during the statutory 90-day appeal period. An appeal must be based on data that show the proposed or proposed modified BFEs are scientifically or technically incorrect.

Appeal Period—The statutory period, beginning on the date of second publication of proposed BFEs and/or proposed modified BFEs in the local newspaper, during which community officials or owners or lessees of real property within the community may appeal proposed or proposed modified BFEs by submitting data to show those BFEs are scientifically or technically incorrect.

Application/Certification Forms—The comprehensive, easy-to-use forms that were implemented by FEMA in October 1992 to facilitate the processing of requests for revisions or amendments to National Flood Insurance Program maps.

Approved Model—A numerical computer model that has been accepted by FEMA for use in performing new or revised hydrologic or hydraulic analyses for National Flood Insurance Program purposes. All accepted models must meet the requirements set forth in Subparagraph 65.6(a)(6) of the National Flood Insurance Program regulations.

Approximate Study—A flood hazard study that results in the delineation of floodplain boundaries for the 1-percent-annual-chance (100-year) flood, but does not include the determination of BFEs or flood depths.

Area—The level of spatial measurement referring to a two-dimensional defined space

Area Not Included (ANI)—An area that is excluded from the mapping for a subject community because (1) the area is under the jurisdiction of another community and is shown on the mapping for that community, or (2) access to the area is limited for security reasons (e.g., military installations).

Artwork—The various layers prepared by the cartographic staff that are components of the manually produced Flood Insurance Rate Map and/or Flood Boundary and Floodway Map.

As-Built—A term used to describe mapping and mapping-related data that reflect conditions within a floodplain based on flood-control and other structures being completed.

Assistance Officer (AO) —The FEMA Regional Office staff person that is responsible for the administration of funding and funding-related activities for a specific contract or agreement.

Area of Special Consideration (ASC) —The name given to a special floodprone area around closed-basin lakes. The ASC is an area that is know to be subject to flooding, but the percent chance of the area being flooded in any given year is not defined.

Attribute—The descriptive characteristic or quality of a feature. An attribute value is a measurement assigned to an attribute for a feature instance.

Backwater—Water backed up or retarded in its course as compared with its normal or natural condition of flow.

Base Flood—The flood that has a 1-percent chance of being equaled or exceeded in any given year.

Base Flood Elevation (BFE) —The elevation of a flood having a 1-percent chance of being equaled or exceeded in any given year.

Base Map—The map of the community that depicts cultural features (e.g., roads, railroad, bridges, dams, culverts), drainage features, and corporate limits.

Batch Processing—The system by which computers process, without operator intervention, all input for an application at one time to produce the desired input, even though input data might have been collected periodically.

Bench Mark (BM)—A permanent monument established by any Federal, State, or local agency, whose elevation and description are well documented and referenced to the National Geodetic Vertical Datum of 1929 or the North American Vertical Datum of 1988.

Bit—An abbreviation for binary digit, a number that can have only a value of 0 or 1.

Block—A group of bytes treated as one unit of information, sometimes called a physical record.

Buffer Zone—An area of specified distance (radius) around a map item or items.

Building—See Structure.

Byte—A group of bits that can be stored and retrieved as a unit.

Cell—The defined geometric shape that stores data or defines an area that is labeled. The most common mapping cell is a square. Also the basic element of spatial information in raster data structures.

Centroid—The point interior to a polygon whose coordinates are the averages of the corresponding coordinates for all points included in the polygon.

Channel—A naturally or artificially created open conduit that periodically or continuously contains moving water or which forms a connecting link between two bodies of water.

Chief Executive Officer (CEO)—The official of a community who has the authority to implement and administer laws, ordinances, and regulations for that community.

Choropleth Map—A map with shaded or hatched areas. (Choro = place and pleth = value.)

Coastal Barrier Resources System (CBRS)—A system of protected coastal areas (including the Great Lakes. The areas within the CBRS are defined as depositional geologic features consisting of unconsolidated sedimentary materials; subject to wave, tidal, and wind energies; and protecting landward aquatic habitats from direct wave attack.

Coastal Flooding—Flooding that occurs along the Great Lakes, the Atlantic and Pacific Oceans, and the Gulf of Mexico.

Coastal High Hazard Area—An area of special flood hazard extending from offshore to the inland limit of a primary frontal dune along an open coast and any other area subject to high-velocity wave actions from storms or seismic sources.

Code of Federal Regulations (CFR)—The codification of the general and permanent rules published in the *Federal Register* by the Executive Departments and agencies of the Federal

Government. National Flood Insurance Program regulations are printed in Parts 59 through 77 of Title 44 of the CFR.

Community—Any State or area or political subdivision thereof, or any Indian tribe or authorized tribal organization, or Alaska Native village or authorized native organization, which has the authority to adopt and enforce floodplain management regulations for the areas within its jurisdiction.

Community Assistance Call (CAC)—A telephone call made by FEMA Regional Office staff or the State National Flood Insurance Program Coordinator to a community to supplement or replace a Community Assistance Visit.

Community Assistance Visit (CAV)—A visit by FEMA Regional Office staff or the State National Flood Insurance Program Coordinator to a community to assess whether the community's floodplain management program meets National Flood Insurance Program participation requirements.

Community Coordination Meeting—A meeting during which Flood Hazard Mapping Partners discuss plans for a Flood Map Project, interim results of a Flood Map Project, and final results of a Flood Map Project for a particular community or group of communities.

Community Identification Number (CID)—A six-digit code used by FEMA to identify each community that is potentially subject to flood hazards.

Community Information System (CIS)—An Oracle database system used by FEMA to track and report on all communities identified by FEMA as potentially floodprone, especially with regard to mapping actions, including Letters of Map Change, taken by FEMA to identify flood hazards in each community.

Community Rating System (CRS)—A FEMA initiative, established under the National Flood Insurance Program, to recognize and reward communities that have implemented floodplain management measures beyond the minimum required by National Flood Insurance Program regulations. Under the CRS, those communities that choose to participate voluntarily may reduce the flood insurance premium rates for property owners in the community by taking these additional actions.

Compliance Period—The period that begins with the issuance of a Letter of Final Determination and ends when a new or revised Flood Insurance Rate Map becomes effective. During the compliance period, a community must enact and adopt new or revised floodplain management ordinances required for participation in the National Flood Insurance Program.

Computer-Assisted Drafting and Design (CADD)—Software with the capability of assisting the operator with the performance of standard engineering and architecture design functions.

Conditional Letter of Map Amendment (CLOMA)—The FEMA response to a requester who believes his or her proposed structure, when constructed on natural ground at or above

the BFE, will be outside the 1-percent-annual-chance floodplain. CLOMAs may not be issued for unimproved or undeveloped property.

Conditional Letter of Map Revision (CLOMR)—The FEMA response to a community request for FEMA's comment on proposed alterations to the floodplain conditions within that community. The CLOMR describes the effect of the proposed project, if constructed as proposed, on the effective FIRM, FBFM, and/or FIS report. A CLOMR often contains detailed information on conditions that must be met by a requester before FEMA will issue a final determination regarding revising the FIRM, FBFM, and/or FIS report.

Conditional Letter of Map Revision Based on Fill (CLOMR-F)—The FEMA response to a community request for FEMA's comment on the effect(s) that a proposed project involving the placement of earthen fill within the SFHA will have on the Special Flood Hazard Area designation for one or more legally defined parcels of land or one or more proposed structures.

Consultation Coordination Officer (CCO)—The individual on the FEMA Regional Office staff who is responsible for coordinating with a community on activities related to National Flood Insurance Program.

Contracting Officer (CO)—The FEMA Headquarters staff person that is responsible for the administration of funding and funding-related activities for a specific contract or agreement.

Control Point—Any station in a horizontal or vertical control network that is identified in a dataset of photograph and used for correlating the data shown in the data set or photograph.

Cooperating Technical Partners (CTP) Initiative—An innovative FEMA program to create partnerships between FEMA and participating National Flood Insurance Program communities, regional agencies, and State agencies that have the interest and capability to become more active participants in the FEMA Flood Hazard Mapping Program.

Coordinate Geometry (COGO)—The use of bearings and distances, azimuths, and coordinate locations to enter and describe graphic data. COGO is usually used for civil engineering and survey applications.

Coordinate Pair—A set of cartesian coordinates describing the location of a point, line or area (polygon) feature in relation to the common coordinate system of the data base.

Coordinate System—A particular kind of reference frame or system, such as plane rectangular coordinates or spherical coordinates, which use linear or angular quantities to designate the position of points within that particular reference frame or system (e.g., State Plane).

Countywide Format—A format used by FEMA to show flooding information for the entire geographic area of a county, including the incorporated communities in the county, on one map and in one report.

Credited Structures Inventory System (CSIS)—A computerized database and information retrieval system used by FEMA to collect and maintain information on all structures shown as providing protection from the base flood on effective and soon-to-be-effective Flood Insurance Rate Maps, including levees, dikes, floodwalls, and road and railroad embankments.

Cultural Features—Railroads, airfields, streets, roads, highways, levees, dikes, seawalls, dams and other flood-control structures, and other prominent manmade features and landmarks shown on a National Flood Insurance Program map.

Database—A collection of information related by a common fact or purpose.

Database Management System (DBMS) —A systematic approach to maintaining, accessing, and manipulating data base files. A DBMS may consist of a single program or a collection of task-specific programs.

Data Capture—The series of operations required to encode data in a computer-readable form (digitizing).

Data Layer—Refers to data having similar characteristics being contained in the same plane or overlay (e.g., roads, rivers) of a Geographic Information System. Usually information contained in a data layer is thematically related and is designed to be used with other layers.

Dataset or Datafile—A named collection of logically related data records arranged in a prescribed manner. The physical set of data of one data type being referred to or being used in the context of a data processing operation.

Detailed Study—A flood hazard study that, at a minimum, results in the delineation of floodplain boundaries for the 1-percent-annual-chance (100-year) flood and the determination of BFEs or flood depths.

Differential Global Positioning System (DGPS)—Global Positioning System (GPS) positioning techniques that use two or more GPS receivers, with a base station on a position of known location, and one or more roving receivers taking GPS measurements at unknown locations.

Digital Data—Data displayed, recorded, or stored in binary notation.

Digital Elevation Model (DEM)—A file with terrain elevations recorded for the intersection of a fine-grained grid and organized by quadrangle as the digital equivalent of the elevation data on a topographic base map.

Digital Flood Insurance Rate Map (DFIRM)—A Flood Insurance Rate Map that has been prepared as a digital product, which may involve converting an existing manually produced FIRM to digital format, or creating a product from new digital data sources using a Geographic Information System environment. The DFIRM product allows for the creation of interactive, multi-hazard digital maps. Linkages are built into an associated database to allow

users options to access the engineering backup material used to develop the DFIRM, such as hydrologic and hydraulic models, Flood Profiles, data tables, Digital Elevation Models, and structure-specific data, such as digital elevation certificates and digital photographs of bridges and culverts.

Digital Flood Insurance Rate Map–Digital Line Graph (DFIRM-DLG)—The product created by extracting the flood risk thematic data from the DFIRM. The format of this product is the U.S. Geological Survey Digital Line Graph Level 3 optional format. The DFIRM-DLG does not include base map information, or graphic data required to create a FIRM in hardcopy format. The DFIRM-DLG is intended to be the primary means of transferring flood risk data depicted by FIRMs to Geographic Information Systems through a public domain data exchange format. The DFIRM-DLGs are tiled the to U.S. Geological Survey 1:24,000 scale topographic map series.

Digital Flood Insurance Rate Map (DFIRM) Spatial Database—A database designed to facilitate collecting, storing, processing, and accessing data developed by FEMA, enabling Mapping Partners to share the data necessary for the DFIRM production and conversion process. Where possible, all mapping and engineering data elements are linked to physical geographic features and georeferenced. The use of a Geographic Information System as a component of the DFIRM spatial database provides the ability to georeference and overlay the mapping and engineering data, allowing the database to support a wide variety of existing and forthcoming FEMA engineering and mapping products.

Digital Line Graph (DLG)—A computer file format for mapping data that provides a topological structure to describe points, lines, and polygons. FEMA has adopted the U.S. Geological Survey (USGS) Digital Line Graph Level 3 optional format for National Flood Insurance Program mapping and engineer requirements. A DLG may contain lists of point coordinates describing boundaries, drainage lines, transportation routes, and other linear features, which are organized by USGS quadrangle areas. These data are the digital equivalent of the linear hydrographic and cultural data on a topographic base map. The flood risk thematic layers developed by FEMA will fit the quadrangle as an overlay.

Digital Line Graph Level 3 (DLG-3)—Data files that are fully topologically structured and are designed to be integrated into Geographic Information Systems.

Digital Orthophoto Quadrangle (DOQ)—Photographic maps distributed by the U.S. Geological Survey. A DOQ is an aerial photograph that is adjusted to remove distortions caused by variations in terrain and the camera lens to produce a photograph that displays features in their planimetrically correct location. This term is sometimes used loosely to mean any photographic map produced by this process.

Digital Terrain Model (DTM)—A land surface represented in digital form by an elevation grid or lists of three-dimensional coordinates.

Digitizing—A process of converting an analog image or map into a digital format usable by a computer.

Drawing Exchange File (DXF)—A commonly used format for the exchange of graphic data.

Edge Matching—The comparison and graphic adjustment of features to obtain agreement along the edges of adjoining map sheets.

Effective Date—The date on which the National Flood Insurance Program Map for a community becomes effective and all sanctions of the National Flood Insurance Program apply.

Effective Map—The National Flood Insurance Program map issued by FEMA that is in effect as of the date shown in the title block of the map as "Effective Date," "Revised," or "Map Revised."

Elevation Reference Mark (ERM) — Temporary vertical control monument established by a FEMA Study Contractor during the performance of a study or restudy.

Elevation Reference Point (ERP)—A temporary mark, the elevation of which is determined by levels or Differential Global Positioning System positioning from a bench mark or elevation reference mark. For purposes of the National Flood Insurance Program, ERPs are submitted with copies of field notes or a documented summary of procedures.

Emergency Phase—The phase of the National Flood Insurance Program that was implemented, on an emergency basis, to provide a first-layer amount of insurance on all insurable structures before the effective date of the initial Flood Insurance Study and Flood Insurance Rate Map.

Emergency Program—See Emergency Phase.

Encroachment—Construction, placement of fill, or similar alteration of topography in the floodplain that reduces the area available to convey floodwaters.

Engineering Study Data Package (ESDP) Project—A project designed to maintain archival engineering data and other pertinent flood hazard data in hardcopy and electronic form and to distribute these data to interested parties.

Engineering Study Data Package Facility (ESDPF) —The facility, maintained for FEMA by a contractor, where archival engineering data and other pertinent flood hazard data, are prepared in final form ready for distribution to interested parties.

Exporting—The process of transferring digital data or software from one system to another system.

Existing Data Study (XDS)—This term is used to describe the process by which FEMA uses previously published flood hazard information to prepare a Flood Insurance Study report and Flood Insurance Rate Map for a community that does not have a FIRM using previously published flood hazard information. This flood hazard information comes from reports prepared by Federal agencies for purposes other than the National Flood Insurance

Program, such as Flood Hazard Analyses Reports and Floodplain Information reports; other engineering reports prepared by Federal, State, or local agencies; or Flood Insurance Study reports and maps issued by FEMA for adjacent communities (especially previously unincorporated areas of a county).

Existing Data Restudy (RXDS)—An Existing Data Study for a community that is already participating in the Regular Phase of the National Flood Insurance Program without a flood map.

External Data Request (EDR)—A request from a State, community, or other non-FEMA source for the archived technical and administrative support data developed and maintained by FEMA for the National Flood Insurance Program.

Extraterritorial Jurisdiction (ETJ) Limits—Areas outside of a community's corporate limits where the community has authority to regulate zoning and issue building permits.

Federal Contractors—The five Federal agencies that conduct flood studies, under contract with FEMA, for the Limited Map Maintenance Program: U.S. Army Corps of Engineers, U.S. Geological Survey, U.S. Soil Conversation Service, U.S. Bureau of Reclamation, and Tennessee Valley Authority.

Federal Emergency Management Agency (FEMA)—The independent Federal agency that, among many other responsibilities, oversees the administration of the National Flood Insurance Program.

Federal Insurance and Mitigation Administration (FIMA)—The component of FEMA that has direct responsibility for administering the National Flood Insurance Program.

Federal Register—The document, published daily by the Federal Government, that presents regulation changes and legal notices issued by Federal agencies. FEMA publications in the Federal Register include Proposed, Interim, and Final Rules for BFE determinations; Compendium of Flood Map Changes published twice each year; and Final Rules concerning community eligibility for the sale of flood insurance.

Fee-Charge System Administrator—The individual that is responsible for processing and maintaining records of payments submitted to the National Flood Insurance Fund for conditional and final map change requests and requests for technical and administrative support data.

FEMA Lead—FEMA staff member (usually the Regional Project Officer or the Flood Map Production Coordination Contractor Project Officer at FEMA Headquarters) that oversees project scope, schedule, and budget, and coordinate the Project-related activities of the various Flood Hazard Mapping Partners.

Fill—Soil that is brought in to raise the level of the ground. Depending on where the soil is placed, fill may change the flow of water or increase flood elevations. Fill may be used to elevate a building to meet National Flood Insurance Program requirements. Sometimes fill is

combined with other methods of elevation such as pilings or foundation walls. Placement of fill requires a local permit from the community.

Fiscal Year—The 12-month period that begins on October 1 and ends on September 30.

Flood—A general and temporary condition of partial or complete inundation of normally dry land areas from (1) the overflow of inland or tidal waters or (2) the unusual and rapid accumulation or runoff of surface waters from any source.

Flood Boundary and Floodway Map (FBFM)—The floodplain management map issued by FEMA that depicts, based on detailed flood hazard analyses, the boundaries of the 1-percent-annual-chance (100-year) and the 0.2-percent-annual-chance (500-year) floodplains and, when appropriate, the regulatory floodway. The FBFM does not show flood insurance risk zones or BFEs.

Flood-Control Storage—Storage of water in reservoirs to abate flood damage.

Flood Elevation Determination Docket (FEDD) — A file maintained by FEMA that includes all correspondence between FEMA and the community concerning a flood study; reports of meetings held among FEMA representatives, community representatives, the State NFIP Coordinator, private citizens, FEMA and community contractors, or other interested parties; relevant publications (e.g., newspaper notices, Federal Register notices); Letter of Final Determination; a copy of the Flood Insurance Study report; and a copy of the Flood Insurance Rate Map and FBFM.

Floodflow-Frequency Curve—A graph showing the number of times per year on the average that floods of certain magnitudes are equaled or exceeded.

Flood Hazard Analyses Report (FHAR) — A flood hazard report prepared by the Natural Resources Conservation Service (formerly, the U.S. Soil Conservation Service) for purposes other than the National Flood Insurance Program.

Flood Hazard Boundary Map (FHBM)—The initial insurance map issued by FEMA that identifies, based on approximate analyses, the areas of the 1-percent-annual-chance (100-year) flood hazard within a community.

Flood Hazard Mapping Program—The program undertaken by FEMA to conduct FISs and prepare reports and maps delineating flood hazards in floodprone communities throughout the United States.

Flood Insurance Rate Map (FIRM)—The insurance and floodplain management map produced by FEMA that identifies, based on detailed or approximate analyses, the areas subject to flooding during a 1-percent-annual-chance (100-year) flood event in a community. Flood insurance risk zones, which are used to compute actuarial flood insurance rates, also are shown. In areas studied by detailed analyses, the FIRM shows Base Flood Elevations (BFEs) to reflect the elevations of the 1-percent-annual-chance flood. For many communities, when detailed analyses are performed, the FIRM also may show areas inundated by 0.2-percent-annual-chance (500-year) flood and regulatory floodway areas.

Flood Insurance Rate Zones— See Flood Insurance Risk Zones.

Flood Insurance Restudy (RFIS)—A revised study of flood hazards performed for a community that already has an effective FIRM (and, in some cases, FBFM). An RFIS also may be referred to as a "Type 19 RFIS" or a "Type 19 restudy." FEMA Study Contractors have traditionally performed RFISs. However, communities, regional agencies, and States that are participating in the Cooperating Technical Partner initiative also may perform these types of Flood Map Projects.

Flood Insurance Risk Zones—The zones, also referred to as "risk premium rate zones" and "flood insurance rate zones," shown on a FIRM or FHBM that are used to determine flood insurance premium rates for properties in the community covered by the FIRM or FHBM. The flood insurance risk zones include Special Flood Hazard Areas (i.e., Zones A, A1-30, AE, A0, A99, AH, AR, AR/A, AR/A1-30, AR/AE, AR/A99, V, V1-30, VE, V0) and areas outside Special Flood Hazard Areas (i.e., Zones B, X, D, M, N, P, E).

Flood Insurance Study (FIS)—The initial study of flood hazards performed for a community that does not have an effective Flood Insurance Rate Map (FIRM) or Flood Boundary and Floodway Map (FBFM). An FIS also may be referred to as a "Type 15 FIS" or a "Type 15 study." FEMA Study Contractors have traditionally performed FISs. However, communities, regional agencies, and States that are participating in the Cooperating Technical Partners initiative also may perform these types of Flood Map Projects.

Flood Insurance Study (FIS) Report—A document, prepared and issued by FEMA, that documents the results of the detailed flood hazard assessment performed for a community. The primary components of the FIS report are text, data tables, photographs, and Flood Profiles.

Flood Map Production Coordination Contractor (MCC)—A private-sector engineering firm that, under contract to FEMA, reviews and processes new and revised flood studies, appeals and protests related to the new and revised flood studies, conditional and final map amendments, conditional and final map revisions, and requests for Letters of Determination Review; performs activities related to program development and program support; and maintains regional archives of flood hazard mapping and related data.

Flood Map Project—Any activity undertaken by FEMA or a Flood Hazard Mapping Partner to create a new flood map or update an existing flood map, including detailed studies, approximate studies, and redelineations of floodplain boundaries based on updated topographic information.

Floodplain—Any land area that is susceptible to being inundated by water from any source.

Floodplain Information Report (FPI)—A flood hazard report prepared by a Federal agency (usually, the U.S. Army Corps of Engineers or U.S. Geological Survey) for purposes other than the National Flood Insurance Program.

Floodplain Management—The operation of a program of corrective and preventative measures for reducing flood damage, including, but not limited to, emergency preparedness plans, flood-control works, and floodplain management regulations.

Floodplain Management Regulations—The zoning ordinances, subdivision regulations, building codes, health regulations, special-purpose ordinances, and other applications of enforcement used by a community to manage development in its floodplain areas.

Floodprone Area—See Floodplain

Floodprone Community—Any community that is subject to inundation by the base (100-year) flood.

Flood Profile—A graph showing the relationship of water-surface elevation to location, with the latter generally expressed as distance above the mouth for a stream of water flowing in an open channel.

Flood Protection System—Those physical works for which funds have been authorized, appropriated, and expended and which have been constructed specifically to modify flooding in order to reduce the extent of the area subject to a "special flood hazard" and the extent of the depths of the associated flooding. Flood protection systems typically include hurricane tidal barriers, dams, reservoirs, levees, or dikes.

Floodway—See Regulatory Floodway.

Floodway Fringe—The portion of the 1-percent-annual-chance (100-year) floodplain that is not within the regulatory floodway and in which development and other forms of encroachment may be permitted under certain circumstances.

Frame—Refers to the size of a FIRM or FBFM panel as follows: A Frame (28"x21"); B Frame (28"x24"); C Frame (28"x28"); D Frame (28"x32"); E Frame (28"x40").

Freeboard—A factor of safety usually expressed in feet above a flood level for purposes of floodplain management.

Fully Analytical Aerial Triangulation (FAAT)—A process for the extension of horizontal and vertical control whereby the measurements of angles and/or distances on overlapping

photographs are related into a spatial solution using the perspective principles of the photographs, obtained totally by computational routines.

Future-Conditions Floodplain or Flood Hazard Area—The land area that would be inundated by the 1-percent-annual-chance (100-year) flood based on future-conditions hydrology.

Future-Conditions Hydrology—The flood discharges associated with projected land-use conditions based on a community's zoning maps and/or comprehensive land-use plans and without consideration of projected future construction of flood detention structures or projected future hydraulic modifications within a stream or other waterway, such as bridge and culvert construction, fill, and excavation.

Geocoding—The process of associating geographic coordinates or grid cell identifiers to data, points, lines, and shapes.

Geographic Information System (GIS)—A system of computer hardware, software, and procedures designed to support the capture, management, manipulation, analysis, modeling, and display of spatially referenced data for solving complex planning and management problems.

Geographic Resources Analysis and Support System (GRASS)—Geographic Information System software that was developed by the U.S. Army Corps of Engineers and is used by several Federal agencies.

Georeference System—An X,Y or X,Y,Z coordinate system that locates points on the surface of the earth as a reference to points on a map.

Global Positioning System (GPS)—A satellite-based navigation and positioning system that enables horizontal and vertical positions to be determined

Grid—A network of uniformly spaced horizontal and perpendicular lines that enclose an area with an associated value assigned. A defined aggregate spatial object.

Hazard—An event or physical condition that has the potential to cause fatalities, injuries, property damage, infrastructure damage, agricultural loss, damage to the environment, interruption of business, and other types of loss or harm.

Headquarters (HQ) —The FEMA office in Washington, DC.

Horizontal Control—A network of stations of known geographic or grid positions referred to a common horizontal datum, which control the horizontal positions of mapped features with respect to parallels and meridians, or northing and easting grid lines shown on the map.

Hydraulic Analysis—An engineering analysis of a flooding source carried out to provide estimates of the elevations of floods of selected recurrence intervals.

Hydraulic Computer Model—A computer program that uses flood discharge values and floodplain characteristic data to simulate flow conditions and determine flood elevations.

Hydraulic Methodology—Analytical methodology used for assessing the movement and behavior of floodwaters and determining flood elevations and regulatory floodway data.

Hydrograph—A graph showing stage, flow, velocity, or other properties of water with respect to time.

Hydrologic Analysis— An engineering analysis of a flooding source carried out to establish peak flood discharges and their frequencies of occurrence.

Hydrology—The science encompassing the behavior of water as it occurs in the atmosphere, on the surface of the ground, and underground.

Ice Jam—An accumulation of ice in a stream that reduces the cross-sectional area available to carry streamflow and increases the water-surface elevation of the stream.

Importing—The process of bringing data or software into a dissimilar system.

Initializing—The process of setting program variables to their starting values, commonly zero, at the beginning of a program.

Interior Drainage Systems—Systems associated with levee systems that usually include storage areas, gravity outlets, pumping stations, or a combination thereof.

Island—A closed two-dimensional figure. In a GIS, an island is a unit of land cover lying completely within another land-cover unit.

Kilobyte—A unit of memory representing 1,024 bytes and often designated with the symbol K, as 4Kb or 4 kilobytes. The symbol K is also used to refer to 1,024 words of any specified size.

Layer—The various "overlays" of data, each of which normally deals with one thematic topic. The overlays are registered to each other by the common coordinate system of the database. In a GIS, a layer or a theme represents a specific kind of data.

Legally Defined Parcel of Land—A parcel of land for which a metes and bounds description or a plat has been recorded. Structure may exist on legally defined parcels of land.

Letter of Determination Review (LODR)—A FEMA response to a request from a borrower and lender that FEMA provide its concurrence or disagreement with the lender's determination on whether the borrower's building is in the SFHA shown on the effective National Flood Insurance Program map.

Letter of Final Determination (LFD)—The letter in which FEMA announces its final determination regarding the flood hazard information, including (when appropriate) proposed

and proposed modified BFEs, presented on a new or revised FIRM, FIS report, and (when appropriate) FBFM for a particular community. In the LFD, FEMA begins the compliance period and establishes the effective date for the new or revised FIRM, FIS report, and/or

Letter of Map Amendment (LOMA) —An official determination by FEMA that a property has been inadvertently included in an SFHA as shown on an effective FHBM or FIRM and is not subject to inundation by the 1-percent-annual-chance flood. Generally, the property is located on natural high ground at or above the BFE or on fill placed prior to the effective date of the first National Flood Insurance Program map designating the property as within an SFHA. Limitations of map scale and development of topographic data more accurately reflecting the existing ground elevations at the time the maps were prepared are the two most common bases for LOMA requests.

Letter of Map Change—A collective term used to describe official amendments and revisions to National Flood Insurance maps that are accomplished by a cost-effective administrative procedure and disseminated by letter.

Letter of Map Change Revalidation (LOMC-VALID) Letter—A letter issued by FEMA, immediately before the effective date of a revised FIRM, to notify community officials about LOMAs, LOMR-Fs, and LOMRs that will remain in effect after the FIRM is published.

Letter of Map Revision (LOMR)—A letter issued by FEMA to revise the FIRM, FBFM, and/or FIS report for a community to change in BFEs, floodplain and floodway boundary delineations, and coastal high hazard areas.

Letter of Map Revision Based on Fill (LOMR-F)—A Letter of Map Change issued by FEMA when FEMA determines that a legally defined parcel of land or structure has been elevated above the BFE based on the placement of earthen fill after the date of the first National Flood Insurance Program map.

Levee—A manmade structure, usually an earthen embankment, designed and constructed in accordance with sound engineering practices to contain, control, or divert the flow of water so as to provide protection from temporary flooding.

Light Detection and Ranging (LIDAR) System—An airborne laser system, flown aboard rotary or fixed-wing aircraft, that is used to acquire x, y, and z coordinates of terrain and terrain features that are both manmade and naturally occurring. LIDAR systems consist of an airborne Global Positioning System with attendant base station(s), Inertial Measuring Unit, and light-emitting scanning laser.

Limited Map Maintenance Program Project Revision (LMMP)—A limited-scope restudy of flood hazards that generally involves a single community and one watercourse. The data submitted to FEMA by the SC for an LMMP are similar in format and level of detail to those submitted for an RFIS.

Line—A level of spatial measurement referring to a one-dimensional defined object having a length, direction, and connecting at least two points.

Local Newspaper—The community newspaper, identified by the CEO or other designated community official, in which FEMA publishes notices at the beginning of a Flood Map Project, at the beginning of the appeal period, and at other times during the processing of a new or revised FIRM when required.

Lot—A parcel of land for which a metes and bounds description or a plat has been recorded and on which one or more structures may be built.

Lowest Adjacent Grade (LAG)—The lowest natural elevation of the ground surface next to a structure.

Lowest Finished Floor Elevation (LFFE)—The lowest floor of the lowest enclosed area (including basement) of a structure.

Manning's n—A coefficient of roughness, used in a formula for estimating the capacity of channel to convey water.

Manufactured Home—Any building that is transportable in one or more sections, which is built on a permanent chassis and designed to be used with or without a permanent foundation when connected to the required utilities. Park trailers, recreational vehicles, and other similar vehicles are not considered manufactured homes.

Map Amendment—A change to an effective National Flood Insurance Program map that results in the exclusion from the Special Flood Hazard Area of an individual structure or legally defined parcel of land that has been inadvertently included in the Special Flood Hazard Area (i.e., no alterations of topography have occurred since the date of the first National Flood Insurance Program map that showed the structure or parcel to be within the Special Flood Hazard Area.

Map Assistance Center—A FEMA customer service center staffed by Map Specialists that are specially trained to answer specific questions about the status of active and completed studies, restudies, conditional and final map revision requests, and conditional and final map amendment requests; answer questions about technical and administrative support data available from the FEMA archives; link callers with other FEMA service and fax numbers and the FEMA website; and provide information regarding, or copies of, FEMA products, brochures, and publications.

Map Needs Update Support System (MNUSS)—The computerized database system that is used by FEMA and its Flood Hazard Mapping Partners to compile information on mapping needs nationwide collected using the Mapping Needs Assessment Process.

Mapping Activity Statement (MAS)—An agreement signed by FEMA and a participant (community, regional agency, or State agency) in the CTP initiative under which the participant will complete specific mapping activities.

Mapping Needs Assessment Process (MNAP)—The process by which FEMA identifies mapping needs nationwide by contacting States, regional agencies, and mapped participating

communities for information; verifies the validity of the identified needs; and compiles information on those needs into a computerized database.

Map Revision—A change to an effective National Flood Insurance Program map that is accomplished by a LOMR or a Physical Map Revision.

Memorandum of Agreement—See Partnership Agreement.

Minimally Floodprone Community—A community that FEMA has determined to be subject to inundation by the 1-percent-annual-chance (100-year) flood, but for which existing conditions indicate that the area is unlikely to be developed in the foreseeable future. The criteria used by FEMA to evaluate a community's development potential are as follows: (1) Floodplains are publicly owned and designed for open space or preservation; (2) Zoning laws, sanitary codes, subdivision regulations, shore land regulations, or community regulations effectively prohibit floodplain development; (3) Surrounding land use or topography effectively limits the development potential; (4) Population is decreasing or stable, and there is no foreseeable pressure for floodplain development; and (5) Floodplains are remote and uninhabited, and future development is unlikely.

Mitigation—A sustained action taken to reduce or eliminate long-term risk to people and property from flood hazards and their effects. Mitigation distinguishes actions that have a long-term impact from those are more closely associated with preparedness for, immediate response to, and short-term recovery from specific events.

Mitigation Directorate—See Federal Insurance and Mitigation Administration.

National Flood Insurance Fund (NFIF) —The fund used as the funding mechanism for the National Flood Insurance Program.

National Flood Insurance Program (NFIP) — Federal Program under which flood-prone areas are identified and flood insurance is made available to the owners of the property in participating communities.

Network Analysis—Analytical technique concerned with the relationships between locations on a network, such as the calculation of optimal routes through road networks, capacities of network systems, best locations for facilities along networks.

Node—A point at which two or more lines meet; called an edge or vertex in graph theory.

Non-Floodprone Community—A community that FEMA has determined not to be subject to inundation by the 1-percent-annual-chance (100-year) flood. The FEMA guidelines employed for determining whether a community is designated as non-floodprone are that all of its SFHAs are less than 200 feet wide and all drain less than 1 square mile, or physiographic features that preclude floodplain development exist in the community.

Non-Participating Community—A community that has been identified by FEMA as being floodprone but has chosen not to participate in the National Flood Insurance Program.

Notice-To-User Revision—A revision made by FEMA to correct a non-technical problem with a published FIS Report, FIRM, or FBFM quickly and inexpensively. These types of revisions are intended solely to correct a noted defect with the product and cannot be used to establish new or revised flood hazard information.

Operating System—The master control program that governs the operation of a computer system, running job entry, input/output services, data management, and supervision or housekeeping.

Otherwise Protected Area (OPA)—An undeveloped coastal barrier within the boundaries of an area established under Federal, State, or local law, or held by a qualified organization, primarily for wildlife refuge, sanctuary, recreational, or natural resource conservation purposes.

Participating Community—Any community that voluntarily elects to participate in the National Flood Insurance Program by adopting and enforcing floodplain management regulations that are consistent with the standards of the National Flood Insurance Program.

Partnership Agreement—An agreement, also referred to as a Memorandum of Agreement, that is signed by FEMA and a community, regional agency, or State agency that wishes to participate in the Cooperating Technical Partners initiative. The Partnership Agreement is a broad statement of principle, emphasizing the value of the National Flood Insurance Program's three components of insurance, floodplain management, and mapping.

Physical Map Revision (PMR)—A revision made by FEMA to a FIRM, FBFM, or FIS report based on community-supplied data. FEMA issues PMRs when (1) changes resulting from the requested revision are extensive, affecting significant portions of a FIRM panel or multiple FIRM panels; (2) revision will add significant SFHAs to the effective FIRM; or (3) revision will result in an increase in the BFEs and/or regulatory floodway.

Pixel—The smallest discrete element that makes up a digital image. (Short for "picture element".)

Planimetric Map—A map representing only horizontal positions from features represented; distinguished from a topographic map by the omission of relief in measurable form. A planimetrically accurate map shows accurate horizontal distances between features.

Point—A level of spatial measurement that refers to an object that has no dimension.

Point Data—In a vector structure, the data that consist of a single, distinct X,Y coordinate. In a raster structure, the data that consist of single cells.

Polygon—A two-dimensional figure with three or more sides intersecting at a like number of points. (In GIS, a polygon is an area.)

Ponding—The result of runoff or flows collecting in a depression that may have no outlet, subterranean outlets, rim outlets, or manmade outlets such as culverts or pumping stations.

Impoundments behind manmade obstructions are included in this type of shallow flooding as long as they are not backwater from a defined channel or do not exceed 3.0 feet in depth.

Position Dilution of Precision (PDOP)—In a study area, an indicator of the positional accuracy that can be derived from the current Global Positioning System satellite geometry, which varies continuously; the smaller the PDOP number, the higher the data quality.

Primary Frontal Dune—A continuous or nearly continuous mound or ridge of sand with relatively steep seaward and landward slopes immediately landward and adjacent to the beach and subject to erosion and overtopping from high tides and waves during major coastal storms.

Probability Density Function (PDF)—A distribution of probability for a continuous random variable.

Project Officer (PO)—A FEMA staff member in the Regional Office or in Headquarters who performs contract monitoring functions, which include providing technical direction to FEMA contractors, monitoring the progress of contractors' work, and evaluating contractor performance.

Proposed Base Flood Elevations/Depths and Proposed Modified Base Flood Elevations/Depths—Those Base Flood Elevations and base flood depths that FEMA publishes in a local newspaper and in the *Federal Register* at the start of the 90-day appeal period.

Protest—An objection to any information, other than BFEs, shown on an NFIP map that is submitted by community officials or interested citizens through the community officials during the 90-day appeal period.

Q3 Flood Data Product—A digital representation of certain features of the FIRM that is intended for use with desktop mapping and Geographic Information System technology. The Q3 Flood Data product is created by scanning the effective FIRM paper maps and digitizing selected features and lines.

Quadrangle—A U.S. Geological Survey (USGS) topographic map;

Quality Assurance/Quality Control (QA/QC) Reviews—The reviews of the Flood Insurance Study reports, maps, and related products and data performed to ensure compliance with FEMA standards.

Raster—The pattern of horizontal, parallel scan lines comprising the image on a CRT screen, on which each scan line consists of segments varying in intensity.

Record—A group of items in a file treated as a unit.

Recurrence Interval—The average interval of time within which a given flood will be equaled or exceeded once.

Regional Offices (ROs)—The FEMA offices located in Boston, Massachusetts; New York, New York; Philadelphia, Pennsylvania; Atlanta, Georgia; Chicago, Illinois; Denton, Texas; Kansas City, Missouri; Denver, Colorado; San Francisco, California; and Bothell, Washington.

Regional Project Officer (RPO)—A FEMA staff member in the Regional Office or in Headquarters who performs contract monitoring functions, which include providing technical direction to FEMA contractors, monitoring the progress of contractors' work, and evaluating contractor performance.

Regression Equation—An experimentally determinable equation of a regression curve; that is, an approximate, generally linear relation connecting two or more quantities and derived from the correlation coefficient.

Regular Phase—The phase of a community's participation in the National Flood Insurance Program when more comprehensive floodplain management requirements are imposed and higher amounts of insurance are available. The FIRM forms the basis for this phase of participation in the National Flood Insurance Program.

Regular Program—See Regular Phase.

Regulatory Floodway—A floodplain management tool that is the regulatory area defined as the channel of a stream, plus any adjacent floodplain areas, that must be kept free of encroachment so that the base flood discharge can be conveyed without increasing the BFEs more than a specified amount. The regulatory floodway is not an insurance rating factor.

Riverine Flooding—The overbank flooding of rivers and streams.

River Mile Marker (RMM) —A marker that indicates the distance in miles from a reference point on a river or other major watercourse.

Root Mean Square Error (RMSE) —The square root of the average of the set of squared differences between dataset coordinate values and coordinate values from an independent source of higher accuracy for identical points RMSE is used to estimate both horizontal and vertical accuracy.

Scale—A representative fraction of a paper map distance to ground distance.

Scanner—Any device that systematically decomposes a sensed image or scene into pixels and then records some attribute of each pixel.

Scanning—The process of using an electronic input device to convert analog information into a digital format usable by a computer.

Sediment—Fragmental material that originates from the weathering of rocks and is transported by, suspended in, or deposited by water or air or is accumulated in beds by other natural occurrence.

Scientifically Incorrect Base Flood Elevations—Those Base Flood Elevations determined through analyses in which the methodologies used and/or assumptions made are inappropriate for the physical processes being evaluated or are otherwise erroneous.

Shallow Flooding— Unconfined flows over broad, relatively low relief areas, such as alluvial plains; intermittent flows in arid regions that have not developed a system of well-defined channels; overbank flows that remain unconfined, such as on delta formations; overland flow in urban areas; and flows collecting in depressions to form ponding areas. For National Flood Insurance Program purposes, shallow flooding conditions are defined as flooding that is limited to 3.0 feet or less in depth where no defined channel exists.

Sheet Runoff—The broad, relatively unconfined downslope movement of water across sloping terrain that results from many sources, including intense rainfall and/or snowmelt, overflow from a channel that crosses a drainage divide, and overflow from a perched channel onto deltas or plains of lower elevation. Sheet runoff is typical in areas of low topographic relief and poorly established drainage systems.

Special Conversion—An action taken by FEMA to convert a community to the Regular Phase of the National Flood Insurance Program without preparing a FIRM with detailed flood risk zones. The exact action taken depends on whether FEMA determines the community is "non-floodprone" or "minimally floodprone."

Special Conversion Recommendation Report (SCRR) —A report, prepared by the FEMA Regional Office and submitted to FEMA HQ, that documents the reasons a community should be converted to the Regular Phase of the National Flood Insurance Program without a detailed engineering study being performed and recommends a specific conversion action.

Special Flood Hazard Area (SFHA)—The area delineated on a National Flood Insurance Program map as being subject to inundation by the base flood. SFHAs are determined using statistical analyses of records of riverflow, storm tides, and rainfall; information obtained through consultation with a community; floodplain topographic surveys; and hydrologic and hydraulic analyses.

Special Problem Report (SPR) —A report, prepared by the Flood Hazard Mapping Partner that is performing an engineering study or other mapping activity, that documents special problems or issues encountered during the performance of the work.

Stage—The height of a water surface above an established datum plane.

Standard Interchange Format (SIF)—A commonly used format for the exchange of alphanumeric data.

State—Any State, the District of Columbia, the territories and possessions of the United States, the Commonwealth of Puerto Rico, and the Trust Territory of the Pacific Islands.

State Coordinating Agency— See State National Flood Insurance Program Coordinator.

State National Flood Insurance Program (NFIP) Coordinator—The agency of the State government, or other office designated by the Governor of the State or by State statute at the request of FEMA to assist in the implementation of the National Flood Insurance Program in that state.

State Plane Coordinates—A system of X,Y coordinates defined by the U.S. Geological Survey for each state. Locations are based on the distance from an origin within each state.

Stillwater Flood Elevation (SWEL)—Projected elevation that flood waters would assume, referenced to National Geodetic Vertical Datum of 1929, North American Vertical Datum of 1988, or other datum, in the absence of waves resulting from wind or seismic effects.

Stillwater Flood Level (SWFL)—Rise in the water surface above normal water level on the open coast due to the action of wind stress and atmospheric pressure on the water surface.

Structure—For floodplain management purposes, a walled and roofed building, including a gas or liquid storage tank that is principally above ground, as well as a manufactured home. For flood insurance purposes, a walled and roofed building, other than a gas or liquid storage tank, that is principally above ground and affixed to a permanent site, as well as a manufactured home on a permanent foundation.

Study Contractor (SC)—An architectural and engineering firm or a Federal, State, or local agency that performs flood hazard studies under contract with FEMA.

Subcritical Flow—Flow with a mean velocity that is less than the critical velocity; in other words, tranquil flow.

Summary of Map Actions (SOMA)—A list, generated by FEMA and delivered to the community, that summarizes the LOMAs, LOMR-Fs, and LOMRs that are or will be affected by a physical update to a FIRM.

Supercritical Flow—Flow with a mean velocity that is greater than the critical velocity; in other words, rapid flow.

Tagged Information File Format (TIFF)—The technical exchange format for raster or image files.

Technical Evaluation Contractor (TEC)—See Flood Map Production Coordination Contractor.

Technical Support Data Notebook (TSDN)—The format for the FEMA-maintained file that contains all of the technical and administrative support data for a community for which FEMA published an National Flood Insurance Program map and all revisions to that map.

Technically Incorrect Base Flood Elevations (BFEs)/Depths—Those BFEs and base flood depths determined through analyses in which the methodologies used have not been applied

properly, are based on insufficient or poor-quality data, or do not account for the effects of physical changes that have occurred in the floodplain.

Temporary Bench Mark (TBM)—Bench mark established for a particular Flood Map Project or community.

Topologically Integrated Geographic Encoding and Referencing System (TIGER)—The nationwide digital database of planimetric base map features developed by the U.S. Bureau of the Census for the 1990 Census.

Topology—A branch of geometric mathematics that is concerned with order, continuity, and relative position, rather than actual linear dimensions.

Transect—Cross section taken perpendicular to the shoreline to represent a segment of coast with similar characteristics

Transformation—The conversion of coordinates between alternative referencing systems.

Triangulated Irregular Network (TIN)—A set of non-overlapping triangles developed from irregularly spaced points that is used to represent the facets of a surface.

Undeveloped Coastal Barrier—Any land area adjacent to the Atlantic Ocean, Pacific Ocean, or Great Lakes, where flood insurance will not be available for new or substantially improved structures. These areas are protected by law to discourage development in an attempt to preserve dunes, beaches, and wildlife habitats.

Unit Hydrograph—The hydrograph of direct runoff from a storm uniformly distributed over a drainage basin during a specified unit of time.

Universal Transverse Mercator (UTM) Grid—A system of plane coordinates based on 60 north-south trending zones, each 16 degrees of longitude wide, that circle the globe.

Unnumbered A Zones—Flood insurance rate zones, designated "Zone A" on a FIRM, that are based on approximate studies.

Vector—A directed line segment with magnitude commonly represented by the coordinates for the pair of endpoints.

Vector Data—Data in the form of an array with one dimension.

Velocity Zone—See Coastal High Hazard Area.

Violation—The failure of a structure or other development to be fully compliant with a community's floodplain management regulations. A structure or other development without an Elevation Certificate, other certifications, or other evidence of compliance required in Section 60.3 of the National Flood Insurance Program regulations is presumed to be in violation until such time as that documentation is provided.

Watershed—An area of land that drains into a single outlet and is separated from other drainage basins by a divide.

Water-Surface Elevations (WSELs)—The heights of floods of various magnitudes and frequencies in the floodplains of coastal or riverine areas, in relation to a specified vertical datum.

Wave Height—Vertical distance between the wave crest and the wave trough.

Wave Runup—Rush of wave water up a slope or structure.

Wave Setup—The Increase in the stillwater surface near the shoreline, due to the presence of breaking waves.

Work Map—Floodplain mapping submitted to FEMA by a Mapping Partner, reflecting the results of a flood study or other mapping activity. The work map depicts floodplain boundaries, regulatory floodway boundaries, BFEs, and cross sections, and provides the basis for the presentation of this information on a FIRM.

Zone Gutter—Boundary, shown on a Flood Insurance Rate Map, dividing Special Flood Hazard Areas of different Base Flood Elevations, base flood depths, flood velocities, or flood insurance risk zone designations.

Map MODERNIZATION

Federal Emergency Management Agency

FEMA's Flood Hazard Mapping Program

Guidelines and Specifications *for* Flood Hazard Mapping Partners

List of Acronyms and Abbreviations

FEDERAL EMERGENCY MANAGEMENT AGENCY

www.fema.gov/mit/tsd/dl_cgs.htm

FINAL

February 2002

List of Acronyms and Abbreviations

The following acronyms and abbreviations will be encountered by the Federal Emergency Management Agency (FEMA) and its Flood Hazard Mapping Partners throughout these *Guidelines* and in the completion of activities as part of the Flood Hazard Mapping Program:

A

AML	ARC Macro Language
AAER	Average Annual Erosion Rate
ACSM	American Congress of Surveying and Mapping
ANI	Area Not Included
AO	(FEMA) Assistance Officer
ASC	Area of Special Consideration
ASCE	American Society of Civil Engineers
ASCII	American Standard Code for Information Interchange
ASFPM	Association of State Floodplain Managers
ASPRS	American Society of Photogrammetry and Remote Sensing

B

BERD	Blocked Erosion Rate Database
BFE	Base Flood Elevation
BIL	Band Interleaved by Line (Format)
BM	Bench Mark
BSQ	Band Sequential Format
BU	Building (Line)

C

CAC	Community Assistance Call
CAD	Computer-Assisted Drafting
CAV	Community Assistance Visits
CADD	Computer-Assisted Drafting and Design
CBN	Cooperative Base Network
CBRA	Coastal Barrier Resources Act (of 1982)
CBRS	Coastal Barrier Resources System
CCO	Consultation Coordination Officer
CD-ROM	Compact Disk Read-Only Memory
CEO	Chief Executive Officer
CFR	Code of Federal Regulations
CID	Community Identification (Number)
CIS	Community Information System
CLOMA	Conditional Letter of Map Amendment
CLOMR	Conditional Letter of Map Revision
CLOMR-F	Conditional Letter of Map Revision Based on Fill
CMA	Community Map Action (Form)
CMAS	Circular Map Accuracy Standard
CO	Contracting Officer
COGO	Coordinate Geometry
CORS	Continuously Operating Reference Stations
CRS	Community Rating System
CSIS	Credited Structures Inventory System
CTP	Cooperating Technical Partners (Initiative)

D

DBMS	Database Management System
DEM	Digital Elevation Model
DFIRM	Digital Flood Insurance Rate Map
DFO	Disaster Field Office
DGN	Design (File)
DGPS	Differential Global Positioning System
DLG	Digital Line Graph
DLG-3	Digital Line Graph Level 3
DMRS	Data Management and Retrieval System
DOI	U.S. Department of the Interior
DOQ	Digital Orthophoto Quadrangle
DTM	Digital Terrain Model
DU	Dune (Line)
DWG	Drawing (File)
DXF	Drawing Exchange (Interchange) File

E

EDR	External Data Request
EO	Exterior Orientation (Parameter)
EPA	U.S. Environmental Protection Agency
ERM	Elevation Reference Mark
ERP	Elevation Reference Point
ESDP	Engineering Study Data Package
ESDPF	Engineering Study Data Package Facility
ESF	Emergency Support Function
EST	Emergency Support Team
ET	End-of-Transect (Line)
ETJ	Extraterritorial Jurisdiction (limits)

F

FAAT	Fully Analytical Aerial Triangulation
FBFM	Flood Boundary and Floodway Map
FDN	Federal Base Network
FCSA	Fee-Charge System Administrator
FEDD	Flood Elevation Determination Docket
FEMA	Federal Emergency Management Agency
FGCC	Federal Geodetic Coordinating Committee
FGDC	Federal Geographic Data Committee
FHAR	Flood Hazard Analyses Report
FHBM	Flood Hazard Boundary Map
FIMA	Federal Insurance and Mitigation Administration (FEMA)
FIPS	Federal Information and Processing Standards (Code)
FIRM	Flood Insurance Rate Map
FIRM-DLG	Flood Insurance Rate Map-Digital Line Graph
FIS	Flood Insurance Study
FOIA	Freedom of Information Act
FPI	Floodplain Information Report
FTP	File Transfer Protocol

G

GeoTIFF	Georeferenced Tagged Image File Format
GIS	Geographic Information System
GLWRM	(FEMA) Great Lakes Wave Runup Model
GPO	U.S. Government Printing Office
GPS	Global Positioning System
GRASS	Geographic Resources Analysis and Support System
GRS	Geodetic Reference System

H

HARN	High Accuracy Reference Network
HEC	Hydrologic Engineering Center (U.S. Army Corps of Engineers)
H&H	Hydrologic and Hydraulic (Analyses)
HMGP	Hazard Mitigation Grant Program
HQ	Headquarters (FEMA)
HS	Human Services (applications)
HSLD	Historic Shoreline Location Database
HSPCD	Historic Shoreline Positional Change Database
HWL	High Water Line

I

IE	Initial Elevation (Line)
IF	Inland Fetch (Line)
ILGD85	International Great Lakes Datum of 1985
IMU	Inertial Measurement Unit
INS	Inertial Navigation System

L

LAG	Lowest Adjacent Grade
LAN	Local Area Network
LFD	Letter of Final Determination
LFFE	Lowest Finished Flood Elevation
LIDAR	LIght Detection and Ranging (System)
LIDEF	Levee Inventory Data Entry Form
LMMP	Limited Map Maintenance Program Project Revision
LODR	Letter of Determination Review
LOMA	Letter of Map Amendment
LOMC	Letter of Map Change
LOMC-VALID	Letter of Map Change Revalidation (Letter)
LOMR	Letter of Map Revision

LOMR-F	Letter of Map Revision Based on Fill

M

MAS	Mapping Activity Statement
MCC	Flood Map Production Coordination Contractor
MG	Marsh Vegetation (Line)
MHWL	Mean High Water Line
MICS	Monitoring Information on Contracted Studies (System)
MIS	Management Information System
MNAP	Mapping Needs Assessment Process
MNUSS	Map Needs Update Support System
MOA	Memorandum of Agreement
mph	Miles per Hour
MRR	Measurement Residual Ratio
MSC	Map Service Center (FEMA)

N

NAD27	North American Datum of 1927
NAD83	North American Datum of 1983
NAVD88	North American Vertical Datum of 1988
NASA	National Aeronautic and Space Administration
NCSSA	National Cartographic Standards for Spatial Accuracy
NFIF	National Flood Insurance Fund
NFIP	National Flood Insurance Program
NFIRA	National Flood Insurance Reform Act of 1994
NGVD29	National Geodetic Vertical Datum of 1929
NGRS	National Geodetic Reference System
NGS	National Geodetic Survey
NMAS	National Map Accuracy Standard
NOAA	National Oceanic and Atmospheric Administration

NOS	National Ocean Survey
NP	Navigation Processor
NRC	National Research Council
NRCS	Natural Resources Conservation Service
NSRS	National Spatial Reference System
NSSDA	National Standard for Spatial Data Accuracy
NWS	National Weather Service

O

ODC	Other Direct Cost
OF	Over-water Fetch (Line)
OGC	Office of General Counsel
OPA	Otherwise Protected Area

P

pdf	Portable Document Format
PDF	Probability Density Function
PDOP	Position Dilution of Precision
PE	Professional Engineer
PLSS	U.S. Public Land Survey System
PMR	Physical Map Revision
PO	Project Officer (FEMA HQ)

Q

QA	Quality Assurance
QC	Quality Control
QA/QC	Quality Assurance/Quality Control

R

RDBMS	Relational Database Management System
RFIS	Flood Insurance Restudy
RLE	Run Length Encoding
RLS	Registered Land Surveyor
RMM	River Mile Marker
RMS	Root Mean Square
RMSE	Root Mean Square Error
RO	Regional Office (FEMA)
ROC	Regional Operations Center (FEMA)
RPO	Regional Project Officer (FEMA RO)
RTK	Real Time Kinematic
RXDS	Existing Data Restudy

S

SC	Study Contractor
SCRR	Special Conversion Recommendation Report
SDTS	Spatial Data Transfer System
SFHA	Special Flood Hazard Area
SIF	Standard Interchange Format
SOMA	Summary of Map Actions
SOS	Status of Studies
SOW	Statement of Work
SPR	Special Problem Report
SWEL	Stillwater Flood Elevation
SWFL	Stillwater Flood Level

T

TBM	Temporary Bench Mark
TCS	(Standard Flood Hazard) Tracking and Correspondence System
TIGER	Topologically Integrated Geographic Encoding and Reference (System)
TIN	Triangulated Irregular Network
TSDN	Technical Support Data Notebook
TVA	Tennessee Valley Authority

U

USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
USGS-DLG	U.S. Geological Survey Digital Line Graph (Format)
UTM	Universal Transverse Mercator

V

VAX	Virtual Address Extension
VE	Rigid Vegetation Line
VMAS	Vertical Map Accuracy Standard
VMS	Virtual Memory System
VPS	Vector Product Format

W

WAN	Wide Area Network
WORM	Write Once Read Many (CD-ROM Drive)
WSEL	Water-Surface Elevation
WWL	Wind/Water Line

X

XDS	Existing Data Study