Upper New River Area Drainage Master Plan

June 2008

Volume One of Two

Flood Control District of Maricopa County

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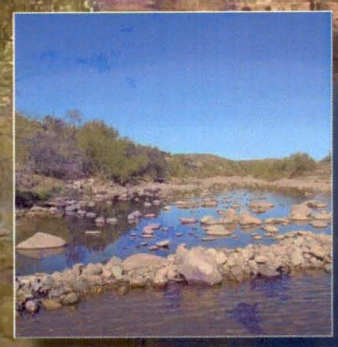

Alternative Formulation Report

Stantec

Upper New River ADMP

Alternatives Formulation Report

Volume 1 of 2

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FLOOD CONTROL DISTRICT

of

MARICOPA COUNTY

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Flood Control District of Maricopa County

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EXECUTIVE SUMMARY

Alternative Formulation

Alternative formulation of flood control management alternatives and policies that form the foundation of the Upper New River Area Drainage Master Plan (ADMP) took into account engineering, environmental, landscape, social, and economic considerations. Watershed/watercourse management alternatives were developed to mitigate/minimize the effect of urbanization on storm water runoff and conveyance while recognizing the values of the community and the opportunity to protect the unique characteristics of the region. The primary purpose for flood control alternative development and evaluation was to develop a range of plans that provide public safety from flood and erosion hazards, determine the cost and benefits of each alternative, qualitatively determine impacts of the alternative on identified environmental resources, and to develop a recommended plan. Flood control alternatives evaluated take into consideration the compatibility of an alternative with the natural environment and scenic beauty of the area. The following vision statement was developed for the project by the project team and project partners:

> "The Vision for the Upper New River ADMP is that residents and future generations will have the appropriate level of protection from the effects of flooding through fiscally responsible and sustainable flood control solutions and multiple-use facilities that incorporate the stakeholders and project partners concerns and preserves, complements, or enhances the beauty and ecological integrity of the desert environment."

Goals of the Upper New River ADMP are summarized below:

- Identity flood and erosion hazards within the project area
- Prepare FEMA floodplain delineations for selected washes
- Develop plans, guidelines and strategies to protect residents from flood and erosion hazards
- Preserve the natural flood control function of the existing washes and channels
- Incorporate public and private interests, issues and concerns
- Consider environmental and landscape characteristics and multi-use activities of the watershed in the development of watershed management alternatives
- Minimize disturbance of existing floodplain and floodway ecosystem and habitats

Flood control management alternatives formulated in a team Brainstorm meeting were grouped into two categories, watercourse-based alternatives and planning area-wide alternatives. Watercourse-based alternatives were developed for areas in which there were specific flood hazards to existing residences, roadways or planned land use. These area's include the New River Planning Area for New River upstream and downstream of I-17; and a reach of Sweat Canyon Wash downstream of New River Road to the

confluence with New River; Deadman Wash downstream of the I-17 (Lower Deadman Planning Area); and Gavilan Peak Wash downstream of New River Road (Gavilian Peak Planning Area). Planning area-wide alternatives were developed for areas that are typically undeveloped or were not covered by the watercourse base alternatives.

Watercourse-based alternatives evaluated include a non-structural, structural, and a no action alternatives. Descriptions of the alternatives evaluated are:

- **Non-Structural Alternative** – The Non-Structural Alternative defines a corridor that allows the watercourse to function naturally. The corridor defines and area in which development is restricted. Watercourses retain their natural condition and appearance, and are managed by policies, ordinances, property acquisition, and multi-agency planning effort. The Non-structural Alternative is defined by the limits of the 100-year floodplain, lateral migration zone or buffer whichever provides the widest setback from the floodplain.

- **Structural Alternative -** Structural alternatives provide protection from floods and erosion through engineered flood control facilities that take into consideration flow depth and erosive velocities. Structural elements of flood control facilities evaluated for the project include channels, levees and associated erosion protection measures. Structural elements are landscape designed (aesthetic treatments) to be context sensitive to the surrounding environment. Landscape aesthetic treatments are intended to create features that fit the form and function of the existing landscape character. Typical landscape aesthetic treatments consist of variations in the form (alignment, profile, side slope) of the structural element, use of color or textual patterns or the use of fill material to hide the structural element.

- **No Action Alternative** – The No Action Alternative provides flood control management based on current federal, state, and local floodplain management regulations that allows encroachment into the floodway fringe. Typically, under current regulations encroachments into the floodway fringe are allowed on a piece-meal fashion without taking into consideration the effect of the encroachment or collective encroachments on the entire watercourse.

Planning area-wide alternatives evaluated included the No Action Alternative and ADMP Guidelines Alternative.

- **No Action** - Discussed above.

- **ADMP Guidelines Alternative** - Communities develop drainage ordinances, policies, and standards with the intent to mitigate/minimize flooding impacts due to urbanization of a watershed. The purpose of these regulations is to minimize the occurrence of losses, hazards, and conditions adversely affecting the public health, safety, and general welfare that might result from flooding caused by surface runoff of rainfall. ADMP guidelines are developed to support a community's development regulations. Development guidance is

based on a set of management goals, objectives, policies, and specific evaluation and design guidance that allows development to occur according to adopted land use plans.

Alternative Evaluation

Flood control management alternatives were evaluated on how well each alternative met the goals of the Upper New River ADMP. The evaluation process to select a recommended alternative or alternatives is based on a set of weighted criteria that was develop by the project team and stakeholders. The criteria are: Public Safety and Flood Hazard Mitigation, Scenery Resources, Recreation and Open Space Resources, Natural Resources and Implementation. Recommended alternatives are based on the overall score that an alternative received in the evaluation process relative to the other alternatives evaluated.

Alternatives recommended for further evaluation are summarized in the following table:

Recommended Alternative

Planning Area	Recommended Alternative	Comments
New River Upstream of I-17	Non-Structural Alternative including the District's Floodprone Property Assistance Program (FPAP)	Watercourse specific to New River upstream of I-17
Gavilan Peak	Non-Structural Alternative including the District's Floodprone Property Assistance Program (FPAP)	Watercourse specific to Gavilan Peak Wash
New River Downstream of I-17	Structural and Non Structural Reaches. Primary element of structural reaches are levees	Watercourse specific to New River downstream of I-17
Lower Deadman	Structural and Non Structural Reaches. Primary element of structural reach is a bridge at the crossing of the Carefree Highway	Watercourse specific Deadman Wash
All Planning Areas	ADMP Guidelines	

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1 INTRODUCTION

This report presents, the results of existing condition evaluations; identified flood and erosion hazards; evaluations of flood control management alternatives developed to mitigate identified hazards; and evaluation criteria used to select a preferred flood control management plan for the Upper New River Area Drainage Master Plan (ADMP) study area. Flood and erosion hazard issues are addressed on a specific watercourse bases and on a planning area-wide base. Approximately 37 linear miles of watercourses were considered in the development of the ADMP. Watercourses in which detail studies were conducted include New River, Sweat Canyon Wash downstream of New River Road, Gavilan Peak Wash downstream of New River Road and Deadman Wash downstream of I-17. In addition to evaluation of specific watercourses, planning area-wide evaluations of drainage issues and potential flood management approaches to mitigate flood and erosion hazards were conducted.

The project area downstream of the Tonto National Forest was divided into 10 planning areas based on land forms, land use and potential flood and erosion hazards. The locations of planning areas are presented in Figure 1.1.

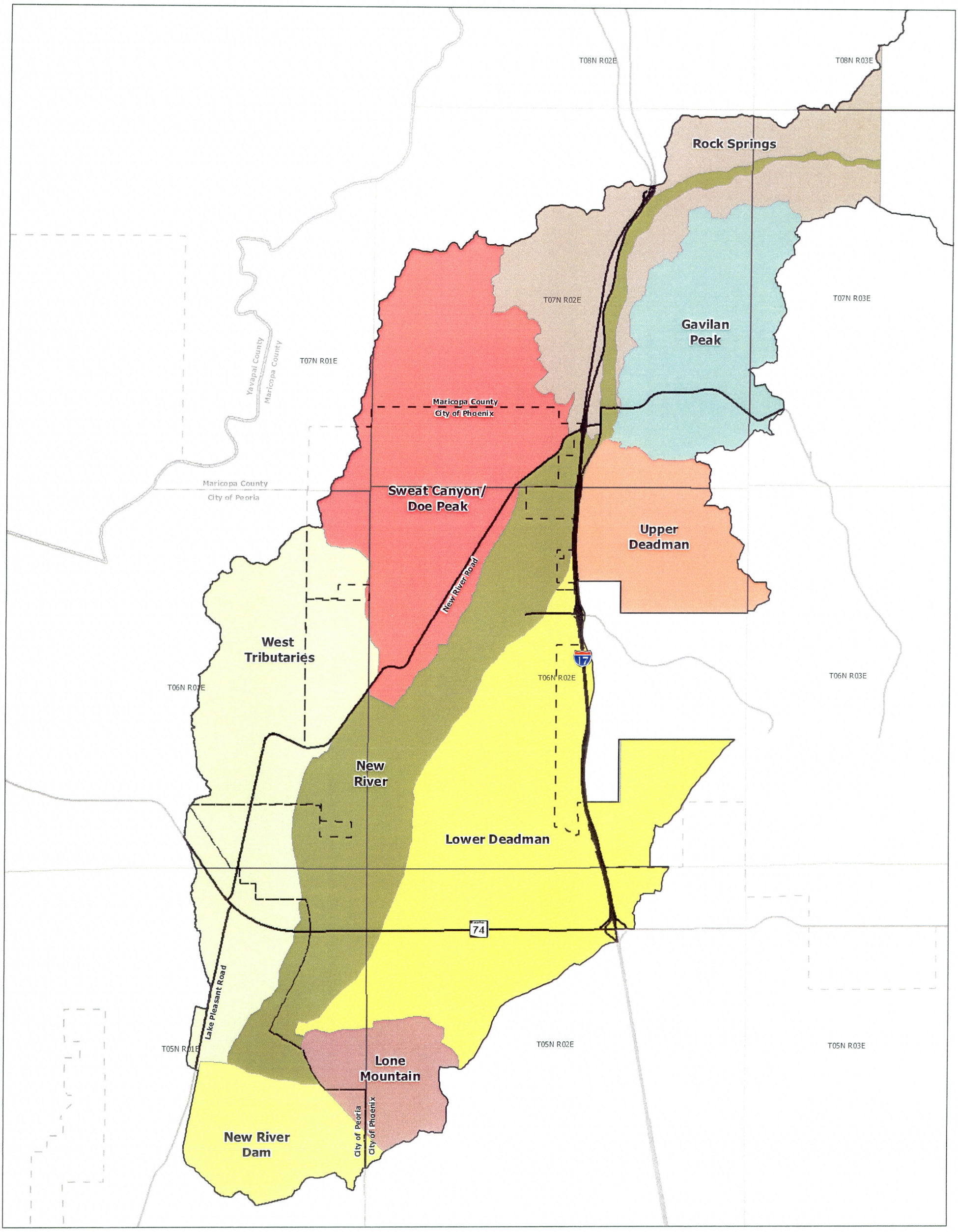
1.1 PURPOSE

The purpose of this report is to present, brief overviews of supporting reports developed for the project; discussions relating the methodology used and results derived from existing and proposed condition hydraulic analyses; total scour calculations; evaluation criteria developed for the evaluation of alternatives; and the process of alternative formulation and evaluation.

The following reports were developed as part of the Upper New River ADMP alternatives formulation process:

- Alternative Formulation Report (this document)
    - Attachment 1 Data Collection Report (prepared by Stantec Consulting)
    - Attachment 2 Environmental Overview (prepared by EcoPlan)
    - Attachment 3 Hydrology (prepared by Stantec Consulting)
    - Attachment 4 Erosion Hazard Zone Delineation Study (prepared by JE Fuller Geomorphology and Hydrology)
    - Attachment 5 Scenery and Recreation Resources Assessment Report (prepared by EDAW)

Brief summaries discussing the purpose and or intent of the Attachments listed above are presented in Section 2 (Data Collection Summary), Section 3 (Environmental Overview and Scenery and recreation Resources Assessment Summary), and Section 4 Hydrology Summary. A summary of Attachment 4 is presented in Section 7 the Sediment Engineering Analysis Section



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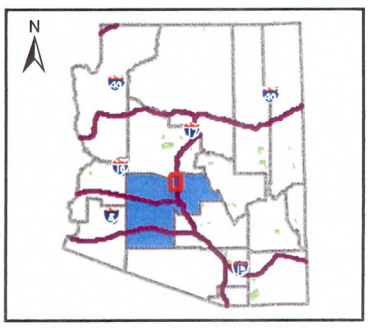
Location Map:



Notes:

Legend:

- Roadway
- Project Boundary
- Corporate Limit
- County Boundary

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May 2008

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Upper New River ADMP
FCD 2005CO20
Figure 1.1: Upper New River Planning Areas

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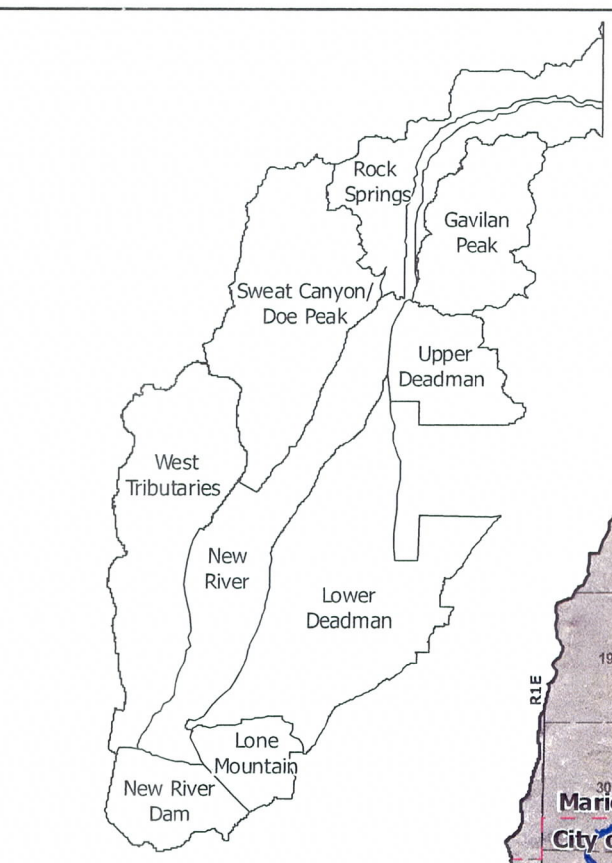
2 DATA COLLECTION SUMMARY

The Data Collection task for the Upper new River Area Drainage Master ADMP Plan consists of collecting information that pertains to engineering, environmental and scenic resource evaluations and land use within the project area. This information is used to define resources, and opportunities and constraints in the study area that may influence design elements. The type of information collected and reviewed includes historical photographs, current land use plans, planning documents, previous hydraulic and hydrologic reports, existing topographic mapping, As-built plans for existing drainage structures, FEMA Flood Insurance Rate Maps, transportation, trails and utility plans, flood control facilities design guidelines and drainage manuals.

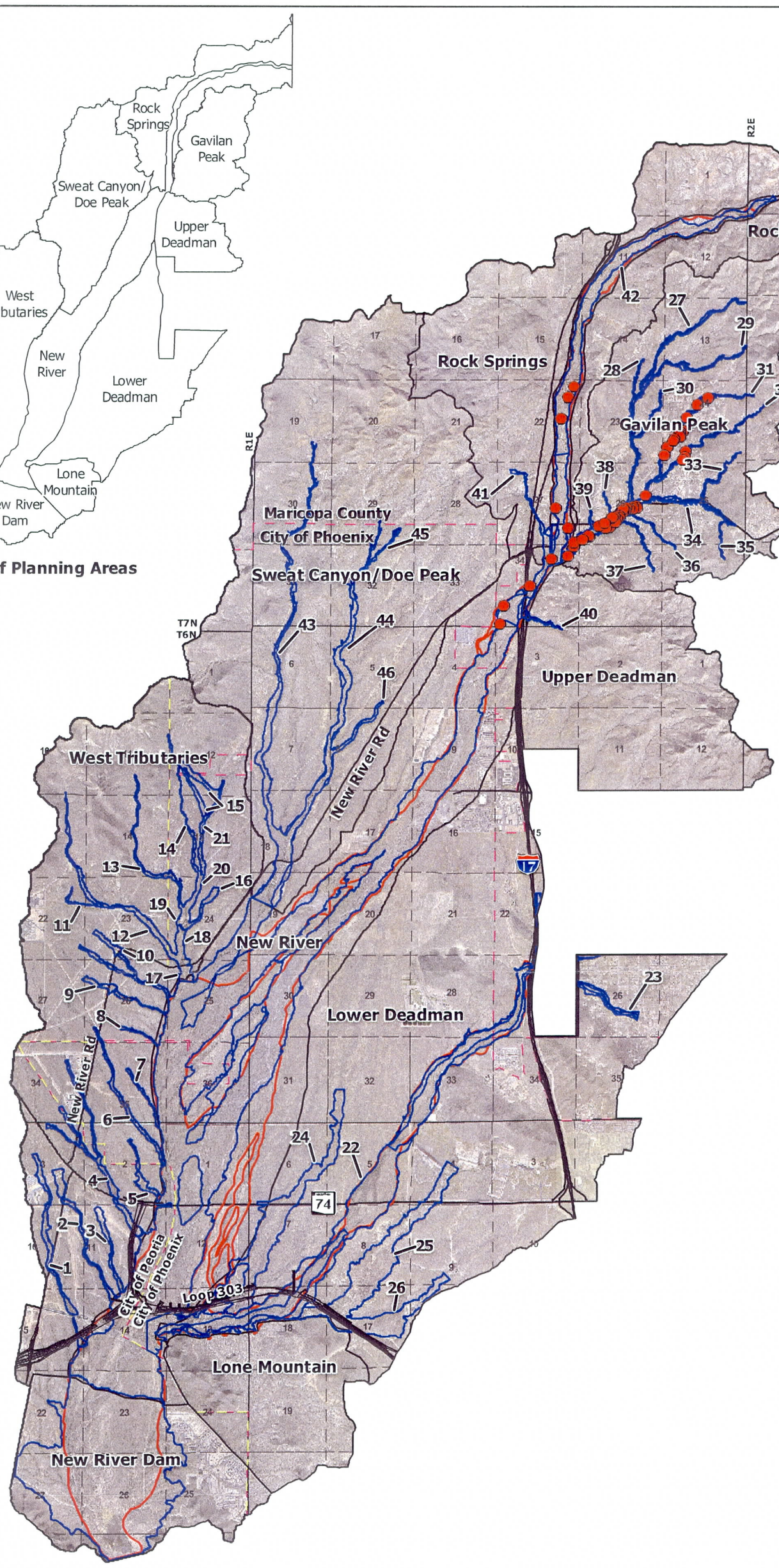
Information collected for the project is presented in the Upper New River ADMP Data Collection Report which is presented as Attachment 1 to this Alternatives Evaluation Report. The report provides a description of the information that has been collected to conduct existing condition evaluations and to develop flood mitigation alternatives for the planning area. The planning area approximately 94 square miles in size is located in the lower portion of the ADMP watershed downstream of the Tonto National Forest. Maps depicting data collected for the planning area were developed to aid existing condition analyses and provided guidance in the development of alternatives. Maps of particular note that are presented again in this report because they are instrumental to the understanding of alternative development are: the Flood and Erosion Hazard Map (Figure 2.1) depicting delineated flood and erosion hazards within the project planning areas; the Land Ownership/Utilities/Drainage Structures Map (Figure 2.2) depicting land ownership, flood and erosion hazards, major utilities and drainage infrastructure; and the Planning Elements and Floodplain Map (Figure 2.3) depicting composite land use for the City of Phoenix, City of Peoria and Unincorporated Maricopa County within the project area.

Notable information used in the formulation and evaluation of flood control management alternatives discussed in Section 8 are:

- Multiple jurisdictions occur with in the project area
- Land ownership with in the planning area includes:
    - 72 % state land
    - 8 % federal land
    - 16 % private
    - 4% (county, parks, other)
- Active sand & gravel mining on new River
- Majority of the project area is undisturbed Sonoran Desert
- Development will occur in the near future
- Area will likely develop as master planned communities
- Land use and transportation plans have been develop for the area.

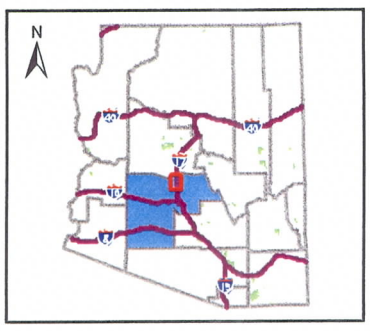


Location of Planning Areas



Location	Wash
1	NRW5
2	NRW10
3	NRW15
4	NRW20
5	NRW25
6	NRW30
7	NRW35
8	NRW40
9	NRW45
10	NRW50
11	NR55T5
12	NR55T10
13	NR55T15
14	NR55T20
15	NR55T25
16	NR55T30
17	NR55A
18	NR55B
19	NR55C
20	NR55D
21	NR55E
22	Deadman Wash
23	Deadman Wash Stream No. 4
24	Deadman Wash Tributary 1
25	Deadman Wash Tributary 2
26	Deadman Wash Tributary 2A
27	Table Mt. Tank Wash
28	Table Mt. Tank Wash Trib. 6
29	Photo View Wash
30	River Creek
31	Soda Springs Wash
32	White Spar Wash
33	Rough Rider Wash
34	Gavilan Peak Wash
35	Lazy G Wash
36	Twink Peaks Wash
37	Sharman Wash
38	Coyote Pass Wash
39	Kelley Road Wash
40	Jenny Lin Wash
41	Black Wash
42	New River
43	Sweat Canyon Wash
44	Doe Peak Wash
45	East Fork Doe Peak Wash
46	South Fork Doe Peak Wash

Location Map:



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Notes:

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Legend:

- Structure within the Floodplain
- Roadway
- Floodplain
- Erosion Hazard
- Peoria Corporate Boundary
- Phoenix Corporate Boundary
- Township & Range
- Section

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Upper New River ADMP
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Figure 2.1: Flood and Erosion Hazard

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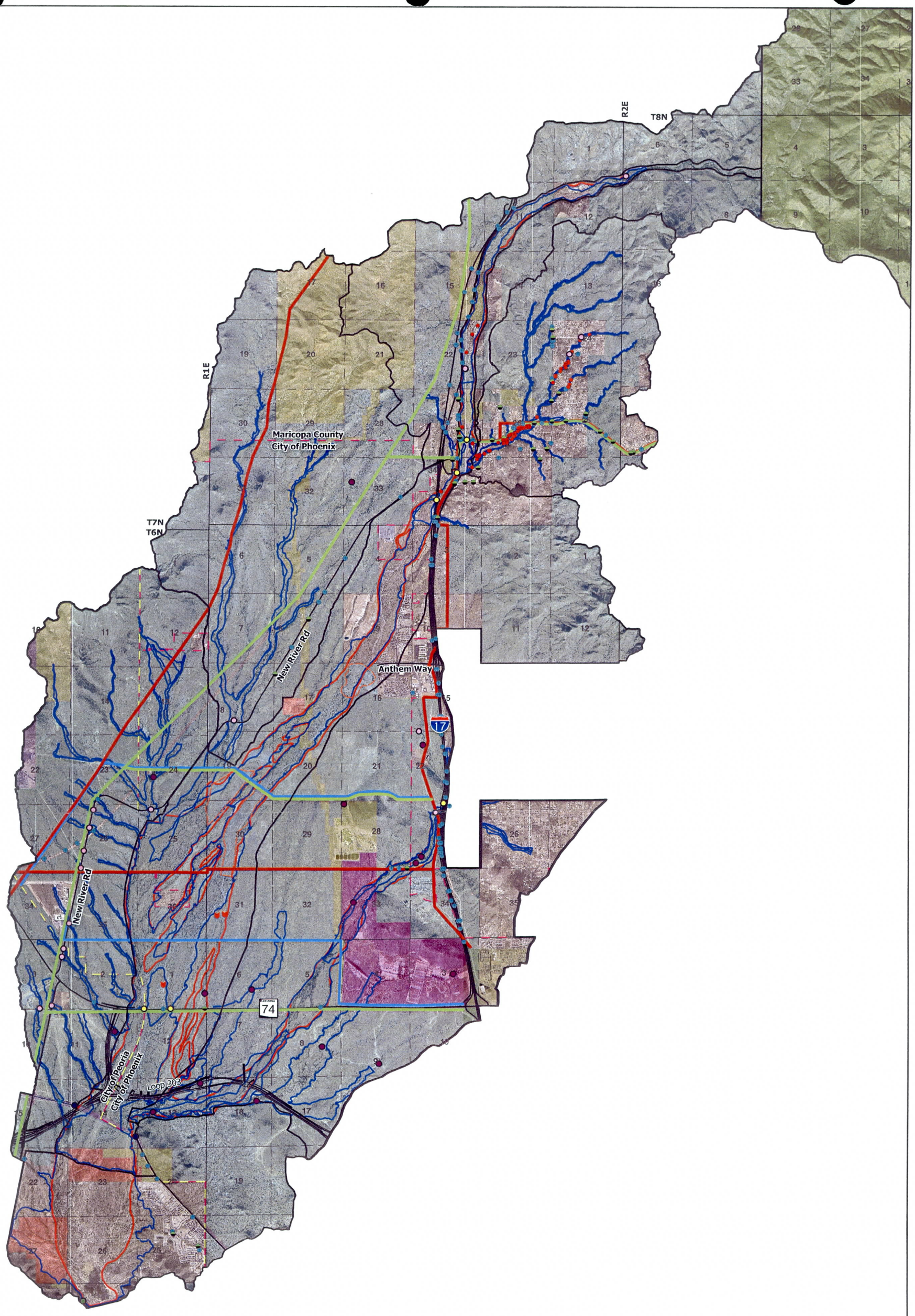
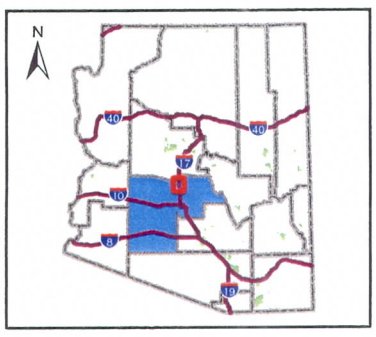


Location Map:



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February 2008

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Notes:

- Potential Breakout Area
- Dip Section
- Structure within the Floodplain
- Bridges
- Culvert with Sedimentation
- Culvert
- Siphon
- Spillway
- Stock Tank

N

N.T.S.

Legend:

- Gasline
- Powerline
- Waterline
- Sand & Gravel Operation
- Roadway
- Floodplain
- Erosion Hazard
- Peoria Corporate Boundary
- Phoenix Corporate Boundary
- Township & Range
- Section
- Bureau of Reclamation
- County Land
- Game and Fish
- BLM
- Forest
- Private
- State Trust

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Figure 2.2: Land Ownership/Utilities/ Drainage Structures

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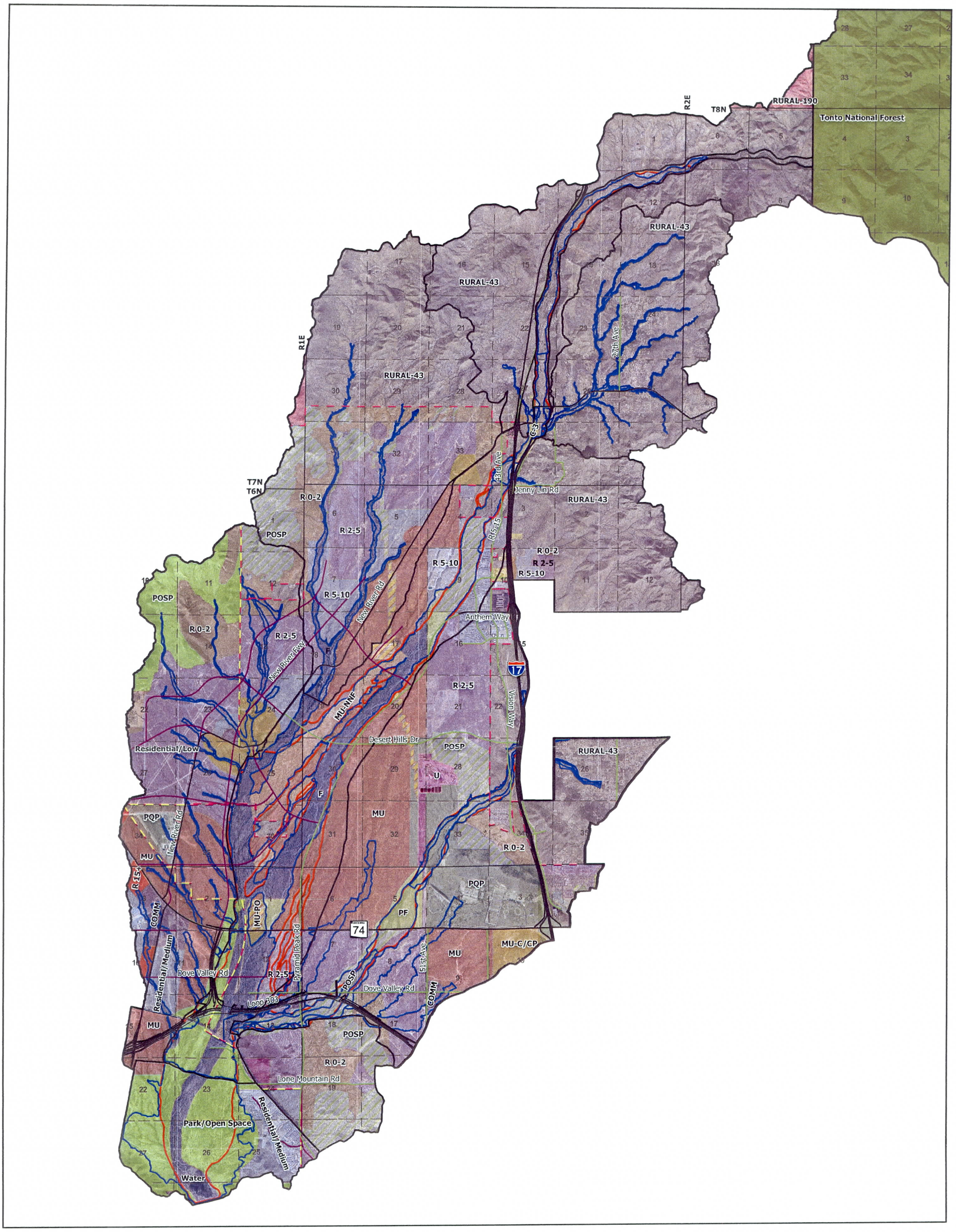
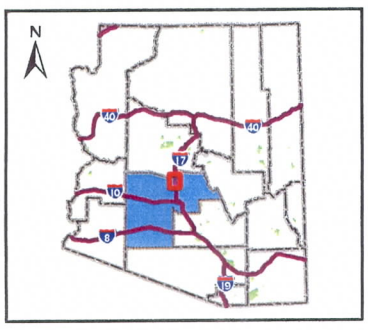


Location Map:



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Notes:

Legend:

- Roadway
- Future Alignment
- Future Alignment
- Erosion Hazard
- Peoria Corporate Boundary
- Phoenix Corporate Boundary
- Township & Range Line
- Section
- Floodplain
- RURAL 43 - 0 to 1 du/acre
- R 0-2 - Residential 0 to 2 du/acre
- R 2-5 - Residential 2 to 5 du/acre
- R 5-10 - Residential 5 to 10 du/acre
- R-15+ - Residential 15+ du/acre
- Residential/Low
- Residential/Medium
- MU - Mixed Use
- MU-NNF - Mixed Use North Gateway and Northwest Area/Floodplair
- COMM - Commercial
- MU-C/CP - Mixed Use Commerciall/Commerce Park
- PQP - Public/Quasi-Public
- MU-PO - Preserves/Mixed Use
- PF - Preserves/Floodplain
- POSP - Parks & Open Space, Future 1 du/acre
- F - Floodplain
- Water - Portion of Floodplain
- U - Undesignated

N

N.T.S.

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Upper New River ADMP
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Figure 2.3: Upper New River Planning Elements Existing Floodplain

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3 ENVIRONMENTAL OVERVIEW AND SCENERY AND RECREATION RESOURCES ASSESSMENT SUMMARY

3.1 INTRODUCTION

The Environmental Overview and Scenery and Recreation Resources Assessment reports provide baseline information that will be utilized to help assess the impact of an alternative on the natural environment.

3.2 ENVIRONMENTAL OVERVIEW

The purpose of the Environmental Overview (Attachment 2) was to identify, inventory, map, and describe the existing ecological resources within a ½-mile buffer around the area of potential effect (APE). The APE is a 10-mile by 2-mile area where structural solutions for flood control management may be necessary for the reach of New River between the New River Dam impoundment area and the crossing of I-17 with New River. The report includes notable or special natural features such as wildlife nesting, foraging, watering, roosting, or denning areas that may warrant protection or special consideration in the planning and design of flood control management alternatives.

Identified ecological resources are used in the alternative formulation process to identify an alternative's impact on the resource and to help formulate design guidelines that are sensitive to the resource.

The Environmental Overview document was prepared by EcoPlan Associates, Inc.

3.3 SCENERY AND RECREATION RESOURCES ASSESSMENT

The scenery and recreation resources assessment for the project area was conducted by EDAW. Their findings are presented in Attachment 5 - Scenery and Recreation Resources Assessment Summary. Excerpts from their report presented below summarizes the purpose of their assessment

The District's overall vision is to have maximum level of protection from the effects of flooding through fiscally responsible flood control actions and multi-use facilities. Once identified, these actions and facilities can then complement and enhance the beauty of the desert environment for the residents of Maricopa County and future generations. A primary objective of the District's Board approved Policy for the Aesthetic Treatment and Landscaping of Flood Control Projects is planning and designing flood control facilities that preserve, enhance and complement the beauty of the natural desert landscapes and character of local communities within Maricopa County. It is the District's goal for aesthetic treatment of flood protection facilities to incorporate features and measures that will:

- Enhance the visual appearance of flood protection facilities by achieving context sensitivity with the surrounding landscapes
- Help preserve the visual character of natural desert landscapes
- Protect and enhance local community character

- Increase aesthetic and public value of the District's flood protection facilities by designing them to incorporate opportunities for year round recreation, open space linkages and multiple-use areas

Essentially, the goal of the District is to enhance the public value of the District's flood protection facilities by planning them to complement or enhance the scenic resources and include recreation and multiuse opportunities for use by residents of Maricopa County as an integral part of the structural design.

A primary purpose of this study was to conduct an assessment of Scenery and Recreation Resources that will serve as a frame of reference to be used as part of planning and designing flood control facilities within the Upper New River ADMP project area. This assessment is intended to serve as a tool for existing and future actions and facilities of flood control alternatives and will aid the District in providing context sensitive solutions that preserve and complement the character of the natural, rural, suburban and urban landscapes within Upper New River ADMP project area. The purpose and significance of Scenery and Recreation Resources assessment is briefly described below:

- *Scenery Resource Assessment (SRA) –*

  The SRA will serve to identify the surrounding natural and local community visual character within the study area. Predominantly, the SRA helps to analyze the visual impact of the flood control structures. The results of the analysis will be utilized to better complement the existing landscape settings as part of the ADMP.

- *Recreation Resource Assessment (RRA) –*

  The RRA will serve to identify the regional and local (study area) recreational features within the study area. The assessment is conducted to enhance the public value of the District's flood protection facilities by identifying potential opportunities for year round recreation and open space linkages as an integral part of flood control facilities' design.

The Scenery and Recreation Resource Assessment is also intended to serve as a tool to assist the District, project partners, stakeholders and the public in determining the desired visual look of the preferred flood control management plan.

4 HYDROLOGY

Hydrology for the alternative analysis was taken from the Upper New River Area Drainage Master Plan Hydrology Report, Attachment 3. Eight previous hydrologic studies have been done in the watershed: three overall hydrology studies and five studies of tributaries to New River. The ADMP hydrologic model is a composite of existing hydrologic models and new, detailed hydrology developed specifically for the ADMP.

In general, the results of the Upper New River ADMP hydrology accord well with the results of previous studies. Runoff peaks for the upper portion of the watershed are lower than those found in previous studies, while the peak runoff values in the lower watershed appear to fall far short of the previous values. The major differences in hydrology arise because of physical changes in the study area, the updated ADMP precipitation values and differences in unit hydrograph methodology. For details concerning differences in peak discharges between previous studies and this refer to Attachment 3

Changes to the main channel of New River since the last hydrologic study, such as borrow and gravel pits, have eliminated previously identified flow splits and created new flow diversions. These diversions can influence the overall timing of runoff. Changes to the magnitude of flow diverted or elimination of the diversion due to proposed alternatives could potentially affect the overall timing of the flood peaks.

The existing borrow pits in the main stem of the New River provide minimal stormwater storage in the watercourse and does not provide significant attenuation or delay to the peak discharge. The results of the HEC-1 model indicate that they have too little storage volume available compared to the volume of water being conveyed through the watercourse, and are too steeply sloped to act as effective detention/retention basins.

Development may have significant impacts on the timing of the peak discharge. This is potentially important for the reach of New River downstream of SR-74 to New River Dam. Altering the timing of the study area runoff could cause the hydrographs to coincide and increase the overall flood peak. For this reason, it was very important to fully evaluate any alternatives and changes in land use that may delay the Sweat Canyon or Deadman Wash runoff hydrograph or advance the New River main stem hydrograph.

Hydrologic evaluation of proposed alternatives include modeling the effects of eliminating flow splits in New River in the New River Downstream of I-17 Planning area and modeling detention basin scenarios for Deadman Wash within the Lower Deadman Planning area. Details of the hydrologic evaluation conducted for various alternatives are presented in the Hydrologic/Hydraulic Evaluations of Proposed Alternatives (Section 9.4).

5 ONE-DIMENSIONAL HYDRAULIC MODELS

5.1 INTRODUCTION

The District has conducted previous hydraulic analysis in the Upper New River ADMP watershed area on numerous washes in which HEC-2 and HEC-RAS hydraulic models were developed. Those hydraulic models were developed to delineate 100-year floodplain limits. The floodplain delineations formed the bases of Letter of Map Revision (LOMR) submittals to the Federal Emergency Management Agency (FEMA). Figure 5.1 depicts the location of previous hydrologic and hydraulic studies. Figure 2.2 depicts that location of watercourses within the study area for which hydraulic models were previously developed for the purpose of estimating 100-year floodplain limits.

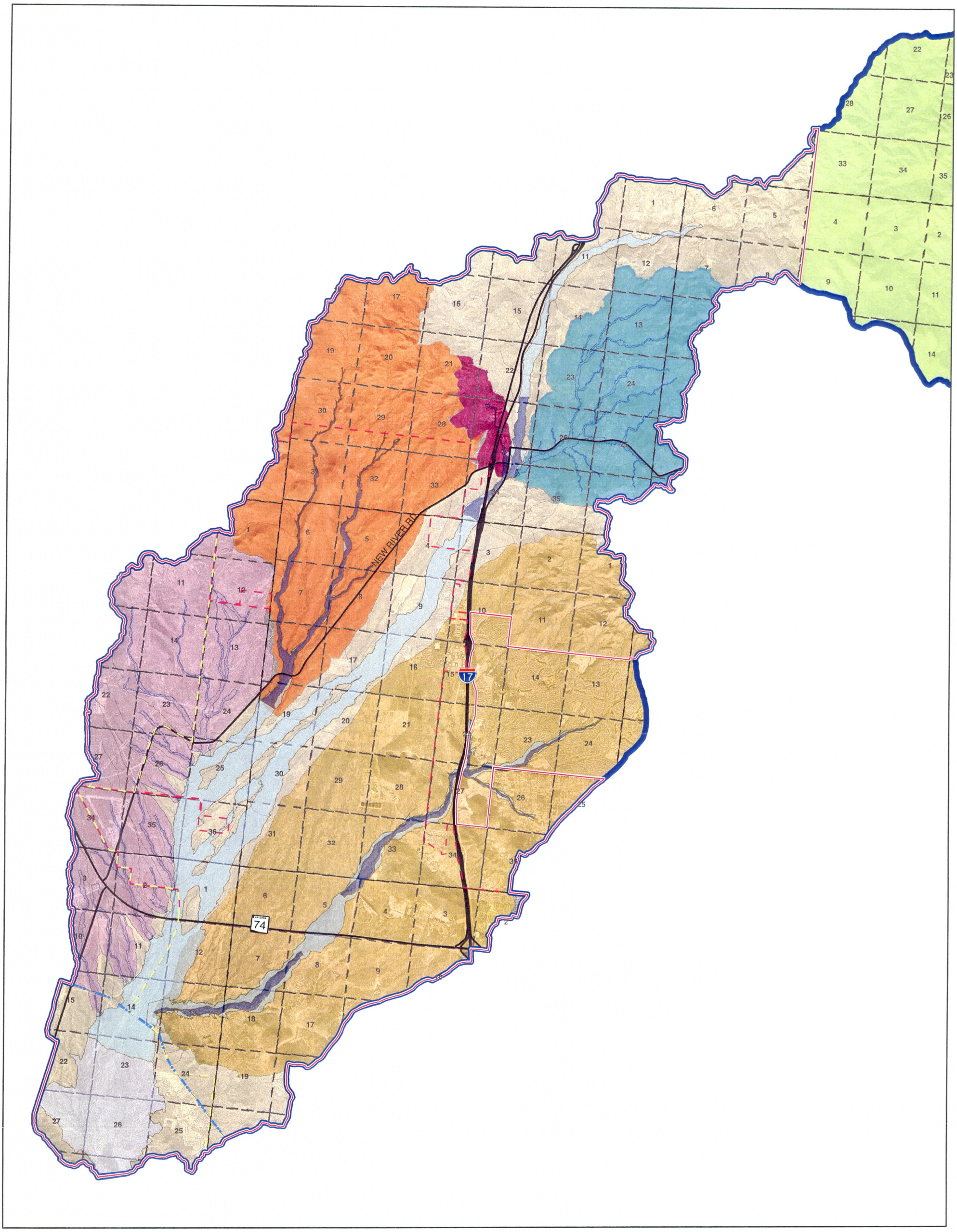
5.2 PURPOSE

Hydraulic evaluations are conducted to determine the feasibility, design parameters and design constraints of proposed alternatives that were developed as part of Phase 1 for the Upper New ADMP project. Hydraulic models were also developed to delineate 100-year floodplains of selected watercourses that were not previously studied. Purposes of the Phase 1 Hydraulic Analysis task are:

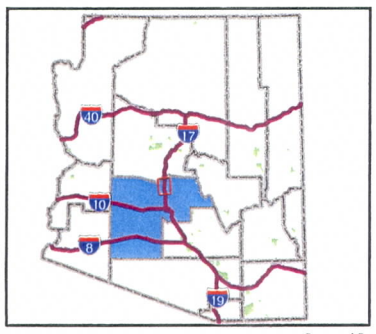
- Collect hydraulic models that were developed under previous studies located within the ADMP watershed.
- Convert existing HEC-2 models to HEC-RAS models.
- Revise existing or converted HEC-RAS models, as applicable, to incorporate the existing drainage system.
- Develop a New River HEC-RAS model from I-17 to the New River impoundment area utilizing new topographic data. The evaluation will include the New River West Split.
- Develop HEC-RAS models for Jenny Lin Wash, Deadman Wash Tributary 1 and Deadman Wash Tributary 2. Results of the modeling effort will be used to delineate 100-year floodplains.
- Conduct preliminary hydraulic evaluation of proposed flood management alternatives to assess the feasibility of alternatives.

5.3 EXISTING HYDRAULIC MODELS

Hydraulic models that were used to evaluate the Upper New River ADMP proposed alternatives, and were developed under previous studies within the project area were obtained from the District. HEC-2 models were converted using the "Import HEC-2 Models" function in HEC-RAS. As necessary, structure data, such as bridges and culverts, were updated. The data for the bridges and culverts were obtained from as-built information or field survey. The models were then checked to make sure the conversion was reasonable. Table 5.1 lists a summary of the hydraulic models that were available for the evaluation of proposed alternatives. The models are included on a CD in Appendix A.



Location Map:



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February 2008

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Notes:

Legend:

- Roadway
- CAP Canal
- Peoria Corporate Boundary
- Phoenix Corporate Boundary
- Sections
- Township & Range Lines
- Reservoir Floodplain
- Floodplain
- Floodway
- Pending Floodplain
- Tonto National Forest
- Flood Insurance Study New River from New River Dam to Rock Springs
- Sweat Canyon Wash Flood Insurance Study
- New River West Tributaries Floodplain Delineation Study
- Gavilan Peak Floodplain Study
- Deadman Wash Floodplain Delineation Study
- New River Above I-17 Floodplain Delineation Study
- Watershed Boundary
- Planning Area Boundary

N

1" = 8000'

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Upper New River ADMP
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Figure 5.1
Existing Hydrologic and Hydraulic Studies

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Table 5.1
Summary of HEC-RAS models

Watercourse	Source Note	Model Limits	Updates	HEC-RAS Project Name	Comments
(1)	(2)	(3)	(4)	(5)	(6)
New River	1	New River Dam impoundment limits to River Mile (RM) 38.847 (Approx. a mile downstream of the Tonto National Forest boundary)	I-17 and SR-74 bridge geometry is updated based on as-built drawings and/or field survey data	New River-CVL	HEC-2 model converted to HEC-RAS model. Model will be utilized to model flood control management alternatives upstream of RM 34.042
New River Upstream of I-17 and Black Wash	2	RM 31.6 (approximately a half mile down-stream of the I-17 Bridge) to RM 34.042	I-17 bridge geometry is updated based on as-built drawings	New River above of I-17 nr0202w, New River I-17 nr0202LV, New River above I-17 nr0202E, New River above I-17 nr0202	HEC-2 model converted to HEC-RAS model. Four project models evaluate various levee scenarios. Model will be utilized to model flood control management alternatives from RM 31.6 to RM 34.042. Project file Includes Black Wash
Sweat Canyon Wash	3	RM 0.557 to RM 4.129. RM 0.557 is located upstream of the confluence with New River (New River RM 23.1)		Southern Portion of Sweat Canyon	HEC-2 model converted to HEC-RAS model. Model will be utilized to model flood control management alternatives from RM 2.053 to RM 4.019.
Sweat Canyon Wash	3	RM 4.019 to RM 10.63		Sweat Canyon FIS	Model will be utilized to model flood control management alternatives.
Doe Peak Wash	3	RM 0.108 to RM 4.696		Sweat Canyon FIS	Model will be utilized to model flood control management alternatives.
East Fork of Doe Peak Wash	3	RM 0.094 to RM 0.661		Sweat Canyon FIS	Model will be utilized to model flood control management alternatives.

Table 5.1
Summary of HEC-RAS models Cont.

Watercourse (1)	Source Note (2)	Model Limits (3)	Updates (4)	HEC-RAS Project Name (5)	Comments (6)
South Fork of Doe Peak Wash	3	RM 0.102 to RM 1.040		Sweat Canyon FIS	Model will be utilized to model flood control management alternatives.
Deadman Wash	4	RM 0.092 to RM 10.544	I-17 bridge geometry and culvert geometry at the crossing of SR-74 and the Federal Prison Road. Updates are based on as-built drawings and/or field survey data.	Deadman Part 1, Deadman Part 2, Deadman Part 3, Deadman Part 4,	HEC-2 model converted to HEC-RAS model. Model will be utilized to model flood control management alternatives between RM 0.092 and RM 7.74
New River West Tributaries	5	Eleven tributaries to New River		NRW5, NRW10, NRW15, NRW20, NRW25, NRW30, NRW35 NRW40, NRW45, NRW50, NRW55	Model will be utilized to model flood control management alternatives.
Coyote Pass Wash	6	Approximately 0.5 Mile Reach		Coyote Pass Wash	Model will be utilized to model flood control management alternatives.
Gavilan Peak Wash	6	Approximately 2.8 Mile Reach		Gavilan Peak Wash	Model will be utilized to model flood control management alternatives.
Kelley Road Wash	6	Approximately 0.6 Mile Reach		Kelley Road Wash	Model will be utilized to model flood control management alternatives.

Table 5.1
Summary of HEC-RAS models Cont.

Watercourse (1)	Source Note (2)	Model Limits (3)	Updates (4)	HEC-RAS Project Name (5)	Comments (6)
Lazy G Wash	6	Approximately 0.4 Mile Reach		Lazy G	Model will be utilized to model flood control management alternatives.
Photo View Wash	6	Approximately 1.8 Mile Reach		Photo View Wash	Model will be utilized to model flood control management alternatives.
River Creek	6	Approximately 0.8 Mile Reach		River	Model will be utilized to model flood control management alternatives.
Rough Rider Wash	6	Approximately 1 Mile Reach		Rough Rider	Model will be utilized to model flood control management alternatives.
Sharman Wash	6	Approximately 1 Mile Reach		Sharman	Model will be utilized to model flood control management alternatives.
Soda Springs Wash	6	Approximately 2 Mile Reach		Soda Springs Wash	Model will be utilized to model flood control management alternatives.
Table Mt. Tank Wash	6	Approximately 3.6 Mile Reach		Table Mt. Tank Wash	Model will be utilized to model flood control management alternatives.
Table Mt. Wash Trib. 6	6	Approximately 0.6 Mile Reach		Table Mt. Wash Trib. 6	Model will be utilized to model flood control management alternatives.
Twin Peaks Wash	6	Approximately 0.8 Mile Reach		Twin Peaks Wash	Model will be utilized to model flood control management alternatives.
White Spar Wash	6	Approximately 2.2 Mile Reach		White Spar Wash	Model will be utilized to model flood control management alternatives.

1) New River, New River Dam to Rock Springs Flood Insurance Study (CVL, 1987)
2) New River Above I-17 Floodplain Delineation Study, FCD 99-13 (Primatech, 2002)
3) Sweat Canyon Wash Flood Insurance Study (David Evans and Associates, Inc., 1999)
4) Deadman Wash Floodplain Delineation Study, FCD 90-65 (HNTB, 1992)
5) New River West Tributaries Floodplain Delineation Study, Contract No: FCD 2003 C057 (URS, 2005)
6) Gavilan Peak Floodplain Delineation Study, 2002C032 (Michael Baker, Jr., Inc. 2005)

A map (Plate 5.1) depicting effective 100-year floodplain delineations and cross section alignments used in the hydraulic modeling was developed from digital data to facilitate cross referencing model results to mapped floodplain limits. Digital data obtained from the District for effective models pertaining to floodplain limits and cross section alignments were limited to available HIS and DFIRM data. Cross section alignments from DFIRM data is limited to cross sections that are depicted on FIRM panels. The FIRM panels do not depict all of the cross sections utilized in the hydraulic evaluation of a watercourse with the exception of Sweat Canyon Wash above RM 4.129. Plate 5.1 depicts effective 100-year floodplain limits within the study area that are based on HEC-2 models. The Sweat Canyon and Doe Peak Wash floodplain limits above Sweat Canyon RM 4.129 are based on a HEC-RAS hydraulic model. The watercourse depicted on Plate 5.1 are identified in the scope of work as watercourses for which flood control management alternatives may be developed to mitigate flooding issues. Cross section identifiers for New River, Sweat Canyon and Doe Peak are not always consistent with model cross section identification. The difference in cross section identification is assumed to be the result of using paper based data to develop digital data or river mile stations have changed because the hydraulic base line was re-calculated.

5.4 NEW HYDRAULIC MODELS

Physical changes, such as sand and gravel operations and lateral migration, have occurred within New River area since the development of the effective 100-year floodplain limits in 1987. Those changes are significant enough to merit development of new hydraulic models. New hydraulic models are developed for reaches of New River, Sweat Canyon / West Split and Deadman Wash. The New River model (referred to as New River Main Stem) extends from approximately the New River Dam impoundment limits (RM 20.95, old RM 20.1) to just below the I-17 crossing (RM 31.68, old RM 31.57) on New River. The Sweat Canyon / West Split models include the reaches between New River Road and the confluence with New River Main Stem. The Deadman Wash model includes the area between I-17 and the confluence with New River Main Stem. Cross section alignments and RM identification for the new and old modeling effort are depicted on Plates 5.2 and 5.3.

The new hydraulic models are based on:

1) New topography provided by the District.

2) New Manning's roughness value estimation

3) As-built and survey data for drainage structures.

5.4.1 Methodology

Hydraulic modeling is facilitated utilizing the HEC-RAS Computer Program, version 3.1.3, dated May 2005 (COE, 2005). Starting water surface elevation for Upper New River Main Stem is computed using normal depth option of HEC-RAS. The starting water surface elevation for the West Split and Deadman Wash models is obtained from the Upper New River Main Stem model. The starting water surface elevation for Sweat

Canyon is obtained from the West Split Model. The estimation of required HEC-RAS input model parameters are described in the following sections.

5.5 PARAMETER ESTIMATION

5.5.1 Manning's Roughness Coefficients

5.5.1.1 Methodology

In order to estimate Manning's n-values for the study watercourses, physical characteristics for each watercourse were identified through field observations and examination of ground and aerial photographs as well as examination of topographic mapping. The discerning characteristics recorded are channel shape, bed material, vegetation density, the presence of meanders or channel bends and the presence or absence of channel obstructions. Physical characteristics of the watercourses were viewed during field reconnaissance and the watercourse and its branches were photographed at representative locations.

Manning's n-values were estimated using the methods set forth in the US Geological Survey (USGS) publication "Selection of Manning's Roughness Coefficient for Natural and Constructed Vegetated and Non-Vegetated Channels, and Vegetation Maintenance Plan Guidelines for Vegetated Channels in Central Arizona" (Phillips and Tadayon, 2006). The method cited in the USGS publication and the method used for this study involved the selection of an initial Manning's n-value based upon the channel bed material and then the adjustment of that value for channel irregularities, effects of obstructions, vegetation and channel cross sectional variations. If the channel has sufficient meander to increase roughness, then the sum of the base n-value plus subsequent adjustments is multiplied by a meander value, m. Degree of meander for the study watercourse was minor.

The base n-value for the bed and overbank material roughness was estimated from field investigations. A 1-foot square grid (grid on 1-inch centers) was utilized for the estimation of the average size of bed material. Adjustment of the base n-value was then made based on vegetation present in the channel and the overbanks, field assessment of the channel bank conditions and the impact of any obstructions as well as a review of topographic data for variations in channel geometry.

5.5.1.2 Manning's n-Value Determination

Manning's roughness coefficients were estimated based on the physical characteristics of each watercourse. Field photographs, presented in Appendix B, document the physical characteristics of the washes evaluated at specific locations. Field photographs are identified by a bed material sampling location number. The corresponding latitude/longitude (and northing/easting) recorded in the field at the location where the photographs were taken is listed in Appendix C. Calculation sheets listing the estimated base n-values and adjustments to that value for each wash evaluated are provided as Appendix D. The calculation sheets were prepared to represent the physical conditions not only in the main channel and the adjacent overbanks but the entire river sections. This made it possible to have a one-to-one correlation between the n-value polygon delineations in ArcGIS and the application of the method used (Phillips and Tadayon,

2006) to set up the calculation sheets. Plate 5.4 graphically depicts estimated Manning's n-value polygons and the bed material sampling or photograph locations.

5.5.1.2.1 Upper New River Main Stem

The Upper New River main stem extends from I-17 Bridges to the north to just below the CAP canal siphon crossing to the south. The main channel of the subject reach of Upper New River main stem is characterized with segments with vegetation such as willow, or cottonwood, growing where the average 100-year event depth of flow is at least three times the height of vegetation. The spheres of influence or turbulence do not always overlap. The average channel bed material size ranges from coarse gravel to large cobbles with significant percentage of small boulders in the reach segment upstream of the West Split (Locations NR-9 and 10 on Plate 5.2). The overbank areas are characterized by bed material ranging in size from firm soil to gravel and at some locations with a cobble component. The overbank areas are vegetated with medium trees and/or shrubs, with limbs extending to the ground. The islands formed in the main stem near location NR 9 are characterized by moderately dense vegetation. The gravel pit (see Plate 5.2) between NR 9, and 10, is characterized by tortuous flow paths, and very little vegetation.

The main stem of the Upper New River is significantly braided in the vicinity of sampling location NR-7 with notable lateral migration within the main stem corridor. The thalweg bed material is mostly cobble, whereas the overbank material is coarse sand. The vegetation composition in the braided thalweg areas is mostly small shrubs and trees. The overbank areas are represented by medium to large vegetation with occasional overlapping of the spheres of influence. Few broad bands of denser vegetation (approximate Manning's n-value of 0.065) were observed from aerial photographs of the overbank area just east of location NR 7.

Locations NR 4, 5 and 6 are in the vicinity of the SR-74 West and East Bridges. The influence of the bridges on the finer bed material distribution was observed during field reconnaissance. The thalweg of the main stem upstream of the West Bridge (NR 5) is represented by cobbles with coarse sand laid over, most likely from settling of suspended load due to backwater conditions caused by the bridges, and that settled from the Sweat Canyon Wash/Upper New River West Split flows. Some small vegetation was notable within the main stem. Similar conditions prevail at location NR 6 upstream of the East Bridge. Downstream of the bridges (NR 4), the thalweg bed material consists of large cobbles to small boulders with very little vegetation. Medium vegetation with overlapping spheres of influence was noted in the overbank areas with bed material varying from coarse sand to gravel.

In the vicinity of the CAP canal siphon crossing (NR 1, and 3), the main stem courses through complex geomorphic conditions. In that area, the channel banks are sloughed, and are a mixed conglomerate composed of caliche and cobbles. Along the outside bends in this gentle sinuous channel form, active erosion and sloughed conditions were observed during field reconnaissance with little or no vegetation on the bank slopes. The bed material is mostly composed of gravels with coarse sand deposit along the inner banks. Medium to large vegetation was observed on the overbank areas with overlapping

spheres of influence. Near the confluence with Deadman Wash (NR 3), the bed material tends to be finer than that found in the New River main stem potentially because of the fine material deposited by Deadman Wash flows at the confluence. In the overbank areas between NR 3 and NR 4, the vegetation and surface material distribution was uniform, and the main channel maintained a regular course with minor sinuous bends.

5.5.1.2.2 Upper New River West Split

The Upper New River West Split begins at the flow split location approximately 2.7 miles downstream of the I-17 Bridges, and continues for 2.7 miles before merging with the Sweat Canyon Wash flow. The 2.7-mile length of the West Split is characterized by large gravel pits with greater storage areas in the upstream end compared with the gently sloping, wide, triangular shaped downstream portion. The gravel pit surface material is mostly composed of coarse sand, desert shrubs and forbs. The banks of the river at those pit locations are gently sloping with desert shrubs, grasses and forbs. Vegetation is dense on the overbanks outside the downstream end of the triangular gravel pit.

Downstream of the pit, the main channel bed material is mostly cobbles. The broad overbank areas are mostly composed of firm soil and cobbles with low lying vegetation such as willows and chollas. Near the confluence with Sweat Canyon Wash, the overbank vegetation is composed of large trees with overlapping spheres of influence. The surface material is mostly firm soil.

5.5.1.2.3 Sweat Canyon Wash

Sweat Canyon Wash begins at the confluence with West Split and continues for 2.5 miles upstream to the New River road crossing. The main channel bed material is mostly composed of cobles, gravels and sands. The vegetation of the channel side slopes are mostly composed of small shrubs and trees with over lapping spheres of influence or turbulence. The overbank areas are mostly composed of firm soil and cobbles with low lying vegetation such as willows and chollas.

5.5.1.2.4 Deadman Wash

Deadman Wash begins at the confluence with New River and is modeled for approximately 6 miles to I-17. The main channel bed material is mostly composed of cobles, gravels and sands. The overbank areas are mostly composed of firm soil. The vegetation on the channel side slopes are mostly composed of small shrubs and trees with over lapping spheres of influence or turbulence. Outside the channel the vegetation is by medium to large vegetation with occasional overlapping of the spheres of influence.

5.5.2 Expansion and Contraction Coefficients

SR-74 crosses Upper New River and associated split flows near RM 23.21. The SR-74 crossing includes two bridges, an east and west bridge. The expansion and contraction coefficients at the bridges were set to 0.5 and 0.3, respectively. In general, expansion and contraction coefficients of 0.3 and 0.1, respectively, are used for the majority of the study. For the locations where the washes contract and expand more severely, larger coefficients for contraction and expansion were selected, such as the sand and gravel pits on the main stem. Guidance for the selection of appropriate coefficients is obtained from

the HEC-RAS Hydraulic Reference Manual (November 2002). Tables summarizing the contraction and expansion coefficients are included in part of the HEC-RAS model output provided in Appendix A.

5.6 MODELING DISCHARGES

Information regarding the development of the HEC-RAS modeling discharges are included in the Upper New River ADMP Hydrology Report and in the Two-Dimensional Modeling Section of this report. Table 5.2 summarizes the peak discharges used in the hydraulic analysis.

Table 5.2 100-year modeling discharges for the study

Wash	Flow Change Location miles	Modeling Peak Discharge cfs	Comments
(1)	(2)	(3)	(4)
Main Stem	31.76	29,000	
	30.93	28,730	
	28.27	22,200	Start of the West Split, 6,600 cfs enters West Split
	27.22	23,200	
	25.43	34,400	Flow includes contributions from Main Stem, Sweat Canyon, West Split, East Split and Deadman Wash
	21.12	34,600	Flow includes contributions from Main Stem, West Split, East Split, West Tributaries, Sweat Canyon and Deadman Wash
West Split	2.24	6,600	
	1.18	16,900	Flow includes contributions from West Split and Sweat Canyon Wash
	0.30	17,100	
Sweat Canyon	14437.5	14,200	
	11279.47	7,700	Start of split flow with the West Split
	3510.049	13,400	Flow includes contributions from West Tributaries
Deadman Wash	38819.16	11,100	
	37701.42	10,900	
	32598.25	10,800	
	31488.81	10,600	
	28405.26	10,100	
	22726.79	10,600	
	21834.81	9,900	
	14456.94	9,700	
	7248.999	10,400	
	4205.259	10,300	

Note: Discharges in the table are rounded.

5.7 CROSS SECTION DESCRIPTION

Since the original FEMA floodplain delineation the study reach has undergone some physical change due to urbanization. Those changes for New River Main Stem include:

- Abandoned gravel pit near RM 25.51
- One active sand and gravel pit located near RM 29.15.
- The Anthem development has encroached on the east side of the main stem between RM 29.46 and 30.49.

An abandoned gravel pit is located on the West Split near RM 2.24. A new road crossing, Correction Centre Road, was constructed over Deadman Wash. Geometry for the HEC-RAS models were developed using the new topography provided by the District and are described below.

5.7.1 General

Cross sectional geometry for the watercourse was determined from a triangulated irregular network (TIN). The TIN was developed from a digital terrain model (DTM) supplied by the District using the 3D Analyst extension of ArcView GIS v3.2. Cross sections are located approximately at the same locations as the original FEMA study. Modifications were made to represent features not present in the original model, such as the sand and gravel pits. The hydraulic baseline was adjusted to estimate the 100-year event flowpath rather than the low flow channel. Because the baseline was changed, cross sectional stationing in the new hydraulic models are different than the FEMA effective hydraulic models. Cross section stationing is from left to right looking downstream.

5.7.1.1 New River Main Stem

Additional cross section alignment modifications were made upstream and downstream of the SR-74 Highway. The effective floodplain delineation indicates divided flow upstream and downstream of the SR-74 Highway. Divided flow in that area is based on two separate models, the New River and the East Split models. Two-dimensional modeling, discussed in Section 63, in that area indicated that upstream of the highway flows from the main stem entered the East Split and divided flow does not occur. It was decided that a new model would combine the main stem and East Split reaches by extending cross sections across both reaches. The total discharge from both the East Split and the main stem are coded into the model. A comparison of the original FEMA and the new cross section alignments cross sections is shown on Plate 5.2.

The effective FEMA model included a Middle Split segment as a separate branch in the New River model. Results of two-dimensional modeling in this area indicate that little to no flow enters the Middle Split and this split was not included in the new HEC-RAS model.

5.7.1.2 West Split

A new hydraulic model was developed for the West Split Reach. The extent of the new reach in which cross section alignments were determined is slightly different than the effective model. The effective hydraulic model for the West Split reach commenced at the confluence with Sweat Canyon Wash (Sweat Canyon RM 1.0, West Spit RM 23.70) and extended upstream to New River RM 28.298. Preliminary results from the two-dimensional model indicated that Sweat Canyon flow mixes with West Split flow at Sweat Canyon RM 0.710. A new one-dimensional hydraulic model for the West Split reach was developed commencing at Sweat Canyon RM 0.710 (New West Split RM 0.02) and extending approximately 2 miles upstream. The new model was not extended to the main stem of New River because of the complicated flow paths between and within the sand and gravel pit located within the West Split reach. The new model includes portions of Sweat Canyon Wash between RM 0.52 and 1.18. A comparison of the original FEMA and the new cross section alignments cross sections is shown on Plate 5.2.

5.7.1.3 Sweat Canyon Wash

A new hydraulic model was developed for Sweat Canyon Wash. The new model commences at the confluence with the West Split and ends just upstream of New River Road. The cross sectional alignments differed from the FEMA model to capture the effects of the West Tributaries and new topography. A comparison of the original FEMA and the new cross section alignments cross sections is shown on Plate 5.2.

5.7.1.4 Deadman Wash

A new hydraulic model was developed for Deadman Wash. The model commences at the confluence with New River Main Stem and ends just downstream of I-17. The alignment of the cross sections matched the FEMA model except upstream and downstream of SR-74. The first part of the effective model stopped approximately 2,000 feet downstream of SR-74 and the second part started approximately 3,900 feet upstream of the SR-74. The flows at SR-74 are braided, complex, not easily defined and cross the road at a skew. A berm upstream of SR-74 blocks flow to a 48-inch culvert is located on the east side of wash. Approximately 9,940 cfs flows over the road during the 100-year event at a depth of approximately three feet. The FEMA cross sections and the new cross sections are shown on Plate 5.3.

5.7.2 Channel and Overbanks

New River Main Stem, Sweat Canyon, West Split and Deadman Wash cross section reach lengths were determined using the HEC-GeoRAS extension for ArcView GIS. The process involves the initial layout of line work representing the hydraulic baseline (channel reach length) and flowpaths (overbank reach lengths). This data, along with cross sectional geometry is exported into a format required by HEC-RAS to approximate the initial flooding limits. Based on the initial results, that data is refined to be representative of the hydraulic conditions of the 100-year event. The bank stations are located the same locations as the sediment models (see Section 7).

Overbank reach lengths for the watercourses are defined as extending from the centroid of the overbank flow area from the upstream cross section to that of the downstream cross section. The overbank reach lengths are therefore directly affected by the location of the channel bank stations. For the cross sections where there is no identifiable overbank area, overbank reach lengths are measured along the channel bank.

5.8 MODELING CONSIDERATIONS

5.8.1 Hydraulic Jump Analysis

No hydraulic jumps are within the study limits.

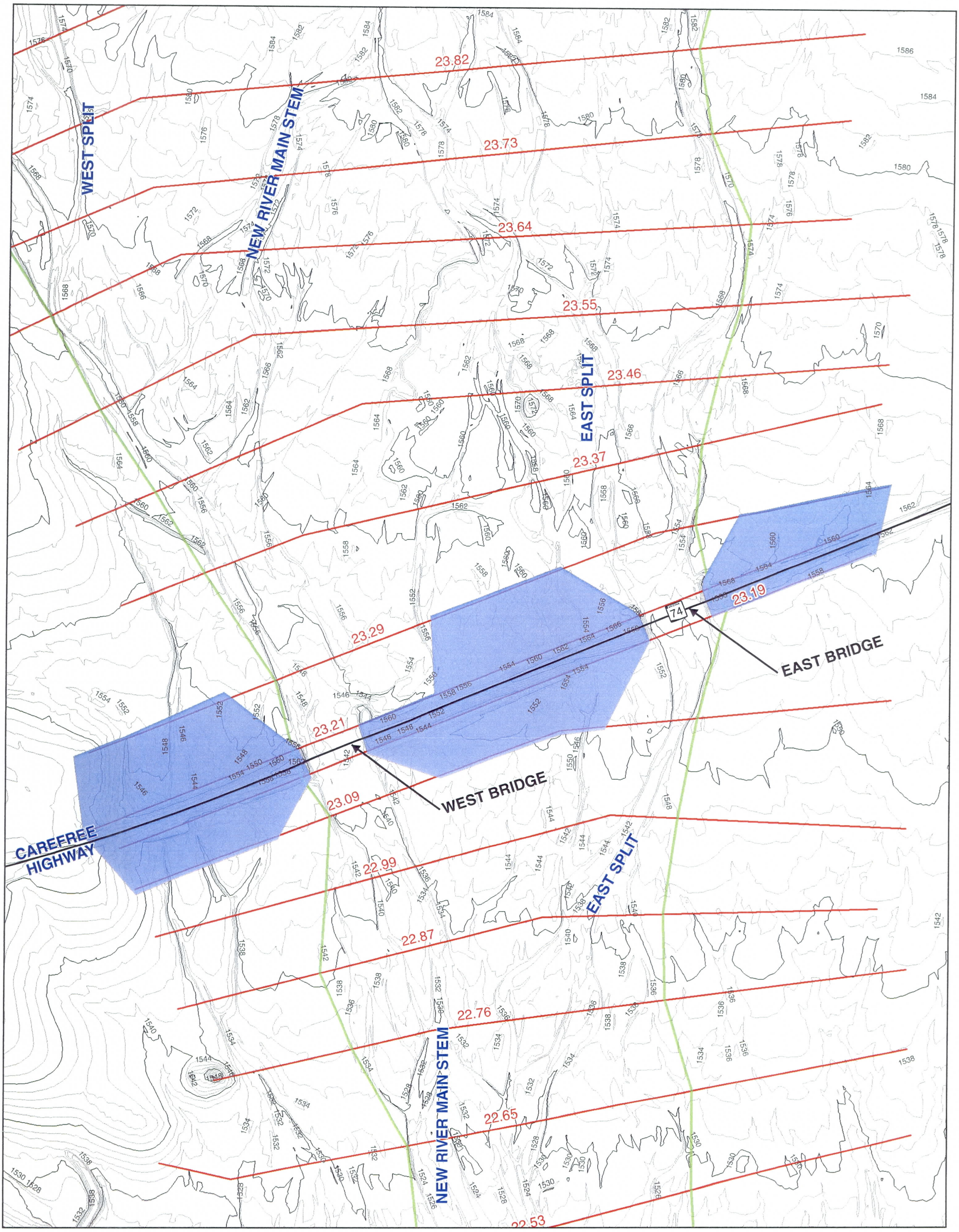
5.8.2 Bridges, Culverts and Constrictions

5.8.2.1 New River Main Stem

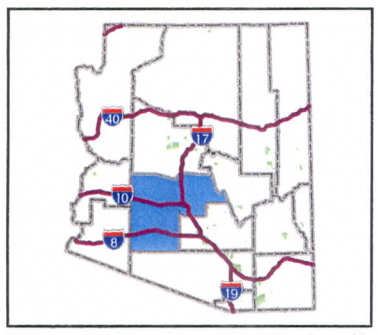
The SR-74 Highway crosses the New River main stem and the East Split near RM 23.2 (see Figure 5.2). At that location there are two bridges that convey flow under the roadway. The bridge geometry is coded into the new hydraulic model. Data for the structures were obtained from as-built plans from ADOT and field survey (ADOT, 1992). The field survey was conducted by Engineering Alliance, Inc. during April 2007. Energy (Standard Step) bridge modeling method was used in HEC-RAS.

5.8.2.2 Sweat Canyon and West Split

No bridges, culverts or constructions are identified with in the study limits.



Location Map:



Project No.
182000418

Prepared By:
AMG
February 2008

W:\active\182000418\GIS\Project\MXDs\Public Meeting\Report Figures\fig5-2.mxd

Notes:

N

1" = 500'

Legend:

- Roadway
- New Bank Stations
- New Cross Sections
- Index Contour
- Intermediate Contour
- Ineffective Flow

Flood Control District of Maricopa County
2801 W. Durango St.
Phoenix, AZ 85009

Upper New River ADMP
FCD 2005CO20
Figure 5.2
Carefree Highway Area

Stantec

Stantec Consulting Inc.
8211 S. 48th Street
Phoenix, AZ U.S.A. 85044

5.8.2.3 Deadman Wash

The SR-74 Highway crosses Deadman wash near RM 17503.86. At this location one 48-inch culvert and a roadway dip section exist. Upstream of the roadway a berm was constructed to prevent flow from entering the culvert. Approximately 9,940 cfs (FEMA FIS discharge) flows over the road at a depth of approximately three feet for the 100-year event.

Upstream of the SR-74 Highway the wash crosses Correction Centre Road (see Figure 5.3). This wash crossing includes the following:

- Roadway dip section
- 4 Culverts at the main braid – two 72-inch and two 48-inch
- 1 culvert located approximately 580 feet east of the main braid
- 1 culvert located approximately 1,200 feet east of the main braid

Figure 5.3 - Culverts at Correction Center Road

CulvertMaster was used to estimate the flows through the culverts and over the roadway. Approximately 510 cfs passes through the culverts at the main braid and 9,500 cfs passes over the roadway during the 100-year event. A rating curve showing the flow through the culverts and over the roadway is shown on Figure 5.4 and supporting information is included in Appendix E. These culverts were not included in the effective model because the roadway was built after the effective model was developed. The culverts were not added to the current model because so much of the flow passes over the roadway.

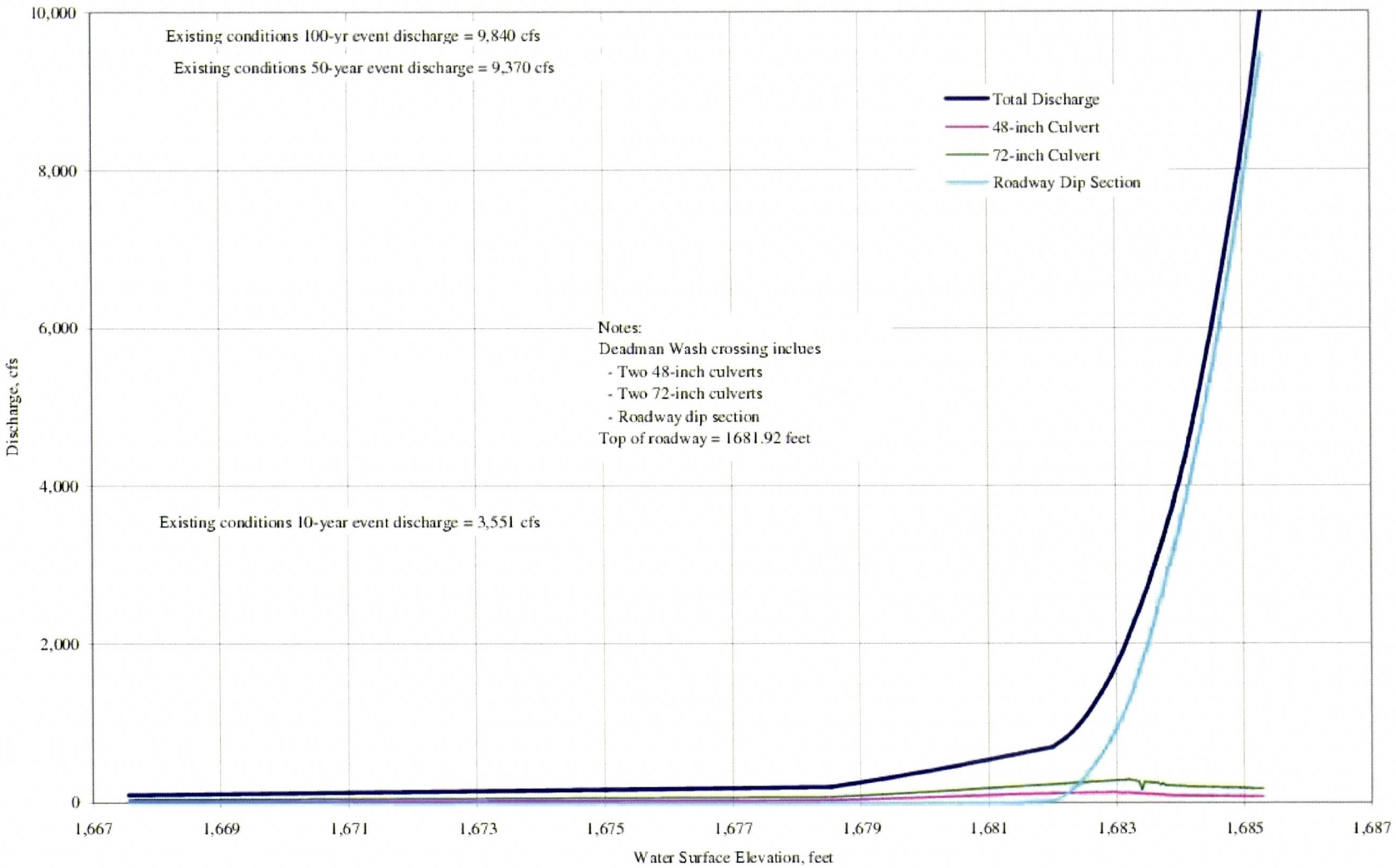


Figure 5.4 - Deadman Wash crossing of Correction Centre Road rating curve

5.8.3 Levees and Dikes

No levees or dikes are identified within the study limits.

5.8.4 Grade Control Structures

There are no engineered grade control structures within the study limits.

5.8.5 Islands and Flow Splits

The West Split of New River starts near RM 28.27 and rejoins the main stem near RM 24.11 (see Plate 5.2). Based on the results of the hydrology and two-dimensional modeling, flow entering the west split is 6,700 cfs. The West Split eventually joins with Sweat Canyon near RM 1.18 and the combined flow amount at this location is 16,900 cfs. A separate HEC-RAS model was created for the West Split Reach to analyze potential flood control management alternatives. The model starts just downstream of the abandoned sand and gravel pit and stops approximately one mile north of the SR-74 Highway.

A reach referred as the Middle Split was modeled as a separate branch in the original FEMA model. Two-dimensional modeling indicates that no flow enters the split (due to the linear gravel pit within New River main stem) and that flow split was not modeled in the new HEC-RAS.

Between New River RM 25.51 and 25.32 on the main stem flow was not contained within the cross section and the end of the cross section in the HEC-RAS model was extended vertically to contain the flow. Those cross sections are located on the downstream end of the sand and gravel pit. Based on the results of the two-dimensional model flow breaks out into a small split to the west of the main stem. Flows from the split eventually reenter the main stem.

Between New River RM 24.42 and 24.31 on the main stem flow was not contained within the cross section and the end of the cross section in the HEC-RAS model was extended vertically to contain the flow. At this location flow from the West Split joins New River.

The East Split of New River determined in the FIS study starts near RM 23.82 and combines with the main stem near RM 22.76. The flow split is contained within the cross sections of the main stem new hydraulic model between RM 23.82 and 22.76 because cross section lengths relative to the effective model were extended so that the alignment crossed both reaches.

5.8.6 Ineffective Flow Areas

The ineffective flow area option of the HEC-RAS computer program is used to model ineffective flow areas. Typical ineffective flow areas are located upstream and downstream of bridges, backwater areas in the floodplain and within topographic depressions in which runoff ponds and there is no apparent conveyance from one cross section to another.

5.8.7 Supercritical Flow

There are no supercritical flows within the study reach.

5.9 CALIBRATION

No calibration procedures were attempted for the study reach.

5.10 FLOODWAY MODELING

Floodway modeling was not completed as part of this study.

5.11 MODEL WARNING AND ERROR MESSAGES

The HEC-RAS models for the New River main stem, West Split, Sweat Canyon Wash and Deadman Wash execute without error messages. However, the models report several different warning messages. In general, these messages are to be expected given the hydraulic characteristics of the watercourses. Common messages are:

"The energy loss was greater than 1.0 ft (0.3 m) between the current and previous cross section." The message pertaining to energy loss of greater than 1 foot is to be expected, given the cross section spacing for the models and the energy grade line slope being calculated. As an example energy grade line slope of 0.005 (ft/ft) for cross sections spaced 500 feet apart would result in energy loss between cross sections of greater than 1 foot.

"The velocity head has changed by more than 0.5 ft (0.15 m)." Channel velocities generally range between 2 and 10 fps within the channel. For a channel velocity in the range of 7 to 10 fps, a velocity difference between cross sections of 2 fps would result in a velocity head difference of more than 0.5 feet. A change of 2 fps between cross-sections is not unreasonable.

"The energy equation could not be balanced within the specified number of iterations. The program used critical depth for the water surface and continued on with the calculations." This warning message indicates that flow at the subject cross section is near critical depth and that the program defaulted to critical depth for an estimation of the water surface profile.

5.12 RESULTS

The HEC-RAS model data files, both input and output, are provided digitally on CD as Appendix A. A comparison of the water surface elevation between the FEMA HEC-2 and the new HEC-RAS models for the main stem, West Split, Sweat Canyon and Deadman Wash are shown on Figures 5.5, 5.6, 5.7 and 5.8, respectively. The FEMA study was completed using NGVD29 and this study is completed using NAVD88. The FEMA study was converted to NAVD88 by adding 2.01 feet elevation differential. Also shown on the figures are locations where peak discharges have changed and model discharges.

Below is a summary of the comparison between the HEC-RAS and HEC-2 models for New River.

- For the upper portion of the study reach, the discharges in the HEC-2 model are generally greater. For the lower portion, the HEC-RAS model discharges are generally greater. The hydrology for the New River was updated using a combination of results from hydrologic and two-dimensional modeling.

- Between HEC-RAS RM 20.95 and 25.43, the water surface elevation for the HEC-RAS model is generally greater except in the area near the confluence with the West Split (near RM 24.11). In that area, the HEC-RAS cross sections were extended to include the west split resulting in a lower water surface elevation. Figure 5.9 shows a comparison between HEC-RAS RM 21.86 and HEC-2 RM 21.173. The cross sections are similar in shape with the HEC-RAS model having a greater water surface elevation.

- Between HEC-RAS RM 25.7 and 27.51, the HEC-2 water surface elevations are greater than the HEC-RAS model. A sand and gravel pit not in the original model is included in the HEC-RAS model. Figure 5.10 shows the change in invert elevation (approximately 6 feet) due to the pit. The figure also shows the difference in water surface elevation between the two models.

- Between HEC-RAS RM 28.74 and 29.46, the HEC-2 water surface elevation is greater the HEC-RAS model. In that area there is an active sand and gravel pit. Figure 5.11 shows the change in invert elevation (approximately 10 feet) between the two models. The figure also shows the difference in water surface elevation between the two models.

- Between HEC-RAS RM 29.64 and 31.76, the different between the two models is approximately 1 to 2 feet. Figure 5.12 shows a comparison between the two models at HEC-RAS RM 30.77. The cross sections are similar in shape with approximately one foot difference in water surface elevation.

Below is a summary of the comparison between the HEC-RAS and HEC-2 models for the West Split.

- Between the sand and gravel pit and the Sweat Canyon Wash confluence the HEC-2 model discharges are greater than the HEC-RAS model. Downstream of the Sweat Canyon confluence the HEC-RAS discharges are greater than the HEC-2 model. The hydrology for the West Split was updated using a combination of results from hydrologic and two-dimensional modeling.

- Generally the HEC-2 model has a higher water surface elevation than the HEC-RAS model except at three cross sections, 0.83, 2.14 and 2.24. Figures 5.13 and 5.14 show a comparison of cross sectional data between the two models at HEC-RAS cross section 1.35 and 2.14. The cross sections are similar in shape between the HEC-RAS and HEC-2 models.

Below is a summary of the comparison between the HEC-RAS and HEC-2 models for Sweat Canyon Wash.

- In general, the FEMA model water surface elevations are slightly greater than the water surface elevations for the new HEC-RAS model, especially in the area downstream of the split flows to the West Split.

- Figure 5.15 shows a comparison of cross sectional data between the models at HEC-RAS cross section 4847.207 (HEC-2 cross section 2.867). The cross sections area similar in shape between the models.

Below is a summary of the comparison between the HEC-RAS and HEC-2 models for Deadman Wash.

- In general, the water surface elevations are slightly less than the water surface elevations for the HEC-RAS model downstream of SR-74 Highway. Figure 5.16 shows a comparison of the invert elevations. The invert elevations downstream of SR-74 are lower than the invert elevations in the HEC-RAS model.

- Just upstream of the SR-74 Highway the FEMA water surface elevations are greater.

- The cross sections just downstream of I-17 in the HEC-RAS model have a higher water surface elevation than the FEMA model.

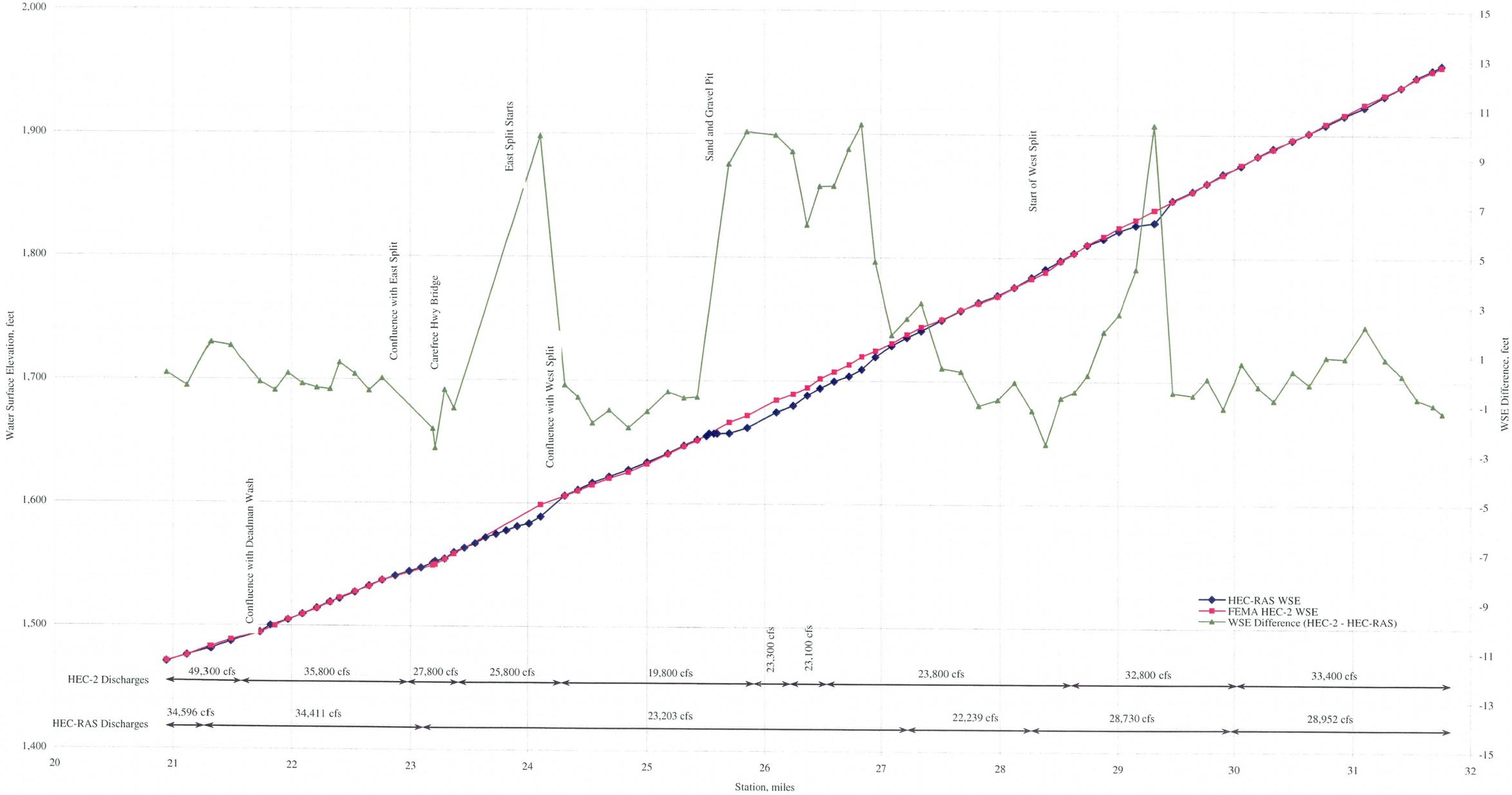


Figure 5.5 - Comparison Between FEMA HEC-2 and HEC-RAS Model for the New River Main Stem

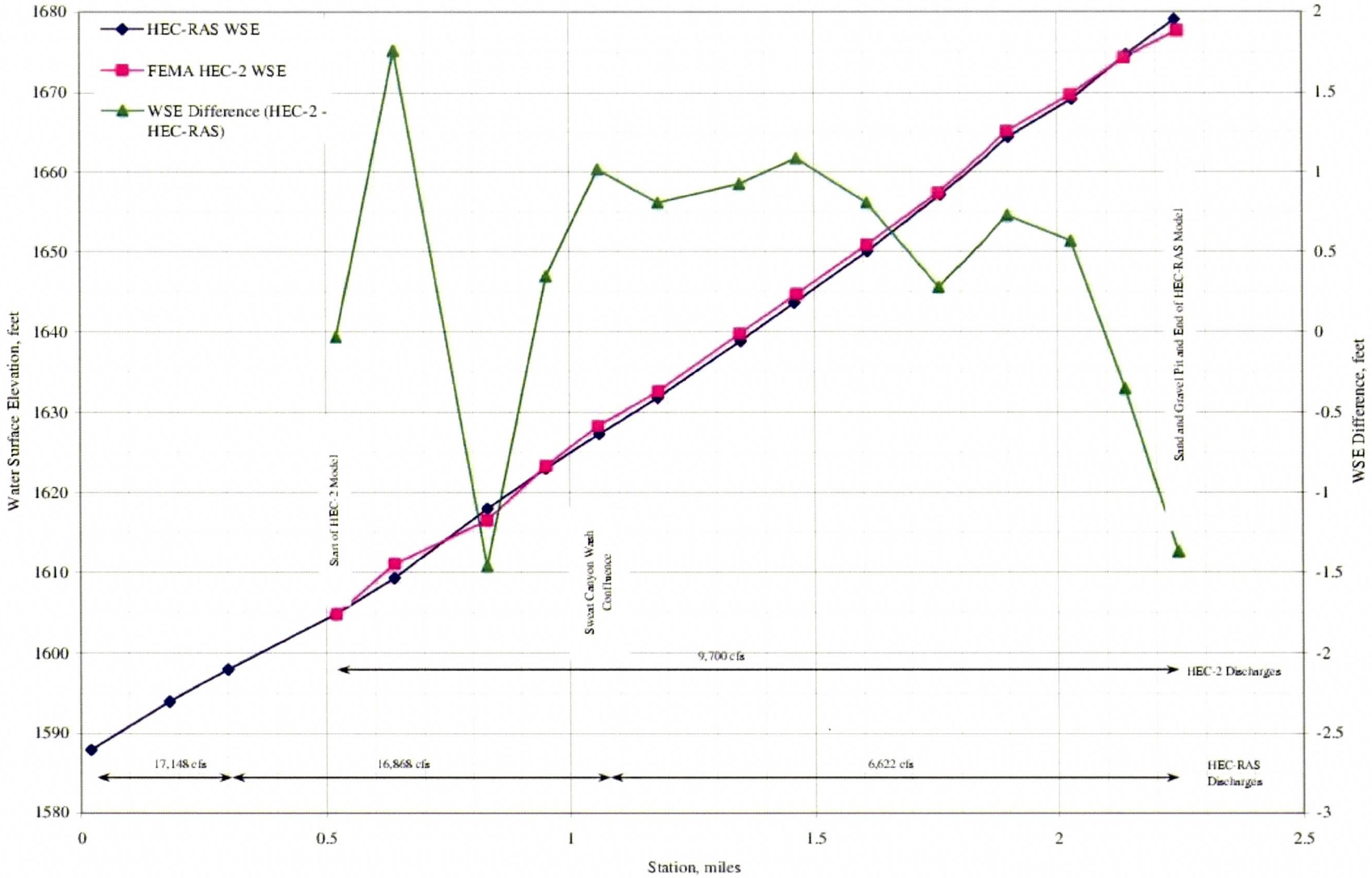


Figure 5.6 - Comparison Between FEMA HEC-2 and HEC-RAS Model for the West Split

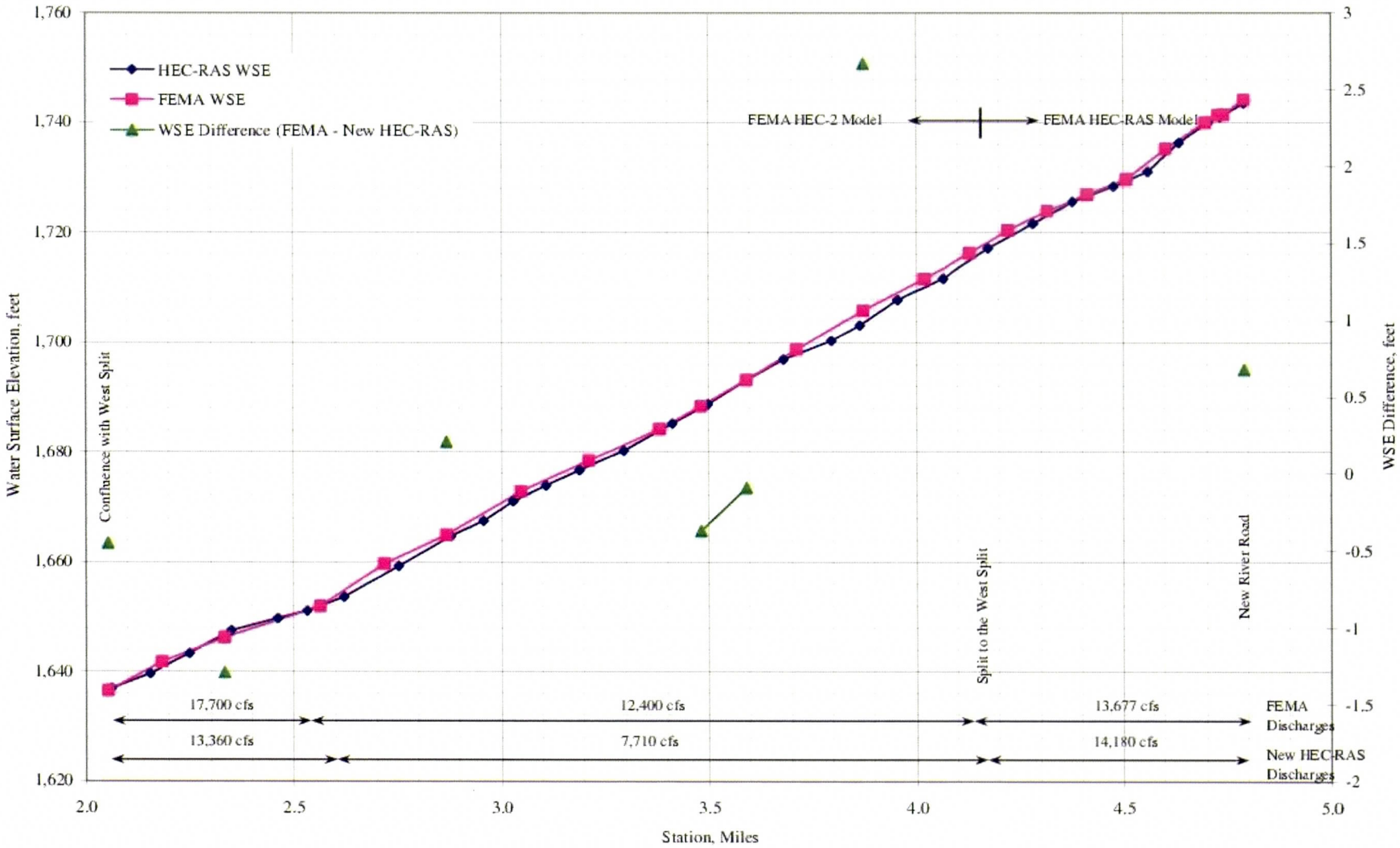


Figure 5.7 - Comparison Between FEMA Models and HEC-RAS Model for Sweat Canyon Wash

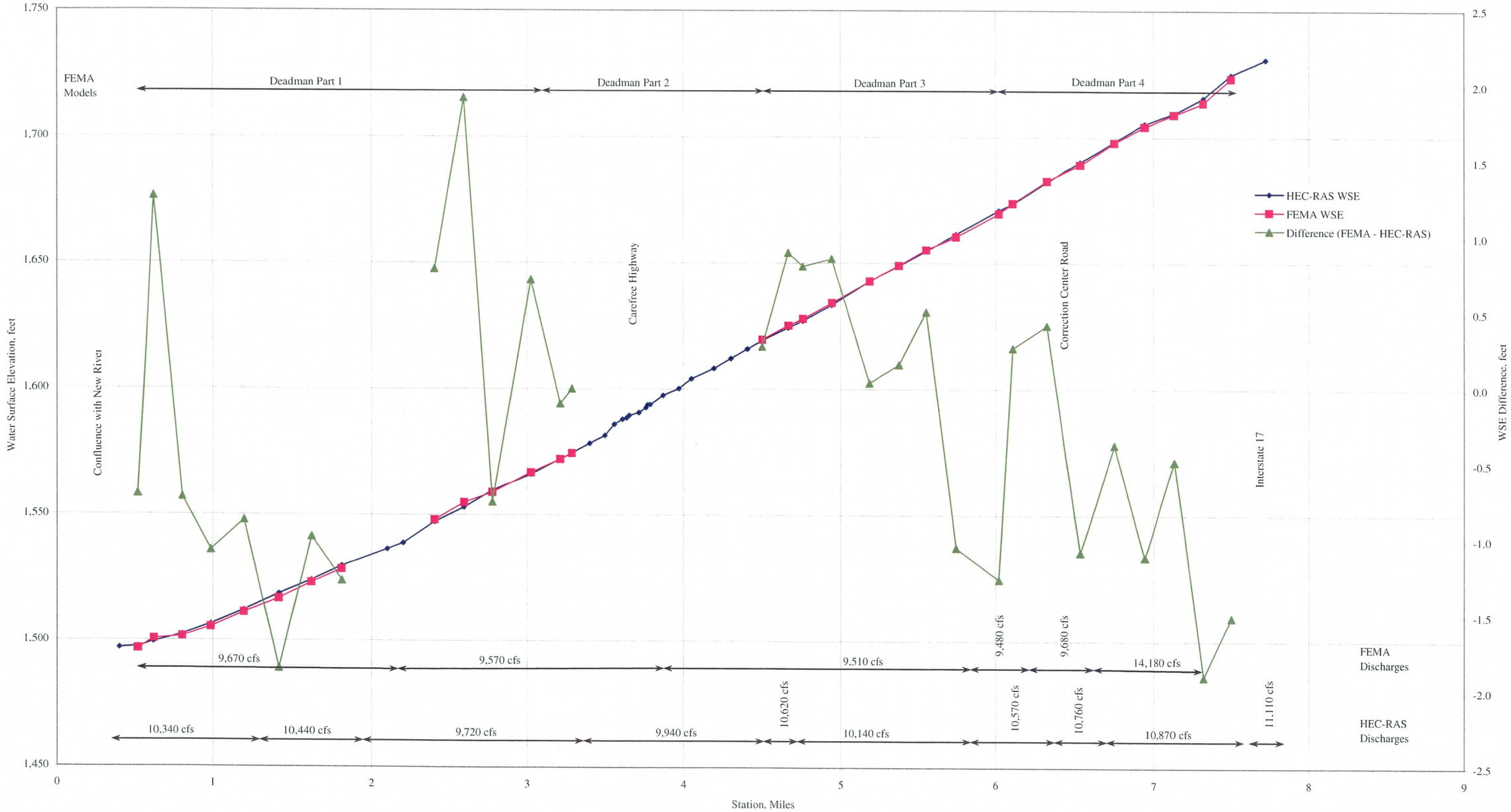


Figure 5.8 - Comparison Between FEMA and HEC-RAS Model WSE for Deadman Wash

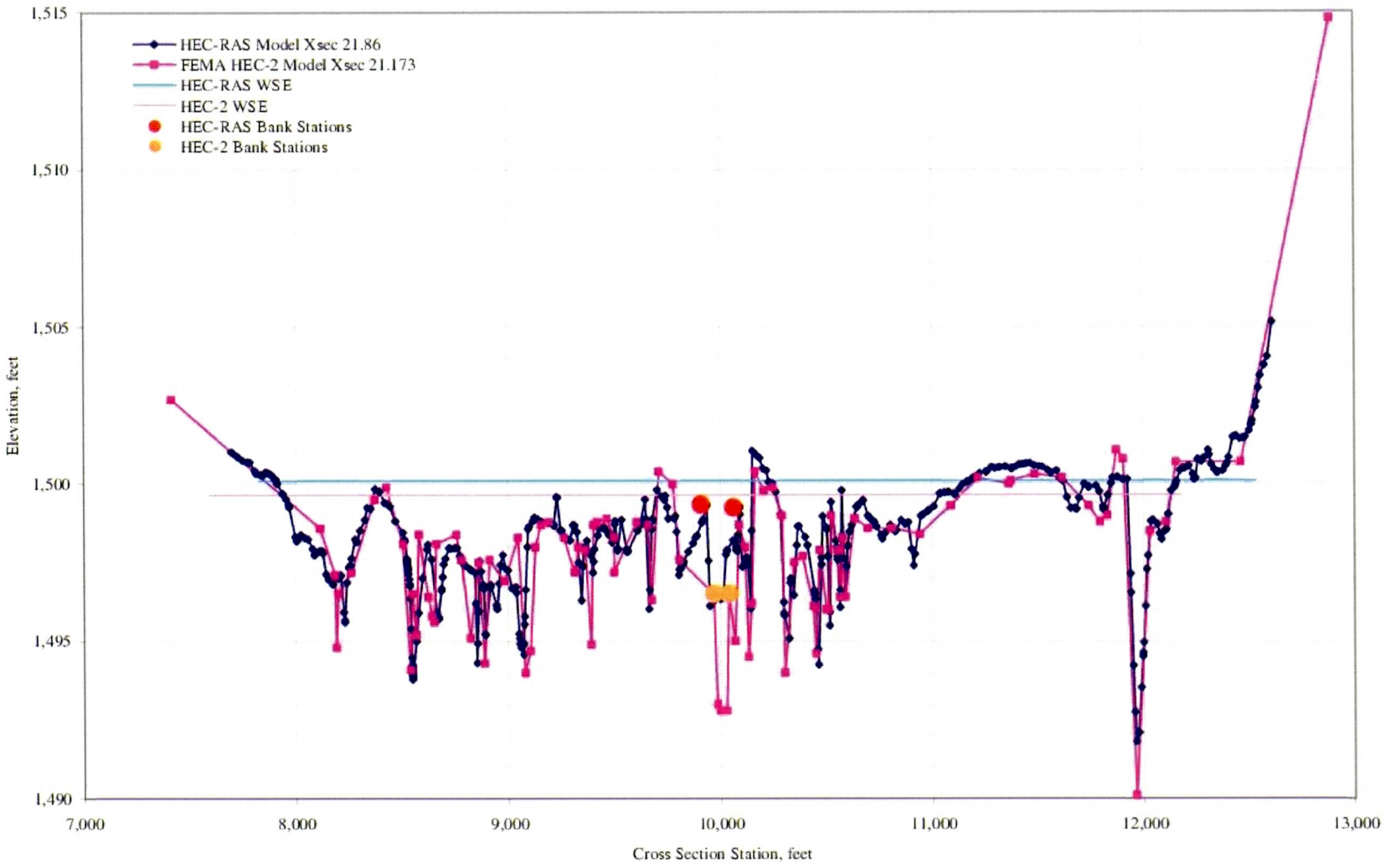


Figure 5.9 - Comparison of Geometry at New River HEC-RAS Cross Section 21.86

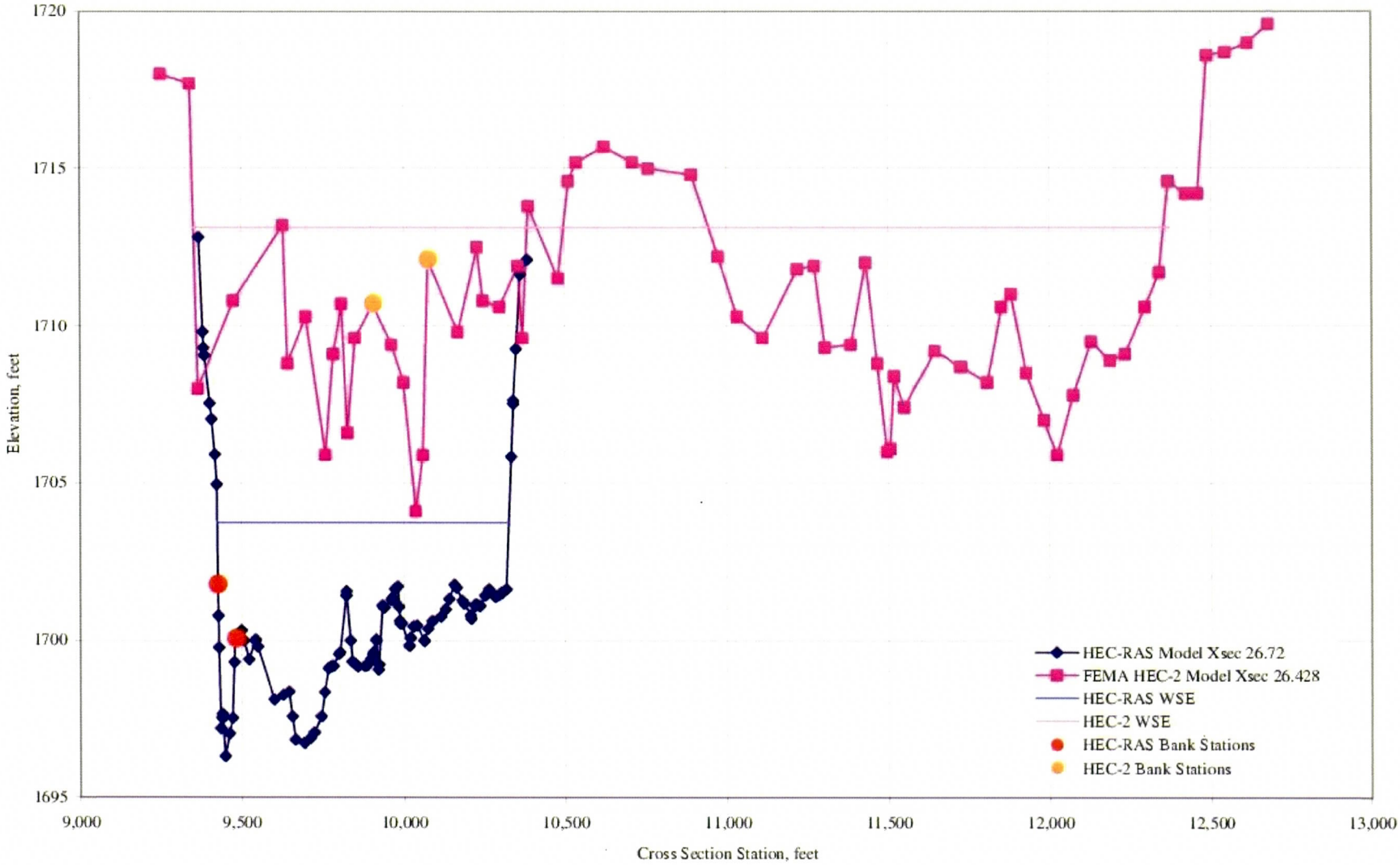


Figure 5.10 - Comparison of Geometry at New River HEC-RAS Cross Section 26.72

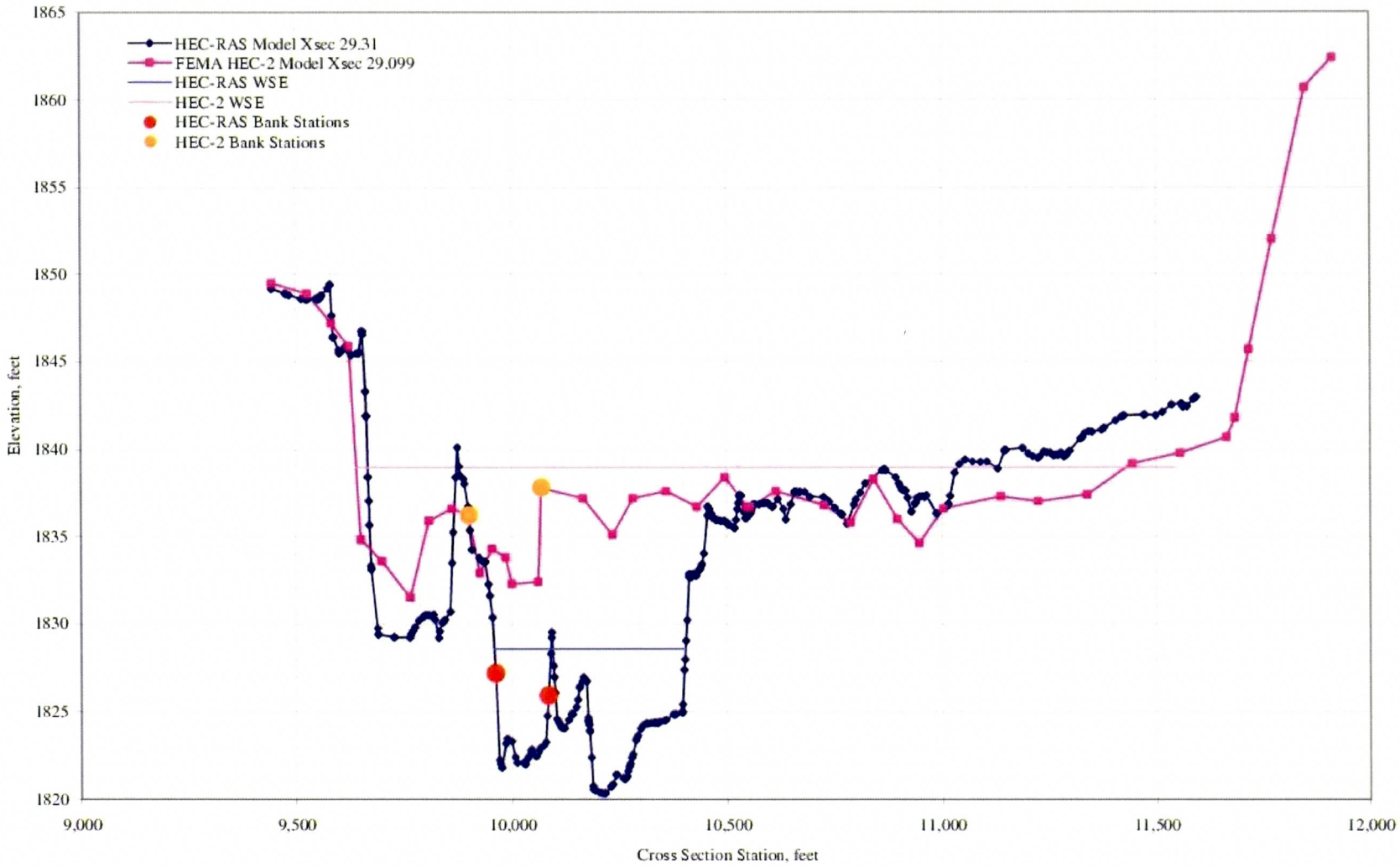


Figure 5.11 - Comparison of Geometry at New River HEC-RAS Cross Section 29.31

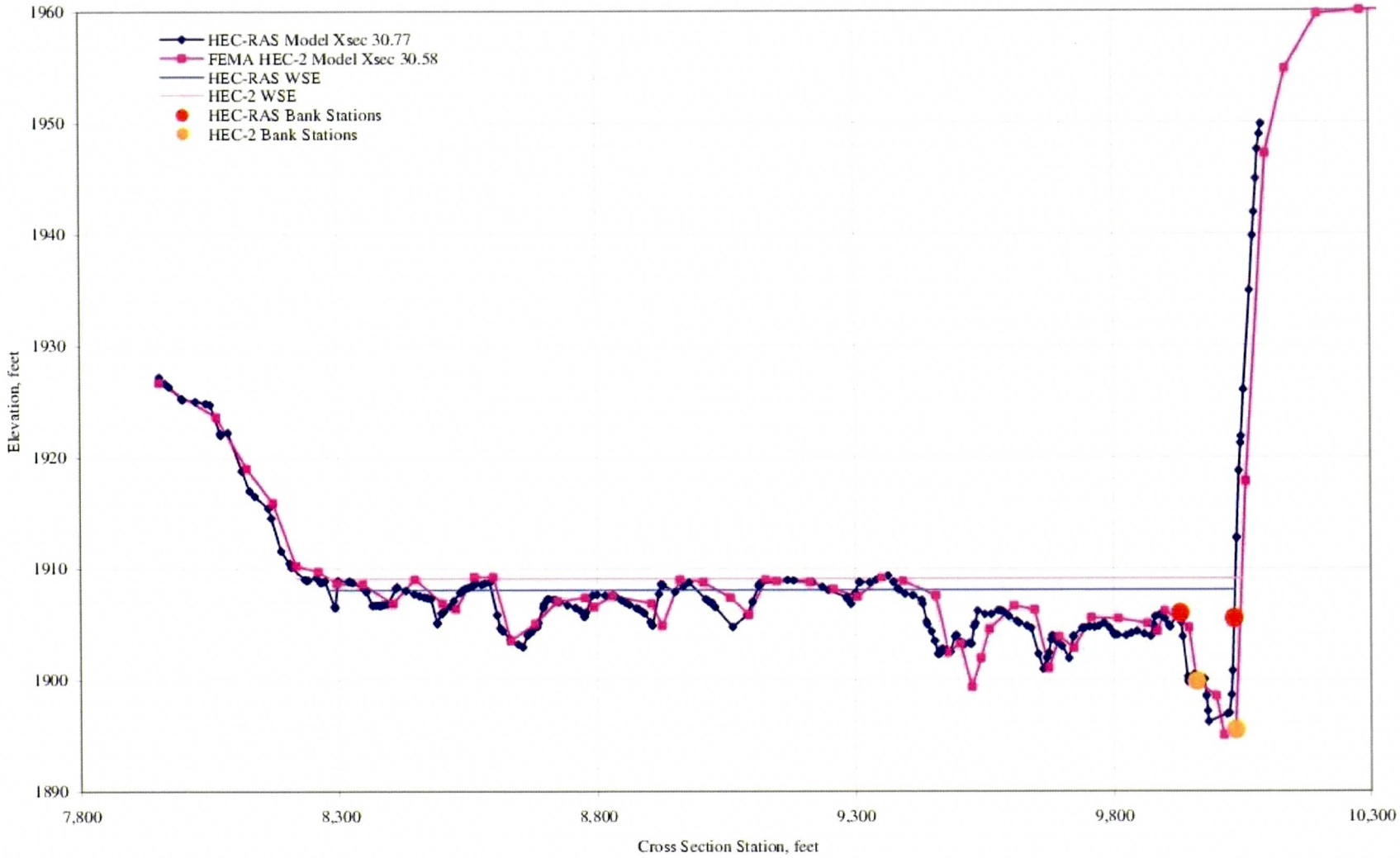


Figure 5.12 - Comparison of Geometry at New River HEC-RAS Cross Section 30.77

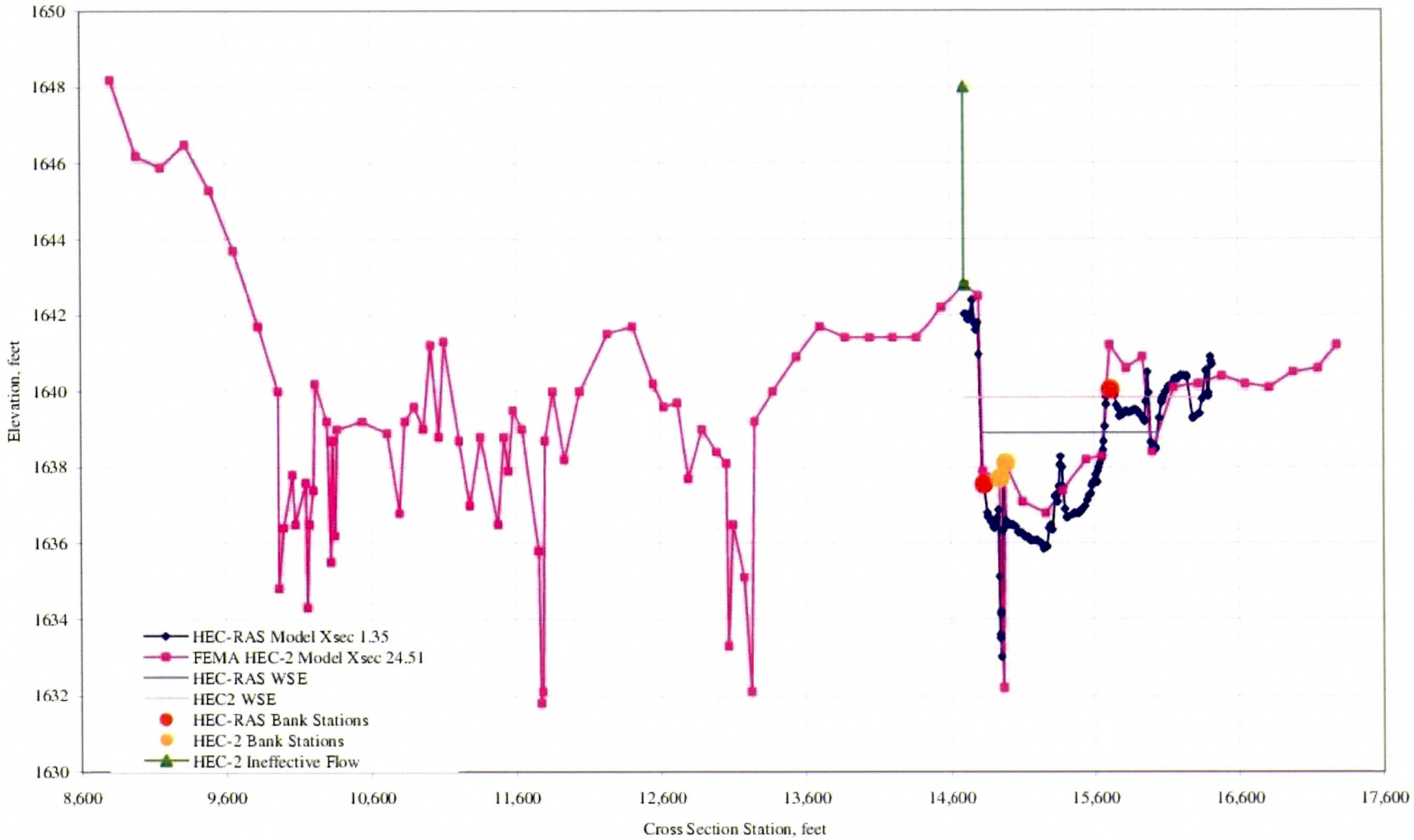


Figure 5.13 - Comparison of Geometry at West Split HEC-RAS Cross Section 1.35

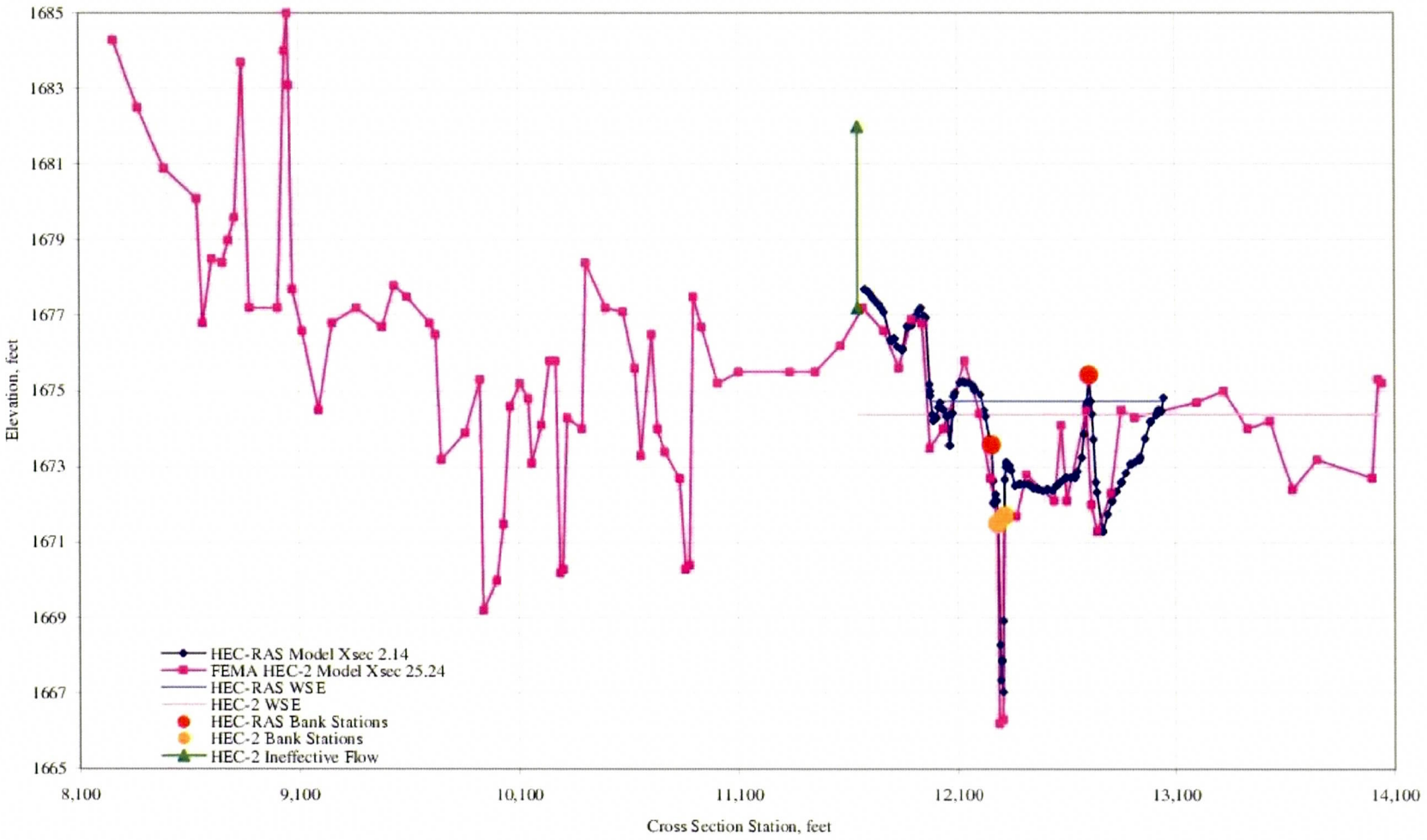


Figure 5.14 - Comparison of Geometry at West Split HEC-RAS Cross Section 2.14

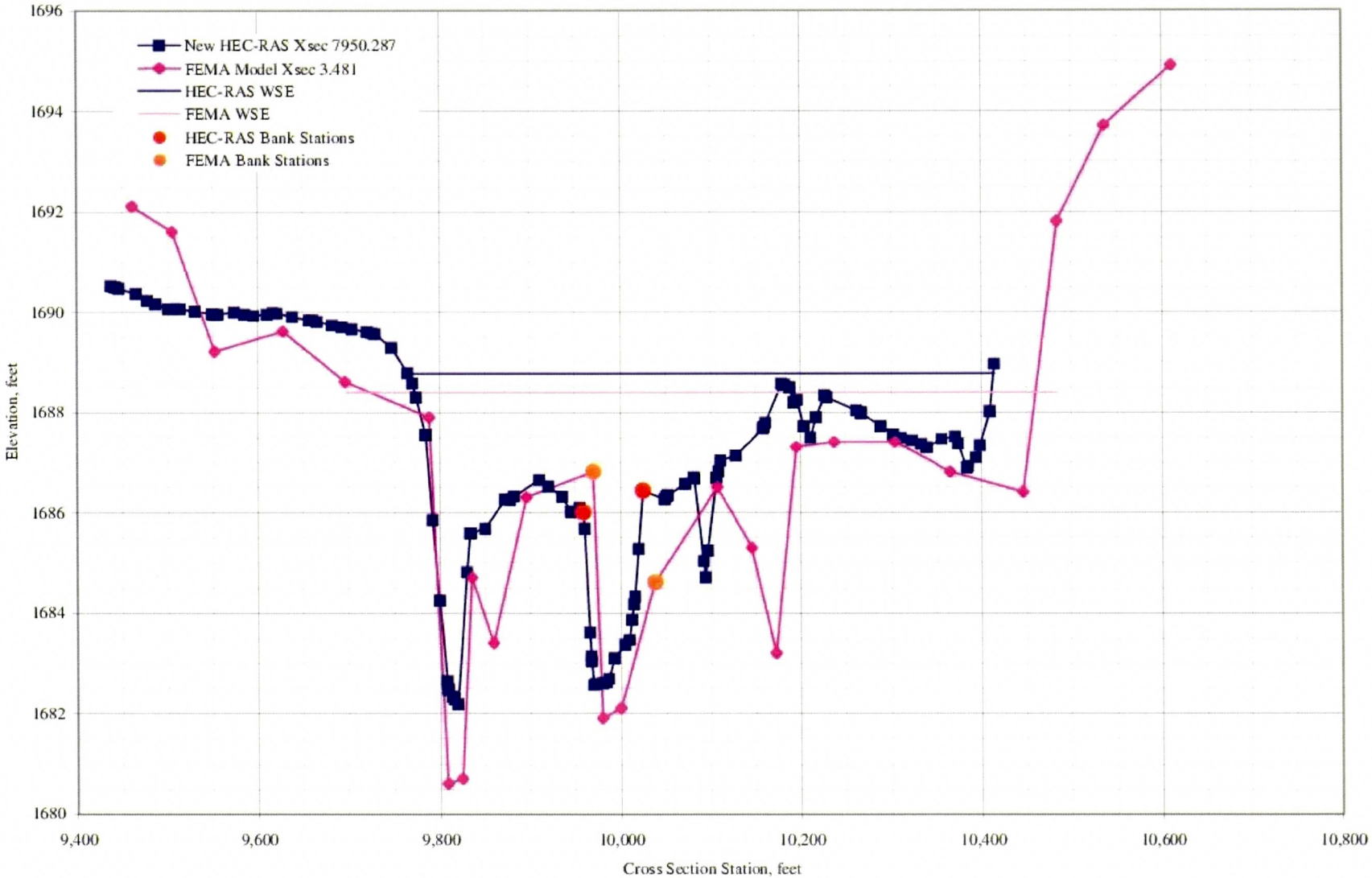


Figure 5.15 - Comparison of Geometry at Sweat Canyon HEC-RAS Cross Section 7950.287

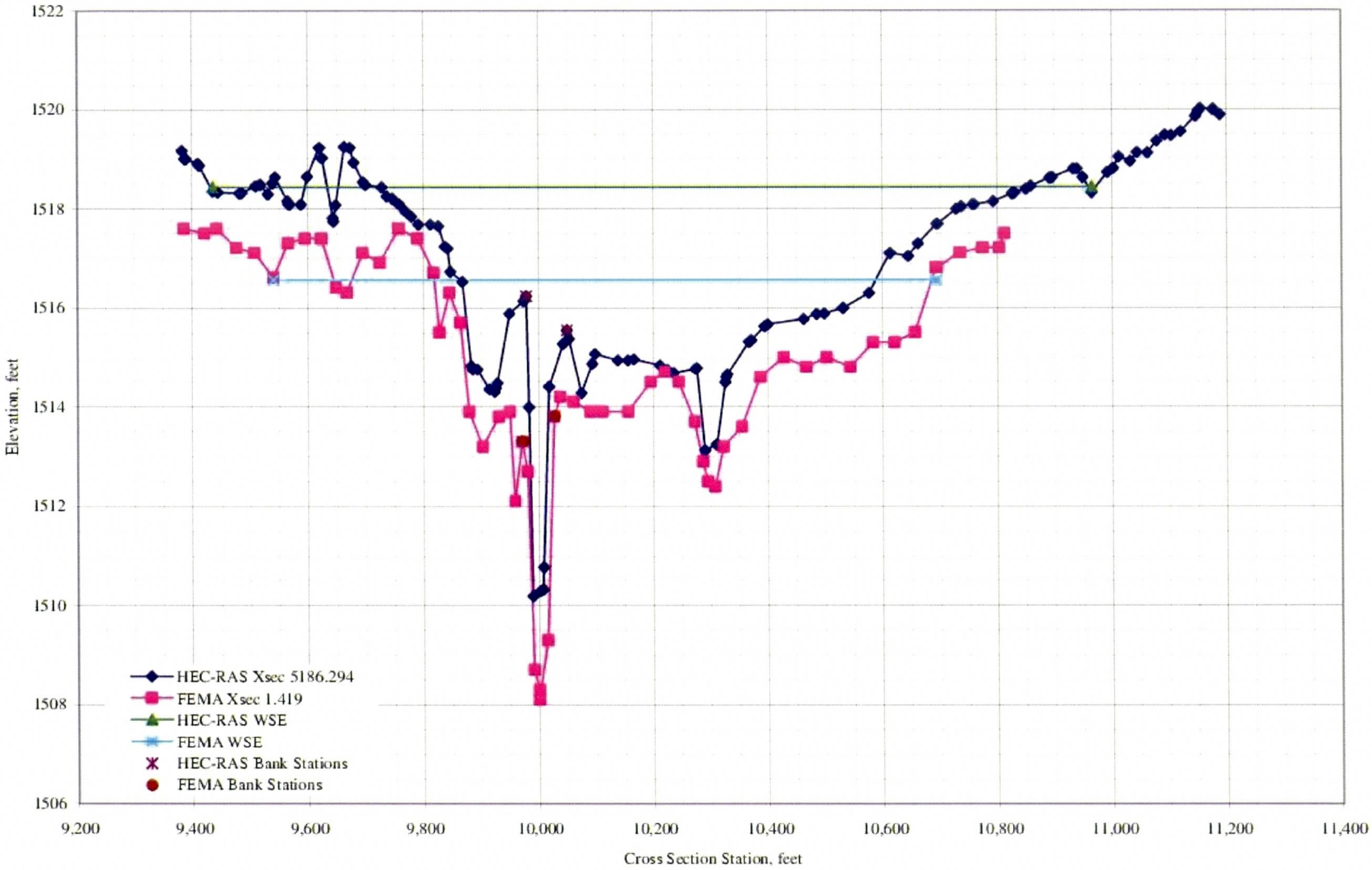


Figure 5.16 - Comparison of Geometry at Deadman Wash HEC-RAS Cross Section 5186.294

5.13 CONCLUSIONS

HEC-2 models for New River near I-17, Deadman Wash and Sweat Canyon Wash were converted to HEC-RAS. Structures, such as bridges and culverts were updated using as-built data or field survey. The models are provided on Hydraulics CD in Appendix A.

Updated HEC-RAS models of New River, West Split, Sweat Canyon and Deadman Wash were developed for the area from the New River Dam ponding limits to just downstream of I-17. The models include the following features.

- Abandoned sand and gravel pit on New River near RM 25.51
- Operating sand and gravel pit on New River near RM 29.15
- Abandoned sand and gravel pit on West Split near RM 2.24
- SR-74 Highway crossing for New River and Deadman Wash

Several split flow locations were encountered during the modeling and are summarized below.

- West Split – Starts at RM 28.27 and rejoins with New River near RM 24.11. A separate HEC-RAS model was created to model the area just downstream of the sand and gravel pit to the confluence with New River.
- East Split – Starts at New River RM 23.82 and rejoins near RM 22.76.
- A small split flow on New River just south of the sand and gravel pit near RM 25.51.

There are two major tributaries that enter the New River watercourse, Sweat Canyon and Deadman Wash. Sweat Canyon Wash enters the West Split near RM 1.18. Deadman Wash enters the New River near 21.31.

New detail topography provided by the District was used to develop the HEC-RAS models. Manning's roughness coefficients, bank stations and ineffective flow locations were updated for the model. Discharges and flow change locations were developed using the results of the hydrologic and two-dimensional modeling.

The results of the model were compared to the FEMA and the two-dimensional models and the results for the most part were found to be reasonable with the difference being due to physical changes in topography or revisions to peak discharge, however, in the vicinity of the SR-74 Highway, the HEC-RAS model results do not compare well with the two-dimensional model results. The HEC-RAS model results for New River main stem indicate that the 100-year peak discharge passes beneath the SR-74 Highway at the east and west bridge locations with the majority of the flow being contained in the channel that drains to the west bridge. The two-dimensional model results at that location indicate that the SR-74 Highway is overtopped and the floodplain limits are much wider. The HEC-RAS model can not model the complicated two-dimensional split flows that occur under existing conditions, however they can be used to evaluate alternatives that eliminate the split flow conditions confining flow to a single channel.

5.14 REFERENCES

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6 TWO-DIMENSIONAL HYDRAULIC ANALYSES

6.1 INTRODUCTION

A two-dimensional existing conditions hydraulic model was developed for a portion of the Upper New River and the West Split to study the flow dynamics at selected flow split locations and gravel/borrow mine pits within the Upper New River ADMP study area (Figure 6.1).

The physical characteristics of the Upper New River included areas of split flow, tributary flow, in-channel mine pits that were post-FIS, critical flow breakout locations, braids, perched channels, roadway crossings, CAP Canal siphon crossing, and the New River Dam pool area. These characteristics along with hydrograph timing issues made it necessary to develop a two-dimensional model. A one-dimensional HEC-RAS model, steady or unsteady state, would fail to capture the resolution that was necessary to identify the flood hazard zones. Given the significant interaction between the main channel and the adjacent terraces and the overbanks, FLO-2D was the software of choice. The following is a summary that justifies the two-dimensional modeling efforts over a one-dimensional HEC-RAS model:

1. While a one-dimensional HEC-RAS model is well accepted, and usually adequate for bank protection design, it generates constant water surface elevation across channel in both steady and unsteady state. A two-dimensional model however generates a realistic variable water surface elevation across channel. Such cross-channel variation in water surface elevation allowed for better representation of depth of flooding in the vicinity of the Carefree Highway Bridges where flow splits, mixing and distribution were noted due to the existing bathymetry. Notable was the elevation differential (upstream of the Carefree Highway Bridges) between the channel that goes under the East Bridge and the one that goes under the West Bridge. The channel that goes under the East Bridge was perched. Variable water surface elevation in such conditions typically helps with better estimation of local pier scour depth, and to hedge against over-protection of banks by limiting the toe-down depth.

2. The flow breakout from the Sweat Canyon Wash to the triangular pit (See Plate 6.1) in the West Split channel would be difficult to capture if not impossible using HEC-RAS. Given that the existing conditions at the location was not pre-determined, unless a HEC-RAS cross section cut line happened to fall in the vicinity of the breakout location, the breakout conditions could not have been captured. Similar conditions, if not as pronounced, existed just downstream of the linear pit constriction in the Upper New River Main stem where flow breakout occurs through two channels on the east overbank (See Plate 6.1). One of these two channels directs the flow toward the Deadman Wash. In its course, the flow overtops the Carefree Highway at east of the East Bridge.

3. The mine pits that went into the system since the FIS, introduced storage and peak attenuation issues for the ADMP study. Although HEC-RAS in unsteady mode

can tackle storage and peak attenuation, such a model would have to be over-simplified to just get it running with the pits in place. Stabilizing the simplified unsteady HEC-RAS model for the system would be a daunting task. Such simplification of model would cause loss of resolution required to capture the physical characteristics of the system and thereby the flow dynamics, not to mention the extended time it would take to project completion.

4. Flow conditions downstream of the Carefree Highway Bridges were distributary due to a braided channel. Flow interaction between channels in the braids was well captured by the two-dimensional models. A one-dimensional model would fail to provide a spatial distribution of flow depth under the braided conditions using a constant water surface elevation.

5. Previous routing studies of the Upper New River were approached using hydrologic routing method. The hydrologic routing method is a simplistic approach that involves the balancing of inflow, outflow and storage volume and is accomplished using a direct application of the continuity equation. This approach does not account for attenuation of the hydrograph peak discharge. Because of the nonlinear nature of a river system, movement of a flood wave cannot be accurately predicted using hydrologic routing methods. In addition, the distributive nature of the inflow results in complex hydraulic conditions with respect to time. The two-dimensional model allowed better understanding of the flow distribution, and helped identify hydraulic characteristics of the reaches that control the flow dynamics and thereby, the hydrology study area.

6.2 METHODOLOGY

The existing condition analysis involves routing of storm runoff through the Upper New River and the West Branch to the downstream model boundary just downstream of the SR-74 Highway Bridges. The analysis was performed for the 100-year, 24-hour storm using FLO-2D (2006.01).

FLO-2D is a volume conservation model that routes runoff hydrographs across a surface represented by a system of square grid elements. Routing of the runoff is accomplished using an explicit central finite difference algorithm that solves the dynamic wave momentum equation, and conservation of volume. Progression of the flood wave is controlled by topography, resistance to flow and the presence of hydraulic structures or obstructions. The general approach to the solution of the dynamic wave momentum equation using FLO-2D is as follows:

- Velocity is the dependent variable,
- Manning's equation is used to solve for an initial estimate of velocity,
- Estimated velocity is used as a first approximation in the Newton-Raphson second order method of tangents to solve for the roots of the dynamic wave momentum equation,

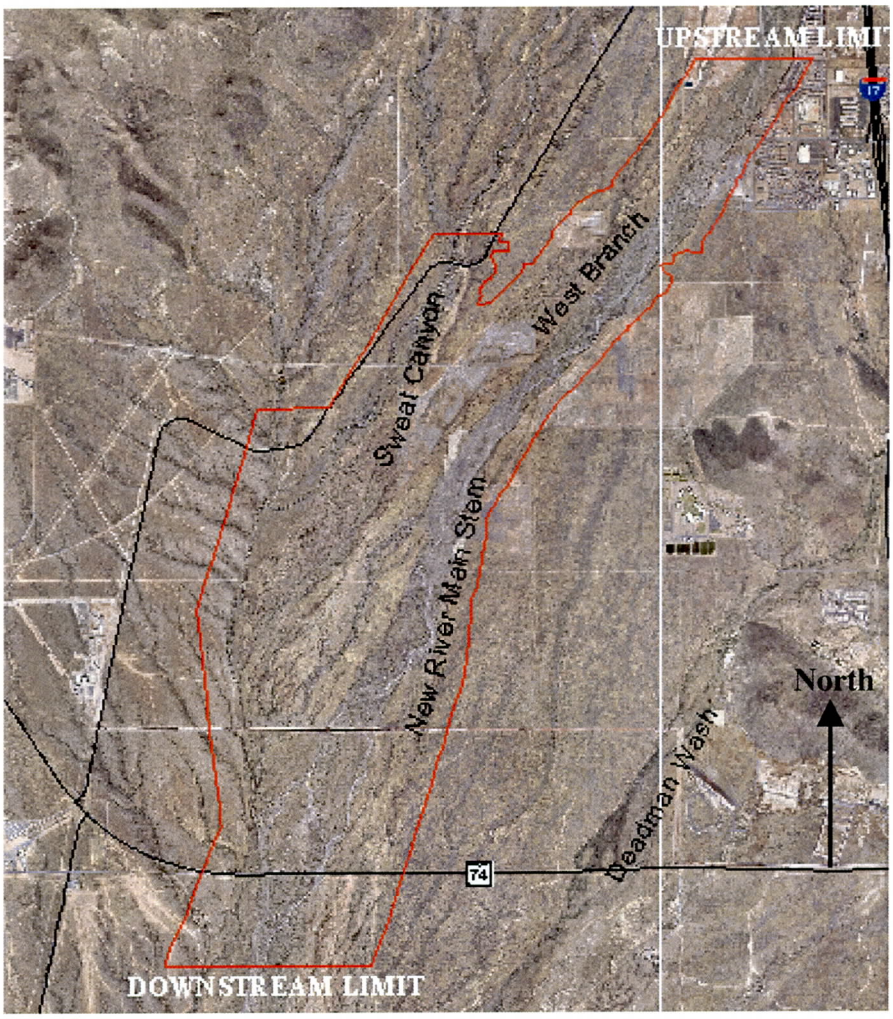


Figure 6.1 - FLO-2D model limits

- Discharge is calculated in the four principal directions (north, south, east and west) and the diagonals,
- The net change in volume is calculated as the product of the net change in discharge and the time step, and
- Change in depth is calculated by dividing the net change in volume with the surface area of the cell.

6.2.1 FLO-2D Grid Development

In FLO-2D, the ground surface is represented as a system of square grid elements. The downstream and the upstream model boundary for the Upper New River system extend from just downstream of the SR-74 Highway Bridges to approximately 1.5 miles downstream of the I-17 Bridges, respectively. The western limit of the model extends to the Sweat Canyon Wash. The upstream boundary within the Sweat Canyon Wash part of the model extends to just below the Sweat Canyon/Doe Peak Wash confluence.

Selection of the grid cell size is a function of the base mapping resolution, numerical stability and the perceived accuracy of the model. Detailed topographic mapping was obtained from the District. The District compiled new topographic data along with the existing topographic data to develop the current topographic mapping for the project area. Flight dates for the new topographic data is August 30 and 31, 2005. New topographic data is mapped at a scale of 1 inch = 200 feet at a 2-foot contour interval and at 1 inch = 400 feet at a 4-foot contour interval.

The FLO-2D grid was constructed using the Grid Developer System (GDS) provided with the FLO-2D software. The boundary grid elements constituting the outline of the FLO-2D system were defined after the GDS overlayed the grid on the limits of the Digital Terrain Model (DTM) points. Representative ground elevations for each grid element are assigned using the elevation interpolation routine of the GDS. A 50-foot cell size was used and agreed to by the District. Overlaying the FLO-2D grid on the DTM points and interpolating elevation points yielded a total of 102,771 elevation data points or a Digital Elevation Model (DEM). The grid was too fine to show in this report but can be accessed by opening the .TOP project file in the GDS, located in Appendix F.

A successful root mean square error analysis was conducted on the DEM by the District. This identified several boundary elements that were outside the DTM extent. The boundary elements were re-selected to avoid incorporating those illegitimate elements in the FLO-2D grid space. No local refinements of cell elevations were necessary.

6.2.2 Model Input

6.2.2.1 Control Parameters

The FLO-2D model was run in floodplain mode. Solution of the equations of motion using a central, finite difference scheme is limited to small time steps due to the stringent numerical stability criteria. Selection of the numerical stability criteria was a significant modeling issue for this analysis. Stability criteria and floodplain depth tolerance values are coded in the TOLER.DAT input file.

Control of the numerical stability criteria and thus the magnitude of the time step is accomplished in FLO-2D by the selection of a floodplain and channel depth tolerance, DEPTOL, a surface detention tolerance, TOL, and the maximum value of the numerical stability coefficient for dynamic wave routing, WAVEMAX. Guidance for the selection of the minimum time step and the user controlled numerical stability criteria is provided in the *FLO-2D User's Manual* (FLO-2D, 2006). The FLO-2D default values for DEPTOL, TOL and WAVEMAX are 0.2, 0.1 and 1.0, respectively.

Because of the mild channel slopes and storage conditions in the gravel/borrow mine pits, the key to a stable solution is a very small time step. Initially the model was run with the default values for the stability criteria. The time step is reduced by FLO-2D if DEPTOL is exceeded. Typically, WAVEMAX is reduced by the modeler to improve volume conservation or reduce surging. However, it is recommended that sensitivity to these two tolerance parameters be investigated by changing the value of one or the other of those two parameters but not both simultaneously (FLO-2D, 2006). Reducing the values of these tolerances did not show any notable difference in computational time or flow magnitude. Therefore, the default values are used in the model.

6.2.2.2 Roughness Coefficients

In FLO-2D, roughness coefficients are assigned to each grid element and are used in the solution of the Manning's equation for velocity as an initial estimate of the solution to the dynamic wave momentum equation. The base roughness coefficients for this study are those used for the one dimensional model development. The values in the Manning' n value polygons created in ArcGIS are directly read in by the GDS and assigned to the specific cells using a weighting scheme in FLO-2D. Selection of the base roughness coefficients accounted for vegetation, surface roughness/irregularities and flow path direction. FLO-2D can increase the base roughness values to account for steep slopes between adjacent cells to reduce flow velocity. Under floodplain mode, the ground resistance controls the flow dynamics. Therefore, FLO-2D steadily increased the base roughness values from the initial values ranging from 0.045 to 0.065 to a range of 0.070 to 0.100 in order to maintain numerical stability. A range of 0.070 to 0.100 is not too high because floodplain n values typically run from 0.125 to 0.4 (FLO-2D, 2006). Higher roughness coefficients are determined by FLO-2D at locations downstream of the linear pit, for example, in the Upper New River main stem where high velocity would otherwise lead to numerical instability. The final distribution of roughness coefficients used in the FLO-2D model is shown in Plate 6.3. The base roughness coefficient map is referenced to in the one-dimensional model development section of this report.

A limiting Froude number of 0.9 was used to prevent the flow regime from going supercritical. A shallow flow n-value of 0.2 is used. When flow depths are greater than 0.2 feet but less than 0.5 feet, the shallow overland flow n-value is decreased by 50 percent (FLO-2D, 2006).

6.2.2.3 Hydrographs

Hydrologic data inputs to the FLO-2D model are in the form of inflow hydrographs generated as part of this study and presented in a separate report. The time interval of the hydrographs in this study is 5 minutes. Grid cells used as inflow nodes were selected such that the distance to the maximum anticipated inundation limit was sufficient for the flow to fully expand, mimicking the distributive behavior of the inflow. Table 6.1 lists the location of the grid cells, grid cell numbers, the corresponding HEC-1 model concentration points (CPs), and the hydrograph peak discharges. The HEC-1 model concentrations points are also shown on the depth and velocity plan Plates 6.1 and 6.2, respectively. A total of 19 grid cells are used as inflow nodes for the 10 inflow hydrographs. The hydrograph at CP-160, inflow to the main stem of New River, is distributed over ten cells (cell numbers 43 through 52) to avoid instability problems associated with small cell size and large volume of water. The cell locations can be identified by opening the .TOP project file (included on the accompanying CD-ROM, Appendix F) in the GDS. Plots of the runoff hydrographs for a 100-year, 24-hour storm event at the HEC-1 concentration points are shown in Figure 6.2 a and b. Inflow hydrographs are coded into FLO-2D in the INFLOW.DAT input file.

Table 6.1
Hydrograph inflow locations and HEC-1 concentration points

River/Wash	Location	HEC-1 C.P.	FLO-2D Cell Number	Peak Discharge cfs
(1)	(2)	(3)	(4)	(5)
UNR	U/S Model Boundary	160	Distributed over cell numbers 43 through 52	28,950
Sweat Canyon	Downstream of Sweat Canyon and Doe Peak Wash Confluence	18	16069	14,940
West Tributary	West of Sweat Canyon	CD1	97906	1,110
West Tributary	West of Sweat Canyon	CE1	91231	450
West Tributary	West of Sweat Canyon	CF1	85943	490
West Tributary	West of Sweat Canyon	CG1	77894	230
West Tributary	West of Sweat Canyon	CH1	58091	440
West Tributary	West of Sweat Canyon	CI1	50189	370
West Tributary	West of Sweat Canyon	CJ1	46215	780
West Tributary	West of Sweat Canyon	CK2	38578	6,990

6.2.2.4 Area Reduction Factors

The two SR-74 Highway bridges crossing New River are modeled using Area Reduction Factor (ARF). ARF in FLO-2D is the percent of a grid element area that can not be covered by surface flows due to blockage created by man-made structures such as bridge abutments. For example, grid elements partially blocked by the SR-74 Highway Bridge abutments cannot store flow volume and are accounted for by the use of ARF values. The maximum allowable value for ARF is 0.95. An ARF value of 0.2 was estimated for the grid elements partially blocked by the SR-74 Highway Bridge abutments. This task was accomplished by locating the bridge abutments on the aerial photographs and measuring the approximate width of the abutments encroaching into the main channels. This left 80 percent of the grid elements under the bridges for flow volume storage. Table 6.2 lists the locations of the grid elements where the ARF factors were applied. The cells listed can be viewed by opening the .TOP project file in GDS. The ARFs were coded into FLO-2D in ARF.DAT input file.

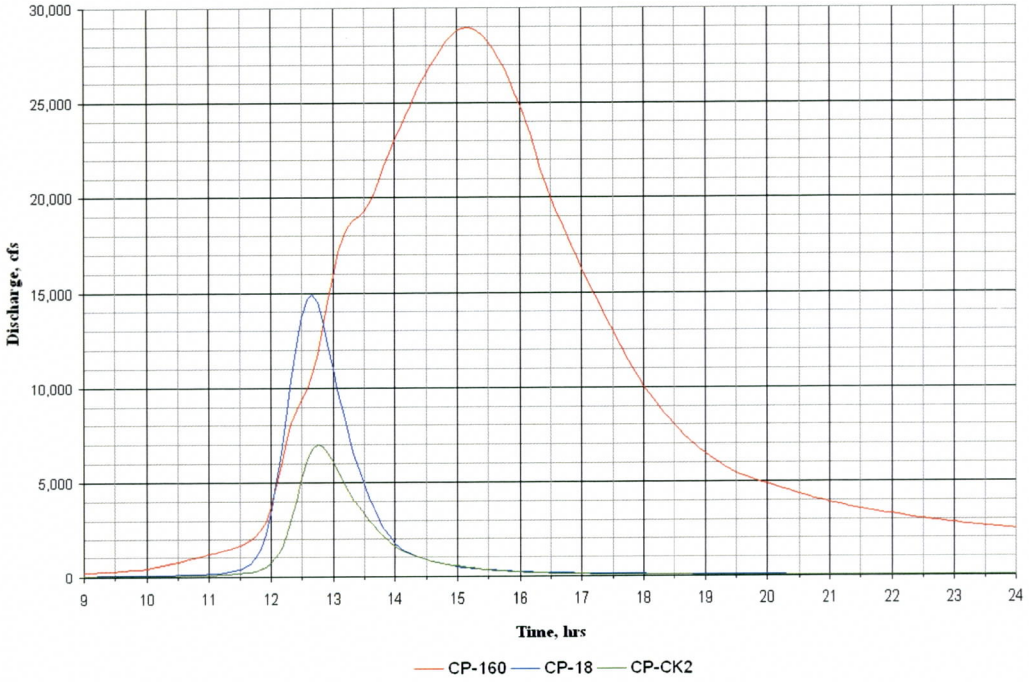


Figure 6.2 a - Inflow hydrographs at HEC-1 concentration points

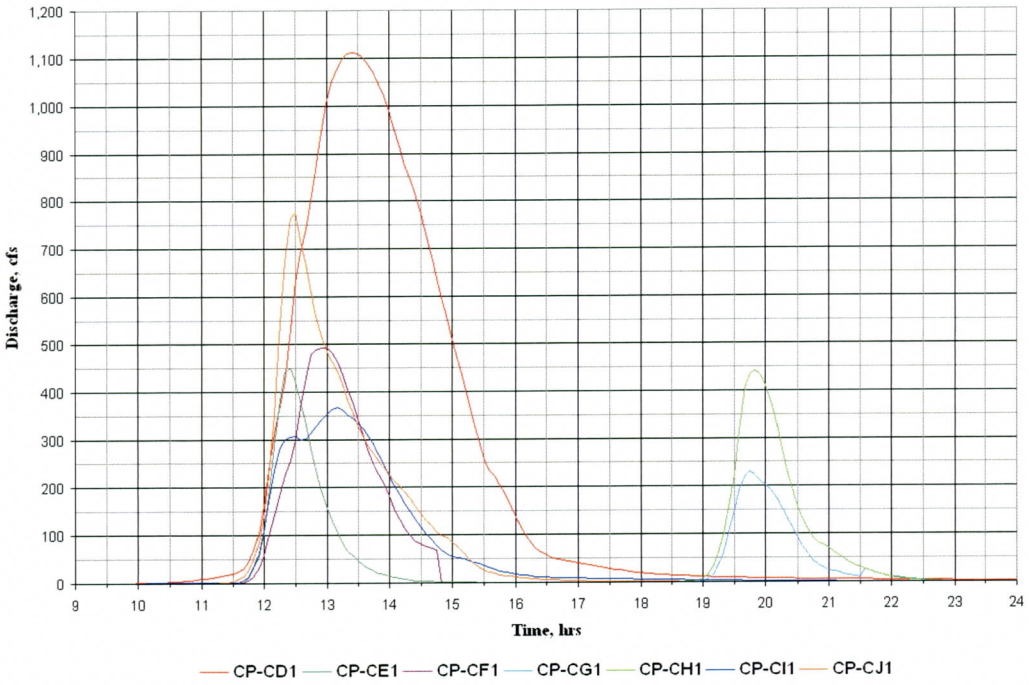


Figure 6.2 b - Inflow hydrographs at HEC-1 concentration points

Table 6.2
Area Reduction Factors (ARFs)

Location in Grid (1)	Location at Bridge (2)	Cell ID (3)	ARF (4)
Carefreee Highway West Bridge:	West abutment	93122	0.2
	East abutment	93128	0.2
Carefree Highway East Bridge:	West abutment; point 1	93016	0.2
	West abutment; point 2	93161	0.2
	East abutment; point 1	93023	0.2

6.2.2.5 Floodplain Cross Sections

In order to obtain information from the FLO-2D model on the split flow ratio and maximum discharges at particular locations of interest within the Upper New River main stem, the West Branch, and the Sweat Canyon Wash, it was necessary to code in floodplain cross sections. FLO-2D estimates the flow hydrographs and corresponding maximum discharges across these cross sections. A total of 12 floodplain cross sections were coded into FLO-2D in the FPXSEC.DAT input file. The location of the floodplain cross sections are shown on Plates 6.1 and 6.2, and those can also be visualized by opening the .TOP project file included on the enclosed CD-ROM (Appendix F).

6.3 RESULTS

The FLO-2D model was run for a model time of 22 hours which covers the time duration of all inflow hydrographs beyond the respective peak discharges. FLO-2D was prompted to generate output at a quarter of an hour interval. The major FLO-2D outputs of interest are the hydrographs and the corresponding maximum discharges across the floodplain cross sections. For visual inspection of flow depth and velocity distribution at peak discharges, depth and velocity output coverage are created in ArcGIS. FLO-2D saves the relevant output in three files; CROSSMAX.OUT, CROSSQ.OUT, and HYCROSS.OUT. The floodplain cross sections are chosen at the locations of potential flow splits, and in areas where knowledge of flow the distribution was necessary to assist with the one-dimensional HEC-RAS model development. The maximum discharges at the floodplain cross section locations are shown on Plates 6.1 and 6.2 with arrows, and are listed in Table 6.3. The output hydrographs at the floodplain cross sections are shown in Figures 6.3 a and b. The information at floodplain cross sections 1, 4, and 9 have been separated by flow splits or diversion locations. The flows shown with arrows on Plates 6.1 and 6.2 correspond to the floodplain cross section ID in Table 6.3. The hydrographs and the corresponding maximum discharges at the selected floodplain cross sections were used to fine tune the HEC-1 hydrologic, and the one-dimensional HEC-RAS hydraulic models. The hydrographs were also used in gravel/borrow pit headcut analysis.

The information on flow depth and velocity distribution was extracted from FLO-2D outputs by generating the FLO2DGIS.OUT file from the FLO-2D Mapper Post-processor. The output data was converted to ArcGIS readable database format before creating Triangular Irregular Networks (TINs) representing the depth and velocity coverage (Plates 6.1 and 6.2). Similar approach was followed to create the final FLO-2D Manning's n value coverage (Plate 6.3). The following is a brief discussion on the observation made on the depth, and velocity plans:

Table 6.3
Floodplain cross section locations and peak discharges

Section ID (1)	Location & Description (2)	Q peak cfs (3)
1a	UNR West Branch	4,700
1b	UNR Main Stem	24,040
1c	UNR Middle (Between two islands)	50
2	Constriction upstream of the triangular pit in UNR West Branch	4,900
3	Just downstream of the triangular pit in UNR West Branch	4,840
4a	Full section just downstream of gravel pit constriction in UNR Main Stem	23,900
4b	Breakout flow that flows into the Main Stem bend d/s of the gravel pit constriction	4,135
5	Breakout from the Sweat Canyon Wash to the triangular pit in UNR West Branch	6,600
6	Full section at Carefree Highway	28,130
7	Carefree Highway West Bridge	18,030
8	Carefree Highway East Bridge	8,000
9a	West breakout flow towards the East Bridge	1,825
9b	East breakout flow towards the Deadman Wash	1,630
10	Sweat Canyon Flow, 6,200 feet upstream of West Bridge	12,400
11	Sweat Canyon Flow, 2,800 feet downstream of the location where Sweat Canyon Flow spills into the triangular pit	7,590

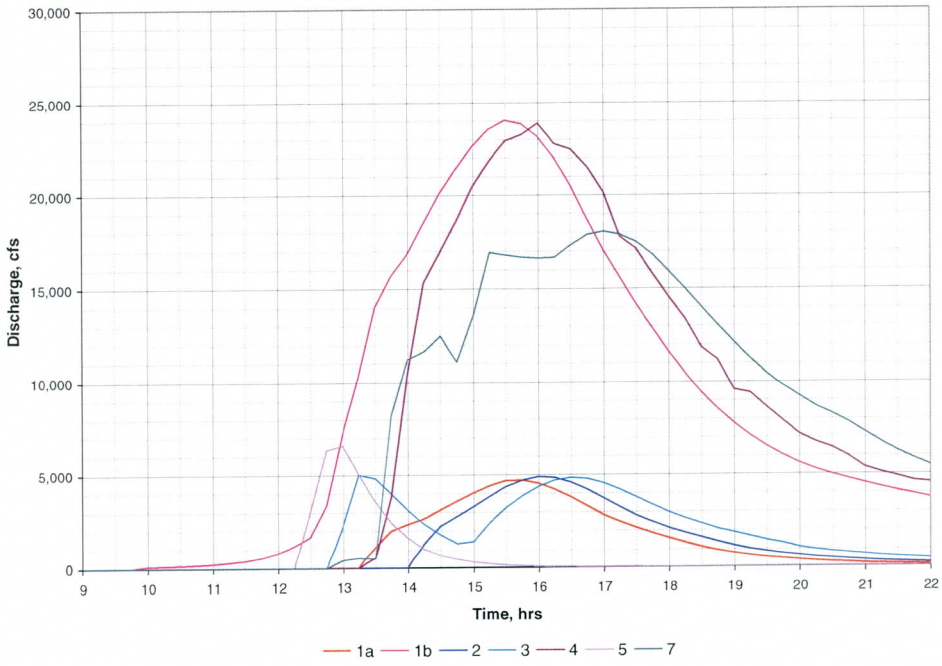


Figure 6.3a - Hydrographs at selected floodplain cross sections

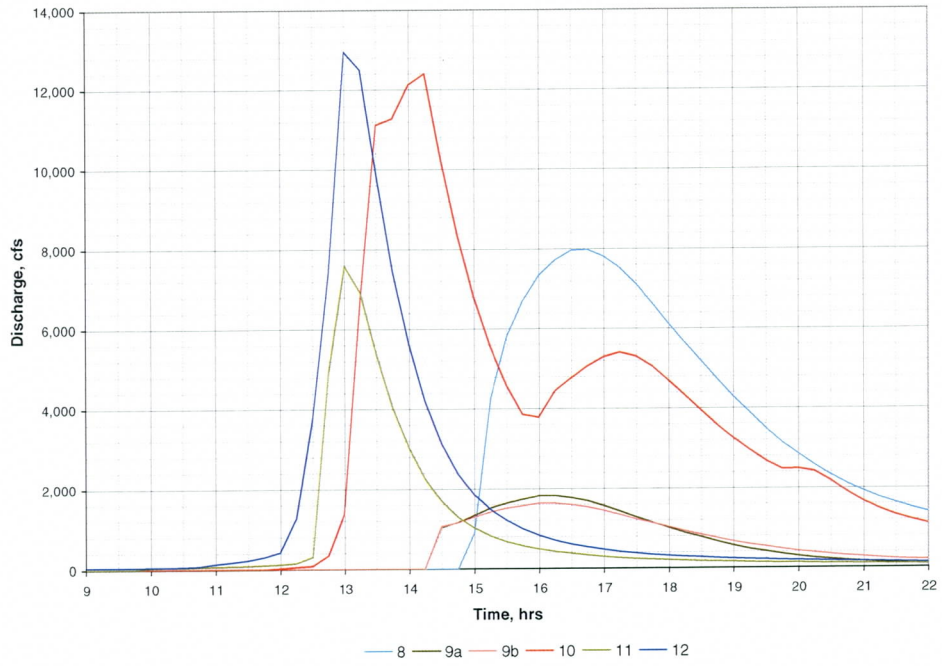


Figure 6.3b - Hydrographs at selected floodplain cross sections

6.3.1 Depth and Velocity Plans (Plates 6.1 and 6.2)

FLO-2D being a distributed parameter model, substantial information can be gathered from the depth coverage on backwater storage conditions in gravel/borrow pits, backwater condition upstream of bridges under design discharge, and floodplain flow limits. The velocity plan provides corresponding information on locations with potential for scour, deposition, and possible lateral bank migration. The combined study of these two plans helps identify the locations where in-depth design calculations should be considered to maintain the existing channel morphology, and protect riverine habitats, and any adjacent developments.

Study of the plans reveal that there are two major features that tend to control the flow dynamics within the Upper New River main stem. These are the flow split location to the West Branch, and the linear gravel pit just downstream from the split. Upstream of the west split flow location the flow is contained, depth is deep in most part, and the corresponding velocity high. At the split flow location with the West Branch, there are two distinct island features in the main stem that causes flow to split within the main channel. This causes the high velocity water from upstream to lose energy, and thus, some of the water simply spills over into the West Branch. At the farthest downstream point of the linear pit, there is a man-made wall, constructed perpendicular to the flow path, which constricts the flow to a 130-foot opening. This constriction causes backwater condition and storage in the lower 1,200 feet length of the pit behind the walls (Figure 6.4, and Plate 6.1). The maximum flow depth in the storage area upstream of the constriction is approximately 13 feet. This condition results in a delayed response in velocity distribution downstream of the pit (Plate 6.2). The flow attains a velocity of 8 to10 feet per second downstream of the pit (Figure 6.5, and Plate 6.1, constriction area).

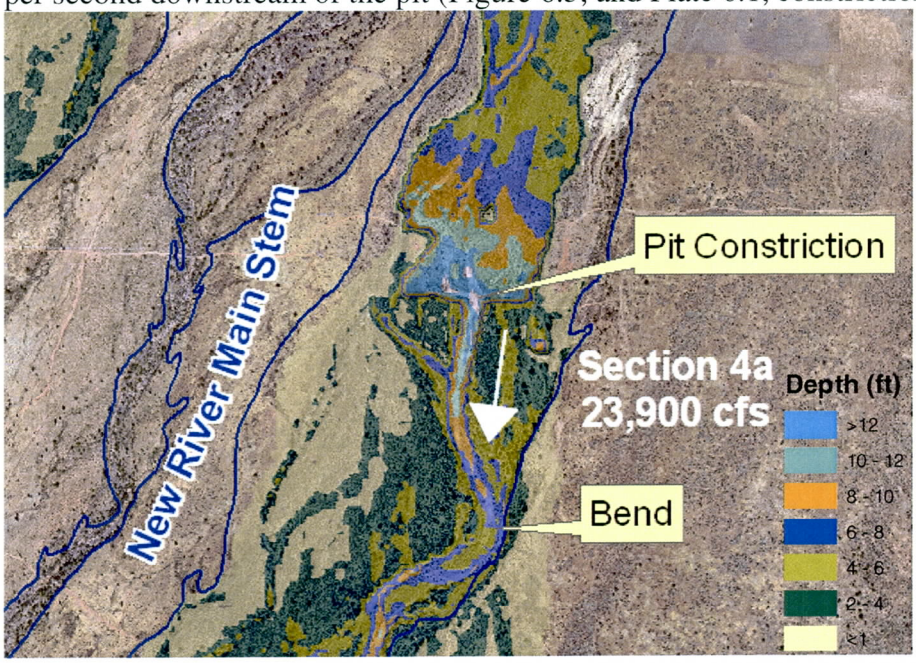


Figure 6.4 - Flow depth distribution at the linear gravel pit constriction

At the bend downstream of the pit, split flow directs water into two diversion channels (floodplain cross section 9 in Table 6.3). The west breakout flow is directed towards the

SR-74 Highway East Bridge at the rate of 1,825 cfs, and the east breakout flow is directed towards the Deadman Wash at the rate of 1,630 cfs (Figure 6.6, and Plate 6.2). These breakouts reduce the velocity farther downstream in the Upper New River main stem to 4 to 6 feet per second. Upstream of the SR-74 Highway Bridges, between the two bridges, the velocity drops to 2 to 4 feet per second. The corresponding depth is approximately 4 to 6 feet. The same condition prevails in the channel (Link Channel in Plates 6.1 and 6.2) linking the main stem with the Lower Sweat Canyon Wash where flow depth reduces further to 2 to 4 feet.

Both FLO-2D and HEC-RAS analyses support that the majority of the flow is conveyed by the channel under the West SR-74 Highway Bridge. The FLO-2D estimate of the flow under the West Bridge is 18,030 cfs whereas the flow under the East Bridge is only 8,000 cfs (sections 7 and 8 in Table 6.3). Flow depth at the West and the East Bridges

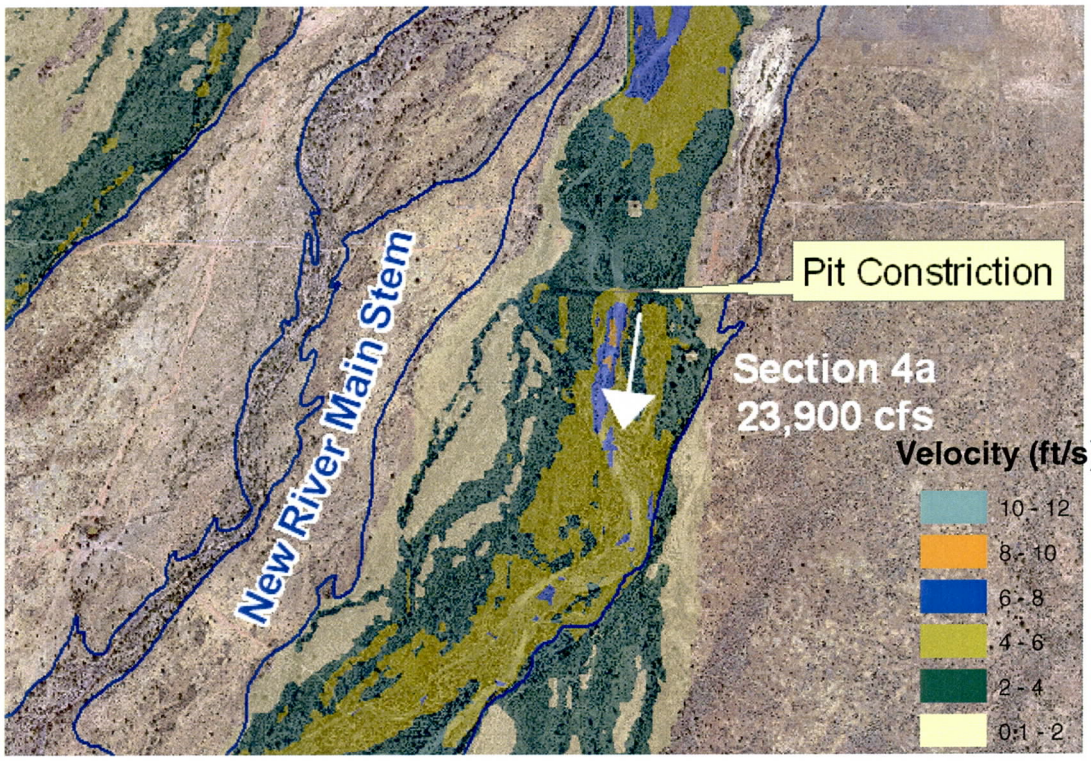


Figure 6.5 - Velocity distribution at the linear gravel pit constriction

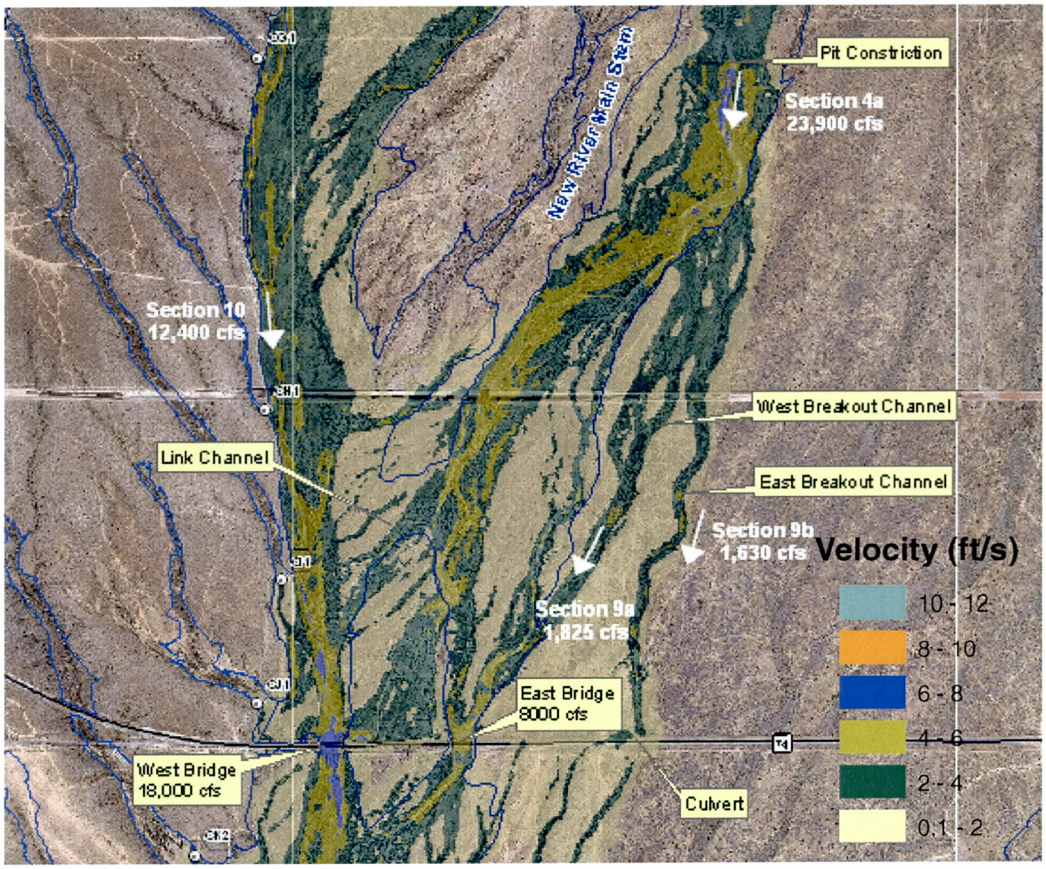


Figure 6.6 - Velocity distribution downstream of gravel pit constriction

are approximately 8 to 10, and 6 to 8 feet, respectively. The corresponding velocity range is approximately 6 to 8, and 4 to 6 feet per second. Upstream of the West Bridge, in the main channel that conveys combined Upper New River and Sweat Canyon Wash flow, the velocity range is approximately 4 to 8 feet per second. The flow depth in this reach varies spatially between 4 to 10 feet. Downstream of the bridges, high flow depth continues for a short distance before flow spreads out over a wider portion of the main stem.

The two major features in the West Branch of the Upper New River system are the two gravel/borrow mine pits called out on Plates 6.1 and 6.2. The upstream pit is linked to the triangular downstream pit via a 200-foot channel that conveys 4,900 cfs flow at 2-4 feet per second velocity, increasing to 8 to 10 feet per second at the entry to the main channel in the triangular pit. An interesting find from the FLO-2D model was the 6,600 cfs breakout flow from the Sweat Canyon Wash to the triangular pit (Plate 6.1). The flow depth in the link channel is shallow (2 to 4 feet) and velocity is high (6 to10 feet per second).

6.4 CONCLUSIONS

A two-dimensional FLO-2D model is developed and successfully executed as part of the Upper New River ADMP. The purpose of the model is to gain in-depth information on the flow distribution at the split flow locations, and other points of interest within the main stem and the West Branch. This information enabled fine tuning of the HEC-1

hydrologic model and helped setting the discharges in the one-dimensional HEC-RAS model. The two-dimensional model also helped identify the major features within the system that control the flow dynamics and thereby vertical stability of the main channels in the main stem, and the West Branch. In conjunction with the one-dimensional model, the two-dimensional flow depth coverage gave an in-depth view of flow distribution in the complex area upstream of the SR-74 Highway Bridges. Interesting channel morphology was revealed in the location where the Sweat Canyon Wash flow breaks out into the triangular pit in the West Branch. The backwater conditions in the major pits and corresponding flow dynamics downstream of these locations could also be ascertained from the two-dimensional model. Overall, the FLO-2D model was a success. The model results are of much higher resolution than what can be gained from an HEC-RAS model. The modeling assumptions are relevant for the area drainage master plan, and the results may be used in support of local design projects. More in-depth, localized models may be needed to make future planning decisions within the Upper New River or other planning areas in the vicinity.

6.4.1 Impacts to Land Use Plans

The FLO-2D model is developed for the existing land use conditions. The flow distribution covers a portion of the Upper New River main stem, the West Branch, and the Sweat Canyon Wash corridor. Almost all of the Upper New River and the Sweat Canyon Wash main stem part of the FLO-2D model are designated in the future land use plan as open space. The future land use type adjacent to the Upper New River main stem is designated as mixed use category. Portions of the land use coverage are observed to fall within the FLO-2D depth coverage. The results of the FLO-2D model indicate that, in some places, the floodplain is wider than the FEMA flooding limits (Plate 6.1), alternatively, in other places the FLO-2D results narrow or eliminate the FEMA flooding limits. If floodplain areas are to be designated as open space then the future land use plan should be revised. Alternatively, if future developments are to take place that significantly encroach on to the FLO-2D depth coverage, then localized engineering analysis should be conducted to determine the post-development depth of flow and FEMA zone designation. The same discussion is valid for the West Branch. If the West Branch is cut off from the Upper New River main stem, then the FLO-2D model should be revised to represent the correct flow distribution downstream of the existing flow split location in the main stem.

6.4.2 Impact to Transportation Plans

Typically, if a new roadway alignment encroaches into a channel, a detailed hydraulic analysis is warranted. This includes sedimentation engineering analyses to support embankment toe down depth estimation. Under existing conditions, FLO-2D results show more floodplain limit overlapping of SR-74 Highway than FEMA floodplains (Plate 6.1) Future roadway developments may require more detailed engineering analysis. Potential encroachments upstream should not undermine the safety of hydraulic and man-made infrastructures downstream. FLO-2D results also suggest potential for significant flow attenuation along New River. If encroachment is allowed, storage in the river can be reduced and travel times shortened, resulting in increased discharge and velocity. The FLO-2D model should only be used as a guideline for local transportation projects, and revised to represent post-developed conditions.

6.4.3 Significance Relative to Previous Studies

No other two-dimensional models of the study area exist. This modeling effort is a significant step towards providing cutting-edge engineering solutions in the study area. The model should be used in conjunction with the one-dimensional HEC-RAS model as a guideline for future design projects. The results of the FLO-2D model indicate that the floodplain is often wider than the FEMA flooding limits (Plate 6.1). If floodplain areas are to be designated as open space then the future land use plan should be revised. A significant find from the two-dimensional modeling is that the FLO-2D water surface limit extends beyond the FEMA floodplain limit at the SR-74 Highway East Bridge. The FLO-2D model results may supercede those based on the HEC-RAS model at critical locations in the Upper New River main stem, the West Branch, and the Sweat Canyon Wash. Those locations include but are not limited to the split flow locations, mine pit storage areas and vicinity, and the breakout flow location from the Sweat Canyon Wash to the triangular pit in the West Branch.

6.5 FLO-2D EXISTING CONDITION MODEL EXTENSION

The existing condition FLO-2D model (Phase-I FLO-2D Model from hereon) discussed in the preceding sections was extended downstream to the New River Dam pool area. This was necessary to let the full flow regime develop under the 100-year discharges, given the broad floodplain limit that was observed at the SR-74 Highway from the Phase-I FLO-2D model run. The FLO-2D model based floodplain limit east of the SR-74 Highway East Bridge extended outside the FEMA floodplain limit (Plate 6.1). Due to this wide east overbank flooding limit, terminating the model approximately 3,200 feet downstream of the SR-74 Highway did not allow for the full flow regime to develop further downstream. The proper solution to this scenario was to extend the downstream boundary of the model. It was therefore decided through discussions with the District that the Phase-I FLO-2D model be extended down to the New River Dam pool area. This was also useful for Alternative Analyses discussed in the Phase-II Alternative Evaluation section of this report.

6.5.1 Method of Model Extension

The following steps were implemented to extend the Phase-I FLO-2D model discussed in the preceding sections. Extension was accomplished by the creation of an entirely new model. The new model's upstream and downstream limits were the SR-74 Highway, and the New River Dam pool area approximately a mile downstream of the CAP Canal siphon crossing (Figure 6.7). This approach was used for the following reasons:

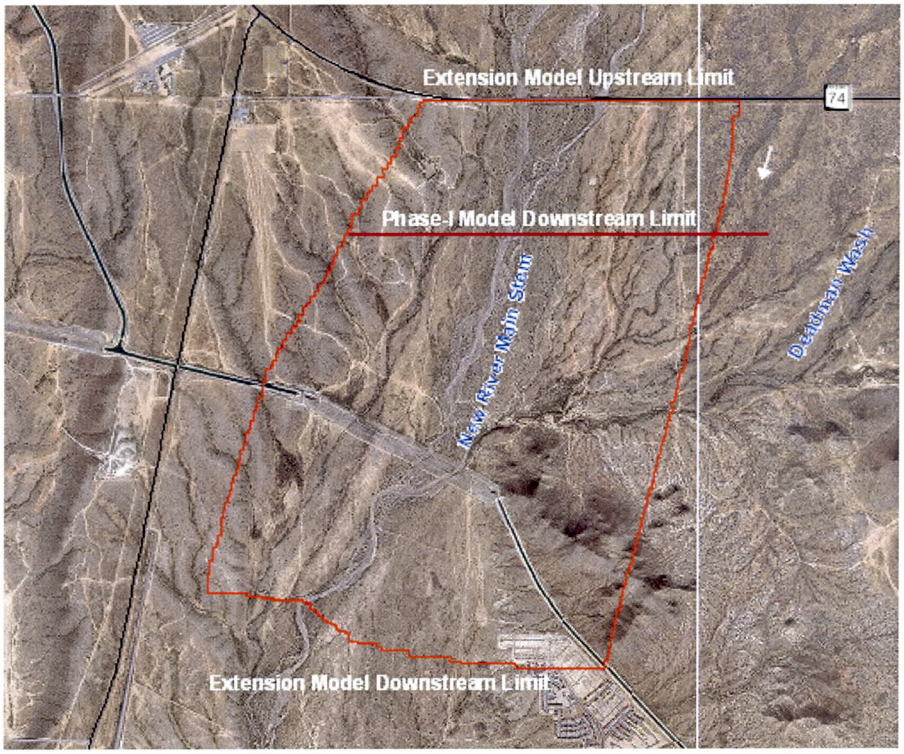


Figure 6.7 - FLO-2D Extension Model Limits

1. Rebuilding a new model of the entire study reach was not justified given the time it would take to complete the run. This would also interfere with the assumptions made in developing the Phase-I FLO-2D model discussed in the preceding sections. Adding cells downstream of an existing model requires very careful assignment of cell numbering to maintain proper connectivity. This type of manual numbering is potentially prone to error. These types of errors are very difficult to catch.

2. A 6,200 feet long floodplain cross section (Plates 6.1, and 6.2) was coded into the Phase-I FLO-2D model just downstream of the SR-74 Highway Bridges that covers the 100-year FLO-2D floodplain limits. The extension FLO-2D model starts at this location, and uses the FLO-2D generated hydrographs in each cell that make up the floodplain cross section. The choice of this upstream model boundary at the SR-74 Highway facilitated the alternative hydraulic analyses that used concentrated flows at the bridges and distribute downstream in a two-dimensional flow environment. Alternative hydraulic model development using FLO-2D is part of the Phase-II tasks under the Upper New River ADMP.

3. A total of 4 west tributary hydrographs were coded into the extension model besides the Deadman Wash hydrograph.

4. Just below the SR-74 Highway there was an overlap of results. The model was calibrated against Manning's n value and the cell elevations within 2,000 feet of the overlap area downstream of the SR-74 Highway Bridges to match hydraulic

parameters namely, depth and velocity between the Phase-I, and the extension model.

6.5.2 Extension Model Grid Development

The upstream and the downstream model boundary of the extension model extended from the SR-74 Highway Bridges to the New River Dam pool area approximately 2.5 miles downstream of the Highway. The CAP Canal siphon crossing is approximately 0.7 miles upstream of the downstream model boundary. The Phase-I FLO-2D model downstream boundary was located approximately 0.6 miles (3,200 feet) downstream of the SR-74 Highway Bridges and is shown in Figure 6.7, and in Plates 6.4 and 6.5 by a red line. The western and the eastern extension model boundaries were set so as to capture the hydrologic concentration points of the West Tributaries, and the Deadman Wash subwatersheds.

The extension model used the same topographic data used to develop the Phase-I FLO-2D model. The topographic data is mapped at a scale of 1 inch = 200 feet at a 2-foot contour interval and at 1 inch = 400 feet at a 4-foot contour interval. However, DTM points had to be regenerated for the extension model area since most of the extension area was not covered by the DTM produced to develop the existing condition model discussed in the preceding sections. The new DTM points were imported into the FLO-2D Grid Developer System (GDS).

The FLO-2D grid for the extension model was constructed using the FLO-2D GDS module. The upstream boundary cells were located by careful identification of the coordinates of the grid cells representing the 6,200 feet long floodplain cross section from the Phase-I FLO-2D model just downstream of the SR-74 Highway Bridges. Exact match in location coordinates was found for the starting cell at the top left corner of the extension model's upstream boundary. The cells were numbered sequentially (across channel) starting at this location. Given the south-westerly flow trend of the New River mainstem in this area, the downstream boundary alignment was set using engineering judgment to represent the expected variation in the water surface elevation. This required a gentle stair-cased boundary starting from the bottom right to the left corner. Results in Plate 6.4 (depth plan) show that such set up indeed helped capture the flow distribution in the southeast corner of the extension model, most of which tend to be ineffective and shallow.

The boundary grid elements constituting the outline of the Phase-I FLO-2D system were defined after overlaying the grid on the DTM points in GDS. Representative ground elevations for each grid element were assigned using the elevation interpolation routine of the GDS. Default FLO-2D interpolation parameters were used. A 50-foot cell size was used to be consistent with the Phase-I model. Overlaying the FLO-2D grid on the DTM points and interpolating elevation points yielded a total of 52,009 elevation data points or a Digital Elevation Model (DEM) points. The grid was too fine to show in this report but can be accessed by opening the .TOP project file for the extension model (provided in CD-ROM) in the GDS, located in Appendix F. Calibration of the cell elevations within the 2,000 feet overlap area mentioned under item 4 in Section 6.5.1 was conducted to achieve good comparison of depth and velocity with those from the Phase-I FLO-2D model. Detail discussion of the calibration effort is given in a latter section.

6.5.3 Model Input

6.5.3.1 Control Parameters

The extension model was run in floodplain mode using the same control parameters discussed in Section 6.2.2.1. The reader is referred to that section of this report for detailed discussion on the parameters controlling the model stability and accuracy.

6.5.3.2 Roughness Coefficients

The Manning's n value polygon coverage developed in ArcGIS for the Phase-I FLO-2D model was extended to the pool area to cover the limits of the extension model. Selection of the base roughness coefficients accounted for vegetation, surface roughness/irregularities and flow path direction. FLO-2D increased the base roughness values to account for steep slopes between adjacent cells to control flow velocity. FLO-2D steadily increased the base roughness values from the initial values ranging from 0.045 to 0.065 to an average range of 0.07 to 0.10 in order to maintain numerical stability. In the main stem of the New River, including the anabranches, the n value distribution predominantly varied from 0.06 to 0.075. Higher roughness coefficients of up to 0.23 were observed in the main channel downstream of the East Bridge, and in various other locations. Such increases are due to the model maintaining numerical stability as flow transitions into natural constrictions or steeply sloped sections. The final distribution of roughness coefficients used in the FLO-2D extension model is shown in Plate 6.6. Manning's n value calibration was performed within the 2,000 feet of the overlap area downstream of the SR-74 Highway. Calibration results are discussed in a latter section.

A limiting Froude number of 0.9 was used to prevent the flow regime from going supercritical. A shallow flow n value of 0.2 is used. When flow depths are greater than 0.2 feet but less than 0.5 feet, the shallow overland flow n-value was decreased by 50 percent (FLO-2D, 2006).

6.5.3.3 Hydrographs for the Extension Model

Hydrologic data input to the FLO-2D extension model were in the form of inflow hydrographs. Hydrographs were input at six locations at 15-minute (0.25-hour) time interval. It should be noted, the inflow hydrographs for the Phase-I FLO-2D model were set at 5-minute (0.083-hour) time interval. However, the output from the Phase-I model was generated at 15-minute time interval. That is why a time interval of 15 minute was chosen for the extension model input/output. The simulation time was 22 hours for consistency with the Phase-I model.

Among the six inflow locations in the extension model, the inflow at the upstream boundary came from output of the Phase-I FLO-2D model at the 124 cells (at 50-foot cell size) that make up the 6,200 feet long FLO-2D floodplain cross section just downstream of the SR-74 Highway Bridges. The majority of these cells carried zero flow since much of the flow was concentrated at the two bridges. Grid cells used along the 6,200 feet long floodplain cross section as inflow nodes were selected such that the distance to the maximum anticipated inundation limit was captured, mimicking the distributive flow conditions at the SR-74 Highway based on the Phase-I FLO-2D model (Plate 6.1).

Four hydrographs were input at the Upper New River West Tributary locations, and the fifth one, for the Deadman Wash subwatershed, was input roughly a mile upstream (in the Deadman Wash main channel) of the confluence with the New River. The Deadman Wash subwatershed hydrograph was input a mile upstream of the actual hydrologic concentration point to allow for the flow regime to fully develop. The Deadman Wash hydrograph was equally distributed over three cells to minimize numerical instability. Compared with the 11,770 cfs peak discharge for the Deadman Wash hydrograph, the peak discharges for the West Tributaries were low, in the order of 120 to 1,100 cfs.

Table 6.4 lists the location of the grid cells, grid cell numbers, the corresponding HEC-1 model concentration points (CPs), and the hydrograph peak discharges. The HEC-1 model concentrations points are also shown on the extension model depth and velocity plan Plates 6.4 and 6.5, respectively. The upstream boundary total inflow of 28,280 cfs is listed as distributed over the cell numbers 22 through 145, a total of 124 cells that make up the 6,200 feet long FLO-2D floodplain cross section. The cell locations can be identified by opening the .TOP project file of the extension model (included on the accompanying CD-ROM, Appendix F) in the GDS. Plots of the runoff hydrographs for a 100-year, 24-hour storm event at the West Tributaries are shown in Figure 6.8. The Deadman Wash subwatershed hydrograph is shown in Figure 6.9. Given that the upstream boundary inflow was distributed over the 124 cells that make up the 6,200 feet long floodplain cross section in the Phase-I model and that the majority of these cells carry zero flows, only the major inflow hydrographs at the cells representing the two bridge openings are shown in Figures 6.10 and 6.11. Figures 6.10 and 6.11 show the hydrograph time line at the bridges up to 22 hours because the Phase-I model, which was used to generate these hydrographs at the 6,200 feet floodplain cross section cells, was also run for 22 hours. The 22-hour simulation captured the peak discharges for all input hydrographs. Total flows at the West and East Bridges were 18,000 cfs and 8,000 cfs, respectively. The combined discharge at the two bridges was (18,000 + 8,000) or 26,000 cfs. All other cells along the floodplain cross section carry a combined discharge of (28,280 – 26,000) or 2,280 cfs. Inflow hydrographs were coded into FLO-2D in the INFLOW.DAT input file of the extension model.

Table 6.4
Extension model hydrograph inflow locations and HEC-1 concentration points

River/Wash	HEC-1 C.P. (or other)	Peak Discharge (cfs)
(1)	(2)	(3)
New River	N/A	28,280
Deadman Wash	C10Y	11,770
West Tributaries	CA1	120
West Tributaries	CB1	540
West Tributaries	CC1	330
West Tributaries	CD1	1,110

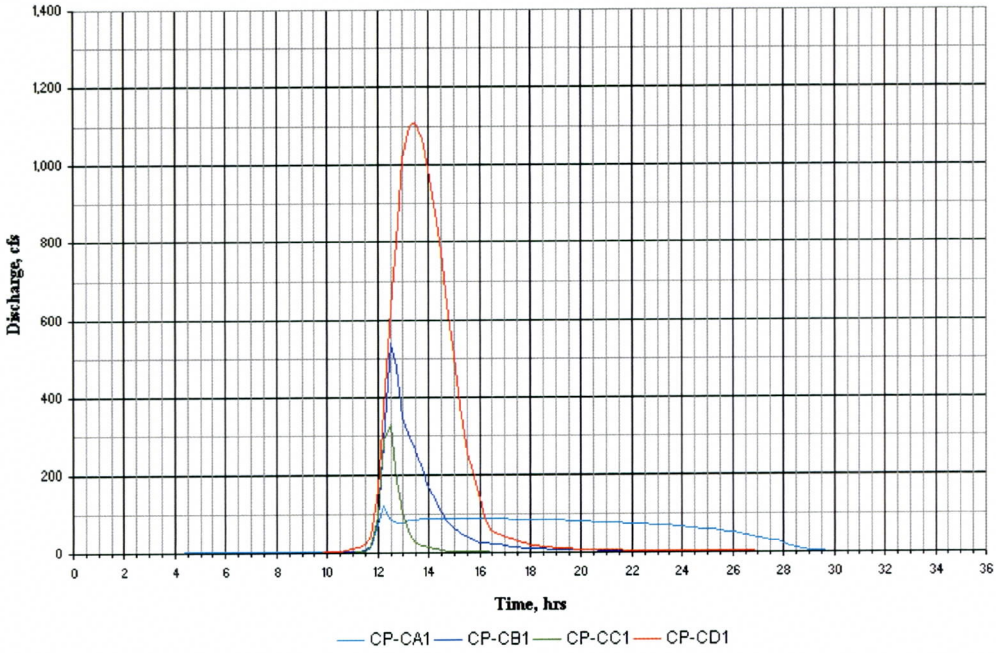


Figure 6.8 - West tributary inflow hydrographs at HEC-1 concentration points

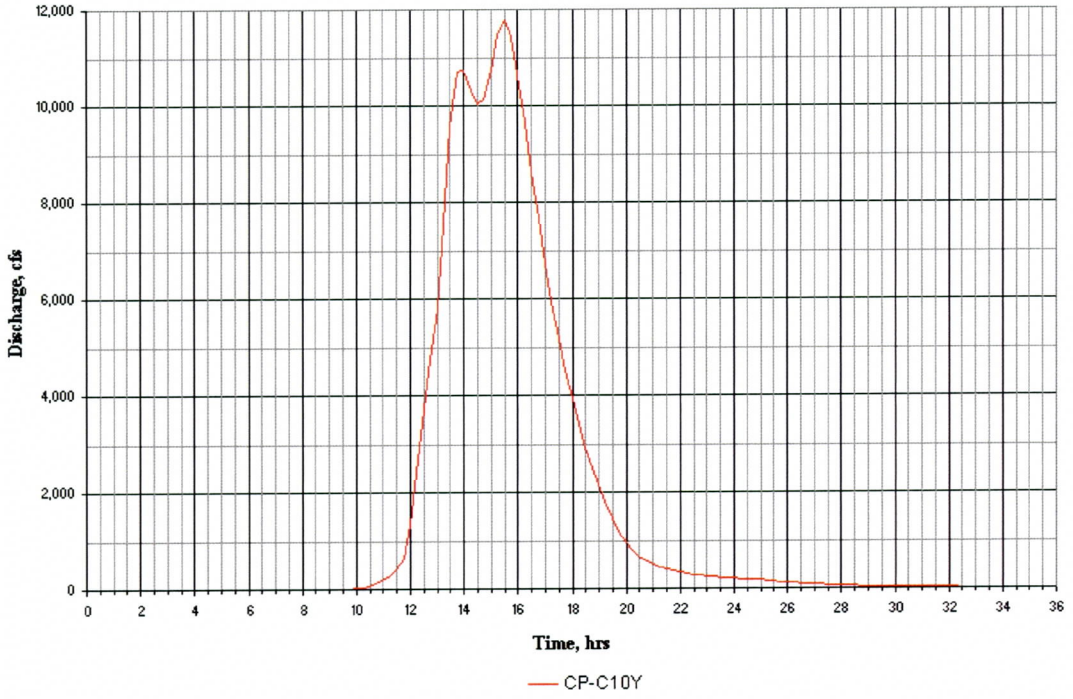


Figure 6.9 - Deadman Wash tributary inflow hydrograph at HEC-1 concentration point

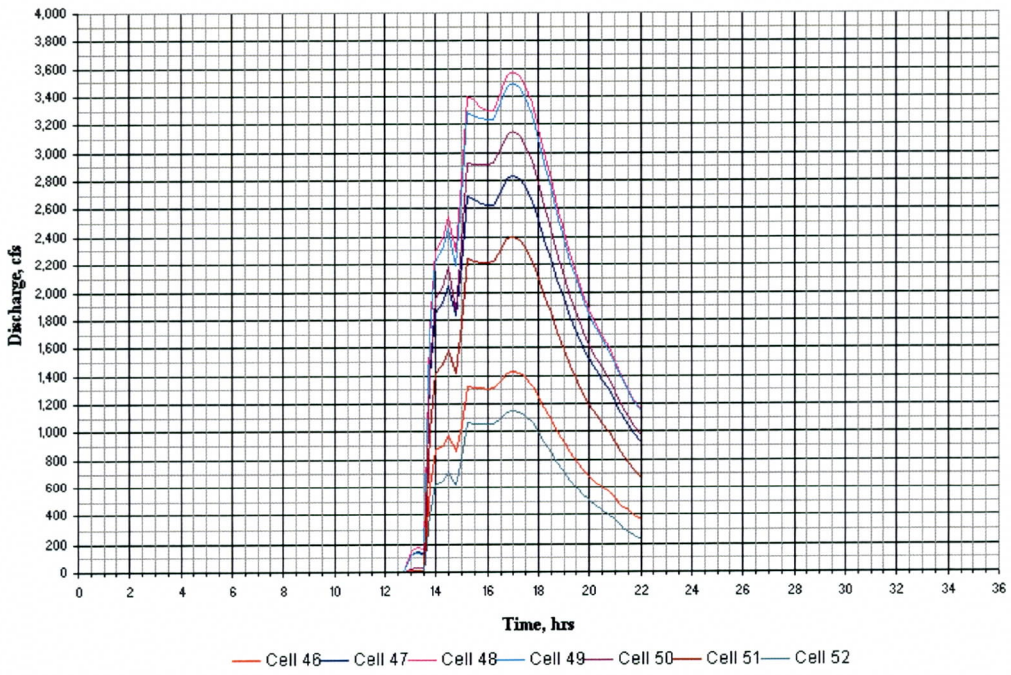


Figure 6.10 - FLO-2D cell inflow hydrographs at the SR-74 Highway West Bridge

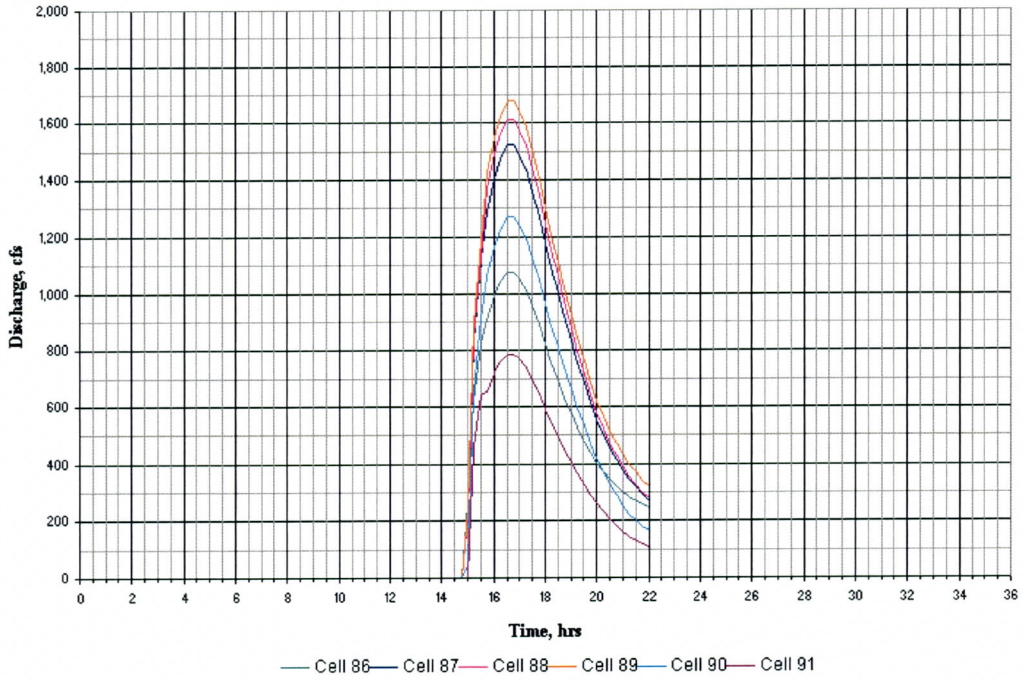


Figure 6.11 - FLO-2D cell inflow hydrographs at the SR-74 Highway East Bridge

6.5.3.4 Area Reduction Factors

In the Phase-I FLO-2D model, the two SR-74 Highway bridges crossing New River were modeled using Area Reduction Factor (ARF). The models referred to free flow conditions under the bridges requiring no use of structure replacement headwater rating tables in FLO-2D. The benefit of the use of the ARF factor was previously discussed in Section 6.2.2.4 of this report. Grid elements partially blocked by the SR-74 Highway Bridge abutments cannot store flow volume and are accounted for by the use of ARF values. An ARF value of 0.2 was estimated for the grid elements partially blocked by the SR-74 Highway Bridge abutments. This task was accomplished by locating the bridge abutments on the aerial photographs and measuring the approximate width of the abutments encroaching into the main channels. This left 80 percent of the grid elements under the bridges for flow volume storage. Table 6.5 lists the locations of the grid elements where the ARF factors were applied in the extension model. The cells listed can be viewed by opening the extension model .TOP project file in GDS. The ARFs were coded into FLO-2D in ARF.DAT input file.

Table 6.5
Extension model Area Reduction Factors (ARFs)

Location in Grid (1)	Location at Bridge (2)	Cell ID (3)	ARF (4)
SR-74 Highway West Bridge:	West abutment	46	0.2
	East abutment	52	0.2
SR-74 Highway East Bridge:	West abutment	85	0.2
	East abutment	92	0.2

6.5.4 Model Calibration

The extension model was calibrated within the overlap area that extends up to 2,000 feet downstream of the SR-74 Highway. The calibration was done against Manning's n values and cell elevations of the Phase-I FLO-2D model over a distance of 2,000 feet downstream of the Carefree Highway to match the hydraulic parameters namely, depth and velocity. Further downstream, calibration was not required as the observed depth and velocity compared within a tenth of a foot and a foot per second, respectively. Variation in Manning's n value downstream of the 2,000-foot calibration zone was in the order of 0.002. This nominal variation in the n value was noted in the channels. Since the upstream boundary of the extension model was at the SR-74 Highway with possible flow constriction at the bridge openings, reasonable discrepancy was noted in velocity over two cells at the West SR-74 Highway Bridge opening when compared with the existing condition model results. Figures 6.12 and 6.13 show the plots of depth and velocity over a distance of 800 feet downstream of the SR-74 Highway West Bridge. After the first 100 feet (with 50-foot cell size), the velocities matched within a tenth of a foot per second (Figure 6.13). The calibrated n values and cell elevations in the overlap area can be found in the FPLAIN.DAT file. The .TOP file, when opened in GDS, will show the original FLO-2D interpolated elevations. Model calibration results were discussed at the District on September 18, 2007. The existing condition extension model was approved by the District, with no comments, on October 23, 2007.

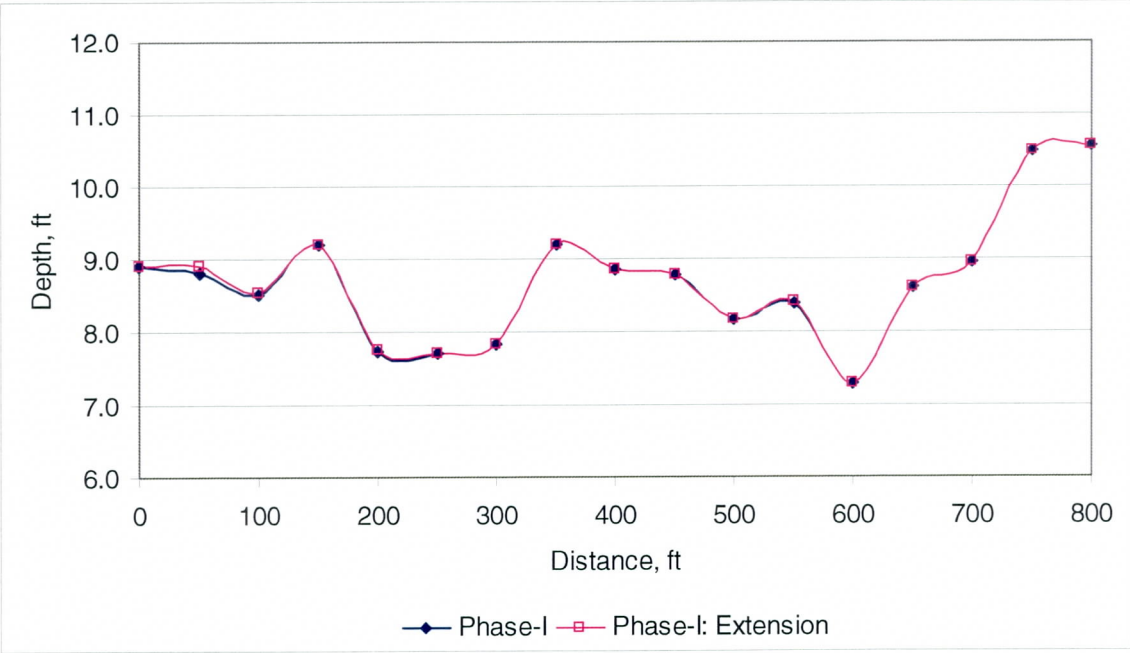


Figure 6.12 - Depth comparison up to 800 feet downstream of West Bridge

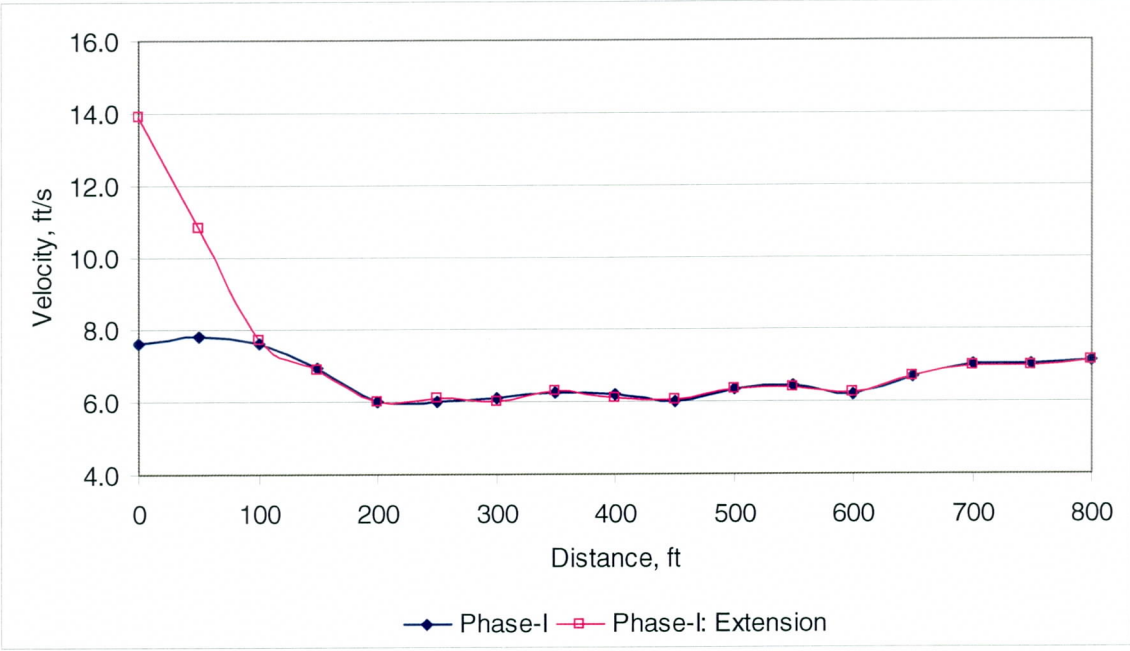


Figure 6.13 - Velocity comparison up to 800 feet downstream of West Bridge

6.5.5 Depth and Velocity Plans (Plates 6.4 and 6.5)

Model results of the depth and velocity distribution for the extension model were developed in ArcGIS and are presented in Plates 6.4 and 6.5. Also shown on the plots are the locations of the HEC-1 hydrologic concentration points, and the SR-74 Highway. The cell depth results were compared with the results from the Phase-I FLO-2D model.

At the SR-74 Highway, the FLO-2D generated floodplain limits were matched. This was an important observation validating model accuracy. The flow depth-range at the West and the East SR-74 Highway Bridges matched with that from the Phase-I FLO-2D model results: 8 to10 feet, and 6 to 8 feet, respectively. Post-calibration depth distribution closely matched between the SR-74 Highway and the Phase-I model downstream limit shown in red line (Plate 6.4, Figure 6.14). Below this limit, the braids of the New River main stem become evident. The main channel flow depth maintains a range of 6 to 8 feet for approximately 2,500 feet before dropping to a range of 4 to 6 feet up to the confluence with the Deadman Wash. Just upstream of the confluence with the Deadman Wash, the New River main channel splits and two of its anabranches flow across the CAP canal siphon crossing. Gentle meandering of the west anabranch is evident given the braided condition upstream of the split (Leopold et al., 1964). The east anabranch meets the Deadman Wash main channel at this location. The depth range remains within 6 to 8 feet in most part of the anabranches before they merge to form the main channel again downstream of the CAP Canal siphon crossing. Thereafter, the main channel shows gentle meandering with a main channel depth range of up to 10 to 12 feet. Downstream of the CAP Canal siphon crossing, gravity seems to push the water on the east bank where it gets distributed from 2 to 4 feet of depth to less than a foot in places (Plate 6.4, Figure 6.14).

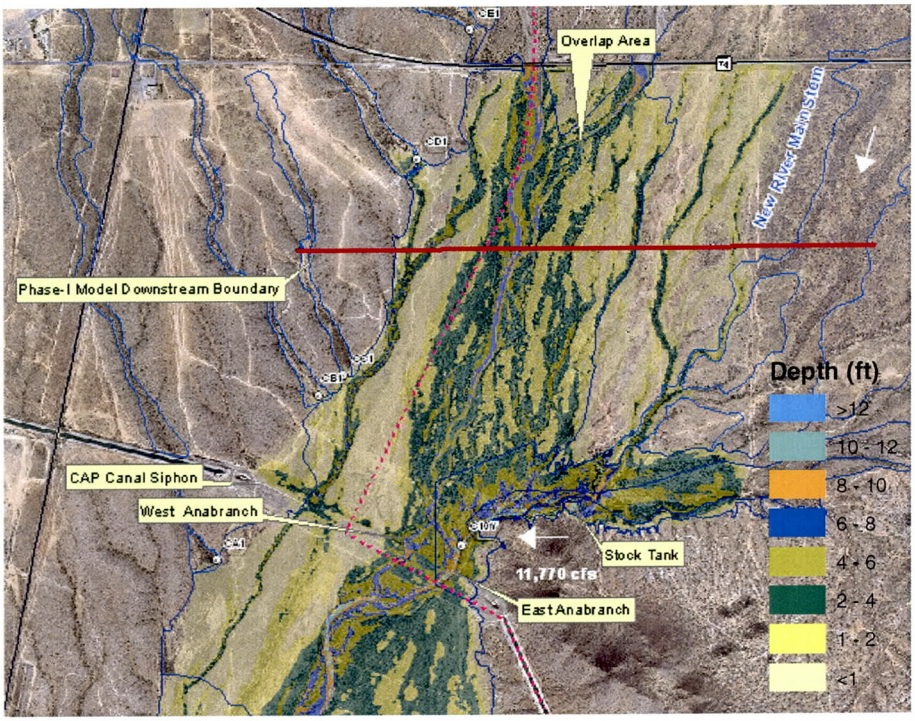


Figure 6.14 - Flow-depth distribution in the overlap area and downstream

A complex flow pattern was observed along the right bank (looking downstream) of the Deadman Wash just upstream of the confluence with the New River mainstem east anabranch. The flows from the New River braids and the east tributary to the Deadman Wash contribute to this complex flow distribution with depth ranging from 4 to 10 feet. The velocity however, remains in the range of 2 to 6 feet per second (Plate 6.5, Figure 6.15), referring to the slow-down of the water due to backwater conditions developed

upstream along the New River braids and the east tributary. A localized rise in velocity of roughly 8 to10 feet per second was noted at the existing stock tank (Plate 6.5).

The post-calibration velocity distribution also closely matched between the SR-74 Highway and the Phase-I model downstream limit shown. However, due to the fact that flows at the upstream boundary was input along the 6,200 feet long floodplain cross section at SR-74 Highway, and not at a location further upstream, the concentrated flow at the West Bridge caused some instability. This instability led to the mismatch in velocity for the first 100 feet of the New River reach downstream from the West Bridge, thereafter, the velocities matched to a tenth of a foot per second (Figure 6.13). No notable discrepancy in velocity was observed at the East Bridge or at areas downstream from it. Further downstream in the extension model, between the Phase-I model downstream boundary and the CAP Canal siphon crossing, the braids in the New River reduced the velocity distribution to a range of 2 to 4 feet per second on the overbanks and up to 6 to 8 feet per second in the main channel (Plate 6.5, Figure 6.15).

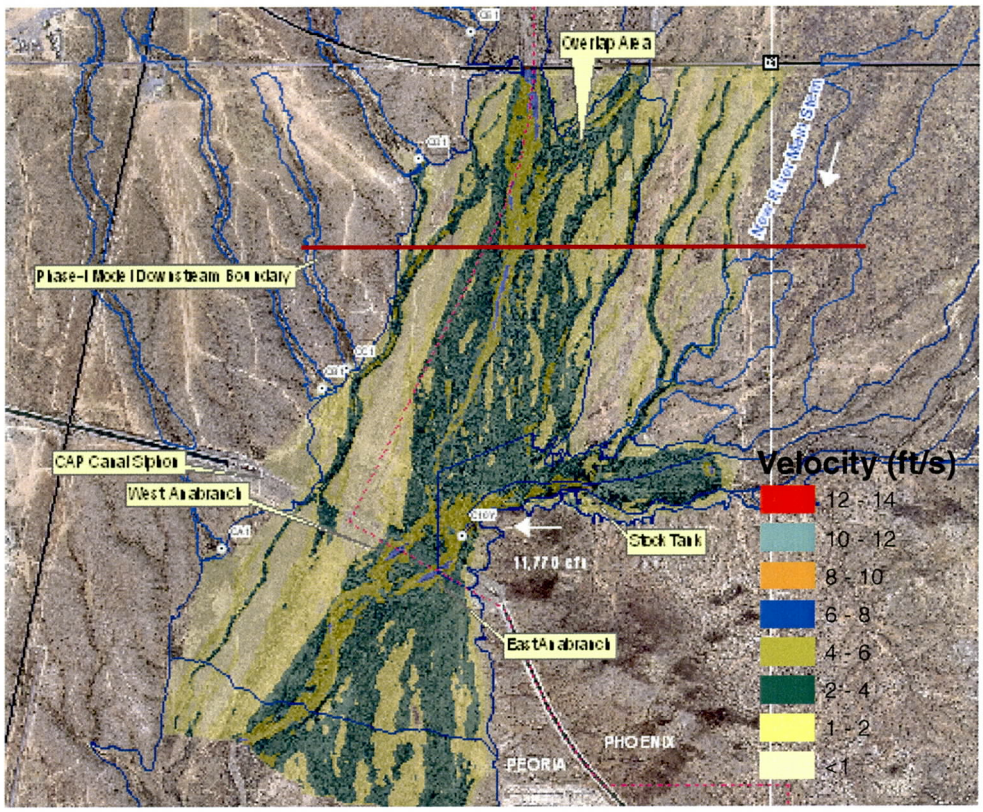


Figure 6.15 - Velocity distribution in the overlap area and downstream

At the confluence with Deadman Wash, and in the New River anabranches, velocity range was predominantly 4 to 6 feet per second. Localized velocity of up to 8 feet per second was predicted in the anabranches. Downstream of the CAP Canal siphon crossing, the gentle bends of the New River main channel lead to increased interaction of flow with the overbank areas. In-channel and adjacent velocity ranged from 4 to 6 feet per second with a reduced velocity range of 2 to 4 feet per second on the east bank (Plate 6.5, Figure 6.15). On the west bank, downstream of the CAP Canal siphon crossing, the velocity drops to less than a foot per second within the effective FEMA floodplain

boundary. At the downstream model limit, the New River main channel becomes naturally constricted with limited interaction with the adjacent floodplain. This constriction raises the channel velocity to approximately 10 feet per second. Therefore, the high velocity is not an anomaly rather the result of the downstream model boundary termination location chosen by the modeler. At the stock tank location in the Deadman Wash, upstream of the confluence with New River, a localized velocity increase of up to 10 feet per second was observed (Plate 6.5). This was expected given the sudden change in ground elevation due to the stock tank.

6.5.6 Merged Depth and Velocity Plans (Plates 6.7 and 6.8)

The depth and the velocity mapping from the Phase-I model, and the extension model were merged to produce full work maps (Plates 6.7 and 6.8). This was accomplished by adding the extension model's depth and flow distribution data, below the Phase-I model downstream boundary (shown in red in Plates 6.1 and 6.2), to that from the Phase-I model. In this process, depth and velocity data for the extension model area between the SR-74 Highway, and the Phase-I model downstream boundary was eliminated from the GIS database. Major features and flow conditions were shown on the merged map to get the full view of the existing condition flow distribution in two-dimension.

6.5.7 Conclusions

The Phase-I FLO-2D model for the Upper New River was successfully extended downstream to the New River Dam pool area. The tasks included the development of an entirely new extension model starting at the SR-74 Highway that uses flows across a FLO-2D floodplain cross section, calibration of the model against Manning's n value and grid cell elevations within the 2,000 feet overlap area downstream of the SR-74 Highway, and merging of the flow and depth distribution of the extension model with that from the Phase-I model. Pre-processing tasks included new DTM point data generation, extension of the Manning's n value polygons to the New River Dam pool area, and identification of inflow locations at the upstream extension model boundary, West Tributaries, and Deadman Wash. Calibration results showed localized discrepancy in velocity distribution at the SR-74 Highway West Bridge due to concentrated flow conditions. This issue was resolved through discussion with the District personnel. In depth discussion was presented in the preceding sections on the depth and velocity distribution patterns in the extension model area. The results from the Phase-I model and the extension model were merged to develop work maps showing the full FLO-2D study reach.

6.6 REFERENCES

FLO-2D, 2006.01, Flood Routing Software: Version 2004, FLO-2D Software, Inc., Nutrioso, AZ.

FLO-2D, 2006, *User's Manual*: Version 2006.01, FLO-2D Software, Inc., Nutrioso, AZ.

Leopold, L.B., Wolman, M.G., and Miller, J.P. 1964, *Fluvial Processes in Geomorphology*, Freeman and Company, San Francisco, CA.

7 SEDIMENT ENGINEERING ANALYSIS

7.1 INTRODUCTION

Currently, the Upper New River ADMP watershed and study area is mostly undeveloped and relatively pristine, undisturbed Sonoran Desert. It is anticipated that wide development interest within the project area will increase over the next 5 years. Generally, the opportune time to develop an Area Drainage Master Plan is before land development significantly affects or impacts the drainage characteristics of the watershed. Floodplain managers, planners, developers, and land owners can use and implement the Upper New River ADMP for planning and designing flood mitigation solutions and for guiding or regulating development that either affects drainage or is within the floodplain in the Upper New River watershed.

7.2 LOCATION

The study area includes the Upper New River and associated split flows, the Sweat Canyon Wash, the Doe Peak Wash and named tributaries, and the Deadman Wash (Figure 7.1). The area starts at the ponding limits of the New River Dam and extends to the Forest Service boundary. It includes the communities of City of Phoenix, City of Peoria, New River and unincorporated Maricopa County.

7.3 FIELD RECONNAISSANCE

Field reconnaissance trips were conducted on November 7, 2006, January 23 and 24, 2007, and March 15, 2007 by Stantec personnel to assess the general condition of study reaches, major flow splits, existing sand and gravel mine pits, and other features of interest such as bridges and culverts. Field photographs were taken of the main channels and the overbanks to document sediment characteristics, and inspect flood control and other structures within the river system. Bed material sampling locations were identified based on geomorphic conditions of the reaches, current aerial photographs, and information gathered on past flooding conditions from FEMA Flood Insurance Studies. Given the size distribution of the bed material, the majority of the sampling was conducted by pebble count. Figure 7.2 shows the sampling locations, and the corresponding mean sediment size (D_{50}) and the sample standard deviation in parentheses. Ten pebble count locations were selected within the Upper New River main stem between the CAP canal siphon crossing and the I-17 Bridges, six in the Sweat Canyon Wash, one in the Deadman Wash between the confluence with Upper New River and I-17 Bridges, and one in Doe Peak South Fork tributary. Pebble count analysis supports a range of bed material from coarse gravel to medium boulders for the Upper New River main stem, fine gravel to small boulders for the Sweat Canyon Wash, coarse gravel to large cobbles for the Deadman Wash, and coarse gravel to large cobbles for the Doe Peak South Fork tributary.

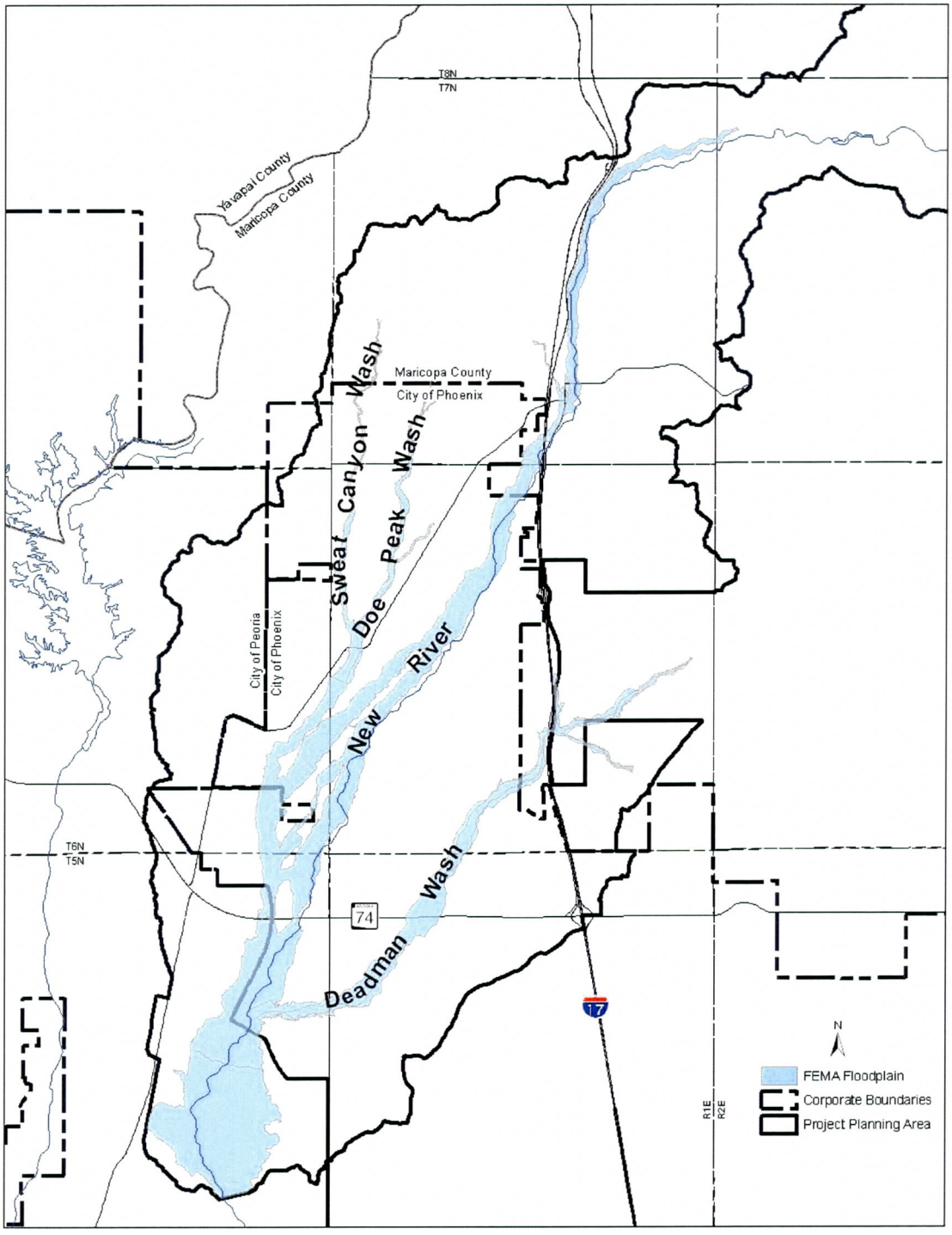
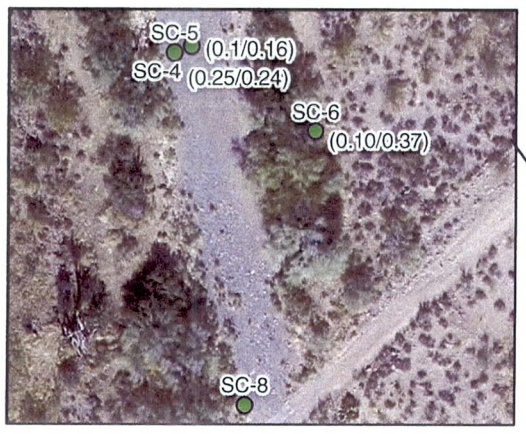


Figure 7.1 - Location map

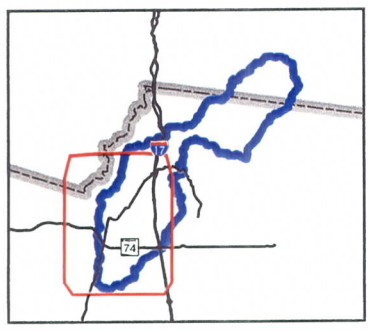


Sweat Canyon Wash
Doe Peak Wash
Doe Peak East Fork
Doe Peak South Fork
EF-1
(0.01/)
NR-10
(0.40/0.34)
SF-1
DP-1
(0.30/0.27)
(0.02/)
SC-5
SC-6
(0.02/)
SC-8
SC-3
(0.05/0.07)
NR-9
(0.25/0.26)
Borrow Pit
Split Flow Location
Gravel Pits
Linear Gravel Pit
NR-8
(0.27/0.50)
SC-2
SC-7
(0.10/0.30)
(0.02/)
New River Main Stem
Culvert
DM-4
(0.21/0.18)
SC-1
(0.15/0.21)
NR-7
(0.20/0.15)
Deadman Wash
W. Bridge
NR-5
NR-6
E. Bridge
NR-4
(0.22/0.25)
(0.15/0.12)
(0.45/0.22)
Culvert
Culvert
74
CAP Canal
(0.35/0.18)
NR-3
DM-1,2,3
NR-2
NR-1
(0.01/)(0.02/)(0.013/)
(0.14/0.22)
(0.40/0.22)

N

1" = 6000'

Location Map:



Notes:

Legend:

- Pebble Count Location
- FEMA_Floodplain
- Roadway

(0.40/0.22) D50 (ft)/Standard Deviation (ft)

Project No.
182000418

Prepared By:
IA
January 2008

W:\active\182000418\GIS\Project\11_17_pebble_counts.mxd

Flood Control District of Maricopa County
2801 W. Durango St.
Phoenix, AZ 85009

Upper New River ADMP
FCD 2005CO20

Figure 7.2: Sampling Locations

Stantec Consulting Inc.
8211 S. 48th Street
Phoenix, AZ U.S.A. 85044

In areas where fine bed material exists, samples were collected for sieve analysis. A total of seven bed samples were collected for sieve analysis. Among these, three were collected from the Deadman Wash lower reach where a foot of coarse sand deposit was observed due to flatter slope (compared with the upstream parts of the reach), two from Sweat Canyon Wash, one from Doe Peak Wash, and one from Doe Peak East Fork tributary. Sieve analysis of the samples supports a range of bed material size from very fine sand to large cobbles.

Field photographs presented in Appendix B document the physical characteristics of the washes evaluated at specific locations. Field photographs are identified by the bed material sampling location number. Detailed observation of channel and overbank vegetation pattern, and bed material characteristics for the Upper New River main stem, and the West Branch (including the Lower Sweat Canyon Wash reach) is recorded in the Manning's n value section for the Upper New River HEC-RAS hydraulic models description included in this report (Section 2.0).

Two key observations made within the Upper New River main stem are the flow split location (Figure 7.2), and two sand and gravel mine pits. Hydraulic analysis verifies that under existing conditions, approximately one-fifth of the main stem flow is diverted into the West Branch at the flow split location. Upstream of the flow split, a borrow pit was identified. Field investigation and aerial photo showed significant land disturbance in that area. Along the main stem thalweg, the borrow pit drops in elevation by as much as 17 feet. Just downstream of the borrow pit, at the split flow, three distinct islands are noted in the main stem. These islands are notable features in the two-dimensional modeling, showing split flow conditions within the main stem. Downstream of the flow split there is a linear gravel pit that is approximately 7,500 feet long. At the farthest downstream point, the man-made pit walls constrict the main channel to a 130 feet wide opening. This constriction plays an important role in two-dimensional modeling, showing delayed channel response in terms of velocity distribution downstream, given the storage of water upstream of the opening behind the pit walls.

The 2.7-mile length of the West Branch is characterized by large gravel pits with greater storage areas in the upstream end compared with the gently sloping, wide, triangular shaped downstream portion (Figure 7.2). The two pits are connected by a 200-foot wide low flow channel. The upstream pit was measured to be approximately 2020 feet wide by 850 feet long in the flow direction with an average depth of approximately 14 feet. No significant vegetation was observed within the upstream pit. The downstream triangular gravel pit surface material is mostly composed of coarse sand, desert shrubs and forbs. The existing banks of the river at these pit locations are gently sloping with desert shrubs, grasses, and forbs. The surface material is mostly firm soil.

Two bridges on the SR-74 Highway (Arizona Highway 74) cross New River. Figure 7.2 identifies the two bridges as the East and the West Bridge. These are reinforced concrete bridges with pre-stressed girder, 4-foot diameter piers with steel reinforced pier caps and deck. The field condition dictates possible backwater condition during high flow events. Evidence of such backwater condition was noted as coarse sand deposits upstream of the bridges. Some of this deposit extended downstream of the bridges, suggesting possible

fine sediment transport by multiple low flow events. The actual bed material, however, varied from very coarse gravel to large cobbles upstream of the bridges, and from very coarse gravel to small boulders downstream of the bridges.

Three culverts were identified (Figure 7.2) that conveys runoff under existing conditions. These culverts were rated using CulvertMaster by Bentley Systems. Two of these culverts are in Deadman Wash; one at the Prison Road crossing, and another at the SR-74 Highway crossing. The third one is just east of the East SR-74 Highway Bridge conveying part of the breakout flow from the Upper New River main stem.

7.4 METHODOLOGY

7.4.1 Introduction

The purpose of the sediment engineering analyses was to assess the existing condition vertical channel stability for the Upper New River, and its tributaries within the study area through field reconnaissance and engineering calculations per the District's guidelines. The specific tasks scoped for were channel bed armoring calculations including depth to armor estimation, assessment of long-term aggradation/degradation trend through equilibrium slope analysis, total scour estimation along the river miles, and headcut analysis at the sand and gravel mine pits that had significant storage capacity. Potential impact to land use, and transportation plans was assessed in addition to design considerations. The sediment engineering task was intended as a guideline on the river morphodynamics as it pertains to the regional hydrologic and hydraulic conditions.

An assessment of vertical channel stability was made for the study reaches by evaluating incipient motion parameters and determining armoring potential, equilibrium slope, total scour, and headcut analysis at the mining pits in gravel-bed channels. The definition of incipient motion is based on the critical or threshold conditions where hydrodynamic forces acting on a grain of sediment have reached a value that, if increased even slightly, will move the grain. Under critical conditions, or at the point of incipient motion, the hydrodynamic forces acting on the grain are just balanced by the resisting forces of the particle. For given hydrodynamic forces, or equivalently for a given discharge, incipient motion conditions will exist for a single particle size. Particles smaller than this will be transported downstream and particles equal to or larger than this will remain in place. Since the degradation is measured from the thalweg elevation, focus is given on the low flow channel under dominant discharge. In the arid southern Arizona, the 10-year event peak discharge is typically taken as the dominant discharge for ephemeral channels (FCDMC, 2007a). It is the frequent low flow event that transports the majority of the bed material, given that they are transportable.

The vertical stability analyses typically consists of (1) armoring critical bed material size determination, (2) equilibrium slope determination to assess if the channel bed is vulnerable to long term aggradation or degradation, and (3) total scour, which is a summation of several scour component. A brief description of the methods is given below:

7.4.2 Armoring

The initial step in analyzing channel bed degradation should consider the potential for armoring. There are number of ways to compute the size of bed material (D_c) required for armoring and each method is regarded as a check on the others (Pemberton and Lara, 1984). The D_{90} or D_{95} size of representative bed material is frequently found to be "paving the channel" when degradation is arrested. Therefore, armoring is probable when computed incipient motion size (D_c) is equal to or smaller than the D_{95} size. The following methods were used in the Upper New River Study per the District's recommendation:

Meyer-Peter, Muller (Bedload Transport Equation)

The bedload transport equation of Meyer-Peter, Muller provides a method to compute the armoring size representing the coarse bed material. Given the nature of bed material size distribution in the Upper New River and tributary reaches, this method was one of the two preferred choices. The Meyer-Peter, Muller equation is written in the form:

$$D_c = \frac{dS}{K\left(\frac{n_s}{D_{90}^{1/6}}\right)^{3/2}} \qquad (7.1)$$

where:

D_c = Individual particle size in millimeters (armoring bed material size)

K = 0.19 (inch-pound units)

d = Mean water depth at dominant discharge, ft

S = Slope of energy gradient, ft/ft

n_s = Manning's *n* for stream bed

D_{90} = Particle size in millimeter at which 90 percent of bed material by weight is finer

Shield's Diagram

An alternative to the Meyer-Peter, Muller method is the use of Shield's diagram (Pemberton and Lara, 1984). For armoring of streambeds with predominantly gravel size material greater than 1.0 mm in size, and Reynold's number greater than 500, the Shield's parameter provides a method to determine armor size:

$$T_* = \frac{T_c}{(\gamma_s - \gamma_w)D_c} = 0.06 \qquad (7.2)$$

where:

T_* = Dimensionless shear stress

T_c = Critical shear stress = γ_w dS, lb/ft^2

γ_s = Specific weight of the particle, lb/ft^3

γ_w = Specific weight of water, lb/ft^3

d = Average (hydraulic) depth, ft

D_c = Diameter of particle, ft

The depth of degradation required to form the armor layer can be computed using the following equation:

$$Y_s = Y_a [(1/P_c) - 1] \quad (7.3)$$

where:

Y_s = Depth of degradation or scour required to form an armor layer, ft (or, the depth of armor)

Y_a = thickness of the armor layer, ft

P_c = percent of material coarser than the critical particle size expressed as a decimal fraction; if $D_c = D_{90}$, then $P_c = 0.10$

The thickness of the armor layer ranges from one to three times the armoring bed material size, D_c. A minimum of two times the critical size is required for a relatively stable armor layer (Lagasse, et al, 2001).

7.4.3 Equilibrium Slope

Equilibrium slope is the bed slope at which the sediment transporting capacity of a channel is equal to the incoming sediment supply. Equilibrium slope equations provide a useful order-of-magnitude assessment of the likelihood of vertical channel adjustment. Since an undisturbed channel will tend towards equilibrium over the long term, this procedure assists in determining long term aggradation/degradation trend of a channel bed.

The iterative procedure described in the Arizona Department of Water Resources' Design Manual for Engineering Analysis of Fluvial Systems (ADWR, 1985) was used in this study to compute the equilibrium slope for the existing conditions. Following is a summary of the equilibrium slope procedure as outlined in ADWR (1985):

1. Select upstream equilibrium supply reach and obtain the following data:
    a. channel geometry
    b. channel slope
    c. sediment size distribution
    d. channel resistance (Manning's *n*)

2. Determine the dominant discharge. The 10-year event peak discharge is taken as the dominant discharge for the reaches under this study.
3. Divide the segment of the rivers system(s) under analysis into separate reaches of similar hydraulic characteristics, and identify any control points.
4. Obtain the same information as in Step 1 for each downstream sub-reach to be analyzed.
5. Select the appropriate sediment transport equation.
6. Establish the sediment supply provided by the upstream supply reach. This rate will be the sediment supply for all downstream sub-reaches unless significant tributary flow is encountered downstream of the supply reach. An equilibrium condition is assumed in the supply reach i.e., the sediment supply will equal the transport capacity of the supply reach.
7. Compute the sediment transport rate for each of the downstream sub-reaches by varying the bed slope through each reach until a transport rate is found which matches the sediment supply. This establishes an equilibrium slope for each reach.
8. Compare the equilibrium bed slope with the existing condition bed slope to assess whether the sub-reaches will tend toward long term aggradation or degradation.
9. If any control or hard points are identified, pivot the equilibrium slopes about the control points to determine potential long-term bed adjustment. No such control points were identified in the Upper New River main stem, and its tributaries or the diversion channels.

Selection of Sediment Transport Equation

Given the nature of the bed material distribution in the Upper New River study reaches, care was taken to identify the most appropriate transport equation presented in ADWR (1985). Among these equations are: (1) the Meyer-Peter Muller total bed load transport equation (Equation 5.7a in ADWR, 1985) that was derived from experimentation with sand, and gravel bed material with little or no suspended load, (2) the empirical power relationship equation (Equation 5.8a in ADWR, 1985), and (3) Colby's equation (Equation 5.9, ADWR, 1985). The last two equations were derived for sand-bed channels, and were considered inappropriate for the Upper New River and its tributary study reaches. Therefore, the Meyer-Peter Muller equation was used:

$$q_b = [12.85/(\sqrt{\rho}\ \gamma_s)]\ (\tau_o - \tau_c)^{1.5} \qquad (7.4)$$

where:

q_b = Bed-load transport rate in cubic feet per second per foot width

τ_o = The tractive force (boundary shear stress) = γ_w RS, lb/ft^2

τ_c = Critical tractive force = 0.047 D_c ($\gamma_s - \gamma_w$), lb/ft^2

ρ = Density of water = 1.94 lb-sec^2/ft^4

R = Hydraulic Radius, ft

Due to the plane bed assumption in its derivation, the above equation is not recommended if dunes or antidunes are expected. No such bedform was evident in the Upper New River and its tributary study reaches during field reconnaissance trips.

7.4.4 Total Scour

Total scour, at river miles along the study reaches, was estimated based on the guidelines presented in the Flood Control District of Maricopa County, Drainage Design Manual (Hydraulics) Sedimentation Chapter Draft Manuscript (FCDMC, 2007a). The total scour estimation included the following component scour:

1. General scour
2. Contraction scour
3. Bend scour
4. Local scour at bridge piers, and culvert outlets
5. Low-flow incisement scour
6. Long-term scour
7. Bedform scour

The total scour, Z_t, is the sum of each of these individual scour components, Z_i, and can be expressed as:

$$Z_t = FS\ (Z_{general} + Z_{contraction} + Z_{bend} + Z_{local} + Z_{low\text{-}flow} + Z_{long\text{-}term} + Z_{bedform}) \qquad (7.5)$$

Where *FS* is a factor of safety, the magnitude of which depends on the purpose of the total scour estimation. An FS = 1.3 is typically used for design of toe-down for bank protection. Higher FS = 1.5 may be justified where underestimation of scour could cause catastrophic failure leading to loss of lives or property damage. The local scour FS may be less than 1.3 under special conditions such as bridge pier scour when debris width is taken into account (FCDMC, 2007a). It should be noted that not all the components are expected to contribute at the same time in the nature due to uncertainty. A brief description of estimation methods and underlying assumptions for each of the above scour components is given below.

1. General Scour

The general scour component due to passage of a design flood (e.g., the 100-year flood) is estimated by the empirical regime equations (Type A & B) of the Bureau of Reclamation (Pemberton and Lara, 1984) per the District's revised guidelines (FCDMC 2007a). These are the Neill equation, the Lacey equation, and the Blench equation for zero-bed transport. In general, the Neill equation is applicable to channel constrictions caused by a bridge or a contraction structure. The Lacey equation is more applicable to natural river systems as in the case of the Upper New River system. The Blench equation, as presented in Pemberton and Lara (1984), is more applicable to clear-water flow conditions downstream of a reservoir or a sand and gravel mining pit that reduces the sediment supply downstream significantly. Deviation from these guidelines is possible due to unique hydraulic conditions such as that in the case of the Upper New

River system. Therefore, care should be taken to eliminate any consideration of unrealistic general scour estimation based on the aforementioned applicability of these empirical equations.

Following is a brief description of the three empirical equations:

a. *Neill Equation*

Under bankfull conditions, the flow depth in an incised low-flow channel can be computed by:

$$d_f = d_i \, (q_f / q_i)^m \tag{7.6}$$

where:

d_f = Scoured depth below the thalweg, ft

d_i = Average (hydraulic) depth at bankfull discharge in the incised reach, ft

q_f = Design flood discharge per unit width, cfs/ft

q_i = Bankfull discharge in incised reach per unit width, cfs/ft

m = Exponent varying from 0.67 for sand to 0.85 for coarse gravel

The above equation is adjusted by the empirical multiplying factor for reach types, *Z*, given in Table 7.1 (Pemberton and Lara, 1984):

$$d_s = Z_{Neill} \, d_f \tag{7.7}$$

where d_s is the general scour

b. *Lacey Equation*

The Neill equation was expanded for Reclamation use to have the following form:

$$d_m = 0.47 \, (Q/f)^{1/3} \tag{7.8}$$

$$d_s = Z_{Lacey} \, d_m \tag{7.9}$$

where:

d_m = Mean scour depth at design discharge, ft

d_s = General scour, ft

Q = Design discharge, cfs

f = Lacey's silt factor = $1.76 \, (D_m)^{1/2}$

D_m = Mean bed material size, mm

c. *Blench Equation*

The Blench equation for "zero bed factor" is:

$$d_{fo} = q_f^{2/3} / F_{bo}^{1/3} \quad (7.10)$$

$$d_s = Z_{Blench}\, d_{fo} \quad (7.11)$$

where:

d_{fo} = Scour depth for zero bed material transport, ft

d_s = General scour, ft

q_f = Design discharge per unit width, cfs/ft

F_{bo} = Blench's "zero bed factor," ft/s^2 from Figure 9 in Pemberton and Lara (1984)

Table 7.1
Multiplication factors, Z (Pemberton and Lara, 1984)

Channel Condition	Value of *Z*		
	Neill	Lacey	Blench
(1)	(2)	(3)	(4)
Straight	0.5	0.25	0.6
Moderate Bend	0.6	0.5	0.6
Severe Bend	0.7	0.75	0.6

2. Contraction Scour

The contraction scour component is estimated using the FHWA (2001) methods, and compared with the general scour component. If the general scour component is greater than the contraction scour component, the general scour controls per discussion in FCDMC (2007a).

The two methods described in FHWA (2001) for contraction scour estimate are the cases for live-bed and clear-water scour. Although negligible live-bed condition is expected in the vicinity of the SR-74 Highway Bridges other than potential transport of the coarse sand deposit from backwater condition, both methods are evaluated for contraction scour depth.

The live-bed contraction scour equation in FHWA (2001) is:

$$\frac{y_2}{y_1} = (\frac{Q_2}{Q_1})^{6/7} (\frac{W_1}{W_2})^{k1} \quad (7.12)$$

$$y_s = y_2 - y_o \quad (7.13)$$

where:

y_s = Average contraction scour depth, ft

y_1 = Average depth in the upstream main channel, ft

y_2 = Average depth in the contracted section, ft

y_o = Existing depth in the contracted section before scour, ft

Q_1 = Flow in the upstream channel transporting sediment, cfs

Q_2 = Flow in the contracted channel, cfs

W_1 = Bottom width of the upstream main channel, ft

W_2 = Bottom width of the main channel in the contracted section less pier width(s), ft

k_1 = Exponent, Table 7.2

Table 7.2
k_1-value determination (FHWA, 2001)

V_*/ω	k_1	Mode of Bed Material Transport
(1)	(2)	(3)
<0.50	0.59	Contact bed material discharge
0.50 to 2.0	0.64	Some suspended bed material discharge
>2.0	0.69	Suspended bed material discharge

V_* = Shear velocity in the upstream section, ft/s

ω = Fall velocity of bed material, Figure 5.8 in FHWA (2001)

Figure 5.8 in FHWA (2001) provides estimate of fall velocity for sand particles. The Upper New River bed material D_{50} in the vicinity of the East and the West SR-74 Highway Bridges are 67 mm and 46 mm, respectively. That mean bed material size refers to very coarse gravel. This is one more reason why the application of the live-bed equation is invalid for the Upper New River ADMP.

The clear-water contraction scour equation in FHWA (2001) is:

$$y_2 = \left[\frac{K_u Q^2}{D_m^{2/3} W^2} \right]^{3/7} \quad (7.14)$$

$$y_s = y_2 - y_o \quad (7.15)$$

where:

y_s = Average contraction scour depth, ft

y_o = Average existing depth in the contracted section, ft

Q = Discharge through the bridge, cfs

D_m = Diameter of the smallest non-transportable particle in the bed material (1.25 D_{50}) in the contracted section, ft

W = Bottom width of the contracted section less pier widths, ft

K_u = 0.0077 (English units)

3. Bend Scour

General scour estimates by the Neill, Lacey, and Blench equations include a bend scour component by the use of the *Z* factor (Pemberton and Lara, 1984). Therefore, per FCDMC (2007a), no additional stand-alone bed scour estimation methods were considered for the bends in the study reaches.

4. Local Scour

Two types of local scour were considered for the Upper New River ADMP: (a) local pier scour at the bridges, and (b) local scour at culvert outlets. Following is a brief description of the methods:

a. Local Pier Scour

Local pier scour depth was computed using the Colorado State University (CSU) (FHWA, 2001). Generally, depths of local scour are much greater than long term or general scour depths. Factors affecting the local pier scour depth are velocity of the approach flow, depth of flow, pier and debris width, length of pier, and the angle of the approach flow. The SR-74 Highway bridges have three sets of 4-foot diameter circular piers. A debris width of 4 feet was added to the pier width of 4 feet, giving a total pier width of 8 feet.

The CSU equation for local pier scour is:

$$Y_s / Y_1 = 2.0\, K_1\, K_2\, K_3\, K_4\, (a / Y_1)^{0.65}\, Fr_1^{0.43} \quad (7.16)$$

where:

Y_a = Depth of scour, ft

Y_1 = Flow depth directly upstream of pier, ft

K_1 = Correction factor for pier nose shape, Table 7.3

K_2 = Correction factor for angle of attack, Table 7.4

K_3 = Correction factor for bed condition, Table 7.5

K_4 = Correction factor for armoring

a = Pier width, Figure 7.3

Fr_1 = Froude number directly upstream of pier

Table 7.3
Correction factor, K_I, for pier nose shape (FHWA, 2001)

Shape of Pier Nose (1)	K_I (2)
Square nose	1.1
Round nose	1.0
Circular cylinder	1.0
Group of cylinders	1.0
Sharp nose	0.9

Table 7.4
Correction factor, K_2, for angle of attack of flow (FHWA, 2001)

Skew Angle of Flow	L/a = 4	L/a = 8	L/a = 12
(1)	(2)	(3)	(4)
0	1.0	1.0	1.0
15	1.5	2.0	2.5
30	2.0	2.75	3.5
45	2.3	3.3	4.3
90	2.5	3.9	5.0

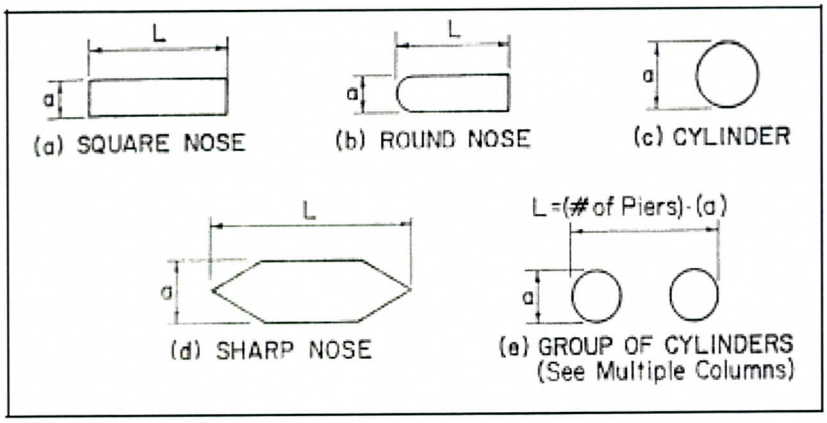


Figure 7.3 - Common pier shapes (FHWA, 2001)

K_2 factor should be also estimated using the following equation (FHWA, 2001), and engineering judgment should be applied in selecting a reasonable value:

$$K_2 = (\text{Cos } \theta + L/a \text{ Sin } \theta)^{0.65} \quad (7.17)$$

where:

θ = Angle of attack of the flow, degrees
L = Effective length of pier, ft

Table 7.5
Increase in equilibrium pier scour depths, K_3, for bed condition (FHWA, 2001)

Bed Condition (1)	Dune Height (ft) (2)	K_3 (3)
Clear-water scour	N/A	1.1
Plane bed and antidune flow	N/A	1.1
Small dunes	$0.6 \leq H < 3$	1.1
Medium dunes	$3 \leq H < 9$	1.1 to 1.2
Large dunes	$H \geq 9$	1.3

The correction factor, K_4, decreases scour depths due to possible armoring of the scour hole for bed materials that have a D_{50} greater than or equal to 2.0 mm and a D_{95} greater than or equal to 20 mm. If the D_{50} is not greater than or equal to 2.0 mm and the D_{95} is not greater than or equal to 20 mm, then K_4 equals 1.0. In this study, the D_{50} and D_{95} in the vicinity of the bridge piers were greater than 2.0 mm and 20 mm, respectively. Therefore, K_4 was estimated by the following procedure (FHWA, 2001):

$$K_4 = 0.4\ (V_R)^{0.15} \tag{7.18}$$

where:

$$V_R = (V_1 - V_{icD50}) / (V_{cD50} - V_{icD95}) > 0 \tag{7.19}$$

and,

$$V_{icDx} = \text{Approach velocity, ft/s} = 0.645\ (D_x / a)^{0.053}\ V_{cDx} \tag{7.20}$$

$$V_{cDx} = K_u\ y_1^{1/6}\ D_x^{1/3} \tag{7.21}$$

y_1 = Depth of flow just upstream of the pier, excluding local scour, ft
V_1 = Velocity of the approach flow just upstream of the pier, ft/s
D_x = Grain size, ft
K_u = 11.17 (English units)

The minimum value of K_4 is 0.4, and should only be used when $V_1 < V_{icD50}$. The appropriate K factors used in this study and the corresponding assumptions are discussed in the Results and Discussions section of this report.

b. Local Scour at Culvert Outlet

Scour analysis at culvert outlets was conducted according to the procedure described in FHWA (1983). This is the method recommended by the District (FCDMC, 1996). The FCDMC (1996) equation used to determine bed scour depth at the culvert outlet is:

$$h_s / D = \alpha [Q / (g^{1/2} D^{5/2})]^{\beta} (t/316)^{\theta} \quad (7.22)$$

where:

h_s = Depth of scour, ft

D = Pipe Diameter, ft

α = Coefficient for culvert outlet scour, for cohesionless materials

σ = Bed-material standard deviation = $(d_{84} / d_{16})^{1/2}$

Q = Discharge per barrel, cfs

g = Acceleration of gravity = 32.2 ft/s^2

β = Coefficient for culvert outlet scour, cohesionless materials

θ = Coefficient for culvert outlet scour, cohesionless materials

t = Time of scour, minutes = 30 minutes unless duration is known

Table 7.6 lists the coefficients used in the above equations. Only the coefficients for graded gravel are listed because σ was found to be greater than 1.5 in this study (FCDMC, 1996).

Table 7.6
Coefficients Used in FCDMC (1996) Scour Equation

Material (1)	α (2)	β (3)	θ (4)
Graded Gravel	1.49	0.50	0.03

5. Low-Flow Incisement Scour

Typically, the low flow incisement scour depth estimate is determined based on field observation during low-flow events. The field investigation approach consists of observing or measuring the actual scour depths during a bankfull discharge in the incised channel. Field visits conducted by Stantec personnel were inconclusive due to dry channel conditions, and presence of bed material ranging from coarse gravel to small and large boulders. If the field visit is inconclusive, the District suggests a value of 1.5 feet of scour depth for low-flow incisement. Therefore, a 1.5-foot low-flow incisement scour depth was added to the total scour estimates.

6. Long Term Scour

In the absence of a sediment transport model, which was the case in the Upper New River ADMP, the typical approach to long term scour estimation is to consider the equilibrium slope analysis described in Pemberton and Lara (1984). Per that approach, the long term scour is determined by locating a downstream control or pivot point i.e., bedrock outcrop,

grade control structure, or a confluence with bed armoring. Field visits of the study reaches were inconclusive on the bed armoring. In addition, no structural control or pivot points were identified. Therefore, the long term scour equation for 100-year discharge recommended in the ADWR State Standard (ADWR, 1996) was used in most part. The ADWR approach is valid when no defined pivot point exists. The ADWR state standard equation for long term scour is:

$$Y_s = 0.02\ Q_{100}^{0.6} \tag{7.23}$$

where:

Y_s = Depth of scour below stream bed, ft

Q_{100} = 100-year peak discharge, cfs

At relatively high 100-year peak discharge, the ADWR method may give unrealistic measure of the long term scour. In this case, the long term scour at hydraulic cross sections is estimated based on historic topography (if available), past FIS study mapping, current topography, and engineering judgment.

7. Bedform Scour

Bedform scour is expected to occur in sand-bed channels. Some localized coarse sand deposits were observed during field visits in the vicinity of the SR-74 Highway bridges due to possible backwater conditions during high flows, and upstream of the CAP canal crossing in the Upper New River main stem where the Deadman Wash flow deposits coarse sand from its lower flat reach. Since the actual bed of the Upper New River and its tributary wash reaches are not made up of sand, no bedform scour component was added to the total scour estimates. However, there was one exception. Coarse sand deposit of up to a foot was observed during field visit along the lower approximately one and a half mile sub-reach of the Deadman Wash. Field observation appeared to suggest bedform scour in this area but needed verification based on flow regime. Bedforms such as antidune form in a transitional or upper regime (supercritical) flows in sand-bed channels, and can deform a channel bed and potentially undermine a bridge structure and significantly change the hydraulic characteristics of the channel in terms of hydraulic roughness and sediment transport capacity. Under sub-critical flow regime antidunes are not expected to occur. However, dune scour is possible in lower regime (subcritical) flows. The dune bedform scour is a direct function of the dune height whereas the dune height is a direct function of the hydraulic depth (FCDMC, 2007a). The dune scour is estimated by:

$$Y_{bf} = 0.5d_h = 0.5(0.066Y_h^{1.21}) \tag{7.24}$$

where:

Y_{bf} = Bedform scour depth below original bed, ft

d_h = Dune height, ft

Y_h = Hydraulic depth, ft

7.4.5 Headcut at Mine Pits

Due to the shallow depth of armor, gravel (or coarser) bed material condition were justified in the vicinity of the existing mining pits in the Upper New River main stem and its West (diversion) Branch. Therefore, the headcut estimation method for gravel-bed channels as outlined in Simons, Li and Associates (1989) was used. Tailcut is typically not considered under gravel-bed conditions. The headcut scour depth was estimated using the Flood Control District of Maricopa County's Pit Scour software, Beta Version 1.0.1 (FCDMC, 2007b). The procedure provides the depth, width, and length of scour upstream (in the case of headcut estimation) of a pit. The scour can be located anywhere across the active channel width. Following is a brief outline of the procedure for calculating short-term scour near the upstream limit of a pit in "gravel-bed" channels:

1. Collect data on pit shape i.e., width, length, and depth, design hydrograph, bed material gradation, and channel slope.
2. Discretize the inflow hydrograph using uniform time increments. A 0.25 hour time increment was used in this study.
3. Calculate the time required to fill the pit under analysis with water, T_f.

Repeat the following steps for each hydrograph time increment:

4. Determine the scoured channel width, W_c, from the appropriate (gravel-bed) regime equation:

$$W_c = 1.85\ Q^{0.45} \tag{7.25}$$

5. Calculate the inflow and outflow unit discharge, and the unit discharge, q, in the pit.

6. Calculate T_{max}:

$$T_{max} = a_1\ T_f^{b1} \tag{7.26}$$

where: $a_1 = 5.4q^{-0.340}$

$b_1 = 0.54q^{0.112}$

7. Calculate the scour depth (y_s) and the length at 5 percent of scour depth (L_{s5}):
8.

$$y_s = a_2\ t^{b2}\ y_p \tag{7.27}$$

where: for $t \leq T_{max}$

$a_2 = 0.0023q^{0.529}$

$b_2 = 1.54q^{-0.162}$

$$L_{s5} = a_3 \, t^{b3} \qquad (7.28)$$

where: for $t \leq T_{max}$

$$a_3 = 10^{(1.637 + 0.0032q)}$$

$$b_3 = 0.538$$

and,

L_{s5} = Scour length at 5 percent of scour depth, ft

q = Discharge per unit width of channel, cfs/ft

Q = Main channel discharge, cfs

t = Flow duration, sec

T_f = Pit fill time, sec

W_c = Channel width, ft

y_p = pit depth, ft

y_s = scour depth, ft

7.5 HYDRAULIC MODELS

Stantec has developed HEC-RAS hydraulic models for the Upper New River main stem, and the West Branch (Diversion Channel) as part of the study. The tributary wash models are converted from HEC-2 models in the Flood Insurance Studies to HEC-RAS models. Those models were modified for the purpose of sediment engineering calculations. The modifications included adjustment of bank stations to define the low-flow channels, and the adjustment of the ineffective flow limits for the 10-year event discharge. The 10-year event discharges were taken as 33 percent of the 100-year event discharge based on the information and procedures in FCDMC (2003). The application of the procedure is discussed in the Upper New River ADMP Hydrology Report. The modified HEC-RAS model files are included on the accompanying CD-ROM in Appendix G.

7.6 GEOTECHNICAL DATA

7.6.1 Introduction

This section describes the sediment sampling procedures and results. Measurements of bed material sizes were obtained for use in the scour and armoring analyses. The sampling procedure selected is a function of the intended results of the study, the stream type and bed material distribution. The section also describes statistical data analyses to establish a confidence limit on the median bed material size (D_{50}). The following guidelines were used to obtain representative sediment samples:

7.6.2 Pebble Count

Wolman (1954) described a method for sampling coarse riverbed material that is rapid and produces statistically reliable information on the median bed particle size. This procedure, commonly known as Pebble Count, involves randomly sampling bed material within a grid system and then plotting these data as a cumulative frequency distribution. Due to typical bed material variation, Wolman's method is commonly modified by establishing transects across the channel (cross sections perpendicular to the flow) and sampling bed material at a selected distance interval from the streambed surface. This was the typical scenario with the Upper New River main stem, the West Branch, and the tributary washes. Where the main channels are narrow, the pebble count procedure was conducted in the longitudinal direction (parallel to the flow) in order to pick up substantial number of representative samples for statistical reliability. Sieve analysis was the sampling method used in the segments of washes with sand and gravel bed material. The pebble count procedure applied on the study reaches is summarized as follows:

1. Pebble count locations were identified based on geomorphic conditions of the reaches, information gathered from current aerial photographs, and on past flooding conditions from FEMA Flood Insurance Studies. Due to variation in bed material distribution in the vicinity of the SR-74 Highway Bridges, and the CAP Canal crossing, sampling locations in these areas were closely spaced compared with other areas within the study reaches. Upstream of SR-74 Highway, the sampling spacing was more or less equally spaced.
2. Disturbed reaches, such as active mining areas and bridge sections were avoided, and distinguished from non-disturbed reaches.
3. A cloth tape was stretched across the sampling section or longitudinally if the channel section was too narrow to collect up to 30 samples.
4. The intermediate axis (b in Figure 7.4) was measured.
5. A close-up photograph was taken of the bed material, as well as a photograph showing the entire sampling location.
6. Data from each sampling location was entered in Excel spreadsheet, and the "@PERCENTILE" function was used to estimate the "percent smaller" size fraction.
7. Results from the spreadsheet were plotted on a frequency diagram (gradation plot). It is important to note that this plot is for percent of size grains, not percent by weight, as is reported for standard sieve analysis or percent by volume.

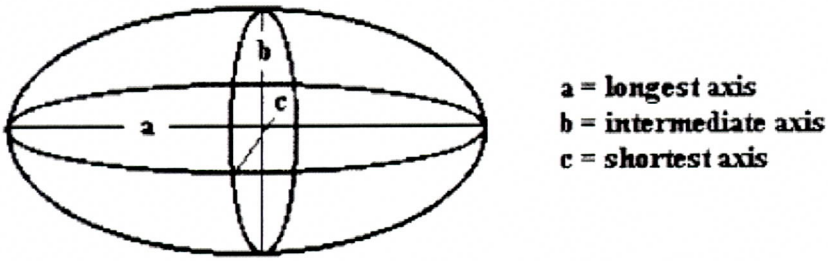


Figure 7.4 - Three dimensions of a sediment grain

Figures 7.5 and 7.6 show the gradation plots generated from pebble count for the ten Upper New River, six Sweat Canyon Wash, one Doe Peak Wash, and one Doe Peak South Fork tributary wash sampling locations. Figure 7.2 in the Field Reconnaissance section of this report shows the sampling locations. The analysis supports a range of bed material from coarse gravel to medium boulders for the Upper New River main stem, fine gravel to small boulders for the Sweat Canyon Wash, coarse gravel to large cobbles for the Deadman Wash, and coarse gravel to large cobbles for the Doe Peak South Fork tributary. Table 7.7 lists the median bed material size (D_{50}), the corresponding sample mean, and the confidence limit on the median obtained from Student's *t*-distribution as described below:

7.6.3 Confidence Interval on the Median by Student's t-distribution

A confidence interval is an interval based on observation of a sample constructed so that there is a specified probability that the interval contains the unknown true value of a population parameter. It is common to calculate confidence intervals that have a 95 percent probability of containing the true value. In practical situations, like in the case of stream bed material sampling, when the true value of the population standard deviation is not known, the Student's *t* Test can be applied to obtain the confidence interval on the sample mean.

The first step is to calculate both the sample average, $\bar{x}$, and the sample standard deviation, *s*. This was accomplished in Excel. For the true value of the mean, μ, and a sample size of *n*, the confidence interval calculation is based on the fact that the quantity $T = \sqrt{n}\,(\bar{x}-\mu)/\,s$ will have a *t*-distribution with *n*-1 degrees of freedom. The density function for the *t*-distribution is bell shaped, somewhat similar to the standard normal distribution (Haan, 2002). Therefore, it was necessary to normalize the pebble count data by square-root transform, a typical choice for normalizing data in a counting problem. The next step is to look in a *t*-distribution table for a value *a* such that $\Pr(-a < T < a) = 0.95$, where *T* has a *t*-distribution with the appropriate degrees of freedom. Then the 95 percent confidence interval for the unknown value of μ is from $\bar{x} - (as/\sqrt{n})$ to $\bar{x} + (as/\sqrt{n})$. The method was implemented in Excel.

7.6.4 Sieve Analysis

Sieve analysis deemed appropriate for a handful of samples collected within the study area where sample size ranging from very fine sand to very coarse gravel was observed. These locations are (Figure 7.2); the lower reach of the Deadman Wash where about a foot of coarse sand deposit was noted due to flat bed slope, Doe Peak Wash above the confluence with South Fork tributary, Doe Peak East Fork, and Sweat Canyon Wash above the confluence with Doe Peak Wash. Figure 7.7 shows the gradation plots from sieve analysis, and Table 7.7 lists the median bed material size (D_{50}). Confidence limit on the median, and the sample standard deviation could not be determined as was done with the pebble count data.

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Table 7.7
Mean Bed Material Diameter (D_{50}), Confidence Limit, Sample Mean, and Standard Deviation

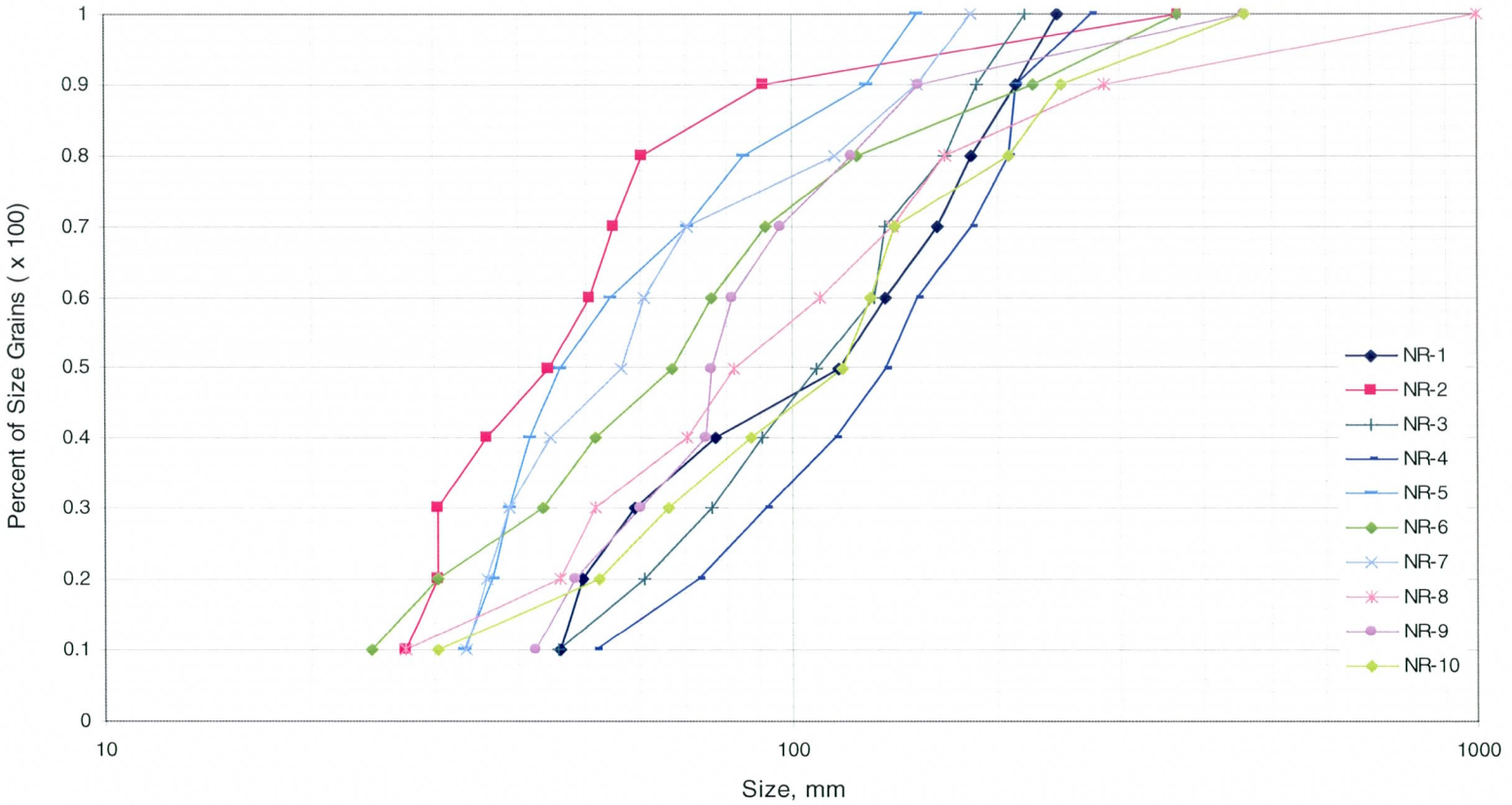
Sample ID	River/Wash	D(50) mm	Confidence Limit +/- mm	D(50) ft	Confidence Limit +/- ft	Sample Mean ft	Sample Standard Deviation ft
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
NR-1	New River	119	13.4	0.39	0.04	0.40	0.22
NR-2	New River	44	18.0	0.14	0.06	0.20	0.22
NR-3	New River	108	17.7	0.35	0.06	0.38	0.18
NR-4	New River	137	22.9	0.45	0.08	0.45	0.22
NR-5	New River	46	14.0	0.15	0.05	0.2	0.12
NR-6	New River	67	13.7	0.22	0.05	0.29	0.25
NR-7	New River	56	15.5	0.18	0.05	0.23	0.15
NR-8	New River	82	18.9	0.27	0.06	0.41	0.50
NR-9	New River	76	20.4	0.25	0.07	0.3	0.26
NR-10	New River	119	27.7	0.39	0.09	0.40	0.34
SC-1	Sweat Canyon	47	18.6	0.15	0.06	0.21	0.21
SC-2	Sweat Canyon	29	27.4	0.10	0.09	0.23	0.30
SC-3	Sweat Canyon	15	13.1	0.05	0.04	0.09	0.07
SC-4	Sweat Canyon	27	18.9	0.1	0.06	0.16	0.16
SC-5	Sweat Canyon	76	23.2	0.25	0.08	0.31	0.24
SC-6	Sweat Canyon	30	32.3	0.10	0.11	0.28	0.37
SC-7	Sweat Canyon	6	Grab Sample	0.02	-	-	-
SC-8	Sweat Canyon	6	Grab Sample	0.02	-	-	-
DM-1	Deadman	3	Grab Sample	0.01	-	-	-
DM-2	Deadman	6	Grab Sample	0.02	-	-	-
DM-3	Deadman	4	Grab Sample	0.013	-	-	-
DM-4	Deadman	64	21.3	0.210	0.07	0.24	0.18
DP-1	Doe Peak	6	Grab Sample	0.02	-	-	-
SF-1	South Fork	83	27.4	0.30	0.09	0.34	0.27
EF-1	East Fork	3	Grab Sample	0.01			

7.6.5 Results and Conclusions

One aspect of the statistical analysis was to see if there exists any spatial correlation between samples. Comparison of the sample standard deviation, and the D_{50} (Table 7.7) suggests a tight bed material size distribution at sampling locations. However, spatial correlation between the samples with similar median size was in most cases, near zero with the exception of a few of the pairs of samples identified in Table 7.8. The covariance between selected pairs of sample was also computed. Covariance is used to determine whether two ranges of data 'move together'---that is, whether large values of one set are associated with large values of the other (positive covariance), whether small values of one set are associated with large values of the other (negative covariance), or whether values in both sets are unrelated (covariance near zero). For all the pairs of sample analyzed for the study reach, the covariance was near zero (Table 7.8). The median size range in the Upper New River main stem represents very coarse gravel to small cobbles, and that in the Sweat Canyon Wash represents medium gravel to very coarse gravel. In the Deadman Wash lower reach, the median size range represents very coarse sand to very fine gravel while bed material in most of the upper reach is represented by very coarse gravel to small cobbles. While the Doe Peak bed material consists of fine gravel, Doe Peak South Fork and East Fork tributary bed material is composed of small to medium cobbles, and very fine gravel, respectively.

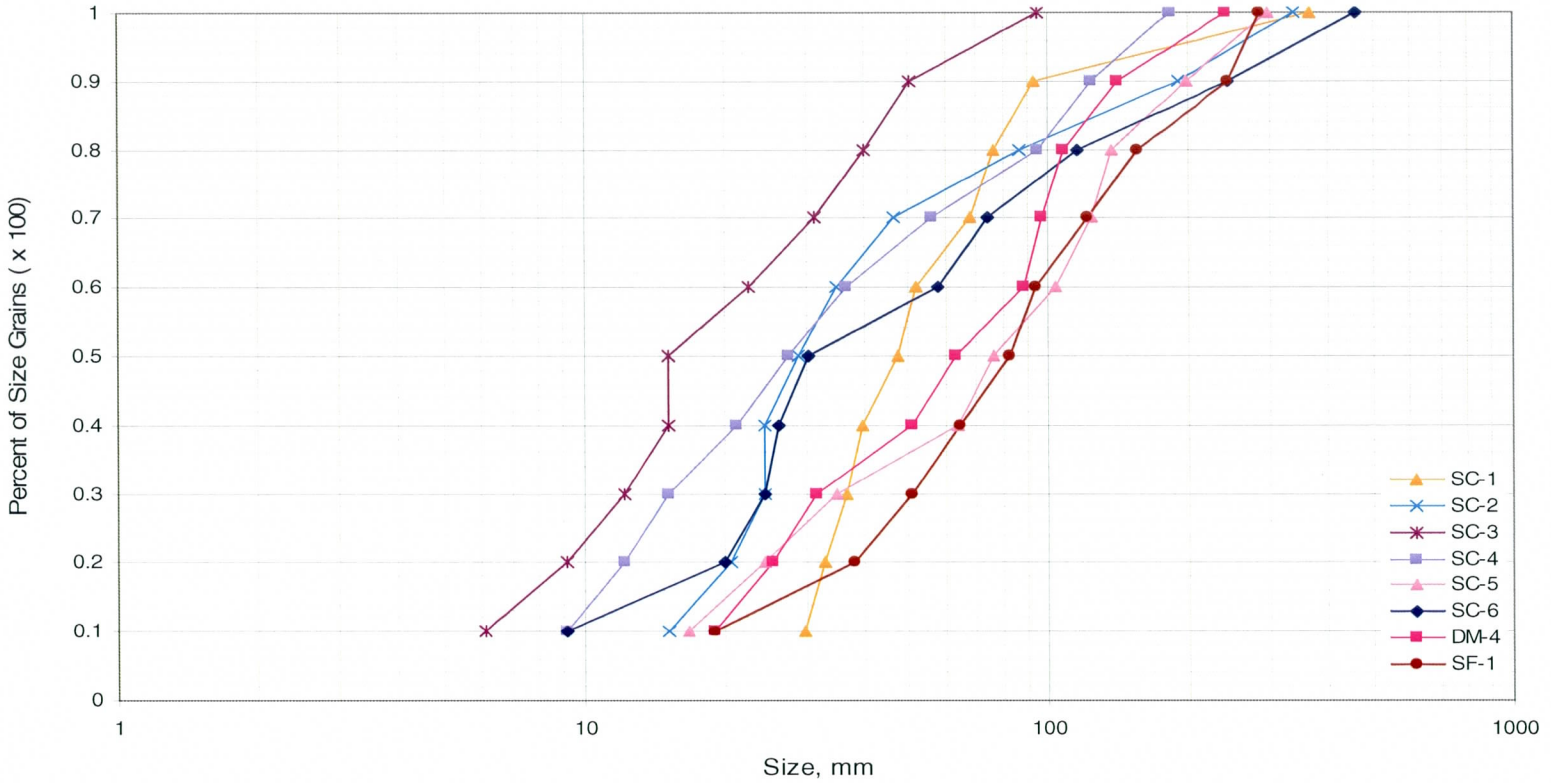
Table 7.8
Covariance and Correlation Summary

Data Pair (1)	Covariance (2)	Correlation (3)
NR-1 & 2	-0.00263	-0.062
NR-3 & 4	0.00533	0.115
NR-2 & 5	-0.00645	-0.245
NR-6 & 7	-0.00314	-0.077
NR-8 & 9	0.023228	0.367
SC-1 & 2	-0.00429	-0.073
SC-2 & 3	-0.00066	-0.032
SC-4 & 6	-0.01388	-0.237
SC-3 & 4	-0.00337	-0.288



Medium Gravel	Coarse Gravel	Very Coarse Gravel	Small Cobbles	Large Cobbles	Small Boulders	Medium Boulders

Figure 7.5 - Upper New River Size Gradation Plots



Very Coarse Sand	Very Fine Gravel	Fine Gravel	Medium Gravel	Coarse Gravel	Very Coarse Gravel	Small Cobbles	Large Cobbles	Small Boulders	Medium Boulders

Figure 7.6 - Sweat Canyon, Doe Peak and South Fork Wash Size Gradation Plots

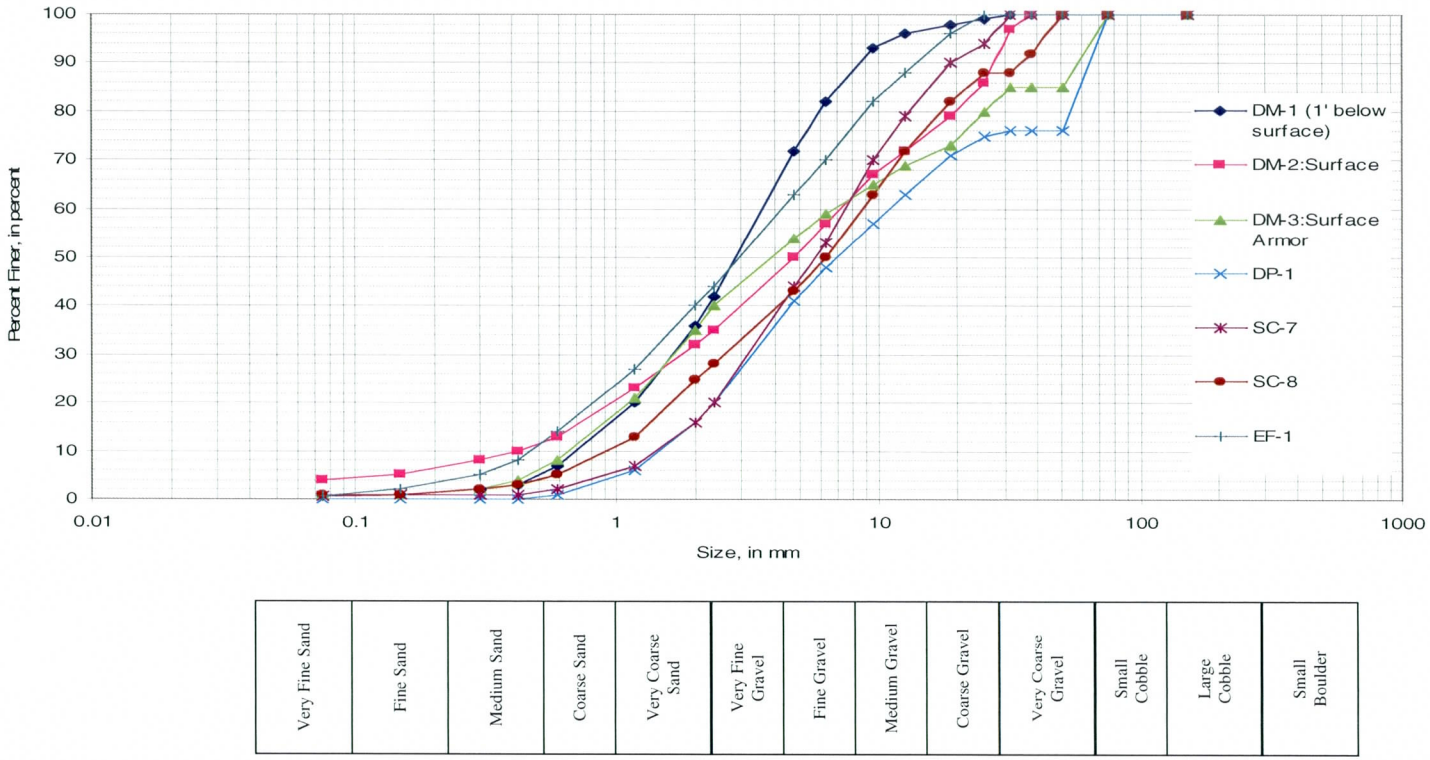


Figure 7.7 - Gradation Plots of Grab Samples from the Upper New River Study Area

7.7 RESULTS AND DISCUSSIONS

7.7.1 Introduction

Discussions on the results of the armoring, equilibrium slope, and total scour analyses are presented in this section by the Upper New River ADMP planning areas. The following planning areas were considered for the sediment engineering tasks:

1. The Upper New River Planning Area
2. The Lower Deadman Planning Area
3. The Sweat Canyon and Doe Peak Planning Area

Figure 7.8a shows the planning areas, and the corresponding scour summary. Also included in this section is discussion on the local bridge pier scour, culvert scour, and headcut scour depth estimations. The spreadsheets are provided on the accompanying CD-ROM and in hard copy format (Appendix G).

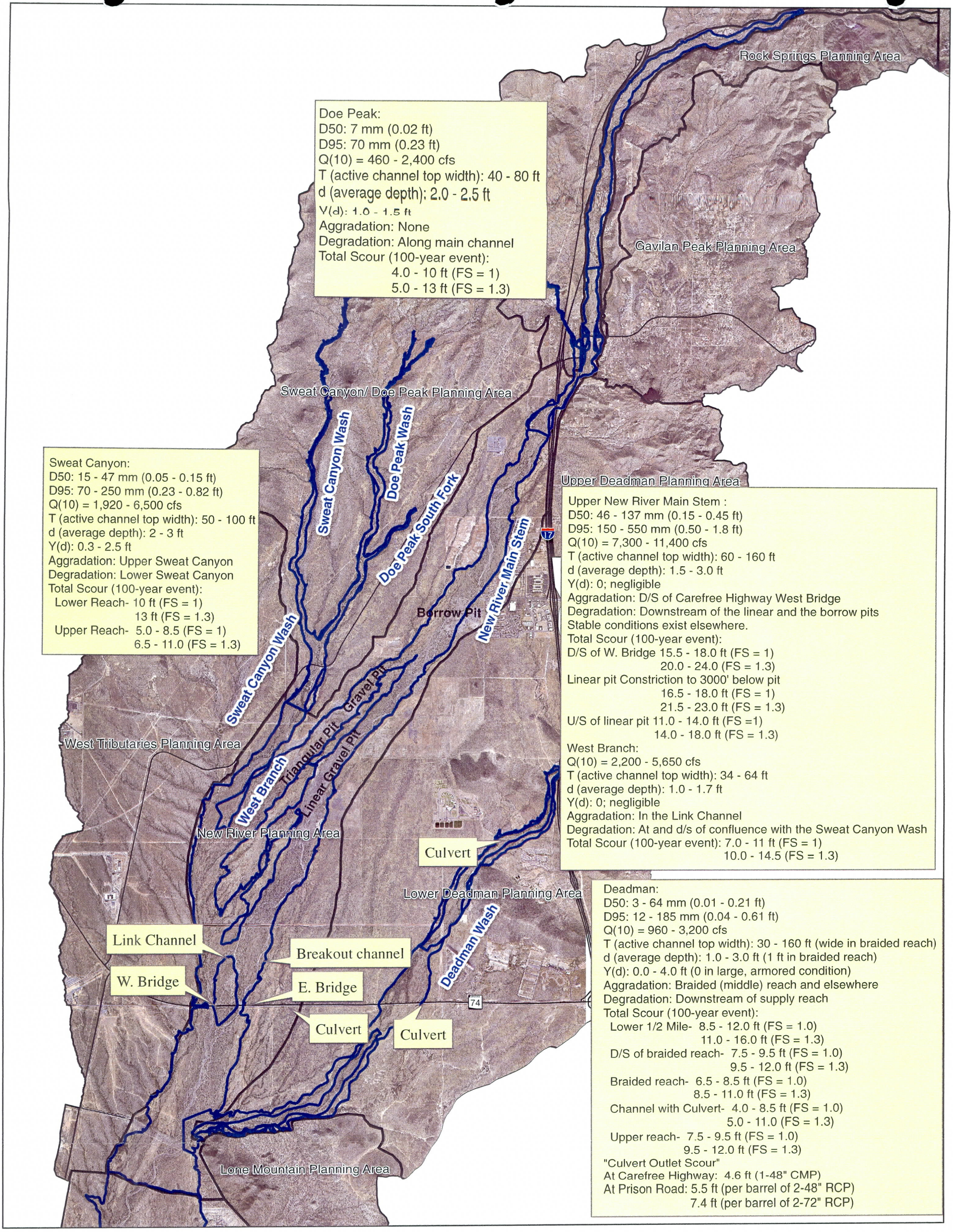
7.7.2 Armor, Equilibrium Slope, and Total Scour

1. The Upper New River Planning Area

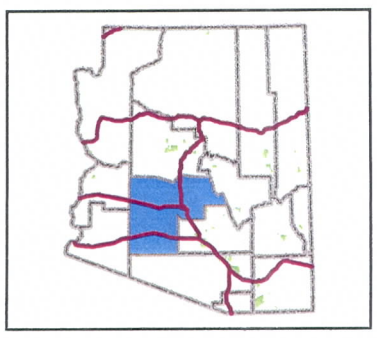
Armoring and Equilibrium Slope

The planning area covers the Upper New River corridor from downstream of the Tonto National Forest to the CAP canal crossing, including the West Diversion Channel (West Branch (Figure 7.8a). The sediment engineering task was limited to the river reach between the I-17 bridges and the CAP canal crossing. The key features within the river corridor that tend to control the flow dynamics, and thereby the vertical stability, are the flow split location at the West Branch, and the linear pit just downstream of it (Figure 7.8a). At the west diversion channel split flow location, within the main stem of the river, there exist distinct islands (Figure 7.8a) that cause the main channel flow to split more than once. The two-dimensional modeling results and experience with past similar situations suggest that such island flow conditions within the main stem causes the high velocity water conveyed from upstream to begin to loose energy. This energy loss reduces the velocity downstream which is expected to keep the low-flow channel within the linear pit vertically stable in the long-term. Such energy loss also causes water to simply spill into the west diversion channel rather than force into it by momentum in the main stem flow. The approximately 130-foot wide man-made constriction at the farthest downstream point of the linear pit leads to backwater storage which in turn delays the increase in the main channel velocity downstream of the pit. Due to the increase in the velocity downstream of the constriction, long-term degradation of the channel bed is expected.

Armoring and equilibrium slope calculations support the aforementioned assumptions on the flow dynamics, and vertical stability of the Upper New River main stem. The main stem was divided into sub-reaches based on grade break and similar hydraulic conditions



Location Map:



Notes:

N

1" = 6000'

Legend:

FEMA_Floodplain

Planning Areas

Roadway

Flood Control District of Maricopa County
2801 W. Durango St.
Phoenix, AZ 85009

Upper New River ADMP
FCD 2005CO20

Figure 7.8a Scour Summary

Stantec Consulting Inc.
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Project No.
182000418

Prepared By:
AG, IA
7 May 2007; Revised 20 August 2007

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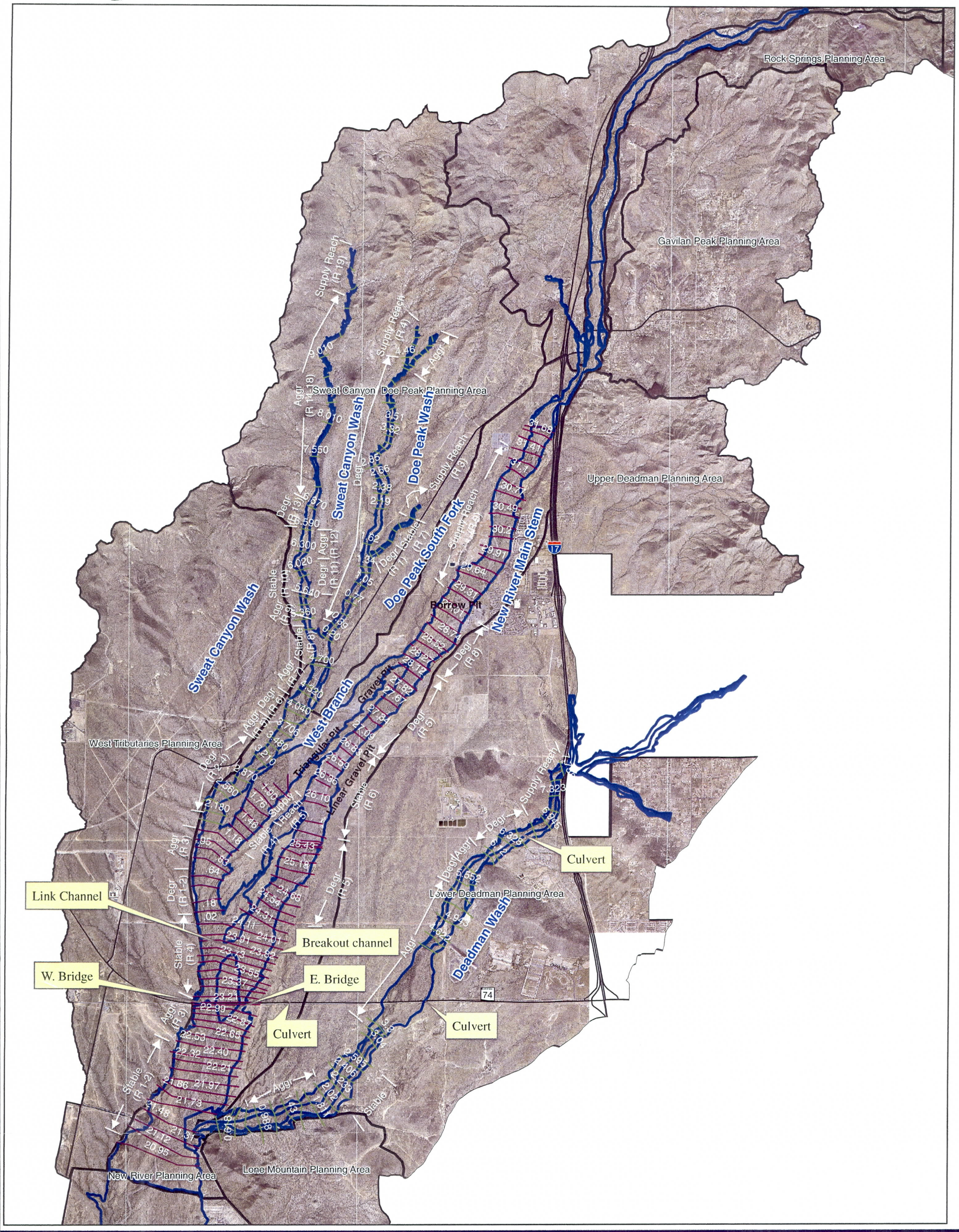

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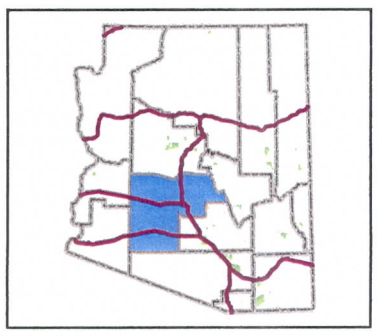

Project No.
182000418

Prepared By:
AG, IA
7 May 2007; Revised 20 August 2007

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Notes:

Legend:

- FEMA Floodplain
- Planning Areas
- Roadway

Aggr. : Aggradation
Degr. : Degradation
R7 : Sub-reach ID

N

1" = 6000'

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Phoenix, AZ 85009

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Figure 7.8b Armor/Equilibrium Slope Sub-reaches, and Long Term Aggradation/Degradation Trend

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namely, active channel top width, depth, and velocity that were obtained from one-dimensional HEC-RAS models (Figure 7.8b). Given the existing bed and bank conditions, the farthest upstream sub-reach was taken as the sediment supply reach for equilibrium slope calculations. The focus was on the low-flow channel which was defined by adjusted bank stations within HEC-RAS. The 10-year peak discharge was used as the dominant discharge.

The depth of armor varied from zero to one foot along the main stem study reach depending on the method used; either the Meyer-Peter Muller bed-load transport equation or the Shield's Diagram method. The existing bed condition is better represented by the Meyer-Peter, Muller equation which consistently gave zero depth to armor for the main stem sub-reaches, pointing to stable existing conditions. The equilibrium slope calculations using the dominant discharge also suggest stable conditions in most part of the main stem with few exceptions; long-term trend towards degradation downstream of the borrow pit (Figure 7.8a), and the linear gravel pit, and aggradation downstream of the West SR-74 Highway Bridge. Majority of the flow, including that from the Sweat Canyon Wash, flow under the West Bridge. Multiple 10-year events are expected to transport the backwater induced coarse sand deposits from upstream of the bridge to downstream, resulting in the possible long-term aggradation of the channel bed.

The West Branch was found to be vertically stable under the existing conditions. The depth to armor was consistently zero. However, the equilibrium slope calculations suggest potential long-term aggradation/degradation trends. At the confluence with the Sweat Canyon Wash and downstream, long-term degradation is expected. Since much of the low-flow is directed towards the Sweat Canyon Wash, the part of the West Branch main channel that links the two (Figure 7.8a) is expected to tend towards long-term aggradation due to low velocity flow. The one-dimensional HEC-RAS model developed by Stantec under the Upper New River ADMP was used to accomplish the task. That model begins downstream of the triangular gravel mine pit and extends up to the confluence with Sweat Canyon Wash.

Total Scour

Total scour is a summation of several scour components, not all of which are expected to contribute at one point in time. Therefore, care was taken not to confuse the relatively high total scour that is estimated at each river mile with the sub-reach averaged shallow depth to armor. Care was also taken in applying the most applicable Bureau of Reclamation general scour equation. The Lacey equation, applicable for natural river systems, gave consistent results along the main stem and the West Branch. The Neill equation, derived for channel constrictions, was used at the bridge section only. The Blench equation, derived for clear water condition downstream of mine pits, was used at the New River main stem cross sections downstream of the linear borrow pit. The method was not used in the West Branch because the triangular pit did not have substantial storage capacity. Channel bends were taken into consideration in the general scour equation per methods described in Pemberton and Lara (1984). No other stand-alone bend scour equations were considered per the District guidelines (FCDMC, 2007a).

Having no data on the channel conditions during a low-flow event, the low-flow incisement scour was set at 1.5 feet per the District guidelines (FCDMC, 2007a). The ADWR (1996) method was used for scour depth estimation. The long-term scour depth estimated by this method was conservative given the high 100-year discharges. However, the long-term scour depth estimated per ADWR (1996) method compensates for the relatively low general scour depths computed by Lacey's equation in the final total scour estimation. Also included in the total scour estimate is the local pier scour at the SR-74 Highway bridges.

Table 7.9 summarizes the results from the armor and equilibrium slope computations for the Upper New River Planning Area. Ranges of values are listed. The long-term aggradation/degradation trends are based on the comparison of the equilibrium slope with the existing bed slope. It should be noted that the range of hydraulic parameter values are not necessarily correlated to the range of discharge values, that is, the minimum hydraulic depth is not necessarily correlated to the minimum discharge due to the nonlinear nature of the system.

2. The Lower Deadman Wash Planning Area

Armoring and Equilibrium Slope

The planning area covers the Deadman Wash and its floodplains between the I-17 bridges and the confluence with the Upper New River. A distinct feature of the Lower Deadman Wash is the heavily braided middle section where a split flow condition exists (Figure 7.8a). Upstream of that location, the main channel is steeper compared with the conditions downstream. For approximately 1.5 miles from the confluence with the Upper New River the bed slope is relatively flat. A coarse sand deposit of up to foot depth was evident in the area during the field visit. The bed material in the Lower Deadman Wash ranges predominantly from coarse gravel to small cobbles. Clearly, the bed material distribution along the study reach dictated the depth to armor. Due to the fine deposits in the downstream section, the depth to armor in that area was approximately 1.5 foot while everywhere else in the study reach it was zero, suggesting an existing armored bed condition. This result was based on the Meyer-Peter, Muller bed load transport equation which was appropriate for the existing bed material size distribution. The result from the Shield's diagram method was inconclusive for the lower reach where armoring is expected. The depth to armor elsewhere along the study reach by Shield's Diagram was near zero.

The equilibrium slope analysis suggests a long-term aggradation trend along the study reach with the exception of one location. This location where long-term degradation is possible is downstream of the supply reach.

Table 7.9
Scour summary for the Upper New River Planning Area

100-year Discharge Q_{100} cfs (1)	10-year Discharge Q_{10}, cfs (2)	10-year event Active Channel Top Width T ft (3)	10-year event Average Depth d ft (4)	Depth to Armor Y_d ft (5)	Aggradation Trend (6)	Degradation Trend (7)	100-year event Total Scour ft (8)
Upper New River Main Stem							
22,857-34,600	7,300-11,400	60-160	1.5-3.0	0	Downstream of the SR-74 Highway West Bridge	Downstream of the linear gravel pit and the borrow pits	Downstream of the West Bridge: 15.5-18.0 (FS=1) 20.0-24.0 (FS=1.3) From the linear gravel pit constriction to 3,000 ft downstream: 16.5-18.0 (FS=1) 21.5-23.0 (FS=1.3) Upstream of the Linear gravel pit: 11.0-14.0 (FS=1) 14.0-18.0 (FS=1.3)
West Branch (Diversion Channel)							
6,623-17,143	2,200-5,650	34-64	1.0-1.7	0	In the channel linking the West Branch with Sweat Canyon Wash	At and downstream of the confluence with the Sweat Canyon Wash	7.0-11.0 (FS=1) 10.0-14.5 (FS=1.3)

FS= Factor of Safety

The long-term trend towards aggradation in the most part is expected given the relatively mild slope of the study reach and the armored bed conditions. Sediment from upstream, in excess of the transport capacity, may be deposited within the downstream sub-reaches. The sub-reaches were established based on the grade breaks and main channel hydraulic conditions under the dominant discharge (Figure 7.8b).

Total Scour

The total scour was estimated at each FIS hydraulic model river mile per the methodology described earlier in this report. The focus was on the appropriate use of the relevant equations given the low-flow channel conditions, and the presence of constrictions due to hydraulic structures. For general scour, the Lacey equation was appropriate. The Neill equation was considered only at the SR-74 Highway culvert crossing. The long-term scour component was estimated using ADWR (1996). Although the maximum long-term scour estimated by this method was as high as 5 feet in the lower 3 miles of the study reach, it was deemed acceptable for the downstream areas where significant coarse sand deposits were noted. Bedform scour due to antidunes was not considered since the flow regime was predominantly subcritical. However, dune scour was considered in the lower reach (cross section 0.092 to 0.618) where coarse sand deposit was noted. The methodology given in FCDMC (2007a) was followed. The average dune scour in the aforementioned reach was approximately two-tenth of a foot which had no significant impact in the total scour estimation. Due to lack of field data under low-flow conditions, a 1.5-foot low-flow incisement scour depth was added to the total scour estimate per the District guideline (FCDMC, 2007a). The local culvert outlet scour of 4.6 feet, downstream of SR-74 Highway, was added to the total scour depth estimate for that location. It should be noted that not all the scour components are expected to contribute to the total scour at a given point in time. Therefore, as explained earlier, the shallow depth of armor and the high total scour depth estimate should not be thought of being contradictory.

Table 7.10 summarizes the results from the armor and equilibrium slope computations for the Lower Deadman Wash Planning Area. Ranges of values are listed. The long-term aggradation/degradation trends are based on the comparison of the equilibrium slope with the existing bed slope. It should be noted that the range of hydraulic parameter values are not necessarily correlated to the range of discharge values, that is, the minimum average (hydraulic) depth is not necessarily correlated to the minimum discharge due to the nonlinear nature of the system.

Table 7.10
Scour summary for the Lower Deadman Wash Planning Area

100-year Discharge Q_{100} cfs (1)	10-year Discharge Q_{10}, cfs (2)	10-year event Active Channel Top Width T ft (3)	10-year event Average Depth d ft (4)	Depth to Armor Y_d ft (5)	Aggradation Trend (6)	Degradation Trend (7)	100-year event Total Scour ft (8)
2,900-10,000	960-3,200	30-160	1.0-3.0	0.0-1.5	Braided (middle) reach, and upstream and downstream of the braided reach	Downstream of the supply reach	Lower ½ mile: 8.5-12.0 (FS=1) 11.0-16.0 (FS=1.3) Downstream of the braided reach: 7.5-9.5 (FS=1) 9.5-12.0 (FS=1.3) Braided reach: 6.5-8.5 (FS=1) 8.5-11.0 (FS=1.3) Channel at SR-74 Highway: 4.0-8.0 (FS=1) 5.0-11.0 (FS=1.3) Upper Reach: 7.5-9.5 (FS=1.0) 9.5-12.0 (FS=1.3)

FS=Factor of Safety

3. The Sweat Canyon and Doe Peak Washes Planning Area

Armoring and Equilibrium Slope

Armoring and equilibrium slope analyses were completed for the Sweat Canyon Wash, Doe Peak Wash main stem, and the Doe Peak Wash tributaries; the East Fork and the South Fork Washes.

Sweat Canyon Wash bed material consists of medium gravel to very coarse gravel, and that for Doe Peak Wash main stem is fine gravel. The maximum depth to armor in the sub-reaches of the two main stems is approximately 1.5 feet per the Meyer-Peter Muller bedload transport equation derived for gravel-bed streams. Given the presence of very fine gravels in the Doe Peak East Fork tributary wash, up to 2.5 feet of armor depth is possible. For the Doe Peak South Fork tributary wash, this depth reduces to zero, pointing an armored bed condition with small to medium size cobbles.

As the discharge of water with little or no sediment increases due to tributary flow contributions, in order to conserve mass, the common trend is to have scour of bed material at the downstream end of the main stem reaches. Such potential for scour in the lower reaches of Sweat Canyon Wash and Doe Peak Wash main stem exists. This was verified through equilibrium slope calculations to determine the long-term aggradation/degradation trend (Figure 7.8b). The Doe Peak South Fork tributary wash showed a similar trend. Long-term aggradation is possible in the lower reach of the Doe Peak East Fork tributary wash.

Total Scour

The Neill equation and the Lacey equation gave consistently acceptable general scour depth at river miles in the Sweat Canyon Wash and the Doe Peak Wash main stem. A similar trend was observed in the case of the Doe Peak tributary washes. However, the general scour result from the Lacey equation for natural rivers was used in the total scour estimate because the Neill equation is more appropriate for locations with channel constriction due to hydraulic structures. A typical 1.5-foot low-flow incisement scour was added to the total scour estimates. No bedform scour existed under the existing bed condition. The long-term scour depth computed by the ADWR method (ADWR, 1996) was reasonable (1.5 to 4.0 feet) for the given discharges in the main stems and the tributaries, except for the downstream reach of the Sweat Canyon Wash where due to high discharge, up to 7.5 feet of long-term scour was estimated. Although a high number for long-term degradation, it should again be noted that not all scour components are expected to contribute to the total scour depth due to uncertainty.

Table 7.11 summarizes the results from the armor and equilibrium slope computations for the Sweat Canyon and Doe Peak Planning Area. Ranges of values are listed. The long-term aggradation/degradation trends are based on the comparison of the equilibrium slope with the existing bed slope. It should be noted that the range of hydraulic parameter values are not necessarily correlated to the range of discharge values, that is, the

Table 7.11
Scour summary for the Sweat Canyon/Doe Peak Wash Planning Area

100-year Discharge Q_{100}	10-year Discharge Q_{10},	10-year event Active Channel Top Width T	10-year event Average Depth d	Depth to Armor Y_d	Aggradation Trend	Degradation Trend	100-year event Total Scour
cfs	cfs	ft	ft	ft			ft
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Sweat Canyon Wash							
5,811-19,800	1,920-6,500	50-100	2.0-3.0	0.3-2.5	Upper sub-reaches	Lower sub-reaches	Upper reach: 5.0-8.5 (FS=1) 6.5-10. (FS=1.5) Lower reach: 10.0 (FS=1) 13.0 (FS=1.3)
Doe Peak Wash							
1,400-7,343	460-2,400	40-80	2.0-2.5	1.0-1.5	Between South Fork and East Fork	Below South Fork	4.0-10.0 (FS=1) 5.0-13.0(FS=1.3)
Doe Peak South Fork Tributary							
1,890	620	34-48	1.0-1.4	0	-	Lower reach near confluence with Doe Peak Wash	4.0-4.5 (FS=1) 5.0-6.0 (FS=1.3)
Doe Peak East Fork Tributary							
1,460	480	26	1.0-1.5	0.0-2.4	Lower reach	-	4.0-6.0 (FS=1) 5.0-7.5 (FS=1.3)

FS=Factor of Safety

minimum hydraulic depth is not necessarily correlated to the minimum discharge due to nonlinear nature of the system. The spreadsheets are provided on the accompanying CD-ROM (Appendix G).

7.7.3 Local Bridge Pier and Contraction Scour

Local pier scour depth was computed using the Colorado State University (CSU) equation (FHWA, 2001) for the 100-year event discharge. Factors affecting the local pier scour depth are velocity of the approach flow, depth of flow, pier and debris width, length of pier, and the angle of the approach flow. The SR-74 Highway bridges have three sets of 4-foot diameter circular piers. A debris width of 4 feet was added to the pier width of 4 feet in HEC-RAS, giving a total pier width of 8 feet. The true pier width was used for the variable *'a'* in the CSU equation. A pier scour depth of 8 feet (6 feet without 1.3 safety factor) was estimated for the combined Upper New River main stem and Sweat Canyon Wash 100-year peak discharge of 31,865 cfs at the West Bridge. The flow of 2,553 cfs under the East Bridge gave a pier scour depth of 4 feet (3 feet without 1.3 safety factor). The FLO-2D flows are 18,000 cfs under the West Bridge, and 8,000 cfs under the East Bridge. The pier scour depths at the West and the East Bridge for the FLO-2D discharges were 6 feet (5 feet without 1.3 safety factor) and 5 feet (4 feet without safety factor), respectively. The FLO-2D based scour depth of 5 feet controlled at the East Bridge. Figures 7.12 and 7.13 summarize the pier scour estimates.

The HEC-RAS discharges reported here were obtained from separate HEC-RAS model run by adjusting the bank stations to define the main channel of interest. The main channel in HEC-RAS is defined by the left and right bank stations. HEC-RAS outputs main channel and overbank flows by "Q-percent, channel," and "Q-percent, left or right overbank." In order to get the flow under the West Bridge for example, the bank stations were placed so that only the main channel under that bridge is defined. Then, in the output table the "Q-percent, channel" or the flow under the West Bridge was found (Using "Options>Define Table") as a percentage of the FEMA FIS flow of 34,411 cfs. The discharge at the "West" Bridge was 92.6% of the FIS discharge of 34,411 cfs, or 31,865 cfs. The "Q-percent, left overbank," (the channel under the East Bridge is located left of the main channel under the West Bridge, looking downstream), was found to be 7.42%. This gave 2,553 cfs flow under the East Bridge, and a corresponding velocity of 3.40 ft/s. The velocity under the East Bridge was obtained by reading the "Velocity-Left Overbank" column (Using "Options>Define Table") in HEC-RAS Standard Table 1. A flow depth of 3.53 feet under the East Bridge was read off the cross section plot. The ineffective flow areas are not accounted for in HEC-RAS for percent flow estimation.

The CSU equation for local pier scour estimation is very sensitive to the K-factors. Tables 7.12 and 7.13 list the K-factors used in the estimation of the pier scour for the West and the East Bridge, respectively. A K_1 factor of 1.0 for round nose piers was used. The K_3 factor of 1.1 for plane bed condition was used for both bridges. K_4 factor was estimated based on the procedure described in the Methodology section of this report.

The estimation of the K_2 factor for angle of attack of flow requires close observation of the flow and velocity distribution in the vicinity of the bridges. This is accomplished by observing the velocity vector distribution from two-dimensional FLO-2D model output.

The velocity magnitude is irrelevant. FLO-2D velocity vectors upstream of the East Bridge show 45 degree angle of attack of the 1,825 cfs flow (obtained from FLO-2D run of the 100-year, 24-hour hydrographs) from the east breakout channel (Figure 7.8a) towards the East Bridge. This resulted in a K_2 factor of 1.6 based on equation 7.17 for estimating the factor, given in the Methodology section. The FLO-2D velocity vector distribution also show that the 45 degree angle flow does not impinge on the bridge piers but turns parallel to the piers at approximately 150 feet upstream of the bridge face as it merges with the southerly Upper New River main stem flow (Figure 7.9). In order to take into account the sensitivity of the CSU equation to the K factors, and to account for the complex existing terrain conditions in the vicinity of the East Bridge, a reasonable value of 1.2 was used. If the flow was absolutely parallel to the piers, K_2 factor would have been 1.0. As a conservative measure, the same K_2 value of 1.2 was applied to the West Bridge pier scour estimation although much of the flow, except for the insignificant lateral contribution around the bridge abutments, was found to be parallel to the piers (Figure 7.10).

Contraction scour depth at the bridges was estimated for the HEC-RAS and FLO-2D flows using the procedures in FHWA (2001), discussed in the Methodology section. The live-bed contraction scour procedure is not applicable because the associated fall velocity estimation chart (Figure 5.8 in FHWA, 2001) is valid for sand size particles. The clear-water contraction scour depth estimation procedure for little or no bed material transport gave scour depths of 5.0 feet (1 foot at FLO-2D discharge) and 0.0 feet (1.8 feet at FLO-2D discharge) for the West and East Bridges, respectively. Per FCDMC (2007a), the greater of the contraction and the general scour depths control in total scour estimation. For the West Bridge, the general scour depth by the Neill equation (Pemberton and Lara, 1984) is 3.0 feet which is lower than the 5.0 feet contraction scour. Therefore, the contraction scour of 5 feet is used in the total scour depth estimation at the West Bridge. As a conservative measure, 1.8 feet of contraction scour based on the FLO-2D discharge is used in the total scour calculation at the East Bridge.

7.7.4 Local Culvert Outlet Scour

Local culvert outlet scour depth was computed using the FCDMC (1996) equation presented in the Methodology section. The culverts were rated using CulvertMaster version 1.0 (Haestad Methods, 1995). Factors affecting the local culvert scour depth are outlet velocity, outlet flow depth, bed material size gradation, duration of flow, and the hydraulic characteristics of the culvert barrel. A total of three culvert locations were identified; two in the Deadman Wash at SR-74 Highway crossings, and one just east of the East SR-74 Highway Bridge that conveys some of the breakout flow from the Upper New River main stem. The set of culverts in the Deadman Wash at Prison Road crossing consist of two 72-inch reinforced concrete pipes (RCP) in the center, and one 48-inch RCP on either side with flared headwall. The other two culverts are 48-inch and 60-inch corrugated metal pipes (CMP) in the Deadman Wash SR-74 Highway crossing, and east of the East Bridge, respectively. Table 7.14 lists the culvert types and hydraulic parameters, and the computed outlet scour depth. The CMP culvert inverts are in 1929 vertical datum per the as-built plans, and the RCP culvert inverts are in 1988 vertical

datum per field survey. The estimated scour depths are reported for the outlet of a single barrel.

Table 7.12
Scour calculation summary: West Bridge

Items (1)	Description (2)	HEC-RAS (3)	FLO-2D (4)
Ys =	Pier Scour depth (ft)	8*	6*
SF =	Safety Factor	1.3	1.3
Y1 =	Max. Flow depth upstream of pier (ft)	12.45	9
K1 =	Pier Shape factor	1	1
K2 =	Angle of Attack at Pier factor	1.2	1.2
K3 =	Bed Condition factor	1.1	1.1
K4 =	Armoring Size factor	0.49	0.44
a =	True Pier width (ft)	4	4
L =	Effective Length of pier (ft)	8	8
Fr =	Froude Number	0.6	0.6
V =	Velocity upstream of Pier (ft/s)	9.6	7
g =	Acceleration of gravity	32.2	32.2

*With Safety Factor = 1.3

Table 7.13
Scour calculation summary: East Bridge

Items (1)	Description (2)	HEC-RAS (3)	FLO-2D (4)
Ys =	Pier Scour depth (ft)	4*	5*
SF =	Safety Factor	1.3	1.3
Y1 =	Max. Flow depth upstream of pier (ft)	3.53	6
K1 =	Pier Shape factor	1	1
K2 =	Angle of Attack at Pier factor	1.2	1.2
K3 =	Bed Condition factor	1.1	1.1
K4 =	Armoring Size factor	0.5	0.4
a =	True pier width (ft)	4	4
L =	Effective Length of pier (ft)	8	8
Fr =	Froude Number	0.6	0.6
V =	Velocity upstream of Pier (ft/s)	3.4	5
g =	Acceleration of gravity	32.2	32.2

*With Safety Factor = 1.3

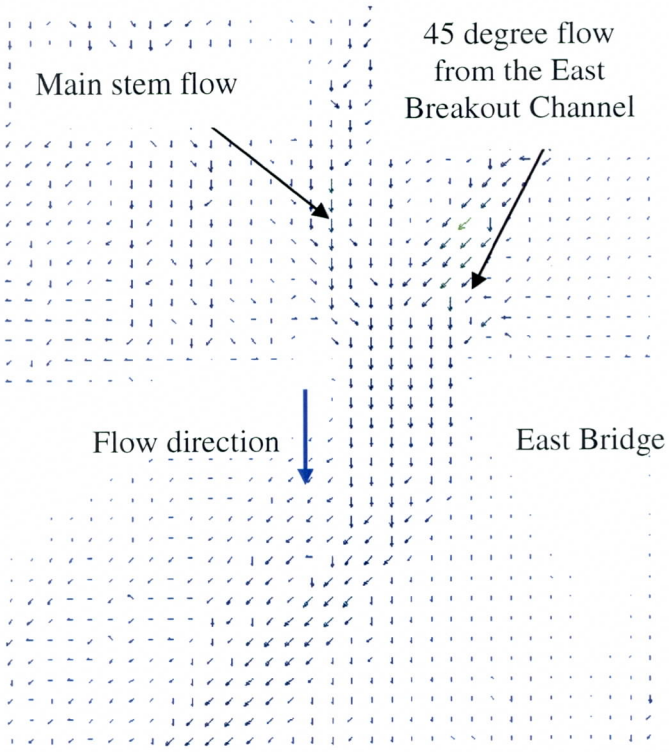

Figure 7.9 - Two-dimensional velocity vectors at the East Bridge (magnitude not shown)

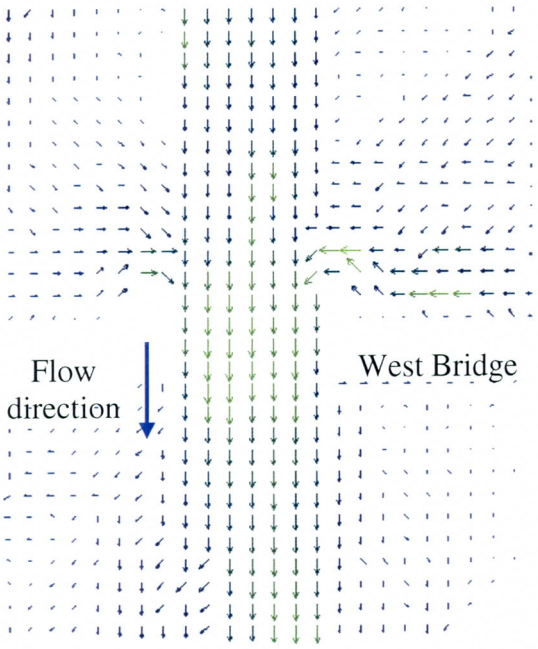

Figure 7.10 - Two-dimensional velocity vectors at the West Bridge (magnitude not shown)

Table 7.14
Culvert outlet scour summary

Culvert ID	Number of Barrels	Location	Type	U/S Invert	D/S Invert	Diameter D	Outlet flow depth y	Discharge per barrel Q	D_{84}	D_{16}	σ	Scour depth hs
				ft	ft	ft	ft	cfs	mm	mm		ft
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
1	1	Deadman Wash at SR-74 Highway	CMP	1587.7	1587.2	4	3.4	125	125	22.5	2.36	4.6
2	1	East of East Bridge at SR-74 Highway	CMP	1560.9	1560.1	5	3.9	183	175	27.5	2.52	5.3
3a	2	Deadman Wash at Prison Road	RCP	1675.9	1675.3	4	3.4	181	125	22.5	2.36	5.5
3b	2	Deadman Wash at Prison Road	RCP	1675	1674.5	6	4.7	394	125	22.5	2.36	7.4

Note: The CMP culvert inverts are in 1929 vertical datum per as-built plans;

The RCP culvert inverts are in 1988 vertical datum per field survey;

The estimated scour depth is at the outlet of a single barrel.

7.7.5 Headcut Analysis at Mine Pits

The methods described in Simons, Li, and Associates (1989) was followed in estimating the headcut for three pits out of four in the Upper New River ADMP study area. Headcut analysis for gravel-bed conditions was conducted for the linear pit in the Upper New River main stem, the upstream pit in the West Branch, and the pit north of the split in the main stem. Those pits were selected based on their significant water storage capacity, and role in controlling the flow dynamics. The triangular pit in the West Branch is very flat for most of its length with low banks. It has limited storage capacity in the furthest south (near the vertex of the triangular shape) where flow breaks out due to low banks (as suggested by FLO-2D results). It is expected that water will spread out in most of its upstream length, and have no effect on its upstream low banks. The Flood Control District of Maricopa County's Pit Scour software (FCDMC, 2007b) was used to analyze the pits. The maximum headcut scour depth at the location of initiation is 1.6 feet for the linear gravel pit, 2.2 feet for the upstream gravel pit in the West Branch, and 1.5 feet for the gravel pit upstream of the West split in the Upper New River main stem. The 100-year 24 hour storm hydrographs were used from the ADMP existing condition HEC-1 models. The West Branch pit area was not modeled in the ADMP HEC-RAS, and so the headcut scour depth of 2.2 feet does not show up on the corresponding total scour spreadsheet. Tailcut is typically not a problem under gravel-bed conditions. In addition, no reasonable pivotal points could be found. Therefore, no additional effort was made to estimate limiting stable slopes per Pemberton and Lara (1984) to estimate long-term scour. Tables 7.15, 7.16, and 7.17 list the physical pit dimension and show the results from the headcut analysis for the two pits.

7.8 CONCLUSIONS

Overall, the Upper New River main stem and tributary washes are vertically stable. Sediment engineering calculations were conducted per the District recommended guidelines. The specific tasks completed were armoring calculations including depth to armor estimation, assessment of long-term aggradation/degradation through equilibrium slope analysis, and total scour estimation along the river miles. Included in the total scour estimate was headcut analysis at the sand and gravel mine pits that have significant storage capacity. The armoring analyses suggest that under the existing conditions, much of the study reaches are either armored or close to being so. Long-term aggradation/degradation trend for the study reaches are summarized in the results section of the report. The locations of those areas are sparsely distributed within the study area but, the locations correlate with flow distribution, and presence of such features as the mine pits, and split flow locations. Although high estimation of total scour was obtained per spreadsheet calculations, it should be noted that not all the scour components that make up the total scour depth are expected to occur at the same time due to uncertainty. Engineering judgment should be made for any future design projects in the vicinity of the river and its tributaries. The total scour estimate is always measured from the thalweg of the channel. Any encroachment into the channels in support of transportation or land development projects should consider review of the scour estimations presented in this report, and re-computed based on local project needs. The sediment engineering results presented in this report are not intended for design but are a guideline on the river morphodynamics as it pertains to regional hydrologic and hydraulic conditions.

Table 7.15
Headcut summary for the Linear Pit in the Upper New River main stem

Pit Information Summary		Dimensionless Scour Profile		Headcut Profile	
(1)	(2)	(3)	(4)	(5)	(6)
Hydrographic File	*LinearPit_MainStem_rev.TXT*	*Ys/Ysbrink*	*Ls/LS5*	*Ys (ft)*	*Ls (ft)*
Time Unit	Hour	0.05	1.00	0.08	225.87
Alluvial Material	Gravel Bed	0.25	0.60	0.41	135.52
Pit Length	1,2000.00 (ft)	0.50	0.30	0.83	67.76
Pit Width	1,000.00 (ft)	0.75	0.15	1.24	33.88
Pit Depth	12.00 (ft)	1.00	0.00	1.65	0.00
Effective Pit Depth	12.00 (ft)				
Ground Water Depth	0.00 (ft)				
Drownout Water Depth	0.00 (ft)				
Pit Volume	13.929,961.00 (cubic ft)				
Pitside Slope	1.5				
Channel Slope	0.004				

Table 7.16
Headcut summary for the Upstream Pit in the West Branch

Pit Information Summary		Dimensionless Scour Profile		Headcut Profile	
(1)	(2)	(3)	(4)	(5)	(6)
Hydrographic File	*WestSplit_rev.TXT*	*Ys/Ysbrink*	*Ls/LS5*	*Ys (ft)*	*Ls (ft)*
Time Unit	Hour	0.05	1.00	0.11	249.12
Alluvial Material	Gravel Bed	0.25	0.60	0.55	149.47
Pit Length	850.00 (ft)	0.50	0.30	1.09	74.74
Pit Width	2,020.00 (ft)	0.75	0.15	1.22	37.37
Pit Depth	14.00 (ft)	1.00	0.00	2.19	0.00
Effective Pit Depth	14.00 (ft)				
Ground Water Depth	0.00 (ft)				
Drownout Water Depth	0.00 (ft)				
Pit Volume	23,201,601.73 (cubic ft)				
Pitside Slope	1.5				
Channel Slope	0.006				
Fill Time	15.51 (hr)				

Table 7.17
Headcut Summary for Gravel Pit North of Split

Pit Information Summary		Dimensionless Scour Profile		Headcut Profile	
(1)	(2)	(3)	(4)	(5)	(6)
Hydrographic File	*UNR Gravel Pit_north of split.TXT*	*Ys/Ysbrink*	*Ls/LS5*	*Ys (ft)*	*Ls (ft)*
Time Unit	Hour	0.05	1.00	0.08	207.92
Alluvial Material	Gravel Bed	0.25	0.60	0.38	124.75
Pit Length	817.00 (ft)	0.50	0.30	0.76	62.38
Pit Width	811.00 (ft)	0.75	0.15	1.14	31.19
Pit Depth	12.00 (ft)	1.00	0.00	1.51	0.00
Effective Pit Depth	12.00 (ft)				
Ground Water Depth	0.00 (ft)				
Drownout Water Depth	0.00 (ft)				
Pit Volume	7,604,579.96 (cubic ft)				
Pitside Slope	1.5				
Channel Slope	0.004				
Fill Time	11.76 (hr)				

7.8.1 Impact to Land Use Plans

The sediment engineering task was limited to three planning areas; the Upper New River, the Lower Deadman Wash, and the Sweat Canyon/Doe Peak Wash Planning areas. Understanding of future or anticipated land use was the key to the development of the Upper New River ADMP. If any local or regional future development should encroach into the Upper New River and its tributary washes, detailed local sediment engineering analysis should be part of the design efforts. This report should be used as a guideline, and collaboration with the District and the consultants involved should be initiated in case of major changes that may affect the hydraulic characteristics of the river and its tributaries.

7.8.2 Impact to Transportation Plans

Roadway embankment encroachment into a river requires an assessment of the bank stability. This requires in-depth sediment engineering analyses. The methodologies followed in this study were implemented to represent local channel hydraulic conditions. This may include but not limited to bank protection toe-down calculations based on the total scour estimation methods, equilibrium slope analysis to determine long-term aggradation/degradation trends, and lateral migration of banks. If a transportation planning corridor encroaches into a floodplain, it may be necessary to place hydraulic structures such as culverts at strategic locations to convey stormwater. This may require detailed analysis of the floodplain flow characteristics using two-dimensional modeling. This report should be consulted for a preliminary assessment of the river mechanics and potential scour hazards.

7.8.3 Design Considerations

The Upper New River ADMP was developed by Stantec for planning purposes. The findings under the study should not be used for design purposes. For any design project in the Upper New River ADMP corridor, site specific sampling of data near existing hydraulic and other infrastructure should be considered. If changes are made to the river bed for scour mitigation, its effect at nearby infrastructure should be taken into account. This sediment engineering report will aid in determining the tasks involved in providing local design measures that do not impair the conveyance capacity of the channels for flood conditions. Interaction among planners, consultants, and local government agencies are recommended.

7.8.4 Significance Relative to Previous Studies

No known sediment engineering (vertical stability analysis) study of the area under any District contract exists for comparison.

7.9 LATERAL MIGRATION

Geomorphology is the study of landforms, the physical processes that forms the land surface and the changes that take place in the evolution of the landform. Geomorphic evaluations conducted for the Upper New River ADMP focused on watercourse landforms and lateral stability of a watercourse. Geomorphic evaluations conducted are based on field observations, aerial photographs (both historic and recent), historical

channel position, stream longitudinal profile and allowable velocity guidelines. The results of the evaluation documents physical changes to the watercourse that have occurred over time and suggest the types of changes that can be expected in the future. Results of the geomorphic investigations are present in Attachment 4 - Erosion Hazard Zone Delineation Study (prepared by JE Fuller Geomorphology and Hydrology).

7.10 REFERENCES

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8 PHASE 1 ALTERNATIVE FORMULATION AND EVALUATION

8.1 INTRODUCTION

This section of the report presents a discussion of the alternative formulation process, alternative evaluation criteria, potential flood and erosion hazard mitigation alternatives, initial alternative evaluation, and recommendations for the advancement of alternatives to be evaluated during the Phase 2 effort.

8.2 PURPOSE

The primary purposes of the Level 1 Alternatives Formulation and Preliminary Alternative Analysis Task was to identify potential alternatives that would mitigate identified flooding and erosion hazards within the project area, evaluate the feasibility of the proposed alternatives and make recommendations for the advancement of alternatives to Phase 2. Alternative formulation included identification of specific design elements for the alternatives. Specific design elements/considerations are identified so that the overall alternative design is consistent with the communities engineering, planning and park and recreation plans. Specific purposes of the Level 1 Alternatives Formulation and Preliminary Alternative Analysis Task included:

- Stakeholder meetings to relate the identification of existing and potential flooding and erosion hazards
- Ideas for potential flood control management alternatives to stakeholders and obtain their input
- Formulation of flood control management alternatives
- Development of evaluation criteria that will be utilized in Phase 2 to rank alternatives
- Recommendation of flood control management alternatives to be considered in Phase 2
- Initial hydraulic evaluation to determine feasibility of proposed alternatives

8.3 ALTERNATIVE FORMULATION

Formulation of alternatives was achieved through a Brainstorming meeting and a stakeholder work group meeting. The project team, City of Phoenix and City of Peoria staff participated in a Brainstorming meeting conducted on April 17th, 2007. The results of the Brainstorming meeting were then presented to stakeholders in a work group meeting held on May 15, 2007.

To facilitate the alternatives formulation process alternatives were developed for specific planning areas. The location and boundaries of the Planning Areas were based on geographic and physical characteristics. Watercourses in specific planning areas have similar physical, hydraulic and watershed characteristics and therefore are evaluated collectively. Figure 1.1 depicts the name and location of the planning areas. Summaries of identified flood and erosion issues and physical and planning characteristics for each

planning area that were used in the alterative formulation and evaluation process are located in Appendix H.

8.3.1 Brainstorming Meeting

An Alternatives Formulation (a.k.a. Brainstorming) meeting was held to present existing and potential flood and erosion hazard identified in the project area, data collection results, and environmental and scenic resource overview and assessments. In addition to assessment presentations, the team developed evaluation criteria that will be used to evaluate alternatives that were developed in the Brainstorming meeting.

8.3.1.1 Evaluation Criteria

The following criteria and goals will be used to select a recommended alternative. Each alternative will be measured on how well the alternative meets the criteria. The five major performance criteria are:

- Public Safety & Flood Hazard Mitigation
- Implementation
- Scenery Resources
- Recreation and Open Space
- Natural Resources

These criteria are described in more detail below. Each of these criteria will have a weight assigned to it that is appropriate for the level of importance of the criteria (e.g., Public Safety & Flood Hazard Mitigation may be weighted as three times as important as the Scenery Resources criteria.). Assigning the weights to the criteria will be done by using input from the project team, project partners, and the stakeholders.

Public Safety & Flood Hazard Mitigation Criteria & Goals

- Solve Existing Flood Hazards - Remove existing structures from the 100-year floodplain / floodway or reduce the potential for damage to existing structures due to lateral migration, bank erosion, flow breakouts, sediment deposition or local scour while providing / maintaining emergency access to existing facilities
- Adverse Consequences/Consequences of Failure (Risk) - Presents potential for an attractive nuisance; failure of the alternative, increase in the risk of loss of life and damage to property
- Reclaimed Floodplain - Provides opportunity for the maximization of developable property.

Implementation Criteria & Goals

- Multiple Funding Sources
- Complexity of Implementation
- Community Support
- Stakeholders' Support

- This element evaluates whether we can expect stakeholders to support, approve and adopt the alternative. Consider the criteria each individual stakeholder will utilize to evaluate each alternative, i.e. regulatory, permitting, funding participation, etc. and the likelihood that they support the alternative. Additionally this element considers the general consensus of the multiple stakeholders for such support, approval and adoption of the alternative.

- Compatibility with other Agency Plans
  - This element ranks how well an alternative accommodates other Agency Plans (i.e., land use, parks, trails, transportation, etc.). Accommodating other Agency Plans has a positive effect on gaining consensus towards a preferred alternative. Each alternative should be ranked relative to each other as to how effectively the alternative accommodates other Agency Plans. The more an alternative accommodates other Agency Plans the higher the score

- Regulatory Permits
  - This element evaluates the level of difficulty or complexity for local, state and federal permitting required for an alternative. Regulatory permitting can make an alternative less desirable or less feasible if creates increased cost, project delays, insurmountable mitigation requirements, or a denial of the permit. Alternatives should be evaluated as to the relative difficulty or complexity in gaining the necessary regulatory permits that lead to successful implementation. An alternative that has the least relative difficulty or complexity in gaining regulatory permits receives the higher score. Each alternative should be ranked relative to each other.

- Optimize the Timing & Phasing
  - This element evaluates whether there are meaningful opportunities to phase the alternative or elements of the alternative. The public safety and flood hazard mitigation alternatives might be implemented however the accompanying aesthetics and recreational elements might have the ability to be deferred. The opportunity for phasing improves the overall implementation of the more critical functions of the alternative.

Scenery Resources Criteria & Goals

- Degree to which Alternative is compatible with Scenic Resources.
- Utilize flood control projects to improve and restore landscapes with visual disturbances to a condition that is complementary to the valued character of the surrounding landscape.

Recreation and Open Space Resources Criteria & Goals

- Degree to which Alternative is compatible with Existing Recreation and Open Space Resources

- Maximize opportunities to meet future needs for passive and active recreation.
- Maximize opportunities to implement the Maricopa Regional Trail Master Plan and meet local community need for trails.

Natural Resources Criteria & Goals

- Impact to Riparian Habitat - Streamside habitat, including ephemeral washes; stock tanks; mesquite bosques.
- Impact to Wildlife Corridors - Areas of dense vegetation and cover that are utilized for wildlife movement.
- Impact to Waters of the U.S. - Federally regulated, jurisdictional ordinary high water mark of rivers and washes.
- Impact to Upland Habitat - Upland habitat with palo verde, ironwood, and cactus forest and stands of brittlebush, bursage and creosote.

8.3.1.2 Flood and Erosion Hazards Issues

Floodplain delineation and erosion hazard zones form the basis for the identification of potential public safety hazards associated with natural processes that form the physical characteristics of watercourses within the study area. Floodplain delineations determined by various studies within the study area are based on the 100-year storm event. The limits and location of 100-year floodplain delineations within the study are depicted on Figure 2.1. Erosion hazard delineations were conducted as part of this study for the study reaches on New River and Deadman Wash. These delineations are also depicted in Figure 2.1. In addition to flood and erosion hazards depicted in Figure 2.1 the following flood issues were identified for each planning area:

8.3.1.2.1 Gavilan Peak Planning Area

- Structures within floodplains -There are residential structures within the floodplain limits of Gavilan Peak Wash and tributaries to Gavilan Peak Wash.
- Meander Road in the community of New **River** - The team observed evidence of scour and signs that runoff had overtopped the roadway at culvert locations after summer rains (2005).
- Flood issue areas identified in a public meeting - Property owners, residential structures and lots within the Gavilian Peak Wash floodplain have been impacted by a flood events.
- New River Road near Gavilan Peak Wash and roadway crossing of tributaries to Gavilan Peak Wash -The project team observed signs of flow overtopping the road, in some areas causing significant erosion and undermining of the roadway shoulder. Many culverts are clogged with sediment or debris. A New River resident provided flood photos from a summer of 2005 rainfall event in which flood flow overtopped New River Road and flooded his property.

- Photo View Wash flow break out -A potential flow breakout occurs along the south bank of Photo View Wash between the roadway alignments of 23rd Drive and 27th Avenue. Linear bands of denser vegetation located in topographic low areas sustained by runoff indicate that there have been historic flow breakouts that have eroded a small drainage swale. There may be a potential for a channel avulsion at this location.

8.3.1.2.2 New River Planning Area Upstream of I-17

- Old Stage Coach Road at Dip Crossing - There was a fatality at the low flow crossing of New River in August 2005. Residents described the flood as a "15-foot wall of water." The incident was documented by The Arizona Republic in the story entitled "1 Dead, 1 lost in Flash Floods."

- Elementary School at New River -The project team received reports of flooding at the New River Elementary School. The flooding is from runoff generated in a watershed located to the west of the school. Runoff drains through the school grounds in a series of box culverts and channels to New River. It was related that the box culverts clogged with debris and runoff overtopped Old Stage Coach Road (35th Ave. alignment) and a pedestrian crossing within the school grounds. Flow that overtopped the culverts and channel impacted school facilities.

- Old Stage Coach Road (35th Ave.) adjacent to New River - Flood and public hazard in this area is related to access. Access is cut off for 15 property owners who have homes along Old Stage Coach Road upstream of the road's crossing with New River. Old Stage Coach Road located within the New River 100-year floodplain is impacted by flood waters from approximately a 10-year event or greater. Historically, this location has been a flood issue. To help alleviate the problem a training levee was constructed in the watercourse so that runoff in the low flow channel of New River would be directed away from Old Stage Road. The levee will be over topped when a runoff peak discharge of greater than approximately 10,000 cfs (approximately the 10-year event) is being conveyed within New River. Portions of the training levee have been eroded away and eventually it will no longer perform the intended function. It is unknown who constructed the levee.

- New River levees downstream of New River Road Bridge - New River Road Bridge levees tie into adjacent linear levee features. The linear levee features appear to be man-made, however they are not certified and have not been maintained. Because the feature does not meet FEMA criteria the 100-year floodplain occurs on both sides of the levee (floodplain is based on an assumption that the levee feature will not provide a benefit). The levee feature forming the east bank of New River Road extends downstream from the bridge approximately a quarter of a mile cutting off an old meander channel in the left overbank area. There is an opening in the levee feature near the end of the old meander channel that allows local flow to drain out. However some flow is impounded behind the levee and during runoff events within New River flow drains back into this

impoundment area. According to a resident in the area, this causes some vector issues.

- Flood issue areas identified in a public meeting - Property owners, residential structures and lots within the New River floodplain upstream of the Old Stage Coach Road crossing of New River have been impacted by a flood event.

8.3.1.2.3 Lower Deadman Planning Area

- Carefree Highway (SR 74) at Deadman Wash - The Carefree Highway crossing of Deadman Wash consists of a roadway dip section and a 48" culvert structure, which does not have the capacity to carry flood flows. Flood flows cross over SR 74 in depths greater than one foot, posing a hazard to the public and emergency vehicles.

- Lower Deadman Planning Area, Sheet Flow - The majority of the Lower Deadman Planning Area lacks defined drainage networks. The area is characterized by broad, flat land surfaces with minimal lateral topographic relief. Sheet and unconfined flow occurs where there is no defined drainage network to convey the majority of floodwater. Flow within sheet flow areas tends to have low lateral erosion potential due to shallow depths and low velocities, however broad floodplains are associated with sheet flow areas.

8.3.1.2.4 Upper Deadman Planning Area

- Structures in Jenny Lin Wash - There are residential structures within the floodplain limits of Jenny Lin Wash.

8.3.1.2.5 New River Planning Area Downstream of I-17

- Structures in New River - Downstream of I-17 there are residential structures within the floodplain limits of New River.

- New River Downstream of I-17 Flow Breakout -Along the reach of New River between I-17 and the Carefree Highway, flood hazards include flow break out and distributary flow areas. Flow break out occurs at locations where the banks of the watercourse are not of sufficient height to contain flow from a 100-year or less event. Flow break out occurs:

    - Along the west bank of New River at the West Split located approximately three and one half miles downstream of I-17. Flow draining to the West Split ultimately combines with flow from Sweat Canyon.

    - Along the east bank of New River approximately two miles upstream of SR 74. Flow breaks out of New River to the Deadman Wash Watershed. Breakout flow ultimately drains to and overtops the Carefree Highway.

    - Distributary flow areas are areas in which the primary flow paths for a given runoff event is unpredictable due to the potential for the channel to change during a flood event. The New River Reach just upstream of the

Carefree Highway between the east and west bridges is a distributary flow area and is physically characterized by:

- Flow paths in the area between bridges are complex and not easily defined. Multiple channels drain flow to the east bridge, west bridge and to the roadway embankment between the two bridges.

- Flow draining along the roadway embankment has undermined and eroded the embankment.

8.3.1.2.6 Rock Springs, Sweat Canyon/Doe Peak, West Tributaries, Upper Deadman and Lone Mountain Planning Areas

- Rock Springs, Sweat Canyon/Doe Peak, West Tributaries, Upper Deadman and Lone Mountain Planning Flood Hazards -These areas have similar physical characteristics, are located predominately within mountain and piedmont landform areas and are primarily undeveloped. Physical characteristics related to flood and erosion hazards include:

    - Watercourses in the piedmont areas consist of moderately steep, well-defined channels with narrow floodplains. These streams generally have low lateral erosion potential due to low peak discharges, relatively resistant boundary materials (cobbles, clay, and/or caliche), and bank vegetation.

    - Channels in mountainous areas consist of well-defined, low sinuosity tributary streams located in bedrock or mountain canyons. These streams have low lateral erosion potential and have narrow floodplains.

8.3.1.3 Formulation of Proposed Alternatives

Formulation of proposed alternatives took into consideration existing flood and erosion hazards, environmental and scenery resources and land use and transportation planning elements. Table 8.1 lists proposed alternatives that were developed in the Brainstorming Meeting for each planning area. Table 8.2 lists specific design/planning elements to be considered in the development of an alternative. Design/planning elements are elements that are specific to an alternative and are not alternatives themselves.

Structural alternatives that involve either, channelization, levee or floodwall designs were proposed for reaches of New River, Deadman Wash and Gavilan Peak Wash. Between the structural reaches, the non-structural alternative is proposed. Nonstructural approaches are proposed for the rest of the watercourses in the project area, however structural improvements at roadway crossing and for unique development situations that require some encroachment in the watercourse could be considered. Figures 8.1, 8.2 and 8.3 depict the location of proposed structural alternatives.

8.3.1.4 Alternatives Recommended for Further Evaluation

Proposed alternatives were reviewed for their function to mitigate identified flood and erosion hazards and the compatibility with proposed land use elements. With the

exception of the alternative that recommends channelization of the West Split area to increase developable area (under Channelization Alternative Descriptions, New River Planning Area Downstream of I-17) and the alternative that recommends draining flow from Doe Peak and Sweat Canyon above New River Road to New River (under Channelization Alternative Descriptions, New River Planning Area Downstream of I-17). All alternatives listed in Table 8.1 are recommended for additional evaluations.

The reasons for not recommending the channelization of the West Split area to increase developable area are:

- Channelization is inconsistent with desired land use in the area referred to as the West Split. The land use designation in this area is made based on the complete removal of the existing floodplain.

- Channelization would require bank protection and grade control structures over approximately a two mile reach. Preventing the breakout flow from New River that drains to the West Split area would require structural improvement (levee and bank protection) over approximately a half mile reach. Fewer structural improvements are required to prevent the flow break out.

The reasons for not recommending draining flow from Doe Peak and Sweat Canyon above New River Road to New River are:

- In order to drain flow from Doe Peak and Sweat Canyon channelization through a proposed Mixed Land Use would be required. Channelization is inconsistent with the desired land use. The proposed channel would be located in the West Split Floodplain which is designated to be reclaimed for a Mixed Land Use.

- Drainage in the area typically drains from the northeast to the southwest, this channelization alternative would take flow from the northwest and drain it to the southeast. The available grade to drain the channel to the southeast may not be sufficient enough that a benefit would be realized for the alternative.

Table 8.1
Summary of Alternatives Developed in Brainstorming Meeting

Gavilan Peak – Alternatives Considered

Detention Basin Alternative

- Construct a detention basin to reduce the 100-year peak flow along Gavilan Peak Wash.
    - If the detention basin significantly reduces runoff, properties could be removed from the floodplain
    - Basin could be a multi-use site, such as an equestrian center

Development Guidelines & Floodplain Management

- Prepare development guidelines for new property development to reduce flood risk
- Promote and continue with sound floodplain management
- Provide existing property owners with guidelines to reduce their flooding and erosion risk
- Delineate additional floodplains where appropriate

Floodprone Property Assistance Program

- Voluntary program
- Floodproof homes in Gavilan Peak Wash Floodplain
- Acquire homes in the Gavilan Peak Wash Floodway
- Estimated cost depends on the number of requests for assistance

Levee Alternative along the main tributary of Gavilan Peak wash

- Reduce width of 100-year Floodplain
- 28 properties would be removed from the floodplain
- Alternative rejected because of high costs for construction and maintenance compared to the number of properties protected

Roadway Improvements

- Increase the culvert sizes along the roads where necessary
- Install culverts at road/wash crossings to reduce the number of dip crossings
- Establish an all-weather access route

Table 8.1 Cont.
Summary of Alternatives Developed in Brain Storming Meeting

New River Upstream of I-17 – Alternatives Considered

Floodplain Management

- Develop a Flood Warning Response plan for the residents
- Promote and continue with sound floodplain management
- Provide existing property owners with guidelines to reduce their flooding and erosion risk
- Delineate additional floodplains where appropriate

Floodprone Property Assistance Program

- Voluntary Program
- Floodproof homes or acquire homes in high hazard areas within New River Floodplain
- Estimated cost depends on the number of requests for assistance

Channelization adjacent to Old Stage Road

- Improve conveyance capacity of New River Channel to reduce flooding on Old Stage Road
- Improve conveyance capacity of the New River channel, which could reduce the floodplain
- Alternative rejected because the flood hazard would not be reduced

Provide levee along alignment of Old Stage Coach Road

- Provides access for residents to their property during a runoff event
- Re-construct Old Stage Road as a levee

Remove or Reduce vegetation from the New River Channel adjacent to Old Stage Road

- Improve conveyance capacity of New River Channel to reduce flooding on Old Stage Road

Divert runoff from New River to the Agua Fria River (New River Diversion Structure)

- Improve conveyance capacity of New River Channel to reduce flooding on Old Stage Road
- Improve conveyance capacity of the New River channel, which could reduce the floodplain and potentially the reduce or eliminate flow split downstream of I-17

Table 8.1 Cont.
Summary of Alternatives Developed in Brain Storming Meeting

New River Downstream of I-17 - Alternatives Considered

Channelization Alternative

- Channelize New River to reduce the floodplain width and prevent flow splits
- Channel could be developed to accommodate multi-recreational uses
- Develop a plan for sand and gravel companies to excavate channel
- Channelization of the West Split area
- Provide channel to drain Doe Peak and Sweat Canyon above New River Road to New River

Detention Basin Alternative

- Sand and Gravel plan would be developed to create a linear detention basin adjacent to or within New River
- Peak Flow would be reduced, which reduces the floodplain width
- Basin could be developed to accommodate multi-recreational uses
- Estimated Costs: Depends on the agreements with the sand and gravel mining and other entities

Development Guidelines & Floodplain Management

- Prepare development guidelines for new property development to reduce flood risk
- Delineate additional floodplains where appropriate

Levees option for New River & East Bank of Sweat Canyon

- Earthen levees approximately 3 to 8 feet high would be constructed to prevent flow from breaking out from the main channel of New River into the West Split of New River
- Earthen levees approximately 3 to 8 feet high and would be constructed to prevent flow from breaking out from Sweat Canyon which reduces the size of the West Split floodplain
- Levees located upstream of SR 74 would be constructed to direct the New River flows to either the east or west bridges or both along SR 74; this reduces the floodplain and prevents future erosion issues along the east bank of New River

Roadway Improvements

- Provide adequate cross drainage structures along roads where necessary
- Install culverts at road/wash crossings to reduce the number of dip crossings
- Construct bridge(s) where appropriate

Table 8.1 Cont.
Summary of Alternatives Developed in Brain Storming Meeting

Lower Deadman Planning Area – Alternatives Considered

Channelization

- Channelize a segment of Deadman Wash to facilitate cross drainage at the Carefree Highway

Detention Basin Alternative

- Construct a detention basin to reduce the 100-year peak flow in Deadman Wash at the Carefree Highway

Floodplain Management

- Prepare development guidelines for new property development to reduce flood risk
- Promote and continue with sound floodplain management
- Provide existing property owners with guidelines to reduce their flooding and erosion risk
- Delineate additional floodplains where appropriate

Roadway Improvements

- Provide drainage structures at the Deadman Wash Crossing of the Care Free Highway

Lone Mountain, Upper Deadman Wash, New River Dam, Rock Springs, Sweat Canyon, & West Tributaries Planning Areas –Alternatives Considered

Floodplain Management

- Prepare development guidelines for new property development to reduce flood risk
- Promote and continue with sound floodplain management
- Delineate additional floodplains where appropriate

Floodprone Property Assistance Program

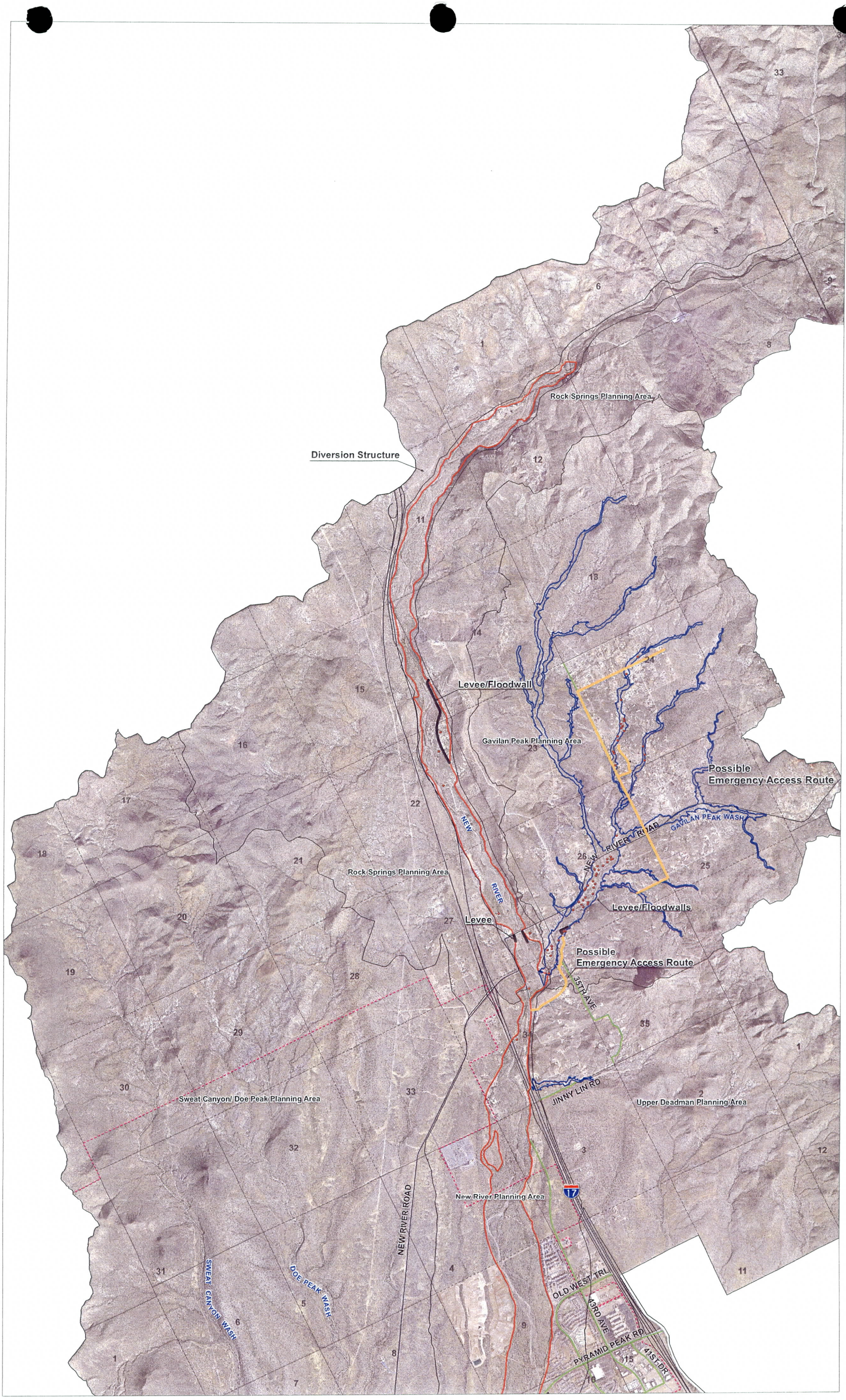
- Voluntary Program
- Floodproof homes in the Jenny Lin Wash Floodplain
- Estimated cost depends on the number of requests for assistance

Roadway Improvements

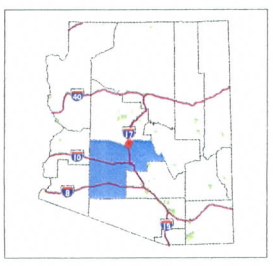
- Provide adequate cross drainage structures along roads where necessary
- Install culverts at road/wash crossings to reduce the number of dip crossings
- Establish an all-weather access route

Table 8.2
Design Considerations

Design elements
• Provide Rules of Development that list design guidelines to be followed
• Regional permit for 404 permit as an implementation tool
• Provide Roadway/wash crossings that are all weather access
• Accommodate Black Canyon Trail
• Accommodate regional trail corridors
• Construct trail passage through bridges and culverts
• Maintain riparian areas and wildlife corridors
• Culverts/Bridges to span the 10-year floodplain at a minimum, 100-year desirable
• Apply open space preserve guidelines in floodplain
• Structures are to be designed to be context sensitive with the environment.



Location Map



Notes:

Prepared By
AMG
May 2008

Revision.
By Appd Date

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N

N.T.S.

Legend:

- Structure Within Floodplain
- Proposed Levee Alignment
- Roadway
- Peoria Future Roadway Alignments
- Phoenix Future Roadway Alignments
- Floodplain
- Erosion Hazards
- Peoria Corporate Boundary
- Phoenix Corporate Boundary
- Sections

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Upper New River ADMP
FCD 2005CO20
Draft Alternative Alignments
Figure 8.1

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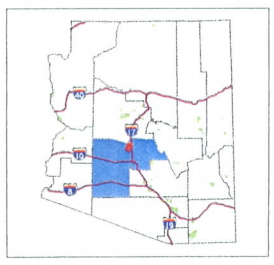
8211 S. 48th Street
Phoenix, AZ U.S.A. 85044

Location Map



Notes:

Prepared By: AMG
February 2008

Revision

By Appd Date

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N.T.S

Legend:

- Structure Within Floodplain
- Proposed Levee Alignment
- Bridge
- Culvert
- Roadway
- Peoria Future Roadway Alignments
- Phoenix Future Roadway Alignments
- Floodplain
- Erosion Hazards
- Peoria Corporate Boundary
- Phoenix Corporate Boundary
- Sections

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Upper New River ADMP
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Draft Alternative Alignments
Figure 8.2

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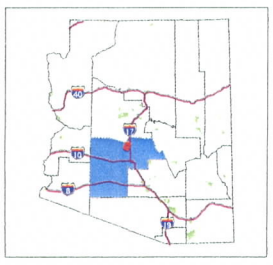
Location Map



Notes:

Prepared By: AMG
February 2008

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N.T.S.

Legend:

- Structure Within Floodplain
- Proposed Levee Alignment
- Bridge
- Culvert
- Roadway
- Peoria Future Roadway Alignments
- Phoenix Future Roadway Alignments
- Floodplain
- Erosion Hazards
- Peoria Corporate Boundary
- Phoenix Corporate Boundary
- Sections

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Figure 8.3

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8.4 PHASE 1 HYDRAULIC EVALUATION OF PROPOSED ALTERNATIVES

Initial hydraulic evaluations were conducted to determine the feasibility of a proposed alternative. Alternatives recommended for Phase 1 evaluations include levee, channel, vegetation maintenance, non-structural and retention basin alternatives for New River, and levee and nonstructural alternatives for Gavilan Peak Wash, a regional retention basin alternative for the Gavilan Peak Wash and Deadman Wash, levee and channel alternatives for Deadman Wash and a dam/diversion alternative recommended for the reach of New River upstream of I-17.

For each planning area, structural alternatives presented in Table 8.1 were evaluated in order to identify alternatives to be considered for further, more detailed analysis. Evaluations were based on generalized, "low resolution" hydraulic modeling and qualitative interpretations of the benefits and impacts in regard to the evaluation criteria and physical constraints of the area.

Hydraulic modeling of the alternatives was accomplished by modifying the existing HEC-RAS models. Modifications to those models were limited to changes in roughness coefficients and the use of the encroachment and levees to represent the general features of the various alternatives. The original and modified models are provided digitally on CD as Appendix I.

8.4.1 Gavilan Peak Planning Area

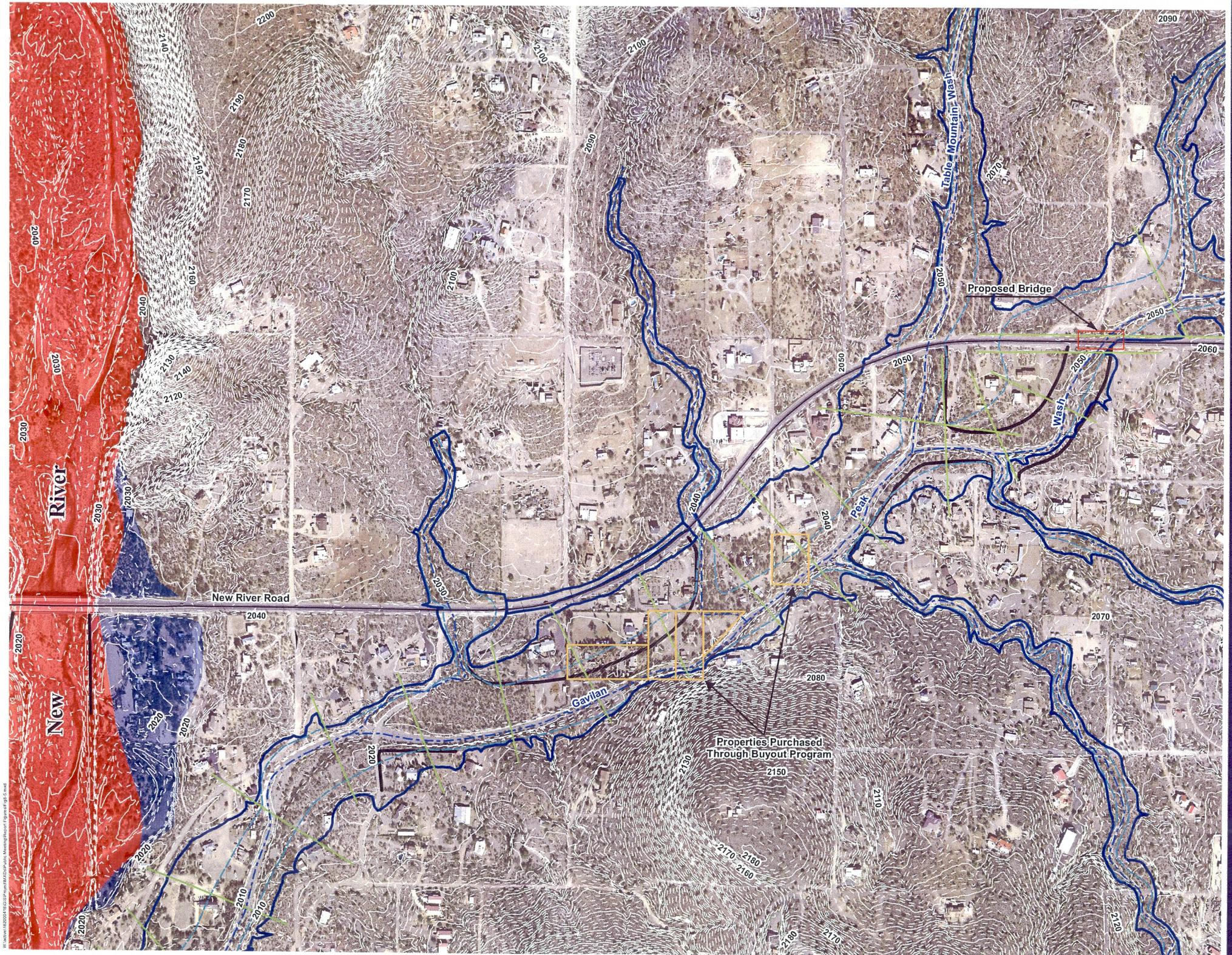
Structural alternatives identified for the Gavilan Peak Planning Area include: upsizing culvert crossings, levee and a detention basin. Each element could be used independently or in combination to minimize the current flooding issues.

There are approximately 28 structures located on properties that have not been acquired through the District's FPAP program within the pending floodplain/floodway limits of Gavilan Peak Wash. Construction of a levee would remove a majority of those structures from the floodplain. The proposed levee alignment is shown in Figure 8.4 and generally follows the FEMA floodway boundary. The proposed levee is modeled using the levee option in the HEC-RAS model. Both the original FEMA model and modified HEC-RAS models are provided digitally on CD as Appendix I. Based on the model results for existing condition peak discharges, a levee with an average height of 7 feet, including 3 feet of freeboard, would be required. Construction of a levee at the floodway boundary would result, in general, in an increase in the channel velocity. The maximum increase in channel velocity would be approximately 6 fps (an increase from 7 fps under existing condition to 13 fps with the proposed levee). The average increase in channel velocity would be less than 1 fps.

Increasing the size of existing culvert crossings will improve emergency access conditions as well as minimize backwater conditions and potential flow splits. The New River Road culvert crossing of Gavilan Peak Wash shown in Figure 8.4 is an example of the problems associated with the roadway profiles in the area and an undersized culvert. Under existing conditions at this location flow breaks out of the main channel and heads west along New River Road combining with flow in Table Mountain Wash before crossing the road. Given the physical conditions at this site (existing roadway profile,

channel depth and width) and based on the results of the hydraulic model, a bridge would be required to reduce the potential for this breakout to occur.

A detention basin could alleviate some of the flooding issues by reducing the peak discharge. A potential location for a detention basin is Table Mountain Wash at the confluence with River Creek as shown on Figure 8.5. The Table Mountain Wash subwatershed is the largest tributary to Gavilan Peak Wash and produces nearly half of the total runoff for the Gavilan Peak Wash watershed. The 100-year, 24-hour peak discharge at the proposed detention basin location is approximately 3,900 cfs. The 100-year, 24-hour peak discharge in Gavilan Peak Wash just upstream of the confluence with Table Mountain Wash is approximately 4,700 cfs. The 100-year, 24-hour peak discharge in Gavilan Peak Wash at the confluence with Table Mountain Wash is approximately 8,400 cfs. Many of the known flooding issues in the Gavilan Peak Planning Area occur along Gavilan Peak Wash in the vicinity of the confluence with Table Mountain Wash. The Table Mountain Wash subwatershed is also largely undeveloped. Thus a basin along Table Mountain Wash would provide the greatest reduction in peak discharge with a minimum number of constraints. An initial evaluation of the potential benefits of this alternative was conducted assuming the proposed detention basin would act as a retention basin providing storage of the entire runoff volume from the Table Mountain Wash subwatershed. The resulting peak discharges along Gavilan Peak Wash were input to the HEC-RAS model. Those results show a reduction in water surface elevation along Gavilan Peak Wash downstream of the confluence with Table Mountain Wash by as much as 2 feet. However, in general the overall flooding limits remain unchanged due to the nature of the channel/overbank geometry. The only benefit is that the depth of flow in the overbank is reduced. Therefore, this alternative is rejected.



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FCD 2005CO20

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Legend:

- Roadway
- Cross Section Alignment
- Hydraulic Baseline
- Proposed Levee Alignment

Pending Flood Zones

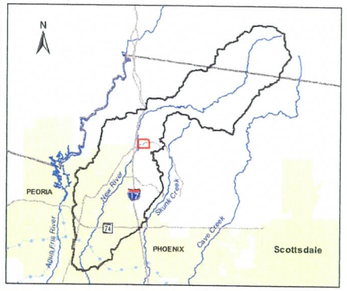
- Floodway
- Floodplain

FEMA Flood Zones

- A
- AE
- FW

Notes:

Location Map:



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0 100 200 400 600 Feet

Project No.
182000418

Title
Gavilan Peak Levee
Figure 8.4

Prepared By:
NCG
June 2008

Revision:

	By	Appd.	Date

Sheet 1 of 1

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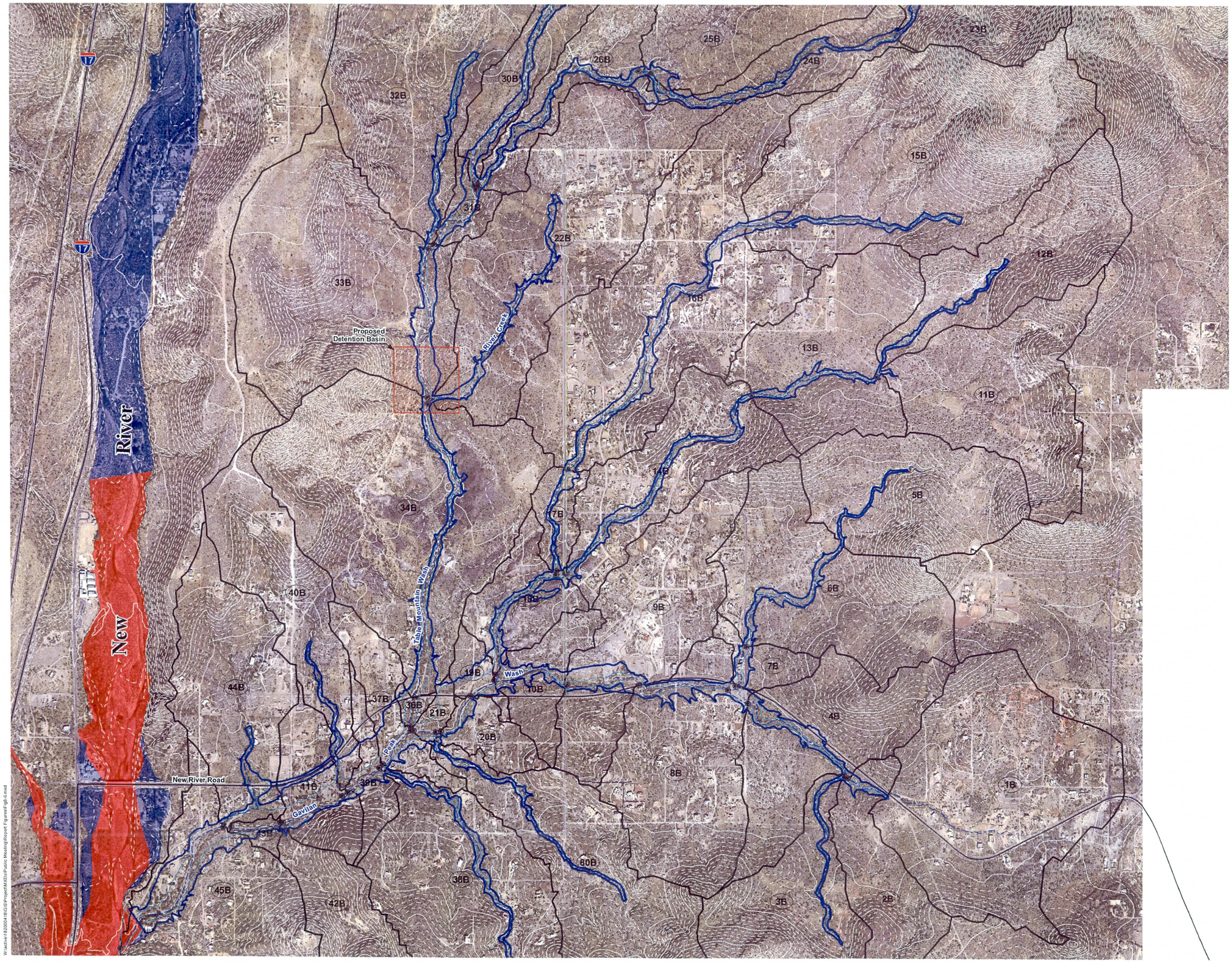

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Phoenix, AZ U.S.A. 85044

Stantec

Legend:

- Concentration Point
- Subbasin Boundary
- Roadway

Pending Flood Zones

- Floodway
- Floodplain

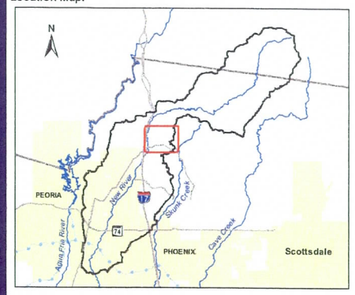
FEMA Flood Zones

- A
- AE
- FW

Notes:

1. Base map: Circa 2005 aerial photography and 2-ft C.I. mapping
2. Cross section alignments from FCDMC DFIRM data. Not all cross section ID's match hydraulic model

Location Map:



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0 300 600 1,200 1,800
Feet

Project No.
182000418

Prepared By:
MCG
February 2008

Title
Gavilan Peak Basin
Figure 8.5

Revision:

	By	Appd.	Date

Sheet 1 of 1

8.4.2 New River Planning Area Upstream of I-17

Historic flooding has occurred for the reach of New River upstream of I-17. Residents with homes within and adjacent to the New River Floodplain have been impacted from runoff events. There are a number of residential structures adjacent and out side of the 100-year floodplain that have not been directly impacted; however access to the structures is across and/or through the floodplain limits of New River and is limited or non-existent in a runoff event. After the 1993 flood event the District investigated four alternatives to mitigate observed flooding. Alternatives evaluated were, levees to protect residential structures from flooding, a dam located upstream of residential structures to retard floodwaters and a buyout programs for houses located within the New River Floodplain (coincidental with floodway) and a No Action Alternative. The alternative that received the highest prioritization scour was the buy out program. The levee and dam alternatives received low scours because of the cost of the facility compared to cost of purchasing houses within the floodplain and environmental impacts associated with the construction of the facility.

Alternatives developed in the Brainstorming Meeting for the New River Planning Area Upstream of I-17 that required hydraulic evaluations to determine the feasibility to advance the alternative to Phase 2 evaluations are; a proposed diversion structure located in New River near the Table Mesa Road I-17 traffic interchange; vegetation management of New River for a reach located adjacent to Old Stage Coach Road, and roadway improvements to Old Stage Coach Road for the segment adjacent to New River. The benefit that the diversion alternative would have if implemented would be to reduce downstream peak discharges that would help mitigated existing problems along Old Stage Coach Road and split flow locations along New River downstream of I-17. The benefits of the vegetation management alternative would be to increase flow conveyance in the New River channel so that flood impacts to Old Stage Coach Road are minimized and access to property located adjacent to Old Stage Road that historically has been flooded during frequent flood event is improved.

8.4.2.1 New River Diversion Structure

The proposed New River diversion structure would be designed to divert flow from New River to the Agua Fria River upstream of New Waddell Dam. This alternative could mitigate or potentially mitigate flooding issues in the New River Planning area both upstream and downstream of I-17. The location of the proposed diversion structure is shown in Figure 8.6. The effectiveness of the proposed diversion structure is evaluated for diverted discharge magnitudes of 2,000, 5,000, 7,000 and 10,000 cfs as well as for a total diversion (approximately 29,400 cfs). The diversion structure is a peak scalping structure that would allow base flow to drain downstream. The purpose to allow base flow to drain downstream is to provide water to downstream riparian vegetation. The 100-year, 24-hour existing condition ADMP HEC-1 model is modified to reflect each diversion condition. Those models are provided on CD as Appendix I. The point of diversion in the HEC-1 model is CP100. The drainage area at this location is approximately 73 square miles. Peak discharges downstream of the diversion for each condition are summarized at key locations in Table 8.3. The modeling results of the diversion to the Agua Fria Watershed show that:

- There is no flood hazard benefit downstream of I-17 for the diversion cases evaluated except for a total diversion of flow to the Agua Fria Watershed and even with the total diversion scenario split flow would still occur at the West Split.

- A total diversion would eliminate water to downstream riparian areas and thus have a significant environmental impact.

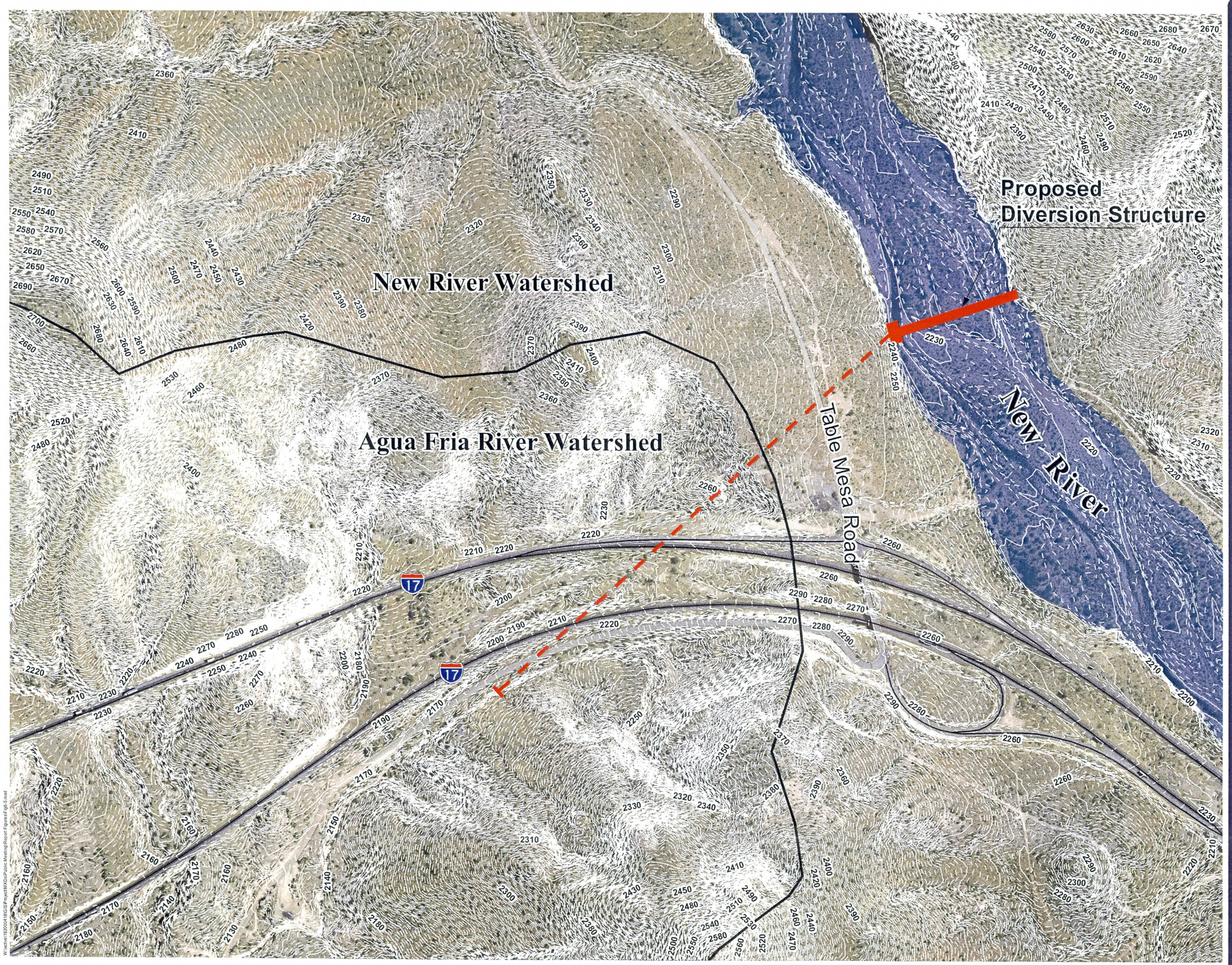
- A significant reduction in peak discharge would be required to reduce the flooding limits and hazards along Old Stage Coach Road.

- Given the magnitude of the size of the facility a probable construction cost of the diversion structure was estimated under two scenarios, diversion of all of the ADMP peak discharge and diversion of 10,000 cfs.. The estimated probable cost of a 10,000 cfs diversion structure is $28,000,000 where as the estimated construction cost for the diversion the ADMP 100-year peak discharge is $60,000,000. Cost estimate is only for the construction of the concrete structures and does not include right of way cost, earthwork cost, I-17 detour cost or I-17 reconstruction cost.

Table 8.3
100-year, 24-hour peak discharge downstream of the proposed New River diversion

HEC-1		100-year Peak Discharge, in cfs					
ID	Location	ADMP	Case A	Case B	Case C	Case D	Case E
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
CP100	Table Mesa Rd.	29,400	0	27,500	24,400	22,400	19,400
CP120	Stage Coach Rd.	29,000	4,000	27,300	24,400	22,400	19,700
CP130	New R. Rd Bridge	28,800	3,700	27,300	24,300	22,400	19,400
CP150	I-17 Bridge	29,000	10,400	27,500	25,000	23,400	21,200
DIV175	Div. to West Split	5,400	100	4,500	3,500	3,200	2,600
DIV170	D/S of West Split	23,300	10,400	23,000	21,500	20,300	18,600
CP200	SR-74 Bridge (East)	7,600	1,000	7,500	7,000	6,400	5,300
CP225	SR-74 Bridge (West)	24,000	20,200	24,000	24,000	24,000	24,000
CP250	New River Dam	34,600	31,200	34,600	34,600	34,600	34,600

Case A: All runoff in New River at the diversion location is diverted to the Agua Fria River
Case B: 2,000 cfs diverted at peak stage to the Agua Fria River
Case C: 5,000 cfs diverted at peak stage to the Agua Fria River
Case D: 7,000 cfs diverted at peak stage to the Agua Fria River
Case E: 10,000 cfs diverted at peak stage to the Agua Fria River



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Legend:

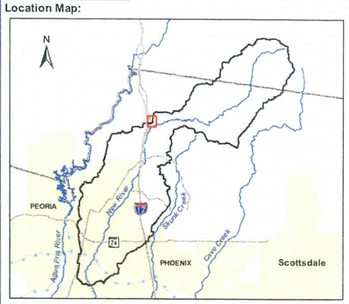
- Roadway
- Watershed Divide

FEMA Flood Zones

- A
- AE
- FW

Notes:

Location Map:



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182000418

Title
New River
Diversion Structure
Figure 8.6

Prepared By:
MCG
February 2008

Revision:

	By	Appd.	Date

Sheet 1 of 1

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8.4.2.2 Stage Coach Road

For the Reach of New River along old Stage Coach Road reach two alternatives are evaluated to determine the alternatives feasibility to mitigate existing flood hazards. The first involves vegetative clearing along a portion of New River. The second alternative involves elevation of Old Stage Coach Road so that access to adjacent properties is improved. Both alternatives are evaluated independently. The base hydraulic model used for evaluation of both alternatives is a modified form of the original FEMA model. That model is provided digitally on CD as Appendix I. The modifications include the following:

- Conversion from HEC-2 to HEC-RAS
- Modification of peak discharge input as needed

Each alternative is evaluated for a range of discharges. The range includes the original FEMA discharges, the 100-year, 24-hour existing condition ADMP discharges and discharges that reflect the five diversion conditions.

8.4.2.2.1 Vegetation Clearing Alternative

The intent of the Vegetation Clearing Alternative is to reduce channel roughness due to dense vegetation so that channel capacity to convey the 100-year event is increased enough to mitigate flood impact to Old Stage Coach Road. The proposed vegetation clearing limits are shown in Figure 8.7. The vegetation clearing limits are set based on the location where Old Stage Coach Road is impacted by flood flows. Vegetation clearing is simulated through the reduction of Manning's n-values that were used in the original FEMA hydraulic analysis. The original hydraulic analysis utilized Manning's n-values of 0.035 for the channel portion of the floodplain and 0.055 or 0.07 for right and left overbank areas. To simulate the vegetation clearing n values for the right and left overbank areas were set to 0.035.The HEC-RAS models representing the vegetation clearing alternative is provided digitally on CD as Appendix I.

For Effective FEMA discharges, the reduction in Manning's n-values results in an average reduction in water surface elevation through out the reach of approximately 0.8 with a maximum reduction in water surface elevation of 1.2 feet. The corresponding average reduction in the flooding limits (top width) is less than 100 feet.

Reduction in water surface elevation and top width in the vicinity of Old Stage Coach Road due to upstream diversion and vegetation clearing is summarized in Table 8.4. Based on the results for the proposed vegetative clearing with the FEMA discharges, reduction in water surface elevations and top widths listed in Table 8.4 are due primarily to the reduction in peak discharge associated with the upstream diversion not with vegetative clearing.

Table 8.4
Hydraulic results at Stage Coach Road due to upstream diversion

Upstream Diversion cfs (1)	Average Reduction Water Surface El feet (2)	Top Width Feet (3)
29,400	5.0	520
2,000	0.2	10
5,000	0.5	70
7,000	0.7	80
10,000	1.1	150

8.4.2.2.2 Roadway Levee Alternative

The second alternative evaluated along Old Stage Coach Road is to raise the roadway grade to provide all weather access. The roadway elevations would be raised one foot above the 100-year water surface elevation and essentially function as a levee. Simulation of this alternative is accomplished by treating the roadway as a levee. The HEC-RAS models representing the Old Stage Coach Road improvements are provided digitally on CD as Appendix I.

For FEMA discharges, encroaching on the floodplain at the roadway alignment results in both an increase and decrease in water surface elevation as shown in Table 8.5. Also shown in that table is the required raise in the roadway grade to provide one foot of freeboard. Much of the length of this reach of Stage Coach Road functions as a small channel resulting in the relatively high requirements for the raise. Adjusting the roadway alignment to east or west can significantly reduce the required raise. Adjustments to the roadway alignment might also be needed to improve the hydraulic conditions between river stations 34.99 and 35.09.

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Upper New River ADMP
FCD 2005CO20

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Phoenix, AZ U.S.A. 85044

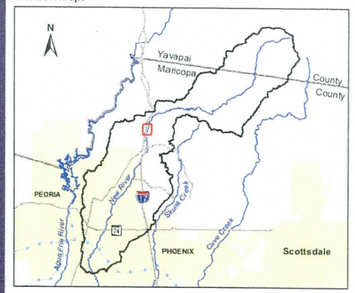
Legend:

- Roadway
- FEMA Flood Zones
  - A
  - AE
  - FW

Notes:

1. Base map: Circa 2006 aerial photography and 2-ft C.I. mapping
2. Cross section alignments from FCDMC DFIRM data. Not all cross section ID's match hydraulic model

Location Map:



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Project No.
182000418

Prepared By:
MCG
February 2008

Title
Stagecoach Road Alternatives
Figure 8.7

Revision:

	By	Appd.	Date

Sheet 1 of 1

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Table 8.5
Stage Coach Road embankment raise for FEMA discharges

River	Differential[1]		Roadway
Station	WSEL	Top Width	Rise in Elevation
miles	feet	Feet	feet
(1)	(2)	(3)	(4)
35.39	0.1	1	0
35.32	0.2	-170	2
35.19	-0.1	-200	4
35.09	1.41	-180	8
34.99	-1.96	-300	5
34.90	0	-440	6
34.81	-0.2	-370	2
34.71	0	-100	5

Note:
1. Differential is the proposed alternative minus the base condition

The required roadway embankment raise for the various upstream diversion conditions along with corresponding average changes in the water surface elevation and top width are listed in Table 8.6. The roadway embankment raise shown in that table are the average raise along the reach. The required raise at each cross section varies similar to what is shown in Table 8.5.

Table 8.6
Stage Coach Road embankment raise due to upstream diversion

Upstream	Differential[1]		Roadway
Diversion	WSEL	Channel Top Width	Rise in Elevation
cfs	feet	Feet	feet
(1)	(2)	(3)	(4)
29,400	-4.7	-510	0
2,000	0.6	-140	4
5,000	0.2	-150	4
7,000	-0.1	-170	3
10,000	-0.2	-180	3

Note:
1. Differential is the proposed alternative minus the base condition

8.4.2.3 Conclusions

Evaluation of the diversion, vegetation clearing and roadway improvement alternatives for the New River Planning Area Upstream of I-17 indicates:

- Benefits of the diversion alternative relative to the cost of the alternative are minimal. The cost of the alternative assuming a 10,000 cfs diversion or total diversion of the 100-year ADMP peak discharge is 7 to 16 times the value of property that would be protected respectively.

- Vegetative clearing alone is not sufficient to provide emergency access along Stage Coach Road.

- The Roadway Levee Alternative (elevation of existing roadway) is a viable option and should be advanced to Phase 2 for further evaluation. The analysis also indicates that upstream diversion of flows less than 10,000 cfs does not have a significant effect on the required roadway embankment raise. This is again, primarily due to the current roadway alignment.

- During the evaluation of the vegetation clearing alterative, it was noted through field investigation that the density of the vegetation has changed since the development of the FEMA hydraulic model. Due to this observation is was recommended that the vegetation clearing alterative be re-evaluated during Phase 2 utilizing updated Manning's roughness coefficients.

The New River Planning Upstream of I-17 Planning Area the New River Diversion Structure does not move forward to Phase 2 evaluations all other alternatives developed in the Brainstorming Meeting move forward for further consideration.

8.4.3 New River Planning Area Downstream of I-17

The hydraulic conditions in New River for the reach below I-17 are by far the most complicated in the overall study area. There are three flow split locations and as well as distributive flow patterns. Hydraulic modeling of this reach was accomplished using FLO-2D as discussed in Section 6.

Structural solutions for this planning area essentially involve the elimination of the flow splits during the 100-year event and the control of the distributive flow area upstream of SR-74. The type of structural elements (e.g. channel, levee or combination) and the dimensions of those elements will be evaluated in Phase 2 should this alternative advance to that level. For the purposes of this level of investigation, it is assumed that the proposed structure can be simulated as a levee with a conveyance corridor of 1,000 feet in width. The corridor width is based on the width of the existing "linear" borrow pit.

Three different levee/channel alternatives are considered. The first alternative, shown in Figure 8.2 keeps runoff in the main stem of New River from breaking out into the Sweat Canyon subwatershed at the west split and the Deadman Wash subwatershed downstream of the linear borrow area. This alternative also uses levees to eliminate the flow split during the 100-year event from Sweat Canyon into the "triangular" borrow pit. The second alternative builds onto the first by extending the levees or channels through the

distributive flow area upstream of SR-74 levees directing flow in Sweat Canyon to the west SR-74 bridge and flow in New River to the east SR-74 bridge. The third alternative also builds on the first alternative by extending the levees or channels through the distributive flow area but directing all flow in both Sweat Canyon and New river to the west SR-74 bridge. The east bridge would only convey local runoff. Both the second and third alternatives are shown in Figure 8.3.

For each levee alternative, the 100-year, 24-hour existing condition HEC-1 model is modified accordingly. The peak discharge at key locations for each alternative is listed in Table 8.7 and presented on Figure 8.8. The modified HEC-1 models are provided digitally on CD as Appendix I. As can be seen from Table 8.7, the levees have a significant impact on the hydrology of New River and Sweat Canyon Wash. By eliminating flow splits and flow mixing, the overall routing and timing characteristics of the runoff changes.

Table 8.7
New River Planning Area alternative 100-year, 24-hour peak discharge

HEC-1 ID	Location	Peak Discharge, in cfs			
		ADMP	Alt 1	Alt 2	Alt 3
(1)	(2)	(3)	(4)	(5)	(6)
CP170	New River at the West Split	28,700	28,700	28,700	28,700
CP180	New River d/s of the West Split	23,200	28,600	28,600	28,600
CP190	New River at Deadman Split	23,200	28,500	28,500	28,500
CP19A	Sweat Canyon at New River Rd	14,200	14,200	14,200	14,200
CP195	Sweat Canyon d/s of west split	13,400	19,800	19,800	19,800
CP215	Sweat Canyon u/s of SR-74	17,100	20,700	20,700	20,700
CP200	SR-74 Bridge (East)	7,600	28,400	1,200	9,900
CP225	SR-74 Bridge (West)	23,900	20,900	29,000	23,500

Hydraulic modeling of the proposed structural alternatives used in this initial evaluation phase is accomplished using HEC-RAS. HEC-RAS models for each structural alternative are provided on CD as Appendix I. Use of HEC-RAS to model the proposed structural alternatives is considered appropriate as the conditions driving the need for a two-dimensional model (flow splits and distributive flow) are controlled by the levees. The base hydraulic model used in this evaluation is discussed in Section 5.

At the three flow split locations, changes in water surface elevation, channel velocity and top width and therefore proposed levee dimensions are the same for all three alternatives. In general, the change in water surface elevation and channel velocity is small or cannot be estimated because the original models were not set up to include the flow split. The latter is the case for the Sweat Canyon diversion into the triangular basin as well as the New River split into the Deadman Wash subwatershed. For both the Sweat Canyon split and New River at the split to Deadman, it is not anticipated that the river hydraulics would change over what is reflected in the existing model due to the proposed levee. The floodplain flow depths outside of the proposed levee alignments are relatively shallow.

Encroachment of this shallow floodplain (modeled as a levee) will not likely result in a significant rise in water surface elevations. The required levee height would therefore be on the order of 4 to 5 feet which includes 3 feet of freeboard. For New River, the proposed levee does not have a significant impact on water surface elevations in the vicinity of the levee. Similar to Sweat Canyon the flow depths in the floodplain at the break out are relatively shallow. Downstream of the West Split break out, the increase in peak discharge results in a rise in water surface elevation. The increased water surface elevation is less than 1-foot and averages 0.6 feet.

For Alternative 2, water surface elevations in the New River side of the distributive area increase on average by approximately 2 feet. The maximum increase is 5.1 feet at River Station 23.55 (approximately 0.3 miles upstream of the SR-74 Bridge (east). At the bridge, the increase in water surface elevation is approximately 1.5 feet, well below the low chord elevation. On the Sweat Canyon side, changes in water surface elevation range from a reduction of 1.6 feet immediately upstream of the SR-74 Bridge (west) to an increase of 1.9 feet at River Station 0.18 (approximately 1 mile upstream of the bridge). The proposed levee for both the New River and Sweat Canyon side would have an average height, including 3 feet of freeboard of approximately 5 feet. The maximum height would be approximately 11 feet.

For Alternative 3, water surface elevations in the New River side of the distributive area immediately upstream of the bridge would be significantly reduced as all the runoff in New River is directed to the west bridge at SR-74. The east bridge would remain open for local flow only. At the west bridge, the water surface elevation would increase slightly due to the increase in peak discharge but would still be well below (approximately 5 feet) the low chord elevation of the bridge. Near the proposed confluence of New River and Sweat Canyon, water surface elevations would increase as much as 2 feet. Levee heights for this alternative are similar to Alternative 2.

For the New River Planning Area below I-17, all three proposed structural alternatives can be considered feasible. Alternative 1 would be the more easily implemented by staying out of the distributive area and letting it function naturally. The results of the other two alternatives indicate that for Alternative 1, the bridges would not be adversely impacted if the morphology of the river were to shift. The results of the modeling also indicate that the dimensions of the structural elements at the flow split locations are manageable and could easily accommodate a soft structural form. It is recommended however, that the Sweat Canyon HEC-RAS model be revised to reflect current topographic and hydraulic conditions. For Alternatives 2 and 3, implementation of a structural element in the distributive flow area because of the need for grade control structures and potentially a low flow channel can present some design challenges.

Structural solutions for the New River Planning Area below I-17 are also evaluated under the various upstream diversion conditions discussed previously. Based on the results of the hydrologic modeling of the upstream diversion, a full diversion would be required to reduce the peak discharge into the West Split to 100 cfs (see Table 8.3). Also, a structural feature will still be required at the split from Sweat Canyon to the triangular

borrow pit. Short of a full diversion which is not practical, the proposed diversion does not individually solve either the flooding issue at Stage Coach Road or the West Split.

Therefore, it is recommended that the upstream diversion, not be advanced for further analysis in Phase 2.

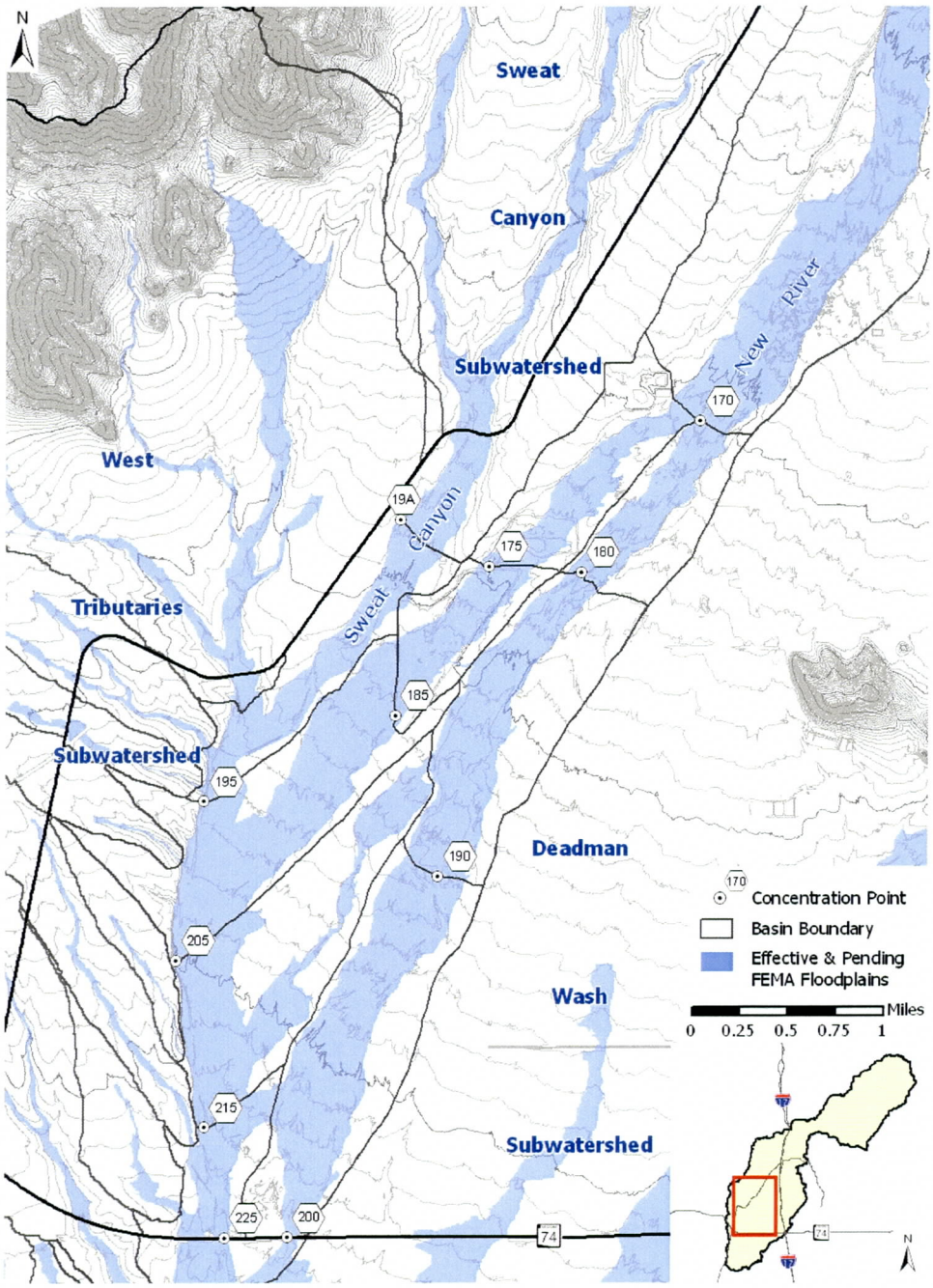


Figure 8.8 Peak Discharge Locations

8.5 DESIGN/PLANNING CONSIDERATIONS

There are a few localized drainage issues that have been identified in which specific alternatives were not developed during the Brainstorming meeting effort but were recognized or brought to the teams attention during the stakeholder meeting that followed the development of the potential alternatives. Following the description of each localized drainage issue is a recommendation as to how the issue should be addressed in Phase 2. The following design/evaluations/planning considerations should be addressed in the Phase 2 alternative evaluations process:

- Based on review of aerial photography, field reconnaissance and team collaboration a potential flow break out area was identified in the Gavilan Peak Planning Area. The potential breakout occurs along the south bank of Photo View Wash between the roadway alignments of 23rd Drive and 27th Avenue. The results of a hydraulic model for Photo View Wash indicates that the wash has the capacity to contain the 100-year event of approximately 500 cfs to within a half foot of the top of bank. Linear bands of denser vegetation due to concentration of runoff indicate that there may have been historic flow breakouts that have eroded a small drainage swale. At this location there may be a potential for a channel avulsion. Future planning efforts should take into consideration the potential for a flow breakout to occur at this location (see Figure 8.9).

- It appears that a flow delineation levee (see Figure 8.7) was constructed within New River between River Mile (RM) 35.09 and 35.19. A functionality/safety concern for this feature was brought to the team by a stakeholder. The hydraulic performance of the flow delineation feature should be evaluated in Phase 2.

- New River levees downstream of New River Road Bridge tie into a linear levee features (Figure 8.10). The linear levee features appear to be man made, however they are not engineered and have not been maintained. Because the feature does not meet FEMA criteria the 100-year floodplain occurs on both sides of the levee (floodplain is based on an assumption that the levee feature will not provide a benefit). The levee features forming the east bank of New River extends downstream from the bridge some distance (maybe a quarter mile or so) cutting off an old meander channel in the left overbank area. There is an opening in the levee feature near the end of the old meander channel that allows local flow to drain out however some flow is impounded behind the levee; during run off events within in New River, flow drains back into this impoundment area. According to a resident in the area, this causes some vector issues. The plan should consider a public education/outreach program concerning the issues associated with this levee feature.

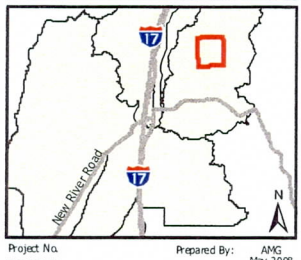
- Along the west bank of New River downstream of the I-17 Bridge there are a number of residences within the floodway, floodplain and erosion hazard limits. A structural alternative was not considered at this location because the presumed cost of the structure would be greater than the value of the property. The residents have been notified about the District's, Floodprone Property Assistance Program.

The plan should consider a public education/outreach program that identifies the hazards and potential mitigating solutions to the residences (see Figure 8.11).

- The evaluation of proposed alternatives conducted as part of Phase 1 was limited to an evaluation of the feasibility of the alternative. In Phase 2, analyses and evaluations should include design and planning considerations. In particular preliminary alignments and dimensions of proposed structural alternatives developed in Phase 1 will be optimized in Phase 2. Optimization criteria should be developed prior to evaluation and refinement of alternatives in Phase 2. The optimization criteria should include:

    - Impacts to the existing hydraulic characteristics of a watercourse
    - Determination of adverse impacts
    - Impacts on existing/proposed infrastructure
    - Impacts on proposed landscape enhancements
    - Impacts to proposed land-use and transportation corridors

Location Map:



Project No.
182000418

Prepared By: AMG
May 2008

Notes:

N

1" = 600'

Legend:

Potential Flow Breakout

100-year Floodplain

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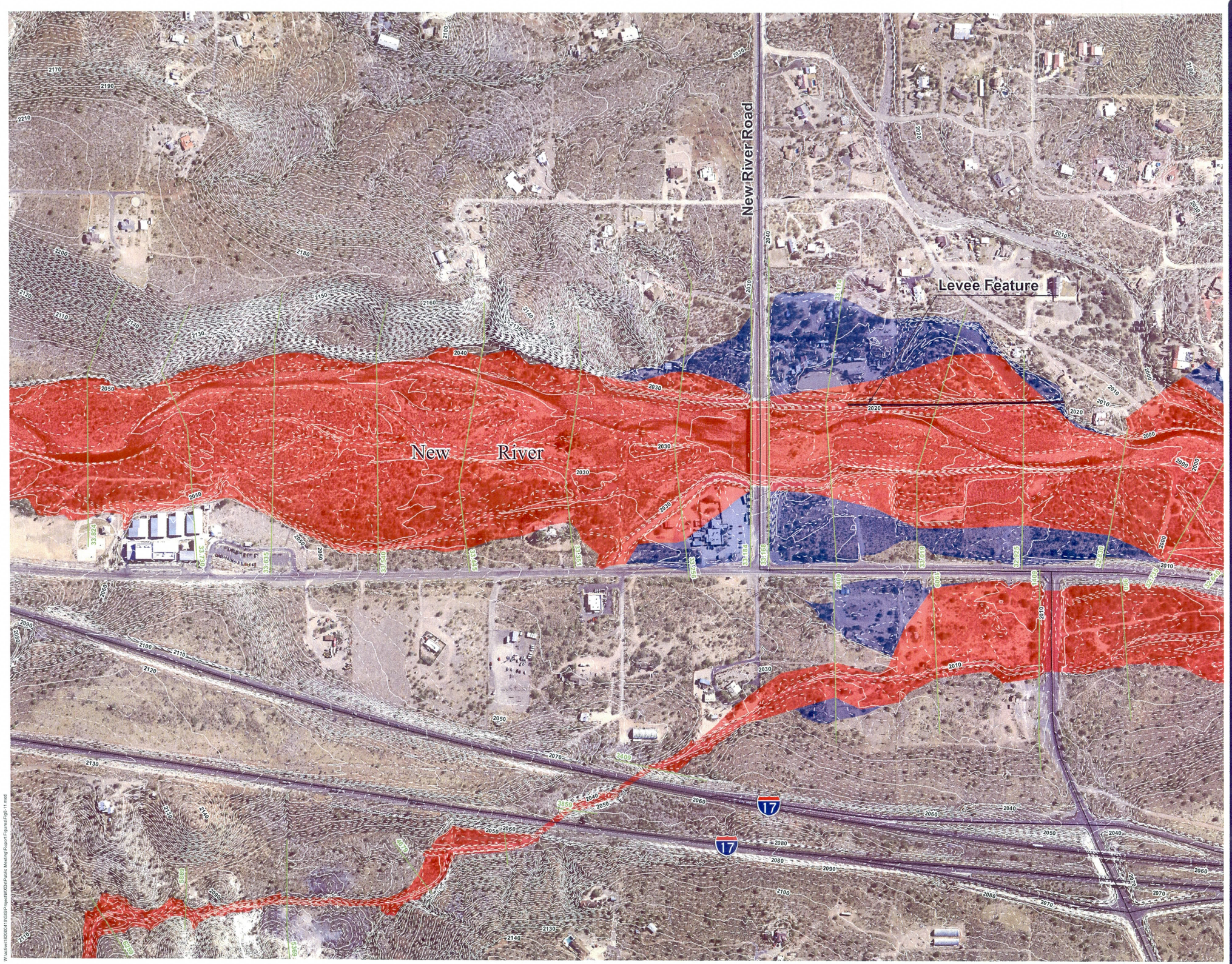
Flood Control District of Maricopa County
2801 W. Durango St.
Phoenix, AZ 85009

Upper New River ADMP
FCD 2005CO20
Gavilan Peak
Figure 8.9

Stantec Consulting Inc.
8211 S. 48th Street
Phoenix, AZ U.S.A. 85044



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Flood Control District of Maricopa County
2801 W. Durango St.
Phoenix, AZ 85009

Upper New River ADMP
FCD 2005CO20

Prepared By:

Stantec Consulting Inc.
8211 S. 48th Street
Phoenix, AZ U.S.A. 85044

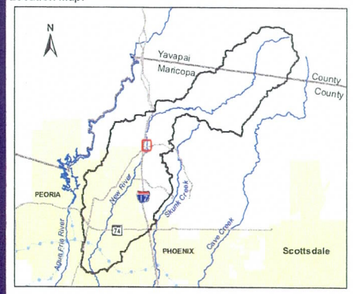
Legend:

- Roadway
- FEMA Flood Zones
  - A
  - AE
  - FW

Notes:

1. Base map: Circa 2006 aerial photography and 2-ft C.I. mapping
2. Cross section alignments from FCDMC DFIRM data. Not all cross section ID's match hydraulic model

Location Map:



N 0 100 200 400 600 Feet

Project No.
182000418

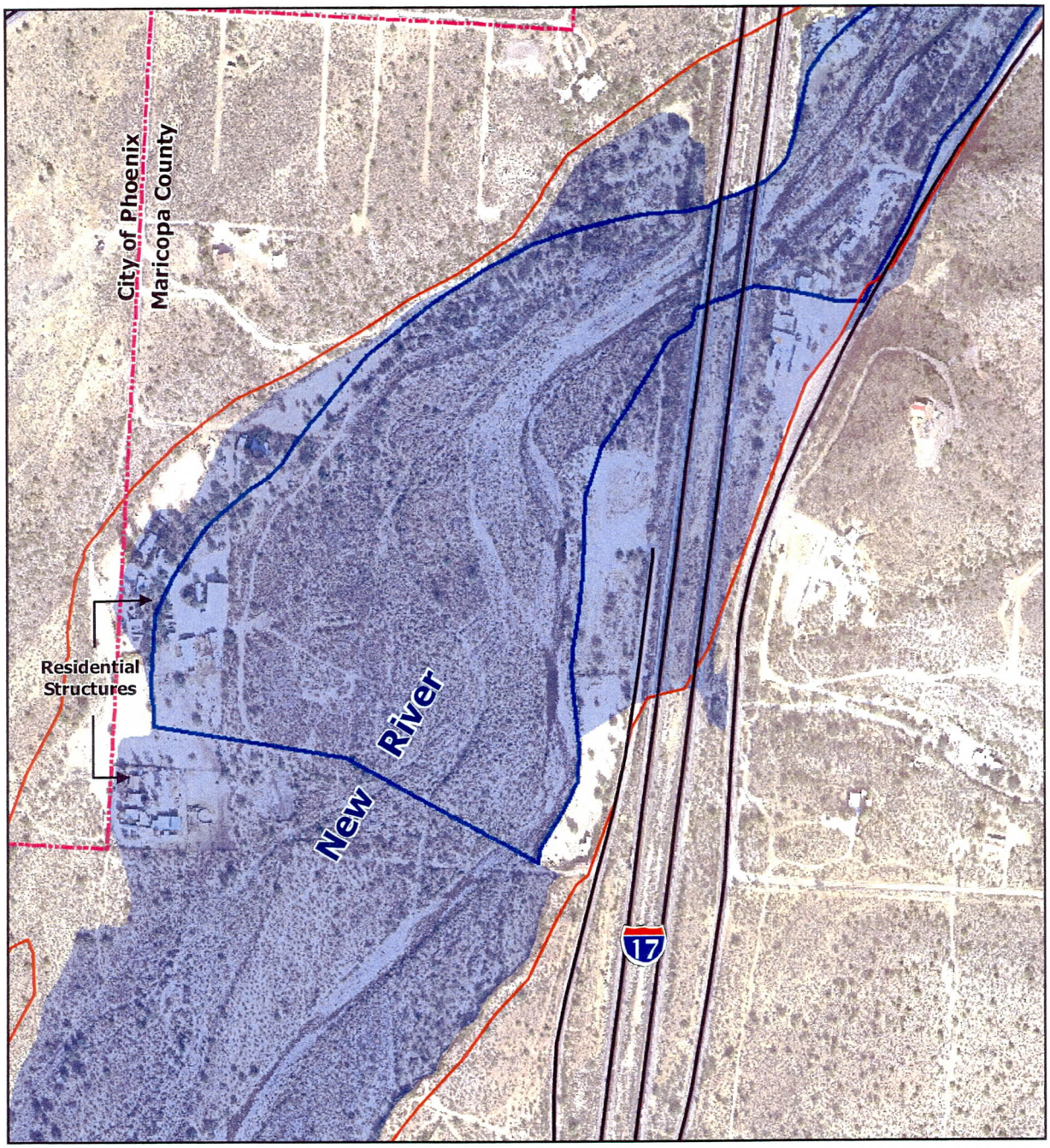
Title
Levee at New River Road
Figure 8.10

Prepared By:
MCG
May 2008

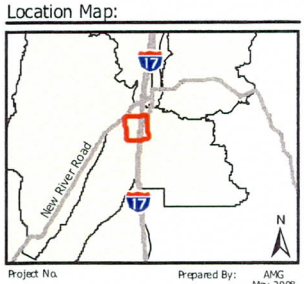
Revision:

	By	Appd.	Date

Sheet 1 of 1



Location Map:



Project No.
182000418

Prepared By: AMG
May 2008

Notes:

N

1" = 500'

Legend:

- Erosion Hazard Boundary
- Floodway
- 100-year Floodplain

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Flood Control District of Maricopa County
2801 W. Durango St.
Phoenix, AZ 85009

Upper New River ADMP
FCD 2005CO20
New River
Downstream of I-17
Figure 8.11

Stantec Consulting Inc.
8211 S. 48th Street
Phoenix, AZ U.S.A. 85044

9 PHASE 2 ALTERNATIVE EVALUATION

9.1 INTRODUCTION

This section of the report presents a discussion of the alternative formulation process, the application of alternative evaluation criteria, potential flood and erosion hazard mitigation alternatives that were evaluated, and elements for the recommended alternatives.

9.2 PURPOSE

The purpose of the Phase 2 alternative evaluation process is to: evaluate the hydraulic performance of potential alternatives that were proposed in Phase 1 to move forward to Phase 2; determine potential impact of an alternative on natural, scenic, and recreational resources; incorporate public and stakeholder participation in the evaluation and selection of alternatives; and to evaluate and rank an alternatives implementation strength and weakness. The evaluations examine the benefits, opportunities and impacts of a range of flood control management plans that addresses the flood and erosion hazards and impending development pressures while considering public safety, social, economic and environmental factors. The ultimate goal of this examination is to recommend a preferred flood control management plan for the Upper New River ADMP planning area.

9.3 ALTERNATIVE ELEMENTS

Alternatives identified in Phase 1 are organized in general alternative categories. Those categories are Non-Structural (watercourse specific), Structural (watercourse specific), No-Action Alternatives and ADMP Guidelines. Structural Alternatives include channel and levee elements that provide opportunities for environmental enhancements, landscape treatments that are context sensitive and multi use recreation. General descriptions of alternatives are provided in the flowing sections.

9.3.1 Non-Structural (Watercourse specific)

The watercourse reach retains its natural condition and appearance, and is managed through regulatory solutions (ADMP Guidelines) that do not require capital improvement funds. Non-Structural solutions were applied to reaches where structural solutions are not required to mitigate identified flood hazards. Non-Structural Solutions include:

- Promote and continue sound floodplain management such as:
    - Floodplain Delineations
    - Erosion Hazard Delineations
    - Provide development guidelines to reduce flooding and erosion risk to new development.

Photographic examples of nonstructural reaches within the planning area are depicted in Figures, 9.1A and 9.1B. These examples represent typical sections of a Non-Structural Alternative for the planning area.

9.3.2 Structural

Structural alternatives or structural elements of an alternative for the project area include channels, levees and grade control structures and associated erosion protection that are landscape designed (aesthetic treatments) to be context sensitive to the surrounding environment. Landscape aesthetic treatments are intended to create features that fit the form and function of the existing landscape character. Typical landscape aesthetic treatments consist of variations in the form (alignment, profile, side slope (6:1 typical average, etc.) of the structural element, use of color or textual patterns or the use of fill material to hide the structural element. For the channel option the entire channel would have a landscape treatment whereas for the levee option the area between the levees would not require a method of treatment however the levees would. Figures 9.2A depicts a typical section for a natural landscape channel. Figure 9.2B depicts a photograph of a channel where the natural landscape theme has been applied. Figure 9.3 depicts a typical landscape levee section.

9.3.3 No Action Alternative

The no-action (do nothing) alternative provides flood control management based on current federal, state, and local floodplain management regulations that allow encroachment into the floodway fringe. Typically under current regulations, encroachments into the floodway fringe are allowed in a piecemeal fashion without taking into consideration the effect of the encroachment or collective encroachments on the entire watercourse or environmental and scenic resources.

9.3.4 ADMP Guidelines

ADMP guidelines allows an area to develop according to the adopted land use plan. Watercourses in which specific alternatives have not been developed within the planning area will be managed through ADMP Guidelines which include non-structural and structural guidelines. Flood mitigation solutions include:

- Manage the non-structural alternatives through floodplain and erosion hazard delineations
- Develop and manage flood and erosion hazards through regionally specific guidelines and ordinances
- Promote and continue sound floodplain management
- Develop a flood warning response/emergency access plan for residents
- Provide existing property owners with guidelines to reduce their flooding and erosion risk
- Floodprone Property Assistance Program
    - Voluntary Program
    - Acquire homes in high hazard areas within New River Floodplain
    - Floodproof homes

Figure 9.1A - Non-Structural Alternative New River near Old Stage Coach Road

Figure 9.1B – Non-Structural alternative New River Downstream of SR-74

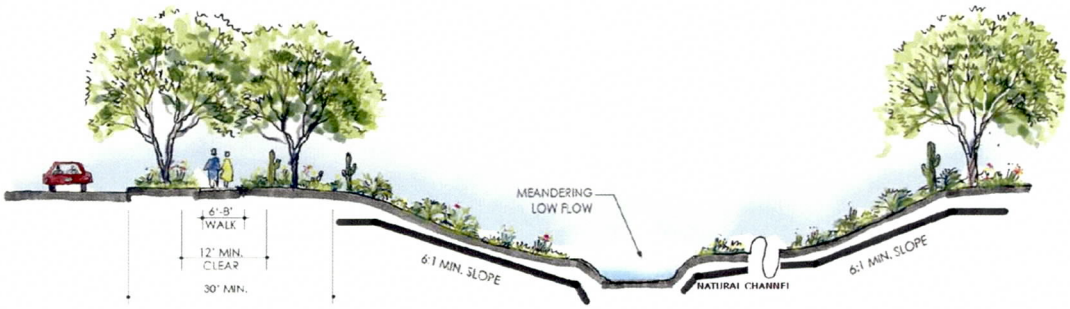


Figure 9.2A – Structural Alternative with Landscape Treatment-Channel Option

Figure 9.2B – Structural Alternative with Landscape Treatment -Channel Option

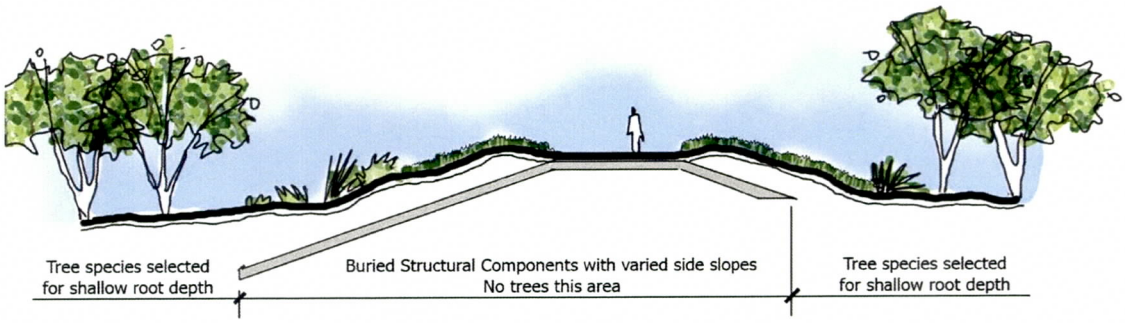


Figure 9.3 – Structural Alternative with Landscape Treatment - Levee Option

9.4 PHASE 2 HYDRAULIC/HYDROLOGIC EVALUATIONS OF PROPOSED ALTERNATIVE

9.4.1 Introduction

This section of the report presents discussions concerning engineering evaluations that were conducted for Phase 2 alternatives; brief discussion concerning methodology used in hydraulic (one-dimensional and two-dimensional modeling analyses) evaluations; evaluations of adverse impacts; hydrologic evaluations (changes in the timing of peaks and evaluation of regional retention basins for the Gavilan Peak and Lower Deadman Wash Planning areas); and estimation of probable construction costs is presented in the Methodology section. Summaries of the results of the alternatives engineering evaluations are organized by planning area and are presented in the Alternatives Analyses Results section. Figure 8.1 depicts the name and location of the planning areas. The results of evaluating alternatives utilizing Scenery Resource, Recreation and Open Space, Natural Resource, Public Safety, and Implementation evaluation criteria developed in Phase 1 are presented in the Alternative Evaluation section.

9.4.2 Methodology

9.4.2.1 One-Dimensional Hydraulic Evaluation

Hydraulic modeling of the alternatives were, in general, accomplished by modifying the Effective FEMA hydraulic model, the HEC-RAS models provided by the District or hydraulic models developed as part of this study. Those models are referred to as the Base models. See Section 5.0 for a discussion concerning the development or refinement of the Effective or existing condition HEC-RAS models for New River, Sweat Canyon Wash, Gavilan Peak Wash and Deadman Wash. Modifications to the Base models are limited to changes in roughness coefficients and the use of the encroachment (levee option in the geometry editor) and the channel modification routines to represent the general features of the various alternatives, such as levees or channelization. For this level of analysis, it was assumed that fill slopes for the landscape aesthetic treatments would have a negligible impact on the hydraulic characteristics given the magnitude in the dimension of the proposed alternatives and therefore not coded into the model.

Hydraulic models developed for the alternatives are provided digitally on CD in Appendix J and are organized by planning area and watercourse name.

The purpose for the hydraulic modeling was to document the hydraulic characteristic for a proposed alternative and compare the results to the base condition to determine if there are impacts due to encroachment or channelization. The encroachment into the floodplain by an alternative was limited such that the alternative did not have an adverse impact to the hydraulic function of the watercourse ("No Adverse Impact"). An adverse impact would mean that there were increases in potential scour or significant increases in velocity or depth. Details of "No Adverse Impacts" are discussed in following sections.

9.4.2.1.1 Hydraulics-No Adverse Impact

Urbanization of a watershed can have adverse impacts to watercourses within the watershed. Types of adverse impacts include:

- Decreases of stormwater infiltration capacity within a watershed due to urbanization increases peak discharge from a watershed unless measures are undertaken to reduce post development peak discharges.
- An increase of peak discharge, frequency, and runoff volume due to urbanization in a watershed increases the potential for erosion and sedimentation within watercourses.
- An increase in erosion potential can result in loss of property and riparian habitat.
- Due to an increase in peak discharge, existing drainage structures downstream of newly urbanized areas will be undersized.
- Increase in peak discharge increases the amount of property within a floodplain. Existing structures within or adjacent to the predevelopment floodplain are at risk of a greater flood impact.
- Disruption of natural flow paths can disrupt the natural system equilibrium and induce bank erosion and long-term degradation of the channel bed.
- An increase in bank erosion and long-term channel bed degradation can result in the need of grade control structures and bank stabilization.
- Increased erosion and deposition will result in greater costs for future structures, higher potential damage and likelihood of failure of existing structures, and increased maintenance cost.
- Increased deposition results in loss of channel capacity and increased flood levels.

Each of the alternatives evaluated for the study were reviewed for adverse impacts, which include changes in hydraulics. The base models results were compared to the alternatives models results to evaluate the impacts. Changes in hydraulics were determined by evaluating the changes in 10-year and 100-year hydraulics.

The 10-year event is assumed to be the channel forming discharge or bankfull discharge and is used to evaluate the changes in sedimentation that may occur with the alternative. This discharge is defined by Dunne and Leopold (1978) as the "the discharge at which channel maintenance is most effective, that is the discharge at which moving sediment, forming or removing bars, forming of changing bends and meanders and generally doing the work that results in the average morphological characteristics of channels." Sedimentation is defined as the process of transport, erosion and deposition of sediment. Three different parameters were reviewed, shear stress, channel velocity and channel hydraulic depth. The average shear stress acting on the channel is computed from the equation:

$$\tau = \gamma RS \qquad (9.1)$$

where

γ = Specific weight of water, lb/ft^3, assumed to be 62.4 lb/ft^3

R = Hydraulic Radius, ft

S = Slope, ft/ft

In the above equation, the hydraulic depth was substituted for hydraulic radius because the width to depth ratio is greater than 10. The average energy slope for a reach was used for the slope because some sections can have adverse channel slopes. Also the channel slopes can vary greatly between cross sections due to local conditions. The channel velocity and channel hydraulic depths were obtained from the HEC-RAS output.

The alternative model parameters were plotted versus the base model parameter for each cross section. For example, the alternative velocity is on the y-axis versus base velocity on the x-axis. A 45 degree line was drawn on the figures. If the data points plot on the 45 degree line there is no change between the alternative and base models. If the data points plot above the line the alternative parameter is greater than the base parameter. If the data points plot below the line the alternative parameter is less than the base parameter.

The 100-year flow event is used to evaluate alternatives where changes are located outside the 10-year event channel. For instance, the levees for the Sweat Canyon Wash and New River main stem alternatives are located outside the 10-year event channel. Two parameters were reviewed: cross section velocity and cross section hydraulic depth. Plots were developed that showed the velocity or hydraulic depth versus river station for the base and alternative models. Evaluation results are presented for specific watercourses by planning area.

9.4.2.2 Two-Dimensional Hydraulic Modeling (FLO-2D)

Three alternatives for the New River Downstream of I-17 Planning Area were modeled/evaluated using FLO-2D. These models are unique in the way the upstream boundary inflow is distributed based on the corresponding alternative HEC-RAS one-dimensional models. The distribution of inflows were governed by the way levees, as structural alternatives, were placed in the one-dimensional models to direct concentrated

flows to the West and the East SR-74 Highway Bridges. One common feature of the three FLO-2D models is the proposed 303 loop alignment (or 303L) just upstream of the New River confluence with the Deadman Wash tributary. Details on FLO-2D model development and results are presented in Section 9.4.3.3.2

9.4.2.3 Hydrology

Hydrologic modeling was conducted to evaluate specific hydrologic features, to provide input for hydraulic evaluations and to evaluate potential adverse impacts of the proposed alternatives. For some alternatives, existing land use modeling prepared as part of this study was sufficient for alternative evaluation or as input for hydraulic analyses of the alternative. See Attachment 3 for full documentation of both existing and future land use condition modeling. For other alternatives, the existing and/or future land use condition models were modified to reflect the proposed features or to evaluate potential adverse impacts or existing FEMA discharges were used. Modifications to the models are discussed in the following sections.

9.4.2.3.1 Hydrology –No Adverse Impact Evaluations

One conclusion drawn from the existing condition modeling of the overall watershed is that the magnitude of peak discharges along New River downstream of SR-74 are potentially very sensitive to changes in the Deadman Wash and Sweat Canyon sub-watershed basin response times due to the various features identified in the alternative formulation process. It was also concluded that those same features could be implemented in certain combinations and locations to minimize the sensitivity. In particular, the proposed features could be used to control/alter the basin response times of the major tributaries (Deadman Wash and Sweat Canyon) so that the runoff peaks did not (from a modeling perspective) occur at the same time as the runoff peak in New River. Therefore, various analyses were conducted to test the sensitivity of the basin response and then evaluate those results for potential adverse impacts. For example, if the Sweat Canyon sub-watershed basin response time under proposed conditions were to decrease along with an increase in the basin response time for the upper Deadman Wash sub-watershed, the proposed condition peak discharges in New River downstream of SR-74 could be reduced compared to existing conditions or at a minimum remain unchanged. The same effect could also be achieved by decreasing the basin response time of the lower portion of the Deadman Wash sub-watershed along with an increase in the basin response time of the upper portion of the Deadman Wash sub-watershed.

Changes of basin response time on a watershed scale can be accomplished through consistent, uniform application of watershed and floodplain management activities. Such activities include:

- Changes in land use/zoning
- Channelization/encroachment of watercourses
- Enforcement of or waiving of the 100-year, 2-hour retention requirements
- In-stream detention

With the exception of changes in land use, these approaches were applied to either the New River Downstream I-17 or lower Deadman planning areas to evaluate the resulting impact to peak discharges in New River downstream of SR-74. Changes in land use were not considered as a viable approach because of the size of the areas and the number of jurisdictions involved. The results of these evaluations were used in combination with similar analyses of hydraulic/sedimentation adverse impacts (discussed in Section 9.4.2.1.1) to help guide the location and dimensions of proposed features.

9.4.2.3.1.1 Impact of Channelization/ Levee Encroachment

Channelization/encroachment of a watercourse can increase the efficiency of conveying runoff from one point to another resulting in a decrease in basin response time and an increase in peak discharge. The degree to which this can be achieved or is desired is tested on the Sweat Canyon sub-watershed. Encroachment was simulated by altering the geometry of the hydrologic routing reaches. The modified routing reaches are downstream of New River Road along Sweat Canyon. Encroachment of the left overbank was gradually increased up to the left channel bank in five steps. The first "step" or encroachment case simulates a minimum amount of encroachment and the fifth case represents the maximum amount of encroachment.

The base HEC-1 model used for this analysis is the 100-year, 24-hour existing land use condition model modified to remove split flows from New River to the West Split and Deadman Wash watershed as well as the split from Sweat Canyon to West Split. Removal of these split flows are common elements to all alternatives. HEC-1 input and output files for each of the five encroachment cases are provided digitally on CD as Appendix J. The location of the routing reaches with respect to the overall watershed is shown in Figure 9.4. An example of the level of encroachment considered for each of the five cases is illustrated in Figure 9.5. A summary of peak discharges and time to peaks for each routing reach that is encroached, for each of the five cases is provided in Table 9.1. Hydrographs illustrating the impact of encroachment are provided in Figure 9.6.

As can be seen from Figure 9.6 and Table 9.1, encroachment of a watercourse can indeed result in increases in peak discharge and faster basin response times. Moreover, it can have cumulative impacts downstream. In the base (unencroached) condition, peak discharges tend to decrease in the downstream direction due to the timing and magnitude of tributary inflow, storage effects and aerial reduction effects. As the amount of encroachment continues to increase, the attenuation in peak discharge diminishes with the loss of storage area. As encroachment increases to the maximum extent, peak discharge in the downstream direction begins to increase. At the maximum extent of encroachment, the increase in peak discharge for the downstream most routing reach evaluated (CP215-CP225) is approximately 14 percent and the time to peak has decreased by 30 minutes.

Sweat Canyon was selected to evaluate the hydrologic impacts of encroachment because the broad, shallow floodplain makes it a good candidate for some form of encroachment in order to maximize developable property. Similar conditions exist along New River as well as with other watercourses in other planning areas and it is reasonable to assume that the Sweat Canyon results would apply to these other areas. However, the loss of floodplain storage due to encroachment can decrease basin response time and increase

peak discharge. Therefore, it is recommended that encroachment of Sweat Canyon, and by extension to New River, be limited so that the resulting conveyance corridor is greater than 1,000 feet. This maximum encroachment recommendation corresponds to Case 2 and the peak discharge and time to peak results are presented in Table 9.1. This case represents a balance between maximizing developable property and minimizing adverse impacts. The 1,000 foot corridor is also consistent with the dimensions of the linear borrow pit along New River and non-disturbed reaches of New River where the river is bounded by terraces.

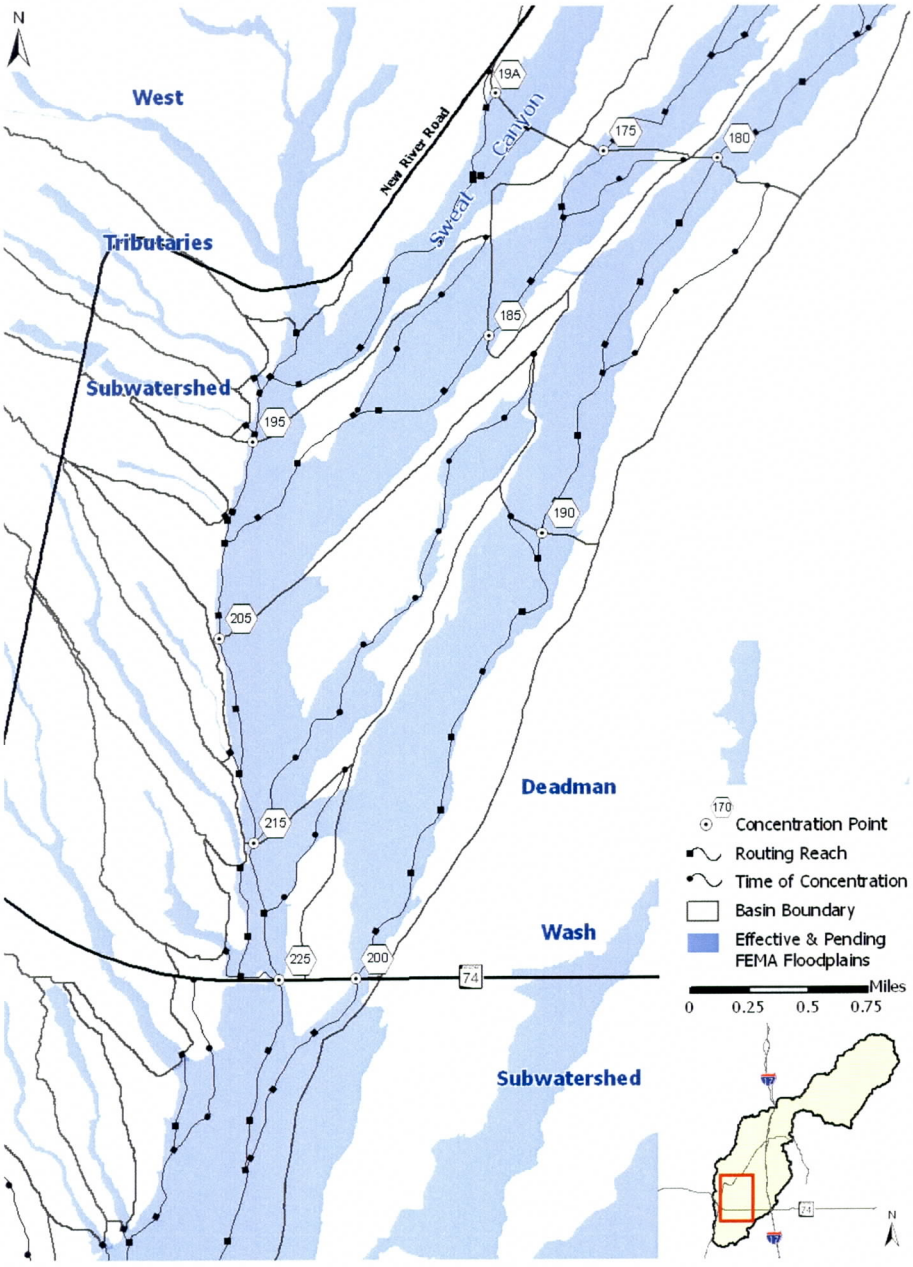


Figure 9.4 – Location of Encroachment Routing Reaches

Table 9.1 Peak Discharge and Time to Peak Summary

Routing Reach	Base Qp cfs	Base Tp hours	Case 1 Qp cfs	Case 1 Tp hours	Case 2 Qp cfs	Case 2 Tp hours
18-19A	14,300	12.75	14,300	12.75	14,400	12.75
19A195	13,200	13.17	13,200	13.17	13,300	13.17
195205	18,700	13.33	18,700	13.33	18,900	13.25
205215	18,200	13.58	18,200	13.58	18,800	13.50
215225	17,900	13.75	18,000	13.75	18,700	13.58

Routing Reach	Case 3 Qp cfs	Case 3 Tp hours	Case 4 Qp cfs	Case 4 Tp hours	Case 5 Qp cfs	Case 5 Tp hours
18-19A	14,500	12.75	14,600	12.75	14,600	12.75
19A195	13,400	13.17	13,500	13.08	13,400	13.08
195205	19,300	13.25	19,100	13.17	19,500	13.17
205215	19,300	13.42	19,600	13.33	20,100	13.17
215225	19,200	13.50	19,700	13.42	20,600	13.25

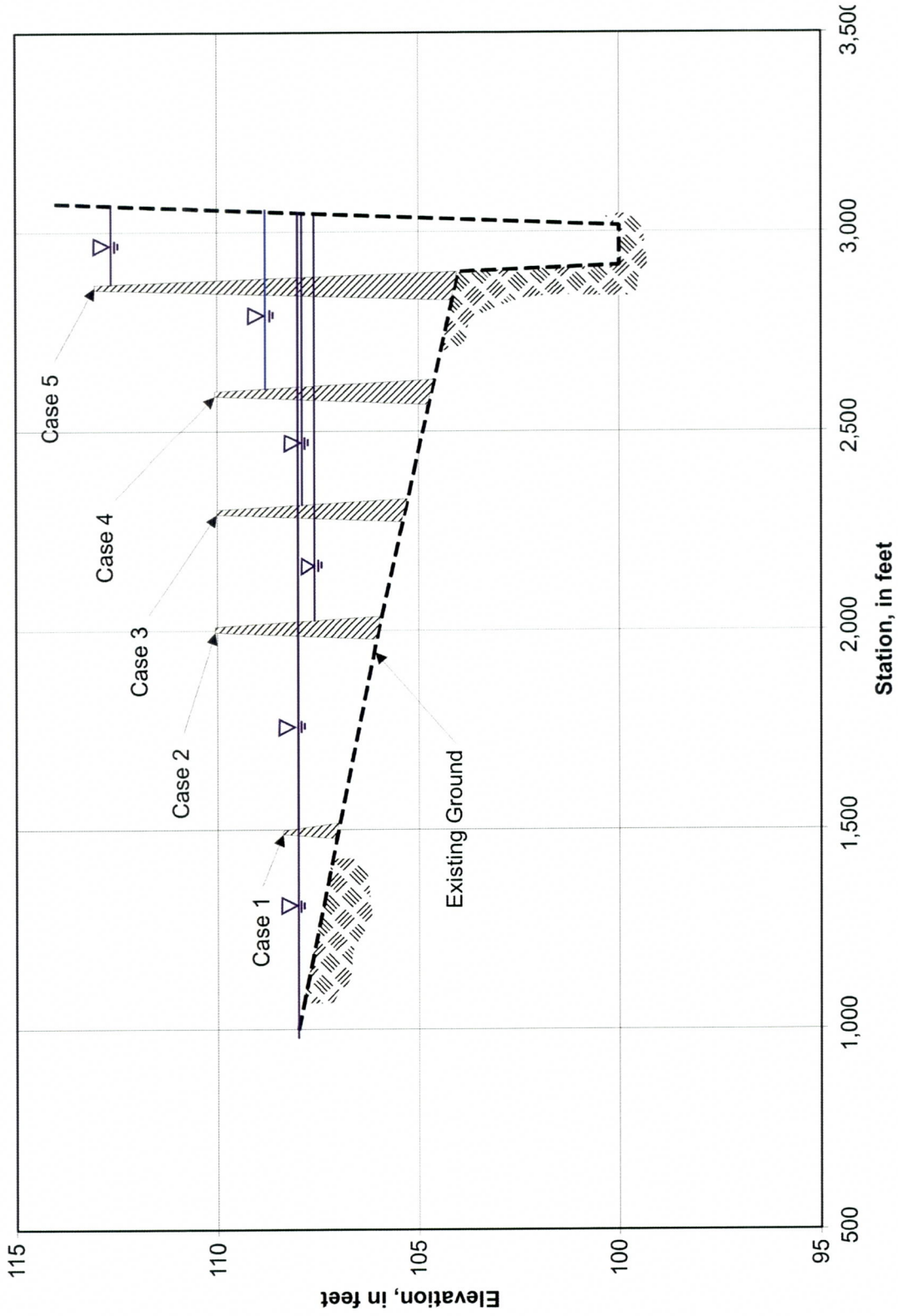


Figure 9.5 – Example Encroachment

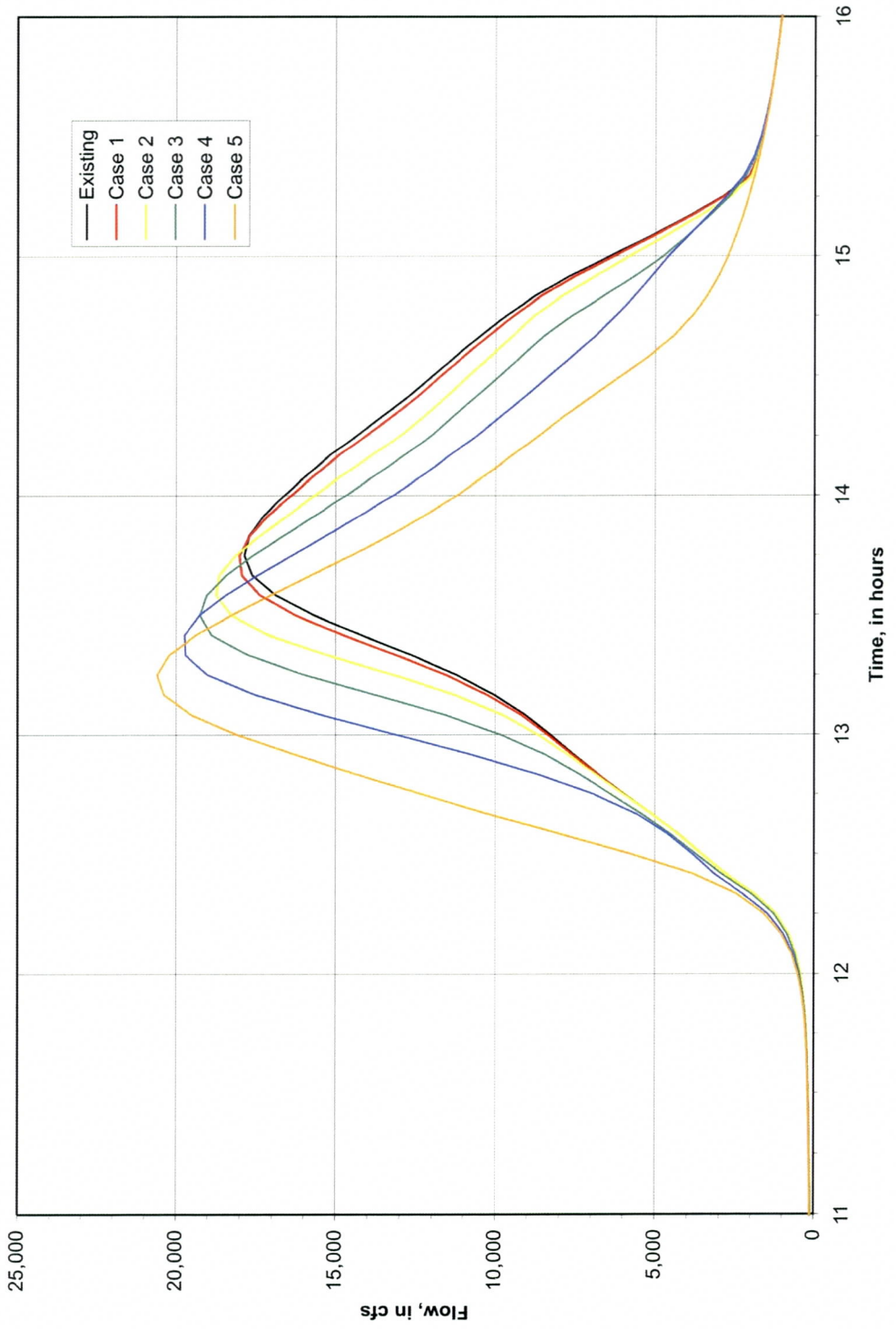


Figure 9.6 – Encroachment Hydrographs

9.4.2.3.1.2 Impact of In-stream Detention:

Results of the Sweat Canyon encroachment tests are useful in understanding the sensitivity of the watershed hydrology to encroachment as well as the location and dimensions of proposed features such as channels and levees that minimize downstream adverse impacts. Another approach to artificially alter basin response times and potential adverse impacts in New River downstream of SR-74 is with in-stream detention. An ideal location for in-stream detention, from a regional perspective, is in the Deadman Wash sub-watershed.

In its physiographic characteristics, the Deadman Wash sub-watershed is essentially a smaller version of the overall Upper New River watershed. The upper portion of the watershed (upstream of I-17) is mountainous and the source of much of the runoff for the sub-watershed. Downstream of I-17, Deadman Wash functions essentially as a conveyance element for runoff from the upper portion of the watershed. Runoff in the lower portion of the watershed is collected in tributaries that do not join Deadman Wash until the very downstream end, near the confluence with New River. The result is a double-peaked hydrograph with the leading portion of the runoff generated in the lower portion of the watershed and the lagging portion of the runoff generated in the upper portion of the watershed. The timing of the runoff from the lower portion of the watershed is more coincident with runoff generated in the Sweat Canyon sub-watershed. The timing of runoff generated in the upper portion of the Deadman Wash sub-watershed is more coincident with runoff generated in the upper portion of the overall watershed.

An ideal location for in-stream detention along Deadman Wash is the area immediately upstream of the I-17 crossing. This location is shown in Figure 9.7. Based on the geometry at this location a basin could be sized that would reduce the peak discharge at this location (HEC-1 ID's C10H & C10H-01) from approximately 10,500 cfs to 5,400 cfs. The resulting hydrograph is shown in Figure 9.8. Also, shown in Figure 9.8 is the existing condition runoff hydrograph for Deadman Wash. HEC-1 input and output files for the Deadman Wash in-stream detention basin are provided digitally on CD as Appendix J.

Results of the in-line detention evaluation show that the reduction in peak discharge can minimize potential adverse impacts downstream resulting from floodplain encroachment or other urbanization activities, particularly the increase in impervious area. The location selected for this evaluation of in-line detention is an ideal candidate for inclusion in the Lower Deadman Planning Area because of the runoff characteristics of the Deadman Watershed and the relatively high density land use proposed for the lower portion of the watershed. Also, the physical characteristics of the selected site readily accommodate an in-line basin. One advantage of in-line detention is that the basin geometry and outlet can be designed to directly pass more frequent events to minimize impacts to environmental conditions and the river morphology.

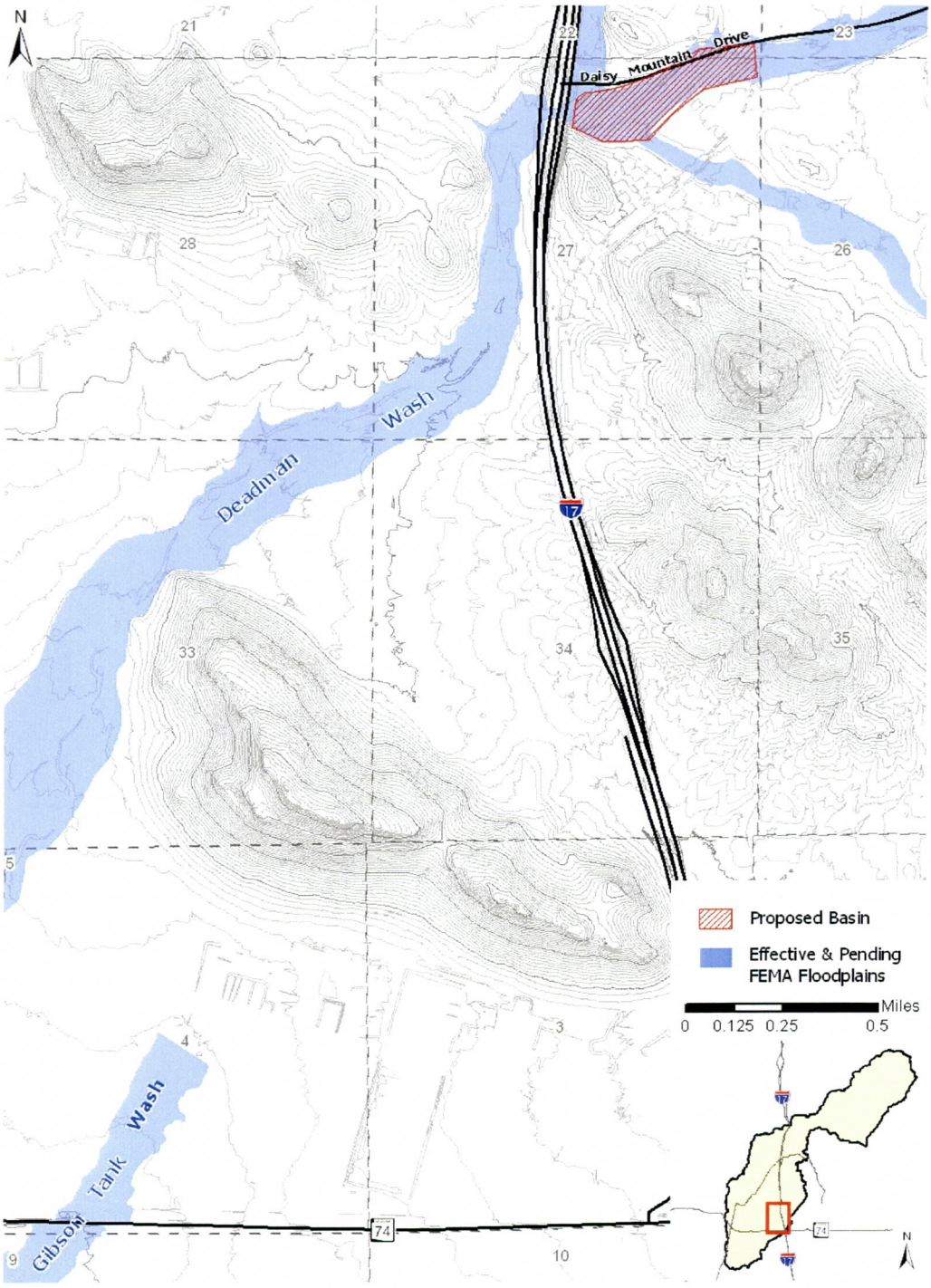


Figure 9.7 – In-stream Detention Location

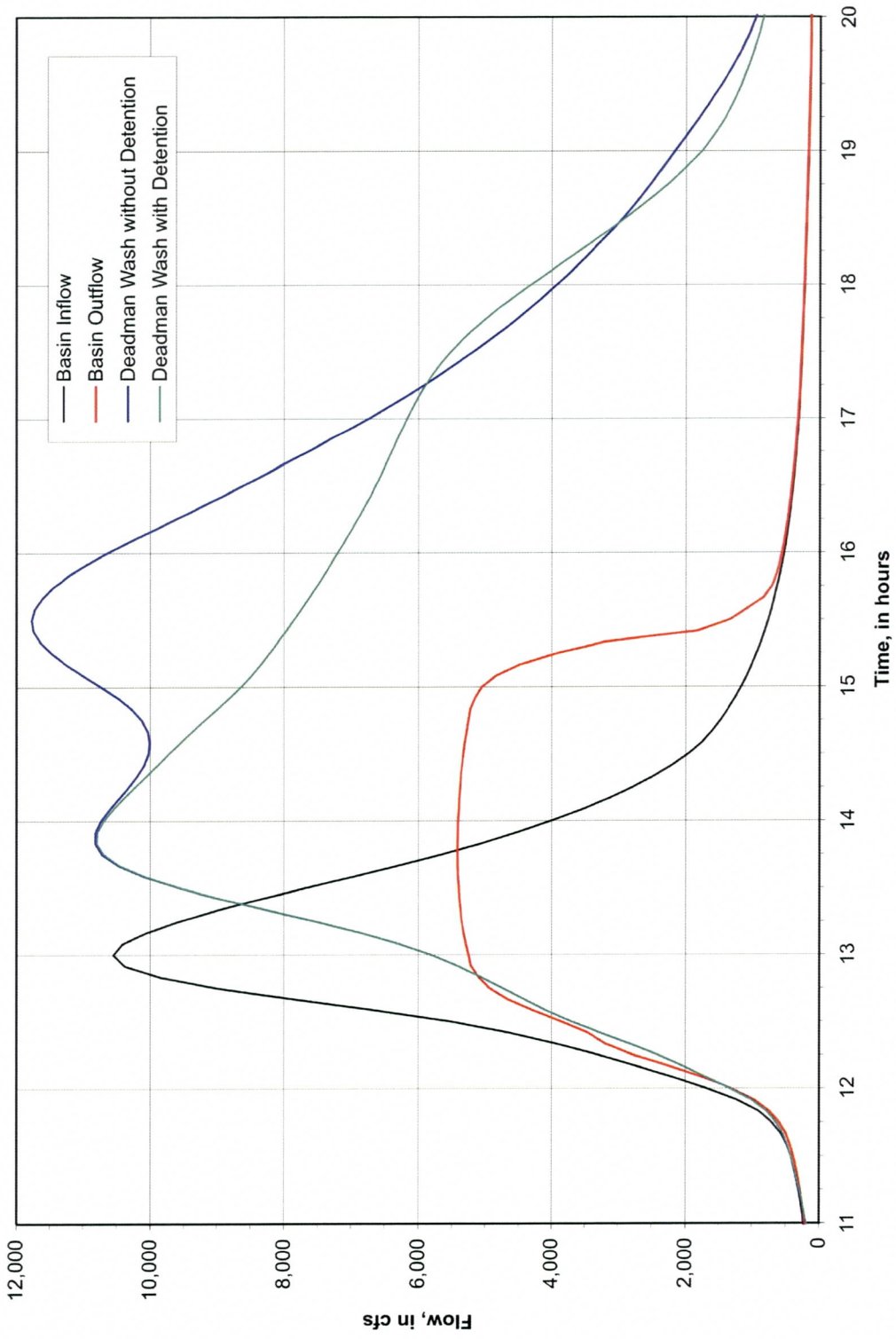


Figure 9.8 – Deadman Wash Hydrographs with In-stream Detention

9.4.2.3.1.3 Impacts of 100-Year, 2-hour Retention:

Retention of the post-development runoff from the 100-year, 2-hour storm is a policy adopted by all three jurisdictions within the Upper New River ADMP watershed. The intent of this policy is to reduce post-development runoff magnitudes to pre-development magnitudes. The impact that enforcement of 100-year, 2-hour retention may have on runoff magnitudes at the watershed scale, and in particular to runoff magnitudes in New River downstream of SR-74, was tested on the Deadman Wash sub-watershed.

The Deadman Wash sub-watershed was selected as a test case because of the future condition land use proposed for the area. The future condition land use proposed for the lower portion of the Deadman Wash sub-watershed is mixed use. Mix use covers a broad range of specific land use types. For hydrologic modeling purposes mixed use was assigned and average use of medium density residential. Most other areas within the overall watershed have low to very low density residential designations proposed. Since it is generally understood that post-development runoff magnitudes increase with increasing densities, the Deadman Wash sub-watershed will have the greatest sensitivity to retention.

Runoff volumes for the 100-year, 2-hour storm were calculated using the modified volume equation (eqn 3.4) presented in the Drainage Design Manual for Maricopa County, Volume I, Hydrology (FCDMC, 1995). The 100-year, 2-hour rainfall depth was estimated from Figure 3.3 of the Manual to be 2.75 inches. The runoff coefficient assigned for medium density residential land use is 0.75 based on the runoff coefficient data for default land use types provided with DDMSW. Because of the uncertainty of how retention will be implemented for each individual development, it was assumed that only certain areas would be considered. Since much of the upper portion of the Deadman Wash sub-watershed is already developed, retention was only considered for the lower portion. Areas in the lower portion of the sub-watershed where retention was applied are shown in Figure 9.9 and designated as Sub-areas 11 and 14. Sub-area 11 is approximately 7 square miles in size and Sub-area 14 is approximately 5 square miles in size. Under existing conditions these tributaries are essentially undeveloped. Retention volumes calculated for each subbasin that comprise these tributaries are listed in Table 9.2. Retention was simulated in HEC-1 by diverting the required volume from the runoff hydrograph for each subbasin. The base model used for the analysis is the 100-year, 24-hour future land use condition model. HEC-1 input and output files for the retention test are provided digitally on CD as Appendix J.

Results of the 100-year, 2-hour retention are compared against the existing and future land use condition runoff magnitudes at select locations in Table 9.3. Runoff hydrographs for the Deadman Wash sub-watershed (at the confluence with New River) are shown in Figure 9.10. Note that future condition runoff magnitudes are only slightly greater than existing condition. This is due to the modeling approach for future conditions which was to only adjust percent impervious values. Due to the future condition modeling approach, the results for the 100-year, 2-hour retention may not accurately reflect the true benefit of retention, but it is reasonable to conclude that enforcement of retention policy could provide a means of minimizing downstream adverse impacts, particularly impacts along New River downstream of SR-74. However, there is a great deal of uncertainty

associated with modeling 100-year, 2-hour retention for future conditions given different development practices (grading, location of retention basin, treatment of off-site flow, etc.). Therefore, 100-year, 2-hour retention is not accounted for in the various alternatives.

Table 9.2
100-Year, 2-hour Retention Volume

Subbasin ID	Area sq. mi.	Retention Volume acre-ft
11A	0.16	17.4
11B	0.22	24.3
11C	0.05	6.0
11D	0.11	12.0
11E	0.42	46.8
11F	0.26	29.2
11G	0.35	38.5
11H	0.17	19.0
11I	0.53	58.3
11J	0.84	92.6
11K	0.43	47.1
11L	2.22	245.4
11M	0.78	86.4
11N	0.23	25.3
14A	2.41	266.1
14B	0.82	90.4
14C	0.73	80.2
14D	0.24	26.7
14E	0.67	73.4
14F	0.28	30.4
14G	0.09	9.5

Table 9.3
100-Year, 2-hour Retention Results

Subbasin ID	Area sq. mi.	Existing Condition Qp cfs	Existing Condition Vol acre-ft	Existing Condition Tp hours	Future Condition Qp cfs	Future Condition Vol acre-ft	Future Condition Tp hours	Future Condition With Retention Qp cfs	Future Condition With Retention Vol acre-ft	Future Condition With Retention Tp hours
11A	0.16	349	19	12.08	353	21	12.08	20	3	12.83
11B	0.22	375	21	12.17	397	30	12.17	46	6	12.90
11C	0.05	125	4	12.00	132	7	12.00	1	1	15.00
11D	0.11	181	12	12.33	186	14	12.33	9	2	13.25
11E	0.42	446	44	12.50	459	51	12.50	21	4	14.83
11F	0.26	498	43	12.33	502	48	12.33	321	19	12.58
11G	0.35	807	46	12.33	817	58	12.17	388	20	12.42
11H	0.17	341	32	12.33	345	41	12.33	345	22	12.33
11I	0.53	810	97	12.58	821	120	12.58	755	61	12.67
11J	0.84	1,184	135	12.58	1,201	163	12.58	853	71	12.92
11K	0.43	677	46	12.42	690	55	12.42	92	7	13.17
11L	2.22	2,430	360	13.00	2,460	412	13.00	1,607	167	13.42
11M	0.78	865	128	13.00	874	143	13.00	597	57	13.42
11N	0.23	438	38	12.33	440	41	12.33	272	15	12.58
C11N	6.78	5,643	959	13.17	5,807	1,136	13.17	2,419	389	13.83
14A	2.41	3,382	433	12.67	3,405	480	12.67	2,349	214	12.92
14B	0.82	1,089	150	12.75	1,097	167	12.75	829	76	13.00
14C	0.73	911	133	12.83	918	148	12.83	708	67	13.08
14D	0.24	448	28	12.33	461	39	12.33	240	13	12.58
14E	0.67	819	122	12.83	826	135	12.83	609	62	13.17
14F	0.28	455	51	12.50	458	56	12.50	356	26	12.67
14G	0.09	168	7	12.17	176	11	12.17	15	2	12.75
C14G	5.22	4,861	1,463	13.33	4,926	1,579	13.33	2,318	1,004	13.83
C10Y	34.01	11,774	4,595	15.50	12,275	5,168	15.42	10,701	3,329	15.50

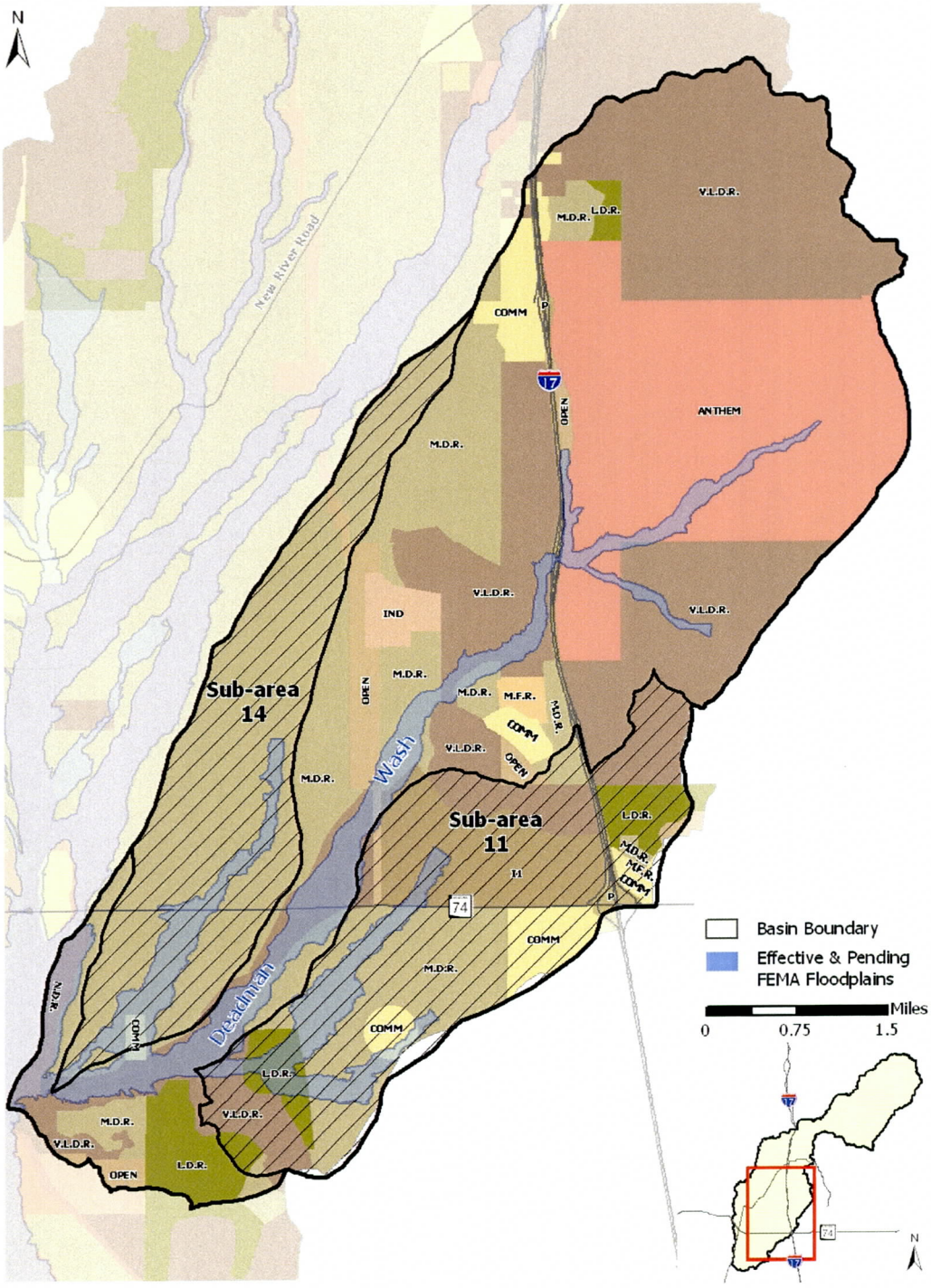


Figure 9.9 – 100-Year, 2hour Retention Area

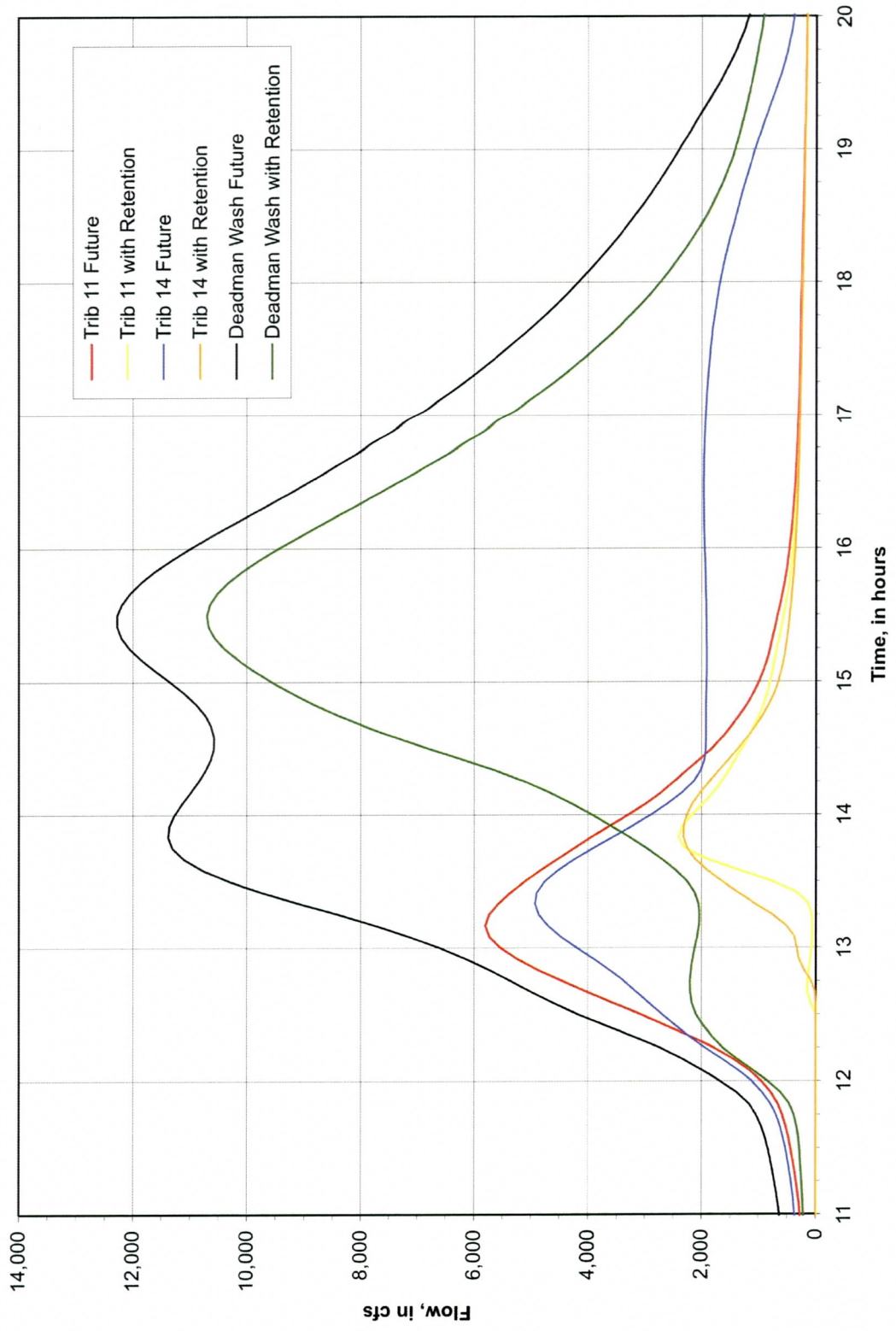


Figure 9.10 – 100-Year, 2-hour Retention Results

9.4.2.4 Opinion of Probable Construction Cost

Preliminary estimates of construction cost were prepared for the structural alternatives and the Floodprone Properties Assistance Program (FPAP) alternative. Cost estimates are used as an aid in the selection process of a recommended alternative. Cost estimates developed for each alternative reflect the proposed improvements developed from generalized hydraulic evaluation and are considered approximate. The value of land removed from the floodplain/erosion hazard zone by an alternative is estimated to determine the benefit of the proposed improvement. In the situation where floodplain area is recovered due to a specific alternative, the overall construction cost is reduced by the value of the property recovered.

Quantities are calculated for earthwork (channel excavation, fill and/or levee fill), volume of bank armoring material required, and for land cost. Volume of fill material was determined by average end area calculations for cross sections (cross sections from the HEC-RAS model were utilized) taken through the proposed channel excavation, fill and/or levee fill area. Bank armoring quantities are determined by applying a typical section along the length of the improvement area. For the purpose of evaluating proposed alternatives, total scour was not calculated for each alternative. A total scour depth of ten feet (minimum toe down depth) was used in the estimation of riprap quantities. Actual calculated scour depth will be used for the recommended alternative.

Dumped riprap was chosen as the type of bank protection for proposed alternatives considering that all structural features would have a method of landscape treatment. The size of the dumped riprap material was determined utilizing procedures cited in the report Design of Riprap Revetment (FHWA 1989).

At locations where there are proposed bridge crossings over New River, Deadman Wash or Sweat Canyon Wash downstream of New River Road a bridge cost was estimated. The bridge cost is included in the over all total cost of construction.

Table 9.4 lists a summary of unit cost utilized to determine cost estimates for each alternative. Given the level of design (conceptual) of the proposed alternatives, a cost contingency is applied to account for design details that are not taken into account at this stage. Contingency cost is estimated at 20 percent of the total construction cost of the proposed improvements.

Probable costs are not estimated for alternatives that are implemented by policy and regulations such as the ADMP Guidelines Alternative or the No Action Alternative.

Table 9.4 Summary of Unit Costs

Description (1)	Unit (2)	Unit Price (3)
Construction		
Clear and Grub	AC	$1,500[1]
Channel Excavation	CY	$12[2]
Structural Fill	CY	$12[3]
Dumped Riprap	CY	$80
Property		
Right of Way (Floodplain Property)	AC	$ 50,000
Right of Way (Non Floodplain Property)	AC	$100,000
Reclaimed Floodway Property	AC	$ 50,000
Property Acquisition - Floodplain	LS	$175,000
Relocation	LS	$32,500
Demolition	LS	$25,000
Environmental Mitigation		
Hydroseed	AC	$3,000
Landscaping		
Landscape Aesthetic Fill	CY	$12
Plantings	AC	$5,000[4]
General Requirement (percentage of subtotal)		
Contingency	LS	20%[5]

1) Does not include salvage of native plants. Clearing unit cost assumes that ground conditions are 50% minor vegetation and 50% heavy vegetation.
2) Assume material is placed on-site.
3) Assume native material is acceptable for structural fill, with only minor processing.
4) Estimate does not include irrigation.
5) Accounts for unknown conditions as well as general conditions, temporary facilities and insurance.

9.4.3 Alternatives Evaluations Results

9.4.3.1 Gavilan Peak Planning Area

The Gavilan Peak Planning Area lies in the north-eastern portion of the New River Watershed and encompasses the community of New River, the only planning area with any appreciable development. Land use in the area is primarily low to very low single lot residential. The majority of the planning area is privately owned.

The planning area is drained by Gavilan Peak Wash. Gavilan Peak Wash is a tributary of New River. Floodplain limits have been delineated for Gavilan Peak Wash and its major tributaries. The result of the delineation is that 28 properties have the primary residential structure located in the floodplain. Another flood hazard common to this planning area is inadequate culvert capacity to convey the 100-year peak flow as well as frequent flows.

Alternatives advanced for evaluation for the Gavilan Peak Planning Area include both watershed/planning area-wide and watercourse scale alternatives. Planning area-wide alternatives considered are the development of ADMP Guidelines (Alternative 1) and the No-action Alternative (Alternative 4). Descriptions and specific elements of both these Planning Area-wide alternatives were presented in Section 9.3.

Watercourse scale alternatives are a non-structural alternative, the Floodprone Property Assistance Program (FPAP, (Alternative 2)) and a structural alternative (Alternative 3). Watercourse scale alternatives are proposed for the reach of Gavilan Peak Wash downstream of New River Road to its confluence with New River. Of the 28 properties that have the primary residence structure located within the floodplain, 22 are along this reach of Gavilan Peak Wash. Flooding issues along this reach are worsened by inadequately sized roadway crossings of Gavilan Peak and its major tributaries.

The structural alternative for Gavilan Peak Wash proposes several levee segments as well as improved wash crossings (bridges) at two locations. The alignment of the various levee segments and improved wash crossing locations are shown in Figure 9.11. The levee segments are located, in general, along the floodway boundary. Levee alignments lying within the floodway boundary will be necessary to remove specific structures form the floodplain. Levees are not necessary for the entire reach of Gavilan Peak Wash. Three properties have already been purchased through the FPAP. These properties are located mid-way along the reach as shown in Figure 9.11. Levee alignments will need to extend up tributaries to accommodate inflow to the reach. At Coyote Pass Wash, the proposed levee ties into the existing dip section at New River Road. At Table Mountain Wash, the proposed levee ties into a proposed bridge crossing at New River Road. A new bridge crossing on Gavilan Peak Wash is also proposed as part of the structural alternative. Bridge crossings and associated roadway approached grade modifications are proposed at these two locations in order to utilize the entire existing channel geometry to pass the entire 100-year peak flow under the road. A sufficiently sized culvert crossing at these locations would require widening of the existing channel.

9.4.3.1.1 Hydrology

Peak discharges used in the hydraulic evaluation of the structural alternative for Gavilan Peak Wash, Table Mountain Wash and Coyote Pass Wash are taken for the existing land use condition ADMP HEC-1 models. Those discharges are listed in Table 9.5.

Table 9.5
Gavilan Peak Wash Peak Discharges

River Station	HEC-1 ID	Peak Discharge, in cfs 100-Year	50-Year	10-Year	Wash Name [1]
1.446	CP19	4,649	4,004	1,436	GPW
1.359	CP20	4,534	3,884	1,361	GPW
1.220	CP21	4,760	4,064	1,424	GPW
1.129	CP37	8,329	7,145	2,425	GPW
0.993	CP39	8,547	7,267	2,472	GPW
0.838	CP41	8,558	7,344	2,472	GPW
0.666	CP43	8,594	7,293	2,471	GPW
0.497	CP45	8,605	7,277	2,453	GPW
0.989	CP34	4,052	3,496	1,191	TMW
0.090	CP36	4,006	3,445	1,167	TMW
0.497	40B	267	232	88	CPW

Note:
1. GPW = Gavilan Peak Wash
TMW = Table Mountain Wash
CPW = Coyote Pass Wash

9.4.3.1.1.1 Hydrologic Considerations

Hydrologic modeling of the proposed structural alternative for the watercourse master planning reach of Gavilan Peak Wash was not performed. Although the proposed levee alignment encroaches the floodplain up to the floodway limits, adverse impacts to peak discharges in New River downstream of the confluence with Gavilan Peak Wash because of the differences in timing and the relatively minor contribution of runoff from the Gavilan Peak Watershed compared to New River at that point.

9.4.3.1.2 Hydraulic Evaluation

Results of the hydraulic models for the structural alternative are compared to the base hydraulic model to determine the impact of the alternative on the hydraulic properties of the watercourse. Table 9.6 provides a description of the HEC-RAS model. Figures 9.12 through 9.16 show the results for Gavilan Peak. The base model was used for evaluation and representation of the proposed alternative features is the pending FEMA model. The pending FEMA HEC-RAS model for Gavilan Peak Wash, Table Mountain Wash and Coyote Pass Wash were modified to reflect the proposed features and those models are provided digitally on CD as Appendix J. Modifications to those models include:

- Removal of encroachment stations representing the floodway boundary for the reaches downstream of New River Road.
- Coding of the proposed levee using the levee option.

- Replacement of existing culvert data with proposed bridge/roadway data.
- Truncation of the portions of Gavilan Peak Wash, Table Mountain Wash and Coyote Pass Wash upstream of the proposed improvements.

Proposed levee heights range from 4 to 11 feet and include a minimum of 3-feet of freeboard. The average levee height is approximately 7 feet. The existing floodplain width through this reach averages 500 feet. The resulting conveyance corridor with the proposed levees averages 250 feet.

The proposed bridges at Gavilan Peak Wash and Table Mountain Wash are sized to span the channel minimizing backwater conditions that cause flow break-out at these locations. The proposed bridge opening is 100 feet with a single pier. The bridge deck width is 40 feet.

Table 9.6
Gavilan Peak Wash Alternative Analysis Hydraulic Model Summary

Project Name	Plan Name	Geometry	Steady Flow
(1)	(2)	(3)	(4)
Gavilan Peak Wash	Levee	Levee	Alternative
Table Mountain Wash	Alternative	Alternative – Bridge at NR Road	Flow Profiles
Coyote Pass Wash	FP/FW with GP Levee	Alternative	Flow Profiles

Conclusions that can be drawn from review of the 10-year event figures for Gavilan Peak are (see Figures 9.12 through 9.14):

- Majority of the points for the 10-year event lie on or near the 45 degree line for the shear stress, channel velocity and hydraulic depth figures. This indicates that there is little change in hydraulic parameters between the base and the alternative models. By inference, the regional sedimentation of New River between I-17 and SR-74 does would not change due to the implementation of the alternative.
- The scatter of points above and below the 45 degree line for all three figures indicates that there are local or isolated changes in channel hydraulics by the alternatives. The alternatives will cause local or isolated changes to sedimentation.

Conclusions that can be drawn from review of the 100-year event figures for Gavilan Peak are (see Figures 9.15 and 9.16):

- The levee causes an increase in velocity for the area downstream of New River Road (RM 1.0 to 1.4) for the 100-year event.

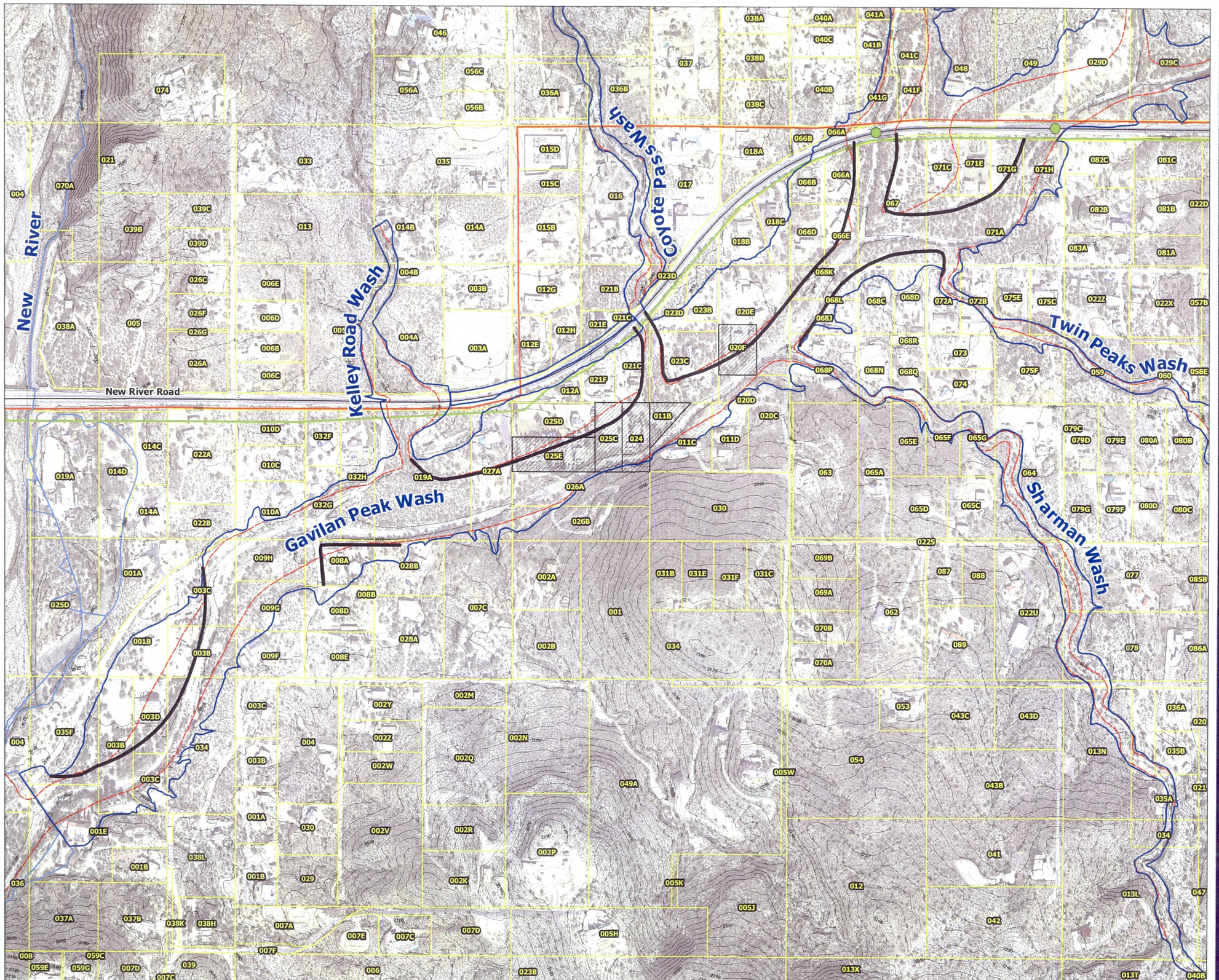
- The levee also causes an increase in hydraulic depth for the area downstream of New River Road (RM 1.2 to 1.4) and a decrease for RM 0.5 to 1.2.

9.4.3.1.3 Probable Cost

Table 9.7 lists a summary of the probable cost estimates of an alternative in which a implementation or construction cost could be calculated. The opinion of construction cost includes a 20 percent contingency. Appendix K includes a detailed breakdown of the construction cost estimates.

Table 9. 7
Gavilan Peak Summary of Probable Cost

Alternative (1)	**Probable Cost** (2)
Alternative 2 - FPAP	$ 5,580,000
Alternative 3 – Structural Levee with Landscape Treatment	
Construction Cost	$ 6,600,000
Land Value Offset	$-1,550,000
Total Cost	$ 5,050,000



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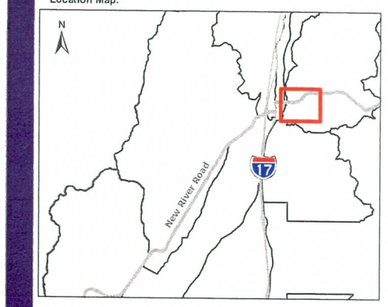
Phoenix, AZ U.S.A. 85044

Legend:

- Proposed Bridge
- Levee
- Roadway
- Powerline
- Gasline
- Index Contour
- 2 ft Intermediate Contour
- Pending Floodway
- Pending Floodplain
- FEMA Floodplain
- Parcel Boundary
- FPAP Aquisition

Location Map:



N

0 200 400 600 800 Feet

Project No.
182000418

Prepared By:
AMG
February 2008

Title:
Gavilan Peak
Alternative 2
Figure 9.11

Revision:

	By	Appd.	Date

Sheet 1 of 1

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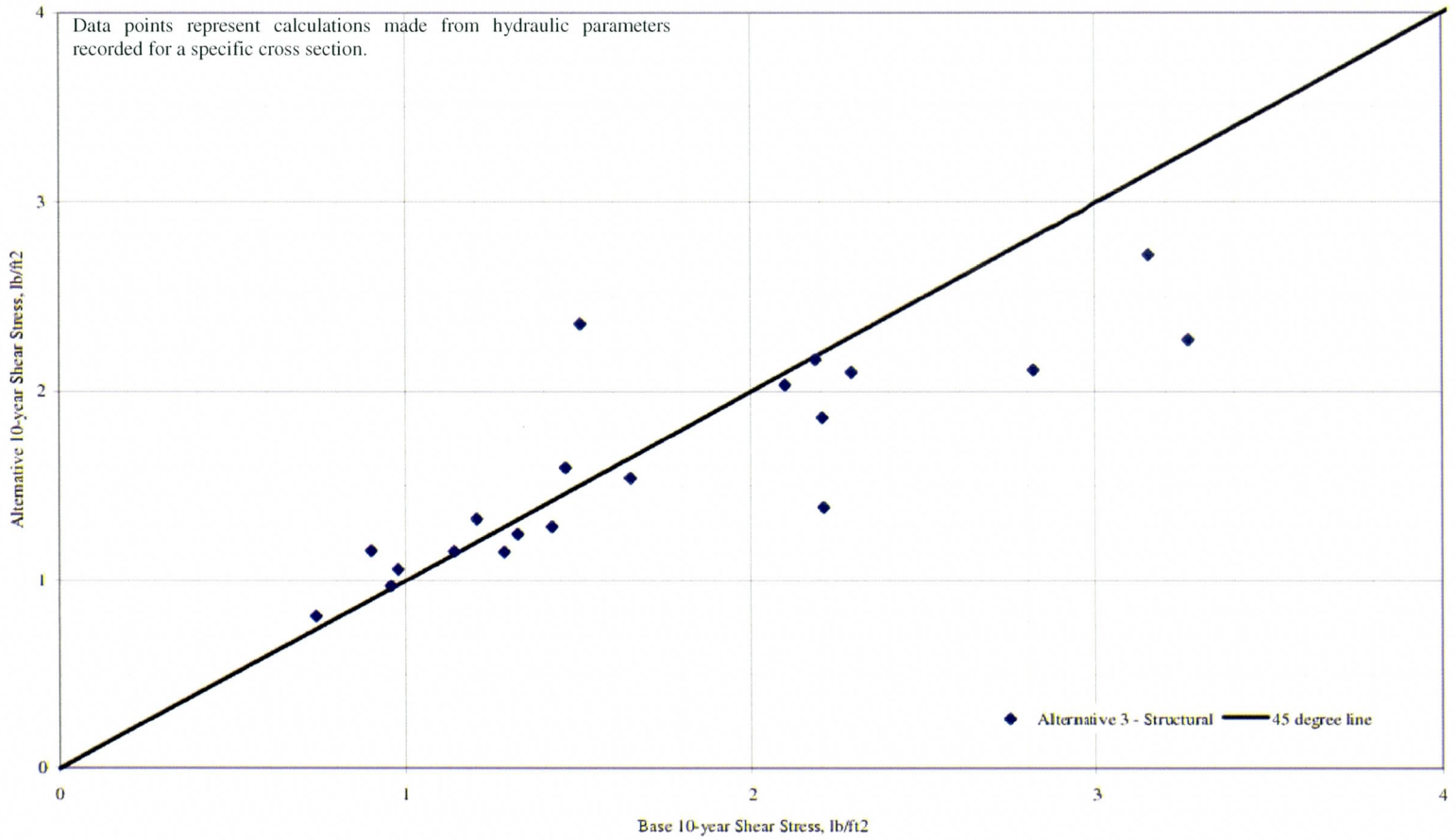


Figure 9.12 - Comparison of Shear Stress for Gavilan Peak Wash Alternative 3 - Structural

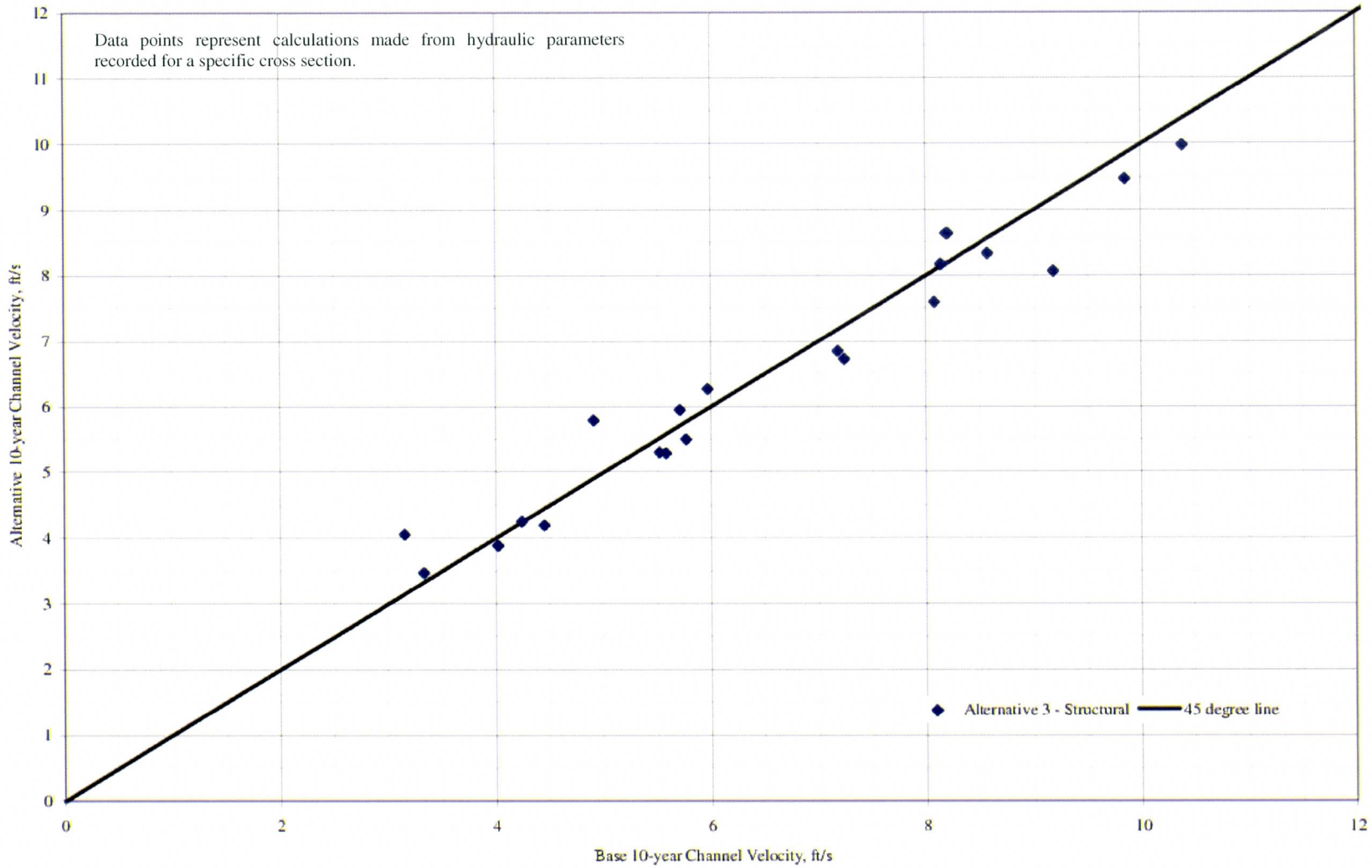


Figure 9.13 - Comparison of Channel Velocity for Gavilan Peak Wash Alternative 3 - Structural

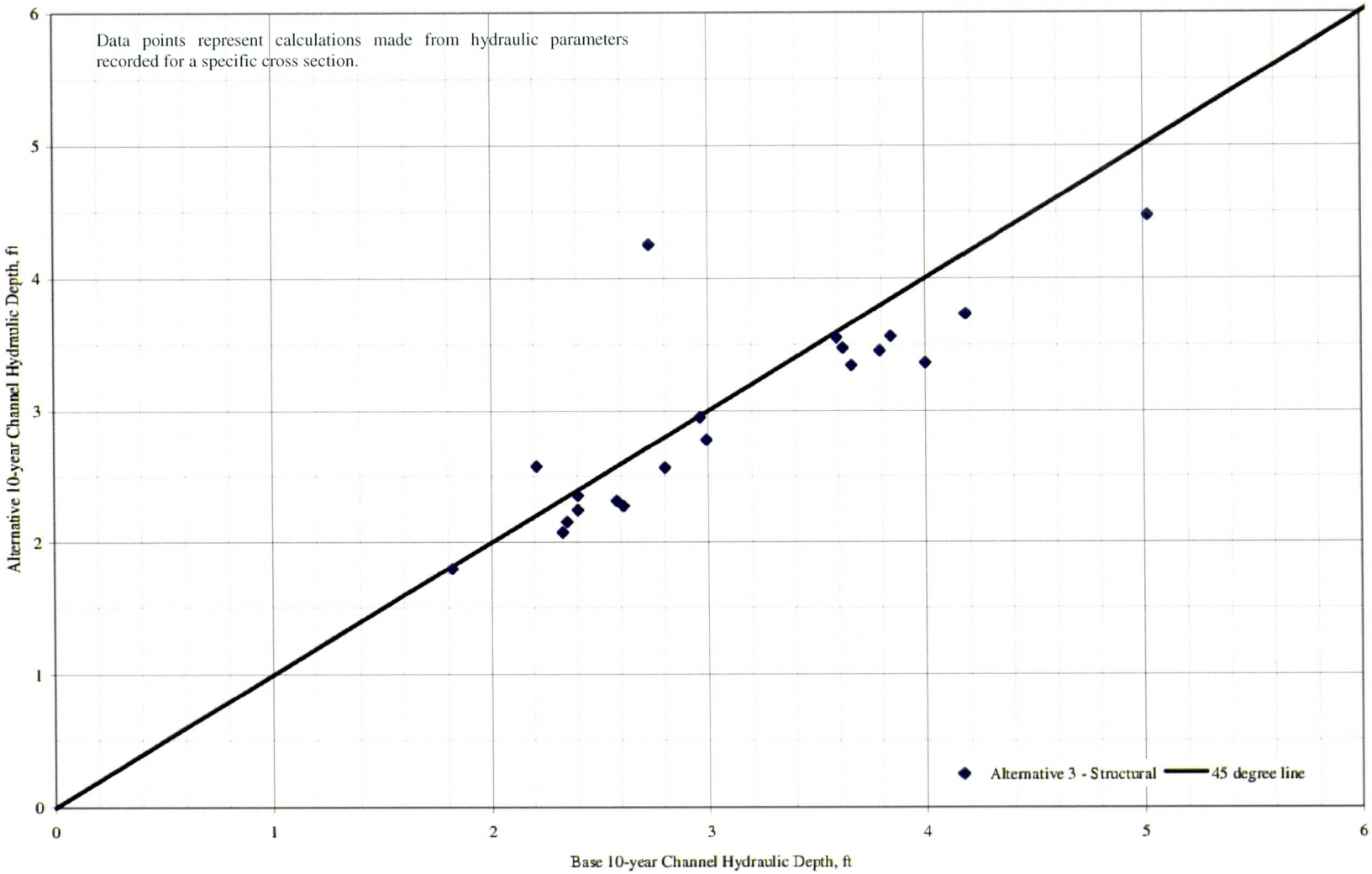


Figure 9.14 - Comparison of Hydraulic Depth for Gavilan Peak Wash Alternative 3 - Structural

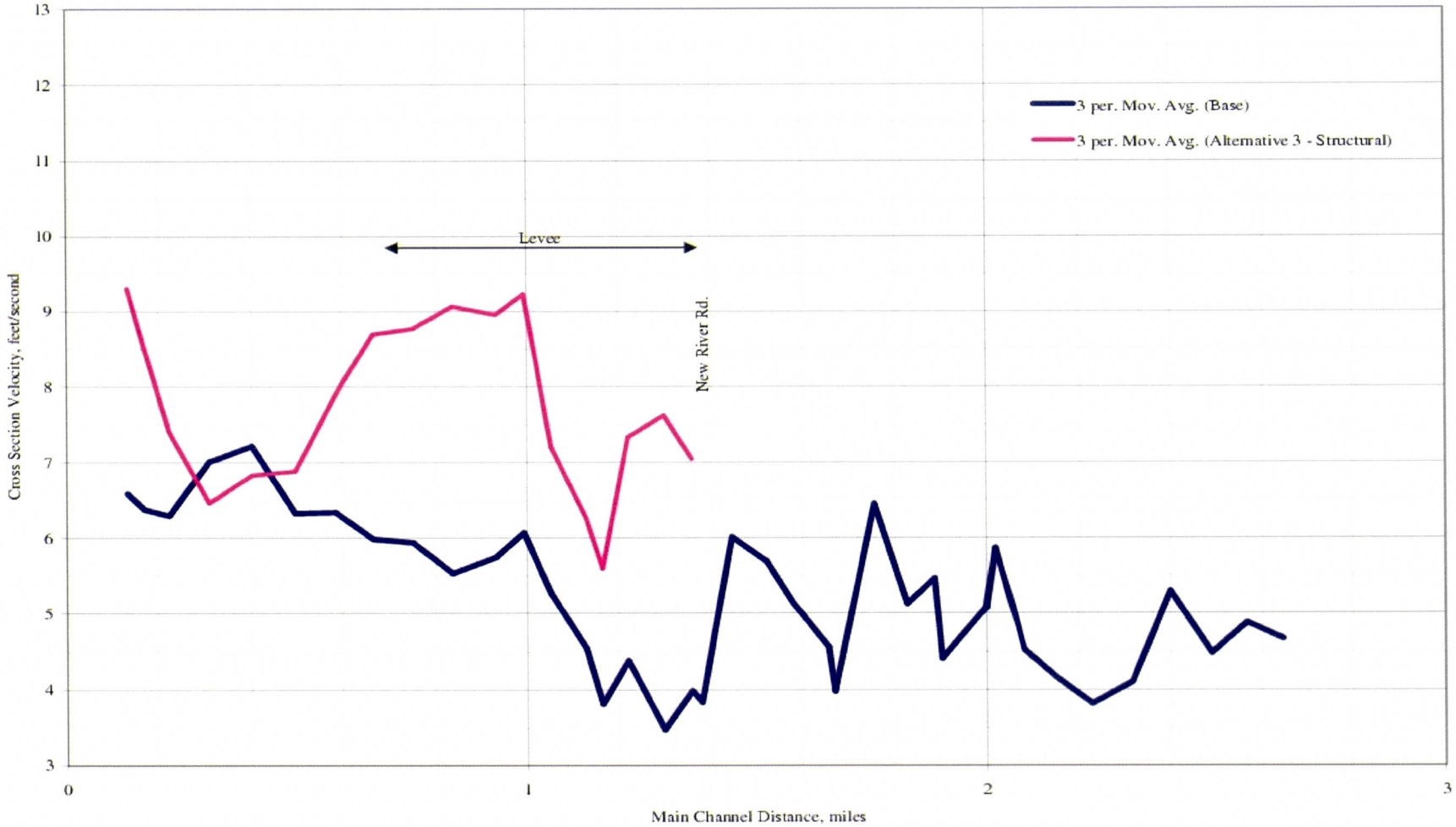


Figure 9.15 - Gavilan Peak Wash - Comparison of Velocity - 100-Year Event

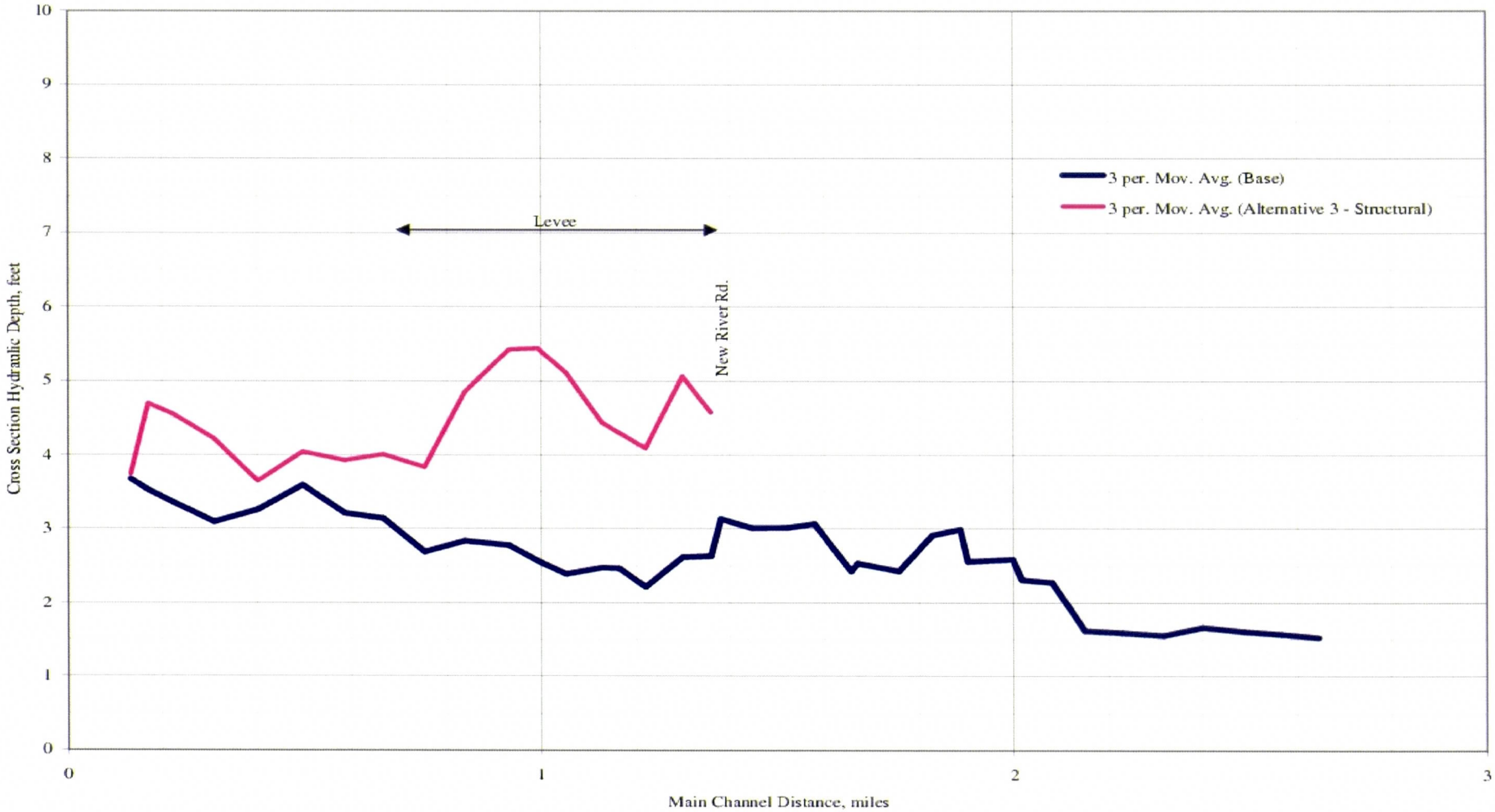


Figure 9.16 - Gavilan Peak Wash - Comparison of Hydraulic Depth - 100-Year Event

9.4.3.2 New River Upstream of I-17 Planning Area

The New River Upstream of I-17 Planning Area is a watercourse planning area for New River between I-17 and the Tonto National Forest boundary. Approximately 6 houses are located within in the New River 100-year floodplain. The locations of the houses are depicted on Figures 9.17 (Sheet 1 and 2). Another flood and public hazard in this area is that access is cut off for 15 property owners (depicted on Figure 9.18) who have house along Old Stage Coach Road upstream of the roads crossing with New River. Old Stage Coach Road is impacted by flood waters from approximately a 10-year event or greater. Historically this has been a flood issue in this area. To help alleviate the problem a training levee was constructed so that runoff in the low flow channel of New River would be directed away from Old Stage Road. The levee will be over topped when a runoff peak discharge of greater than approximately 10,000 cfs (approximately the 10-year event) is being conveyed within New River. Portions of the training levee have been eroded away and eventually it will no longer perform the intended function. It is unknown who constructed the levee.

Structural, non-structural and No Action alternatives were proposed to mitigate existing flood hazards. Non-structural alternatives are proposed for the entire reach whereas structural alternatives are also proposed for the reach along and adjacent to Old Stage Coach Road where property egress is limited during a runoff event.

Below lists alternatives developed to mitigated egress issues along Old Stage Road adjacent to New River. The locations and type of structure are depicted on Figure 9.18.

- Alternative 1 - Re-construct Old Stage Road as a levee
    - Old Stage Road would provide egress during frequent flooding events
- Alternative 2 - Channelization adjacent to Old Stage Road to improve conveyance capacity of New River channel to reduce flooding on Old Stage Road
- Alternative 3 - Floodprone Property Assistance Program
    - Voluntary Program
    - Acquire homes in high hazard areas within the New River Floodplain and properties with existing residential structures which have access problems in a flooding event
- Alternative 4 – Alternative is based on operation and maintenance to remove or reduce vegetation from the New River Channel
    - Potentially improve conveyance capacity of the New River channel, which could reduce the floodplain
    - Alternative rejected because flood hazard would not be reduced

Alternative 5 and 6 were developed for reaches other then the Old Stage Coach reach are the Non-Structural alternative which is managed through ADMP guidelines and the No Action alternative which is managed through existing FEMA and agency guidelines. Details of Alternatives 5 and 6 are:

- Alternative 5 - ADMP Guidelines
    - Manage Non-structural alternative through floodplain and erosion hazard delineations.
    - Develop a Flood Warning Response plan for residents
    - Promote and continue sound floodplain management
    - Provide existing property owners with guidelines to reduce their flooding and erosion risk
    - Floodprone Property Assistance Program
        - Voluntary Program
        - Acquire homes in high hazard areas within New River Floodplain
        - Floodproof homes
- Alternative 6
    - No Action Alternative - (FEMA Regulatory Solutions)

9.4.3.2.1 Hydrology

Peak discharges used in the hydraulic evaluation of the proposed alternative for the structural alternatives in the New River Upstream of I-17 Planning Area for the 100-year event are the effective FEMA discharges. Peak discharges for the 10-year event are ratios of the 100-year FEMA discharges (Table 9.8). The 10-year ratio is 0.33 and is based on flood frequency data for the USGS gage New River near Rock Springs. FEMA discharges were used for alternative evaluation purposes because of the differences in the ADMP discharges compared with the FEMA discharges (see the Upper New River ADMP Hydrology Report for a discussion of this issue) and because the proposed improvements would alter the effective floodplain delineation.

Table 9.8
New River Upstream of I-17 Peak Discharges

River Station	Peak Discharge, in cfs 100-year	10-year
38.847	34,500	11,385
38.561	33,700	11,121
36.544	32,800	10,824
35.203	32,000	10,560
34.042	33,400	11,022
32.54	33,400	11,022

9.4.3.2.1.1 Hydrologic Considerations

Hydrologic modeling of the proposed structural alternatives was not performed. Although all the structural alternatives will to some degree impact the timing of runoff through the reach, the magnitude and the cumulative downstream impacts will be negligible.

9.4.3.2.2 Hydraulic Evaluation

Results of the hydraulic models for the structural alternatives are compared to the base hydraulic model to determine the impact of the alternative on the hydraulic properties of the watercourse. A summary of the hydraulic models is included on Table 9.9. Figures 9.19 through 9.22 show the results for Old Stage Coach Road.

Table 9.9
Old Stage Coach Road Alternative Analysis Hydraulic Model Summary

Project Name	Plan Name	Geometry	Steady Flow
(1)	(2)	(3)	(4)
NR along Old Stage Coach Rd	Levee	Levee	FEMA Q
	Channel Option	Channel	FEMA Q
	Veg Maintenance	Veg Maintenance	FEMA Q

Conclusions that can be drawn from review of the 10-year event figures for Old Stage Coach Road are (see Figures 9.19 through 9.21):

- Majority of the points for the 10-year event lie on or near the 45 degree line for the shear stress, channel velocity and hydraulic depth figures. This indicates that there is little change in hydraulic parameters between the base and the alternative models. By inference, the regional sedimentation of New River between I-17 and SR-74 does would not change due to the implementation of the alternative.

- The scatter of points above and below the 45 degree line for shear stress, channel velocity and hydraulic depth indicates that there are local or isolated changes by the alternatives. The alternatives will cause local or isolated changes to sedimentation.

- Majority of the shear stress and hydraulic depth scatter for the levee and channel alternatives lie below the 45 degree line. This indicates that there is a decrease in the shear stress and hydraulic depth. By inference for localized areas the amount of scour decrease or deposition may increase.

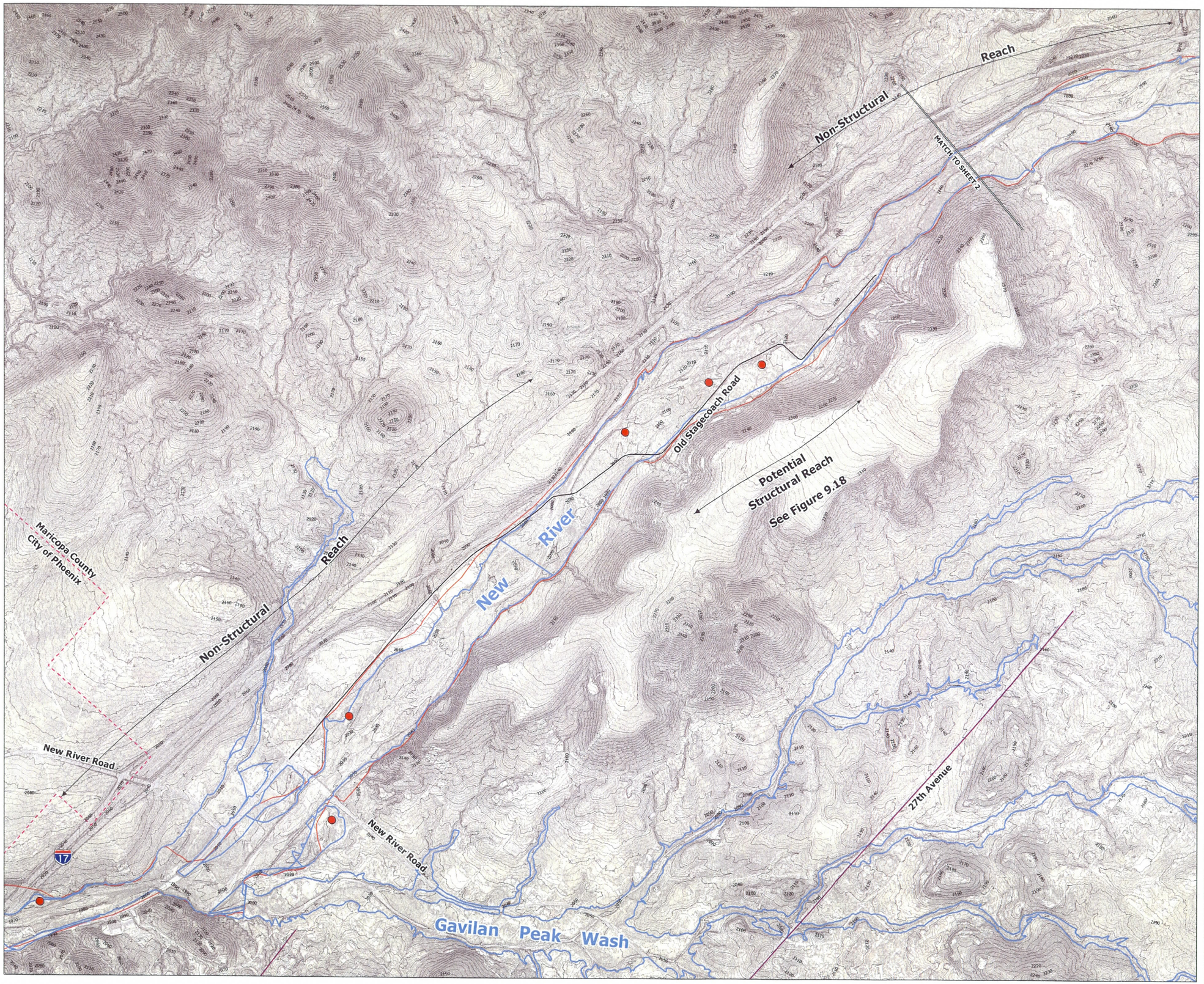
- For the vegetative maintenance alternative there is little scatter from the 45 degree line as shown on the three figures. This indicates that there is little change in hydraulics from the base model. By inference there is little change in regional sedimentation for this alternative.

Conclusions that can be drawn from review of the 100-year event figures for Old Stage Coach Road are (see Figures 9.22 and 9.23):

- For the channel alternative the velocity between RM 34.8 and 35.8 increased, as much as 4 ft/sec, from the base model. Between RM 35.2 and 35.7 the hydraulic depth decreased. The cross section is able to convey more flow with a lower water surface elevation.

- For the levee alternative the hydraulic depth increases in the area of the levee with a slight increase in velocity. The channel is able to convey the same amount of flow with an increased water surface elevation.

- For the vegetation maintenance alternative there is little change in velocity and hydraulic depth from the base model.



Flood Control District of Maricopa County
2801 W. Durango St.
Phoenix, AZ 85009

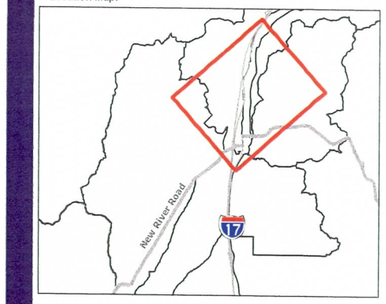
Upper New River ADMP
FCD 2005CO20

Prepared By:
Stantec Consulting Inc.
8211 S. 48th Street
Phoenix, AZ U.S.A. 85044

Legend:

- Structure within the Floodplain
- Proposed Roadway Alignment
- Roadway
- Index Contour
- 2 ft Intermediate Contour
- FEMA Floodplain
- Erosion Hazard
- Phoenix Corporate Boundary

Location Map:



0 600 1,200 1,800 2,400 Feet

Project No.
182000418

Prepared By:
AMG
May 2008

Revision:

	By	Appd.	Date

Title
New River Upstream of I-17 Alternatives Figure 9.17

Sheet 1 of 2

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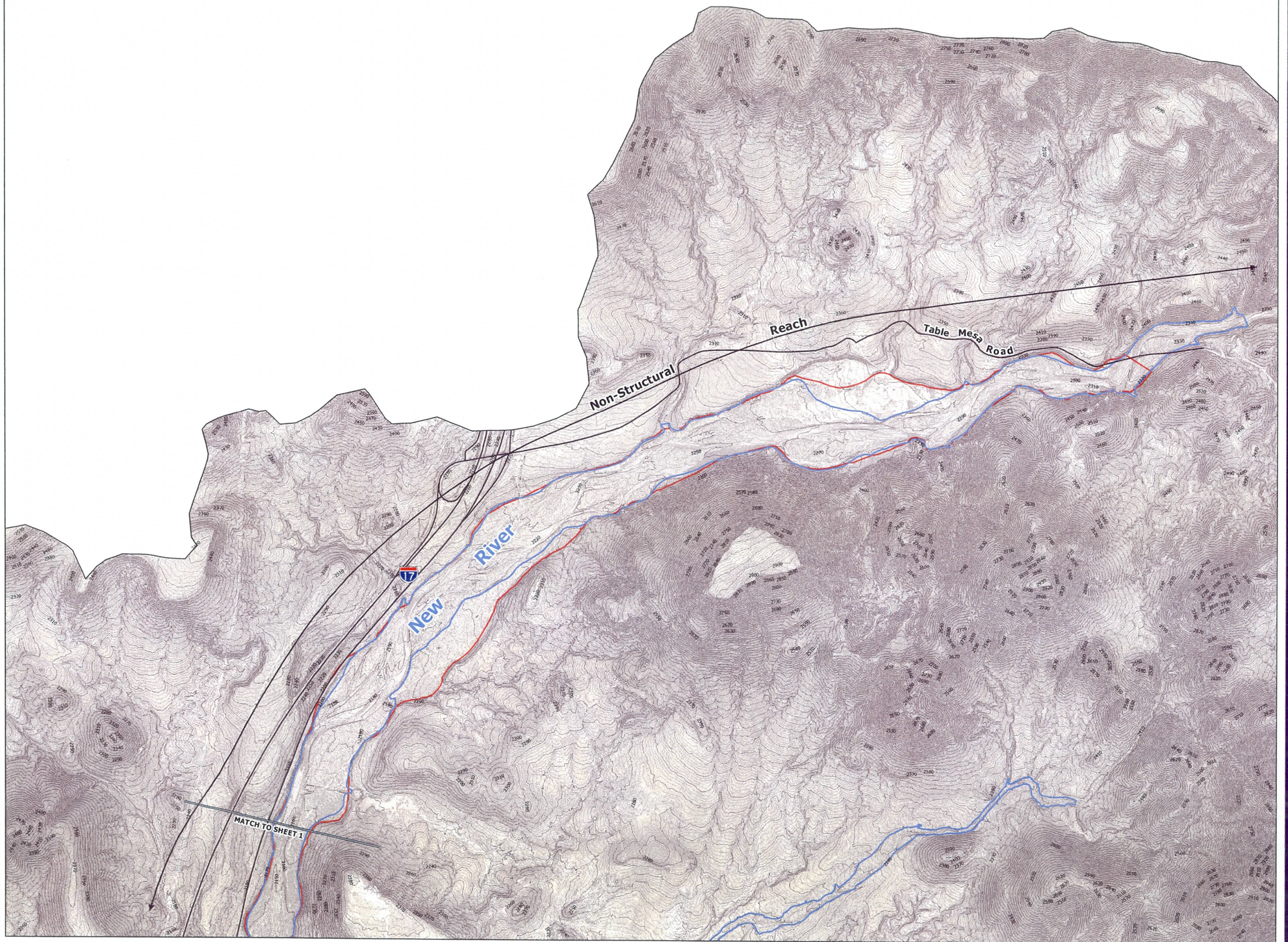

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Flood Control District of Maricopa County
2801 W. Durango St.
Phoenix, AZ 85009

Upper New River ADMP
FCD 2005CO20

Prepared By:
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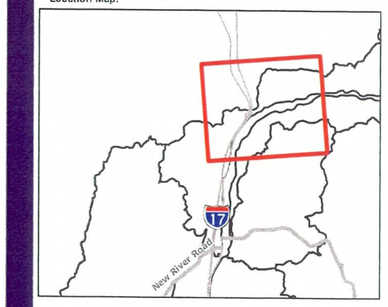
Phoenix, AZ U.S.A. 85044

Legend:

- Roadway
- Index Contour
- 2 ft Intermediate Contour
- FEMA Floodplain
- Erosion Hazard

Location Map:



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0 600 1,200 1,800 2,400 Feet

Project No.
182000418

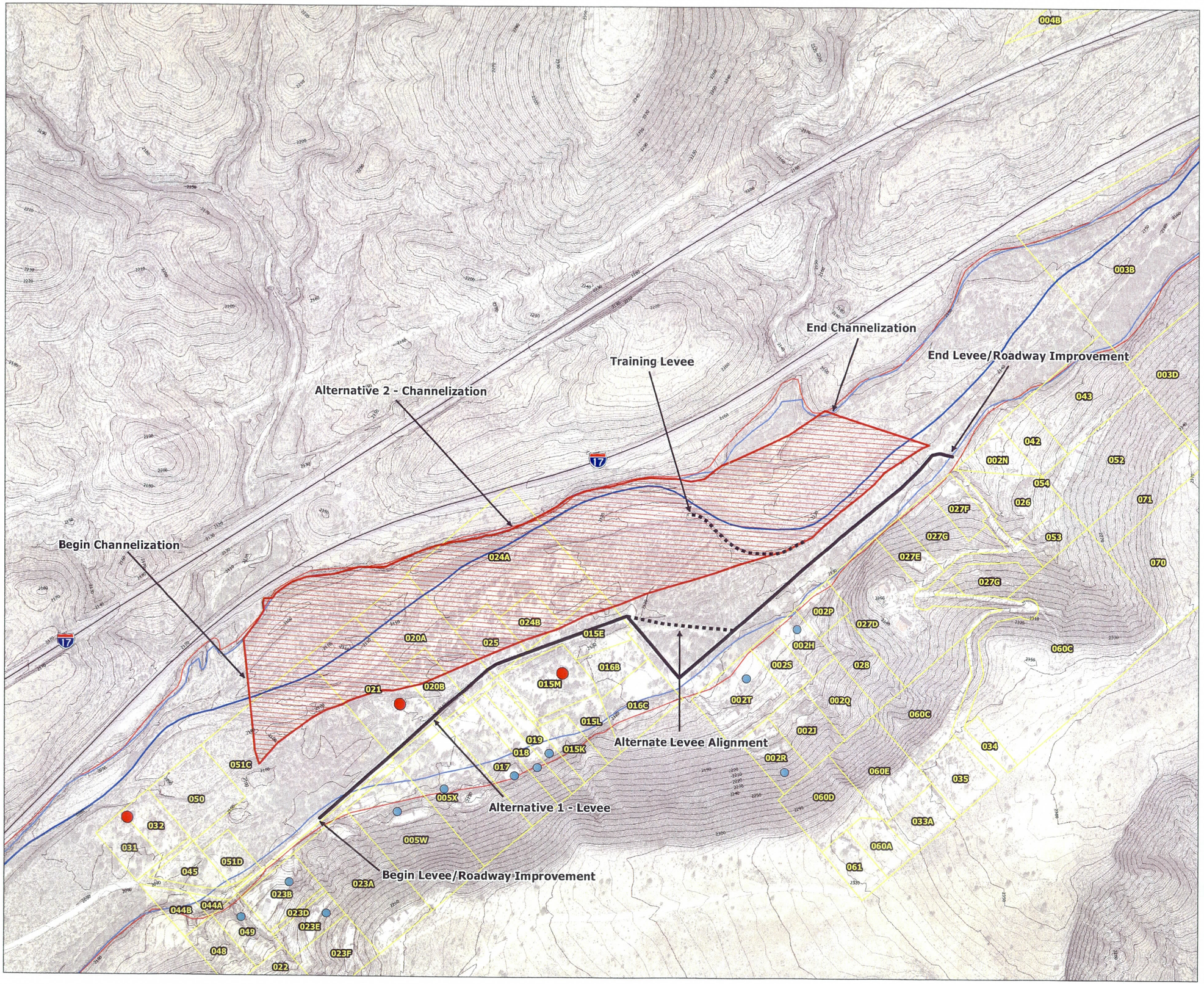
Prepared By:
AMG
February 2008

Revision:

By Appd. Date

Title
New River Upstream of I-17 Alternatives
Figure 9.17

Sheet 2 of 2



Flood Control District of Maricopa County
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Upper New River ADMP
FCD 2005CO20

Prepared By:
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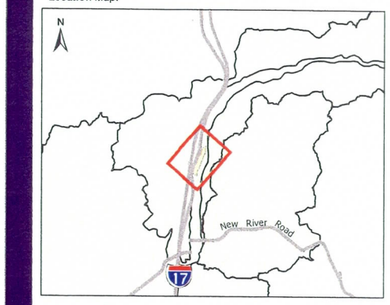
8211 S. 48th Street
Phoenix, AZ U.S.A. 85044

Legend:

- Parcel without access in a flood event
- Structure within the Floodplain limits
- Alternative Levee/Training Levee
- Levee
- Channelization Option
- Channel Centerline
- Roadway
- Parcel Boundary
- FEMA Floodplain
- Erosion Hazard
- Index Contour
- 2 ft Intermediate Contour

Location Map:



0 200 400 600 800 Feet

Project No.
182000418

Prepared By:
AMG
June 2008

Revision:

By Appd. Date

Title:
New River Upstream I-17 Alternatives Considered Along Stagecoach Road Figure 9.18

Sheet 1 of 1

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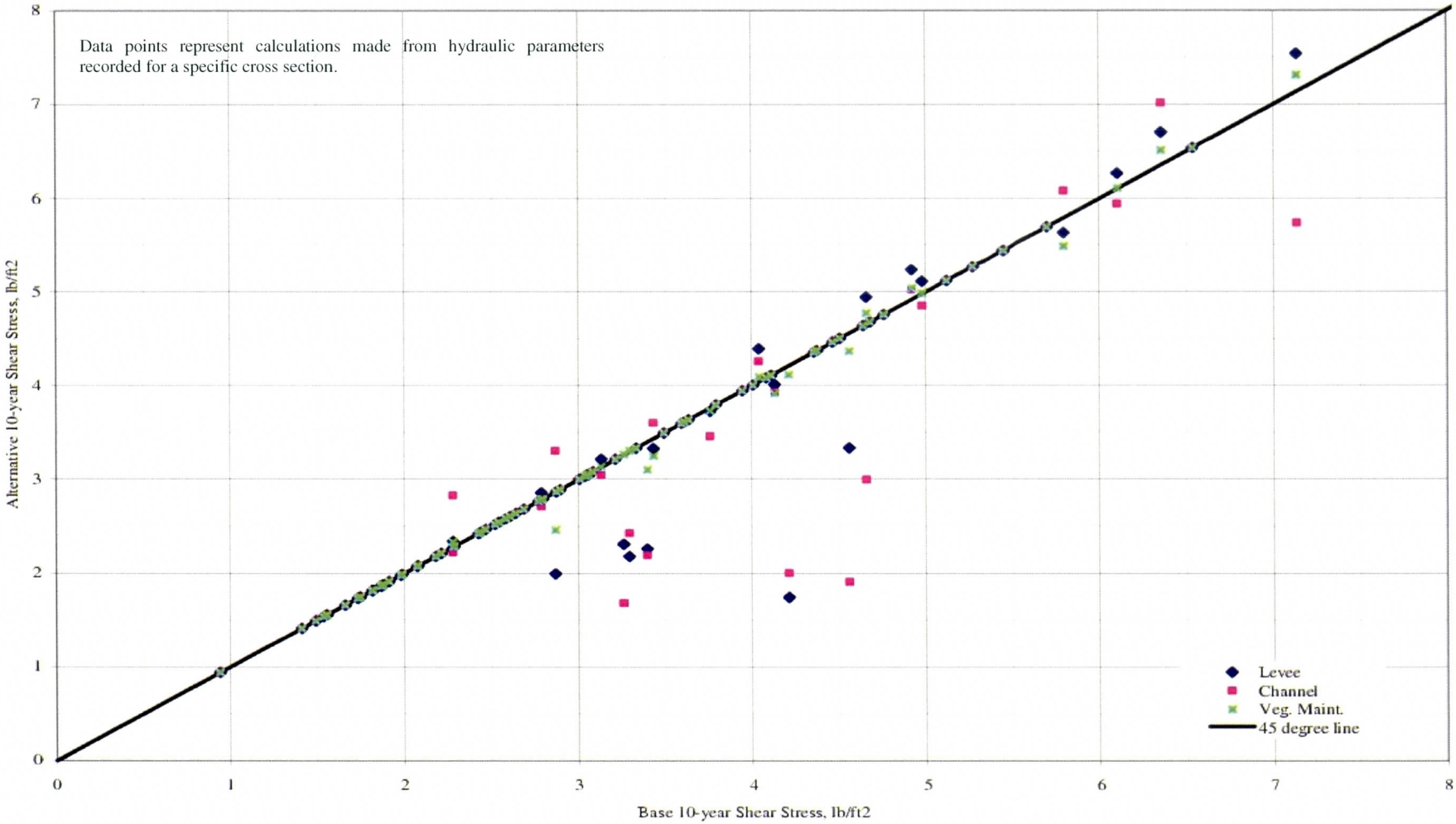


Figure 9.19 - Comparison of Shear Stress for Old Stage Coach Road Alternative

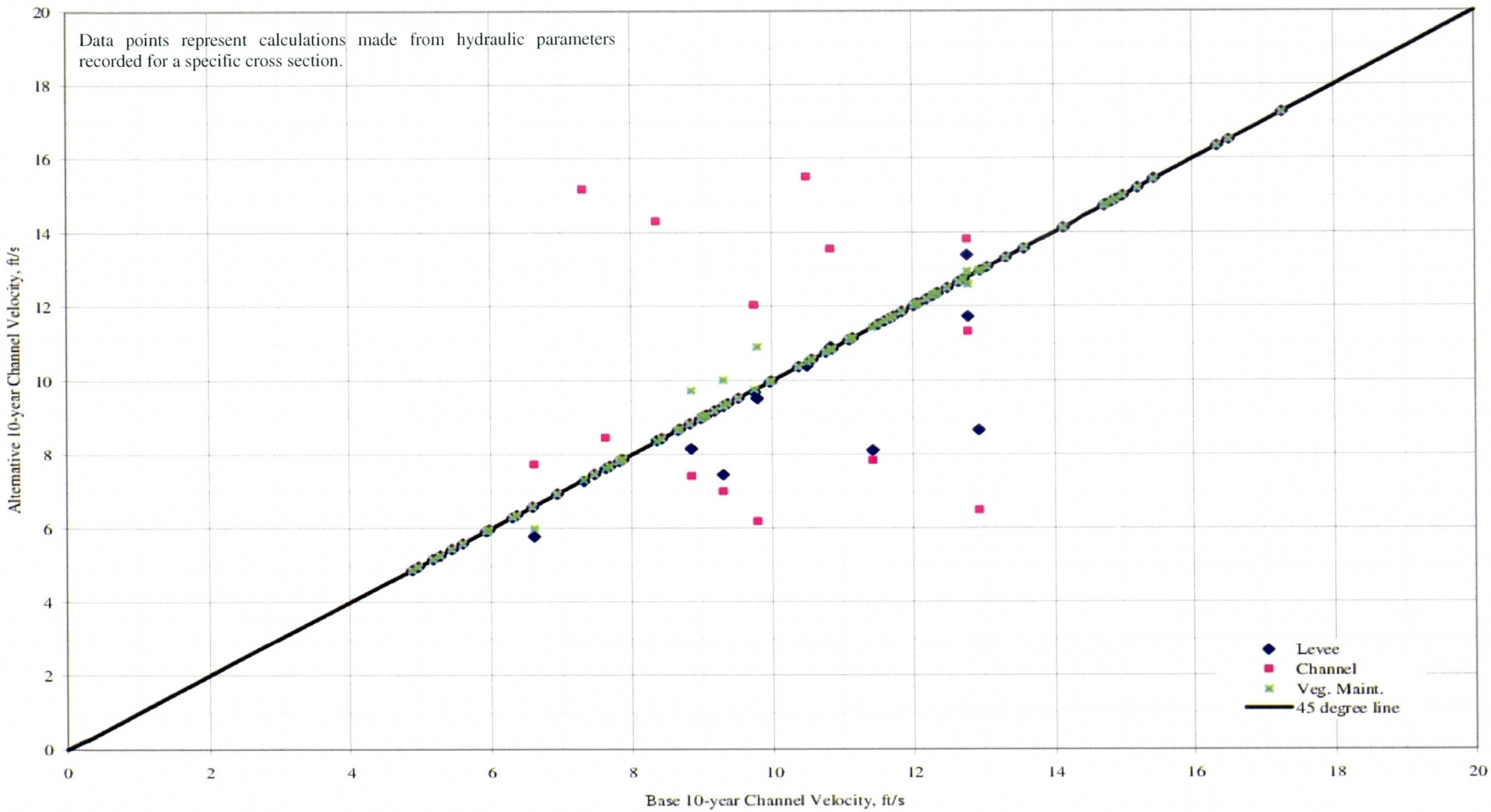


Figure 9.20 - Comparison of Channel Velocity for Old Stage Coach Road Alternative

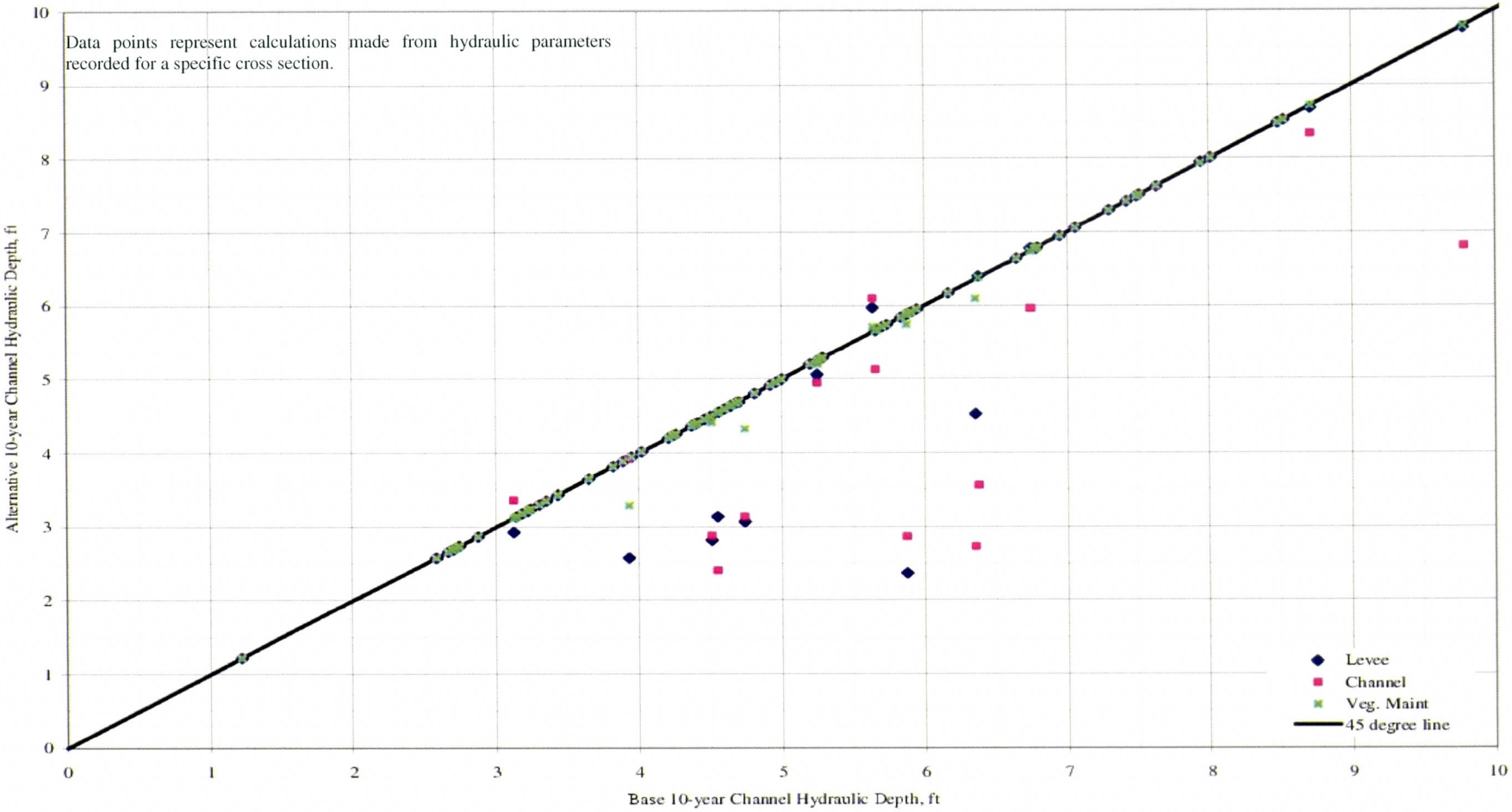


Figure 9.21 - Comparison of Hydraulic Depth for Old Stage Coach Road Alternative

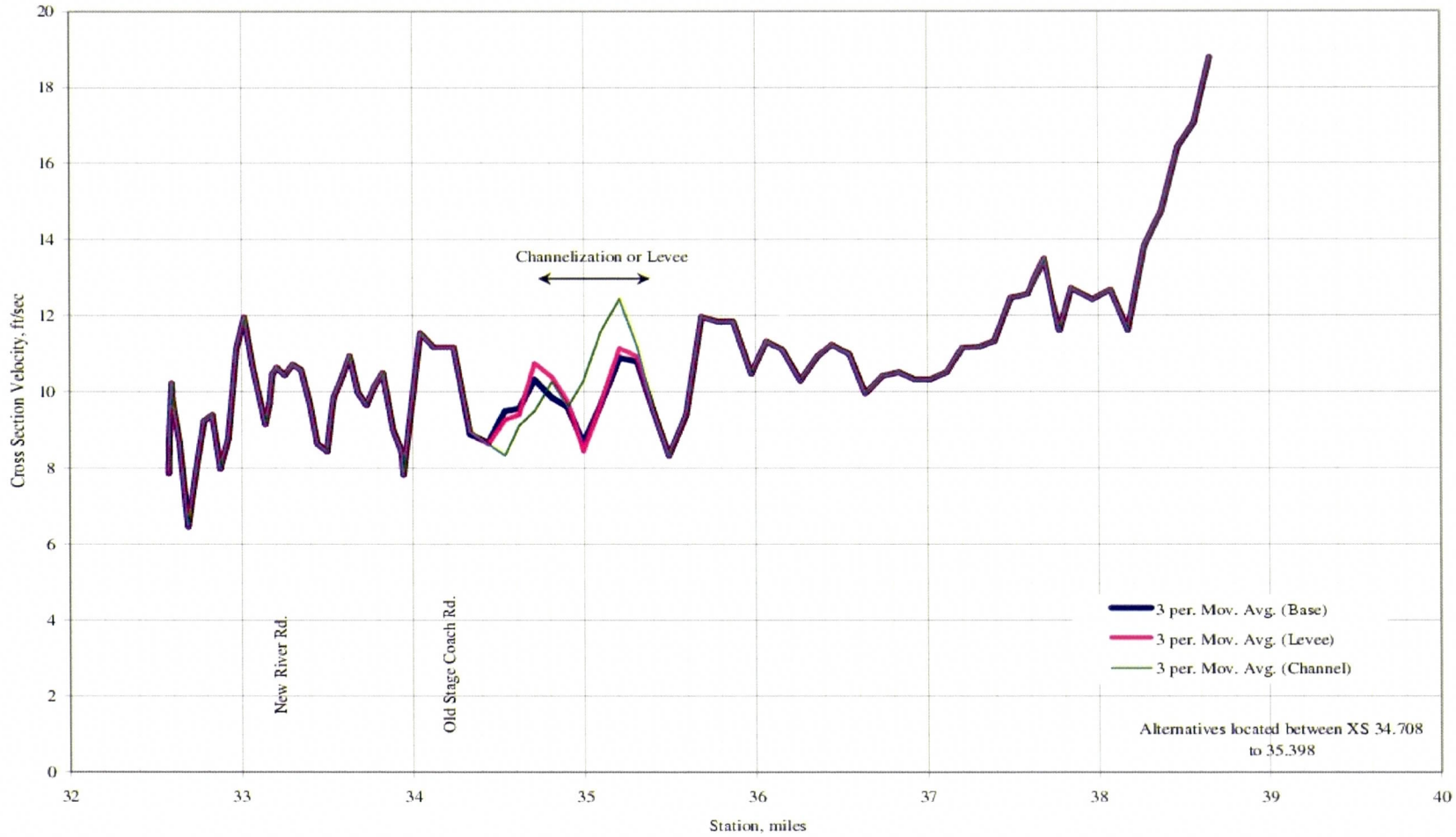


Figure 9.22 - Old Stage Coach Road - Comparison of Velocity - 100-year Event

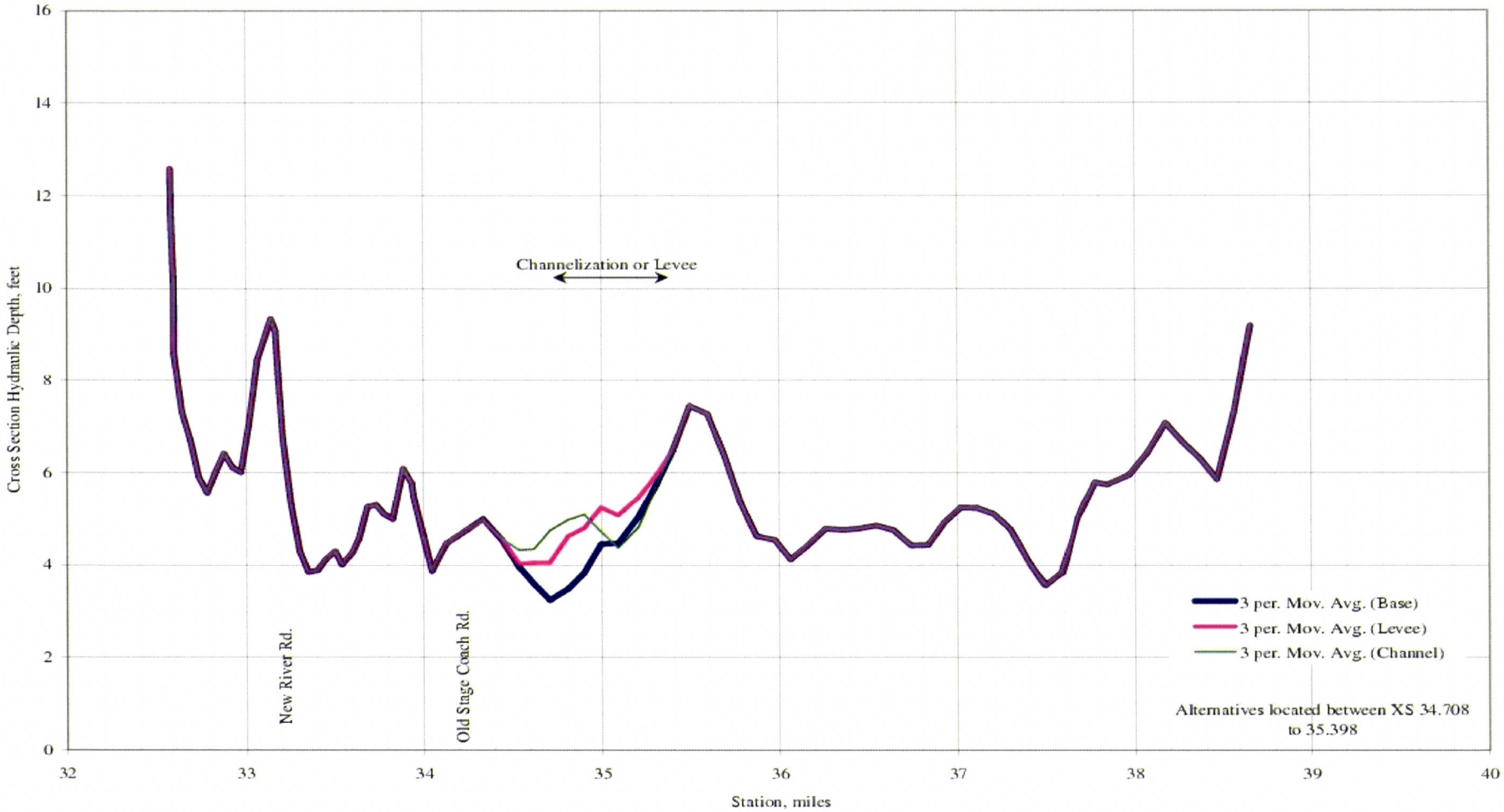


Figure 9.23 - Old Stage Coach Road - Comparison of Hydraulic Depth - 100-year Event

9.4.3.2.3 Probable Cost

Table 9.10 lists a summary of the probable cost estimates of an alternative in which an implementation or construction cost could be calculated. The opinion of construction cost includes a 20 percent contingency. Appendix K includes a detailed breakdown of the construction cost estimates.

Table 9.10
Old Stage Coach Road Summary of Cost

Alternative (1)	Probable Cost (2)
Alternative 1 – Structural Levee with Landscape Treatment	
Construction Cost	$3,870,537
Land Value Offset	$0
Total Cost	$3,870,537
Alternative 2 – Structural Channel Levee with Landscape Treatment	
Construction Cost	$7,621,914
Land Value Offset	-$1,550,000
Total Cost	$6,071,914
Alternative 3 - FPAP	$3,720,000

9.4.3.3 New River Planning Area Downstream of I-17

This relatively undeveloped area encompasses New River from I-17 downstream to the New River Dam impoundment area. Anthem West, and active sand and gravel mine are some of the existing development/activities within this planning area. However, most of the area is zoned as mixed-use and has several new roads proposed in the study area so substantial development is anticipated along New River. Some of the flooding issues include dip crossings, braided channels/streams, and floodplain limits inconsistent with future land use plans.

The planning area is a watercourse planning area for New River and reaches of Sweat Canyon. The New River reach extends for its crossing with I-17 to the New River Dam impoundment. The Sweat Canyon reach commences below New River Road and extends to the confluence with the West Split. The New River reach includes New River, the West Split, Middle Split and East Split. Figures 9.24 through 9.30 depict the locations of the subject watercourses/reaches along with alignment of proposed flood mitigation alternatives.

The planning area was broken into two segments, alternatives located between I-17 and SR-74 and alternatives located between SR-74 and the impoundment limits of New River

Dam. Proposed alternatives located between I-17 and SR-74 address the following flood hazards:

- Flow break out at three locations:
    - Along the west bank of New River at the West Split located approximately three and half miles downstream of I-17. Break out flow drains to the West Split ultimately combining with flow from Sweat Canyon.
    - Along the east bank of Sweat Canyon approximately one mile downstream of New River Road flow breaks out into the West Split.
    - Along the east bank of New River approximately two miles upstream of SR-74 flow breaks out and drains to SR-74. Flow draining to SR-74 overtops the roadway.
- Distributive flow area just upstream of SR-74. Flow within New River is split into multiple flow paths just upstream of SR-74. Due to the multiple flow paths two bridges were required to pass flow under SR-74. Flood hazard issues at this location includes:
    - Invert of New River channel at the west bridge is approximately 10 feet lower than the invert at the east bridge. The east channel will have a tendency to laterally migrate to the west, resulting in changes to flow quantity, depth and velocities.
    - The area upstream of the east bridge is mapped by FEMA as the East Split. Multiple flow paths in the area between the East Split and New River are complex and unpredictable.
- Flooding at roadway/wash crossings:
    - New River at SR-74 -Based on two-dimensional hydraulic models flow that breaks out of the east bank of New River overtops SR-74.
- Existing floodplain limits are inconsistent with future Land Use designation

The evaluation of alternatives located between SR-74 and the impoundment limits of New River Dam include:

- Proposed Loop 303 bridge.
- Two-dimensional flow.

9.4.3.3.1 Alternatives Located Between I-17 and SR-74

Five alternatives are evaluated for the New River Downstream of I-17 Planning area. Alternatives consist of Structural, Non-Structural and regulatory elements/reaches. The type and distribution of structural alternatives that are proposed are depicted in Figures 9.24 through Figure 9.30. Areas within the floodplain limits where no structures are

depicted define the limits of nonstructural reaches of an alternative. The 5th alternative is the No-Action Alternative.

At some locations alternatives have common non-structural and structural solutions. Figure 9.30 depicts a non-structural reach for New River that is common to Alternatives 1 through 4. The Structural Alternative proposed for the Sweat Canyon improvement reach is common to Alternatives 1 through 4. Alternative 2 and 3 include levee and channel options for a structural reach of New River. Alternatives 1 through 4 include bridges at the following locations:

- New River Main Stem approximately RM 1.9 miles upstream of SR-74
- New River Main Stem approximately 3.2 miles upstream of SR-74 for Desert Hills Drive
- New River Main Stem approximately 3.6 miles downstream of I-17
- Sweat Canyon Wash approximately 1.2 miles upstream of SR-74
- Sweat Canyon Wash approximately 2 miles upstream of SR-74
- Sweat Canyon Wash approximately 1 mile downstream of New River Road for Desert Hills Drive

Proposed bridge configurations are based on the existing bridge configurations of the SR-74 Bridge crossings of New River.

Alternative 1

Alternative 1 mitigates flow splits that were identified along the banks of New River and Sweat Canyon and flow splits in the distributary flow area upstream of SR-74. In areas where flow splits are being mitigated, structural type solutions are proposed. For areas outside of the flow split areas, non-structural type solutions are proposed.

A non-structural reach is a reach of a watercourse in which the natural condition and appearance is retained, and is managed through regulatory solutions that do not require capital improvement funds. Non-Structural solutions are applied to reaches where structural solutions are not recommended to mitigate identified flood hazards. Non-Structural solutions include:

- Promote and continue sound floodplain management such as:
    - Floodplain Delineations
    - Erosion Hazard Delineations
- Provide development guidelines to reduce flooding and erosion risk to new development.

A structural reach is a reach in which structural improvements such as levees, channels and erosion protection is required to mitigate a flood hazard. Two structural options are

considered for Alternative 1, a channel option (Figure 9.24) and a levee option (Figure 9.25).

- Channel Option - this option is similar to the Levee Option with the exception that a channel is proposed instead of levees along a reach of New River. The channel would replace the levee for a reach of New River commencing at the SR-74 east bridge and extending upstream for approximately 2.3 miles. Due to existing topography at locations the channel bank would be considered a levee.

- Levee Option - this option provides levees that prevent flow break-out to the West Split from New River and Sweat Canyon Wash, and from New River to the Deadman Wash Watershed. The alignments of the levees along the main stem of New River convey flow through the East Split to the SR-74 east bridge. Levee alignments along the east bank of Sweat Canyon Wash and the west bank of New River (reach below Sweat Canyon Wash) convey flow to the SR-74 west bridge.

Alternative 2

Alternative 2 mitigates the same flow splits described above for Alternative 1, however all the flow draining from the New River and Sweat Canyon watersheds is conveyed to the SR-74 west bridge crossing of New River. Alternative 2 consists of non-structural and structural solutions. The structural solutions include a channel option (Figure 9.26) and a levee option (Figure 9.27).

- Channel Option -this option is similar to Alternative 1 - Channel/Levee Option with the exception that flow within the main stem of New River is conveyed to the West Branch of New River where it combines with Sweat Canyon Wash flow. The combined New River and Sweat Canyon runoff is conveyed to the SR-74 west bridge. Due to existing topography at locations the channel bank would be considered a levee.

- Levee Option - this option is similar to Alternative 1 - Levee Option with the exception that flow within the main stem of New River is conveyed to the West Split of New River and combined with Sweat Canyon Wash. The New River and Sweat Canyon runoff is then conveyed to the SR-74 west bridge.

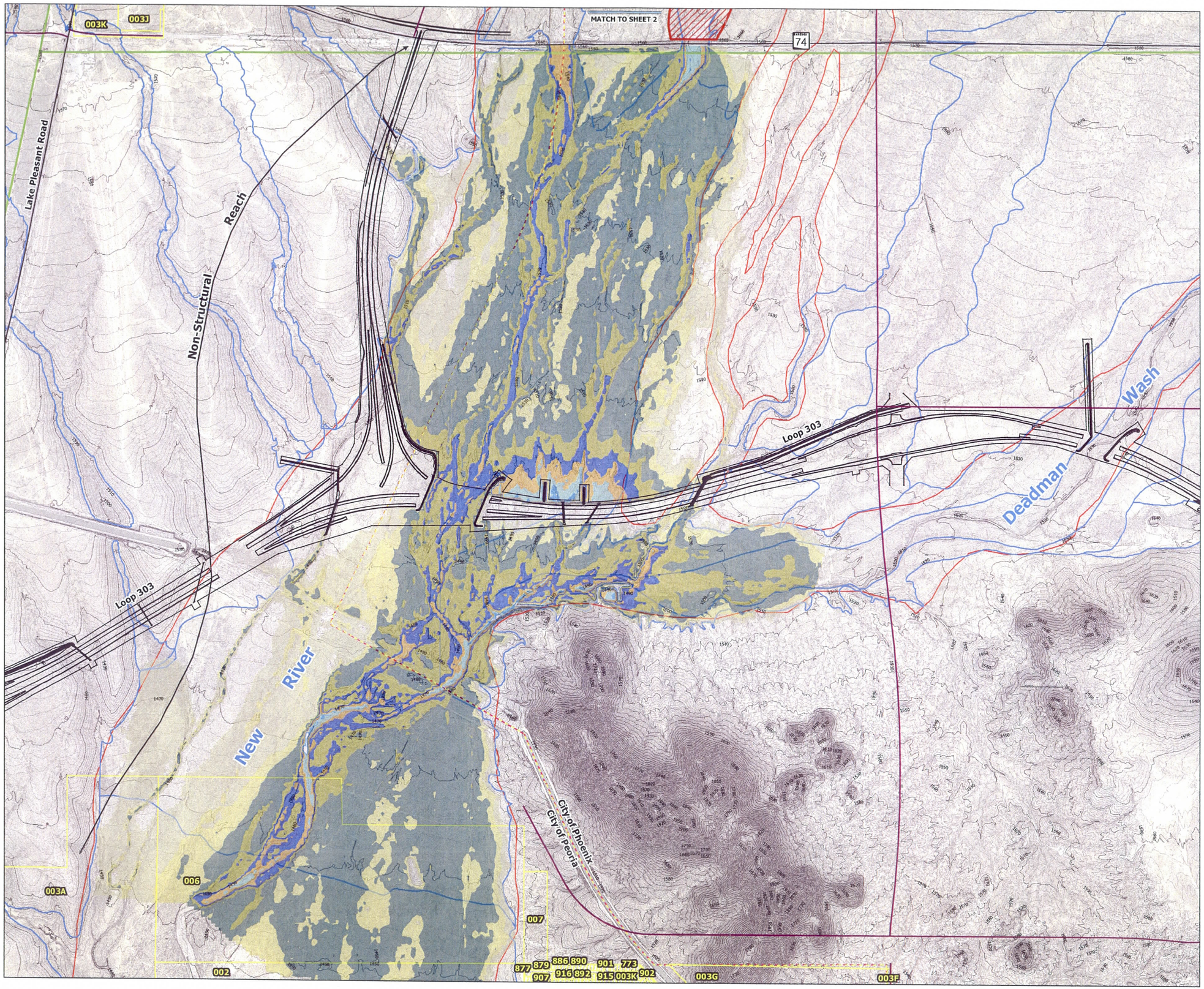
Alternative 3

Alternative 3 (Figure 9.28) is similar to Alternatives 1 and 2 in that it mitigates split flow along New River and Sweat Canyon Wash, however flow splits upstream of SR-74 in the distributary flow area are not mitigated. Alternative 3 also consists of non-structural and structural solutions. The structural solution is a levee solution at the split flow locations.

Alternative 4

This alternative is similar to Alternative 2 in that all flow in the New River and Sweat Canyon watercourses upstream of SR-74 drains through the SR-74 western bridge. The difference is that four regional off-line basins are located strategically along New River

(Figure 9.29) to prevent split flow. The off-line basins also serve to reduce peak discharges in New River which in turn reduces flow depths and velocities while preserving low flow conditions.



Flood Control District
of Maricopa County
2801 W. Durango St.
Phoenix, AZ 85009

Upper New River ADMP
FCD 2005CO20

Prepared By:
Stantec Consulting Inc.
8211 S. 48th Street
Phoenix, AZ U.S.A. 85044

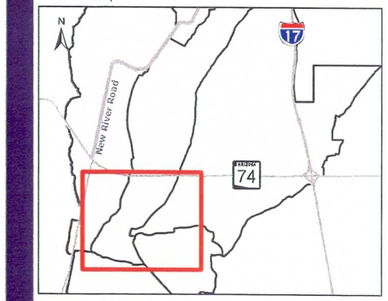
Legend:

- Proposed Roadway Alignment
- Roadway
- Levee
- Waterline
- Powerline
- Gasline
- Index Contour
- 2 ft Intermediate Contour
- Channel
- FEMA Floodplain
- Erosion Hazard
- Parcel Boundary
- Phoenix Corporate Boundary
- Peoria Corporate Boundary

Depth (ft)

- >12
- 10 - 12
- 8 - 10
- 6 - 8
- 4 - 6
- 2 - 4
- 1 - 2
- <1

Location Map:



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Project No.
182000418

Prepared By:
AMG
February 2008

Revision:

	By	Appd.	Date

Title:
New River Downstream I-17
Alternative 1
Channel Option
Figure 9.24

Sheet 1 of 3

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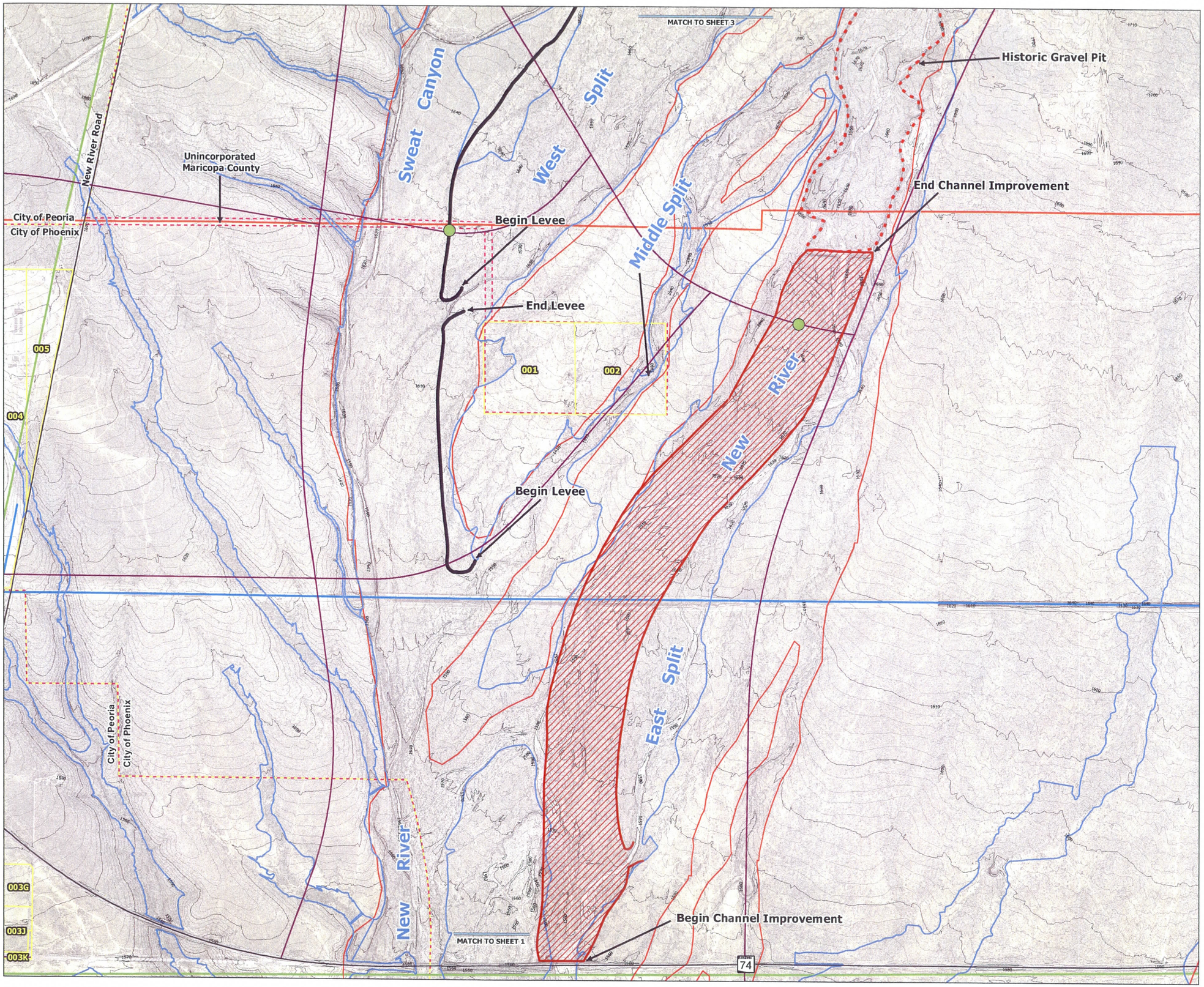

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Upper New River ADMP
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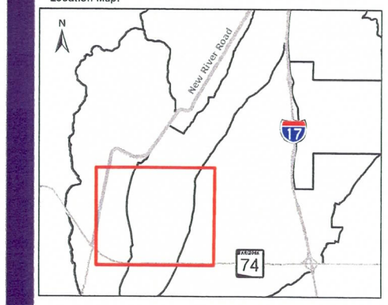
Legend:

- Proposed Bridge
- Proposed Roadway Alignment
- Roadway
- Levee
- Waterline
- Powerline
- Gasline
- Index Contour
- 2 ft Intermediate Contour
- Channel
- FEMA Floodplain
- Erosion Hazard
- Parcel Boundary
- Phoenix Corporate Boundary
- Peoria Corporate Boundary

Location Map:



N

0 600 1,200 1,800 2,400 Feet

Project No.
182000418

Prepared By:
AMG
February 2008

Title:
New River Downstream I-17
Alternative 1
Channel Option
Figure 9.24

Revision:

	By	Appd.	Date

Sheet 2 of 3

J:\Drive\182000418\GIS\Project\MXDs\Public Meeting\Report Figures\Alt1Chan6.mxd

City of Peoria

City of Phoenix

End Levee

001

Sweat Canyon Wash

New River Road

End Levee

Begin Levee

Split

Historic Gravel Pit

West New River

Historic Gravel Pit

MATCH TO SHEET 2

W:\active\182000418\GIS\Project\MXDs\Public Meeting\Report Figures\AA1Channels3D.mxd

Flood Control District of Maricopa County
2801 W. Durango St.
Phoenix, AZ 85009

Upper New River ADMP
FCD 2005CO20

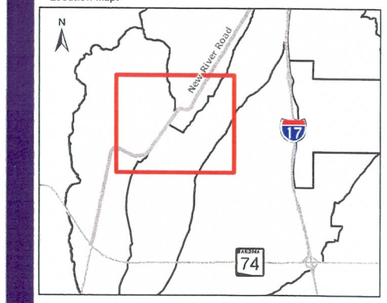
Prepared By:

Stantec Consulting Inc.
8211 S. 48th Street
Phoenix, AZ U.S.A. 85044

Legend:

- Proposed Bridge
- Proposed Roadway Alignment
- Roadway
- Levee
- Waterline
- Powerline
- Gasline
- Index Contour
- 2 ft Intermediate Contour
- Channel
- FEMA Floodplain
- Erosion Hazard
- Parcel Boundary
- Phoenix Corporate Boundary
- Peoria Corporate Boundary

Location Map:



N

0 600 1,200 1,800 2,400 Feet

Project No.
182000418

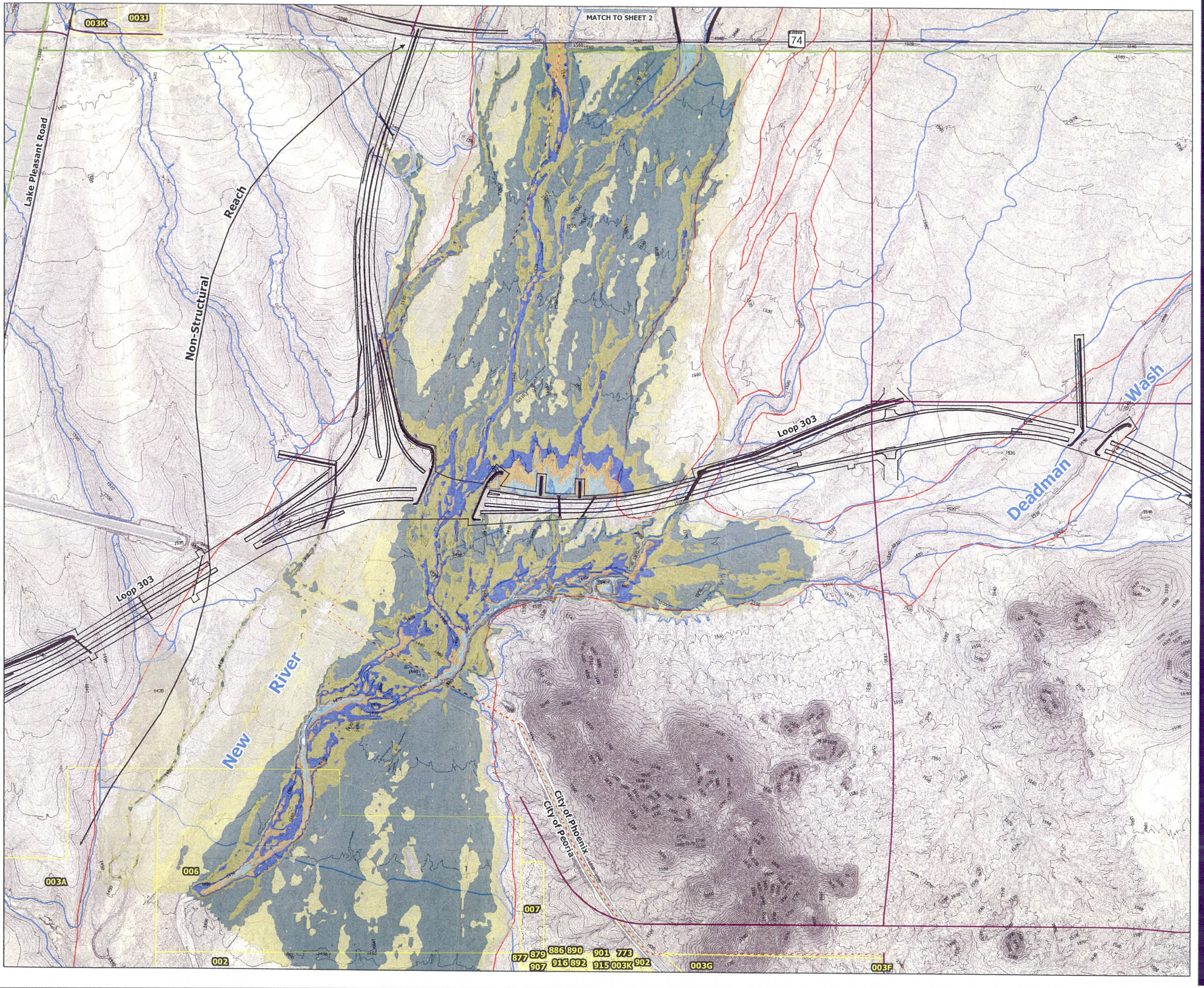
Prepared By:
AMG
February 2008

Revision:

	By	Appd.	Date

Title:
New River Downstream I-17
Alternative 1
Channel Option
Figure 9.24

Sheet 3 of 3



Flood Control District of Maricopa County
2801 W. Durango St.
Phoenix, AZ 85009

Upper New River ADMP
FCD 2005CO20

Prepared By:
Stantec Consulting Inc.
8211 S. 48th Street
Phoenix, AZ U.S.A. 85044
Stantec

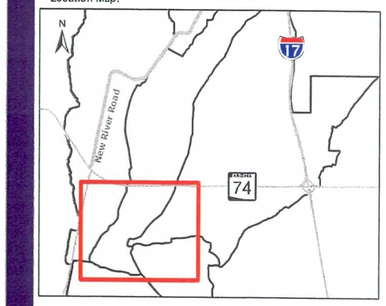
Legend:

- Proposed Roadway Alignment
- Roadway
- Levee
- Waterline
- Powerline
- Gasline
- Index Contour
- 2 ft Intermediate Contour
- FEMA Floodplain
- Erosion Hazard
- Parcel Boundary
- Phoenix Corporate Boundary
- Peoria Corporate Boundary

Depth (ft)

- >12
- 10 - 12
- 8 - 10
- 6 - 8
- 4 - 6
- 2 - 4
- 1 - 2
- <1

Location Map:



N

0 600 1,200 1,800 2,400 Feet

Project No.
182000418

Prepared By:
AMG
February 2008

Revision:

	By	Appd.	Date

Title:
New River Downstream I-17
Alternative 1
Levee Option
Figure 9.25

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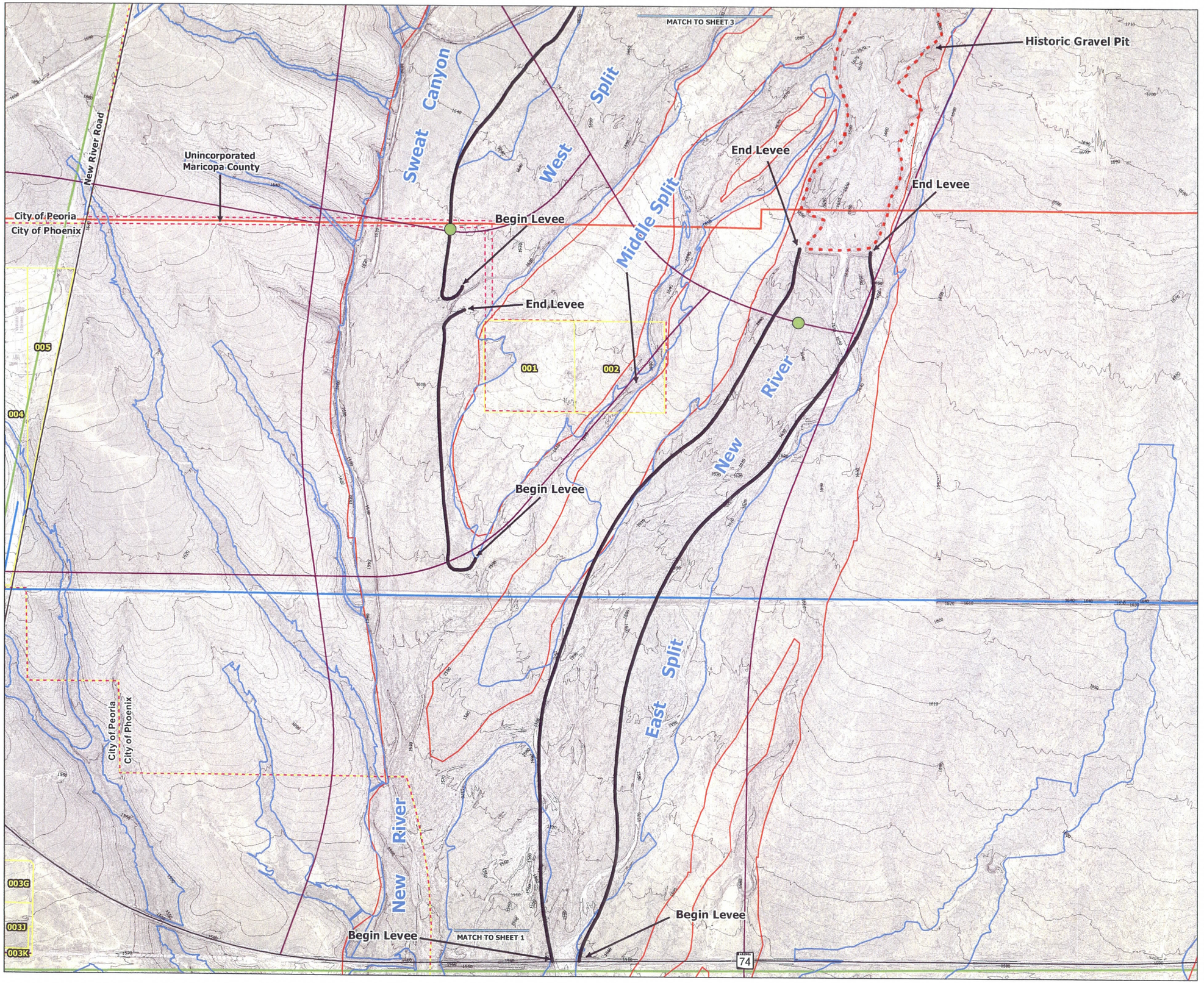


Flood Control District of Maricopa County
2801 W. Durango St.
Phoenix, AZ 85009

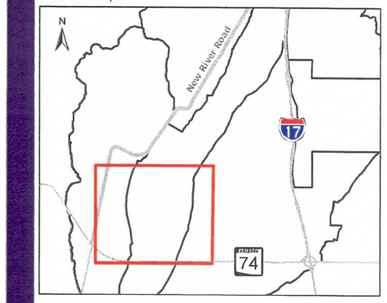
Upper New River ADMP
FCD 2005CO20

Prepared By:
Stantec Consulting Inc.
8211 S. 48th Street
Phoenix, AZ U.S.A. 85044

Legend:

- Proposed Bridge
- Proposed Roadway Alignment
- Roadway
- Levee
- Waterline
- Powerline
- Gasline
- Index Contour
- 2 ft Intermediate Contour
- FEMA Floodplain
- Erosion Hazard
- Parcel Boundary
- Phoenix Corporate Boundary
- Peoria Corporate Boundary

Location Map:



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0 600 1,200 1,800 2,400 Feet

Project No.
182000418

Prepared By:
AMG
February 2008

Revision:

	By	Appd.	Date

Title:
New River Downstream I-17
Alternative 1
Levee Option
Figure 9.25

Sheet 2 of 3

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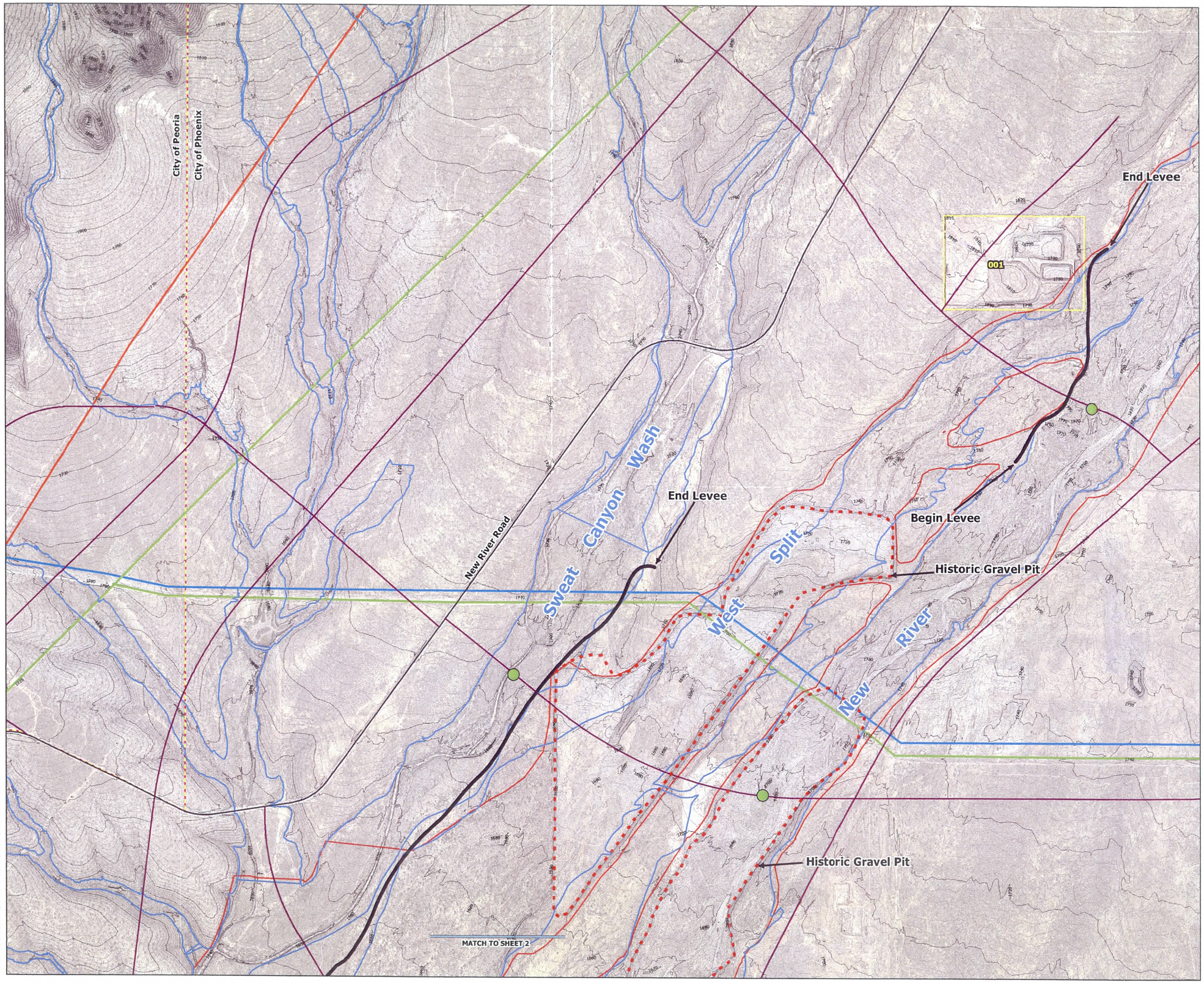

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Flood Control District of Maricopa County
2801 W. Durango St.
Phoenix, AZ 85009

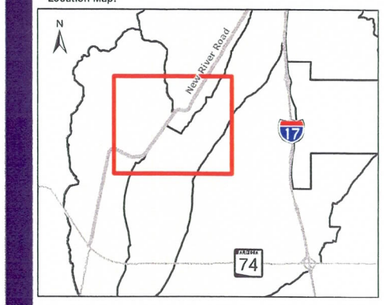
Upper New River ADMP
FCD 2005CO20

Prepared By:
Stantec Consulting Inc.
8211 S. 48th Street
Phoenix, AZ U.S.A. 85044

Legend:

- Proposed Bridge
- Proposed Roadway Alignment
- Roadway
- Levee
- Waterline
- Powerline
- Gasline
- Index Contour
- 2 ft Intermediate Contour
- FEMA Floodplain
- Erosion Hazard
- Parcel Boundary
- Phoenix Corporate Boundary
- Peoria Corporate Boundary

Location Map:



N

0 600 1,200 1,800 2,400 Feet

Project No.
182000418

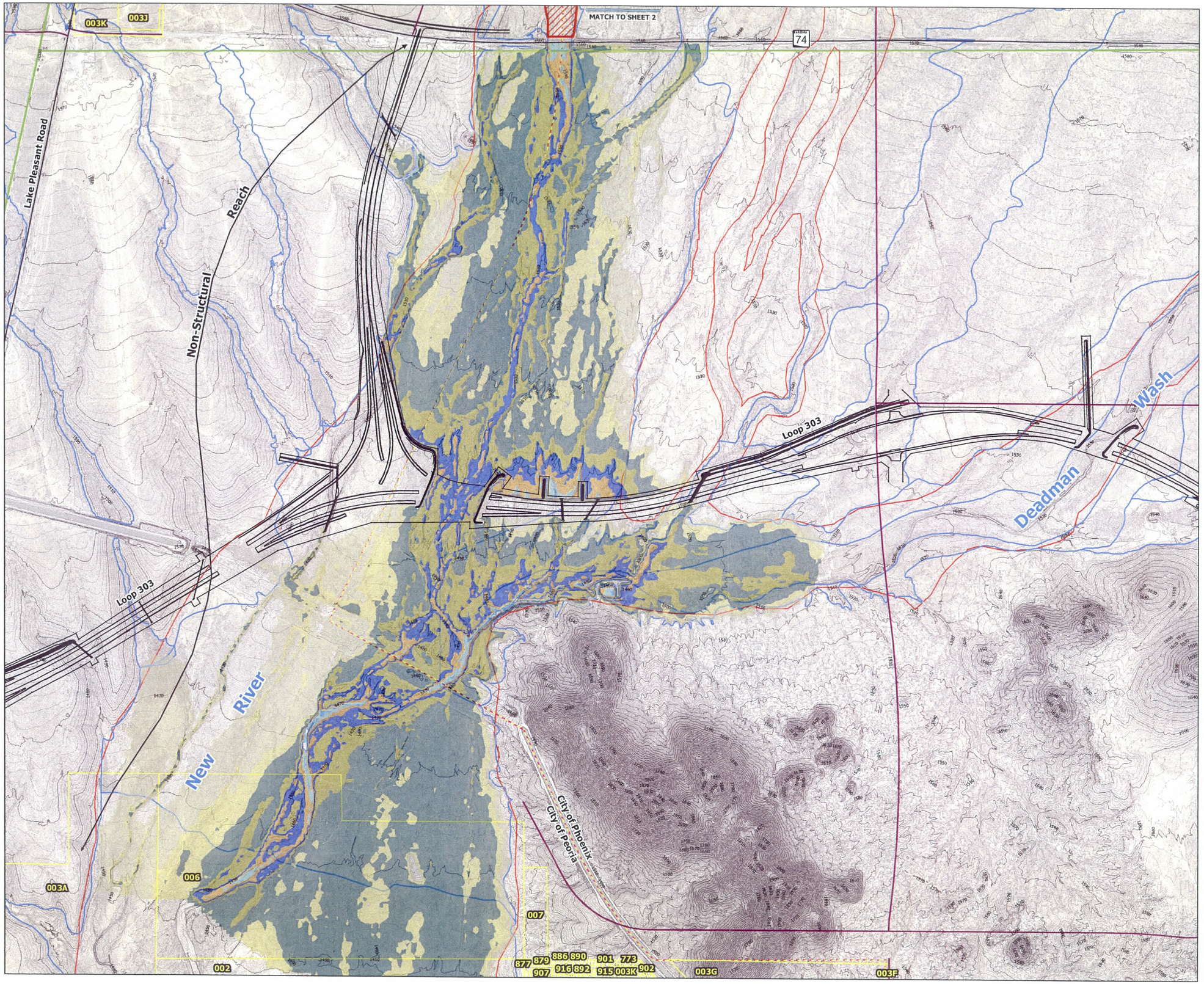
Prepared By:
AMG
February 2008

Revision:

	By	Appd.	Date

Title:
New River Downstream I-17
Alternative 1
Levee Option
Figure 9.25

Sheet 3 of 3



Flood Control District of Maricopa County
2801 W. Durango St.
Phoenix, AZ 85009

Upper New River ADMP
FCD 2005CO20

Prepared By:
Stantec Consulting Inc.
8211 S. 48th Street
Phoenix, AZ U.S.A. 85044

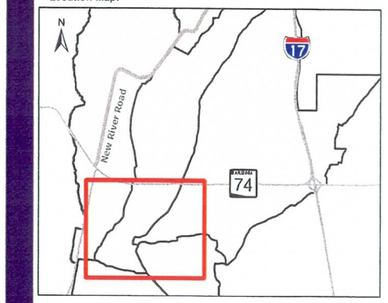
Legend:

- Proposed Roadway Alignment
- Roadway
- Levee
- Waterline
- Powerline
- Gasline
- Index Contour
- 2 ft Intermediate Contour
- Channel
- FEMA Floodplain
- Erosion Hazard
- Parcel Boundary
- Phoenix Corporate Boundary
- Peoria Corporate Boundary

Depth (ft)

- >12
- 10 - 12
- 8 - 10
- 6 - 8
- 4 - 6
- 2 - 4
- 1 - 2
- <1

Location Map:



N

0 600 1,200 1,800 2,400 Feet

Project No.
182000418

Prepared By:
AMG
February 2008

Revision:

	By	Appd.	Date

Title:
New River Downstream I-17
Alternative 2
Channel Option
Figure 9.26

Sheet 1 of 3

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MATCH TO SHEET 3

Historic Gravel Pit

Sweat Canyon

West Split

Middle Split

New River Road

Unincorporated Maricopa County

City of Peoria
City of Phoenix

Begin Levee

End Levee

End Channel Improvement

005

004

001

002

New River

Begin Levee

City of Peoria
City of Phoenix

East Split

003G

003J

003K

Begin Channel Improvement

MATCH TO SHEET 1

74

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Flood Control District of Maricopa County
2801 W. Durango St.
Phoenix, AZ 85009

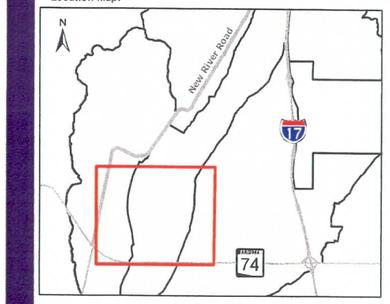
Upper New River ADMP
FCD 2005CO20

Prepared By:
Stantec Consulting Inc.
8211 S. 48th Street
Phoenix, AZ U.S.A. 85044

Legend:

- Proposed Bridge
- Proposed Roadway Alignment
- Roadway
- Levee
- Grade Control Structure
- Waterline
- Powerline
- Gasline
- Index Contour
- 2 ft Intermediate Contour
- Channel
- FEMA Floodplain
- Erosion Hazard
- Parcel Boundary
- Phoenix Corporate Boundary
- Peoria Corporate Boundary

Location Map:



N

0 600 1,200 1,800 2,400 Feet

Project No.
182000418

Prepared By:
AMG
February 2008

Revision:

	By	Appd.	Date

Title:
New River Downstream I-17
Alternative 2
Channel Option
Figure 9.26

City of Peoria

City of Phoenix

End Levee

001

Sweat Canyon Wash

End Levee

New River Road

Begin Levee

Split

Historic Gravel Pit

West

New River

Historic Gravel Pit

MATCH TO SHEET 2

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Flood Control District of Maricopa County
2801 W. Durango St.
Phoenix, AZ 85009

Upper New River ADMP
FCD 2005CO20

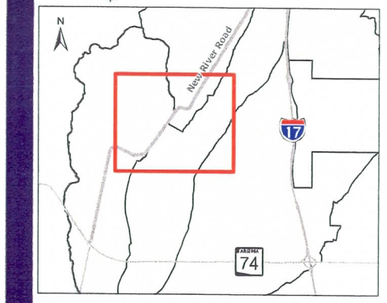
Prepared By:

Stantec Consulting Inc.
8211 S. 48th Street
Phoenix, AZ U.S.A. 85044

Legend:

- Proposed Bridge
- Proposed Roadway Alignment
- Roadway
- Levee
- Waterline
- Powerline
- Gasline
- Index Contour
- 2 ft Intermediate Contour
- Channel
- FEMA Floodplain
- Erosion Hazard
- Parcel Boundary
- Phoenix Corporate Boundary
- Peoria Corporate Boundary

Location Map:



N

0 600 1,200 1,800 2,400 Feet

Project No.
182000418

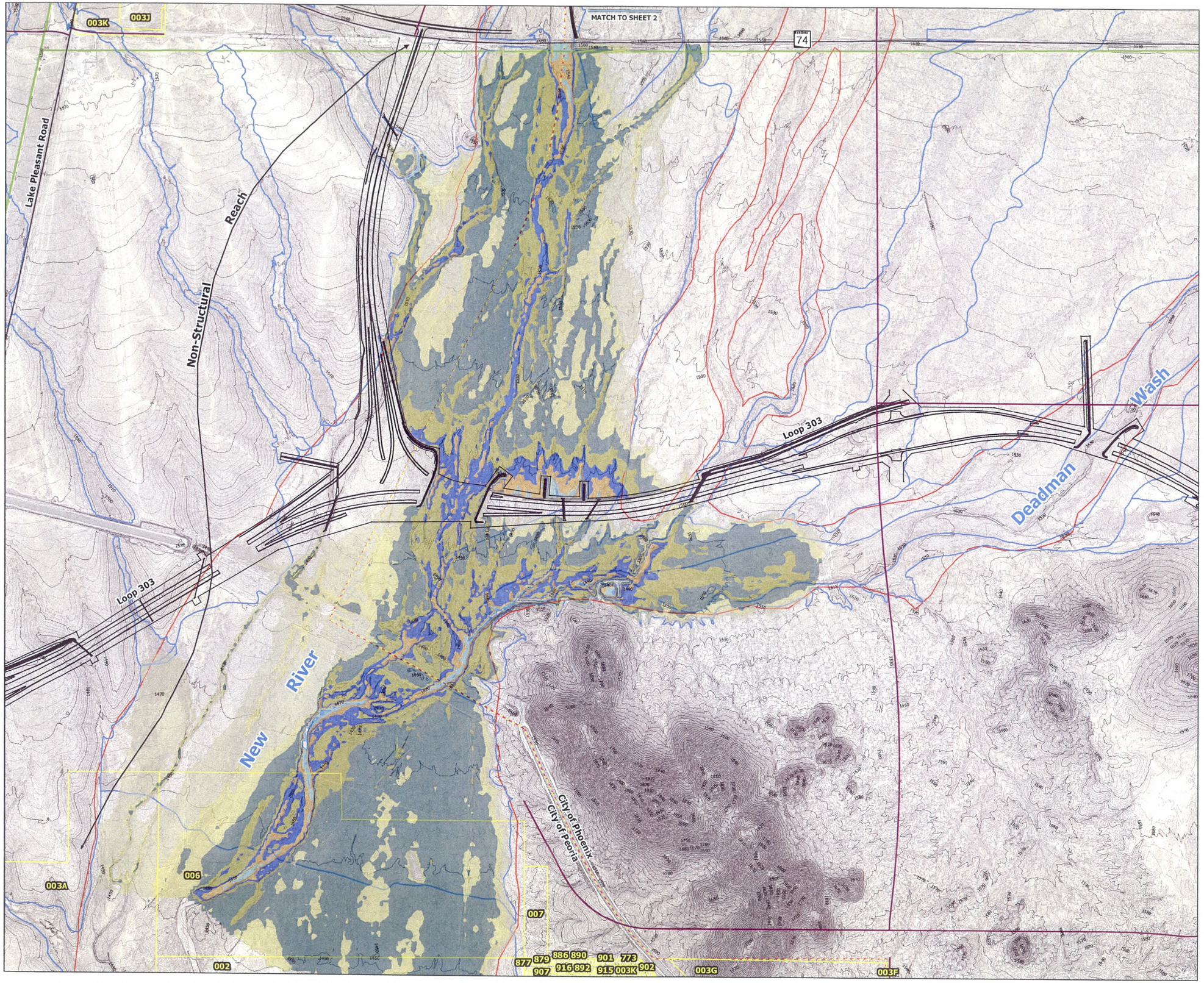
Prepared By:
AMG
February 2008

Title:
New River Downstream I-17
Alternative 2
Channel Option
Figure 9.26

Revision:

By Appd. Date

Sheet 3 of 3



Flood Control District of Maricopa County
2801 W. Durango St.
Phoenix, AZ 85009

Upper New River ADMP
FCD 2005CO20

Prepared By:
Stantec Consulting Inc.
8211 S. 48th Street
Phoenix, AZ U.S.A. 85044
Stantec

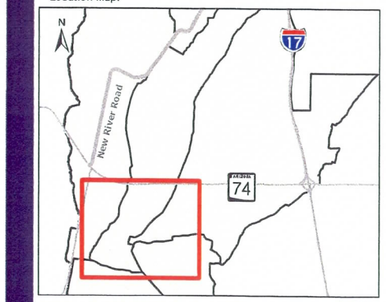
Legend:

- Proposed Roadway Alignment
- Roadway
- Levee
- Waterline
- Powerline
- Gasline
- Index Contour
- 2 ft Intermediate Contour
- FEMA Floodplain
- Erosion Hazard
- Parcel Boundary
- Phoenix Corporate Boundary
- Peoria Corporate Boundary

Depth (ft)

- >12
- 10 - 12
- 8 - 10
- 6 - 8
- 4 - 6
- 2 - 4
- 1 - 2
- <1

Location Map:



N

0 600 1,200 1,800 2,400 Feet

Project No.
182000418

Prepared By:
AMG
February 2008

Revision:

Title:
New River Downstream I-17
Alternative 2
Levee Option
Figure 9.27

By Appd. Date

Sheet 1 of 3

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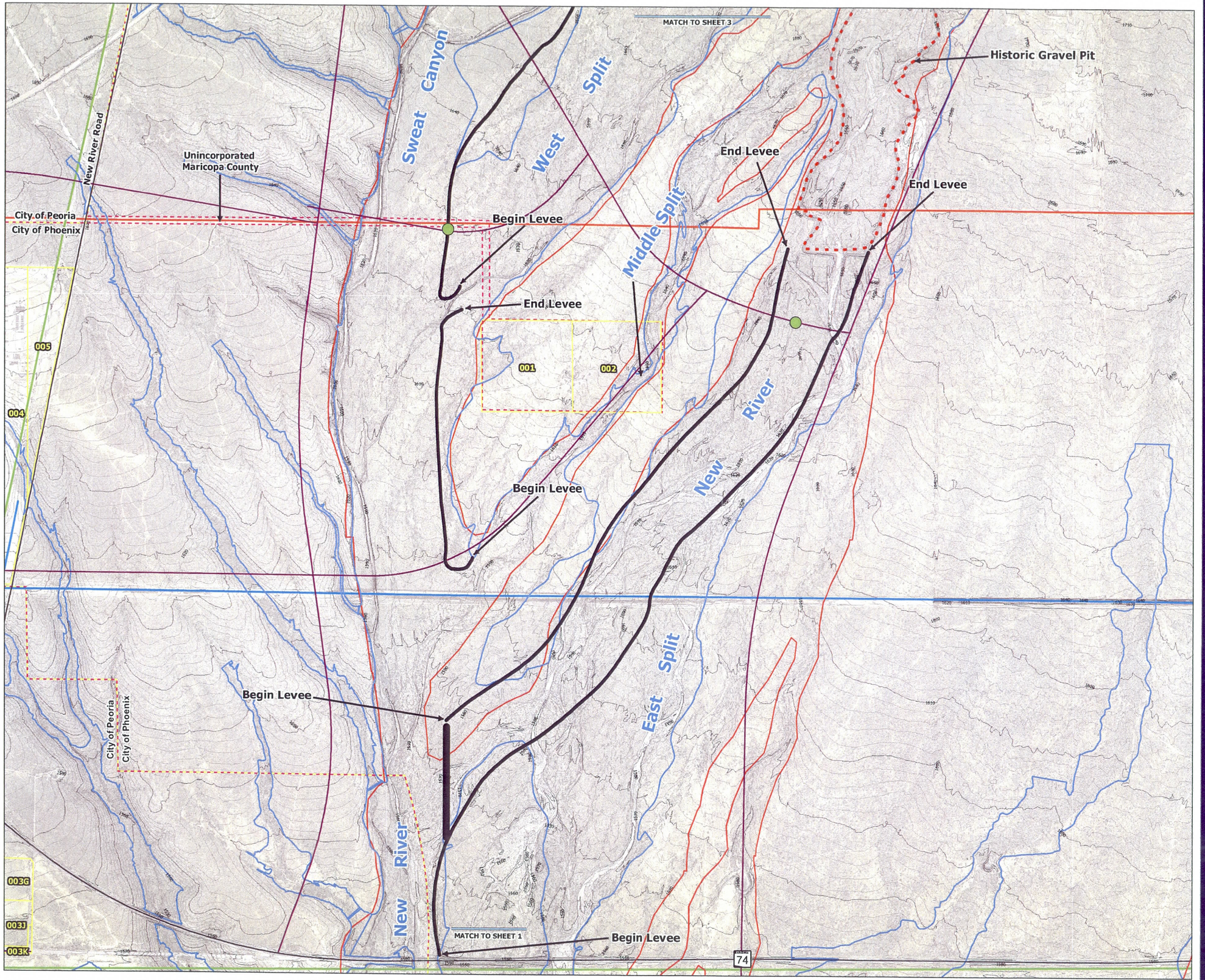


Flood Control District of Maricopa County
2801 W. Durango St.
Phoenix, AZ 85009

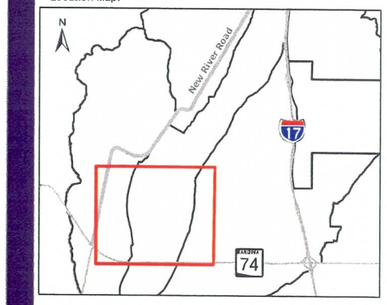
Upper New River ADMP
FCD 2005CO20

Prepared By:
Stantec Consulting Inc.
8211 S. 48th Street
Phoenix, AZ U.S.A. 85044

Legend:

- Proposed Bridge
- Proposed Roadway Alignment
- Roadway
- Levee
- Grade Control Structure
- Waterline
- Powerline
- Gasline
- Index Contour
- 2 ft Intermediate Contour
- FEMA Floodplain
- Erosion Hazard
- Parcel Boundary
- Phoenix Corporate Boundary
- Peoria Corporate Boundary

Location Map:



N

0 600 1,200 1,800 2,400 Feet

Project No.
182000418

Prepared By:
AMG
February 2008

Revision:

Title:
New River Downstream I-17
Alternative 2
Levee Option
Figure 9.27

By Appd. Date

Sheet 2 of 3

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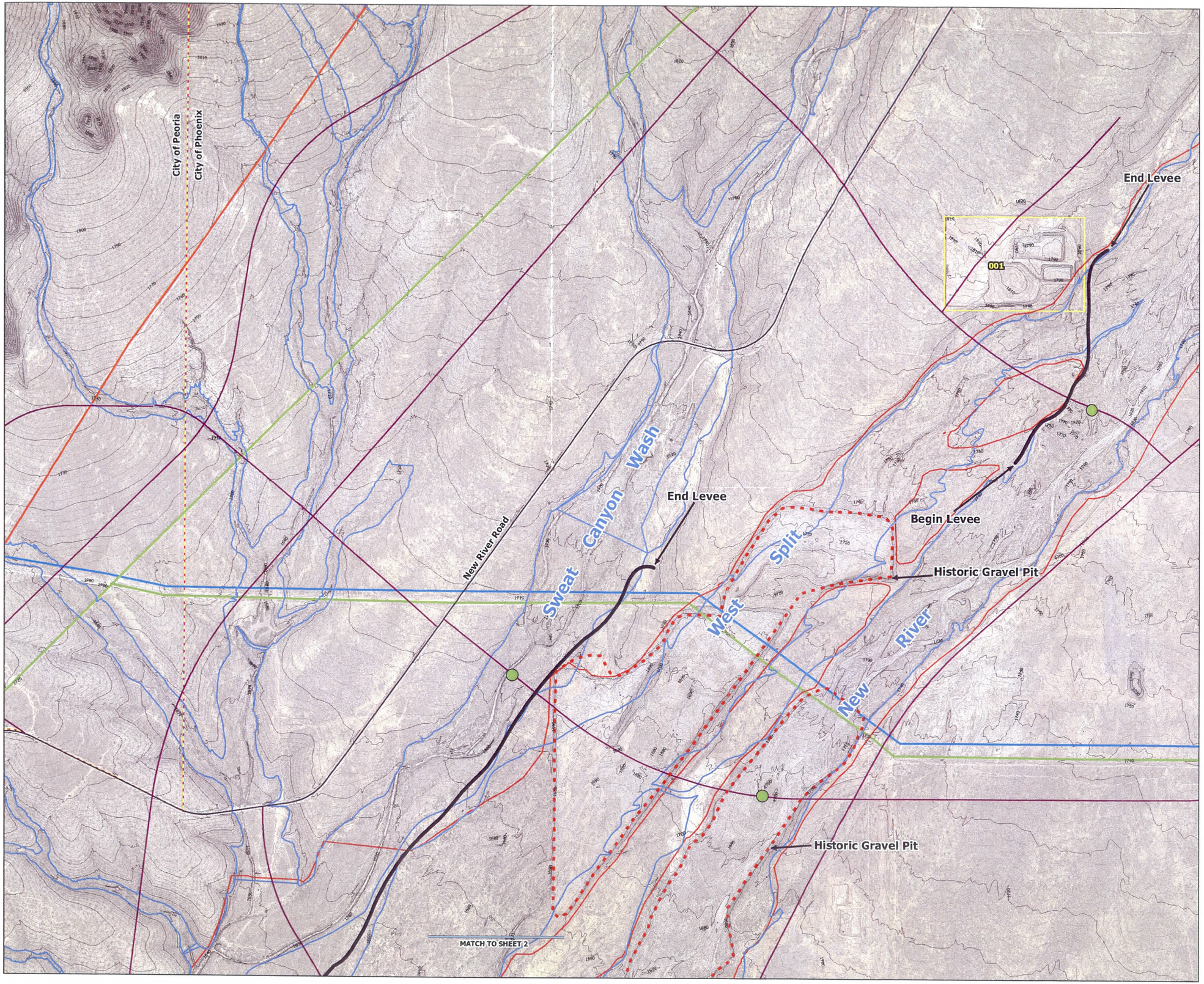

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Flood Control District
of Maricopa County
2801 W. Durango St.
Phoenix, AZ 85009

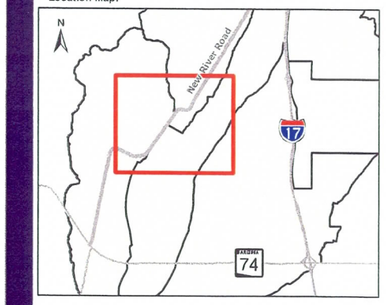
Upper New River ADMP
FCD 2005CO20

Prepared By:
Stantec Consulting Inc.
8211 S. 48th Street
Phoenix, AZ U.S.A. 85044

Legend:

- Proposed Bridge
- Proposed Roadway Alignment
- Roadway
- Levee
- Waterline
- Powerline
- Gasline
- Index Contour
- 2 ft Intermediate Contour
- FEMA Floodplain
- Erosion Hazard
- Parcel Boundary
- Phoenix Corporate Boundary
- Peoria Corporate Boundary

Location Map:



N

0 600 1,200 1,800 2,400 Feet

Project No.
182000418

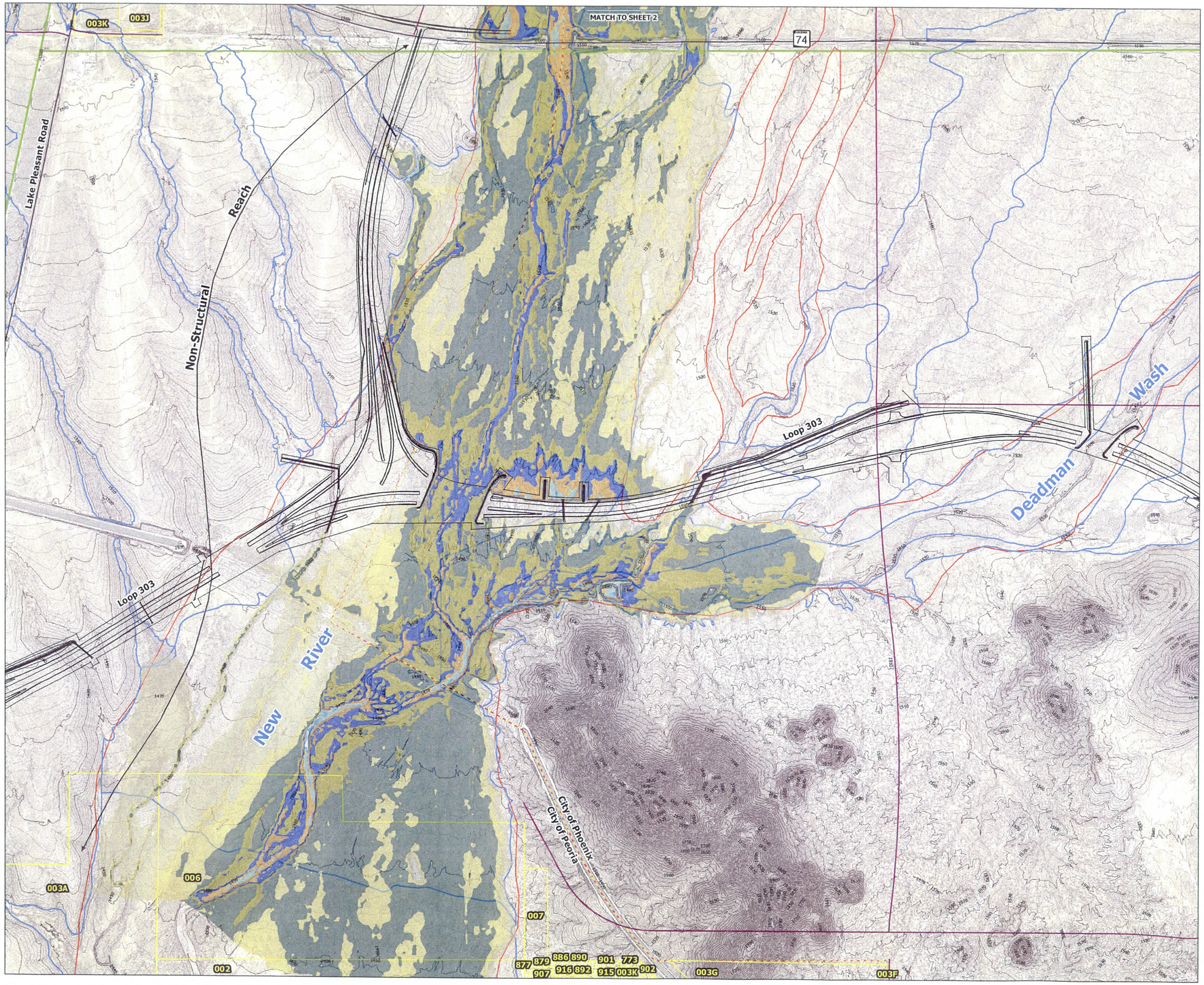
Prepared By:
AMG
February 2008

Revision:

By Appd. Date

Title:
New River Downstream I-17
Alternative 2
Levee Option
Figure 9.27

Sheet 3 of 3



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Flood Control District
of Maricopa County
2801 W. Durango St.
Phoenix, AZ 85009

Upper New River ADMP
FCD 2005CO20

Prepared By:
Stantec Consulting Inc.
8211 S. 48th Street
Phoenix, AZ U.S.A. 85044
Stantec

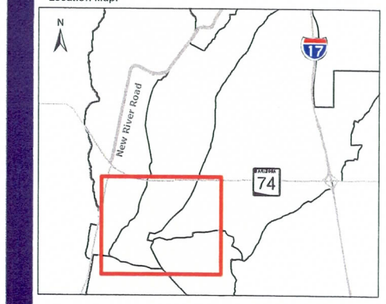
Legend:

- Proposed Roadway Alignment
- Roadway
- Levee
- Waterline
- Powerline
- Gasline
- Index Contour
- 2 ft Intermediate Contour
- FEMA Floodplain
- Erosion Hazard
- Parcel Boundary
- Phoenix Corporate Boundary
- Peoria Corporate Boundary

Depth (ft)

- >12
- 10 - 12
- 8 - 10
- 6 - 8
- 4 - 6
- 2 - 4
- 1 - 2
- <1

Location Map:



N

0 600 1,200 1,800 2,400 Feet

Project No.
182000418

Prepared By:
AMG
February 2008

Revision:

	By	Appd.	Date

Title:
New River Downstream I-17
Alternative 3
Levee Option
Figure 9.28

Sheet 1 of 3

MATCH TO SHEET 3

Historic Gravel Pit

Sweat Canyon

West Split

Middle Split

New River Road

Unincorporated Maricopa County

City of Peoria
City of Phoenix

Begin Levee

End Levee

End Levee

005

004

001

002

River

Begin Levee

New

Begin Levee

East Split

City of Peoria
City of Phoenix

003G

003J

003K

New River

MATCH TO SHEET 1

74

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Flood Control District of Maricopa County
2801 W. Durango St.
Phoenix, AZ 85009

Upper New River ADMP
FCD 2005CO20

Prepared By:

Stantec Consulting Inc.
8211 S. 48th Street
Phoenix, AZ U.S.A. 85044

Stantec

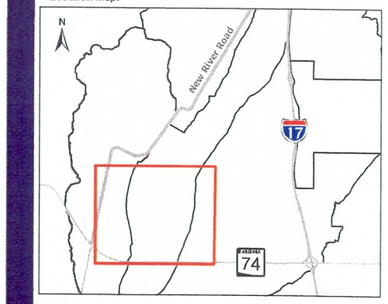
Legend:

- Proposed Bridge
- Proposed Roadway Alignment
- Roadway
- Levee
- Waterline
- Powerline
- Gasline
- Index Contour
- 2 ft Intermediate Contour
- FEMA Floodplain
- Erosion Hazard
- Parcel Boundary
- Phoenix Corporate Boundary
- Peoria Corporate Boundary

Depth (ft)

- >12
- 10 - 12
- 8 - 10
- 6 - 8
- 4 - 6
- 2 - 4
- 1 - 2
- <1

Location Map:



N

0 600 1,200 1,800 2,400 Feet

Project No.
182000418

Prepared By:
AMG
February 2008

Revision:

By Appd. Date

Title:
New River Downstream I-17
Alternative 3
Levee Option
Figure 9.28

Sheet 2 of 3

City of Peoria

City of Phoenix

End Levee

001

Sweat Canyon Wash

End Levee

New River Road

Begin Levee

Split

Historic Gravel Pit

West

New River

MATCH TO SHEET 2

Historic Gravel Pit

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Flood Control District of Maricopa County
2801 W. Durango St.
Phoenix, AZ 85009

Upper New River ADMP
FCD 2005CO20

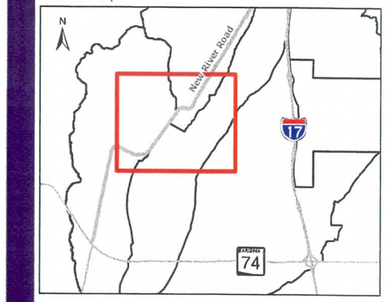
Prepared By:

Stantec Consulting Inc.
8211 S. 48th Street
Phoenix, AZ U.S.A. 85044

Legend:

- Proposed Bridge
- Proposed Roadway Alignment
- Roadway
- Levee
- Waterline
- Powerline
- Gasline
- Index Contour
- 2 ft Intermediate Contour
- FEMA Floodplain
- Erosion Hazard
- Parcel Boundary
- Phoenix Corporate Boundary
- Peoria Corporate Boundary

Location Map:



N

0 600 1,200 1,800 2,400 Feet

Project No.
182000418

Prepared By:
AMG
February 2008

Revision:

	By	Appd.	Date

Title:
New River Downstream I-17
Alternative 3
Levee Option
Figure 9.28

MATCH TO SHEET 2

End Embankment

Historic Gravel Pit

Sweat Canyon

West Split

Middle Split

New River Road

Unincorporated Maricopa County

City of Peoria
City of Phoenix

Begin Levee

End Levee

005

004

001

002

Begin Embankment

New River

Begin Levee

End Embankment

East Split

City of Peoria
City of Phoenix

New River

Begin Embankment

003G

003J

003K

74

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Flood Control District of Maricopa County
2801 W. Durango St.
Phoenix, AZ 85009

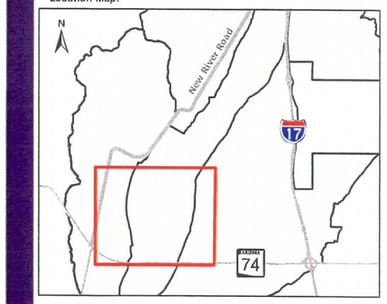
Upper New River ADMP
FCD 2005CO20

Prepared By:
Stantec Consulting Inc.
8211 S. 48th Street
Phoenix, AZ U.S.A. 85044

Legend:

- Proposed Bridge
- Basin Outlet Structure
- Levee/Basin Embankment & Lateral Weir
- Proposed Roadway Alignment
- Roadway
- Waterline
- Powerline
- Gasline
- Index Contour
- 2 ft Intermediate Contour
- Detention Basin
- FEMA Floodplain
- Erosion Hazard
- Parcel Boundary
- Phoenix Corporate Boundary
- Peoria Corporate Boundary

Location Map:



N

0 600 1,200 1,800 2,400 Feet

Project No.
182000418

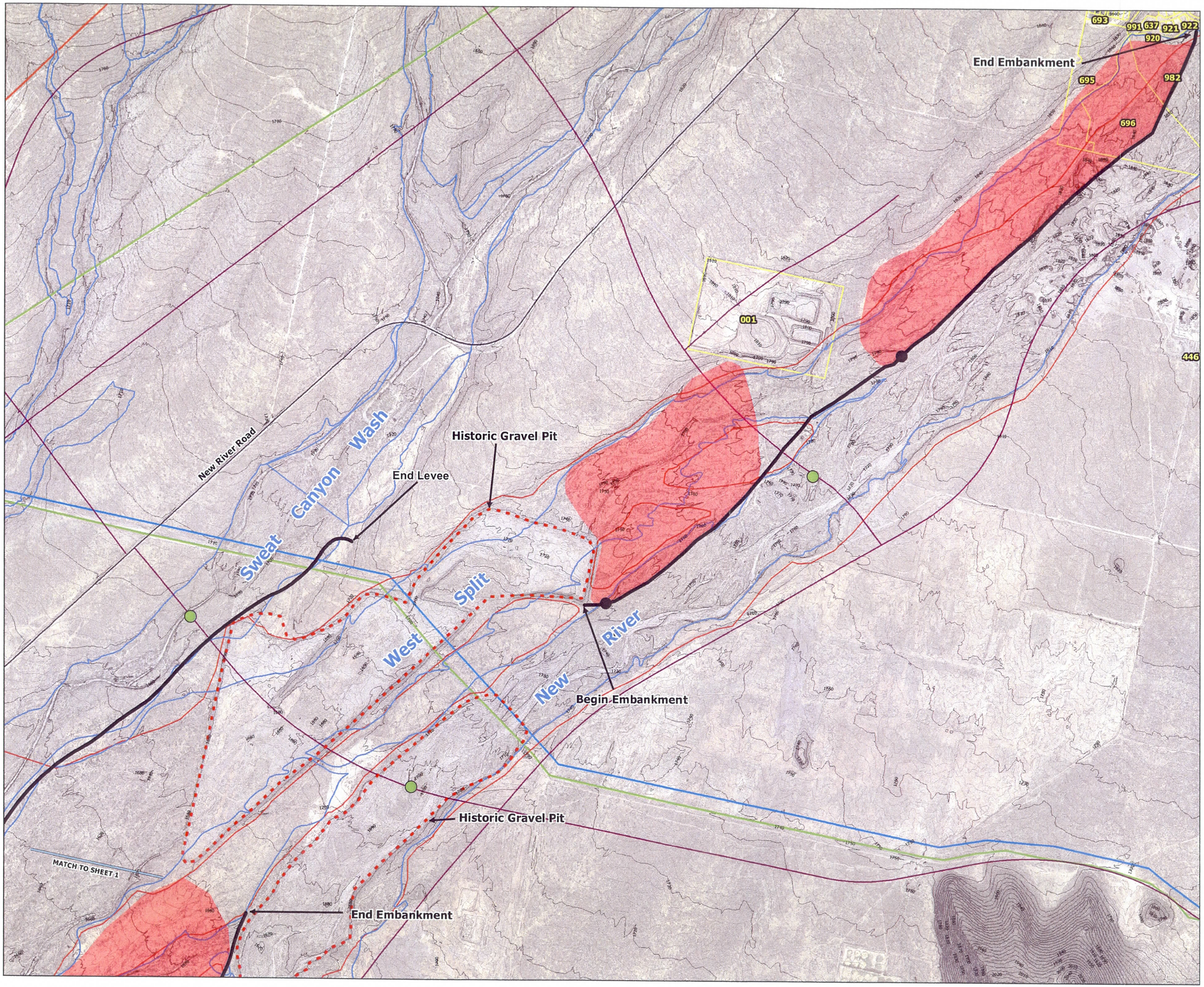
Prepared By:
AMG
February 2008

Title:
New River Downstream I-17
Alternative 4
Regional Detention Option
Figure 9.29

Revision:

By Appd. Date

Sheet 1 of 2



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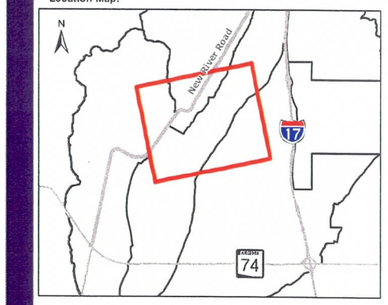
Flood Control District of Maricopa County
2801 W. Durango St.
Phoenix, AZ 85009

Upper New River ADMP
FCD 2005CO20

Prepared By:
Stantec Consulting Inc.
8211 S. 48th Street
Phoenix, AZ U.S.A. 85044

Legend:
- Proposed Bridge
- Basin Outlet Structure
- Levee/Basin Embankment & Lateral Weir
- Proposed Roadway Alignment
- Roadway
- Waterline
- Powerline
- Gasline
- Index Contour
- 2 ft Intermediate Contour
- Detention Basin
- FEMA Floodplain
- Erosion Hazard
- Parcel Boundary
- Phoenix Corporate Boundary
- Peoria Corporate Boundary

Location Map:



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0 600 1,200 1,800 2,400 Feet

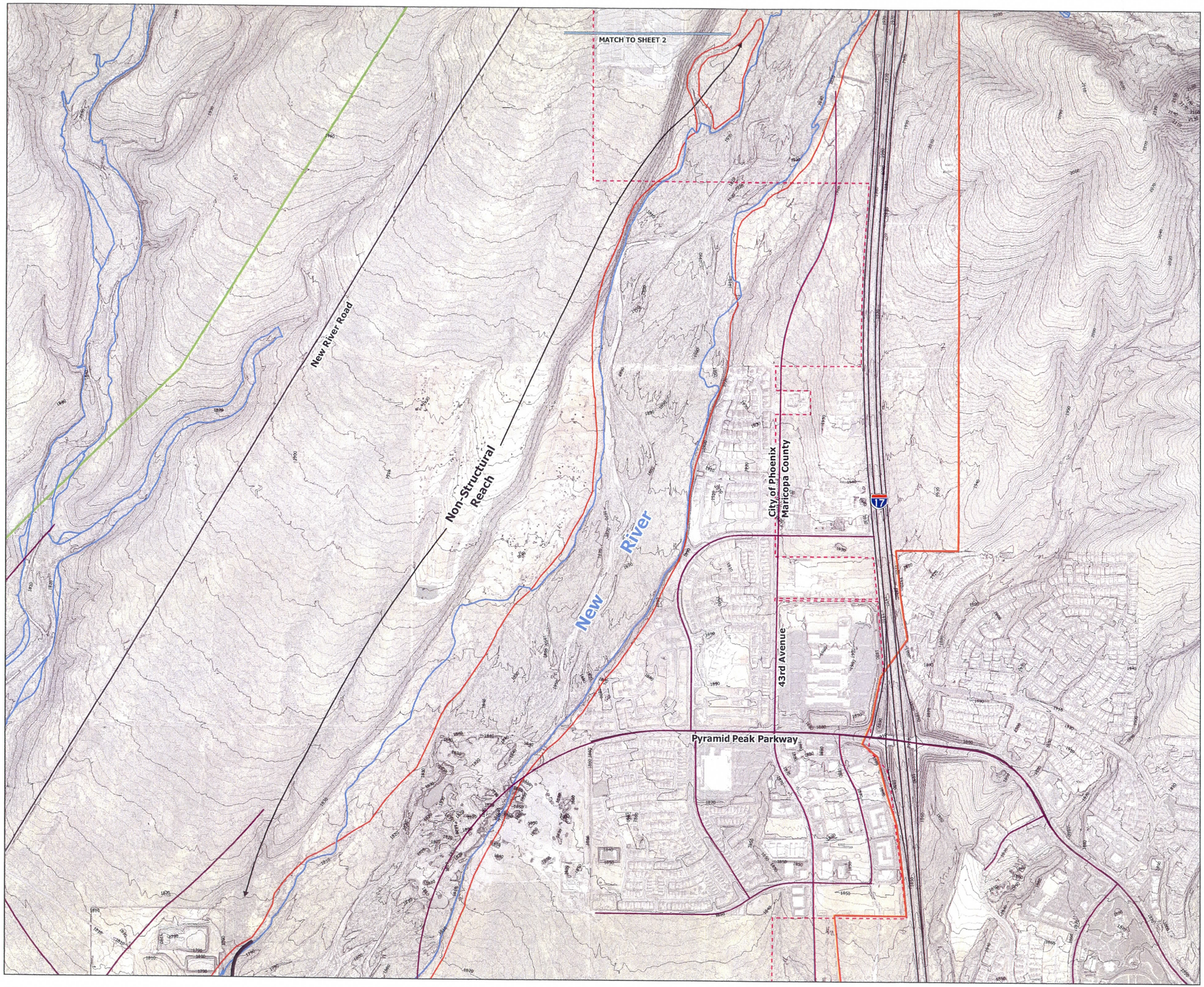
Project No.
182000418

Prepared By:
AMG
February 2008

Revision:

	By	Appd.	Date

Title:
New River Downstream I-17
Alternative 4
Regional Detention Option
Figure 9.29



Flood Control District
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Phoenix, AZ 85009

Upper New River ADMP
FCD 2005CO20

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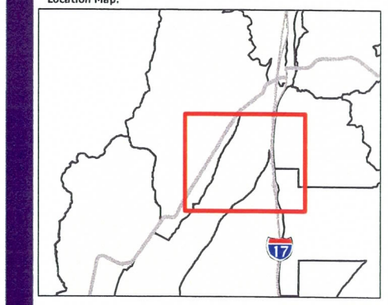
Phoenix, AZ U.S.A. 85044

Legend:

- Proposed Roadway Alignment
- Roadway
- Levee
- Powerline
- Gasline
- Index Contour
- 2 ft Intermediate Contour
- FEMA Floodplain
- Erosion Hazard
- Phoenix Corporate Boundary
- Peoria Corporate Boundary

Location Map:



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Project No.
182000418

Prepared By:
AMG
February 2008

Revision:

	By	Appd.	Date

Title:
New River Downstream I-17 Non-Structural Reach Common to Alternatives 1, 2, 3 and 4 Figure 9.30

Sheet 1 of 2

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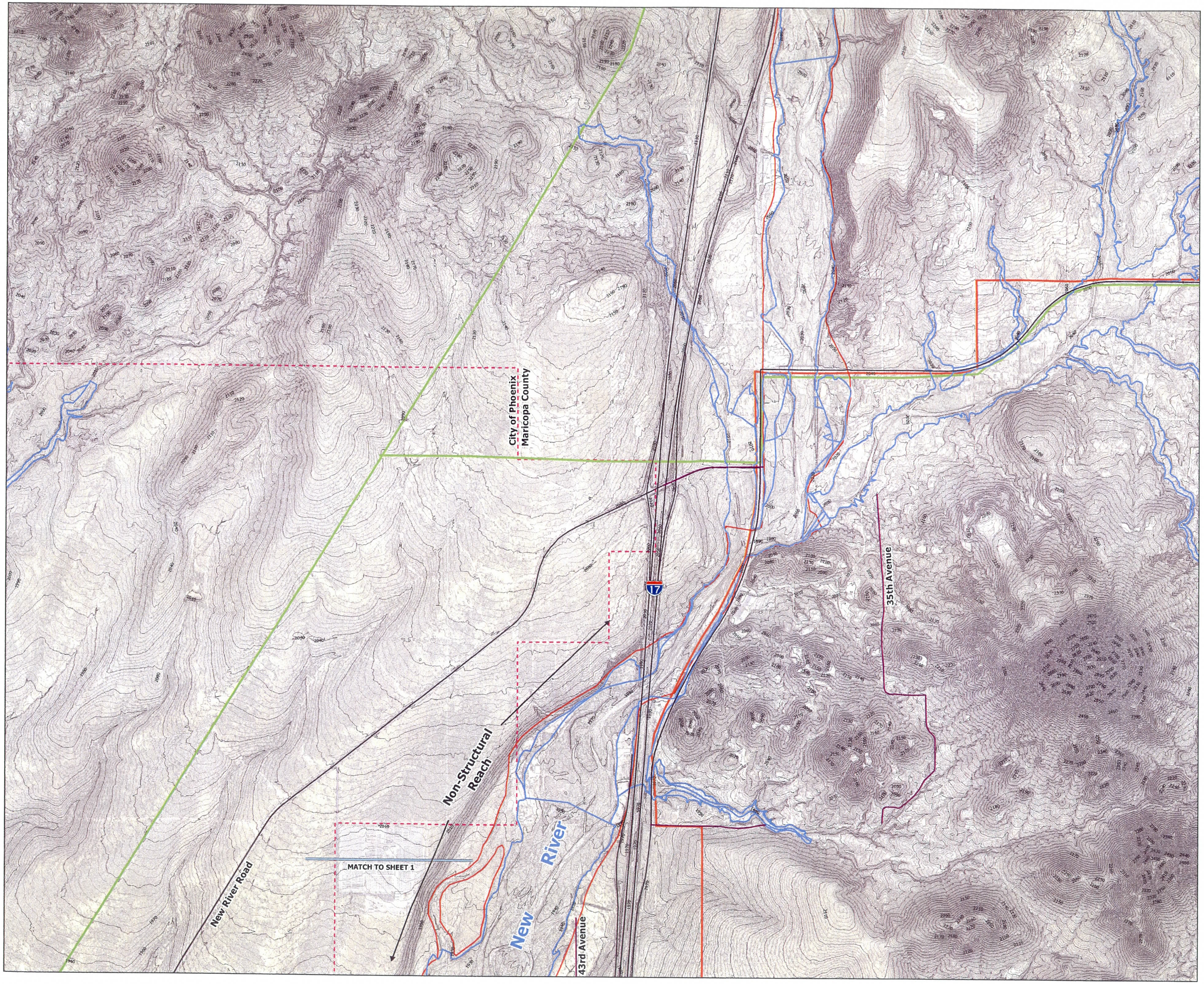

Flood Control District of Maricopa County
2801 W. Durango St.
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Upper New River ADMP
FCD 2005C020

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Legend:
- Proposed Roadway Alignment
- Roadway
- Waterline
- Powerline
- Gasline
- Index Contour
- 2 ft Intermediate Contour
- FEMA Floodplain
- Erosion Hazard
- Phoenix Corporate Boundary
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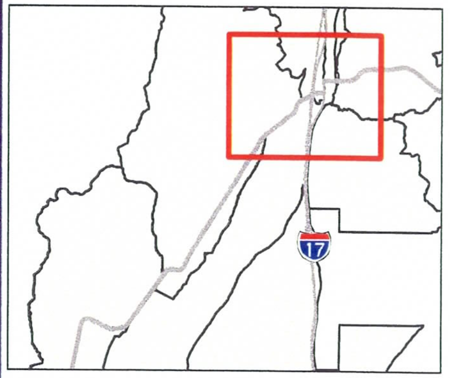
Location Map:



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Project No.
182000418

Prepared By:
AMG
February 2008

Revision:

	By	Appd.	Date

Title:
New River Downstream I-17 Non-Structural Reach Common to Alternatives 1, 2, 3 and 4
Figure 9.30

9.4.3.3.1.1 *Hydrology*

Alternatives 1, 2 and 3 consider levees along segments of New River and Sweat Canyon as well as the channelization of a portion of New River. These proposed features are intended to control existing flow splits along the two watercourses and direct stream flow in different proportions to the two SR-74 Highway Bridges. The base model used to reflect the hydrologic conditions for these alternatives is the 100-year, 24-hour existing land use condition ADMP HEC-1 model. The base model is revised to model the effect of eliminating identified splits from New River and Sweat Canyon Wash on downstream peak discharges. The alternative models are provided digitally on CD as Appendix J. A summary of results is given in Tables 9.11, 9.12 and 9.13, for each alternative for the 100-, 50- and 10-year frequencies. Alternative 4 also considers features to control existing flow splits along New River and Sweat Canyon. Along New River, these features are off-line detention basins placed at strategic locations. Modeling of the off-line basins was accomplished using the unsteady flow option of HEC-RAS and is discussed in Section 9.4.3.3.1.2. For Sweat Canyon, the flow split is controlled using levees and the results are the same as for Alternatives 1, 2 and 3.

Table 9.11
New River Downstream of I-17 Peak Discharges for Alternative 1

		Peak Discharge, in cfs				
River Station (1)	**HEC-1 ID (2)**	**100-Yr, Base (3)**	**100-Yr, Alt. (4)**	**50-Yr, Alt. (5)**	**10-Yr, Alt. (6)**	**Location (7)**
31.76	CP160	28,952	28,952	25,211	9,954	New R. d/s of I-17
30.93	CP170	28,730	28,730	25,081	9,481	New R. at the West Split
28.27	CP180	23,239	28,595	24,921	9,436	New R. d/s of the West Split
27.22	CP190	23,203	28,516	24,809	9,410	New R. at the Deadman Split
25.43	CP200	7,554	28,364	24,652	9,360	SR-74 Bridge (East)
23.19	INT230	26,332	29,157	25,254	9,622	New R. u/s of Deadman Wash
14,437.5	CP19A	14,178	14,178	11,967	4,679	Sweat Canyon d/s of New R. Rd.
3,510.0	CP195	13,355	19,811	16,743	6,538	Sweat Canyon u/s of West Split
118	CP205	16,868	20,442	17,216	6,746	Sweat Canyon d/s of West Split
30	CP215	17,148	20,736	17,359	6,843	Sweat Canyon u/s of SR-74
23.64	CP225	23,929	20,949	17,465	6,913	SR-74 Bridge West
23.19	INT230	26,332	29,157	25,254	9,622	New R. u/s of Deadman Wash

Table 9.12
New River Downstream of I-17 Peak Discharges for Alternative 2

River Station (1)	HEC-1 ID (2)	Peak Discharge, in cfs: 100-Yr, Base (3)	100-Yr, Alt. (4)	50-Yr, Alt. (5)	10-Yr, Alt. (6)	Location (7)
31.76	CP160	28,952	28,952	25,211	9,954	New R. d/s of I-17
30.93	CP170	28,730	28,730	25,081	9,481	New R. at the West Split
28.27	CP180	23,239	28,595	24,921	9,436	New R. d/s of the West Split
27.22	CP190	23,203	28,516	24,809	9,410	New R. at the Deadman Split
25.43	CP225	23,929	29,005	24,652	9,572	SR-74 Bridge (West)
23.19	INT230	26,332	28,985	25,138	9,565	New R. u/s of Deadman Wash
14,437.5	CP19A	14,178	14,178	11,967	4,679	Sweat Canyon d/s of New R. Rd.
3,510.0	CP195	13,355	19,811	16,743	6,538	Sweat Canyon u/s of West Split
118	CP205	16,868	20,442	17,216	6,746	Sweat Canyon d/s of West Split

Table 9.13
New River Downstream of I-17 Peak Discharge for Alternative 3

River Station (1)	HEC-1 ID (2)	Peak Discharge, in cfs: 100-Yr, Base (3)	100-Yr, Alt. (4)	50-Yr, Alt. (5)	10-Yr, Alt. (6)	Location (7)
31.76	CP160	28,952	28,952	25,211	9,954	New R. d/s of I-17
30.93	CP170	28,730	28,730	25,081	9,481	New R. at the West Split
28.27	CP180	23,239	28,595	24,921	9,436	New R. d/s of the West Split
27.22	CP190	23,203	28,516	24,809	9,410	New R. at the Deadman Split
25.32	INT230	26,332	28,764	24,977	9,492	New R. u/s of Deadman Wash
14,437.5	CP19A	14,178	14,178	11,967	4,679	Sweat Canyon d/s of New R. Rd.
3,510.0	CP195	13,355	19,811	16,743	6,538	Sweat Canyon u/s of West Split
118	CP205	16,868	20,442	17,216	6,746	Sweat Canyon d/s of West Split
30	CP215	17,148	20,736	17,359	6,843	Sweat Canyon u/s of SR-74

9.4.3.3.1.1.1 Hydrologic Considerations

The proposed channel and levee conveyance corridor dimensions were sized to minimize potential adverse/cumulative impacts downstream based on the results of the sensitivity modeling discussed in Section 9.4.2.3.1.1. Therefore, no modifications were made to the ADMP hydrology models to reflect the proposed features. However, all alternatives use the proposed features to control existing flow splits along New River and Sweat Canyon. Modifications to the ADMP hydrology models to reflect the proposed changes at those locations were performed and the results of those modifications are summarized in Tables 9.11, 9.12, and 9.13.

In general, removal of the existing flow splits results in an overall increase in peak discharges along Sweat Canyon and New River. Locally, and for some distance downstream of the existing flow split location, increase in peak discharge is due to the removal of the split flow itself. However, peak flow rates in New River and Sweat Canyon for each alternative remain higher than existing conditions even for the reaches downstream of where the split flows return to the main channel, and in particular downstream of SR-74 where flow in New River and Sweat Canyon combine. This is primarily due to the loss of floodplain storage and longer travel times of the alternate flow paths with respect to the magnitude of the break-out flows and the timing differentials between runoff breaking out of New River and combining with local runoff and runoff breaking out of Sweat Canyon.

9.4.3.3.1.2 Hydraulic Evaluation

Hydraulic models were developed to evaluate the hydraulic performance of alternatives proposed for New River and Sweat Canyon. Tables 9.15 and 9.16 provide a description for each HEC-RAS hydraulic model. Hydraulic model input and output files are located in Appendix J. Due to the distributary/braided nature of New River downstream of SR-74 Highway FLO-2D is utilized to model the effects of Alternatives 1, 2, and 3 through this reach. FLO-2D modeling was not conducted for Alterative 4 because the effort to develop a model was not in the original budget and a change order was not pursued because the likelihood that the alternative moves foward is slight given the environmental impacts that would be sustained due to the implementation of the alternative. The flowing list design elements that were incorporated into the hydraulic evaluation.

Alternative 1

In Alternative 1, flows within New River are contained and conveyed through either a channel or a levee to the existing east bridge of SR-74 while flows from Sweat Canyon are conveyed to the west bridge. Two HEC-RAS models were created, one for New River and one for Sweat Canyon Wash. Both models end just downstream of SR-74. At this point a two-dimensional alternative model is utilized to model the area between SR-74 and the New River Dam impoundment limits. The results of the two-dimensional modeling analyses are presented in a Section 9.4.3.3.2.

A typical channel section with the following characteristics was modeled:

- Channel slopes were set to 3:1.
- The top width was set to 1,000 feet or greater.
- The n-value of the channel was set to 0.05 which is consistent with the existing condition. This allows for vegetation to be reestablished to the existing condition.
- The n value for estimated for existing conditions is used for the levee option

The levee option of the HEC-RAS Geometry editor was utilized to models the levee option by setting levee stations approximately 1000 feet apart.

The alternative evaluation HEC RAS model for Sweat Canyon model required combining reaches of the West Split model (RM 1.18 through 0.02) and New River models (RM 24.01 through 22.87) to develop one continuous model form the confluence with Sweat Canyon to the SR-74 west bridge. The cross section labels for the West Split were modified to numerically fit between the cross section labels for Sweat Canyon and New River. Sweat Canyon flows are contained using a levee. The levee starts approximately one-mile downstream of New River Road and ends approximately two miles upstream of SR-74.

Alternative 2

For Alternative 2 flows from New River and Sweat Canyon are routed through the existing west bridge of SR-74. Two models were created. One model includes New River from I-17 to the area just below SR-74 (RM 22.87). A two-dimensional model was developed for the area from SR-74 to the New River ponding limits (see Section 9.4.3.3.2). The second model includes Sweat Canyon and the West Split to the confluence with New River. Two options were developed for the New River model to prevent flow breakout and convey flows to the west side, levee and channel option. As before, the levee option uses the HEC-RAS geometry levee editor to keep flow within New River. The channel option includes a channel from RM 25.51 to 23.21. The channel has the following characteristics:

- The side slopes were set to 3:1.
- The top width was set to 1,000 feet or greater.
- The n-value of the channel was set to 0.05.
- The n-value for estimated for existing conditions is used for the levee option

The downstream boundary condition for New River was obtained from the results of the two-dimensional modeling.

The Sweat Canyon model was created by adding cross sections from the West Split model (RM 1.18 through 0.02) and includes levees to prevent split flows to the West Split. The levees start approximately one mile downstream of New River Road and end approximately two miles upstream of SR-74. The downstream boundary condition for Sweat Canyon was obtained from the New River model at the confluence.

The flow rates for the New River and Sweat Canyon models were modified from the base models to remove split flows to the West Split and Deadman Wash and routing flows to the west bridge. The flow rates are summarized in Table 9.12.

Alternative 3

Two models were developed, the New River and Sweat Canyon Wash models. The New River model removes split flows to the West Split and Deadman Wash. The alternative does not include changes to the area just north of SR-74 and the HEC-RAS model was ended at RM 24.11. A two-dimensional model begins at RM 24.11, continues to the New River Dam ponding limits and includes the SR-74 Bridge (see Section 9.4.3.3.2). The

downstream boundary condition for the HEC-RAS model was obtained from the two-dimensional model.

The Sweat Canyon model has the same levee configuration as Alternative 2. The only difference is the downstream boundary condition. The downstream boundary condition for Sweat Canyon was obtained from the two-dimensional model.

The flow rates for the New River and Sweat Canyon models were modified from the base model to remove split flows to the West Split and Deadman Wash. The flow rates are summarized on Table 9.13.

Alternative 4

Three models were developed for Alternative 4, Upper New River, Lower New River and Sweat Canyon Wash models. The Upper New River model includes the area from I-17 to just below SR-74 (RM 22.87). It includes four regional off-line basins located strategically along New River to prevent flow break out to the West Split and Deadman Wash (see Figure 9.29). The basins also reduce the peak discharges in New River, which in turn reduce the flow depths and velocities while preserving low flow conditions. The unsteady flow option in HEC-RAS is used to model the basin inflow and outflow and to determine the maximum flow rate at SR-74. The basins were modeled in HEC-RAS with the following:

- A lateral structure was added to the cross sections adjacent to the basins. Inflow to the basin is controlled by a lateral weir. The operation of the weir for the upstream most basin is illustrated in Figure 9.31
- Basins 1, 2, 3 and 4 stage-storage relations are shown on Figure 9.32.
- Three 10' x 5' gates meter the flow back into New River.

Inflow to the model is input at two locations. The first location is the upstream boundary of the model, R.S. 31.76. The second location accounts for inflow from Sweat Canyon and is input as lateral inflow at R.M. 24.11. Hydrographs for each inflow location are obtained from the HEC-1 models for Alternative 2 at CP160 (New River upstream boundary condition) ad CP125 (Sweat Canyon lateral inflow). Both hydrographs are taken directly from the HEC-1 output. As a model constraint, a minimum discharge of 600 cfs is imposed on the upstream boundary condition. This constraint provides a low flow condition in the model that is necessary for numerical stability. Inflow and outflow hydrographs for the 100-year event are illustrated in Figure 9.33.

Outflow from the upper model is used in the estimation of peak discharge for the lower segment. As discussed previously, peak discharges in New River downstream of I-17 are sensitive to changes in the basin response time. Therefore, outflow from the HEC-RAS model for the upper segment was coded into a HEC-1 model for Alternative 4. This hydrograph was used to replace all HEC-1 operations for the watershed upstream of SR-74. The hydrograph was then routed downstream and combined with tributary inflow. The resulting peak discharge values for the lower segment model are listed in Table 9.14.

Table 9.14
New River downstream of SR-74 Peak Discharges for Alternative 4

River Station (1)	HEC-1 ID (2)	Peak Discharge, in cfs 100-Yr, Base (3)	100-Yr, Alt. (4)	50-Yr, Alt. (5)	10-Yr, Alt. (6)
---	CP225	23,929	16,529	14,122	6,847
22.87	INT230	26,332	16,671	14,254	5,501
21.12	CP250	34,575	26,239	22,466	8,659

The Sweat Canyon model is the same as the model developed for Alternative 2. The downstream boundary condition for Sweat Canyon was obtained from the New River Alternative 4 model at the confluence.

Table 9.15
New River Alternative Analysis Hydraulic Model Summary

Project Name (1)	Plan Name (2)	Geometry (3)	Steady Flow (4)	Description (5)
Upper New River Alt 1 East Bridge	Alt1 East Channel	Alt1 East Channel	Alt 1 - Channel	A levee is used that prevent flow breakout to the West Split from New River. A channel is proposed between SR-74 and approximately 2.3 miles upstream that prevent flow break out to Deadman Wash. The alignments convey flow through the East Split to the SR-74 east bridge.
	Alt1 East Levee	Alt1 East Levee	Alt 1 - Levee	A levee is used to prevent flow breakout to the West Split and Deadman Wash from New River. The alignments of the levees along the main stem of New River convey flow through the East Split to the SR-74 east bridge.
Upper New River Alt 2 West Bridge	Alt2 West Channel	Alt2 West Channel	Alt2	A channel is proposed along a portion of the river starting from SR-74 and continuing approximately 2.3 miles upstream. The alignment of the channel conveys flow to the West Split of New River where it combines with Sweat Canyon Wash flow. The combined New River and Sweat Canyon runoff is conveyed to SR-74 west bridge.
	Alt2 West Levee	Alt2 Levee	Alt2	Provides a levee that prevents blow breaking out to the West Split and Deadman Wash from New River. The proposed levees along the New River main stem convey flow to the West Split where it combines with Sweat Canyon Wash flow. The combined New River and Sweat Canyon runoff is conveyed to SR-74 west bridge.

Table 9.15 Continued
New River Alternative Analysis Hydraulic Model Summary

Project Name	Plan Name	Geometry	Steady Flow	Description
Upper New River Alt 3	Alt3	Alt3	Alt3	A levee is used to prevent flow break out to the West Split and Deadman Wash from New River. Existing drainage patterns directly upstream of SR-74 are not mitigated.
Upper New River Alt 4 - Upper	Alt 4-100Yr	Off-line Detention Alternative	100-Yr Inflow w/ Gated Basins	Regional off-line basins are located strategically along New River to prevent flow break out and reduce peak discharges. The proposed levees along the New River Main Stem convey flow to the West Split where it combines with Sweat Canyon Wash flow. The combined New River and Sweat Canyon runoff is conveyed to SR-74 west bridge. Model stops at RM 22.87 (just downstream of SR-74)
Upper New River Alt 4 – Lower	Alt 4 Lower	Alt 4 Lower	Alt 4 Lower	Model begins at RM 22.87 and continues to New River ponding limits. Flow rate at the upstream boundary for model is obtained from Upper model at the maximum flow rate.

Table 9.16
Sweat Canyon Wash Alternative Analysis Hydraulic Model Summary

Project Name (1)	Plan Name (2)	Geometry (3)	Steady Flow (4)	Description (5)
Upper New River Alt 1 – Sweat Canyon	Alternative – Levee	Alternative – Levee	Alt 1	Provides a levee that prevents flow breaking out to West Split from Sweat Canyon Wash. The alignments of the levee convey flow through West Split. Downstream boundary condition from 2-D model.
Upper New River Alt 2 – Sweat Canyon	Alt 2 – Channel	Alt 2	Alt 2 - Channel	Provides a levee that prevents flow breaking out to West Split from Sweat Canyon Wash. Flow joins New River upstream of SR-74. Downstream boundary condition from Alternative 2 Channel model.
	Alt 2 – Levee	Alt 2	Alt 2 - Levee	Provides a levee that prevents flow breaking out to West Split from Sweat Canyon Wash. Flow joins New River upstream of SR-74. Downstream boundary condition from Alternative 2 Levee model.
Upper New River Alt 3 – Sweat Canyon	Alt 3 – Levee	Alternative – Levee	Alt3	Provides a levee that prevents flow breaking out to West Split from Sweat Canyon Wash. Flow joins New River upstream of SR-74. Downstream boundary condition from Alternative 3 model.
Upper New River Alt 4 – Sweat Canyon	Alt 4 – Levee	Alternative – Levee	Alt 4	Provides a levee that prevents flow breaking out to West Split from Sweat Canyon Wash. Flow joins New River upstream of SR-74. Downstream boundary condition from Alt 4 Upper model.

The downstream boundary condition for both the New River and Sweat Canyon Wash models for the 100-year event uses the results of the two-dimensional modeling for the average starting water surface elevation at RM 22.87. Tables 9.17 and 9.18 summarize the starting water surface elevations for the New River and Sweat Canyon models.

Table 9.17
New River Starting Water Surface Elevations

Model	Water Surface Elevation Feet	Comment
(1)	(2)	(3)
Alternative 1		
Levee	Known WS = 1541.00	From 2-D model
Channel	Known WS = 1541.00	From 2-D model
Alternative 2		
Levee	Known WS = 1543.50	From 2-D model
Channel	Known WS = 1543.50	From 2-D model
Alternative 3	Known WS = 1591.00	From 2-D model
Alternative 4		
Upper	Normal Depth = 0.0007	
Lower	Normal Depth = 0.007	

Table 9.18
Sweat Canyon Water Surface Elevations

Model	Water Surface Elevation Feet	Comment
(1)	(2)	(3)
Alternative 1	Known WS = 1541.00	From 2-D model
Alternative 2		
Levee	Known WS = 1584.38	From New River Alt 2 Levee model @ xsec 23.82
Channel	Known WS = 1575.79	From New River Alt 2 Channel model @ xsec 23.82
Alternative 3	Known WS = 1591.00	From 2-D model
Alternative 4	Known WS = 1587.64	From New River Alt 4 Upper model @ xsec 24.11

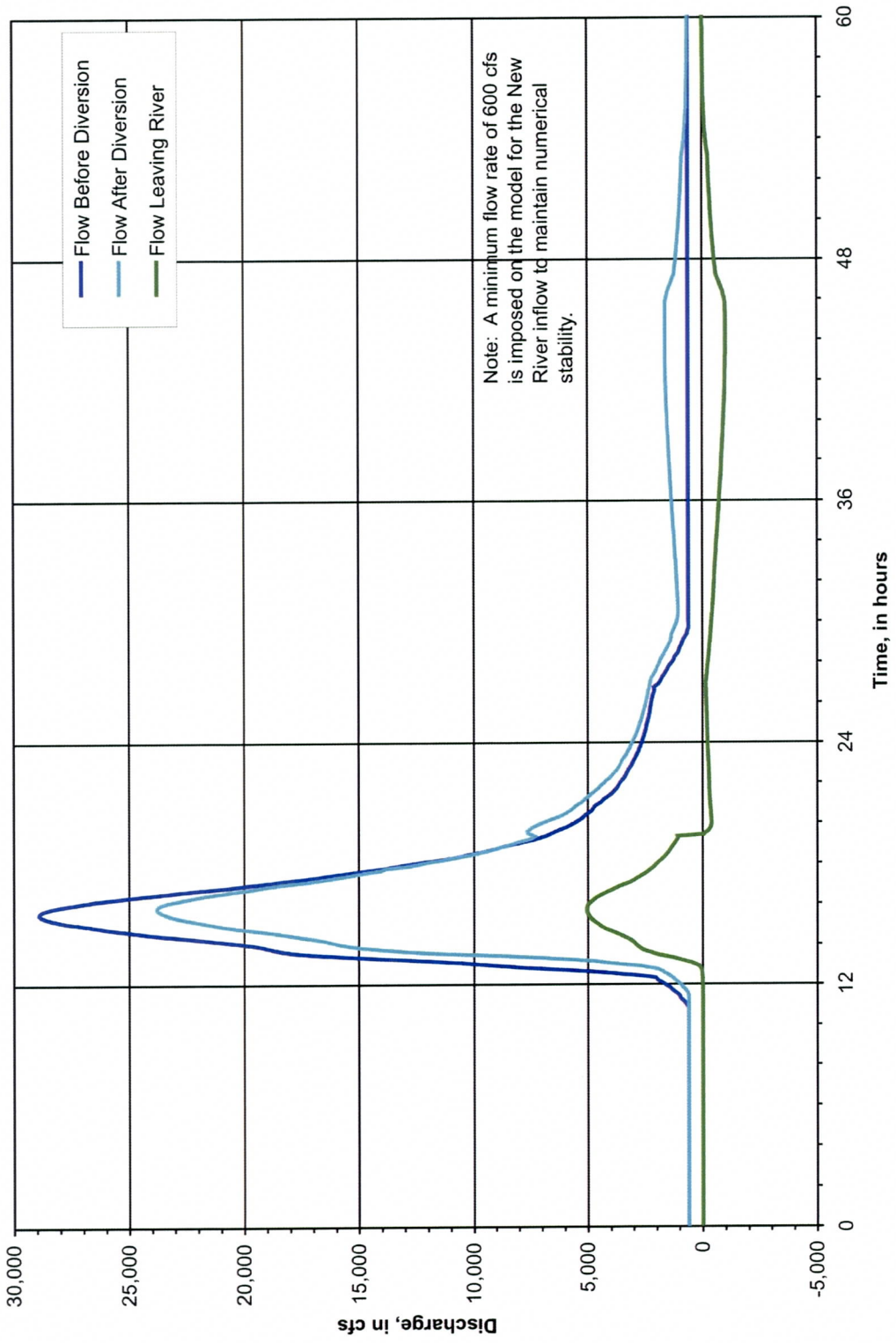


Figure 9.31 – Off-line Basin Operation

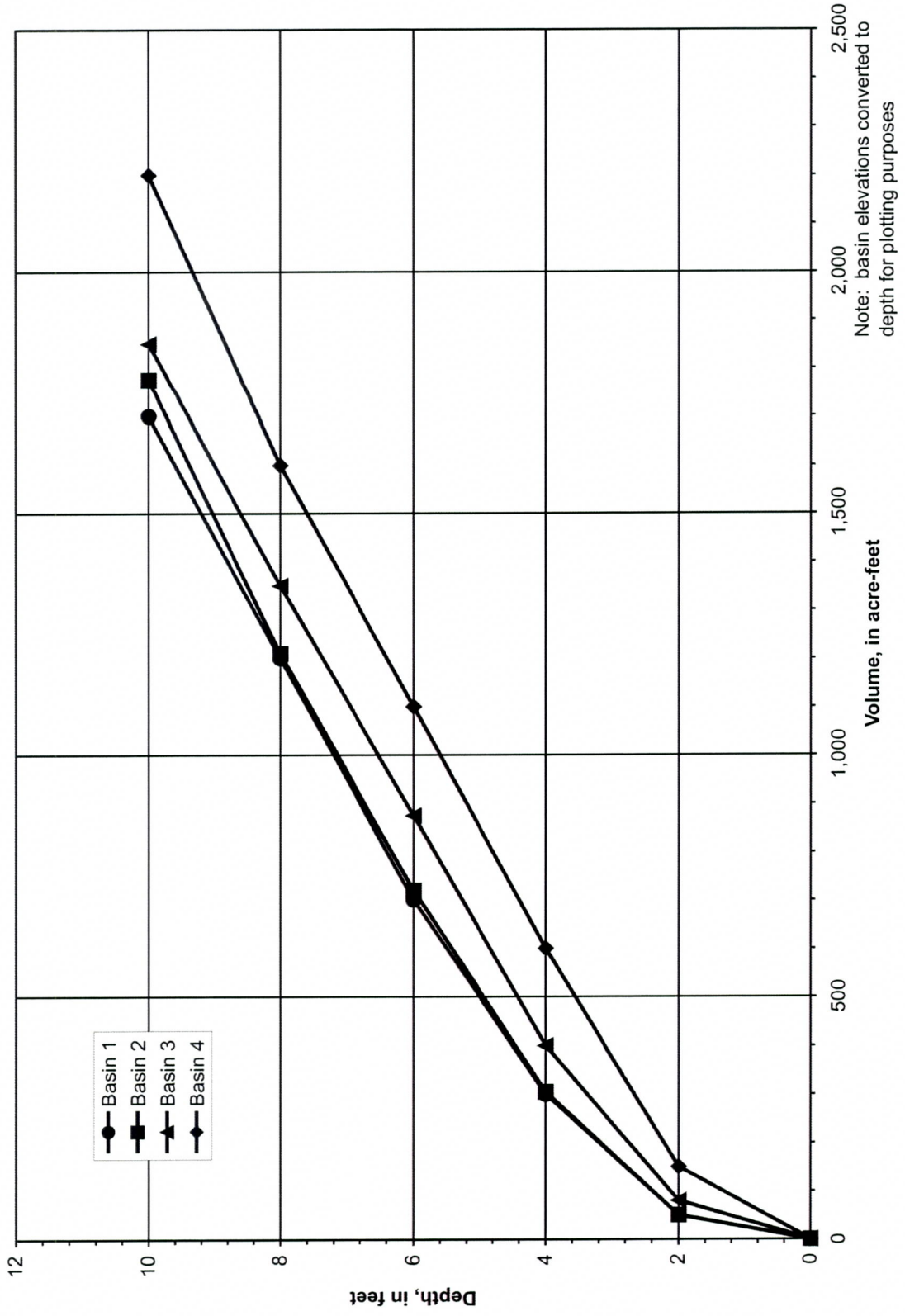


Figure 9.32 – Alternative 4 Stage-storage Relations

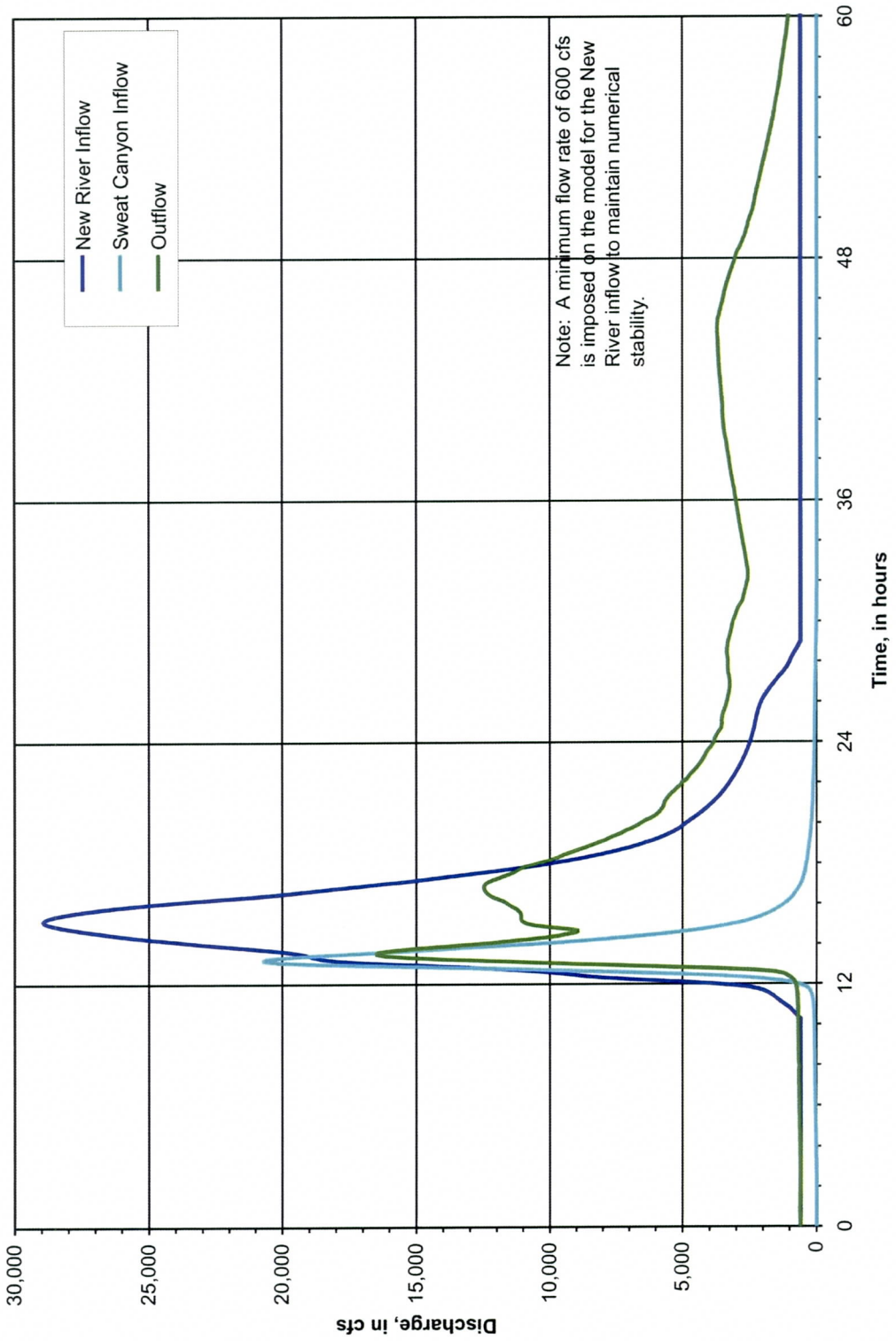


Figure 9.33 - Alternative 4 Unsteady Flow Inflow and Outflow Hydrographs

Results of the hydraulic models for the structural alternatives are compared to the base hydraulic model to determine the impact of the alternative on the hydraulic properties of the watercourse. Conclusions that can be drawn from review of the 10-year event figures for New River are (see Figures 9.34 through 9.46):

- For all alternatives the majority of the points for the 10-year event lie on or near the 45 degree line for shear stress, channel velocity and hydraulic depth. This indicates that there is little change in the hydraulic parameters between the base and the alternative models. By inference, the regional sedimentation of New River between I-17 and SR-74 would not change due to the implementation of the alterative.

- For all alternatives, the scatter of points for shear stress, channel velocity and hydraulic depth that lie above and below the 45 degree line indicates that there are local or isolated changes in channel hydraulics by the alternatives. The alternatives will cause local or isolated changes to sedimentation.

- For Alternative 1 levee model, the scatters of points for the shear stress are above the 45 degree line. This may indicated that the alternative may cause an increase in the rate of scour for some areas. For the channel model, the scatter of points are below the 45 degree line, indicating that the alternative may cause a decrease in the rate of scour for some areas.

- For the Alternative 2 levee model, the scatter of points are above the 45 degree line for shear stress and hydraulic depth. This may indicate that the alternative will cause an increase in the rate of scour for some areas. For the channel model, the scatter is both above and below the line.

- For Alternative 3 there is some scatter, mostly above the line, indicating a slight increase in the rate of scour for some areas.

- For Alternative 4 there is some scatter, mostly above the line, indicating a slight increase in the rate of scour for some areas.

Conclusions that can be drawn from the review of the 100-year event figures for New River are (see Figures 9.46 through 9.51):

- For Alternatives 1, 2 and 3 the removal of the breakout to the West Split (near RM 28.27) using a levee causes an increase in the hydraulic depth and a decrease in velocity.

- For Alternatives 1 and 2 the channelization or levee causes an increase in hydraulic depth and velocity.

- For Alternative 3 there are only slight changes from the base model.

- For Alternative 4 the basins reduce the velocity and flow depths in New River for the 100-year event.

For Sweat Canyon, figures were developed for Alternative 1 where the flows from the West Split and Sweat Canyon Wash were routed through the west bridge of SR-74 (see Figures 9.52 through 9.54). For Alternatives 2 through 4 Sweat Canyon flows are combined with New River flows at the existing confluence. Figures representing Alternatives 2 through 4 were developed for just the worse case, Alternative 3. Alternative 3 is considered the worse case because it has the highest water surface elevation. Conclusions that can be drawn from review of the 10-year event figures for Sweat Canyon Wash are:

- Majority of the points do not lie on the 45 degree line but lie near the line. This indicates that alternatives may cause slight regional wide changes in hydraulics. By inference the overall sedimentation of Sweat Canyon Wash will change slightly based on the alternative.

- Majority of the points for shear stress, velocity and hydraulic depth lie above the 45 degree line for the alternatives. This indicates the alternatives cause an increase in the shear stress and hydraulic depth. By inference the alternatives may cause an increase in erosion and local scour.

Conclusions that can be drawn from the review of the 100-year event figures (Figures 9.55 and 9.56) for Sweat Canyon Wash are:

- The removal of the breakout to the West Split and the levee cause an increase in velocity and hydraulic depth for both alternatives starting approximately ½-mile downstream of New River Road to the confluence with New River.

- For Alternative 1, the routing of just Sweat Canyon flows through the west bridge of SR-74 does not cause significant changes to the hydraulics.

Conclusions that can be drawn for Alternative 4 from a hydrologic perspective are:

- Off-line basins provide an effective means of reducing peak discharge for less frequent events and maintaining runoff characteristics for more frequent events. More frequent events typically drive river morphology and environmental characteristics.

- Runoff volume stored by the basins can be metered out reducing the volume of runoff stored behind New River Dam or at a minimum off-setting increased runoff due to the development of the watershed.

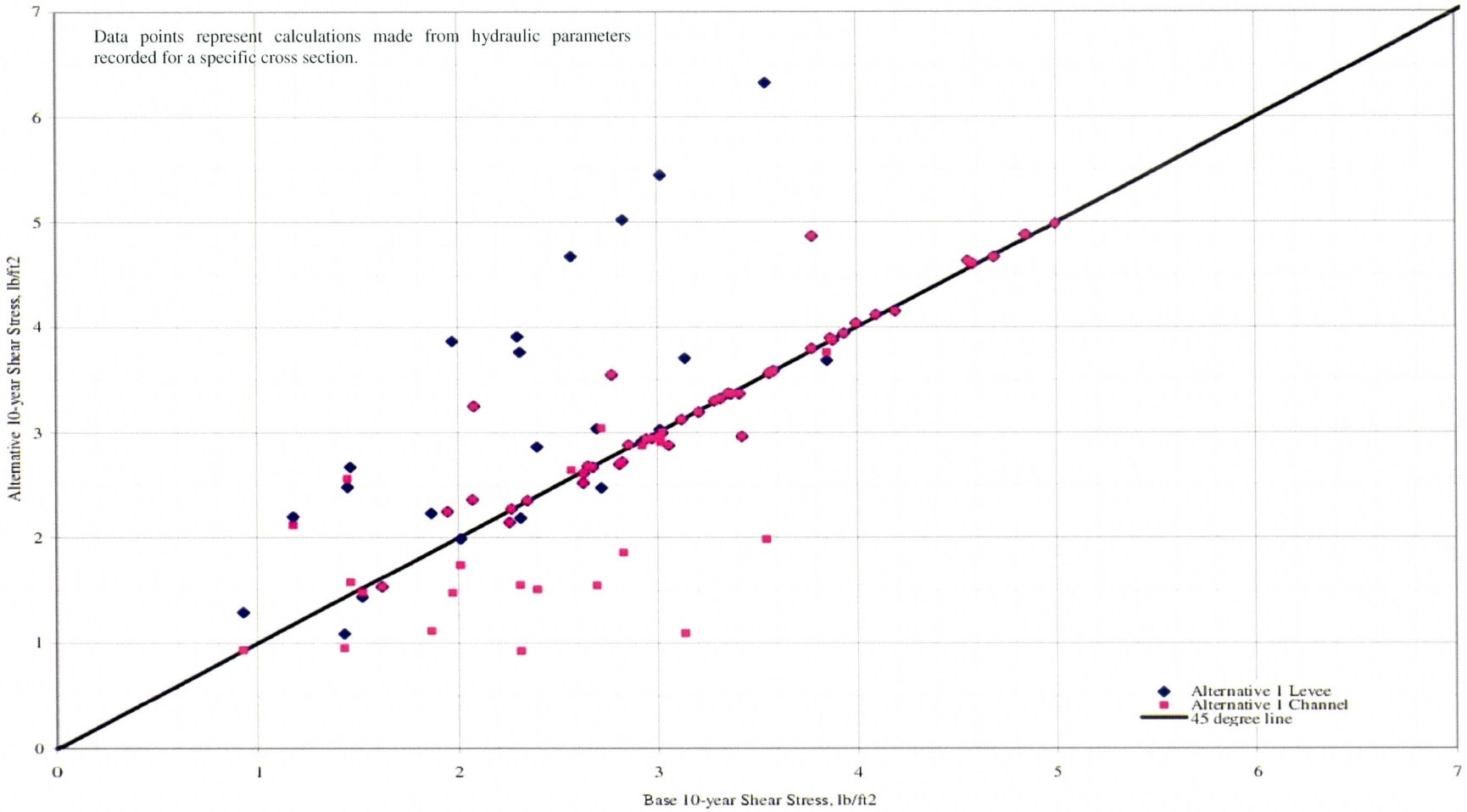


Figure 9.34 - Comparison of Shear Stress for New River Alternative 1

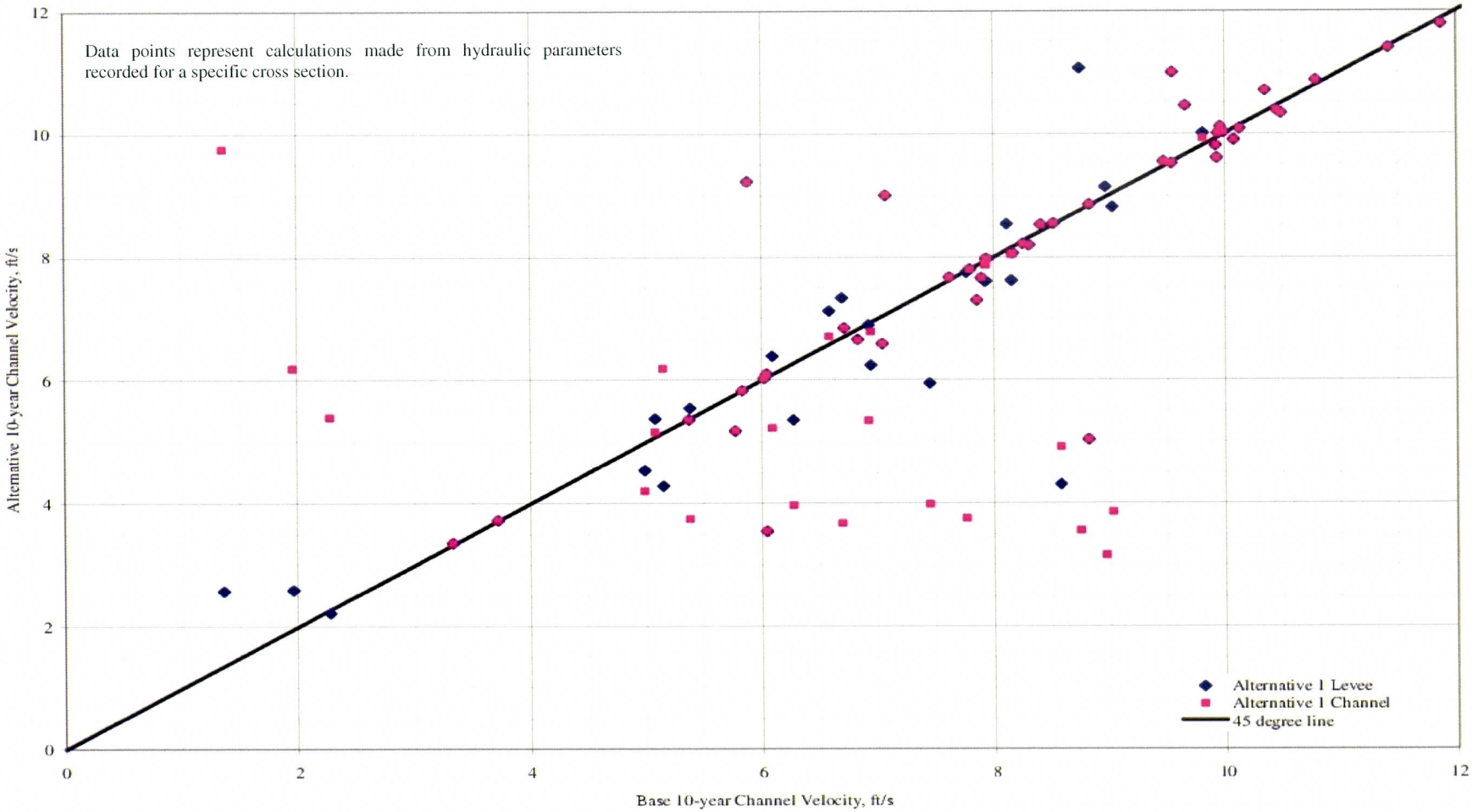


Figure 9.35 - Comparison of Channel Velocity for New River Alternative 1

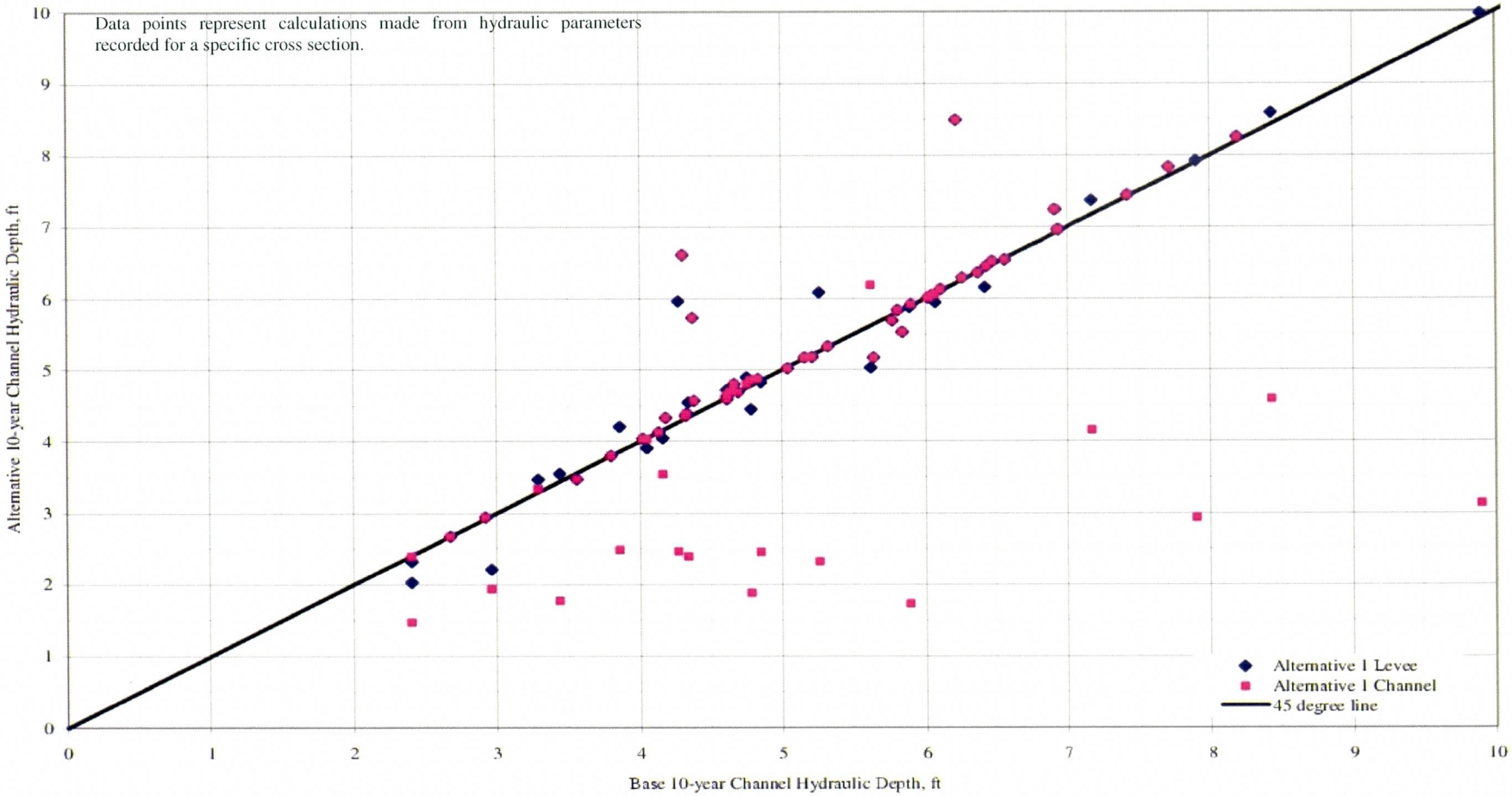


Figure 9.36 - Comparison of Channel Hydraulic Depth for New River Alternative 1

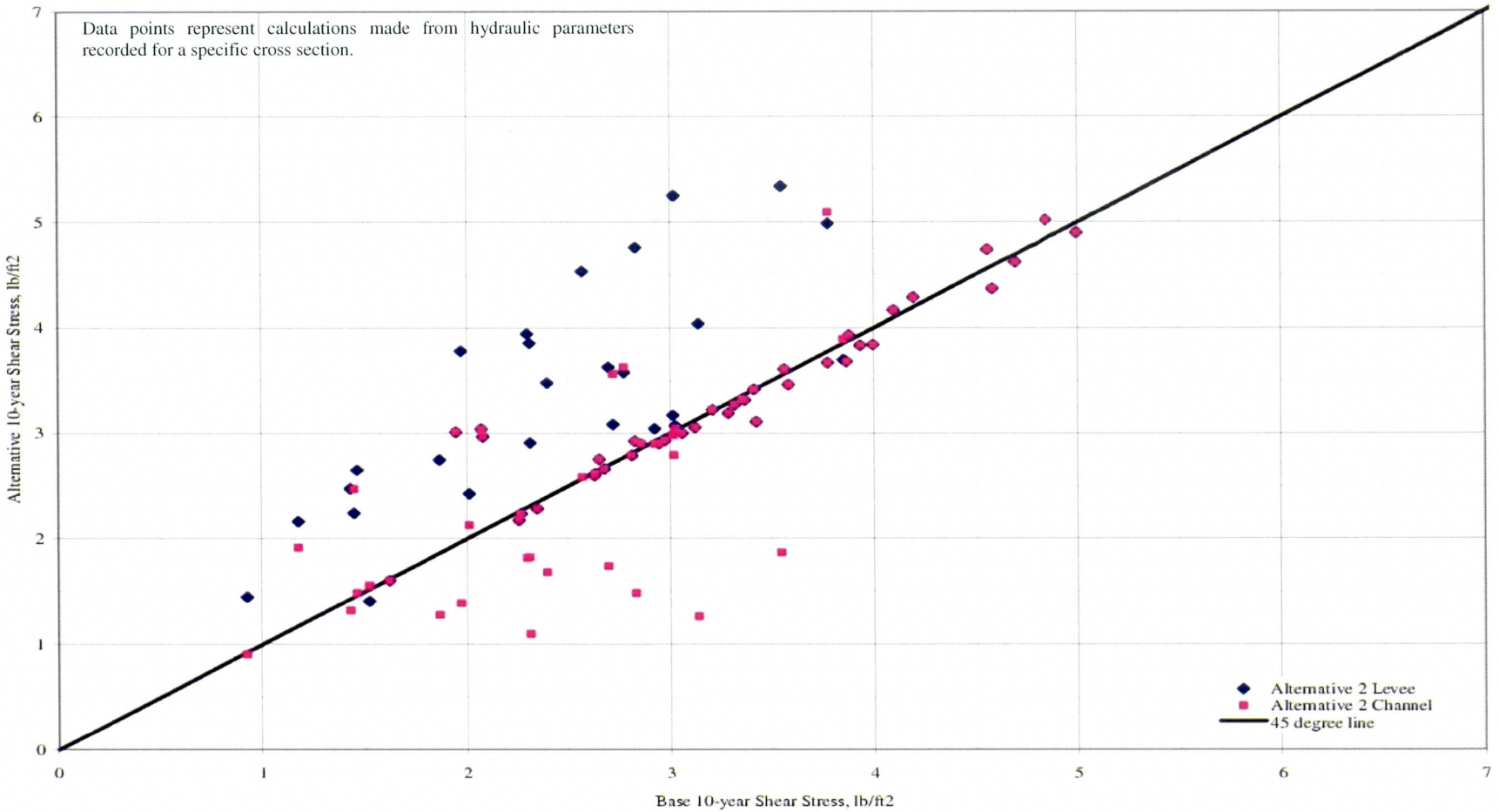


Figure 9.37 - Comparison of Shear Stress for New River Alternative 2

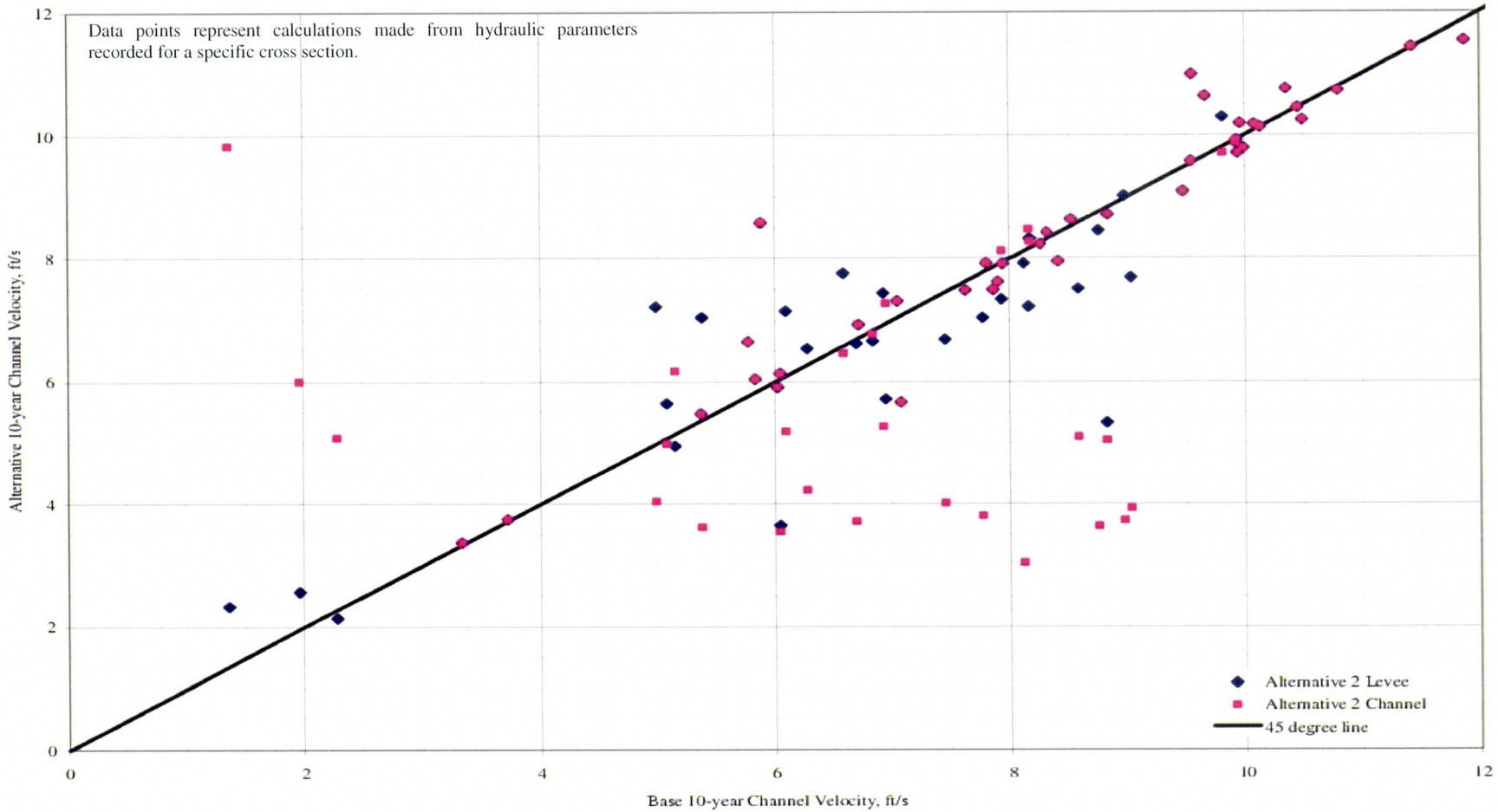


Figure 9.38 - Comparison of Channel Velocity for New River Alternative 2

Figure 9.39 - Comparison of Channel Hydraulic Depth for New River Alternative 2

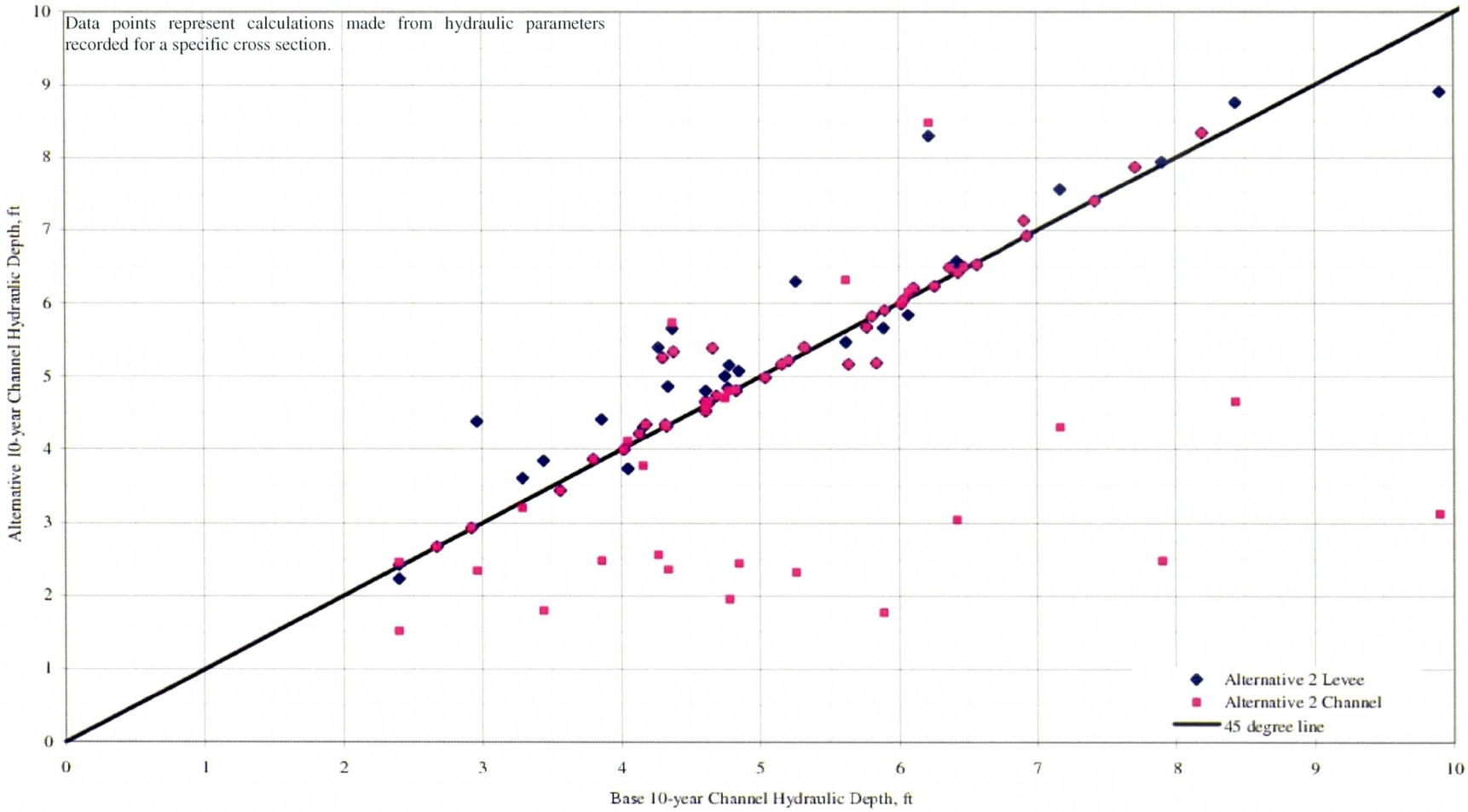


Figure 9.39 - Comparison of Channel Hydraulic Depth for New River Alternative 2

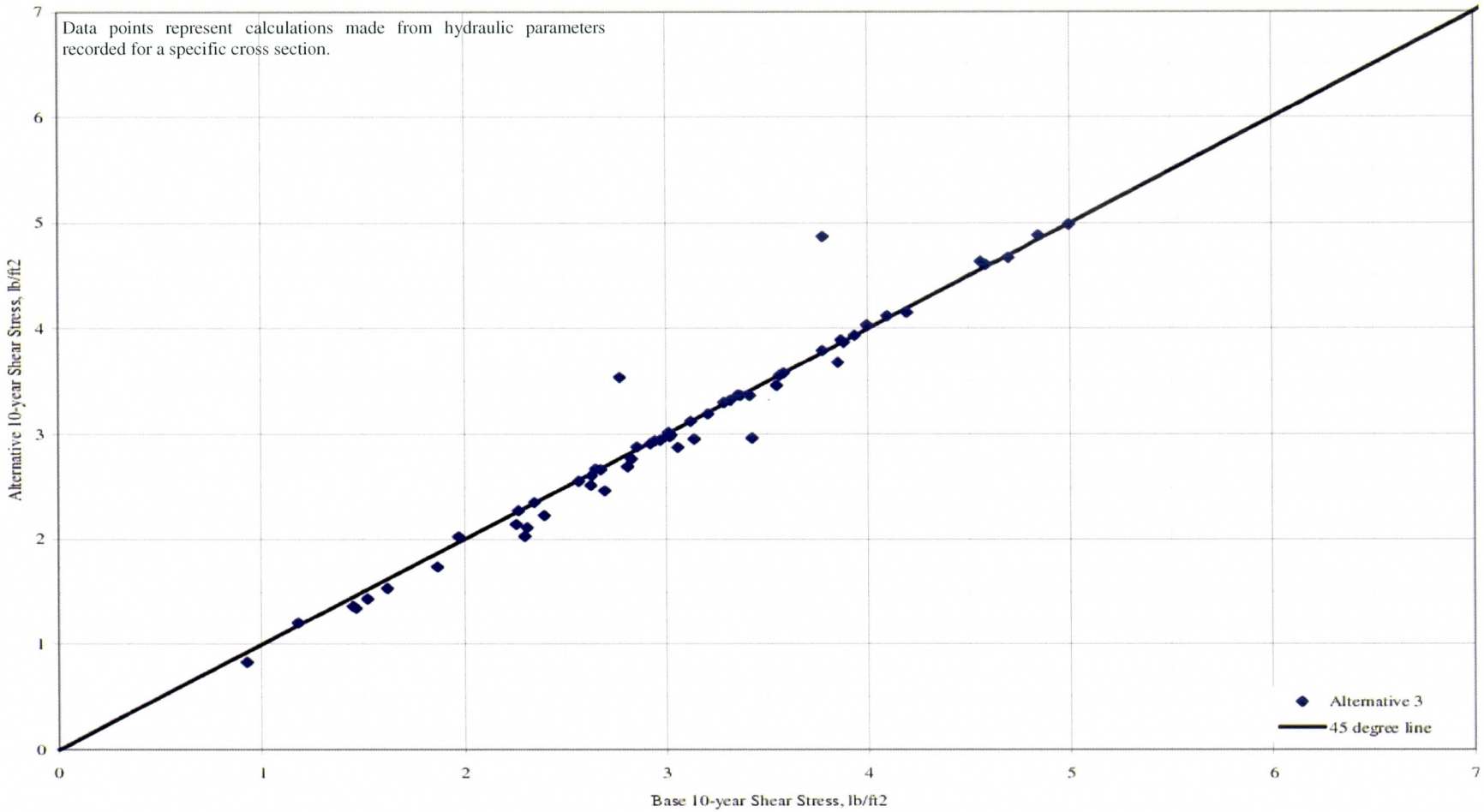


Figure 9.40 - Comparison of Shear Stress for New River Alternative 3

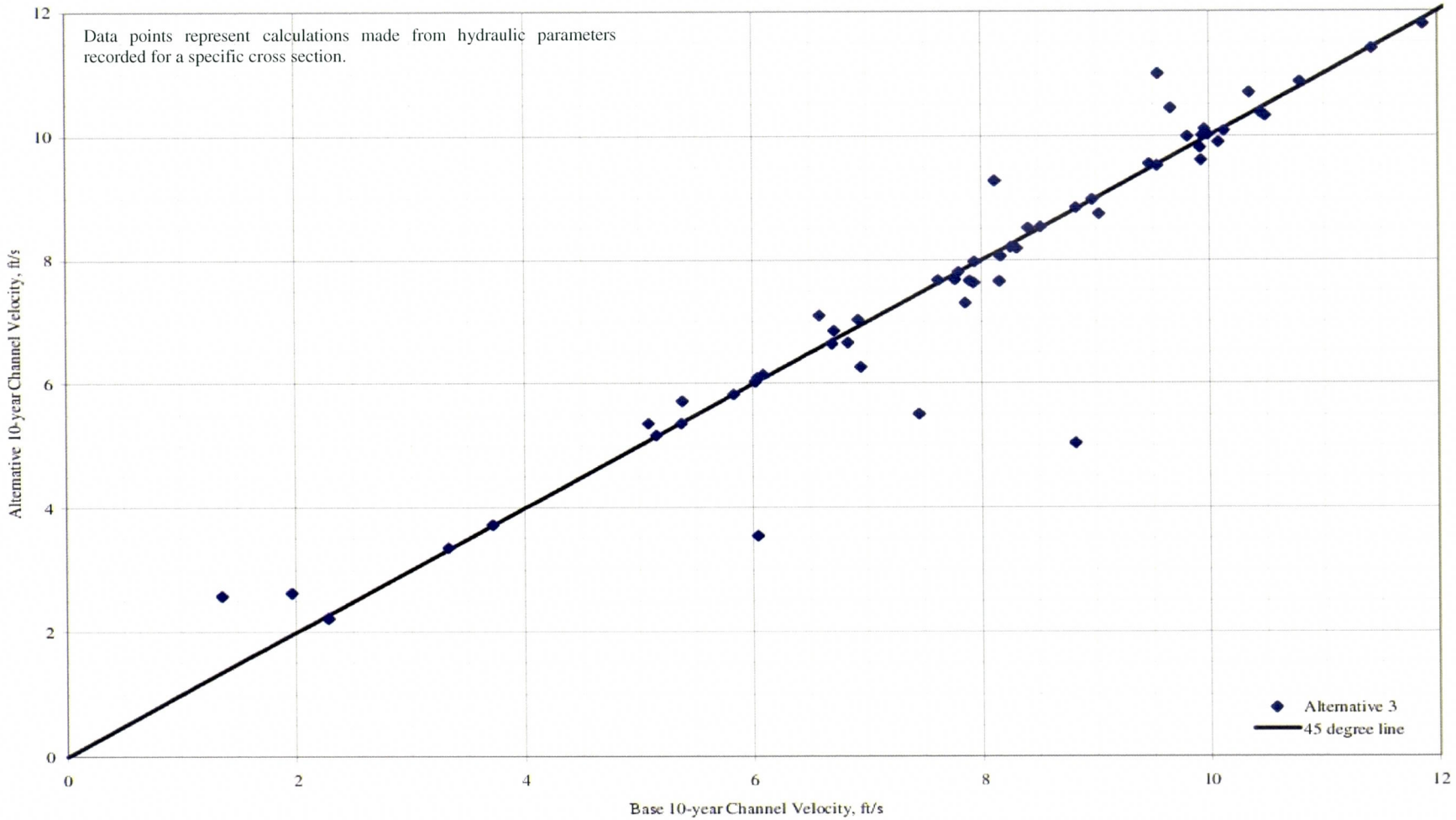


Figure 9.41 - Comparison of Channel Velocity for New River Alternative 3

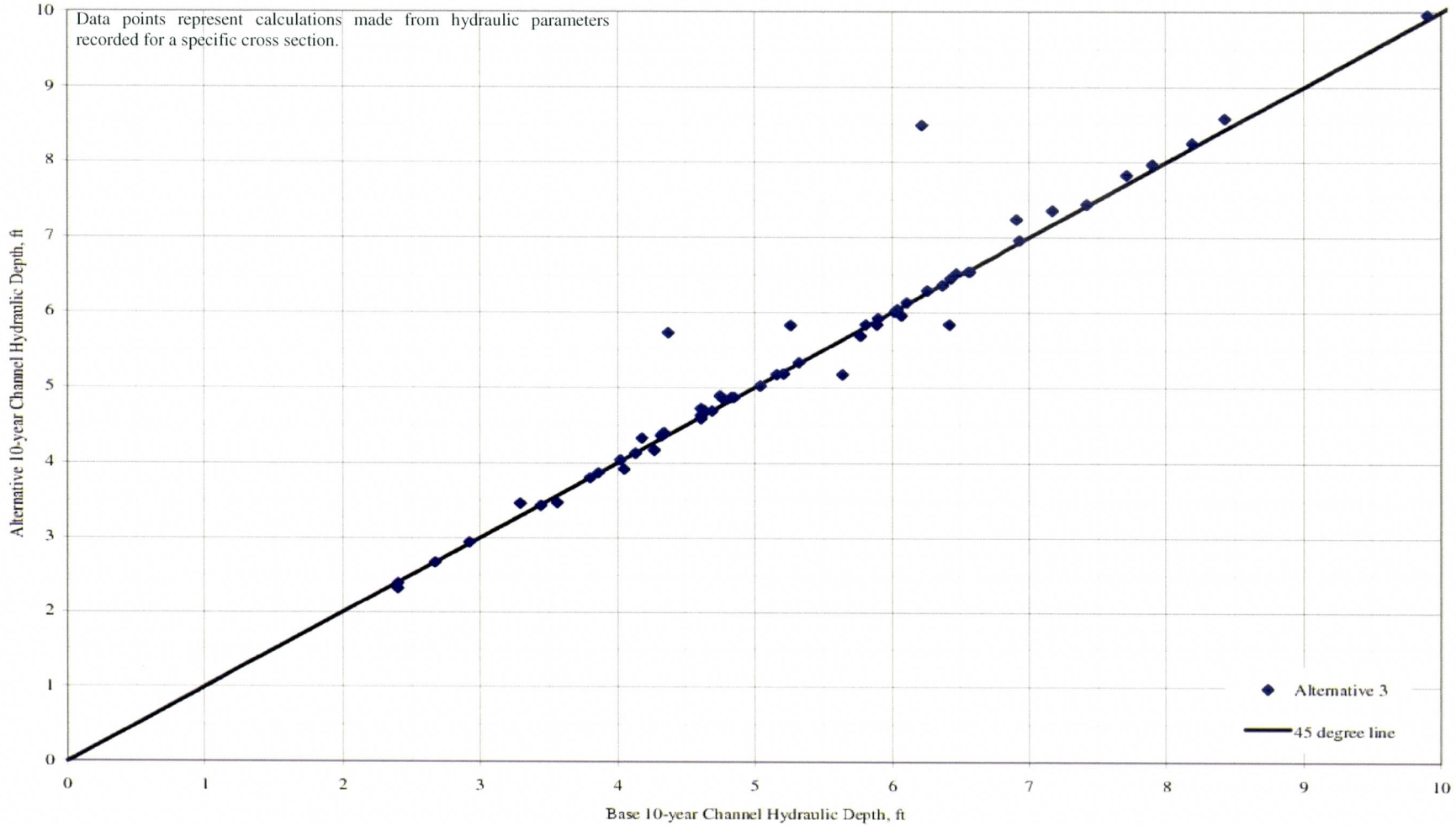


Figure 9.42 - Comparison of Channel Hydraulic Depth for New River Alternative 3

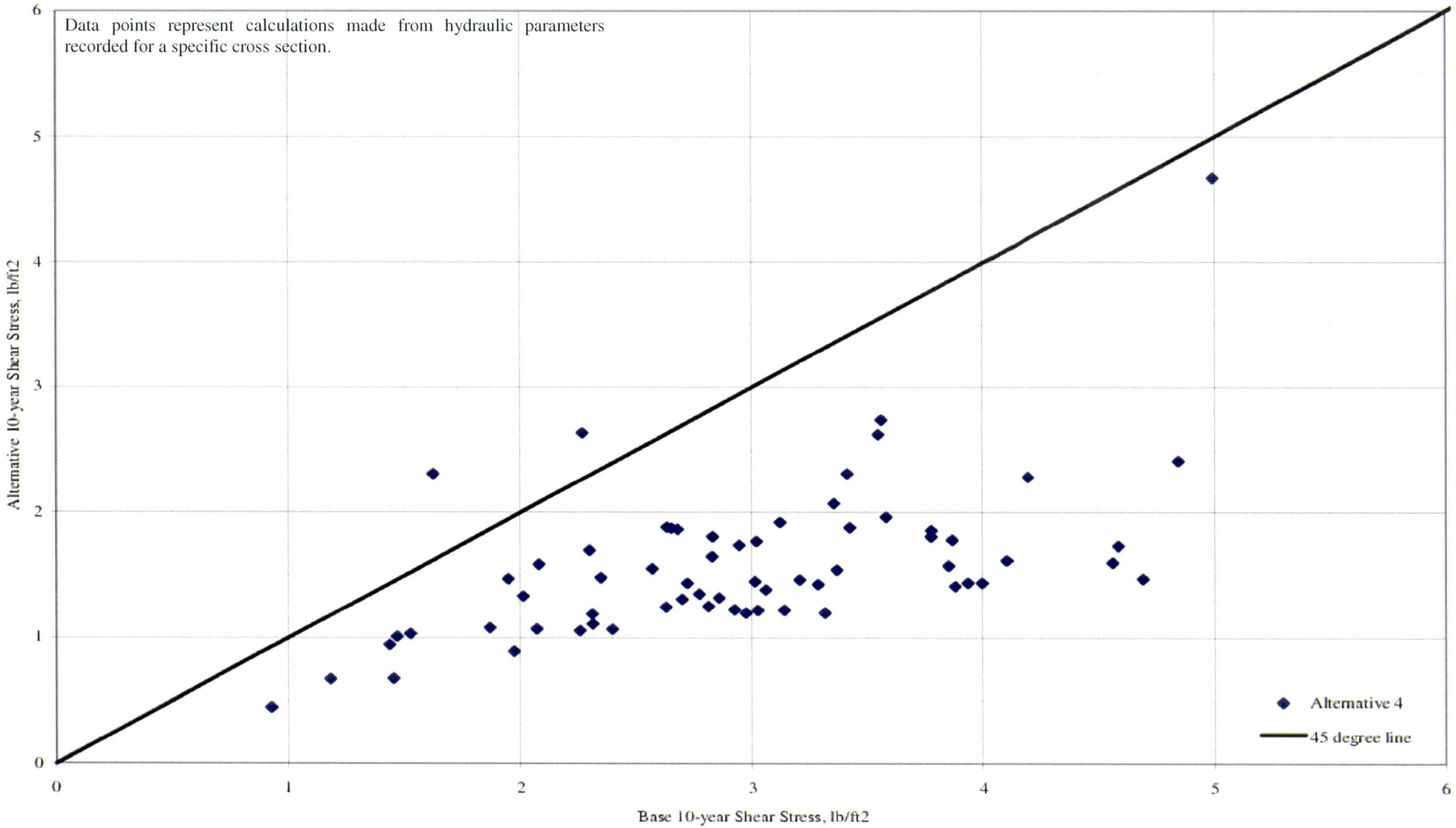


Figure 9.43 - Comparison of Shear Stress for New River Alternative 4

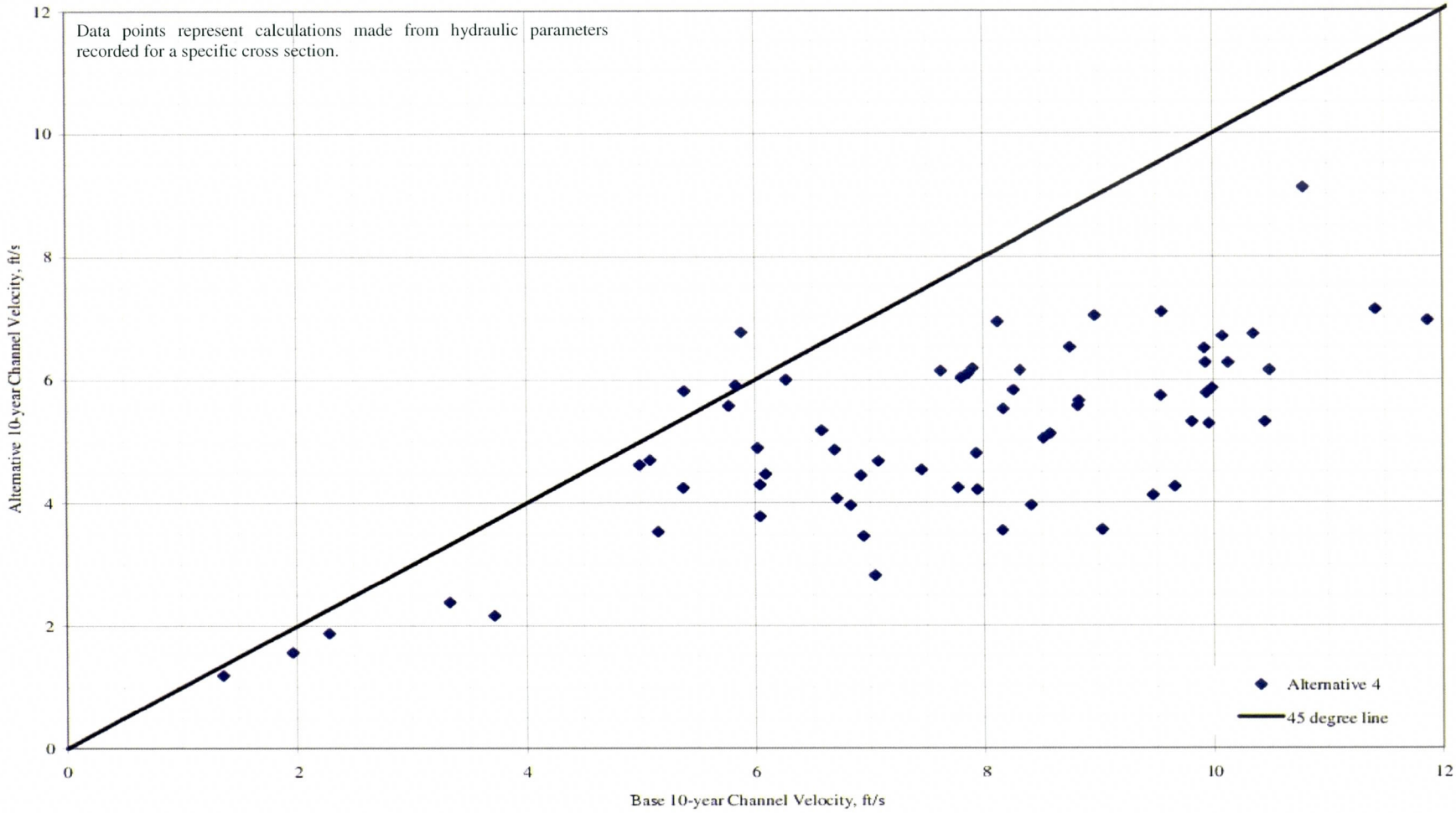


Figure 9.44 - Comparison of Channel Velocity for New River Alternative 4

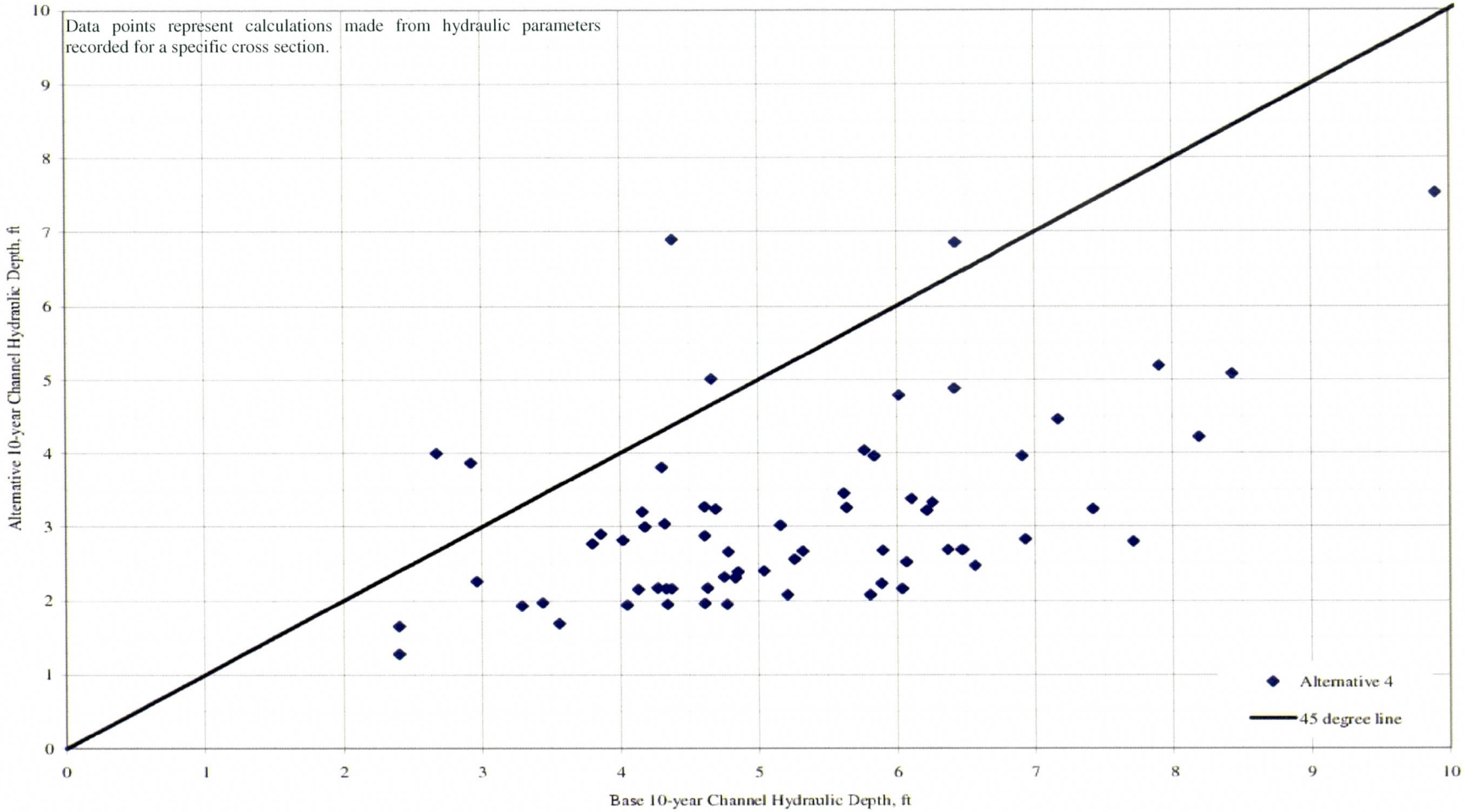


Figure 9.45 - Comparison of Channel Hydraulic Depth for New River Alternative 4

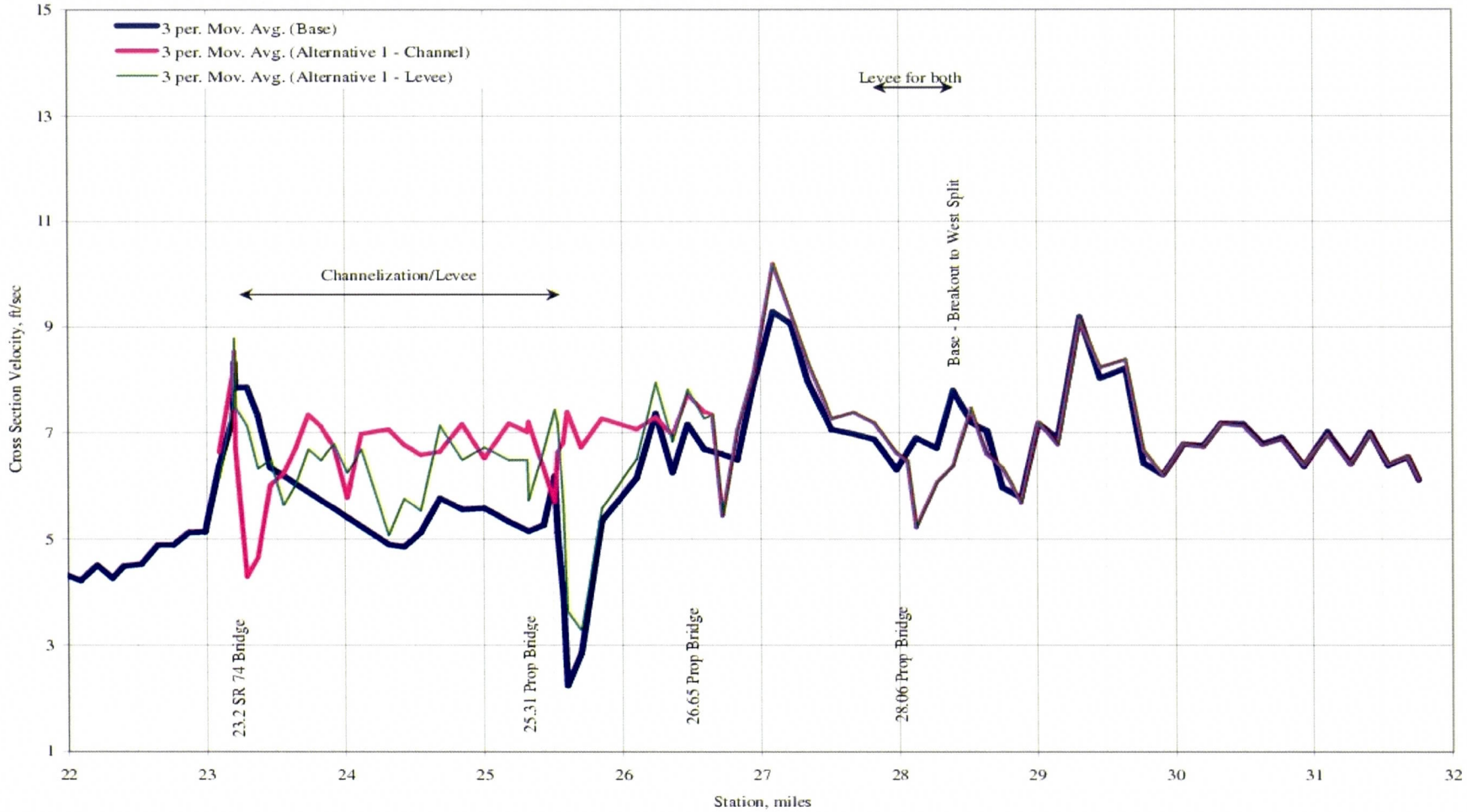


Figure 9.46 - New River - Comparison of Alternative 1 Velocity - 100-year Event

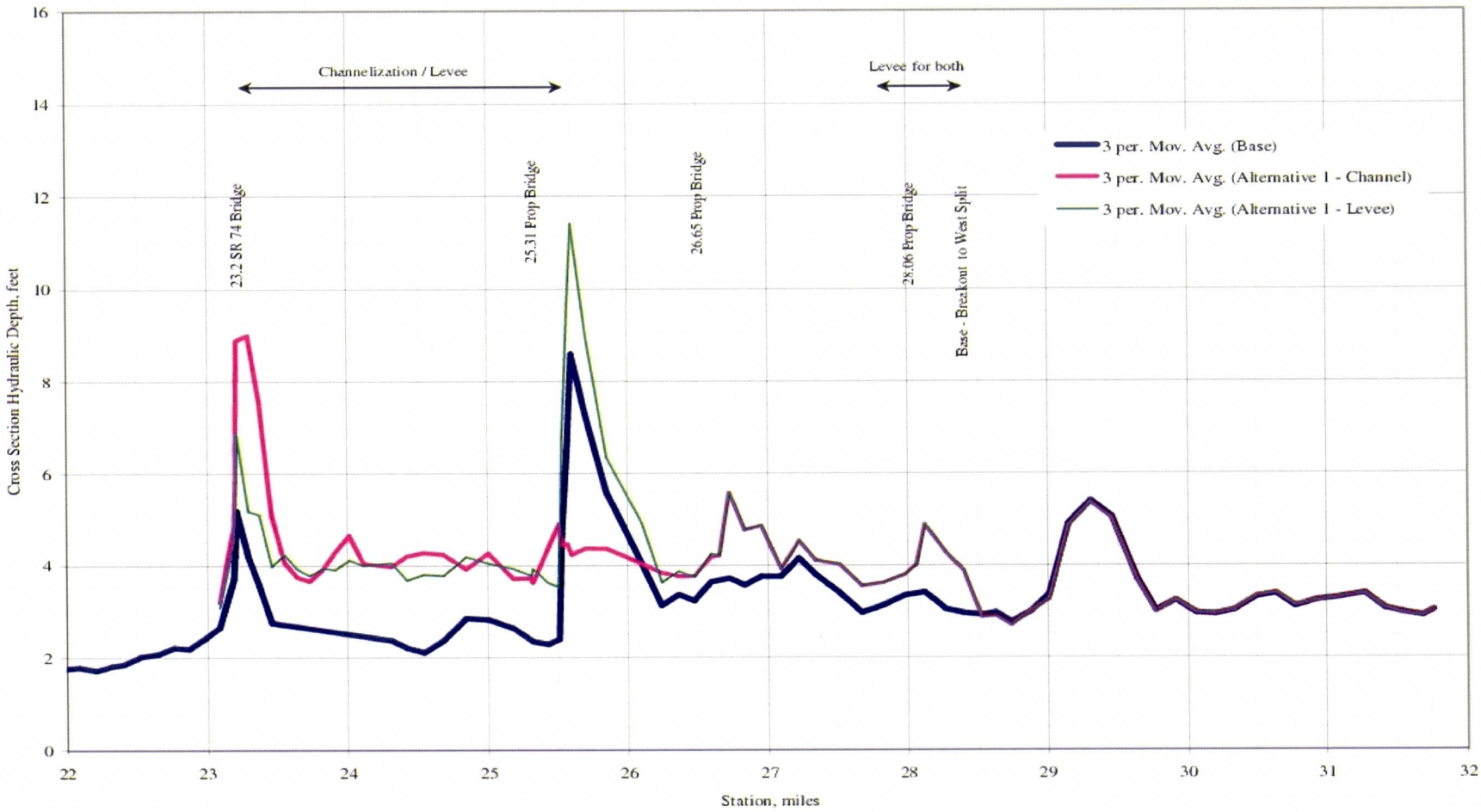


Figure 9.47 - New River - Comparison of Alternative 1 Hydraulic Depth, 100-year Event

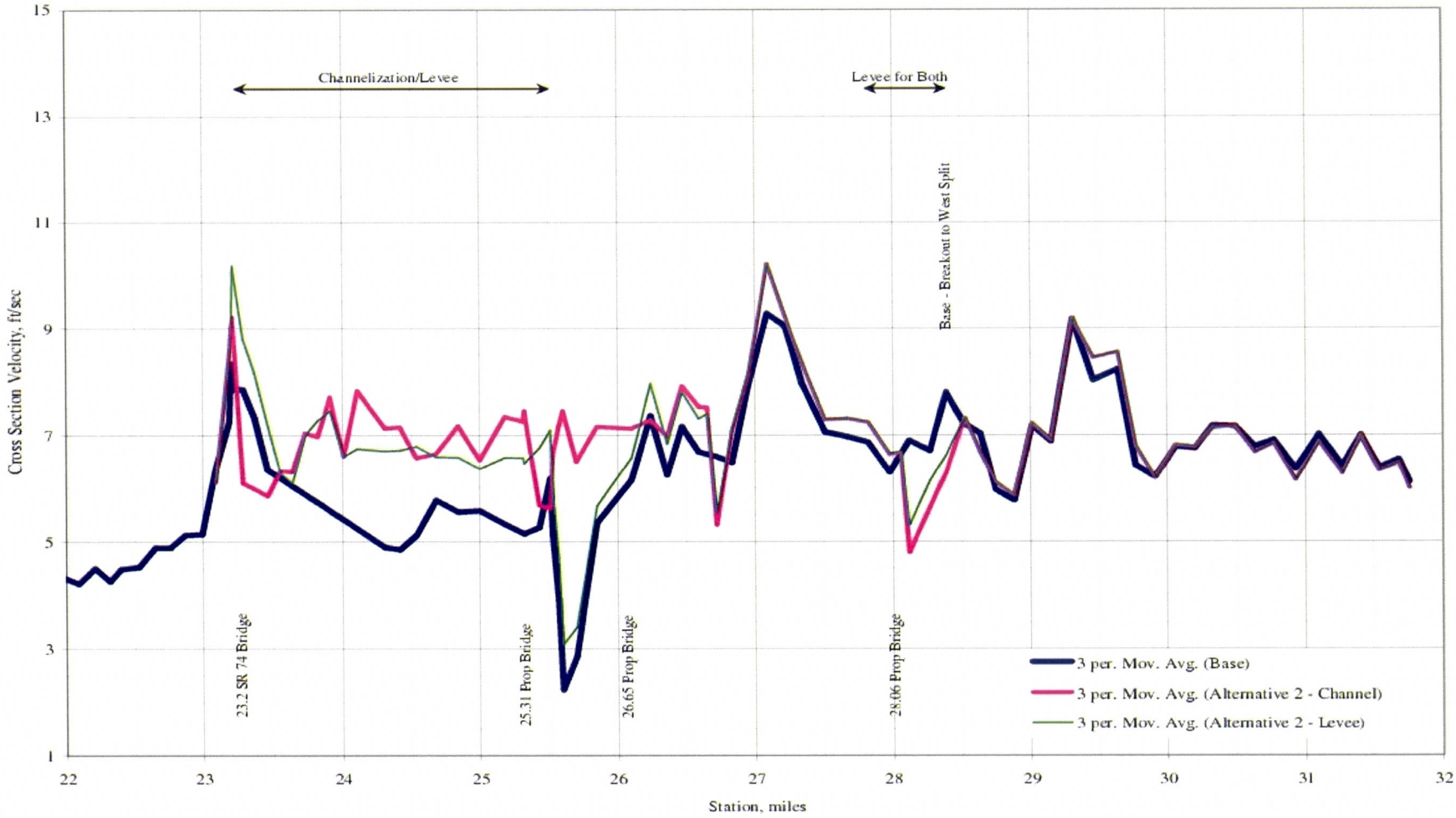


Figure 9.48 - New River - Comparison of Alternative 2 Velocity - 100-year Event

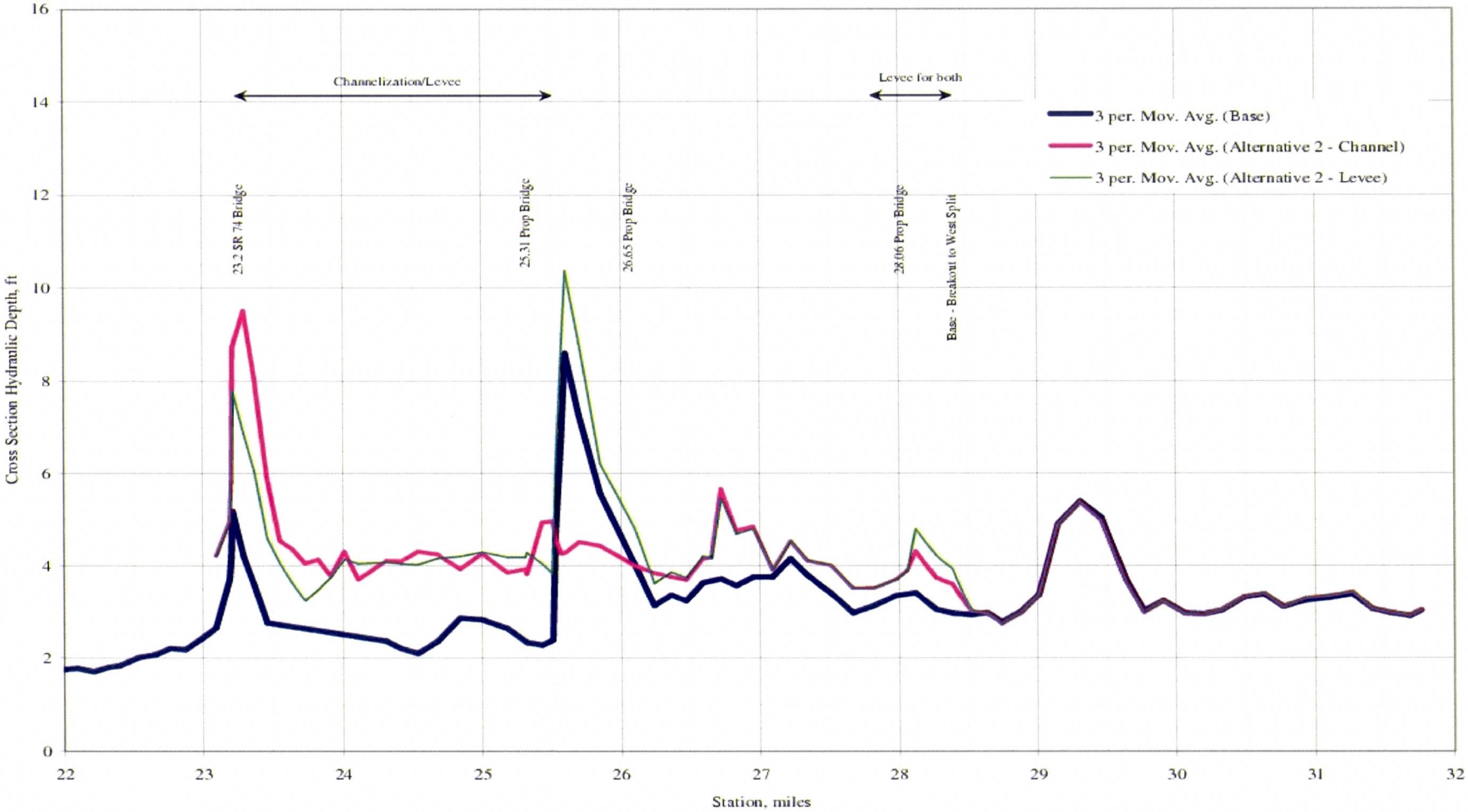


Figure 9.49 - New River - Comparison of Alternative 2 Hydraulic Depth - 100-year Event

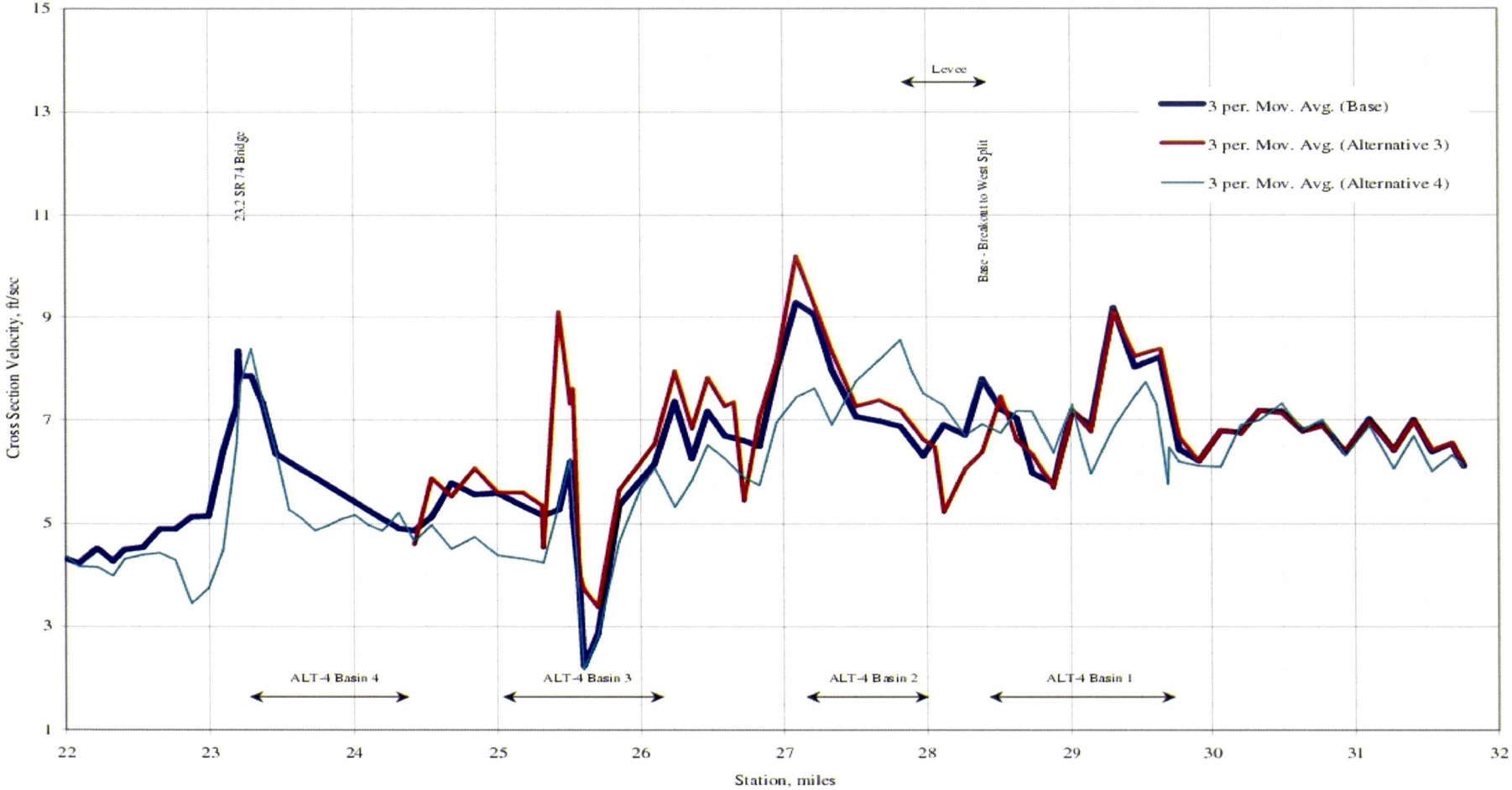


Figure 9.50 - New River - Comparison of Alternative 3 and 4 Velocity - 100-year Event

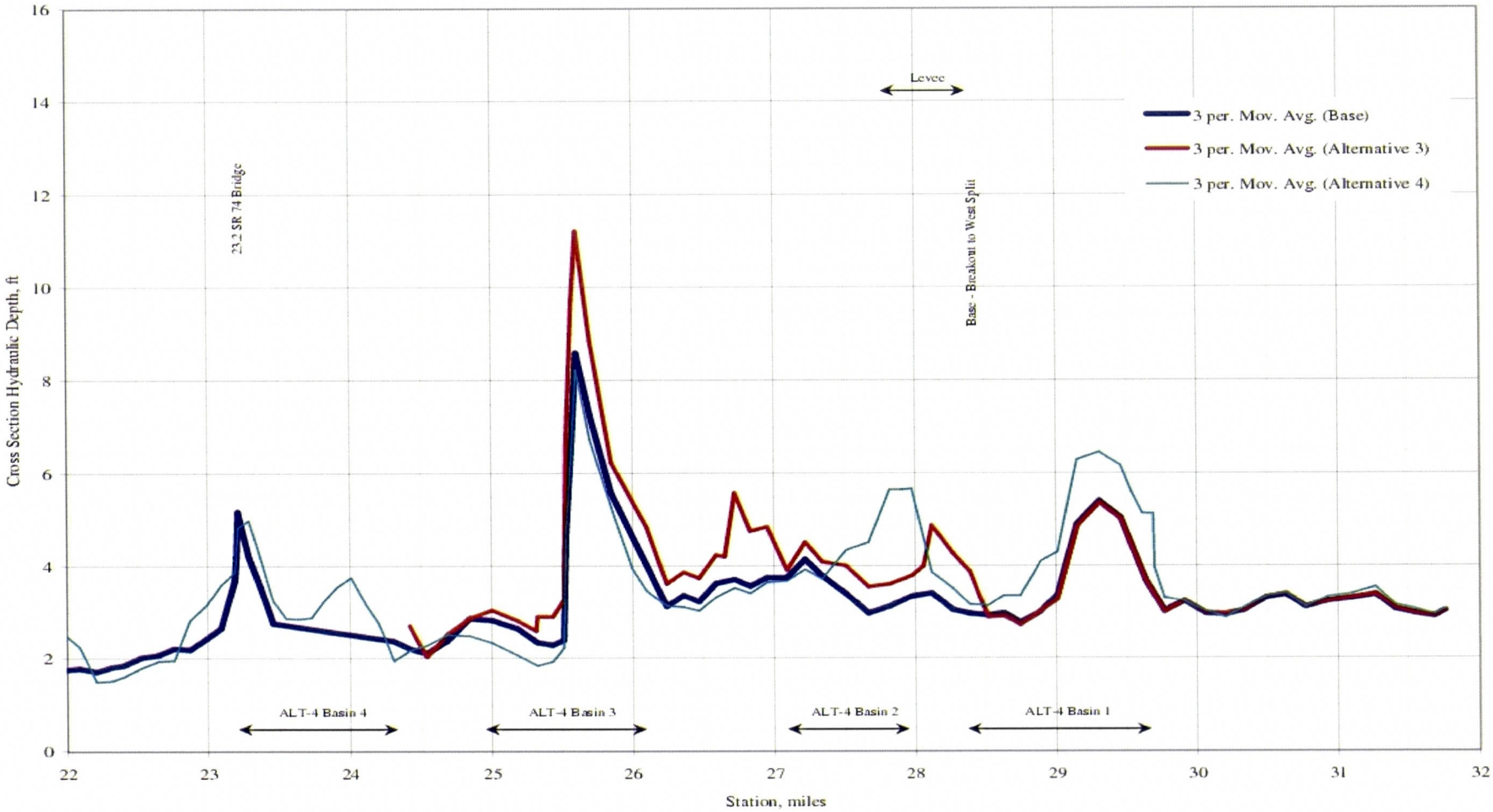


Figure 9.51 - New River - Comparison of Alternative 3 and 4 Hydraulic Depth - 100-year Event

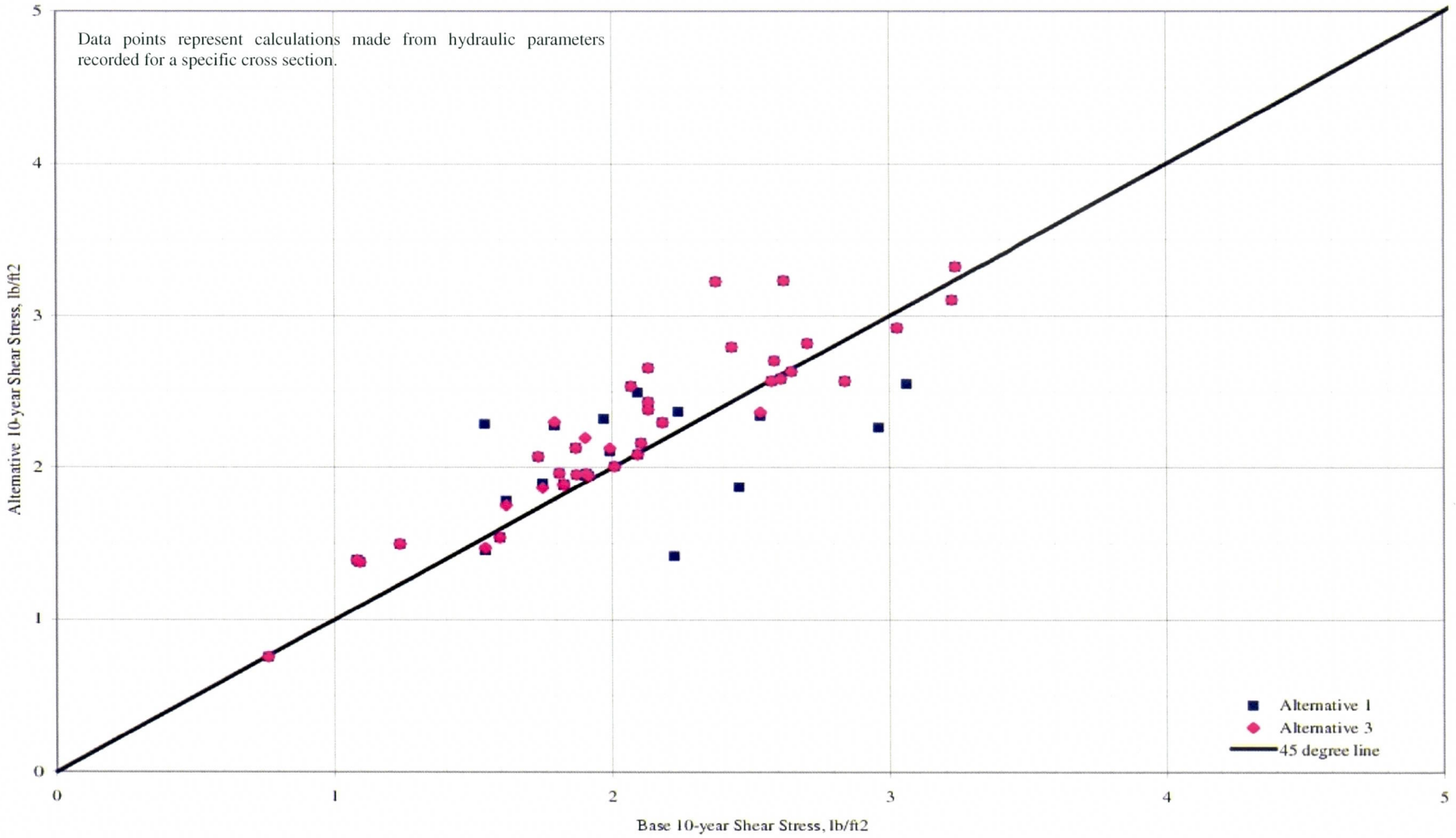


Figure 9.52 - Comparison of Shear Stress for Sweat Canyon Wash Alternatives

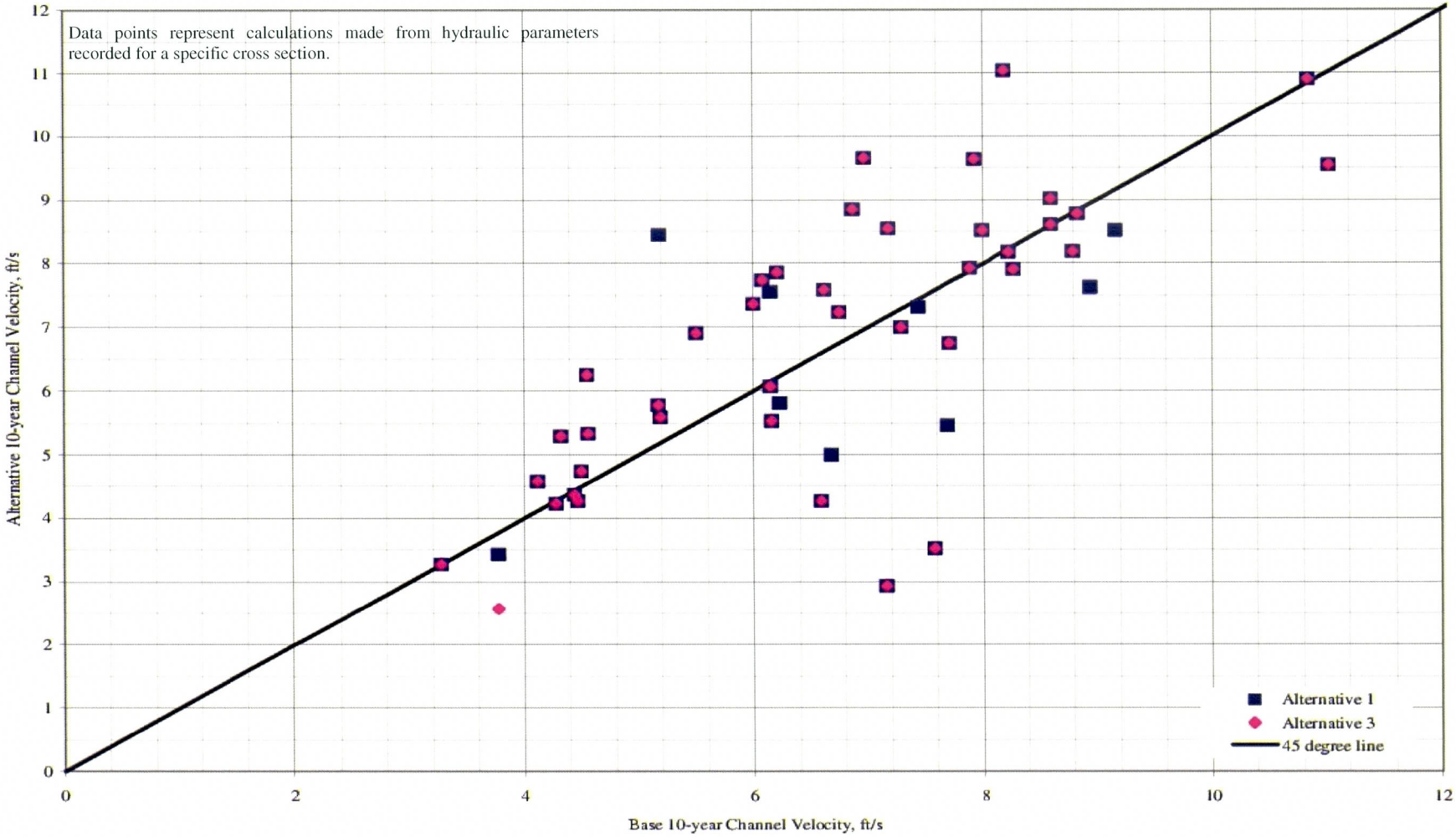


Figure 9.53 - Comparison of Channel Velocity for Sweat Canyon Wash Alternatives

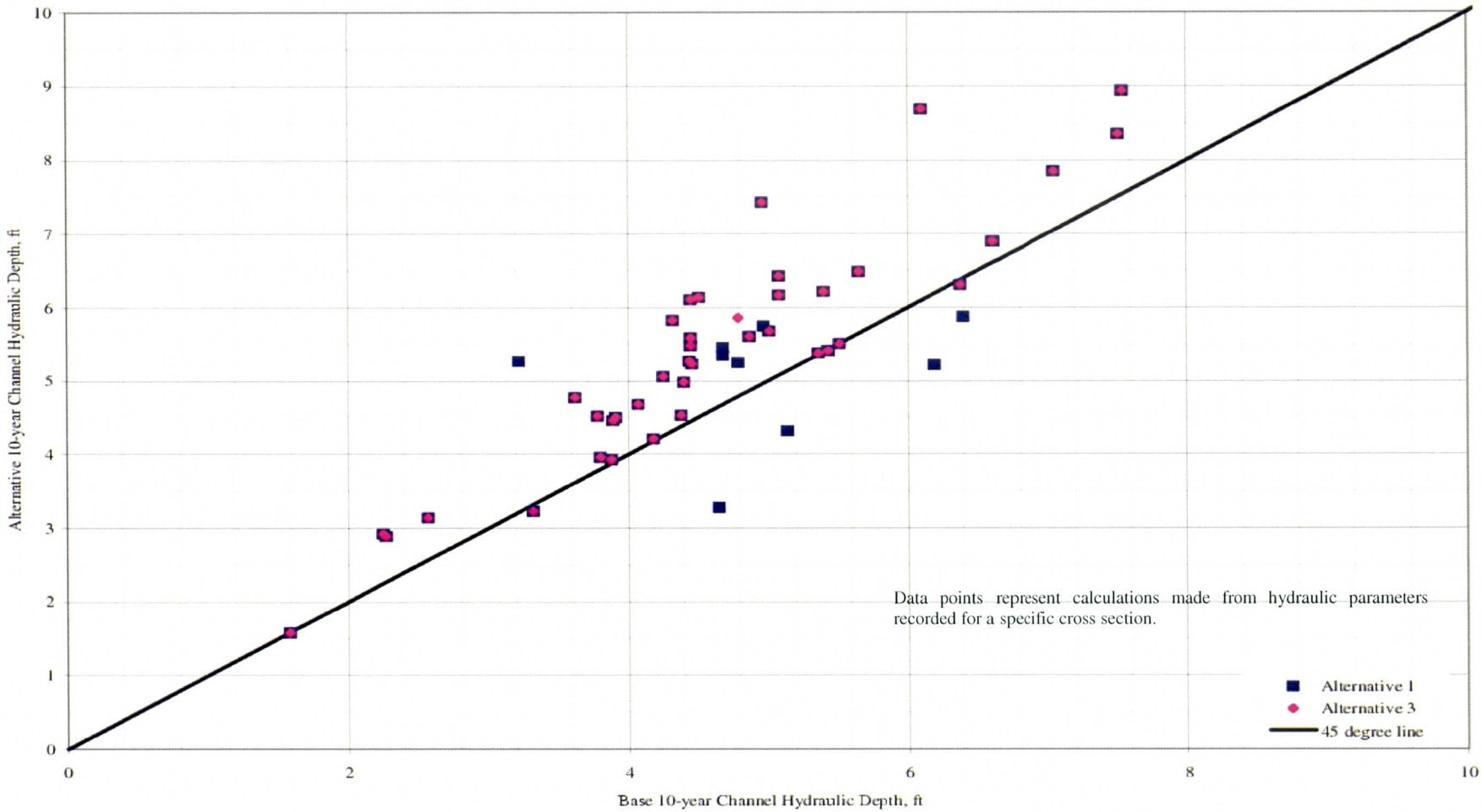


Figure 9.54 - Comparison of Channel Hydraulic Depth for Sweat Canyon Wash Alternatives

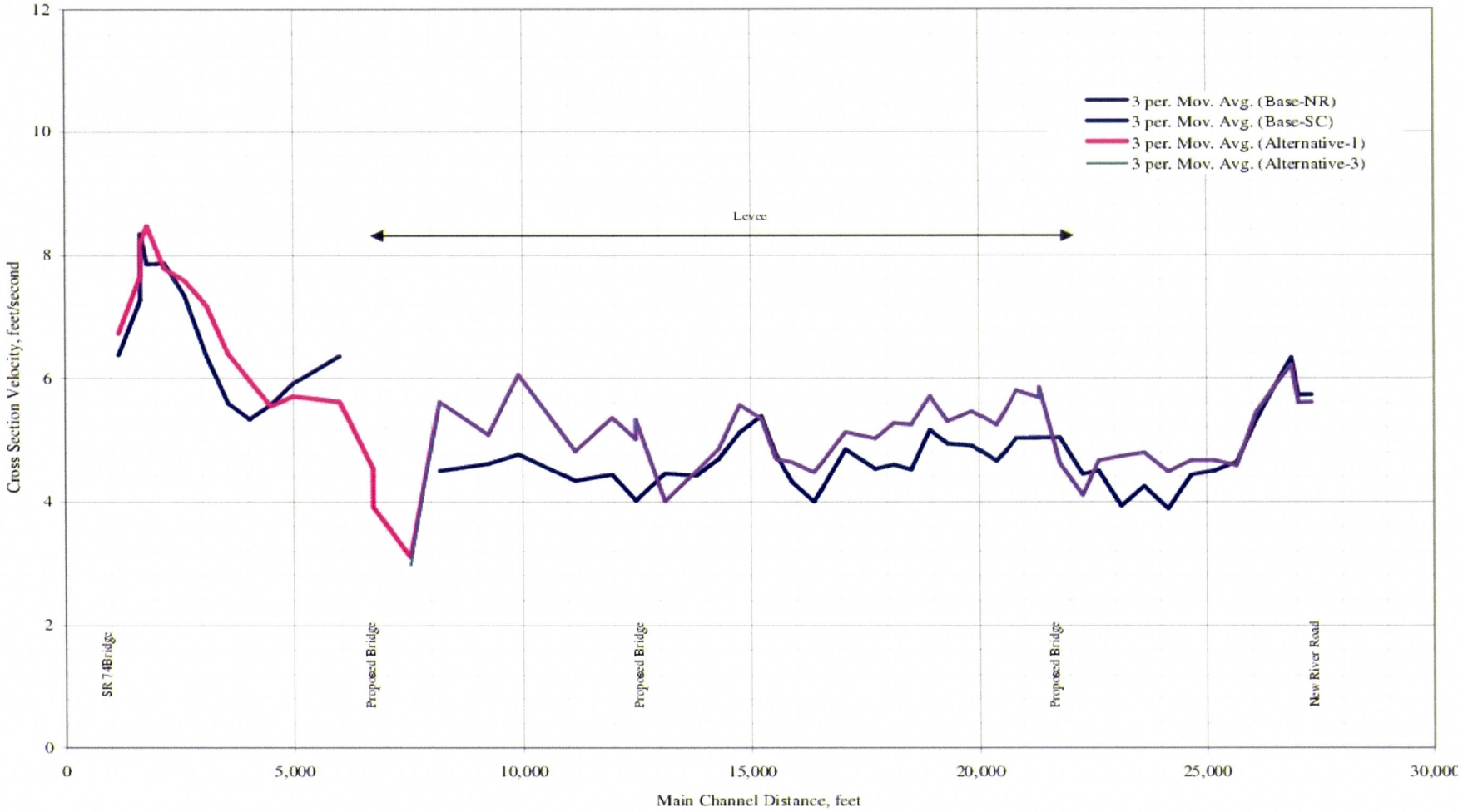


Figure 9.55 - Sweat Canyon Wash - Comparison of Velocity - 100-Year Event

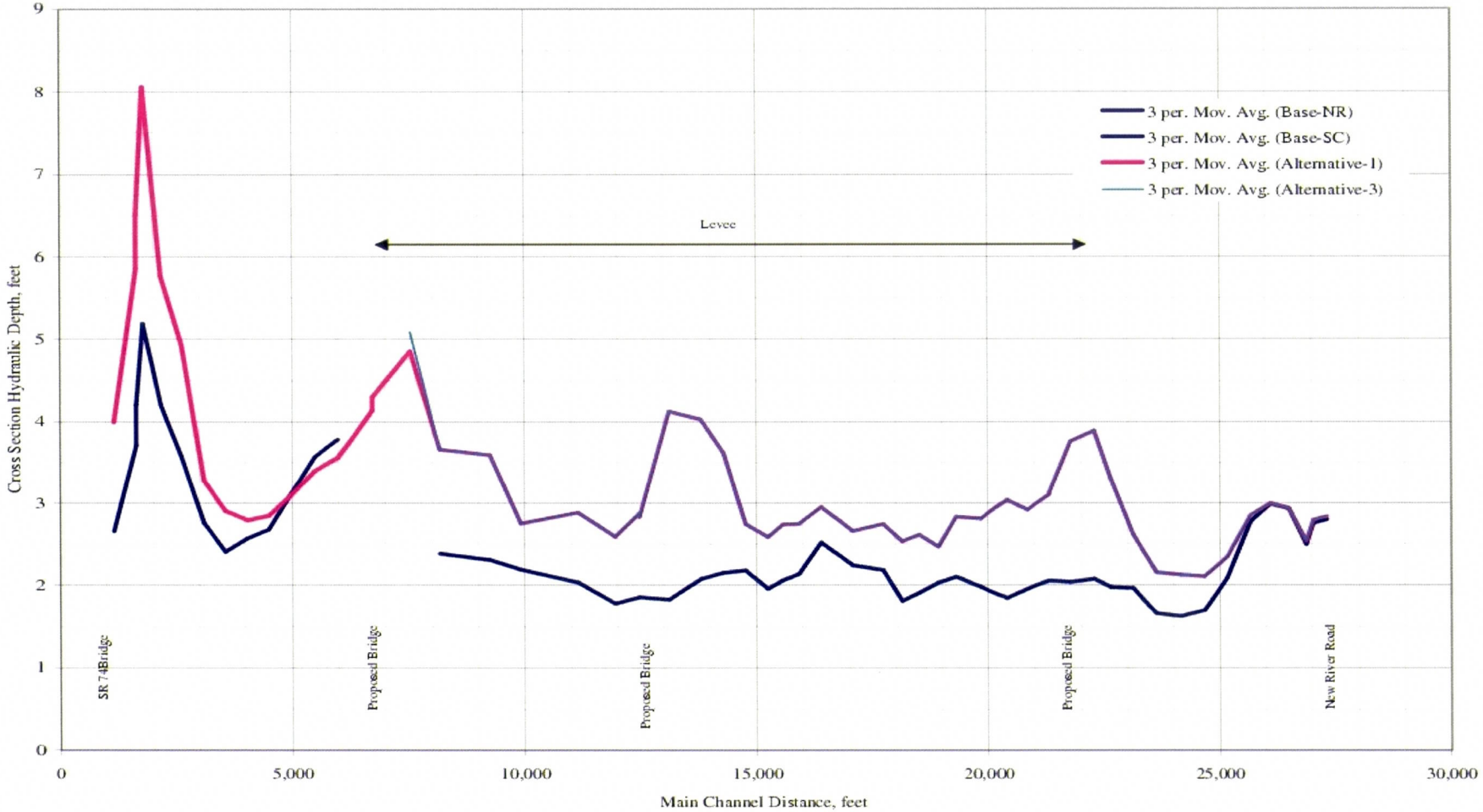


Figure 9.56 - Sweat Canyon Wash - Comparison of Hydraulic Depth - 100-Year Event

9.4.3.3.2 Alternatives Located Between SR-74 and New River Dam Ponding Limits

Due to the distributary/braided nature of New River downstream of SR-74 Highway FLO-2D is utilized to model the effects of Alternatives 1, 2, and 3 through this reach. The following sections discuss the FLO-2D alternative model development methods and assumptions, the peak discharges, and model results. Also included are model based discussions on land reclamation benefits, hydraulic pros and cons, and design limitations.

9.4.3.3.3 Model Grid Development

Alternatives 1 and 2

Hydraulic modeling of New River downstream of SR-74 Highway for Alternatives 1 and 2 was accomplished using FLO-2D. The base model used for the analysis is the extension model (See Section 6.5 for a discussion of this model). No structural features were proposed for the reach downstream of SR-74 Highway. Modeling was performed to determine potential impacts that may result due to the proposed features upstream as well as to evaluate potential impacts due to the proposed Loop 303L crossing of the New River. Modifications to the base model were therefore limited to hydrologic input at the upstream boundary and to reflect the 303L roadway/bridge geometry. The 303L alignment was coded in by updating the grid cell elevations based on a GIS shape file representing the alignment and the published roadway profiles in ADOT (2006). The .TOP file generated by FLO-2D GDS is provided on the enclosed CD-ROM in Appendix F. The FPLAIN.DAT files list the cell elevations used by the models.

Alternative 3

The Alternative-3 FLO-2D model was developed in two parts using 50-foot cell size. Under this alternative, natural mixing of flow is allowed upstream of the SR-74 Highway. This zone was designated as the 'upper segment model,' and the zone downstream of the SR-74 Highway was designated as the 'lower segment model.' The FLO-2D Phase-I existing condition model grid was used to represent the upper segment, and generate distributed flow hydrographs in the cells that make up the 6,200 feet long floodplain cross section (Plate 6.1 and 6.2). The inflow hydrographs for the upper segment model was input at locations where the proposed alternative levees terminate in the one-dimensional model. The distributed hydrographs (output from the upper segment model) at the floodplain cross section were used as input to the grid downstream of the SR-74 Highway to represent the lower segment. The grid downstream of the SR-74 Highway was the same as the one used for Alternatives 1 and 2, with the 303L alignment coded in. The .TOP files for the two model segments generated by FLO-2D GDS is provided on the enclosed CD-ROM in Appendix F. The FPLAIN.DAT files list the cell elevations used by the models. Results from the upper and the lower segment model grids were merged to create one work map for Alternative 3.

9.4.3.3.4 Model Input

Control Parameters

The alternative FLO-2D models were executed in floodplain mode using the same control parameters discussed in Section 6.2.2.1. The reader is referred to that section of this

report for detailed discussion on the parameters controlling the model stability and accuracy.

Roughness Coefficients

Manning's n-values established for the Phase-I existing condition model, and that for the existing condition extension model downstream of the SR-74 Highway were used in the alternative models. Final calibrated n-values are coded in the FPLAIN.DAT file, and can be found in the folders for each of the three models in the enclosed CD-ROM in Appendix F. A limiting Froude number of 0.9 was used to prevent the flow regime from going supercritical. A shallow flow n-value of 0.2 is used. When flow depths are greater than 0.2 feet but less than 0.5 feet, the shallow overland flow n-value was decreased by 50 percent (FLO-2D, 2006). A limiting Froude number of 0.9 was used to prevent the flow regime from going supercritical. A shallow flow n-value of 0.2 is used. When flow depths are greater than 0.2 feet but less than 0.5 feet, the shallow overland flow n-value was decreased by 50 percent (FLO-2D, 2006).

Hydrographs for the Alternative Models

The inflow hydrographs at the upstream boundary of the three FLO-2D alternative models came from the Phase-II alternative HEC-1 hydrologic models. Table 9.19 lists the location of the grid cells, grid cell numbers, the corresponding HEC-1 model concentration points (C.P.s), and the hydrograph peak discharges for Alternative 1 and 2 models. Table 9.20 lists the same information for the Alternative 3 upper and lower segments models. A 15-minute (0.25-hour) time interval, and simulation time of 22 hours were used for consistency with the Phase-I models. The cell locations can be identified by opening the .TOP project file of the alternative models (included on the enclosed CD-ROM, Appendix F). Inflow hydrographs were coded into FLO-2D in the respective INFLOW.DAT input files. Figures 9.57 through 9.58 show the hydrographs listed in Table 9.19 for the Alternative 1 and 2 models. The hydrographs at the SR-74 Highway West and the East Bridge and at the Deadman Wash concentration points were distributed equally over the specified cells.

Table 9.19
Alternative 1 & 2 model inflow locations and HEC-1 concentration points

River/Wash	HEC-1 C.P.	Peak Discharge (cfs)
(1)	(2)	(3)
Alternative 1:		
New River	225	20,950
New River	200	28,340
Deadman Wash	C10Y	11,770
West Tributaries	CA1	120
West Tributaries	CB1	540
West Tributaries	CC1	330
West Tributaries	CD1	1,110
Alternative 2:		
New River	225	29,000
New River	200	1,200
Deadman Wash	C10Y	10,815
West Tributaries	CA1	120
West Tributaries	CB1	540
West Tributaries	CC1	330
West Tributaries	CD1	1,110

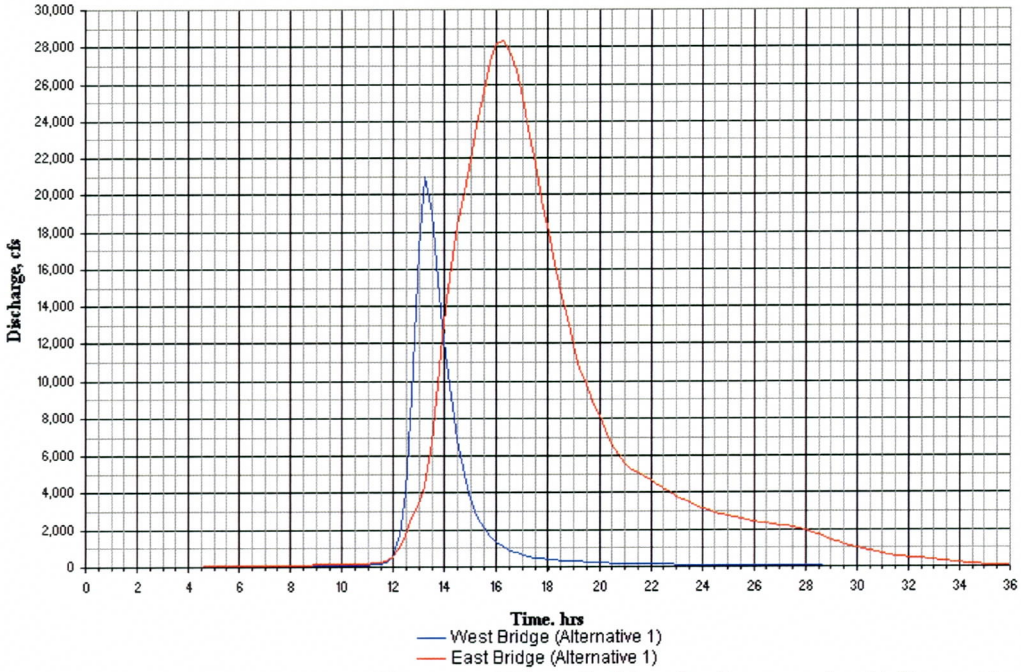


Figure 9.57 - SR-74 Highway West and East Bridge hydrographs (Alternative 1)

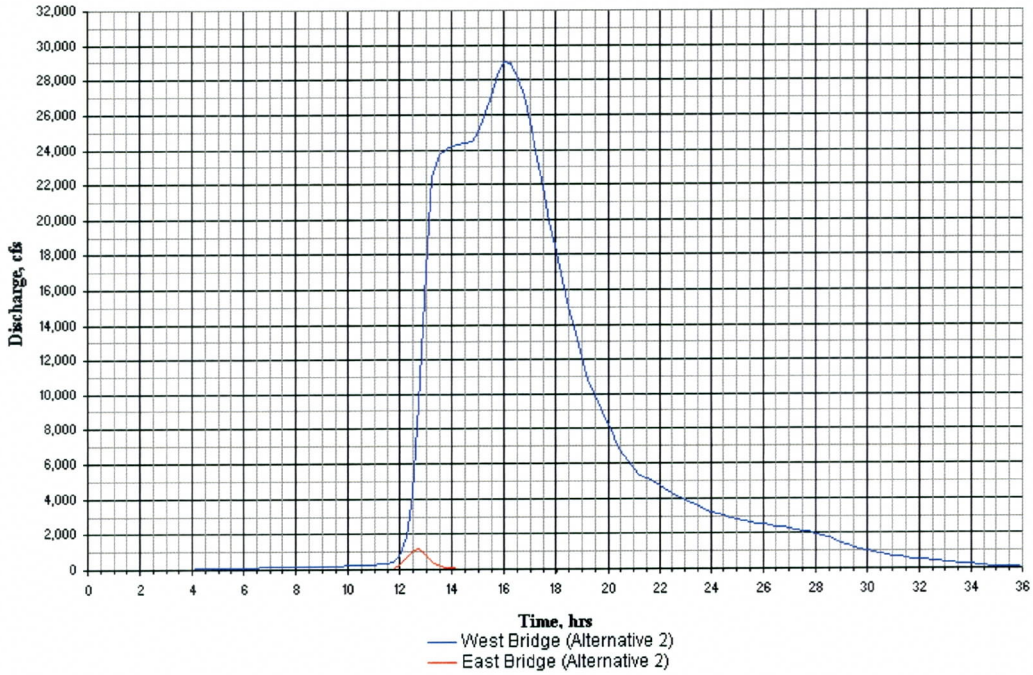


Figure 9.58 - SR-74 Highway West and East Bridge hydrographs (Alternative 2)

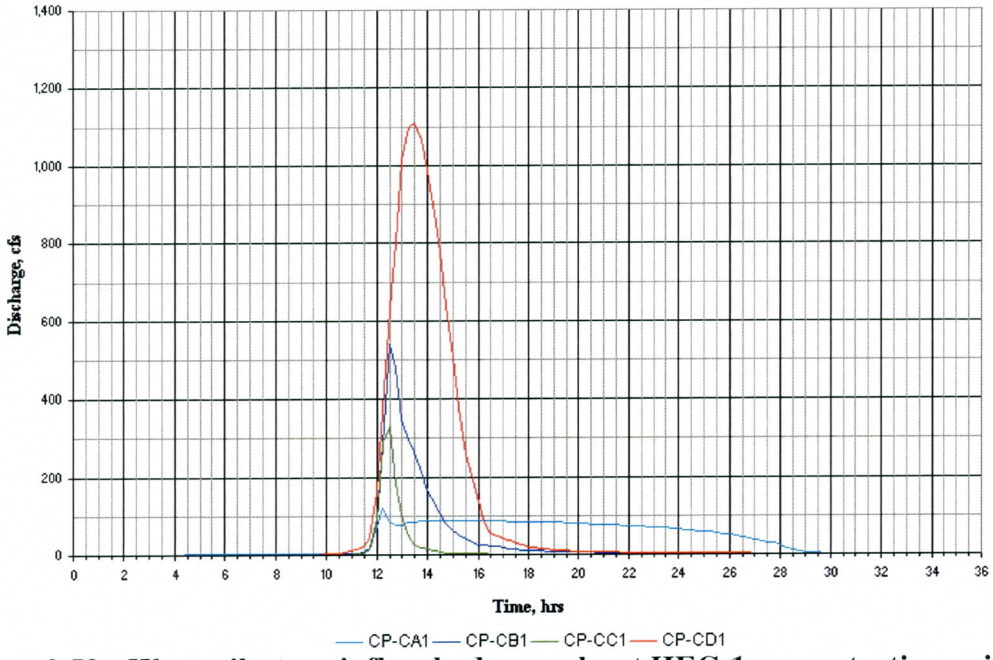


Figure 9.59 - West tributary inflow hydrographs at HEC-1 concentration points

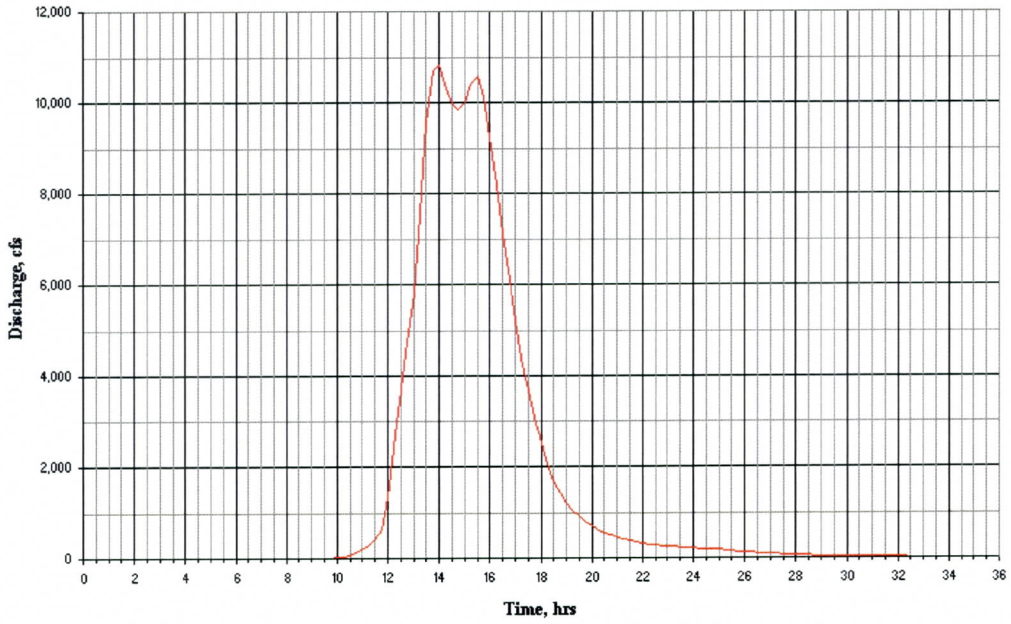


Figure 9.60 - Deadman Wash tributary inflow hydrograph at HEC-1 concentration point

Figures 9.60 through 9.63 show the hydrographs listed in Table 9.20 for Alternative 3 upper and lower segment models. Only the major inflow hydrographs at the 6,200 feet long floodplain cross section cells representing the two SR-74 Highway bridge openings are shown for the alternative 3 lower segment model. The location of the upper segment inflow hydrographs at C.P. 215 (in the Sweat Canyon Wash), and C.P 190 (in the New River main stem) were introduced at the grid cells near the Upper New River HEC-RAS main stem River Mile 24.11 where the proposed alternative levees (See HEC-RAS model for Alternative 3) from upstream terminate and natural flow mixing is allowed upstream of the SR-74 Highway. The Deadman Wash and the West Tributary hydrographs are the same for all three alternative models except the West Tributary hydrographs at the HEC-1 concentration points CE1 and CF1 upstream of the SR-74 Highway which were only applicable to the Alternative 3 upper segment model.

Table 9.20
Alternative 3 model inflow locations and HEC-1 concentration points

River/Wash	HEC-1 C.P.	Peak Discharge (cfs)
(1)	(2)	(3)
Upper Segment:		
Sweat Canyon	215	20,610
New River	190	28,450
West Tributaries	CF1	490
West Tributaries	CE1	450
West Tributaries	CD1	1,110
Lower Segment:		
New River	Distributed flow at SR-74 Highway from upper segment model	32,360
Deadman Wash	C10Y	11,770
West Tributaries	CA1	120
West Tributaries	CB1	540
West Tributaries	CC1	330
West Tributaries	CD1	1,110

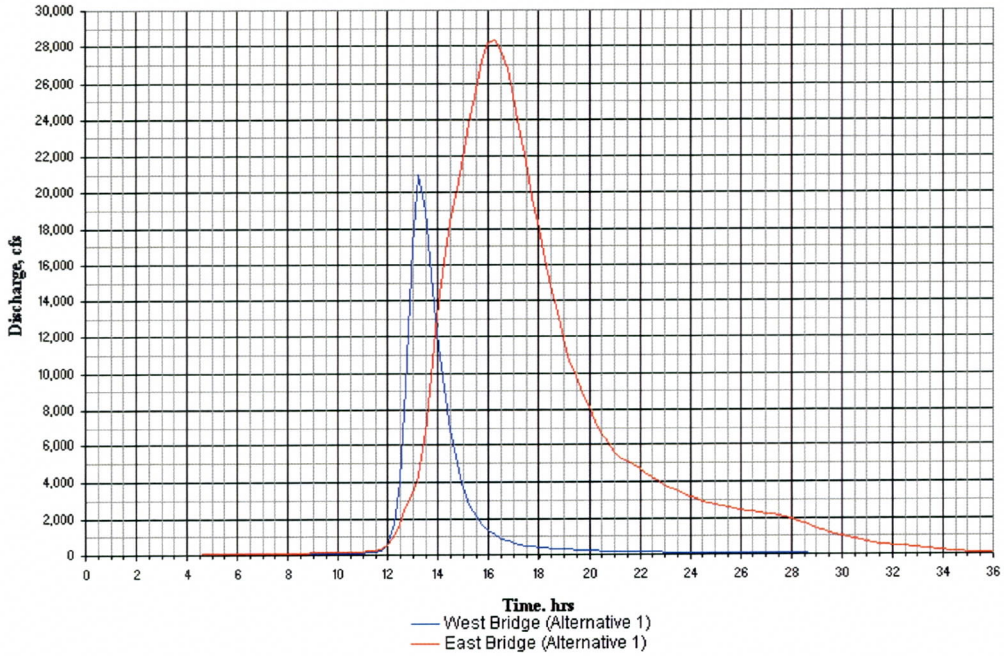


Figure 9.61 - Upper segment model inflow hydrographs (Alternative 3)

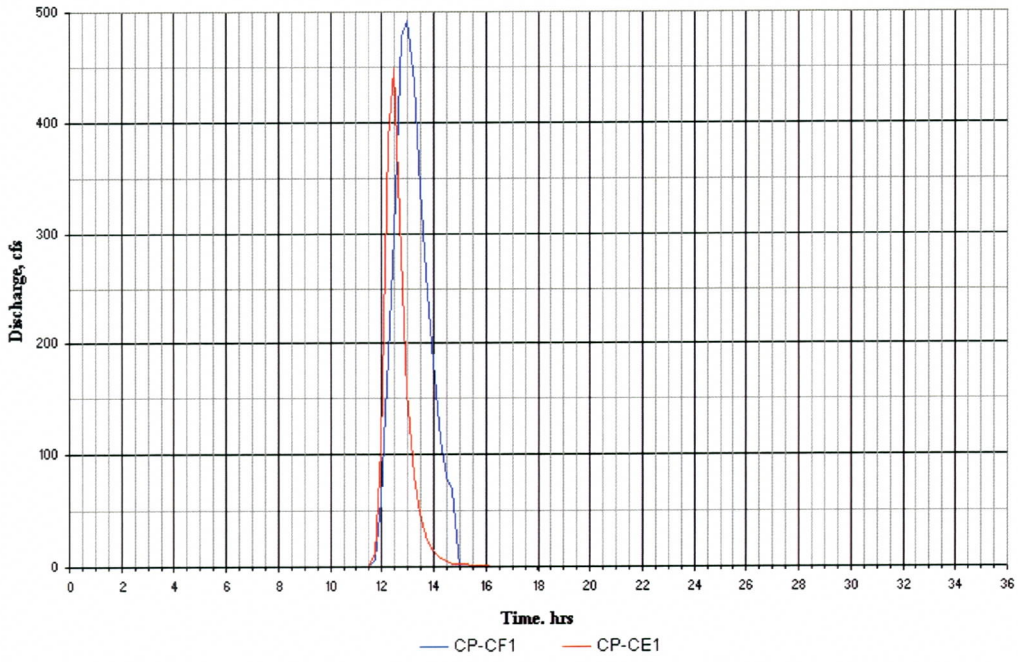


Figure 9.62 - Upper segment model west tributary inflow hydrographs at HEC-1 concentration points (Alternative 3)

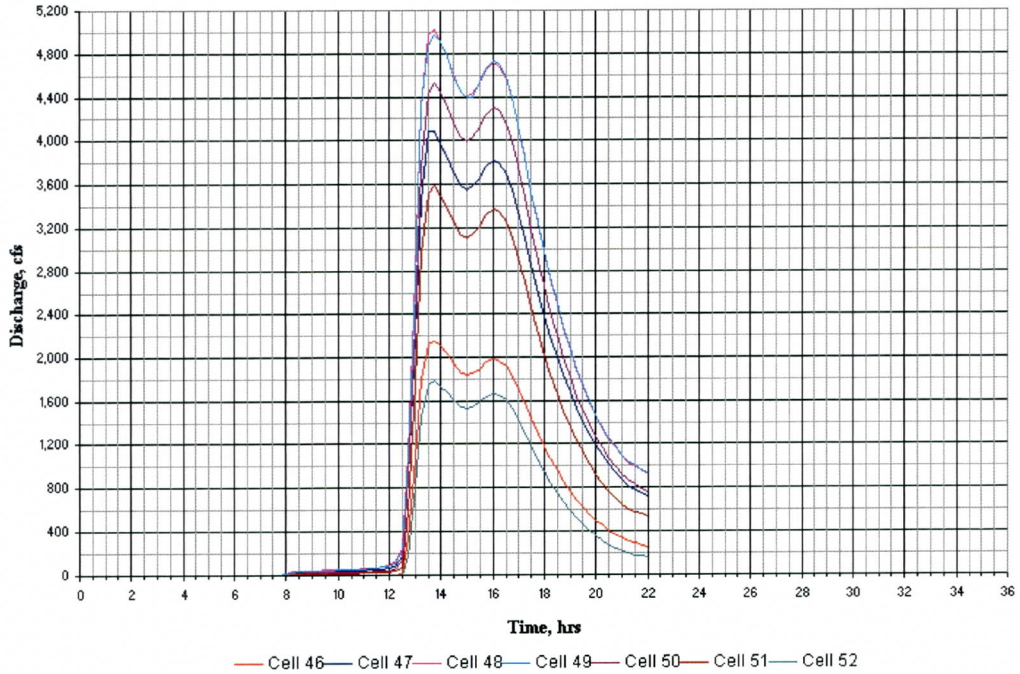


Figure 9.63 - FLO-2D cell inflow hydrographs at the SR-74 Highway West Bridge

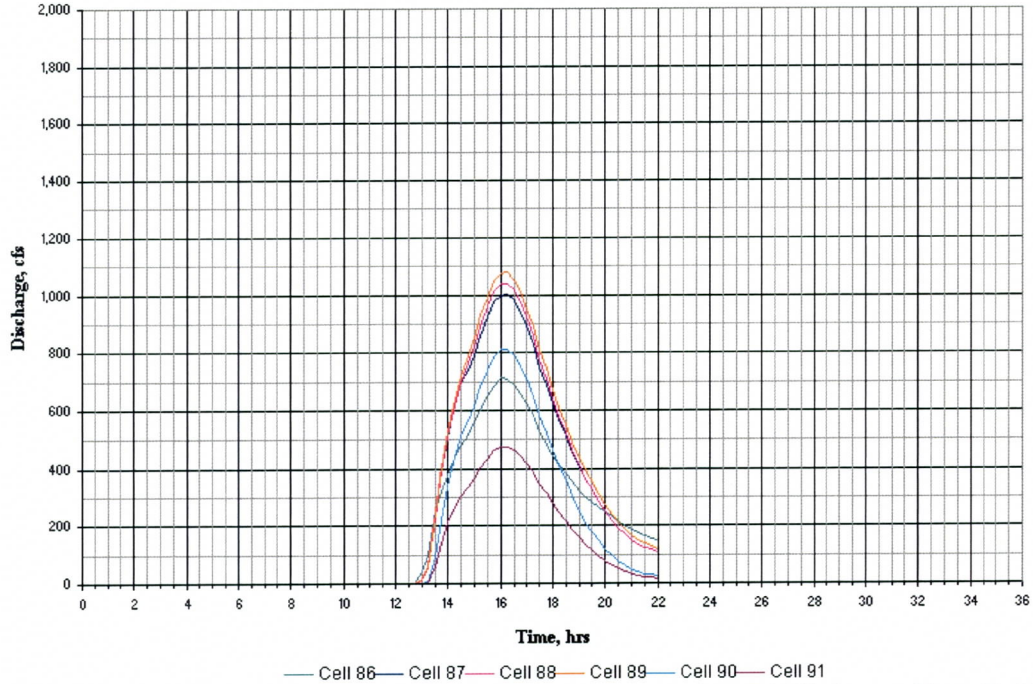


Figure 9.64 - FLO-2D cell inflow hydrographs at the SR-74 Highway East Bridge

9.4.3.3.5 Loop 303 Culverts

The proposed loop 303 culverts east of the proposed bridges were modeled in FLO-2D using the depth-discharge rating tables. The culvert physical characteristics are given in Table 9.21. The depth-discharge rating tables were generated using the HY-8 Culvert Analysis Program (Windows version 7.0), and coded into HYSTRUC.DAT input file as rating tables. Tailwater conditions were not simulated for these culverts because the HEC-RAS model developed with the 303L Bridges coded in consistently reported that the culverts were under inlet-control condition. Figures 9.65 through 9.67 show the depth-discharge rating curves for the three sets of culverts. Figure 9.65 shows the total rating curve for the culvert set-1 with one 10'x 8' RCBC, and one 10'x10' RCBC where the 10'x10' RCBC was to be used for City of Phoenix trail crossing (located roughly 1000' east of 303L Bridge opening). The 10'x10' RCBC design inverts were set 2-foot higher than the adjacent 10'x 8' RCBC to eliminate any nuisance flows. Due to this difference in the invert elevations, a kink shows up in the total rating curve at roughly 2.5-foot of depth. This allows for water to fill up the 10'x 8' RCBC up to the invert elevation of the 10'x10' RCBC before the total discharge through both barrels are accounted for. The culvert sets are called out in the alternative model depth and velocity distribution plates. Culvert flow outputs can be found in the HYDROSTRUCT.OUT files of the alternative FLO-2D models.

Table 9.21
Loop 303L culvert physical data

Culvert Set ID	Type	Number of Barrels	Size	Remark
(1)	(2)	(3)	(4)	(5)
1	RCBC	2	1-10'x8' 1-10'x10'	- City of Phoenix Trail Crossing
2	RCBC	1	12'x8'	-
3	RCBC	4	8'x8'	-

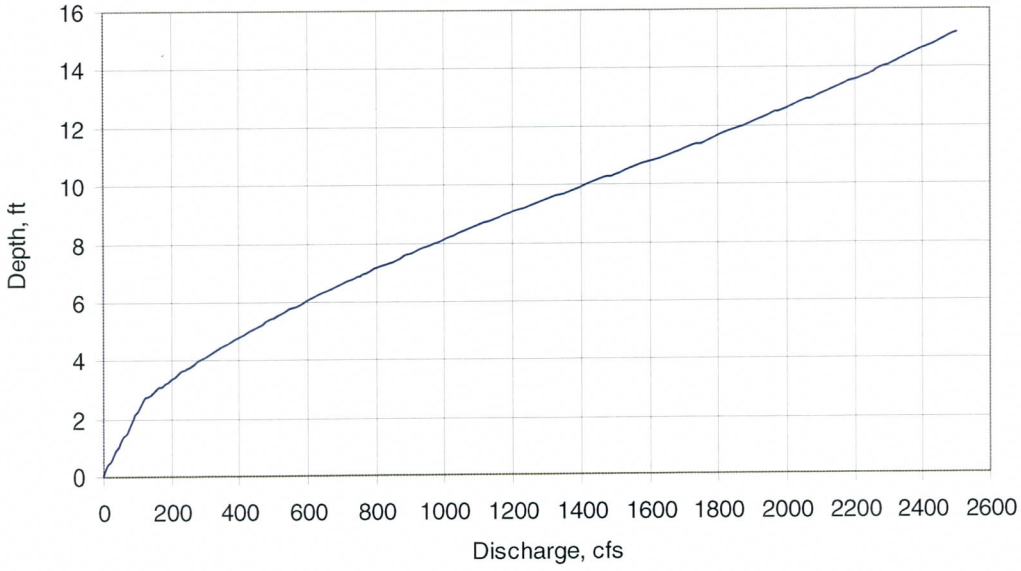


Figure 9.65 - Depth-discharge curve for 303L culvert Set-1

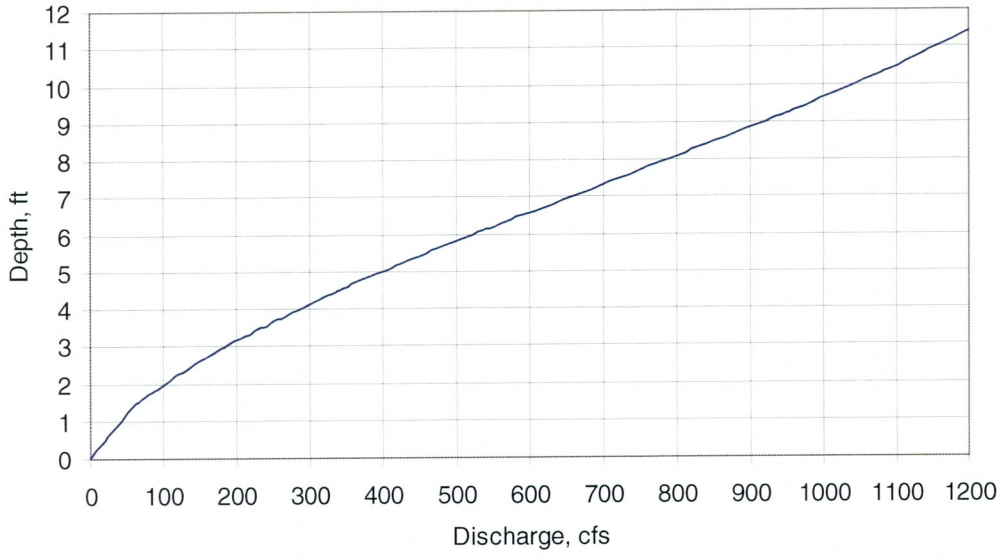


Figure 9.66 - Depth-discharge curve for 303L culvert Set-2

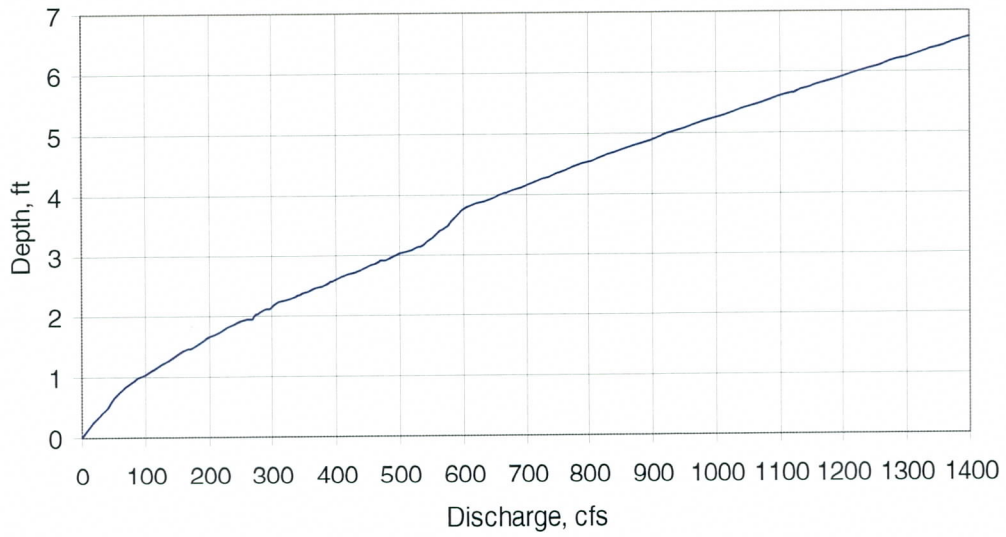


Figure 9.67 - Depth-discharge curve for 303L culvert Set-3

9.4.3.3.6 Area Reduction Factors

The two SR-74 Highway bridges were modeled using the Area Reduction Factor (ARF). No ARFs were used at the proposed 303L Bridge because representation of the flow blockage by the bridge abutments and the spur dikes were accomplished by updating (increasing) the cell elevations, as was done to represent the 303L alignment. The FLO-2D models referred to free flow conditions under the proposed bridge requiring no use of structure replacement headwater rating tables in FLO-2D.

9.4.3.3.7 Depth and Velocity Plans

Two work maps for each alternative analysis were prepared for visual representation of the depth and velocity distribution. These maps provide information the flow distribution, probable land reclamation benefits, affect of the 303L alignment and the bridge on the hydraulics, and future design limitations.

The 303L alignment crosses the New River roughly 1.25 miles downstream of the SR-74 Highway. The 303L alignment extends into the FEMA effective floodplain by roughly 1800 feet from the east and the west, leaving an approximate 810 feet of bridge opening (measured abutment to abutment). The alignment crosses the New River just upstream of its confluence with the Deadman Wash. A T-interchange west of the proposed 303L Bridge connects a north-south roadway alignment to the SR-74 Highway. Based on the ADOT 30% design plans (ADOT 2006), the T-interchange was in the FEMA Effective floodplain, and would be taken out of the floodplain upon construction. FLO-2D model results support this foresight. Spur dikes were proposed (ADOT, 2006) at the bridge abutments to reduce the erosive impact of flow. The west abutment spur connects to an approximate 2000-foot levee that extends parallel to the north-south roadway alignment that connects the 303L alignment with the SR-74 Highway. The physical characteristics of the proposed sets of reinforced concrete box-culverts (RCBCs) east of the 303L Bridge, modeled in FLO-2D, were noted in the alternative summary section earlier.

The presence of the 303L alignment brought up the issue of tackling the West Tributary hydrograph inflow locations. Under the assumption that any drainage work west of the 303L and the north-south roadway alignments would convey all local flows down to New River, the hydrographs at the HEC-1 concentration points CB1 and CC1 were input at locations south of the 303L alignment. This was a conservative assumption. The drainage work west of the alignments was not part of the Upper New River ADMP.

The following is a brief discussion on the observed highlights from the FLO-2D runs for each alternative.

Alternative 1 (Plates 9.1 and 9.2)

Under Alternative 1, HEC-RAS model directs 28,340 cfs and 20,950 cfs, 100-year peak discharges toward the East and the West SR-74 Highway bridges, respectively. The 100-year, 24-hour hydrographs were input at the bridges in the FLO-2D model which starts at the SR-74 Highway and extends to the New River Dam pool area (Plates 9.1, and 9.2).

No land reclamation is achieved downstream of the SR-74 Highway for Alternative 1. The FLO-2D flooding limit downstream of SR-74 Highway extends beyond the FEMA effective floodplain limit on the east bank. No significant hydraulic benefit was observed either. Significant ponding, up to 12 feet, was observed upstream of the proposed culverts east of the 303L Bridge opening. This ponding led to backwater conditions that reduced flow velocity to 2 to 4 feet per second on the east bank. Velocity at the 303L Bridge ranged from 4 to 8 feet per second. Flow depth at the 303L Bridge ranged from 4 to 8 feet with localized channel depth of up to 10 feet.

The 303L alignment acts as a hydraulic constraint and poses future design limitations. Any upstream future development may have impact on the hydraulics at the 303L Bridge. FLO-2D results support that there was not much opportunity to reduce the impact of backwater unless more culverts were placed east of the 303L Bridge. The culvert sets 1, 2, and 3 carried approximately 2300, 1325, and 590 cfs maximum flows, respectively.

Alternative 2 (Plates 9.3 and 9.4)

Under Alternative 2, HEC-RAS model directs 29,000 cfs and 1,200 cfs for the 100-year peak discharges through the West and the East SR-74 Highway bridges, respectively. The flow at the East Bridge was negligible as almost all of the combined New River and Sweat Canyon flows were directed towards the West Bridge. The 100-year, 24-hour hydrographs were input at the bridges in the FLO-2D model which starts at the SR-74 Highway and extends to the New River Dam pool area (Plates 9.3 and 9.4).

Seventy two acres of future residential land was reclaimed from the FEMA effective floodplain on the east bank just downstream of SR-74 Highway (Plate 9.3) due to the low- magnitude inflow at the East Bridge. The hydraulic benefit achieved was that the flooding limit on east bank downstream of SR-74 Highway was reduced in addition to the reduction of the ponding limit and depth distribution upstream of the 303L culverts.

Velocity at the 303L Bridge ranged from 4 to 6 feet per second in most part with localized velocity of up to 8 feet per second near the east abutment. Compared with Alternative 1, flow depth increased to a range of 4 to 8 feet through the 303L Bridge opening.

Although the 303L alignment acts as a hydraulic constraint and poses future design limitations, the impact upstream of the alignment was not substantial given the reduced east bank floodplain limit. Upstream future development within the east-bank reclaimed area is not expected to have a negative impact at the 303L alignment hydraulic structures. FLO-2D results support that there could not be much opportunity to reduce the impact of backwater unless more culverts were placed east of the 303L Bridge. The culvert sets 1, 2, and 3 carried approximately 1930, 1000, and 0 cfs maximum flows, respectively.

Alternative 3 (Plates 9.5 ,and 9.6)
Under Alternative 3, the optional levee alignments in the HEC-RAS model terminate approximately at River Mile 24.11, a mile upstream of SR-74 Highway. The New River and the Sweat Canyon flows at this location were 28,450 cfs and 20,600 cfs respectively. The 100-year, 24-hour hydrographs were input at this location in the FLO-2D model which extends to the New River Dam pool area (Plates 9.5 and 9.6). The proposed levee modeled in the New River Alternative 3 HEC-RAS model cut off the flow breakout just downstream of the linear pit and keeps the flow in the main channel. This allows reduction of the floodplain limit on the east bank of the New River.

Fifty-four acres of future mixed-use land was reclaimed from the FEMA effective floodplain on the east bank just downstream of the New River FLO-2D inflow location (Plate 9.5) due to the containment of flow by the proposed levee on the New River east bank. No other land reclamation was possible within the FLO-2D model study reach. Ponding limit and depth distribution upstream of the 303L culverts were reduced compared with the results from the Alternative 1 run. Velocity at the 303L Bridge ranged from 4 to 6 feet per second in most part with localized velocity of up to 8 feet per second near the east abutment. Compared with Alternative 1, flow depth increased to a range of 6 to 8 feet through the 303L Bridge opening.

The 303L alignment acts as a hydraulic constraint and poses future design limitations. Any upstream future development may have impact on the hydraulics at the 303L Bridge. FLO-2D results support that there was not much opportunity to reduce the impact of backwater unless more culverts were placed east of the 303L Bridge. The culvert sets 1, 2, and 3 carried approximately 2000, 1060, and 20 cfs maximum flows, respectively. The reduction of flooding limit beyond the FEMA floodplain limits east of the culverts resulted in low culvert discharges compared with Alternative 1 results.

9.4.3.4 Conclusions

Due to the distributary/braided nature of New River downstream of SR-74 Highway FLO three two-dimensional alternative evaluation models were developed using FLO-2D. The models use the inflow hydrographs generated in the HEC-1 models for the three alternatives. The FLO-2D model's upstream boundary starts where the levees terminate

in the corresponding HEC-RAS models. The 303L alignment was coded into the model grids by manually adjusting the cell elevations based on 30% ADOT design plans. The purpose of the FLO-2D models was to study the impact of the various flow distribution alternatives upstream and downstream of the SR-74 Highway, including potential for future land reclamation. Depth and velocity distribution was studied in the model reaches and the observations reported. Future land reclamation was considered a possibility under Alternatives 2 and 3 but not under Alternative 1. The 303L alignment would act as a hydraulic constraint and might pose future design limitations. However, the impact upstream of the alignment was not substantial under Alternative 2 given the reduced east bank floodplain limit downstream of the SR-74 Highway. The notable backwater condition upstream of the proposed 303L culverts would sustain unless more barrels are introduced.

9.4.3.5 Probable Cost

Table 9.22 lists a summary of the probable cost estimates of an alternative in which an implementation or construction cost could be calculated. The opinion of construction cost includes a 20 percent contingency. Appendix K includes a detailed breakdown of the construction cost estimates.

Table 9.22
New River Downstream of I-17 Planning
Summary of Cost

Alternative (1)	Probable Cost (2)
Alternative 1 – Channel Option	
Opinion of Construction Cost	$108,903,294
Land Value Offset	-$48,850,000
Potential Sand and Gravel Resource Benefit	-$27,010,824
Total	$33,042,470
Alternative 1 – Levee Option	
Opinion of Construction Cost	$63,570,996
Land Value Offset	-$48,650,000
Total	$14,920,996
Alternative 2 - Channel Option	
Opinion of Construction Cost	$117,695,605
Land Value Offset	-$54,750,000
Potential Sand and Gravel Resource Benefit	-$36,465,084
Total	$26,480,521
Alternative 2 - Levee Option	
Opinion of Construction Cost	$56,474,902
Land Value Offset	-$54,750,000
Total	$1,724,902
Alternative 3	
Opinion of Construction Cost	$46,186106
Land Value Offset	-$38,850,000
Total	$7,336,106
Alternative 4	
Opinion of Construction Cost	$118,800,000
Land Value Offset	-$21,600,000
Total	$97,200,000

9.4.3.6 Lower Deadman Planning Area

The major existing flood hazard issue in the planning area is flooding along and over SR-74 at the Deadman Wash crossing. SR-74 is used by the public for ingress and egress to the area. The roadway includes one 48" culvert crossing, which does not have the capacity to carry flood flows. Flood flows currently cross over SR-74 posing a hazard to the public and emergency vehicles. Approximately 9,940 cfs crosses the road at a depth

of approximately three feet during the 100-year event. Frequently the roadway is closed for much smaller events.

Alternatives developed for the planning area include watercourse and watershed wide solutions. The watercourse planning element considers Deadman Wash commencing approximately 200 feet downstream of the SR-74 Highway and extending upstream of the crossing of I-17. Both structural and non-structural alternatives are proposed for Deadman Wash to mitigate flooding at the SR-74 Highway. The type and distribution of structural elements are depicted on the attached Figures 9.68 to 9.72. Areas within the Deadman Wash Floodplain where no structural elements are depicted are non-structural reaches.

Alternative 1 and Alternative 2 were developed to mitigate flooding at the Deadman Wash crossing of SR-74. Alternatives 1 and 2 have with and without detention basin options. For the detention basin option, the proposed detention basin would be located within Deadman Wash just upstream of I-17. The basin would function to reduce peak discharge at the SR-74 crossing and potentially decrease the size and extent of proposed structures. Alternatives designated 1a or 2a (Figures 9.68 and 9.70, respectively) do not include detention, whereas, alternatives designated 1b or 2b (Figures 9.69 and 9.71, respectively) do include detention.

9.4.3.6.1 Hydrology

Peak discharges in the hydrologic and hydraulic evaluation of the structural alternatives for the watercourse planning reach are taken from both existing land use condition ADMP models with the proposed detention basin. These discharges are listed in Table 9.23. The location and general characteristics of the proposed basin as well as a description of the modifications to the base HEC-1 model are discussed in Section 9.4.2.3.1.

Table 9.23 Lower Deadman Wash Alternative Peak Discharges

River Station	HEC-1 ID	Peak Discharge, in cfs				Location
		100-Yr, Base	100-Yr, Detention	50-Yr, Detention	10-Yr, Detention	
(1)	(2)	(3)	(4)	(5)	(6)	(7)
---	C10H	10,546	10,546	9,191	3,480	I-17, inflow to basin
---	C10H-0	N/A	5,420	5,341	1,789	Outlfow to basin
38,819.16	C10I	10,475	5,420	5,340	1,789	Downstream of I-17
37,701.42	C10K	10,816	5,950	5,721	1,964	
32,598.25	C10M	10,760	6,016	5,765	1,985	
31,488.81	C10N	10,547	5,959	5,721	1,966	
28,405.26	C10QL	10,135	5,923	5,676	1,955	
21,834.81	C10T	9,936	6,542	6,037	2,159	Just d/s of SR-74
14,456.94	C10UR	9,719	6,477	5,984	2,137	
7,248.99	C10V	10,439	8,263	7,156	2,727	
4,205.26	C10WL	10,340	8,213	7,112	2,710	Just u/s of confluence w/New River

9.4.3.6.1.1 Hydrologic Considerations

Hydrologic modeling was performed for alternatives that are considered regional detention. The proposed detention basin is an in-line structure. Use of an in-line basin is consistent with upstream basin implemented throughout the Anthem development. The proposed outlet structure is sized to pass more frequent events and thus minimize potential impacts to environmental characteristics and the form and function of the river downstream. Hydrologic modeling of the proposed channelization of new roadway crossings was not performed. From a regional perspective, the impact of these features on the watershed hydrology will be negligible.

9.4.3.6.2 Hydraulic Evaluations

Structural elements of the alternative are:

- Alternative 1A
    - Spur Levee (approximately 300 feet) just upstream of SR-74 on the west side of Deadman Wash to direct flows to the proposed bridge location.
    - Retain the existing 48"culvert structure on the east side of Deadman Wash
    - Provide a 600 foot span bridge on the west side of Deadman Wash. Assume a bridge configuration consistent with SR-74 bridges located on New River.
    - SR-74 roadway profile is raised to accommodate proposed bridge
- Alternative 1B
    - Same as Alternative 1a with the exception that a regional detention basin upstream of I-17 is proposed and the proposed bridge span is 400 feet.
- Alternative 2A
    - Channelization of Deadman Wash starting approximately one-mile upstream and continuing for approximately one-quarter mile downstream of SR-74. The purpose of the channel is to convey the 100-year event to the east side of wash and through a bridge. The channel includes bank stabilization and where necessary levees to contain the 100-year event. The channel has the following characteristics:
        - The side slopes were set to 3:1.
        - The channel top width was set to 500 feet.
        - The n-value of the channel was set to 0.05.
        - Due to the existing terrain levees are required to contain flow within the proposed channel.

- Provide a 550 foot span bridge at the proposed channel location of Deadman Wash. Assume a bridge configuration consistent with SR-74 bridges located on New River.
- Existing 48" culvert is eliminated.
- SR-74 roadway profile is raised to accommodate proposed bridge

- Alternative 2B
  - Same as Alternative 2A with the exception that a regional detention basin upstream of I-17 is proposed, proposed bridge span was 400 feet and proposed channel top width was 300 feet.

The downstream boundary condition for all models was set to the existing condition base model for New River. A summary of the alternatives is included in Table 9.24.

All alternatives include the proposed bridge crossing of the Loop 303 near RM 9143.42. The bridge configuration was obtained from plans provided by ADOT.

The detention basin for Alternative 1B and 2B has the following characteristics:

- Inflow to the basin for the 100-year, 24-hour storm event is approximately 10,500 cfs
- In-line detention basin.
- The basin storage is approximately 500 acre-feet.
- The embankment height is approximately 10 feet.
- The outlet structure is a notch or channel through the embankment with a bottom width of 40 feet, side slopes of 3:1 and rip-rap lining. The lining extends downstream of the embankment for approximately 200 feet.
- The outflow from the basin is approximately 5,400 cfs.

Table 9.24
Deadman Wash Alternative Analysis Hydraulic Model Summary

HEC-RAS Plan Name (1)	Geometry (2)	Steady Flow (3)	Description (4)
Existing Conditions – Stantec Q's	Existing (In-line Structure)	Stantec Q's – 100-yr w/o retention	Base model
Alternative 1 – w/o detention	Alternative 1 – w/o detention	Stantec Q's – 100-yr w/o detention	No channelization and no detention • Keep the existing culvert on the east side of Deadman Wash • Construct a bridge on the west side
Alternative 1 – with detention	Alternative 1 – 100yr Detention	Stantec Q's – Detention	No channelization with detention • Keeping the existing culvert on the east side of Deadman Wash • Construct a bridge on the west side • Construct a basin on the upstream side of I-17
Alternative 2 – w/o detention	Alternative 2 w/o detention	Stantec Q's – 100-yr w/o detention	Channelization and no detention • Construct a 500' bottom width channel to carry all flow to the east side • Replace the existing culvert with a bridge
Alternative 2 – with detention	Alternative 2 – 100yr Detention	Stantec Q's – Detention	Channelization with detention • Construct a 300' bottom width channel to carry all flow to the east side • Replace the existing culvert with a bridge • Construct a basin on the upstream side of I-17

Results of the hydraulic models for the structural alternatives are compared to the base hydraulic model to determine the impact of the alternative on the hydraulic properties of the watercourse. Figures 9.73 through 9.82 shows the results for Deadman Wash.

Conclusions that can be drawn from review of the 10-year event figures are (see Figures 9.73 through 9.78):

- For Alternative 1, the majority of data points for the 10-year event lie on or near the 45 degree line for shear stress, channel velocity and hydraulic depth. This indicates that there is little change between the base condition and the alternative models. By inference, the regional sedimentation of Deadman Wash does not change because of the modifications at SR-74.

- For Alternative 1, there is some scatter above and below the line indicating local or isolated changes in channel hydraulics. The majority of data points for the alternative with detention above I-17 lie below the line indicating a decrease in shear stress, velocity and hydraulic depth. By inference the alternatives may cause a decrease in erosion and local scour.

- For Alternative 2, the majority of data points do not lie on the 45 degree line indicating that the alternative causes a regional change in the hydraulics. The scatter lies above and below the line indicating that some areas may see an increase in erosion while others may see an increase in deposition.

Conclusions that can be drawn from review of the 100-year event figures are (see Figures 9.79 through 9.82):

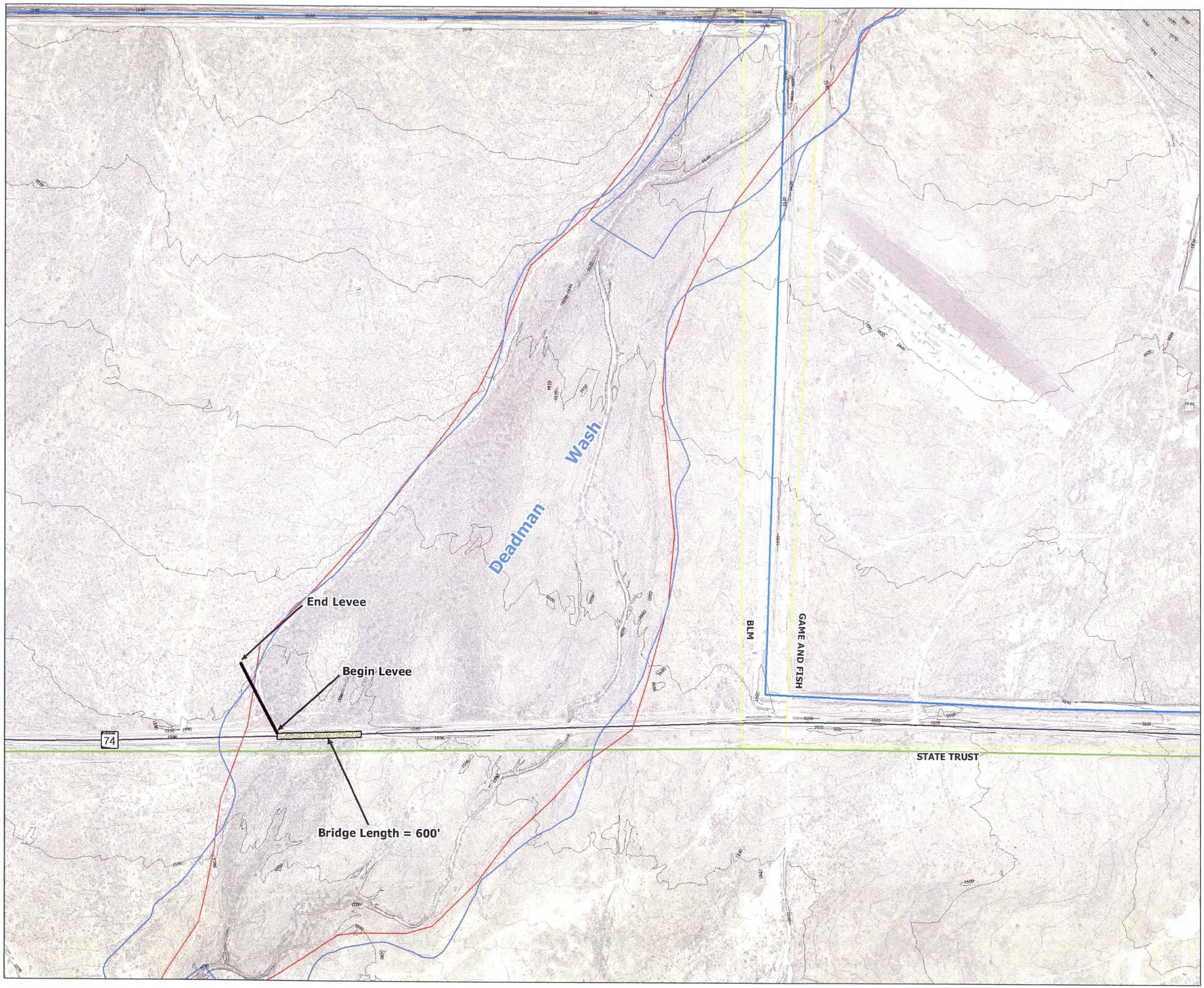
- All alternatives mitigate flooding at the SR-74.

- The Loop 303 bridge causes an increase in velocity and flow depth for all alternatives.

- In general, alternatives that include detention upstream of I-17 show a decrease in velocity, top width and flow depth.

- Alternative 2 channelization causes an increase in velocity and hydraulic depth in Deadman Wash.

The watershed planning effort considers two alternatives, an ADMP Guidelines Alternative (Alternative 3) and a FEMA Regulatory Guidelines Alternative (Alternative 4). ADMP guidelines developed as part of the ADMP provided a uniform approach to flood hazard mitigation and protection/enhancement of natural resources. FEMA Regulatory Guidelines provide an approach to flood hazard mitigation, however the approach may not be a uniform and the approach may not take into consideration impact to natural resources.



Flood Control District
of Maricopa County
2801 W. Durango St.
Phoenix, AZ 85009

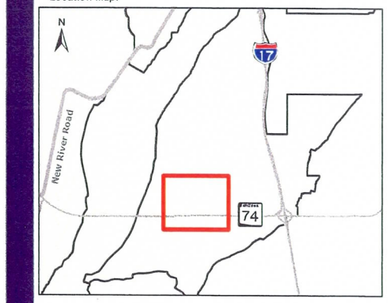
Upper New River ADMP
FCD 2005CO20

Prepared By:
Stantec Consulting Inc.
8211 S. 48th Street
Phoenix, AZ U.S.A. 85044

Legend:

- Roadway
- Levee
- Waterline
- Gasline
- Index Contour
- 2 ft Intermediate Contour
- FEMA Floodplain
- Erosion Hazard
- Parcel Boundary
- Proposed Bridge

Location Map:



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0 300 600 900 1,200 Feet

Project No.
182000418

Prepared By:
AMG
February 2008

Title:
Lower Deadman Planning Area
Alternative 1A
Figure 9.68

Revision:

	By	Appd.	Date

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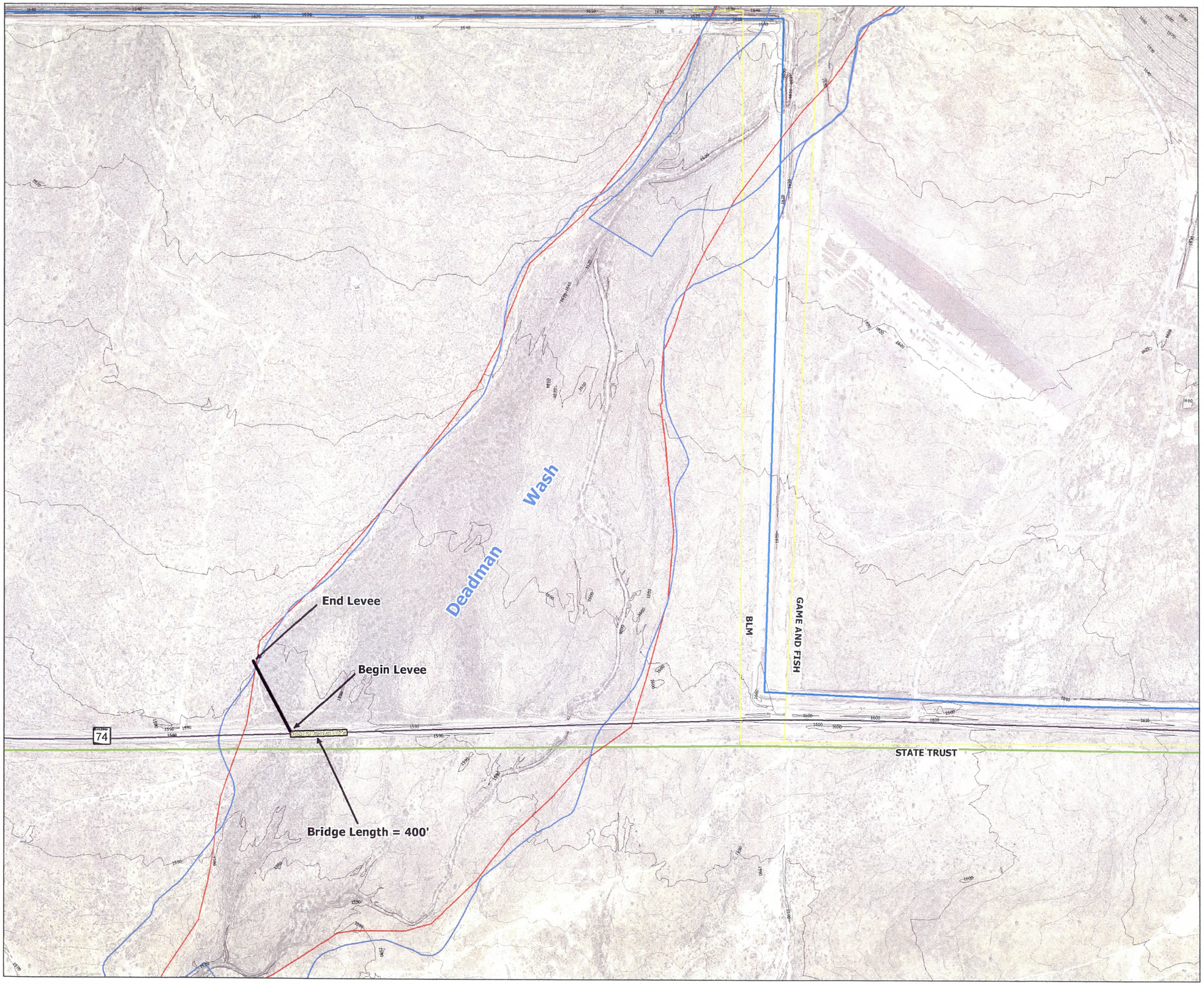

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Upper New River ADMP
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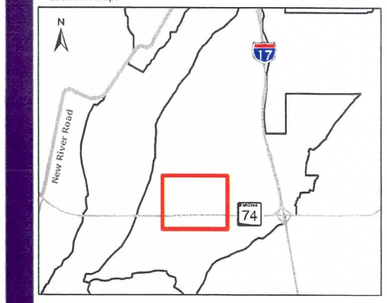
Phoenix, AZ U.S.A. 85044

Legend:

- Roadway
- Levee
- Waterline
- Gasline
- Index Contour
- 2 ft Intermediate Contour
- FEMA Floodplain
- Erosion Hazard
- Parcel Boundary
- Proposed Bridge

Location Map:



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Project No.
182000418

Prepared By:
AMG
February 2008

Title:
Lower Deadman Planning Area
Alternative 1B
Figure 9.69

Revision:

	By	Appd.	Date

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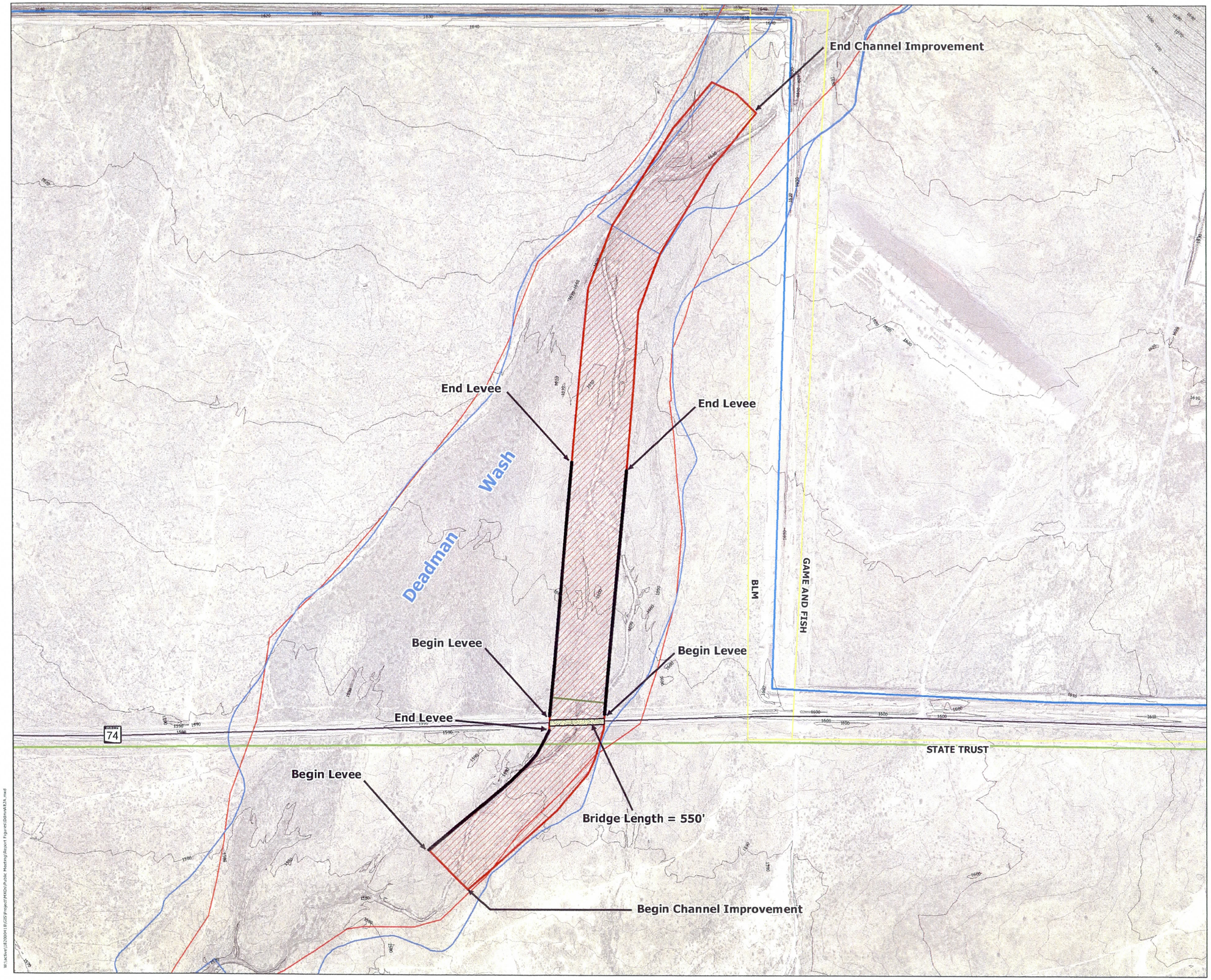

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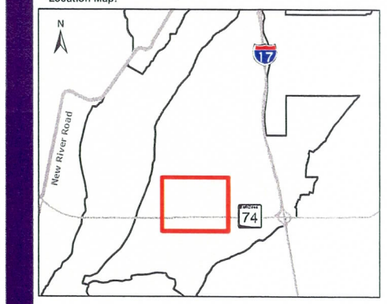
Stantec

Legend:

- Roadway
- Levee
- Waterline
- Gasline
- Index Contour
- 2 ft Intermediate Contour
- Channel
- FEMA Floodplain
- Erosion Hazard
- Parcel Boundary
- Grade Control Structure
- Proposed Bridge

Location Map:



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Prepared By:
AMG
February 2008

Revision:

By Appd. Date

Title:
Lower Deadman Planning Area
Alternative 2A
Figure 9.70

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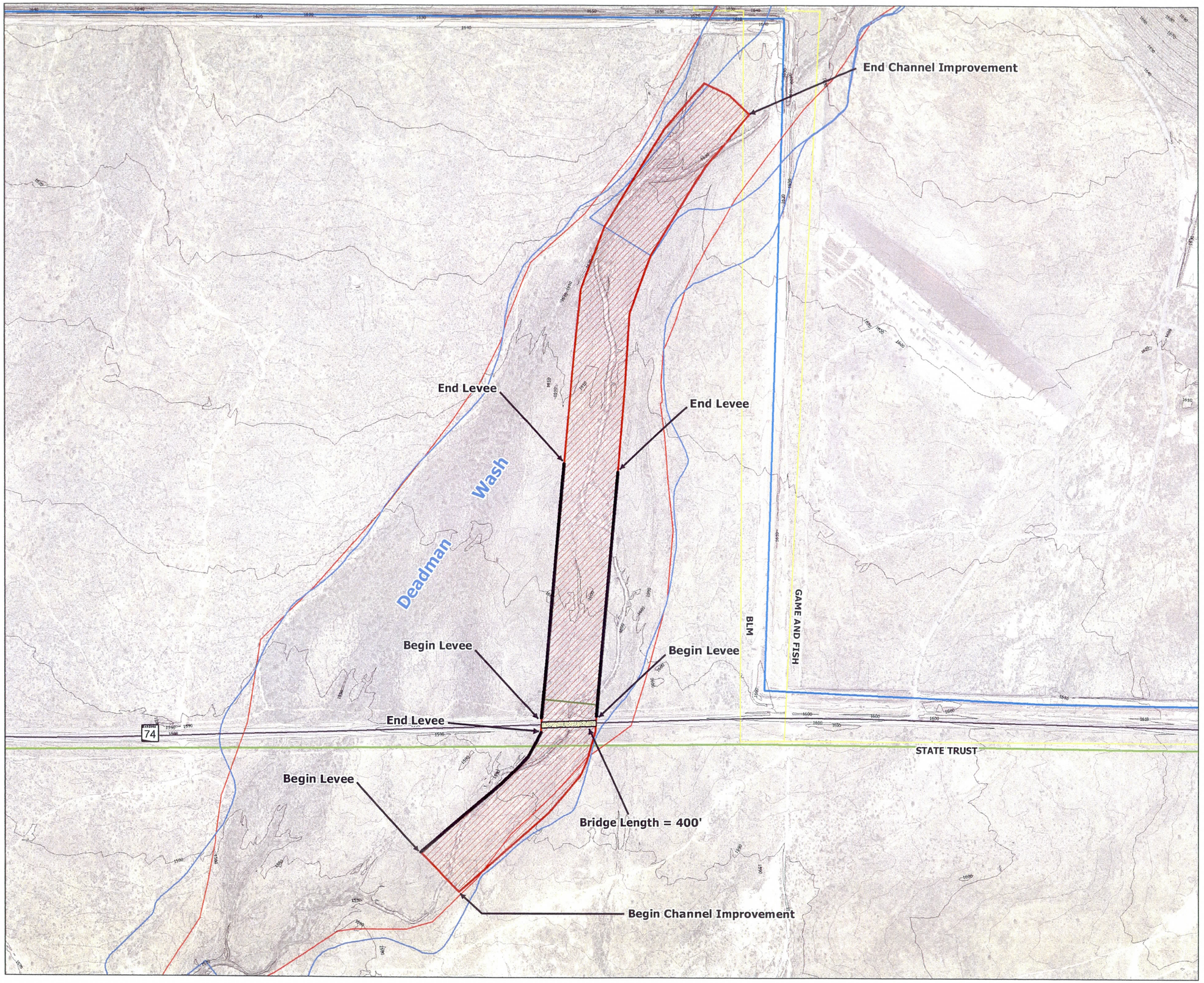

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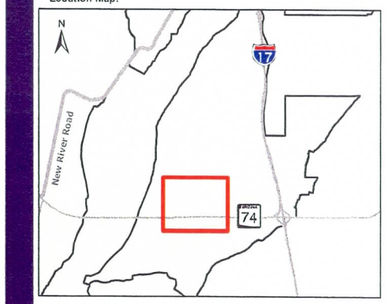
Legend:

- Roadway
- Levee
- Waterline
- Gasline
- Index Contour
- 2 ft Intermediate Contour
- Channel
- FEMA Floodplain
- Erosion Hazard
- Parcel Boundary
- Grade Control Structure
- Proposed Bridge

Location Map:



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Project No.
182000418

Prepared By:
AMG
February 2008

Title:
Lower Deadman Planning Area
Alternative 2B
Figure 9.71

Revision:

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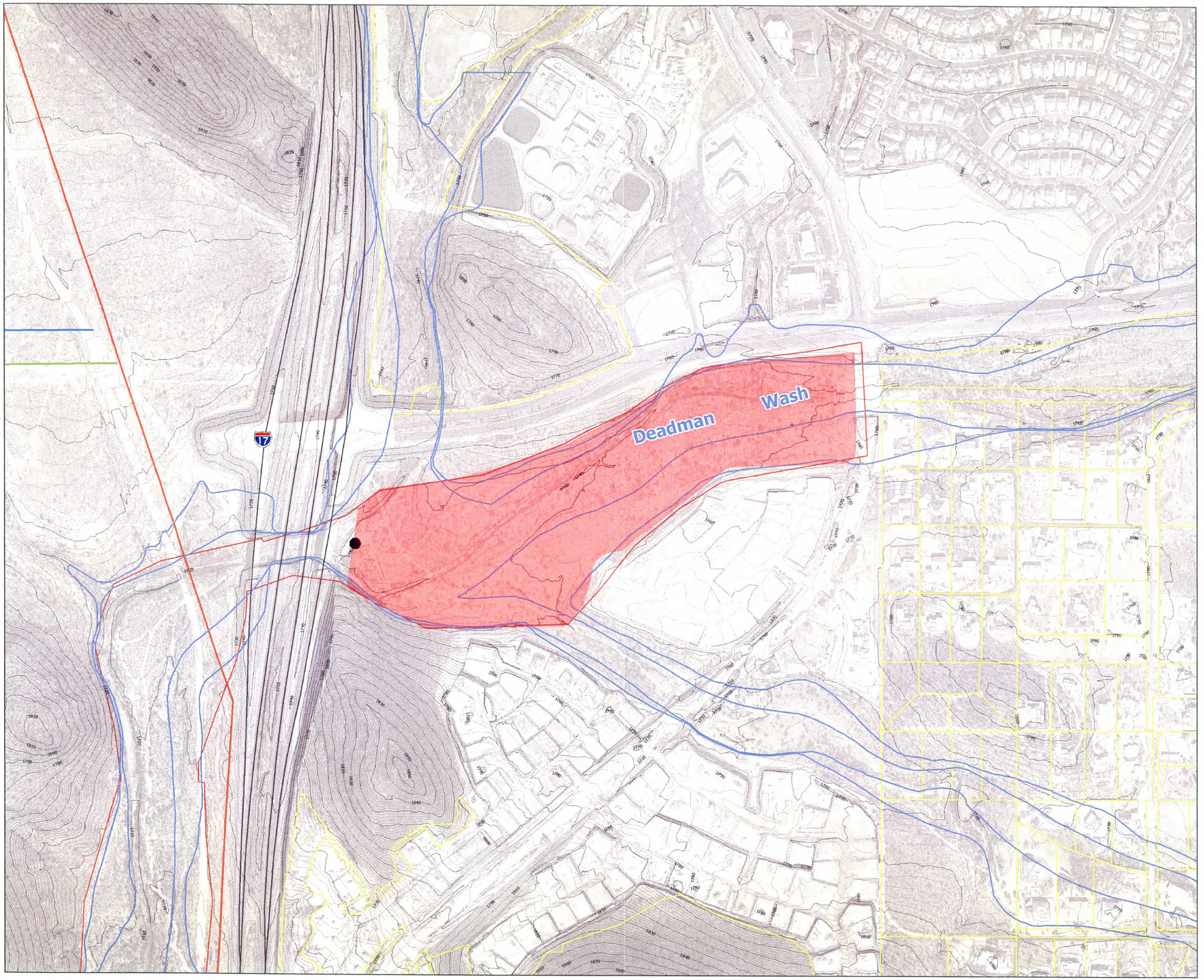

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Upper New River ADMP
FCD 2005CO20

Prepared By:
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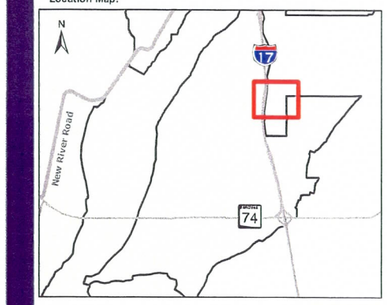
Phoenix, AZ U.S.A. 85044
Stantec

Legend:

- Basin Outlet Structure
- Roadway
- Waterline
- Gasline
- Index Contour
- 2 ft Intermediate Contour
- Detention Basin
- FEMA Floodplain
- Erosion Hazard
- Parcel Boundary

Location Map:



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Project No.
182000418

Prepared By:
AMG
February 2008

Title:
Lower Deadman Planning Area Retention Basin for Alternative 1B and 2B Figure 9.72

Revision:

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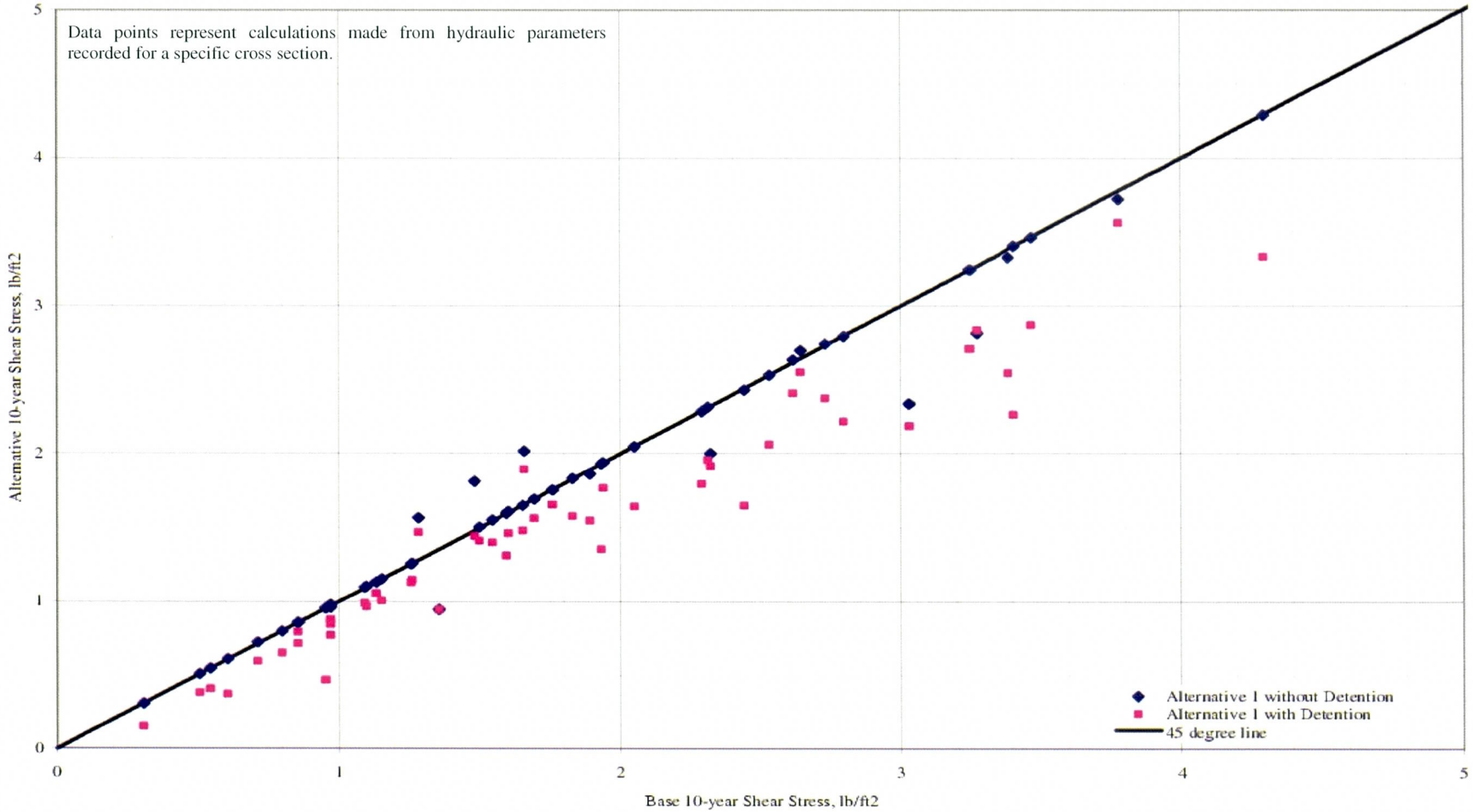

Figure 9.73 - Comparison of Shear Stress for Deadman Wash Alternative 1

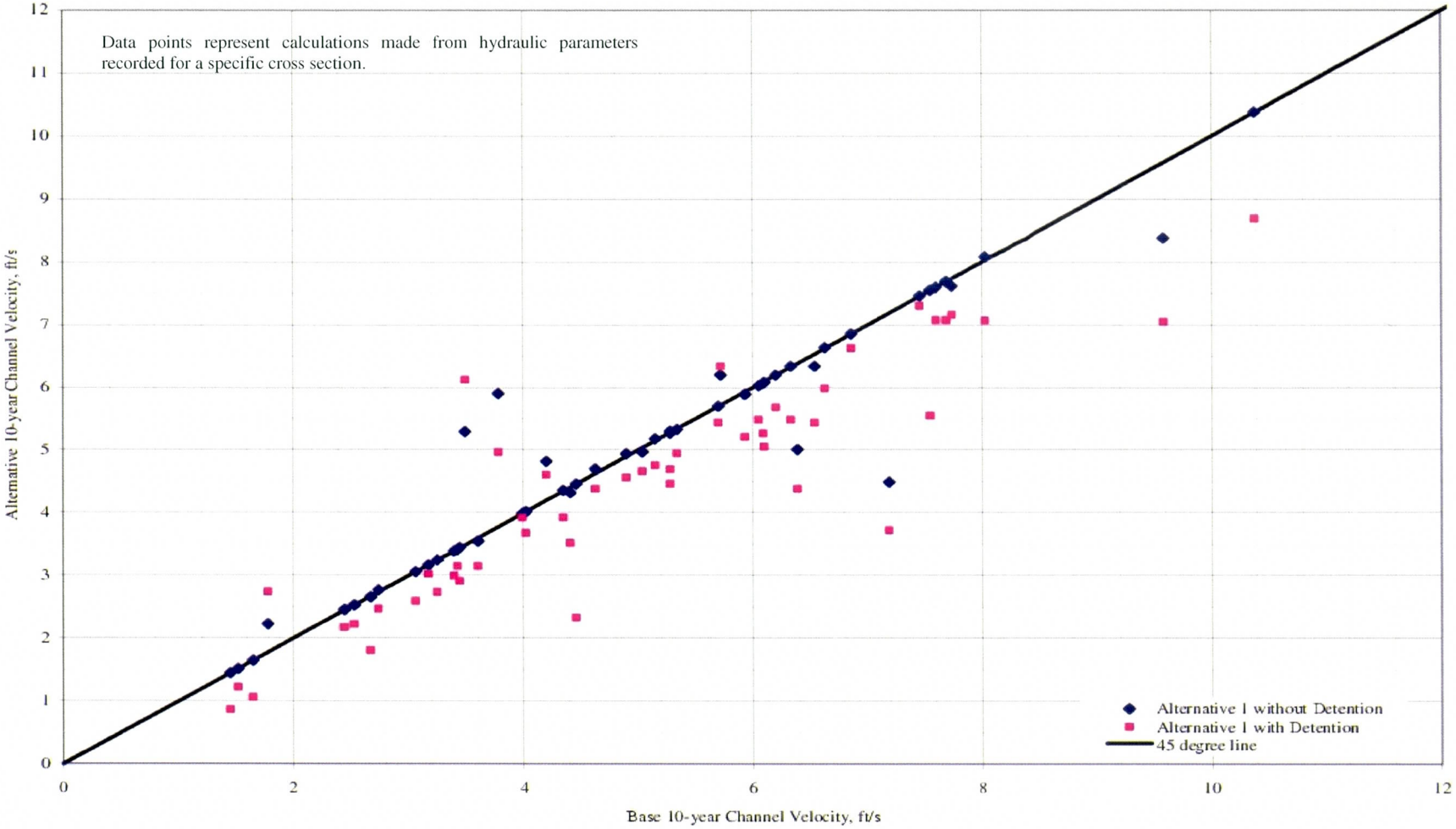

Figure 9.74 - Comparison of Channel Velocity for Deadman Wash Alternative 1

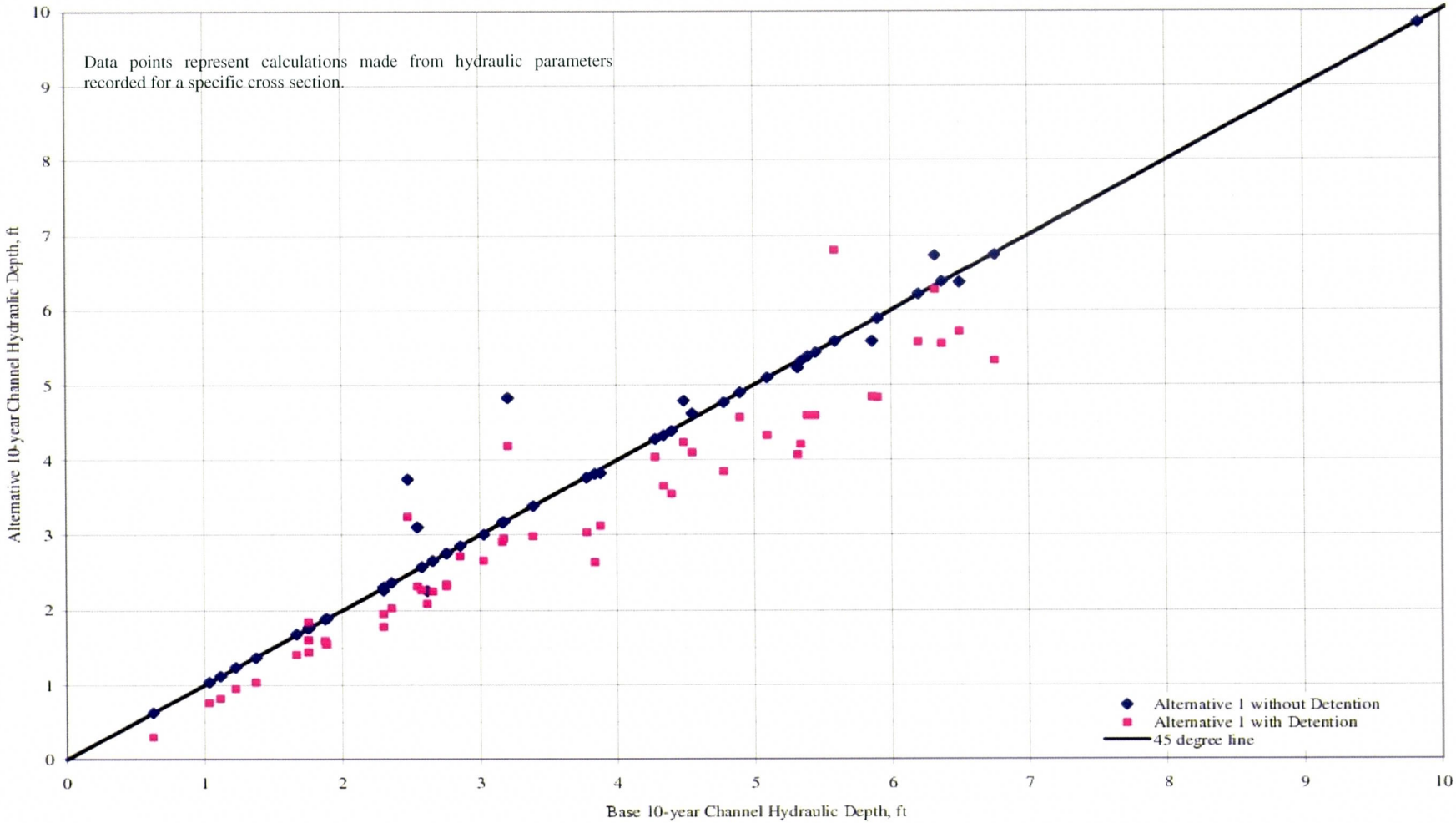

Figure 9.75 - Comparison of Hydraulic Depth for Deadman Wash Alternative 1

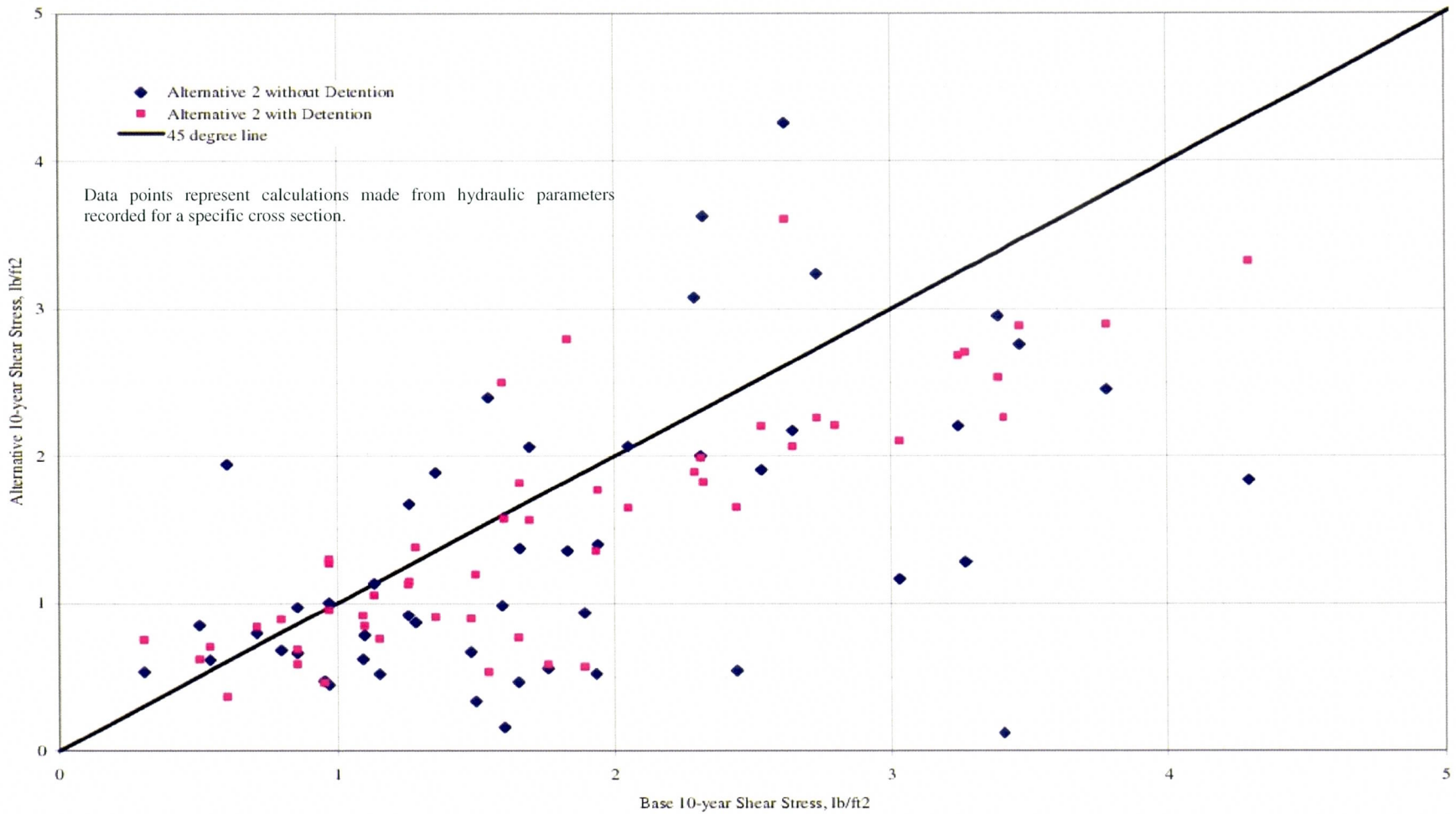

Figure 9.76 - Comparison of Shear Stress for Deadman Wash Alternative 2

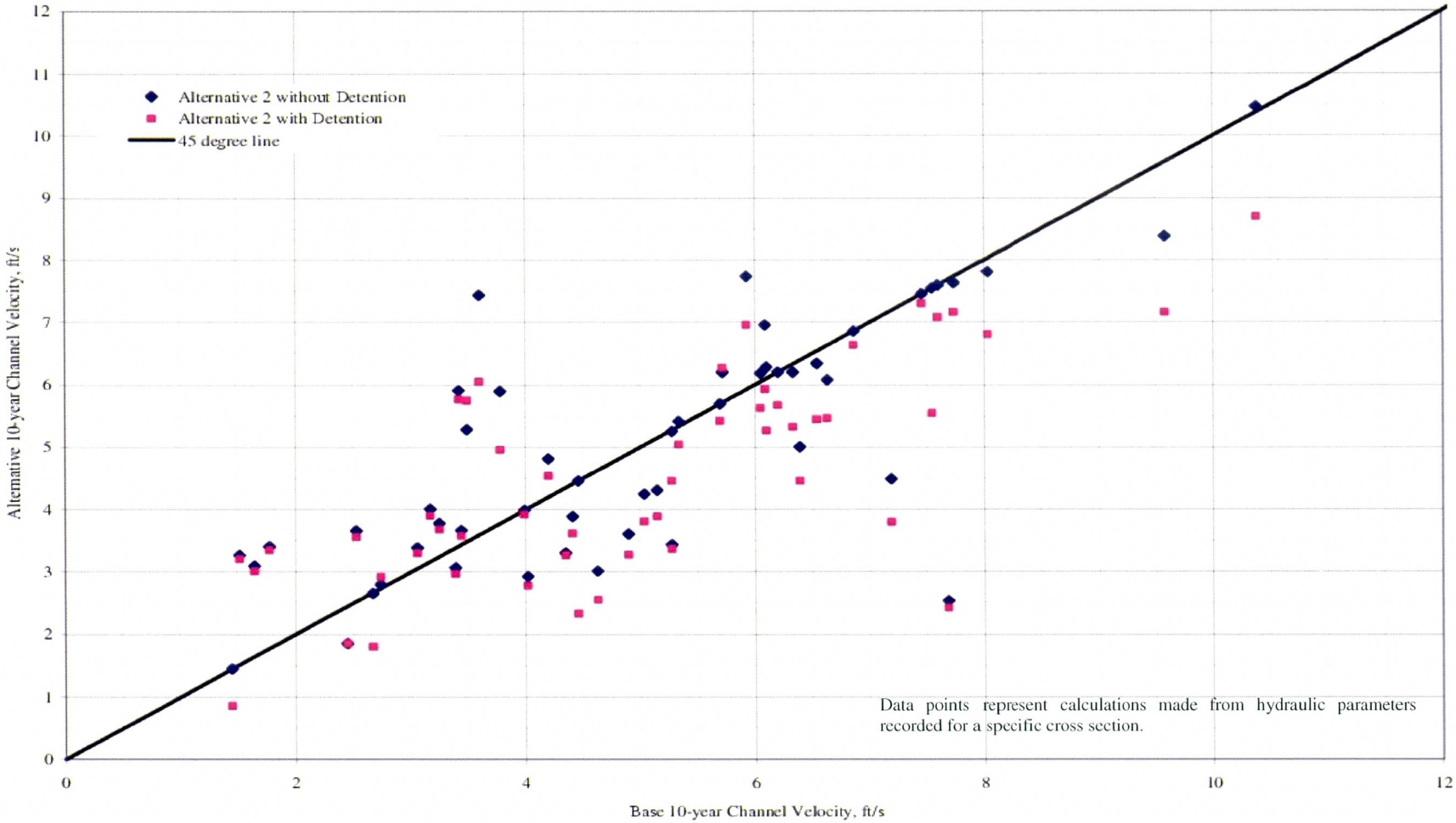

Figure 9.77 - Comparison of Channel Velocity for Deadman Wash Alternative 2

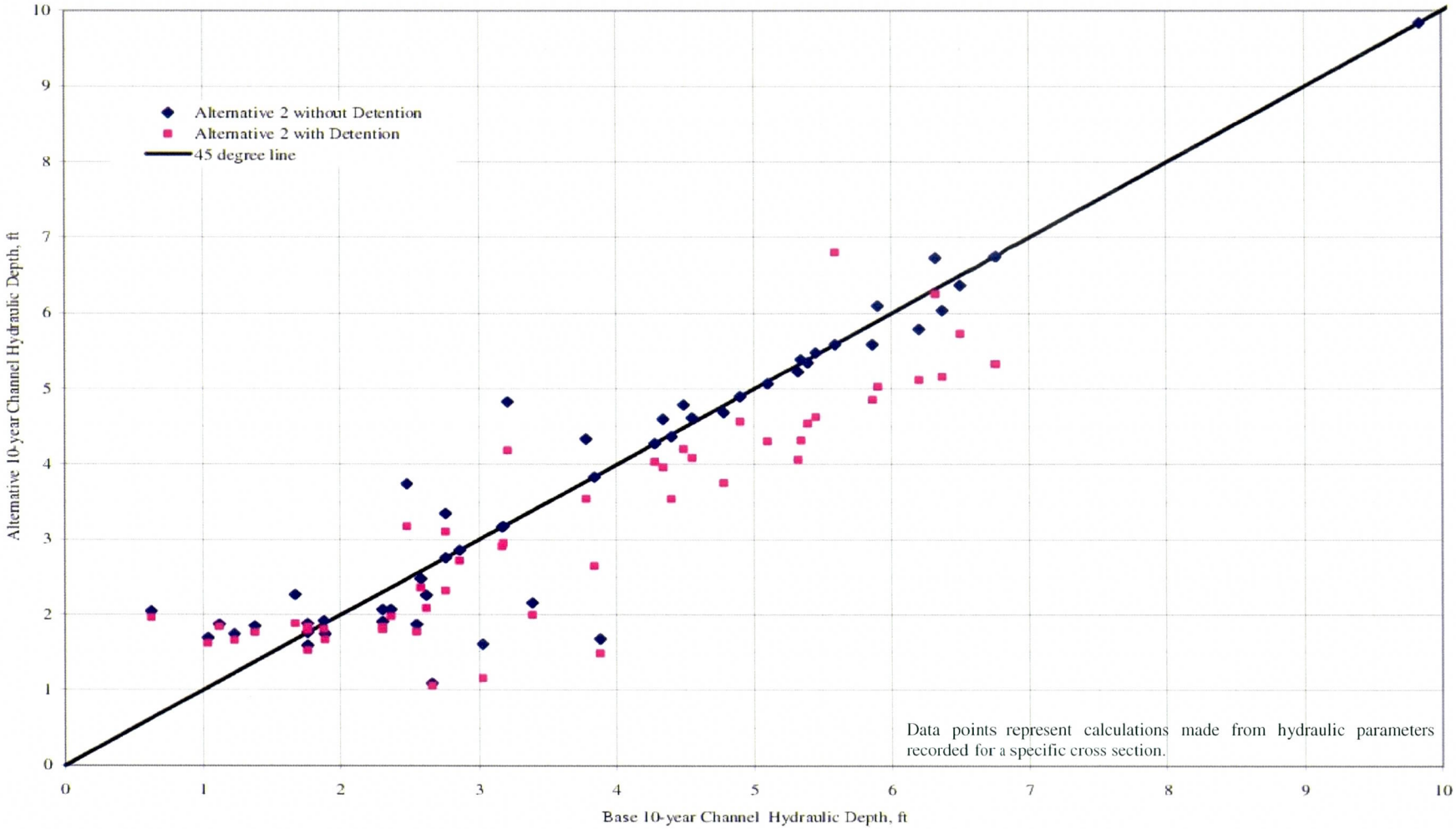

Figure 9.78 - Comparison of Hydraulic Depth for Deadman Wash Alternative 2

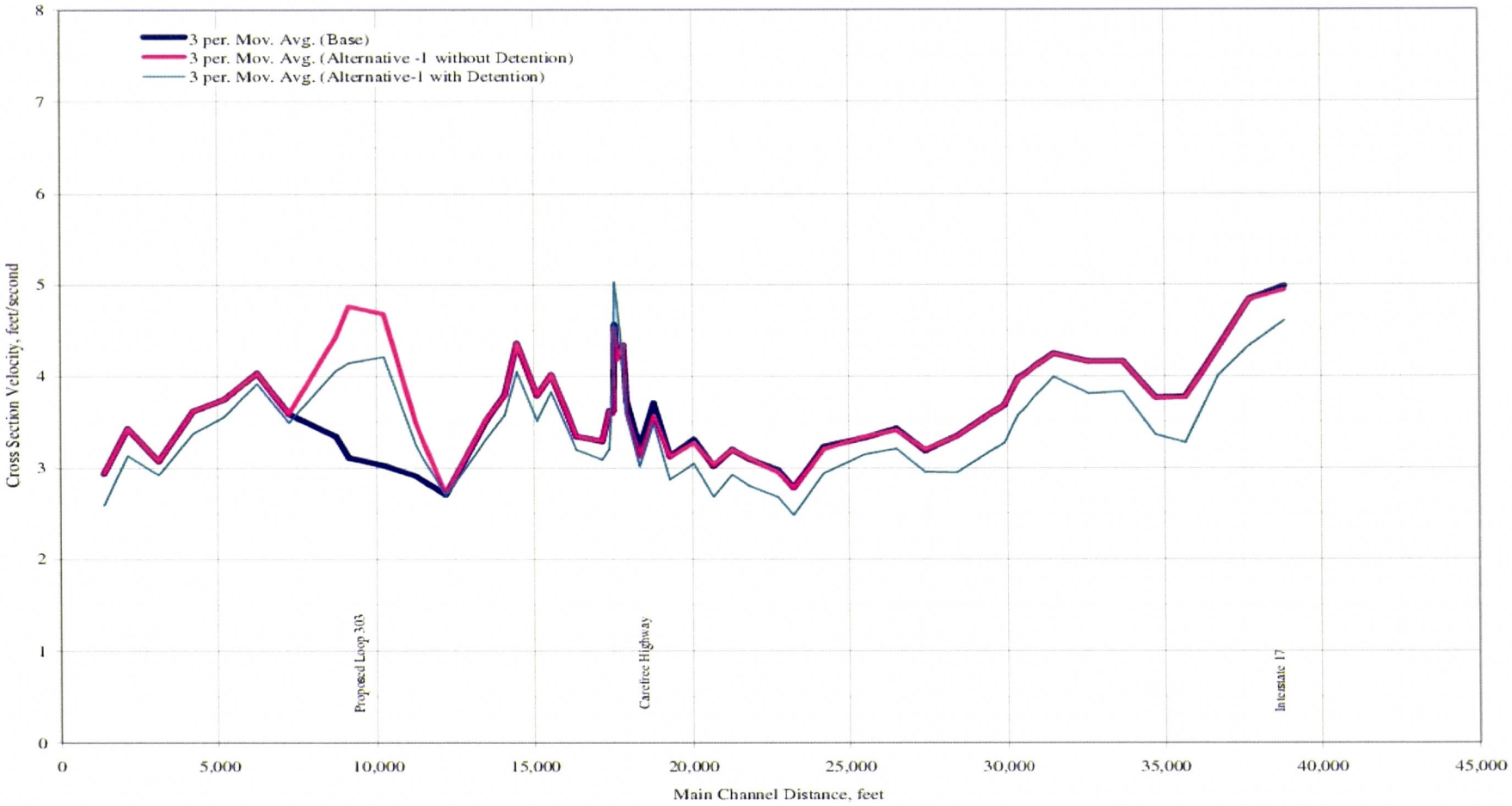

Figure 9.79 - Deadman Wash - Alternative 1 - Comparison of Velocity - 100-Year Event

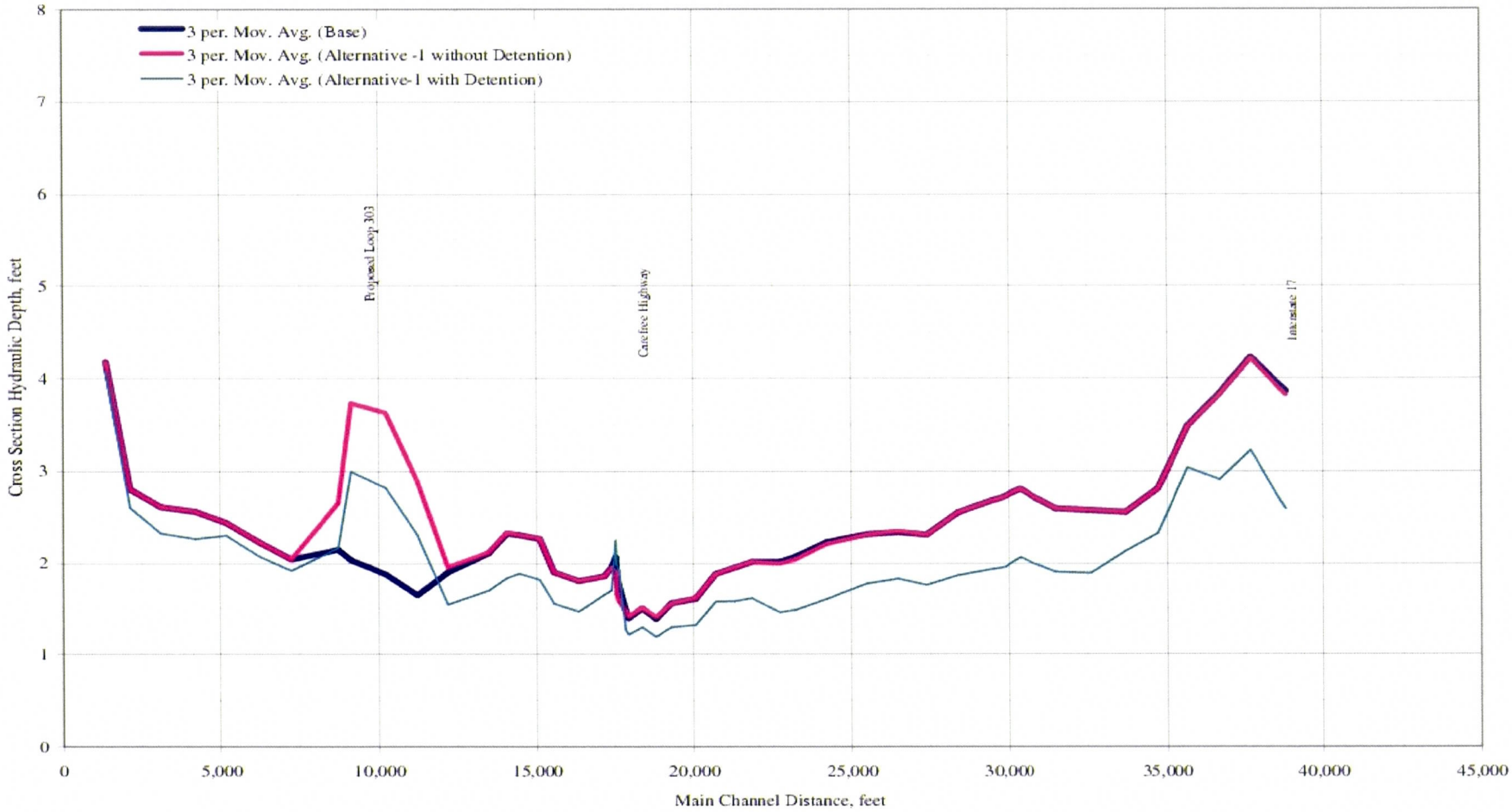

Figure 9.80 - Deadman Wash - Alternative 1 - Comparison of Hydraulic Depth - 100-Year Event

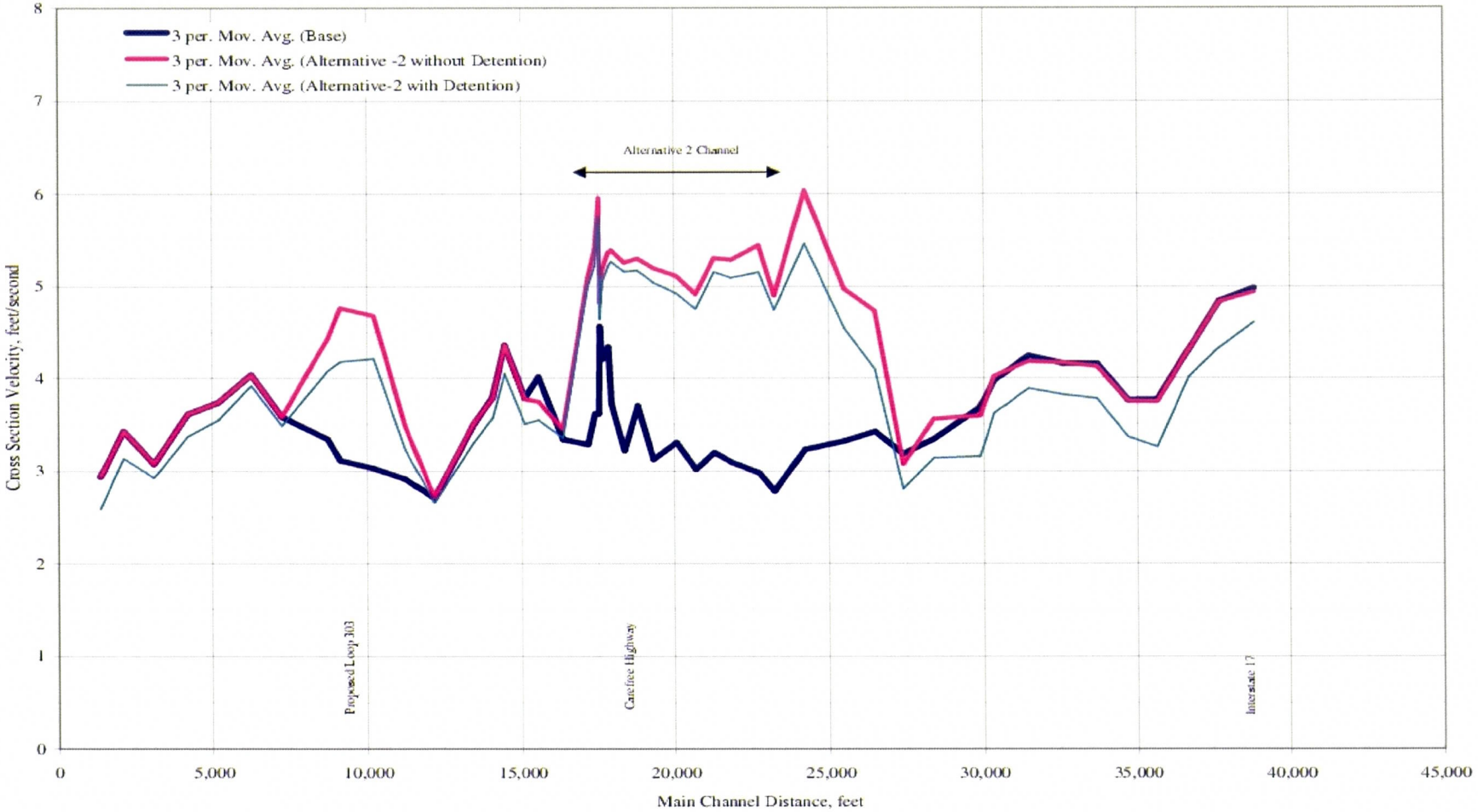

Figure 9.81 - Deadman Wash - Alternative 2 - Comparison of Velocity - 100-Year Event

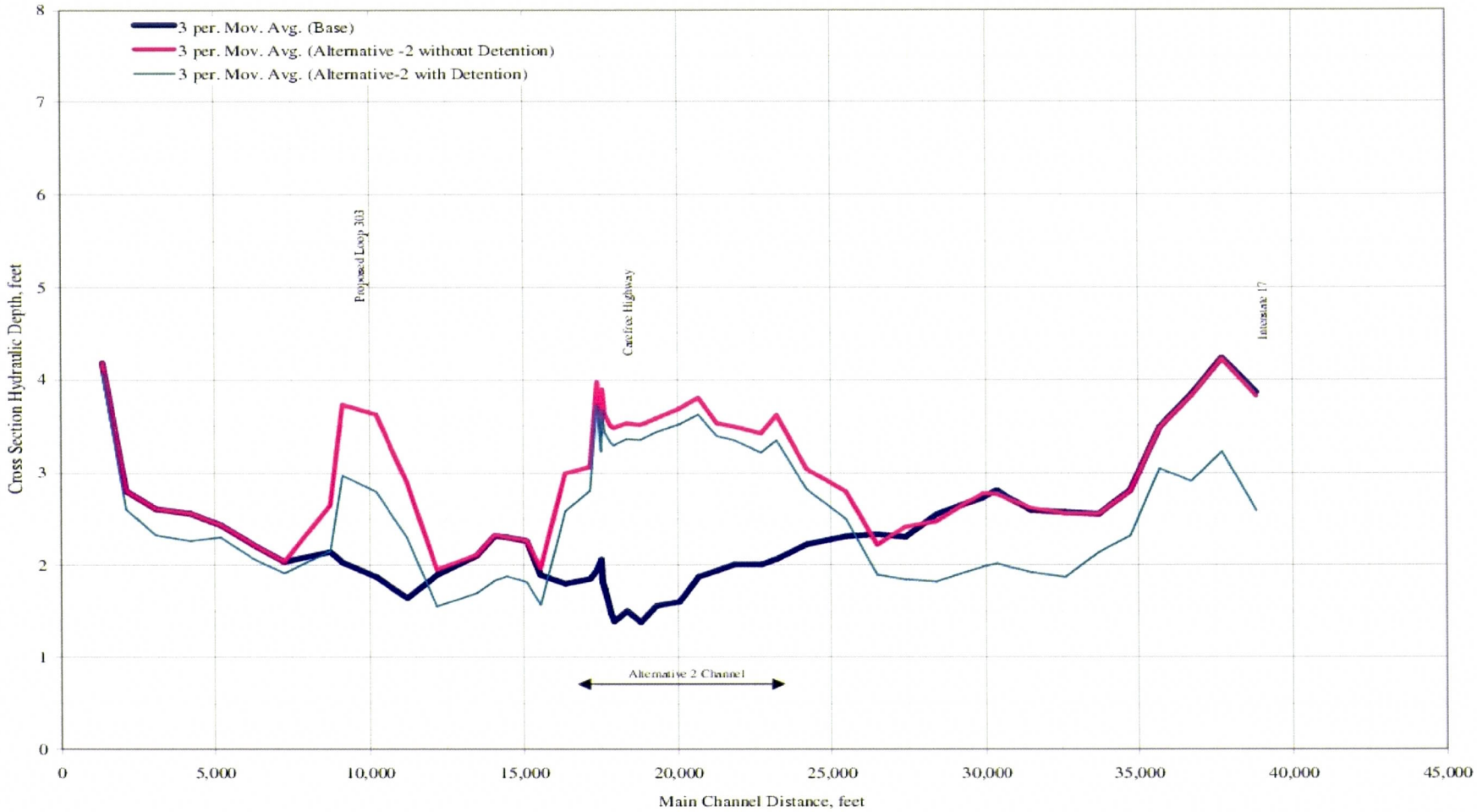

Figure 9.82 - Deadman Wash - Alterantive 2 - Comparison of Hydraulic Depth - 100-Year Event

9.4.3.6.3 Probable Cost

Table 9.25 lists a summary of the probable cost estimates of an alternative in which an implementation or construction cost could be calculated. The opinion of probablecost includes a 20 percent contingency. Appendix K includes a detailed breakdown of the construction cost estimates.

Table 9. 25
Deadman Wash Summary of Probable Cost

Alternative (1)	Probable Cost (2)
Alternative 1A –Bridge without Retention Basin Option	
Opinion of Construction Cost	$3,250,236
Land Value Offset	$0
Total	$3,250,236
Alternative 1B – Bridge with Retention Basin Option	
Opinion of Construction Cost	$13,366,810
Land Value Offset	$0
Total	$13,366,810
Alternative 2A - Channel/Bridge without Retention Basin Option	
Opinion of Construction Cost	$23,473,853
Land Value Offset	$0
Total	$23,473,853
Alternative 2B - Channel/Bridge with Retention Basin Option	
Opinion of Construction Cost	$27,885,124
Land Value Offset	$0
Total	$27,885,124

9.4.3.7 Lone Mountain, Upper Deadman, New River Dam, Rock Springs, Sweat Canyon, & West Tributaries Planning Areas

This section presents alternatives developed for the Lone Mountain, Upper Deadman, New River Dam, Rock Springs, Sweat Canyon, & West Tributaries Planning Areas. The planning areas are predominately undeveloped; therefore, a regional watershed approach is proposed to mitigate potential flood and erosion hazards due to urbanization.

Communities develop drainage ordinances, policies, and standards with the intent to mitigate/minimize flooding impacts due to urbanization of a watershed. The purpose of these regulations is to minimize the occurrence of losses, hazards and conditions adversely affecting the public health, safety and general welfare that might result from flooding caused by the surface runoff of rainfall.

The watershed planning effort considers two alternatives, an ADMP Guidelines Alternative (Alternative 1) and a FEMA Regulatory Guidelines Alternative (Alternative 2). ADMP Guidelines developed as part of the Upper New River ADMP provided a uniform approach to flood hazard mitigation and protection/enhancement of natural resources. FEMA Regulatory Guidelines provide an approach to flood hazard mitigation, however the approach may not be a uniform and the approach may not take into consideration impact to natural resources.

Alternative 1 (ADMP Guidelines) provide guidance for development so that the impacts to watercourse and associated floodplain and erosion hazard boundaries are minimized as urbanization occurs in the watershed. Non-structural solutions provided the least amount of impact to the natural form and function of a watercourse and are the recommended solution for the subject planning areas. ADMP Guidelines recognizes that there may be situations in which structural solutions are required. In situations where a structural solution is required, a structural solution that is context sensitive with scenic resources is proposed.

Alternative 2 is the No Action Alternative. The No-Action (do nothing) Alternative provides flood control management based on current federal, state, and local floodplain management regulations that allow encroachment into the floodway fringe. Typically under current regulations, encroachments into the floodway fringe are allowed in a piecemeal fashion without taking into consideration the effect of the encroachment or collective encroachments on the entire watercourse.

9.5 ALTERNATIVES SELECTION

Flood control management alternatives that were formulated for specific project areas are evaluated on how well each alternative meets the goals of the Upper New River ADMP. The evaluation process to select a recommended alternative or alternatives was based on a set of weighted criteria developed by the project team and stakeholders. The criteria are: Public Safety and Flood Hazard Mitigation, Scenery Resources, Recreation and Open Space Resources, Natural Resources and Implementation. Recommended alternatives selected for the plan are based on the overall score that an alternative receives in the evaluation process relative to the other alternatives evaluated. Descriptions of the 5 major criteria were presented in Section 8 of this report.

The alternative formulation and evaluation process was conducted in two phase. Elements of the process are:

- Phase 1
    - Flood and erosion hazards, existing and current land use; transportation plans; existing drainage infrastructure, land ownership;

scenic and recreational resources, and environmental resources were identified. Evaluation criteria were developed that were used in Phase 2 to rank each alternative.

- Preliminary flood mitigation alternatives are developed and evaluated. The formulation and evaluation of alternatives took into consideration the integration of natural resources, existing infrastructure, and land use with solutions identified to mitigate flood and erosion hazards.
- Hydrologic and hydraulic analysis of preliminary alternatives.
- The team recommends alternatives to be evaluated in Phase 2.

- Phase 2
  - Present proposed alternatives and evaluation criteria to public and stakeholders.
  - Refine evaluation criteria and assign measurement and weighting values for criteria and sub-categories.
  - Use evaluation criteria to select a Recommended Alternative.

The project team evaluated the alternatives using a value analysis approach. With input from stakeholders and the public, the project team developed weighted, measurable performance criteria to represent the Upper New River ADMP's vision, goals, and objectives. The project team used the performance criteria to evaluate the alternatives and choose the recommended alternatives. The criteria that were developed are: Public Safety and Flood Hazard Mitigation, Scenery Resources, Recreation and Open Space Resources, Natural Resources and Implementation, which are defined and described in detail below.

These criteria were defined to have quantifiable elements so the team could determine a score for each alternative. The assigned values for each criterion ranged from one to ten. A value of one indicated that the alternative "performed" poorly or ranked low with respect to that criterion; a value of ten indicated that alternative "performed" really well or ranked high with respect to that criterion. Each criterion also had a weight assigned to it, which represented the "relative importance" of each criterion in the evaluation process. The weights were assigned by using a paired comparison matrix by select members of the project team. One team member representing the various disciplines or areas of expertise (e.g., engineering, landscape architect, environmental, stakeholder involvement, etc.) took part in assigning the weights. Weighting factors of 0.5 for Recreation and Open Space Resources, 1.5 for Scenery Resources, 2.0 for Implementation, 2.5 for Natural Resources and 3.5 for Public Safety and Flood Hazard Mitigation were utilized in the evaluation.

Stakeholders and project team members met to evaluate proposed alternatives for each planning area utilizing evaluation criteria and qualitative and quantitative data (Appendix L). Team members with similar technical background and/or experience were assigned to a specific criteria evaluation team. Five teams were formulated, each representing the five major evaluation criteria. The evaluation team used criteria and associated sub-categories to rank each alterative. Criteria, subcategories scoring values and weighting values used by each team are provided in Appendix L.

Results of the alternatives evaluation for each planning area are presented in Table 9.26. The total score for each alternative is divided by probable construction of acquisition cost to obtain an overall ranking. Listings of overall alternative rankings for each planning area are provided in Table 9.27.

Watercourse specific and watershed wide alternatives were developed for some of the planning areas resulting in two or a combination of alternatives to be recommended for a planning area. For all planning areas, the ADMP Guidelines Alternative will be utilized to manage watercourses within the planning area instead of the No Action Alternative. The Non-Structural Alternative which is managed through ADMP Guidelines and the District's Floodprone Properties Assistance Program (FPAP) was selected for the Gavilan Peak, New River Upstream of I-17 Planning areas and reaches of New River in the New River Downstream I-17 Planning area and reaches of Deadman Wash for the Lower Deadman Planning Area.

Table 9.26 Alternatives Evaluation Results

Planning Area	Alternative	Scenery Resources Criteria	Recreation and Open Space Resources Criteria	Natural Resources	Public Safety and Flood Hazard Mitigation Sub-Criteria	Implementation Criteria	Total Score
Gavilan Peak	Alternative 1 - ADMP Guidelines	150	50	121	243	176	739
	Alternative 4 - No Action Alternative	66	10	108	131	124	439
	Alternative 2 - Non-Structural Gavilan Peak Wash (FPAP)	150	50	173	265	163	801
	Alternative 3 - Structural Alternative (levees)	114	39	115	189	50	507
New River Upstream of I-17	Alternative 1 - Levee along Old Stage Coach Rd. (Roadway Embankment)	114	45	99	173	38	469
	Alternative 2 - Channelization adjacent to Old Stage Coach Rd	15	18	79	227	34	373
	Alternative 3 - Floodprone Property Assistance Program	150	50	173	278	183	834
	Alternative 5 - ADMP Guidelines	150	50	121	242	176	738
	Alternative 6 - No Action	66	10	108	131	124	439

Table 9.26 Cont.
Alternatives Evaluation Results

Planning Area	Alternative	Scenery Resources Criteria	Recreation and Open Space Resources Criteria	Natural Resources	Public Safety and Flood Hazard Mitigation Sub-Criteria	Implementation Criteria	Total Score
New River Downstream I-17	Alternative 1-Levee, Option	116	41	114	185	129	584
	Alternative 1-Channel Option	36	24	105	190	32	387
	Alternative 2-Levee Option	110	41	110	185	157	601
	Alternative 2-Channel Option	30	24	101	190	32	377
	Alternative 3-Levee Option	135	41	124	175	100	574
	Alternative 4-Retention Basin	90	21	91	178	154	533
	Alternative 5 - No Action	66	10	108	131	124	439
Lower Deadman Planning Area	Alternative 1A	150	47	164	217	180	757
	Alternative 1B	36	34	123	222	77	492
	Alternative 2A	26	18	122	183	88	436
	Alternative 2B	15	13	103	192	77	400
	Alternative 3 - ADMP Guidelines	150	50	121	232	176	728
	Alternative 4 - No Action	66	10	110	131	124	441
Lone Mountain, Upper Deadman, New River Dam, Rock Springs, Sweat Canyon, & West Tributaries Planning Areas	Alternative 1 - ADMP Guidelines	150	50	121	243	176	739
	Alternative 2 - No Action	66	10	108	131	124	439

Table 9.27
Alternative Evaluation Results Divided by Cost

Planning Area	Alternative	Total Score	Probable Construction Cost	Total Score divided by probable construction cost
			$ (millions)	
Gavilan Peak	Alternative 1 - ADMP Guidelines	739	NA	NA
	Alternative 4 - No Action Alternative	439	NA	NA
	Alternative 2 - Non-Structural Gavilan Peak Wash (FPAP)	801	5.6	143
	Alternative 3 - Structural Alternative (levees)	507	5.1	99
New River Upstream of I-17	Alternative 1 - Levee along Old Stage Coach Rd. (Roadway Embankment)	469	3.9	120
	Alternative 2 - Channelization adjacent to Old Stage Coach Rd	373	6.1	61
	Alternative 3 - Floodprone Property Assistance Program	834	3.7	225
	Alternative 5 - ADMP Guidelines	738	NA	NA
	Alternative 6 - No Action	439	NA	NA
New River Downstream of I-17	Alternative 1-Levee, Option	584	14.9	39
	Alternative 1-Channel Option	387	33.0	12
	Alternative 2-Levee Option	601	1.7	354
	Alternative 2-Channel Option	377	26.5	14
	Alternative 3-Levee Option	574	7.3	79
	Alternative 4-Retention Basin	533	97.2	5
	Alternative 5 - No Action	439	NA	NA

Table 9.27 Cont.
Alternative Evaluation Results Divided by Cost

Planning Area	Alternative	Total Score	Probable Construction Cost	Total Score divided by probable construction cost
			$ (million)s	
Lower Deadman Planning Area	Alternative 1A	757	3.3	230
	Alternative 1B	492	13.4	37
	Alternative 2A	436	23.5	19
	Alternative 2B	400	27.9	14
	Alternative 3 - ADMP Guidelines	728	NA	NA
	Alternative 4 - No Action	441	NA	NA
Lone Mountain, Upper Deadman, New River Dam, Rock Springs, Sweat Canyon, & West Tributaries Planning Areas	Alternative 1 - ADMP Guidelines	739	NA	NA
	Alternative 2 - No Action	439	NA	NA

9.6 REFERENCES

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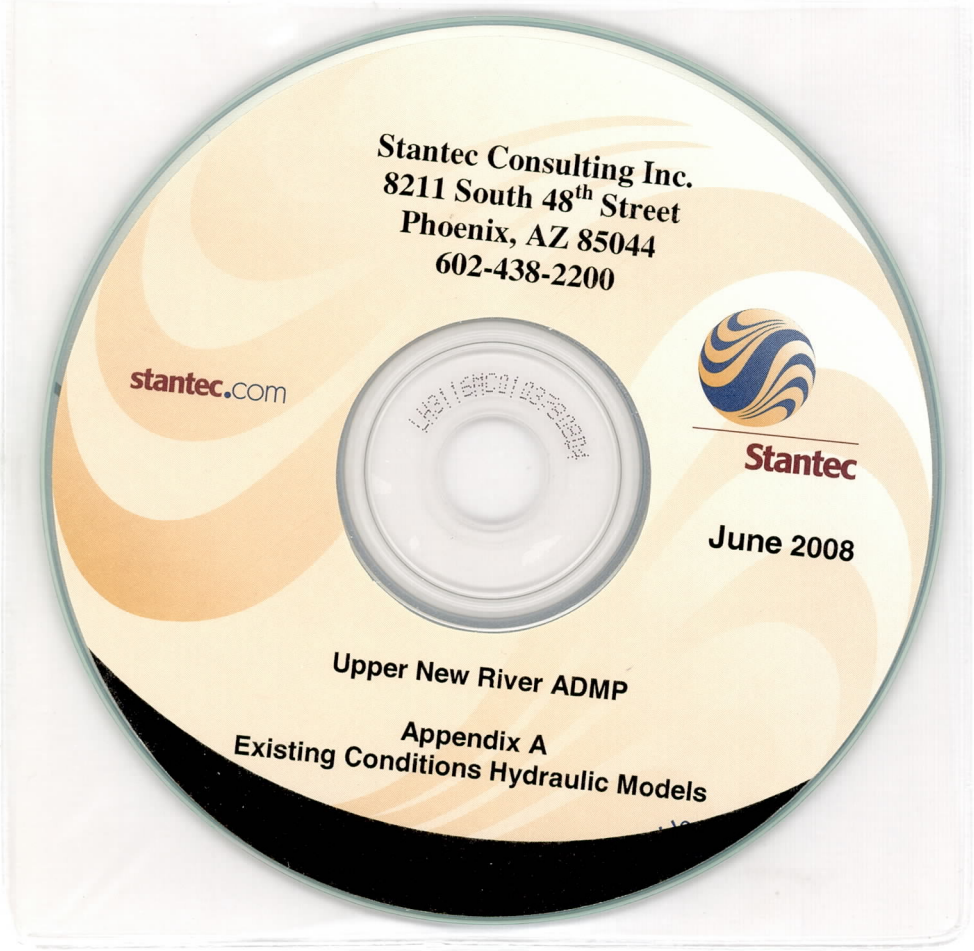


Appendix A

Digital Files for Existing Conditions Hydraulic Models

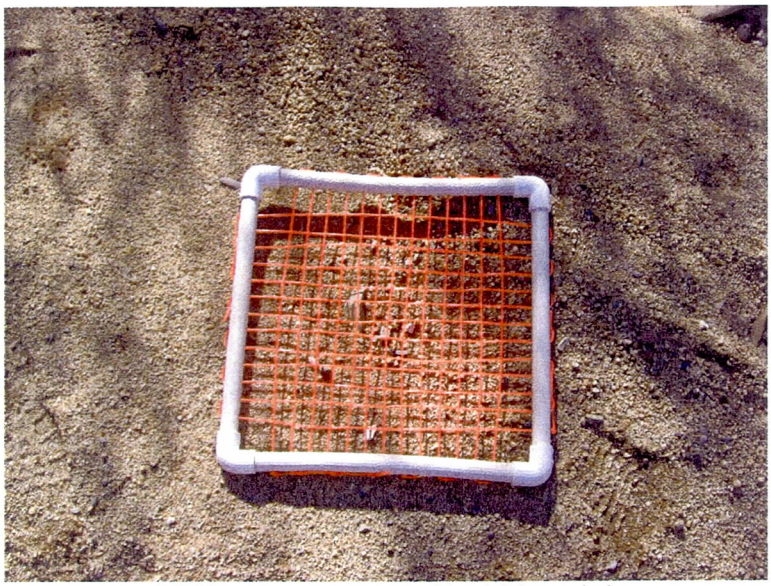
Appendix B

Field Photographs

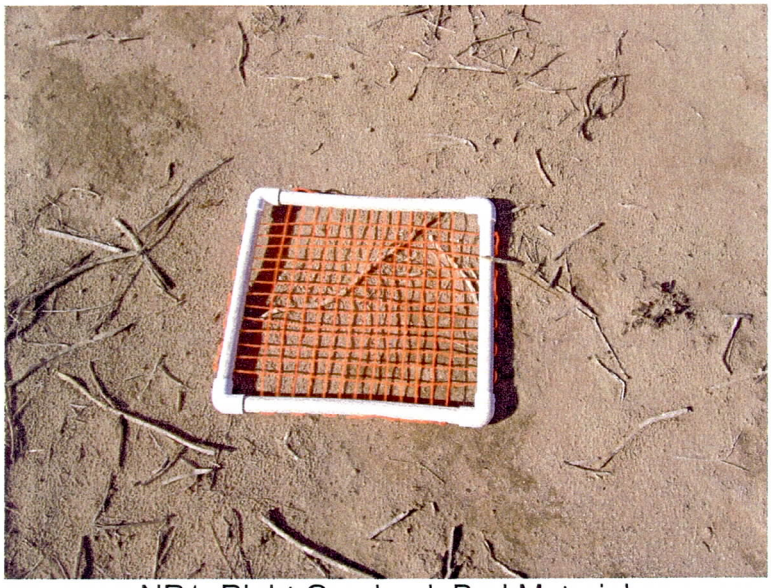
NR1: Bed Material

NR1: Looking Upstream

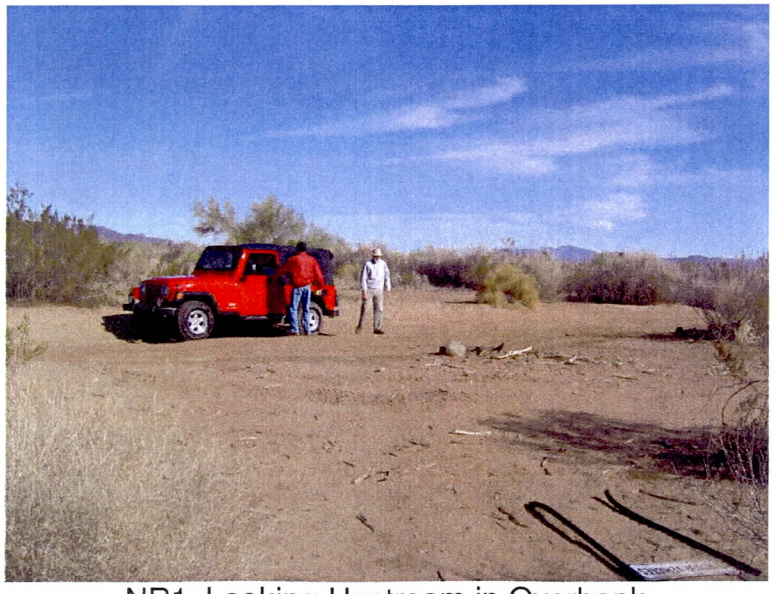
NR1: Looking Downstream



NR1: Left Overbank Bed Material



NR1: Right Overbank Bed Material



NR1: Looking Upstream in Overbank

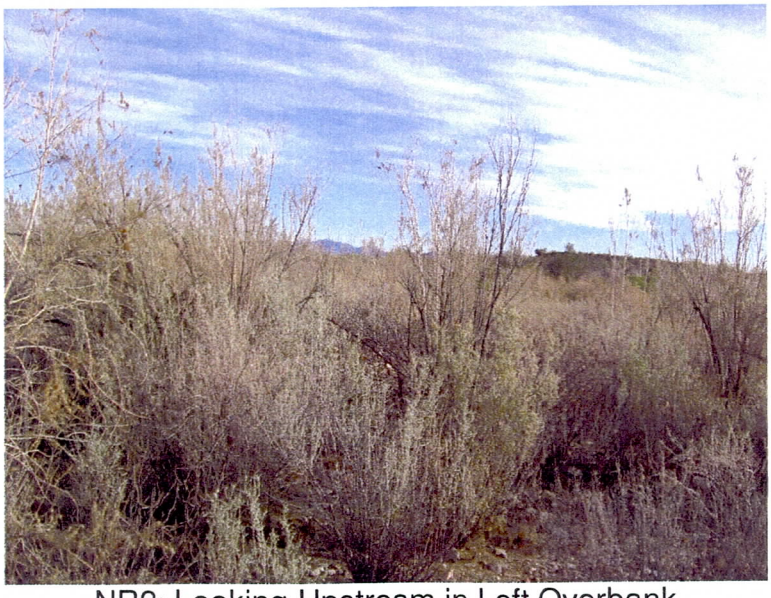
NR1: Looking Downstream in Overbank

NR2: Bed Material

NR2: Looking Upstream

NR2: Looking Downstream

NR2: Left Overbank Bed Material



NR2: Looking Upstream in Left Overbank

NR2: Looking Downstream in Left Overbank

NR2: Right Overbank Bed Material

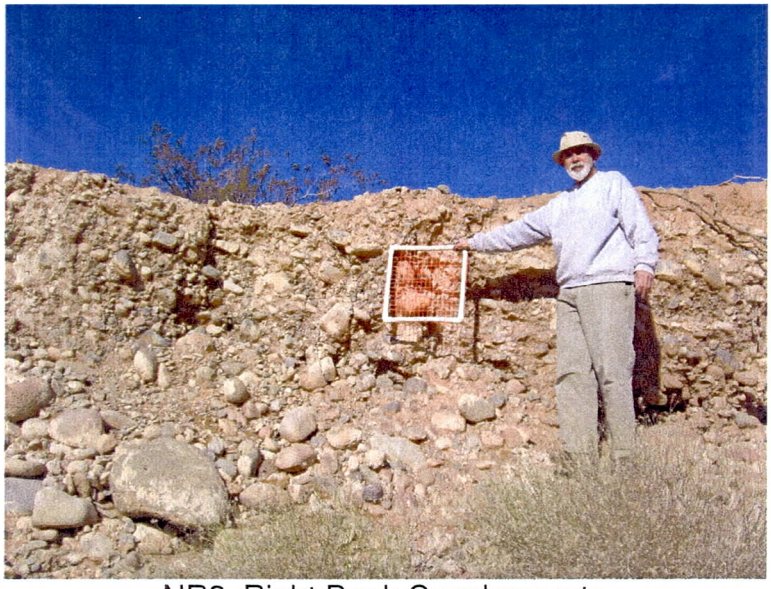
NR2: Looking Upstream in Right Overbank

NR2: Looking Downstream in Right Overbank

NR3: Bed Material

NR3: Looking Upstream

NR3: Looking Downstream



NR3: Right Bank Conglomerate

NR3: Overbank Surface Material

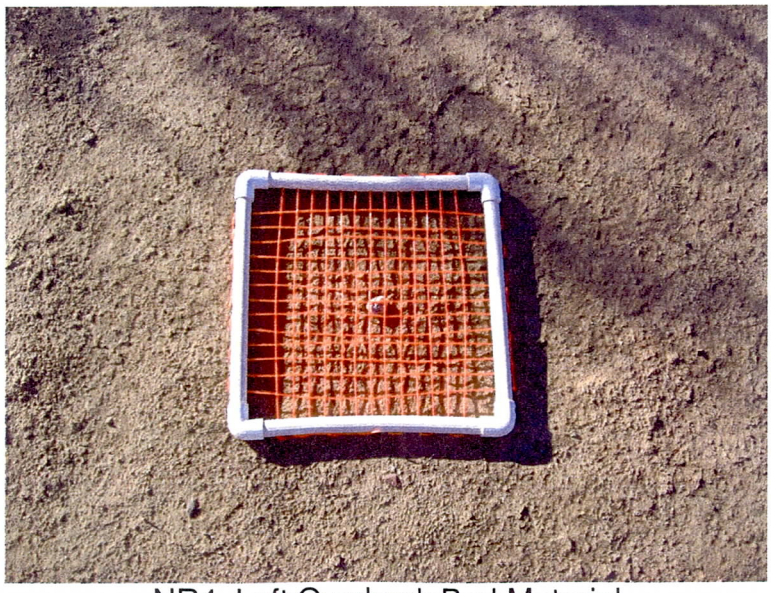
NR3: Looking Upstream in Overbank

NR3: Looking Downstream in Overbank

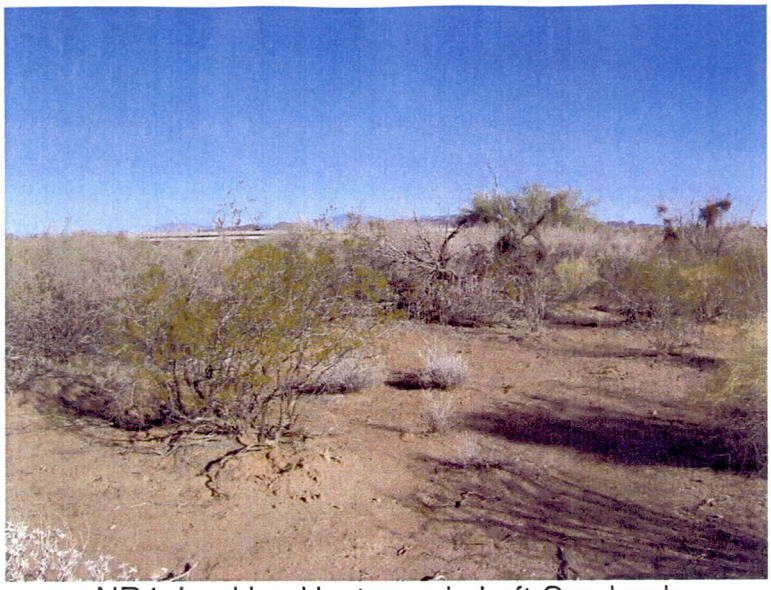
NR4: Bed Material

NR4: Looking Upstream

NR4: Looking Downstream

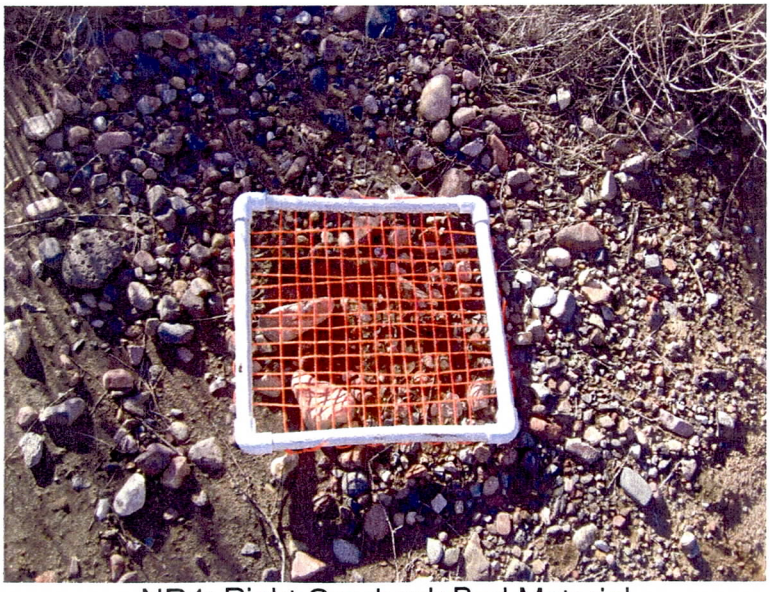


NR4: Left Overbank Bed Material



NR4: Looking Upstream in Left Overbank

NR4: Looking Downstream in Left Overbank



NR4: Right Overbank Bed Material

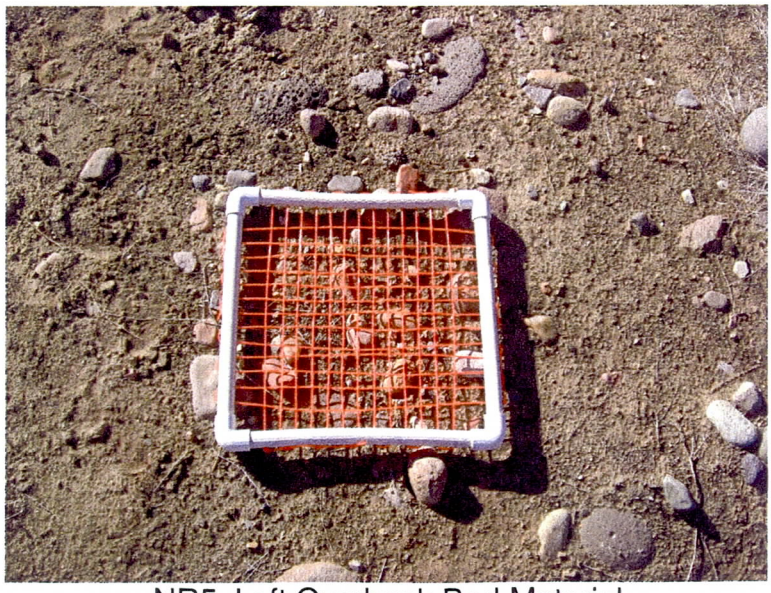
NR4: Looking Upstream in Right Overbank

NR4: Looking Downstream in Right Overbank

NR5: Bed Material

NR5: Looking Upstream

NR5: Looking Downstream



NR5: Left Overbank Bed Material

NR5: Looking Upstream in Right Overbank

NR5: Looking Downstream in Left Overbank

NR5: Right Overbank Bed Material

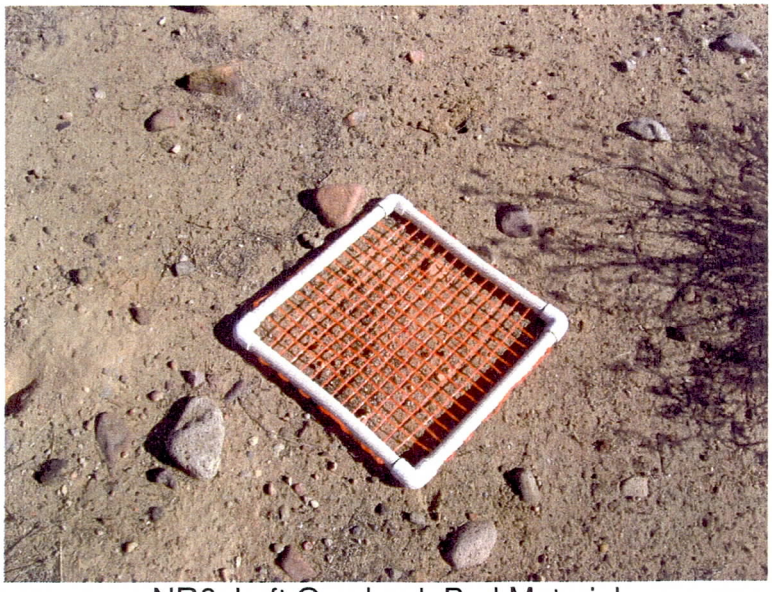
NR5: Looking Upstream in Right Overbank

NR5: Looking Downstream in Right Overbank

NR6: Bed Material

NR6: Looking Upstream

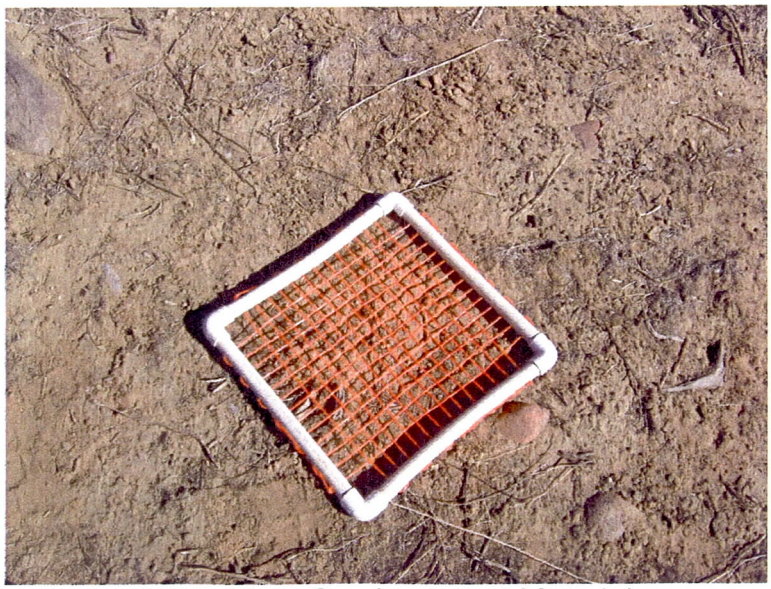
NR6: Looking Downstream



NR6: Left Overbank Bed Material

NR6: Looking Upstream in Left Overbank

NR6: Looking Downstream in Left Overbank



NR6: Right Overbank Bed Material

NR6: Looking Upstream in Right Overbank

NR6: Looking Downstream in Right Overbank

NR7: Bed Material

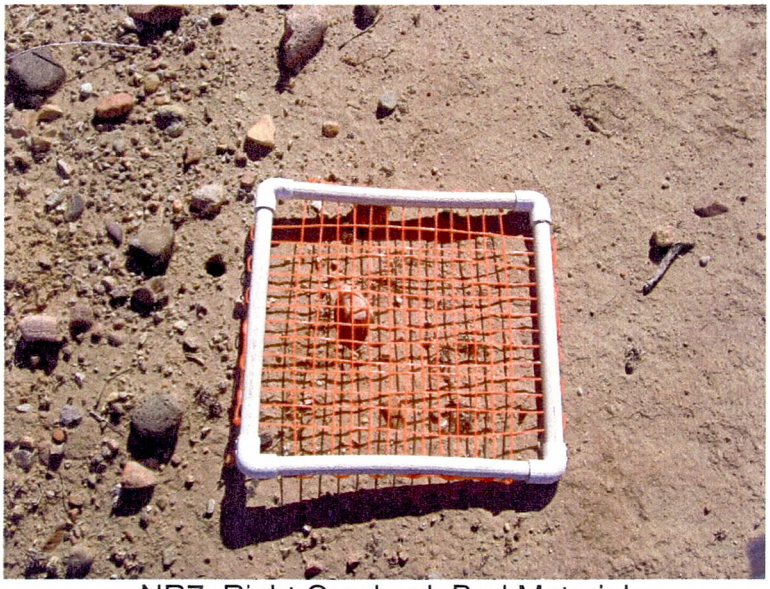
NR7: Looking Upstream

NR7: Looking Downstream

NR7: Left Overbank Bed Material

NR7: Looking Upstream in Left Overbank

NR7: Looking Downstream in Left Overbank



NR7: Right Overbank Bed Material

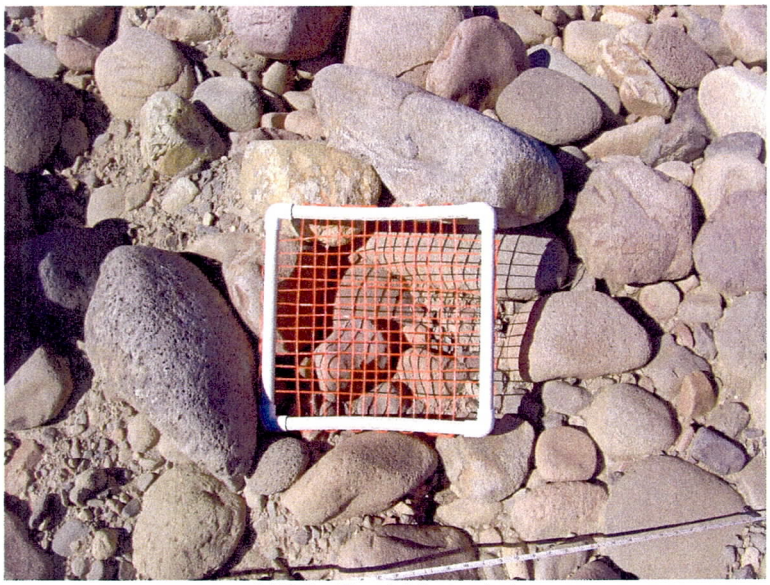
NR7: Looking Upstream in Right Overbank

NR7: Looking Downstream in Right Overbank

NR8: Bed Material

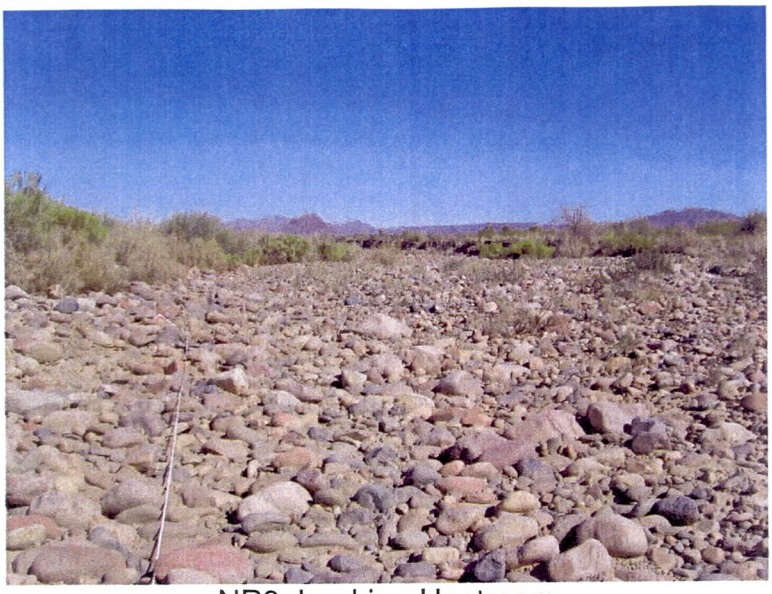
NR8: Looking Upstream

NR8: Looking Downstream

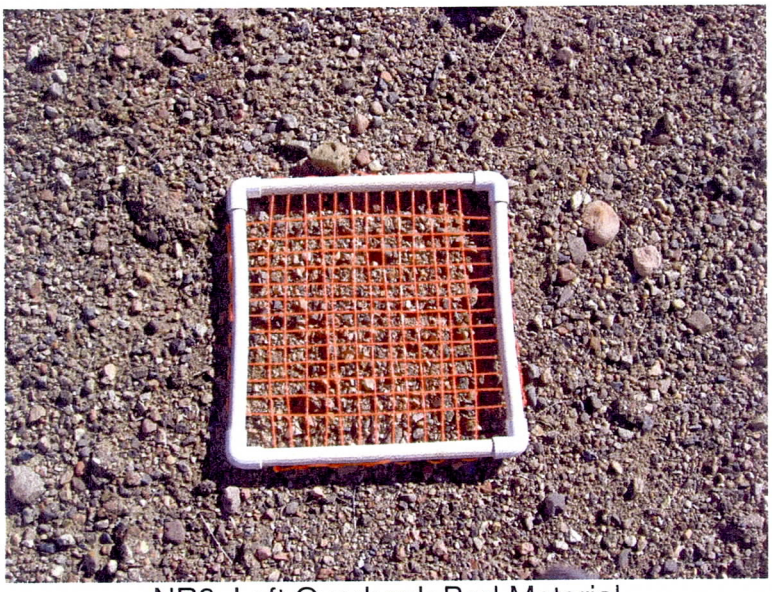


NR9: Bed Material

NR9: Looking Downstream



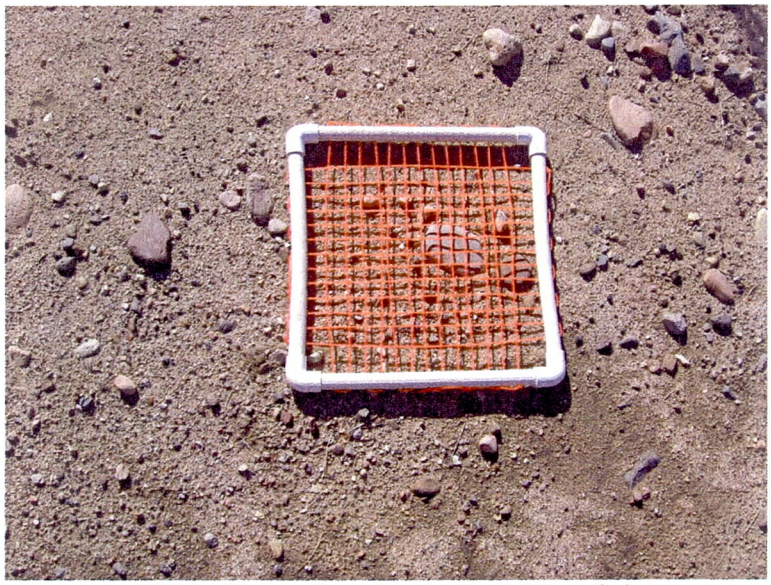
NR9: Looking Upstream



NR9: Left Overbank Bed Material

NR9: Looking Upstream in Left Overbank

NR9: Looking Downstream in Left Overbank



NR9: Right Overbank Bed Material

NR9: Looking Downstream in Right Overbank

NR9: Looking Upstream in Right Overbank

NR10: Bed Material

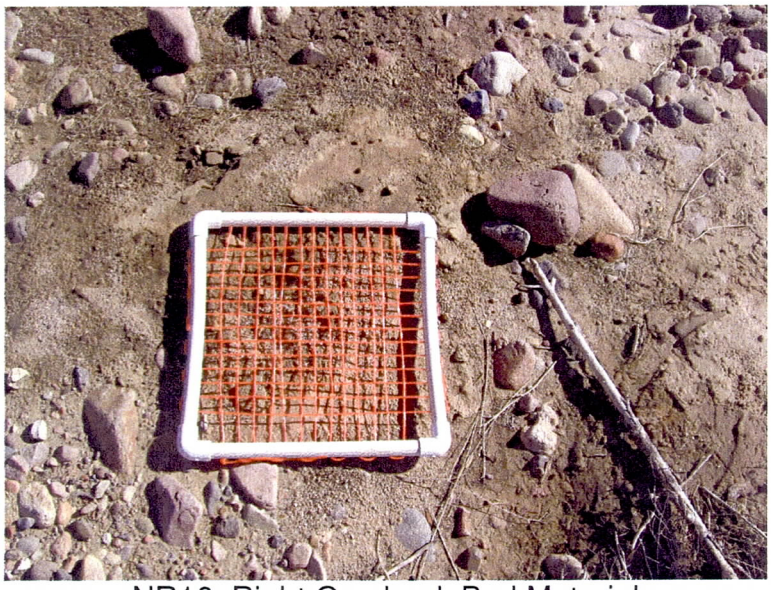
NR10: Looking Upstream

NR10: Looking Downstream

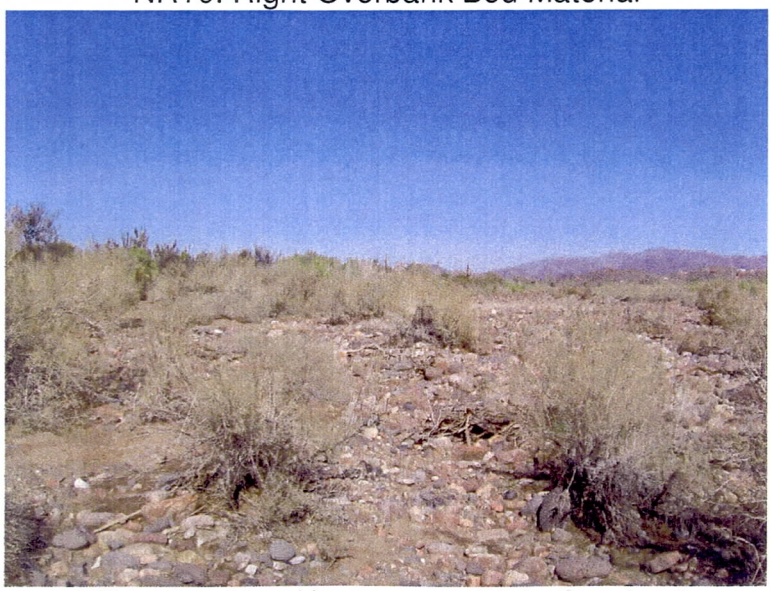
NR10: Left Overbank Bed Material

NR10: Looking Upstream in Left Overbank

NR10: Looking Downstream in Left Overbank

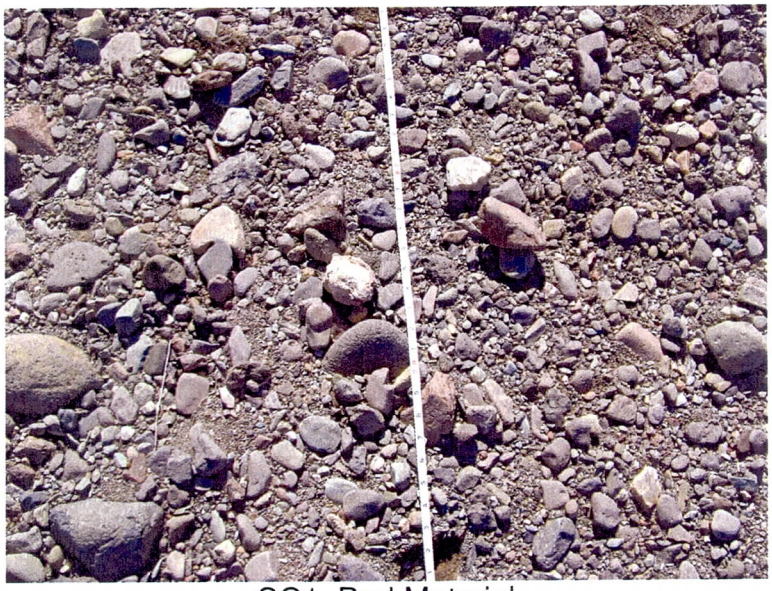


NR10: Right Overbank Bed Material



NR10: Looking Upstream in Right Overbank

NR10: Looking Downstream from Right Overbank

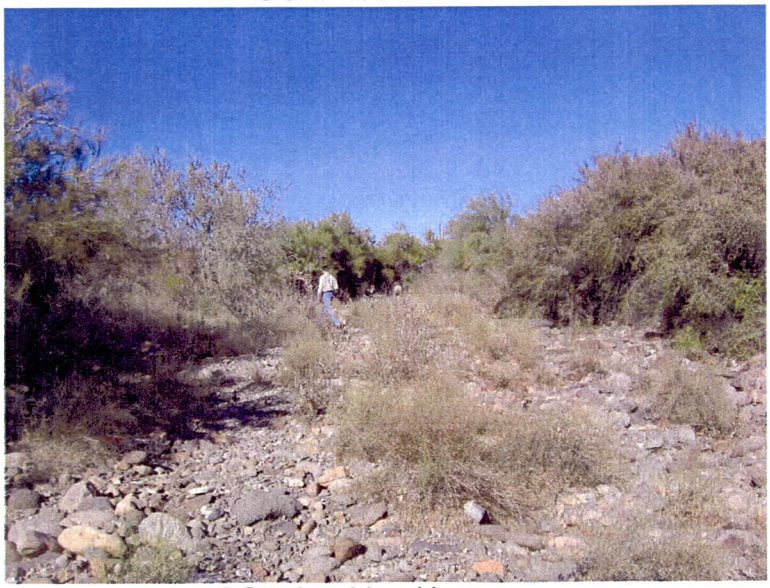


SC1: Bed Material

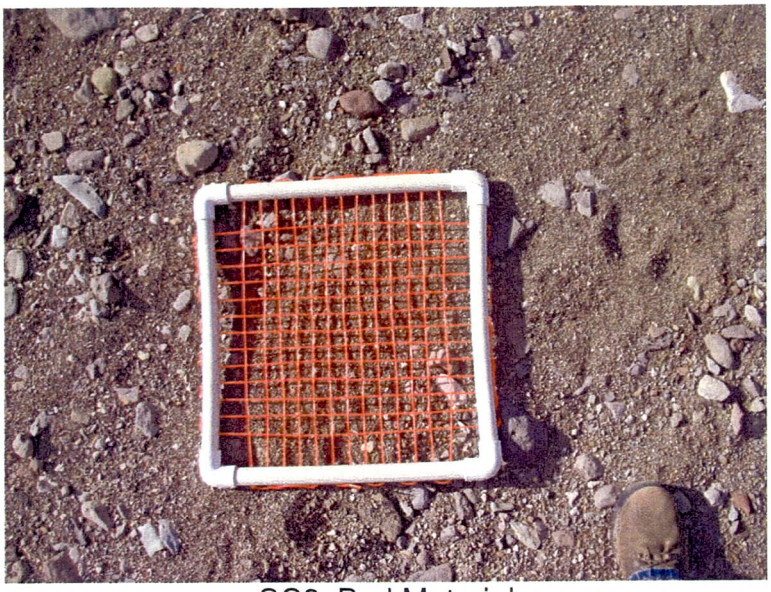
SC1: Looking Upstream

SC1: Looking Downstream

SC2: Bed Material



SC2: Looking Upstream



SC3: Bed Material

SC3: Looking Upstream

SC3: Looking Downstream

SC3: Left Overbank Bed Material

SC3: Left Overbank

SC3: Right Overbank Bed Material

SC3: Right Overbank

SC4,5,6,8: Bed Material

SC4,5,6,8: Looking Upstream

SC4,5,6,8: Looking Downstream

Appendix C

Field Photograph
Location Log

Upper New River ADMP
Upper New River Manning's *n* Value Estimation

Sampling & Photograph Location Coordinates

Location ID	Latitude (North)	Longitude (West)	Easting (X)	Northing (Y)
NR-1	33° 46' 14.09"	112° 13' 52.13"	604434.9271	1008054.437
NR-2	33° 46' 21.18"	112° 13' 27.79"	606487.1012	1008766.968
NR-3	33° 46' 37.51"	112° 13' 27.56"	606460.1573	1010543.14
NR-4	33° 47.976'	112° 7.733'	608122.4117	1017073.905
NR-5	33° 47.974'	112° 7.441'	607978.1748	1018718.532
NR-6	Not Recorded	Not Recorded	610524.7186	1019125.136
NR-7	33° 48' 58.55"	112° 12' 16.38"	612472.796	1024663.731
NR-8	Not Recorded	Not Recorded	617048.8426	1034632.915
NR-9	33° 51.423'	112° 10.521'	621496.5726	1039490.906
NR-10	33° 53.44'	112° 9.371'	627353.3305	1051709.315
SC-1	33° 49' 35.43"	112° 13' 18.54"	607346.9969	1028416.306
SC-2	33° 50' 28.33"	112° 12' 39.77"	610559.6837	1033864.89
SC-3	Not Recorded	Not Recorded	615045.1963	1041006.347

Appendix D

Manning's n Value Calculation Sheets

Determination of Manning's n-value by the FCDMC Method

Project: Upper New River ADMP
Stream: New River
Reach: RM
Photo Location: NR-1 - Just downstream of CAP

By: ia

Date: 04/10/07

pebble count location

Channel Conditions		Manning's n Adjustment		LOB 1	CH 1	LOB 2	CH 2	ROB 1	ROB 2
Channel Bed Material	Concrete	n_0	0.012 - 0.018						
	Rock Cut		0.025						
	Firm Soil		0.025 - 0.032						
	Fine Sand		0.023 - 0.026						
	Coarse Sand		0.026 - 0.035	0.033		0.030		0.030	0.033
	Gravel		0.028 - 0.035						
	Cobble		0.030 - 0.050		0.038		0.038		
	Boulder		0.040 - 0.070						
Degree of Irregularity	Smooth	n_1	0.000						
	Minor		0.001 - 0.005	0.002	0.002	0.002	0.002	0.002	0.002
	Moderate		0.006 - 0.010						
	Severe		0.011 - 0.020						
Effects of Obstructions	Negligable	n_2	0.000 - 0.004	0.000	0.001	0.000	0.001	0.000	0.000
	Minor		0.005 - 0.015						
	Appreciable		0.020 - 0.030						
	Severe		0.040 - 0.060						
Vegetation	Negligible	n_3	0.000 - 0.002						
	Small		0.002 - 0.010		0.002				
	Medium		0.010 - 0.025			0.025	0.010	0.025	
	Large		0.025 - 0.050	0.025					0.025
	Very Large		0.050 - 0.100						
	Extremely Large		0.100 - 0.200						
Variations in Channel Cross Section	Gradual	n_4	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Alternating (occasionally)		0.001 - 0.005						
	Alternating (frequently)		0.010 - 0.015						
Degree of Meandering	Minor	m	1.00	1.000	1.000	1.000	1.000	1.000	1.000
	Appreciable		1.15						
	Severe		1.30						
$n = (n_0 + n_1 + n_2 + n_3 + n_4)m$				0.060	0.043	0.057	0.051	0.057	0.060
Round values to the nearest 0.005:				**0.060**	**0.045**	**0.055**	**0.050**	**0.055**	**0.060**
Photograph No.:				1896	1890, 1891, 1892	1893, 1894, 1895	1890	1895	1895

Determination of Manning's n-value by the FCDMC Method

Project: Upper New River ADMP
Stream: New River
Reach: RM
By: ia
Date: 04/10/07
Photo Location NR-2 - Just downstream of Deadman and New River Confluence
pebble count location

Channel Conditions		Manning's n Adjustment		LOB 1	CH 1	LOB 2	CH 2	LOB 3	CH 3	ROB 1	ROB 2
Channel Bed Material	Concrete	n_0	0.012 - 0.018								
	Rock Cut		0.025								
	Firm Soil		0.025 - 0.032								
	Fine Sand		0.023 - 0.026								
	Coarse Sand		0.026 - 0.035	0.033		0.033		0.030		0.030	0.033
	Gravel		0.028 - 0.035								
	Cobble		0.030 - 0.050		0.038		0.038		0.038		
	Boulder		0.040 - 0.070								
Degree of Irregularity	Smooth	n_1	0.000								
	Minor		0.001 - 0.005	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
	Moderate		0.006 - 0.010								
	Severe		0.011 - 0.020								
Effects of Obstructions	Negligable	n_2	0.000 - 0.004	0.000	0.001	0.000	0.001	0.000	0.001	0.000	0.000
	Minor		0.005 - 0.015								
	Appreciable		0.020 - 0.030								
	Severe		0.040 - 0.060								
Vegetation	Negligible	n_3	0.000 - 0.002								
	Small		0.002 - 0.010		0.002		0.002				
	Medium		0.010 - 0.025					0.025	0.010	0.025	
	Large		0.025 - 0.050	0.025		0.025					0.025
	Very Large		0.050 - 0.100								
	Extremely Large		0.100 - 0.200								
Variations in Channel Cross Section	Gradual	n_4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Alternating (occasionally)		0.001 - 0.005								
	Alternating (frequently)		0.010 - 0.015								
Degree of Meandering	Minor	m	1.00	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	Appreciable		1.15								
	Severe		1.30								
$n = (n_0 + n_1 + n_2 + n_3 + n_4)m$				0.060	0.043	0.060	0.043	0.057	0.051	0.057	0.060
Round values to the nearest 0.005:				**0.060**	**0.045**	**0.060**	**0.045**	**0.055**	**0.050**	**0.055**	**0.060**
Photograph No.:				1868, 1869, 1870	1865, 1866, 1867	1869, 1870	1866	1871, 1872, 1873	1890	1873	1950

Determination of Manning's n-value by the FCDMC method

Project: Upper New River ADMP
Stream: New River
Reach: RM
Photo Location NR-3 - Just upstream of CAP

By: ia

Date: 04/10/07

pebble count location

Channel Conditions		Manning's n Adjustment		LOB 1	CH 1	LOB 2	LOB 3	CH 2	LOB 4	LOB 5	CH 3	ROB 1	ROB 2
Channel Bed Material	Concrete	n_0	0.012 - 0.018										
	Rock Cut		0.025										
	Firm Soil		0.025 - 0.032										
	Fine Sand		0.023 - 0.026										
	Coarse Sand		0.026 - 0.035	0.028		0.028	0.028		0.028	0.028		0.028	0.028
	Gravel		0.028 - 0.035										
	Cobble		0.030 - 0.050		0.035			0.035			0.035		
	Boulder		0.040 - 0.070										
Degree of Irregularity	Smooth	n_1	0.000										
	Minor		0.001 - 0.005	0.001	0.002	0.002	0.001	0.002	0.002	0.001	0.002	0.001	0.002
	Moderate		0.006 - 0.010										
	Severe		0.011 - 0.020										
Effects of Obstructions	Negligable	n_2	0.000 - 0.004	0.000	0.002	0.000	0.000	0.002	0.000	0.000	0.002	0.000	0.000
	Minor		0.005 - 0.015										
	Appreciable		0.020 - 0.030										
	Severe		0.040 - 0.060										
Vegetation	Negligible	n_3	0.000 - 0.002										
	Small		0.002 - 0.010					0.007					
	Medium		0.010 - 0.025		0.015	0.025					0.015	0.025	
	Large		0.025 - 0.050	0.025			0.025		0.027	0.025			0.027
	Very Large		0.050 - 0.100										
	Extremely Large		0.100 - 0.200										
Variations in Channel Cross Section	Gradual	n_4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Alternating (occasionally)		0.001 - 0.005										
	Alternating (frequently)		0.010 - 0.015										
Degree of Meandering	Minor	m	1.00	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	Appreciable		1.15										
	Severe		1.30										
$n = (n_0 + n_1 + n_2 + n_3 + n_4)m$				0.054	0.054	0.055	0.054	0.046	0.057	0.054	0.054	0.054	0.057
Round values to the nearest 0.005:				**0.055**	**0.050**	**0.055**	**0.055**	**0.045**	**0.060**	**0.055**	**0.050**	**0.055**	**0.060**
Photograph No.:				1885	1881	1885	1884,1885,1886	1880,1881,1882	1883	1885	1881	1885	1886

Determination of Manning's n-value by the FCDMC method

Project: Upper New River ADMP
Stream: New River
Reach: RM
By: ia
Date: 04/10/07
Photo Location NR-4 - Just downstream of Carefree Highway (West) Bridge

pebble count location
map

Channel Conditions		Manning's n Adjustment		LOB 1	CH 1	LOB 2	CH 2	LOB 3	CH 3	LOB 4	CH 4	LOB 5	CH 5	ROB 1	CH 6	ROB 2
Channel Bed Material	Concrete	n_0	0.012 - 0.018													
	Rock Cut		0.025													
	Firm Soil		0.025 - 0.032													
	Fine Sand		0.023 - 0.026													
	Coarse Sand		0.026 - 0.035	0.028		0.028		0.028		0.028		0.028		0.028		0.028
	Gravel		0.028 - 0.035													
	Cobble		0.030 - 0.050		0.040		0.040		0.040		0.040				0.040	
	Boulder		0.040 - 0.070										0.045			
Degree of Irregularity	Smooth	n_1	0.000													
	Minor		0.001 - 0.005	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
	Moderate		0.006 - 0.010													
	Severe		0.011 - 0.020													
Effects of Obstructions	Negligable	n_2	0.000 - 0.004	0.000	0.001	0.000	0.001	0.000	0.001	0.000	0.001	0.000	0.001	0.000	0.001	0.000
	Minor		0.005 - 0.015													
	Appreciable		0.020 - 0.030													
	Severe		0.040 - 0.060													
Vegetation	Negligible	n_3	0.000 - 0.002													
	Small		0.002 - 0.010													
	Medium		0.010 - 0.025		0.010		0.010		0.010		0.010		0.007			
	Large		0.025 - 0.050	0.027		0.027		0.027		0.027		0.028		0.028	0.010	0.028
	Very Large		0.050 - 0.100													
	Extremely Large		0.100 - 0.200													
Variations in Channel Cross Section	Gradual	n_4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Alternating (occasionally)		0.001 - 0.005													
	Alternating (frequently)		0.010 - 0.015													
Degree of Meandering	Minor	m	1.00	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	Appreciable		1.15													
	Severe		1.30													
$n = (n_0 + n_1 + n_2 + n_3 + n_4)m$				0.056	0.052	0.056	0.052	0.056	0.052	0.056	0.052	0.057	0.054	0.057	0.052	0.057
Round values to the nearest 0.005:				**0.055**	**0.050**	**0.055**	**0.050**	**0.055**	**0.050**	**0.055**	**0.050**	**0.060**	**0.050**	**0.060**	**0.050**	**0.060**
Photograph No.:				1885	1947	1885	1947	1885	1947	1885	1947	1948, 1949, 1950	1942, 1946, 1947	1951, 1952, 1953	1947	1950

Project: Upper New River ADMP
Stream: New River
Reach: RM
Photo Location NR-5 - Just upstream of Carefree Highway (West) Bridge

Determination of Manning's n-value by the FCDMC method

By: ia Date: 04/10/07

pebble count location
main

Channel Conditions		Manning's n Adjustment		LOB 1	CH 1	LOB 2	CH 2	LOB 3	CH 3	LOB 4	CH 4	LOB 5	CH 5	ROB 1
Channel Bed Material	Concrete	n_0	0.012 - 0.018											
	Rock Cut		0.025											
	Firm Soil		0.025 - 0.032											
	Fine Sand		0.023 - 0.026											
	Coarse Sand		0.026 - 0.035	0.030		0.030		0.030		0.030		0.030		0.030
	Gravel		0.028 - 0.035		0.035		0.035		0.035					
	Cobble		0.030 - 0.050								0.035		0.035	
	Boulder		0.040 - 0.070											
Degree of Irregularity	Smooth	n_1	0.000											
	Minor		0.001 - 0.005	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
	Moderate		0.006 - 0.010											
	Severe		0.011 - 0.020											
Effects of Obstructions	Negligable	n_2	0.000 - 0.004	0.000	0.001	0.000	0.001	0.000	0.001	0.000	0.001	0.000	0.001	0.000
	Minor		0.005 - 0.015											
	Appreciable		0.020 - 0.030											
	Severe		0.040 - 0.060											
Vegetation	Negligible	n_3	0.000 - 0.002											
	Small		0.002 - 0.010											
	Medium		0.010 - 0.025	0.025	0.010	0.025	0.010	0.025	0.010		0.010	0.025	0.010	
	Large		0.025 - 0.050							0.027				0.027
	Very Large		0.050 - 0.100											
	Extremely Large		0.100 - 0.200											
Variations in Channel Cross Section	Gradual	n_4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Alternating (occasionally)		0.001 - 0.005											
	Alternating (frequently)		0.010 - 0.015											
Degree of Meandering	Minor	m	1.00	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	Appreciable		1.15											
	Severe		1.30											
$n = (n_0 + n_1 + n_2 + n_3 + n_4)m$				0.056	0.047	0.056	0.047	0.056	0.047	0.058	0.047	0.056	0.047	0.058
Round values to the nearest 0.005:				**0.055**	**0.050**	**0.055**	**0.050**	**0.055**	**0.050**	**0.060**	**0.050**	**0.055**	**0.050**	**0.060**
Photograph No.:				1885	1959	1885	1959	1885	1959	1965	1959	1960, 1961, 1962	1954, 1958, 1959	1963, 1964, 1965

Determination of Manning's n-value by the FCDMC method

Project: Upper New River ADMP
Stream: New River
Reach: RM
By: ia
Date: 04/10/07
Photo Location NR-6 - Just upstream of Carefree Highway (East) Bridge

pebble count location

Channel Conditions		Manning's n Adjustment		LOB 1	CH 1	LOB 2	CH 2	LOB 3	CH 3	LOB 4	CH 4	ROB 1	CH 5	ROB 2
Channel Bed Material	Concrete	n_0	0.012 - 0.018											
	Rock Cut		0.025											
	Firm Soil		0.025 - 0.032											
	Fine Sand		0.023 - 0.026											
	Coarse Sand		0.026 - 0.035	0.030		0.030		0.030		0.030		0.030		0.030
	Gravel		0.028 - 0.035		0.035		0.035							
	Cobble		0.030 - 0.050						0.035		0.035		0.035	
	Boulder		0.040 - 0.070											
Degree of Irregularity	Smooth	n_1	0.000	0.000		0.000		0.000				0.000		
	Minor		0.001 - 0.005		0.002		0.002		0.002	0.001	0.002		0.002	0.001
	Moderate		0.006 - 0.010											
	Severe		0.011 - 0.020											
Effects of Obstructions	Negligable	n_2	0.000 - 0.004	0.000	0.001	0.000	0.001	0.000	0.001	0.000	0.001	0.000	0.001	0.000
	Minor		0.005 - 0.015											
	Appreciable		0.020 - 0.030											
	Severe		0.040 - 0.060											
Vegetation	Negligible	n_3	0.000 - 0.002											
	Small		0.002 - 0.010											
	Medium		0.010 - 0.025	0.025	0.013	0.025	0.013	0.025	0.013		0.013	0.025	0.013	
	Large		0.025 - 0.050											
	Very Large		0.050 - 0.100							0.027				0.027
	Extremely Large		0.100 - 0.200											
Variations in Channel Cross Section	Gradual	n_4	0.000	0.000		0.000		0.000		0.000		0.000		0.000
	Alternating (occasionally)		0.001 - 0.005		0.003		0.003		0.003		0.003		0.003	
	Alternating (frequently)		0.010 - 0.015											
Degree of Meandering	Minor	m	1.00	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	Appreciable		1.15											
	Severe		1.30											
$n = (n_0 + n_1 + n_2 + n_3 + n_4)m$				0.055	0.054	0.055	0.054	0.055	0.054	0.058	0.054	0.055	0.054	0.058
Round values to the nearest 0.005:				**0.055**	**0.050**	**0.055**	**0.050**	**0.055**	**0.050**	**0.060**	**0.050**	**0.055**	**0.050**	**0.060**
Photograph No.:				1544	1959	1544	1540	1542, 1543, 1544	1536, 1540, 1541	1545, 1546, 1547	1958	1547	1958	1547

Project: Upper New River ADMP
Stream: New River
Reach: RM
Photo Location NR-7 - Between Power & Water Line

Determination of Manning's n-value by the FCDMC method

By: ia Date: 04/10/07

pebble count location

Channel Conditions		Manning's n Adjustment		LOB 1	LOB 2	LOB 3	CH 1	LOB 4	LOB 5	LOB 6	CH 2	LOB 7	CH 3	ROB 1	CH 4	ROB 2
Channel Bed Material	Concrete	n_0	0.012 - 0.018													
	Rock Cut		0.025													
	Firm Soil		0.025 - 0.032													
	Fine Sand		0.023 - 0.026													
	Coarse Sand		0.026 - 0.035	0.030	0.030	0.030		0.030	0.030	0.030		0.030		0.030		0.030
	Gravel		0.028 - 0.035				0.035									
	Cobble		0.030 - 0.050								0.037		0.037		0.037	
	Boulder		0.040 - 0.070													
Degree of Irregularity	Smooth	n_1	0.000													
	Minor		0.001 - 0.005	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.001
	Moderate		0.006 - 0.010													
	Severe		0.011 - 0.020													
Effects of Obstructions	Negligable	n_2	0.000 - 0.004	0.000	0.000	0.000	0.002	0.000	0.000	0.000	0.002	0.000	0.002	0.000	0.002	0.000
	Minor		0.005 - 0.015													
	Appreciable		0.020 - 0.030													
	Severe		0.040 - 0.060													
Vegetation	Negligible	n_3	0.000 - 0.002													
	Small		0.002 - 0.010													
	Medium		0.010 - 0.025				0.013				0.013		0.013		0.013	
	Large		0.025 - 0.050	0.025	0.034	0.025		0.025	0.034	0.025		0.025		0.025		0.027
	Very Large		0.050 - 0.100													
	Extremely Large		0.100 - 0.200													
Variations in Channel Cross Section	Gradual	n_4	0.000	0.000	0.000	0.000		0.000	0.000	0.000		0.000		0.000		0.000
	Alternating (occasionally)		0.001 - 0.005				0.002				0.002		0.002		0.002	
	Alternating (frequently)		0.010 - 0.015													
Degree of Meandering	Minor	m	1.00	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	Appreciable		1.15													
	Severe		1.30													
$n = (n_0 + n_1 + n_2 + n_3 + n_4)m$				0.057	0.066	0.057	0.054	0.057	0.066	0.057	0.056	0.057	0.056	0.057	0.056	0.058
Round values to the nearest 0.005:				**0.055**	**0.065**	**0.055**	**0.050**	**0.055**	**0.065**	**0.055**	**0.050**	**0.055**	**0.050**	**0.055**	**0.050**	**0.060**
Photograph No.:				1922	1923	1922	1916	1922	1923	1921, 1922, 1923	1915, 1916, 1917	1918, 1919, 1920	1916	1920	1916	1919

Determination of Manning's n-value by the FCDMC method

Project: Upper New River ADMP
Stream: New River
Reach: RM
By: ia
Date: 04/10/07
Photo Location NR-8 - On Main Stem, east of the triangular pit in diversion (west split) channel

Channel Conditions		Manning's n Adjustment		LOB 1	CH 1	LOB 2
Channel Bed Material	Concrete	n_0	0.012 - 0.018			
	Rock Cut		0.025			
	Firm Soil		0.025 - 0.032			
	Fine Sand		0.023 - 0.026			
	Coarse Sand		0.026 - 0.035	0.030		0.030
	Gravel		0.028 - 0.035			
	Cobble		0.030 - 0.050		0.040	
	Boulder		0.040 - 0.070			
Degree of Irregularity	Smooth	n_1	0.000			
	Minor		0.001 - 0.005	0.002	0.001	0.001
	Moderate		0.006 - 0.010			
	Severe		0.011 - 0.020			
Effects of Obstructions	Negligable	n_2	0.000 - 0.004	0.000	0.001	0.000
	Minor		0.005 - 0.015			
	Appreciable		0.020 - 0.030			
	Severe		0.040 - 0.060			
Vegetation	Negligible	n_3	0.000 - 0.002			
	Small		0.002 - 0.010		0.010	
	Medium		0.010 - 0.025	0.025		0.025
	Large		0.025 - 0.050			
	Very Large		0.050 - 0.100			
	Extremely Large		0.100 - 0.200			
Variations in Channel Cross Section	Gradual	n_4	0.000	0.000	0.000	0.000
	Alternating (occasionally)		0.001 - 0.005			
	Alternating (frequently)		0.010 - 0.015			
Degree of Meandering	Minor	m	1.00	1.000	1.000	1.000
	Appreciable		1.15			
	Severe		1.30			
$n = (n_0 + n_1 + n_2 + n_3 + n_4)m$				0.057	0.052	0.056
Round values to the nearest 0.005:				**0.055**	**0.050**	**0.055**
Photograph No.:				Aerials	1570, 1576, 1577	Aerials

Determination of Manning's n-value by the FCDMC method

Project: Upper New River ADMP
Stream: New River
Reach: RM
By: ia
Date: 04/10/07
Photo Location NR-9 - Just Below West Split on the Main Stem

Channel Conditions		Manning's n Adjustment		LOB	Main Channel	ROB
Channel Bed Material	Concrete	n_0	0.012 - 0.018			
	Rock Cut		0.025			
	Firm Soil		0.025 - 0.032			
	Fine Sand		0.023 - 0.026			
	Coarse Sand		0.026 - 0.035			0.030
	Gravel		0.028 - 0.035	0.033		
	Cobble		0.030 - 0.050			
	Boulder		0.040 - 0.070		0.050	
Degree of Irregularity	Smooth	n_1	0.000		0.000	
	Minor		0.001 - 0.005	0.001		0.001
	Moderate		0.006 - 0.010			
	Severe		0.011 - 0.020			
Effects of Obstructions	Negligable	n_2	0.000 - 0.004	0.000	0.001	0.000
	Minor		0.005 - 0.015			
	Appreciable		0.020 - 0.030			
	Severe		0.040 - 0.060			
Vegetation	Negligible	n_3	0.000 - 0.002			
	Small		0.002 - 0.010		0.003	
	Medium		0.010 - 0.025	0.023		0.025
	Large		0.025 - 0.050			
	Very Large		0.050 - 0.100			
	Extremely Large		0.100 - 0.200			
Variations in Channel Cross Section	Gradual	n_4	0.000	0.000	0.000	0.000
	Alternating (occasionally)		0.001 - 0.005			
	Alternating (frequently)		0.010 - 0.015			
Degree of Meandering	Minor	m	1.00	1.000	1.000	1.000
	Appreciable		1.15			
	Severe		1.30			
$n = (n_0 + n_1 + n_2 + n_3 + n_4)m$				0.057	0.054	0.056
Round values to the nearest 0.005:				**0.055**	**0.050**	**0.055**
Photograph No.:				1980, 1981, 1982	1970, 1974, 1975	1976, 1977, 1978

Determination of Manning's n-value by the FCDMC method

Project: Upper New River ADMP
Stream: New River
Reach: RM
By: ia
Date: 04/10/07
Photo Location NR-10 - Just North of Anthem Sub-division on the main stem

Channel Conditions		Manning's n Adjustment		LOB	Main Channel	ROB
Channel Bed Material	Concrete	n_0	0.012 - 0.018			
	Rock Cut		0.025			
	Firm Soil		0.025 - 0.032			
	Fine Sand		0.023 - 0.026			
	Coarse Sand		0.026 - 0.035	0.030		
	Gravel		0.028 - 0.035			
	Cobble		0.030 - 0.050			0.033
	Boulder		0.040 - 0.070		0.045	
Degree of Irregularity	Smooth	n_1	0.000			
	Minor		0.001 - 0.005	0.001	0.002	0.001
	Moderate		0.006 - 0.010			
	Severe		0.011 - 0.020			
Effects of Obstructions	Negligable	n_2	0.000 - 0.004	0.000	0.001	0.000
	Minor		0.005 - 0.015			
	Appreciable		0.020 - 0.030			
	Severe		0.040 - 0.060			
Vegetation	Negligible	n_3	0.000 - 0.002			
	Small		0.002 - 0.010		0.002	
	Medium		0.010 - 0.025	0.023		0.025
	Large		0.025 - 0.050			
	Very Large		0.050 - 0.100			
	Extremely Large		0.100 - 0.200			
Variations in Channel Cross Section	Gradual	n_4	0.000	0.000	0.000	0.000
	Alternating (occasionally)		0.001 - 0.005			
	Alternating (frequently)		0.010 - 0.015			
Degree of Meandering	Minor	m	1.00	1.000	1.000	1.000
	Appreciable		1.15			
	Severe		1.30			
$n = (n_0 + n_1 + n_2 + n_3 + n_4)m$				0.054	0.050	0.059
Round values to the nearest 0.005:				**0.055**	**0.050**	**0.060**
Photograph No.:				1993, 1994, 1995	1985, 1986, 1987	1988, 1989, 1990

Determination of Manning's n-value by the FCDMC method

Project: Upper New River ADMP
Stream: Sweat Canyon Wash
Reach: RM
By: ia
Date: 04/10/07
Photo Location SC-1 - At the confluence with New River West split

Channel Conditions		Manning's n Adjustment		LOB	Main Channel	ROB
Channel Bed Material	Concrete	n_0	0.012 - 0.018			
	Rock Cut		0.025			
	Firm Soil		0.025 - 0.032			
	Fine Sand		0.023 - 0.026			
	Coarse Sand		0.026 - 0.035	0.030		0.030
	Gravel		0.028 - 0.035			
	Cobble		0.030 - 0.050		0.035	
	Boulder		0.040 - 0.070			
Degree of Irregularity	Smooth	n_1	0.000			
	Minor		0.001 - 0.005	0.001	0.002	0.001
	Moderate		0.006 - 0.010			
	Severe		0.011 - 0.020			
Effects of Obstructions	Negligable	n_2	0.000 - 0.004	0.000	0.001	0.000
	Minor		0.005 - 0.015			
	Appreciable		0.020 - 0.030			
	Severe		0.040 - 0.060			
Vegetation	Negligible	n_3	0.000 - 0.002			
	Small		0.002 - 0.010		0.002	
	Medium		0.010 - 0.025			
	Large		0.025 - 0.050	0.030		0.030
	Very Large		0.050 - 0.100			
	Extremely Large		0.100 - 0.200			
Variations in Channel Cross Section	Gradual	n_4	0.000	0.000	0.000	0.000
	Alternating (occasionally)		0.001 - 0.005			
	Alternating (frequently)		0.010 - 0.015			
Degree of Meandering	Minor	m	1.00	1.000	1.000	1.000
	Appreciable		1.15			
	Severe		1.30			
$n = (n_0 + n_1 + n_2 + n_3 + n_4)m$				0.061	0.040	0.061
Round values to the nearest 0.005:				**0.060**	**0.040**	**0.060**
Photograph No.:				Aerials	1910, 1911, 1912	Aerials

Determination of Manning's n-value by the FCDMC method

Project: Upper New River ADMP
Stream: Sweat Canyon Wash
Reach: RM
By: ia
Date: 04/10/07
Photo Location SC-2 - Upstream of Sweat Canyon confluence with New River west split

Channel Conditions		Manning's n Adjustment		LOB	Main Channel	ROB
Channel Bed Material	Concrete	n_0	0.012 - 0.018			
	Rock Cut		0.025			
	Firm Soil		0.025 - 0.032			
	Fine Sand		0.023 - 0.026			
	Coarse Sand		0.026 - 0.035	0.030		0.030
	Gravel		0.028 - 0.035		0.035	
	Cobble		0.030 - 0.050			
	Boulder		0.040 - 0.070			
Degree of Irregularity	Smooth	n_1	0.000			
	Minor		0.001 - 0.005	0.001	0.002	0.001
	Moderate		0.006 - 0.010			
	Severe		0.011 - 0.020			
Effects of Obstructions	Negligable	n_2	0.000 - 0.004	0.000	0.001	0.000
	Minor		0.005 - 0.015			
	Appreciable		0.020 - 0.030			
	Severe		0.040 - 0.060			
Vegetation	Negligible	n_3	0.000 - 0.002			
	Small		0.002 - 0.010		0.010	
	Medium		0.010 - 0.025			0.025
	Large		0.025 - 0.050	0.027		
	Very Large		0.050 - 0.100			
	Extremely Large		0.100 - 0.200			
Variations in Channel Cross Section	Gradual	n_4	0.000	0.000	0.000	0.000
	Alternating (occasionally)		0.001 - 0.005			
	Alternating (frequently)		0.010 - 0.015			
Degree of Meandering	Minor	m	1.00	1.000	1.000	1.000
	Appreciable		1.15			
	Severe		1.30			
$n = (n_0 + n_1 + n_2 + n_3 + n_4)m$				0.058	0.048	0.056
Round values to the nearest 0.005:				**0.055**	**0.050**	**0.055**
Photograph No.:				Aerials	1924, 1927	Aerials

Determination of Manning's n-value by the FCDMC method

Project: Upper New River ADMP
Stream: Sweat Canyon Wash
Reach: RM By: ia Date: 04/10/07
Photo Location SC-3 - Just downstream of Sweat Canyon and Doe Peak confluence

Channel Conditions		Manning's n Adjustment		LOB	Main Channel	ROB
Channel Bed Material	Concrete	n_0	0.012 - 0.018			
	Rock Cut		0.025			
	Firm Soil		0.025 - 0.032			
	Fine Sand		0.023 - 0.026			
	Coarse Sand		0.026 - 0.035	0.030		0.030
	Gravel		0.028 - 0.035		0.033	
	Cobble		0.030 - 0.050			
	Boulder		0.040 - 0.070			
Degree of Irregularity	Smooth	n_1	0.000			
	Minor		0.001 - 0.005	0.001	0.001	0.001
	Moderate		0.006 - 0.010			
	Severe		0.011 - 0.020			
Effects of Obstructions	Negligable	n_2	0.000 - 0.004	0.000	0.001	0.000
	Minor		0.005 - 0.015			
	Appreciable		0.020 - 0.030			
	Severe		0.040 - 0.060			
Vegetation	Negligible	n_3	0.000 - 0.002			
	Small		0.002 - 0.010		0.010	
	Medium		0.010 - 0.025	0.023		0.023
	Large		0.025 - 0.050			
	Very Large		0.050 - 0.100			
	Extremely Large		0.100 - 0.200			
Variations in Channel Cross Section	Gradual	n_4	0.000	0.000	0.000	0.000
	Alternating (occasionally)		0.001 - 0.005			
	Alternating (frequently)		0.010 - 0.015			
Degree of Meandering	Minor	m	1.00	1.000	1.000	1.000
	Appreciable		1.15			
	Severe		1.30			
$n = (n_0 + n_1 + n_2 + n_3 + n_4)m$				0.054	0.045	0.054
Round values to the nearest 0.005:				**0.055**	**0.045**	**0.055**
Photograph No.:				721, 722	718, 719, 720	723, 724

Appendix E

Correction Center Road Culverts

Culvert Designer/Analyzer Report
Multiple RCPs Deadman Wash at Prison RD. <duplicate>

Analysis Component			
Storm Event	Design	Discharge	2,000.00 cfs

Peak Discharge Method: User-Specified			
Design Discharge	2,000.00 cfs	Check Discharge	1,000.00 cfs

Tailwater Conditions: Tailwater Rating

Discharge (cfs)	TW Elev (ft)
3,488.00	1,680.16
9,170.00	1,681.91
10,570.00	1,682.19

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-48 inch Circular	134.59 cfs	1,683.15 ft	13.17 ft/s
Culvert-2	1-72 inch Circular	280.15 cfs	1,683.15 ft	14.44 ft/s
Culvert-3	1-48 inch Circular	134.43 cfs	1,683.15 ft	11.64 ft/s
Culvert-4	1-72 inch Circular	286.03 cfs	1,683.15 ft	14.96 ft/s
Weir	Roadway	1,165.68 cfs	1,683.15 ft	N/A
Total	----------	2,000.89 cfs	1,683.15 ft	N/A

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Culvert Designer/Analyzer Report
Multiple RCPs Deadman Wash at Prison RD. <duplicate>

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	1,683.15 ft	Discharge	134.59 cfs
Inlet Control HW Elev	1,683.15 ft	Tailwater Elevation	0.00 ft
Outlet Control HW Elev	1,682.55 ft	Control Type	Inlet Control
Headwater Depth/ Height	1.81		

Grades			
Upstream Invert	1,675.93 ft	Downstream Invert	1,675.28 ft
Length	51.87 ft	Constructed Slope	0.012531 ft/ft

Hydraulic Profile			
Profile	S2	Depth, Downstream	3.03 ft
Slope Type	Steep	Normal Depth	2.80 ft
Flow Regime	Supercritical	Critical Depth	3.46 ft
Velocity Downstream	13.17 ft/s	Critical Slope	0.008072 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	4.00 ft
Section Size	48 inch	Rise	4.00 ft
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev	1,682.55 ft	Upstream Velocity Head	2.11 ft
Ke	0.50	Entrance Loss	1.06 ft

Inlet Control Properties			
Inlet Control HW Elev	1,683.15 ft	Flow Control	Submerged
Inlet Type	Square edge w/headwall	Area Full	12.6 ft²
K	0.00980	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	1
C	0.03980	Equation Form	1
Y	0.67000		

Culvert Designer/Analyzer Report
Multiple RCPs Deadman Wash at Prison RD. <duplicate>

Component:Culvert-2

Culvert Summary			
Computed Headwater Elevation	1,683.15 ft	Discharge	280.15 cfs
Inlet Control HW Elev	1,683.05 ft	Tailwater Elevation	0.00 ft
Outlet Control HW Elev	1,683.15 ft	Control Type	Outlet Control
Headwater Depth/ Height	1.33		

Grades			
Upstream Invert	1,675.16 ft	Downstream Invert	1,674.52 ft
Length	53.97 ft	Constructed Slope	0.011858 ft/ft

Hydraulic Profile			
Profile	S2	Depth, Downstream	3.89 ft
Slope Type	Steep	Normal Depth	3.38 ft
Flow Regime	Supercritical	Critical Depth	4.58 ft
Velocity Downstream	14.44 ft/s	Critical Slope	0.005051 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	6.00 ft
Section Size	72 inch	Rise	6.00 ft
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev	1,683.15 ft	Upstream Velocity Head	2.27 ft
Ke	0.50	Entrance Loss	1.14 ft

Inlet Control Properties			
Inlet Control HW Elev	1,683.05 ft	Flow Control	Submerged
Inlet Type	Square edge w/headwall	Area Full	28.3 ft²
K	0.00980	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	1
C	0.03980	Equation Form	1
Y	0.67000		

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Culvert Designer/Analyzer Report
Multiple RCPs Deadman Wash at Prison RD. <duplicate>

Component:Culvert-3

Culvert Summary			
Computed Headwater Elevation	1,683.15 ft	Discharge	134.43 cfs
Inlet Control HW Elev	1,683.15 ft	Tailwater Elevation	0.00 ft
Outlet Control HW Elev	1,682.49 ft	Control Type	Inlet Control
Headwater Depth/ Height	1.81		

Grades			
Upstream Invert	1,675.93 ft	Downstream Invert	1,675.55 ft
Length	52.52 ft	Constructed Slope	0.007235 ft/ft

Hydraulic Profile			
Profile	M2	Depth, Downstream	3.46 ft
Slope Type	Mild	Normal Depth	N/A ft
Flow Regime	Subcritical	Critical Depth	3.46 ft
Velocity Downstream	11.64 ft/s	Critical Slope	0.008058 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	4.00 ft
Section Size	48 inch	Rise	4.00 ft
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev	1,682.49 ft	Upstream Velocity Head	1.94 ft
Ke	0.50	Entrance Loss	0.97 ft

Inlet Control Properties			
Inlet Control HW Elev	1,683.15 ft	Flow Control	Submerged
Inlet Type	Square edge w/headwall	Area Full	12.6 ft²
K	0.00980	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	1
C	0.03980	Equation Form	1
Y	0.67000		

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Culvert Designer/Analyzer Report
Multiple RCPs Deadman Wash at Prison RD. <duplicate>

Component:Culvert-4

Culvert Summary			
Computed Headwater Elevation	1,683.15 ft	Discharge	286.03 cfs
Inlet Control HW Elev	1,683.09 ft	Tailwater Elevation	0.00 ft
Outlet Control HW Elev	1,683.15 ft	Control Type	Outlet Control
Headwater Depth/ Height	1.35		

Grades			
Upstream Invert	1,675.04 ft	Downstream Invert	1,674.29 ft
Length	53.20 ft	Constructed Slope	0.014098 ft/ft

Hydraulic Profile			
Profile	S2	Depth, Downstream	3.84 ft
Slope Type	Steep	Normal Depth	3.24 ft
Flow Regime	Supercritical	Critical Depth	4.63 ft
Velocity Downstream	14.96 ft/s	Critical Slope	0.005150 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	6.00 ft
Section Size	72 inch	Rise	6.00 ft
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev	1,683.15 ft	Upstream Velocity Head	2.32 ft
Ke	0.50	Entrance Loss	1.16 ft

Inlet Control Properties			
Inlet Control HW Elev	1,683.09 ft	Flow Control	Submerged
Inlet Type	Square edge w/headwall	Area Full	28.3 ft²
K	0.00980	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	1
C	0.03980	Equation Form	1
Y	0.67000		

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Culvert Designer/Analyzer Report
Multiple RCPs Deadman Wash at Prison RD. <duplicate>

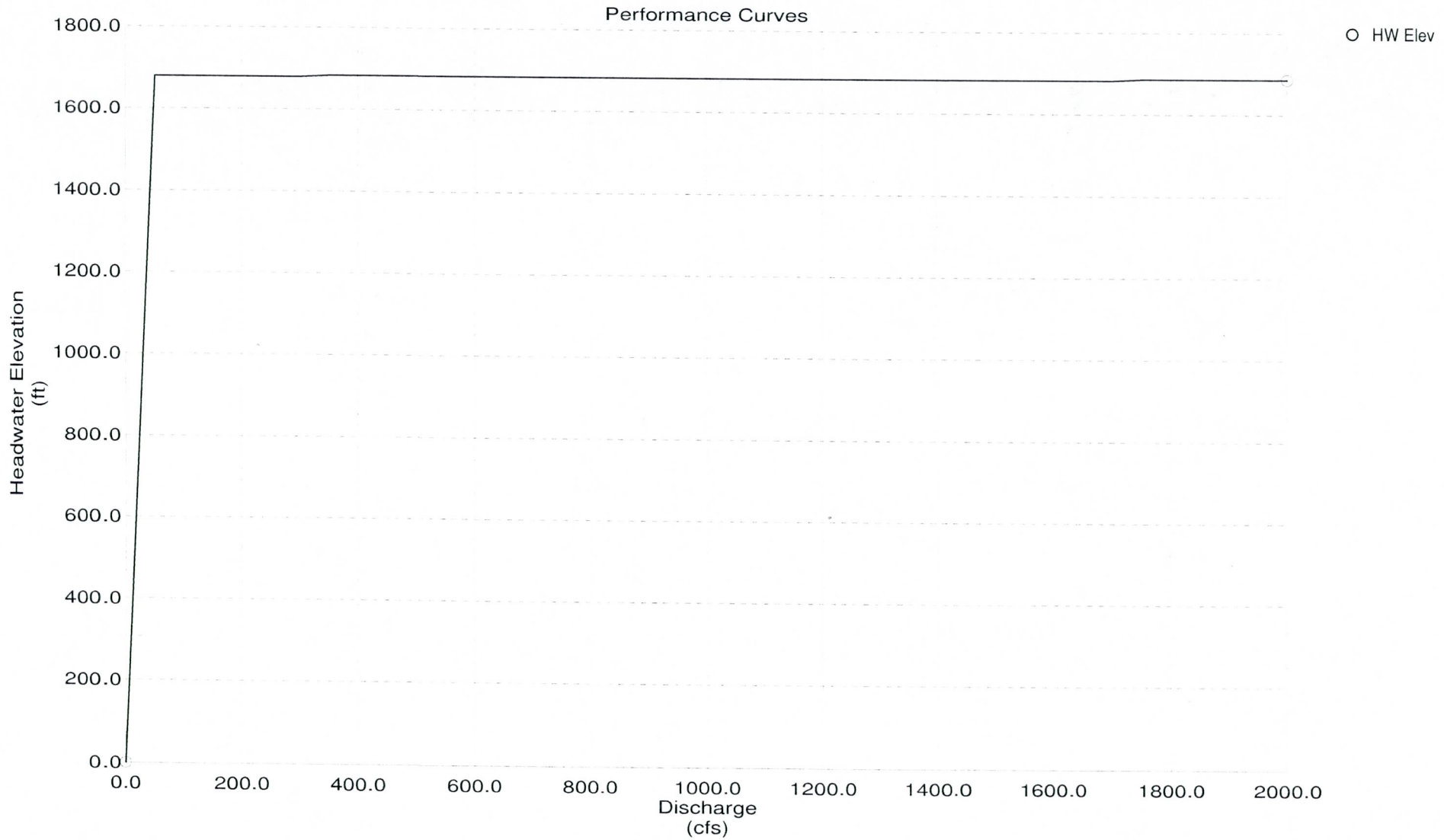
Component:Weir

Hydraulic Component(s): Roadway			
Discharge	1,165.68 cfs	Allowable HW Elevation	1,683.15 ft
Roadway Width	29.00 ft	Overtopping Coefficient	2.96 US
Low Point	1,681.92 ft	Headwater Elevation	1,683.15 ft
Discharge Coefficient (Cr)	2.96	Submergence Factor (Kt)	1.00
Tailwater Elevation	0.00 ft		

Sta (ft)	Elev (ft)
0.00	1,700.00
181.77	1,698.00
339.81	1,696.00
480.82	1,694.00
670.63	1,692.00
865.73	1,690.00
1,180.08	1,688.00
1,426.34	1,686.00
1,861.61	1,684.00
2,100.94	1,681.92
2,299.16	1,681.92
2,492.47	1,684.00
2,696.83	1,686.00

Performance Curves Report
Multiple RCPs Deadman Wash at Prison RD. <duplicate>

Range Data:			
	Minimum	Maximum	Increment
Discharge	0.00	2,000.00	50.00 cfs



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Rating Table Report
Multiple RCPs Deadman Wash at Prison RD. <duplicate>

Range Data:

	Minimum	Maximum	Increment
Discharge	0.00	2,000.00	50.00 cfs

Discharge (cfs)	HW Elev (ft)
0.00	0.00
50.00	1,676.89
100.00	1,677.56
150.00	1,678.08
200.00	1,678.54
250.00	1,678.95
300.00	1,679.33
350.00	1,679.69
400.00	1,680.05
450.00	1,680.39
500.00	1,680.72
550.00	1,681.05
600.00	1,681.38
650.00	1,681.74
700.00	1,682.01
750.00	1,682.11
800.00	1,682.19
850.00	1,682.26
900.00	1,682.33
950.00	1,682.38
1,000.00	1,682.44
1,050.00	1,682.49
1,100.00	1,682.54
1,150.00	1,682.58
1,200.00	1,682.62
1,250.00	1,682.66
1,300.00	1,682.70
1,350.00	1,682.74
1,400.00	1,682.78
1,450.00	1,682.81
1,500.00	1,682.85
1,550.00	1,682.88
1,600.00	1,682.92
1,650.00	1,682.95
1,700.00	1,682.98
1,750.00	1,683.01
1,800.00	1,683.04
1,850.00	1,683.07
1,900.00	1,683.10
1,950.00	1,683.12
2,000.00	1,683.15

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Appendix F

Digital Files for 2D Hydraulics (FLO-2D)

Appendix G

Digital Files and Spreadsheets for Sediment Engineering

Appendix H

Planning Areas Physical Characteristic Summaries

Gavilan Peak Planning Area

- **Jurisdiction/Agency/Community Coordination**
  - Maricopa County
  - New River/Desert Hills Community Association
  - Desert Foothills Land Trust

- **Land Ownership**

	Square Miles	Acres	Percent of Ownership
BLM	0.1	71	1.3
BOR	0	0	0
County	0	0	0
Game and Fish	0	0	0
Parks and Rec.	0.1	45	0.8
Private	2.7	1747	32.6
State Trust	5.5	3491	65.2
Tonto N.F.	0.0	0	0
Totals	**8.4**	**5353**	**100**

- **Planning Documents, Regulations, Ordinance**

Maricopa County Eye to the Future 2020	Applicable
New River Area Plan	Applicable
County Hillside Ordinance	Applicable
Floodplain Regulations	Applicable
MAG Desert Spaces	Applicable
MAG Transportation Plan	Applicable
BLM Bradshaw-Harquahala DEIS	NA
COP City of Phoenix General Plan	NA
Sonoran Preserve Master Plan	NA
COP Grading and Drainage Ordinance	NA
COP FH-Flood Hazard and Erosion Management District	NA
COP Development Standards of General Applicability	NA
COP Desert Character Overlay Districts	NA
COP North Black Canyon Overlay District	NA
Peoria's General Plan	NA
Peoria's Loop 303 Specific Area Plan	NA
Peoria's Hillside Development Overlay District	NA
Peoria's Floodplain Management Code	NA

Gavilan Peak Planning Area Cont.

- **Infrastructure**
  - Roadway
    - ADOT
    - MCDOT — Improved and Unimproved
    - Private — Unimproved
    - Not Maintained — Private
  - Gas — Potential Conflicts Yes
  - Power — Potential Conflicts Yes
  - Water

Existing Drainage Infrastructure	**Number of Elements**
Dip Sections	2
Culverts	44
Culverts with Sediment	20
Bridges	0
Stock Tanks	0
Levees	
Dams	
Spur Dikes	
Spillways	
Channels	
Bank Protection	
Retention/Detention	

Flooding Hazards	**Length (Miles)**	**Area of Floodplain (acres)**
Defined		
Table Mt. Wash	3.6	62
Table Mt. Wash Trib. 6	0.6	6
Photo View Wash	1.8	24
River Creek	0.77	8
Soda Springs Wash	1.9	27
White Spar Wash	2.2	25
Rough Rider Wash	1.0	11
Gavilan Peak Wash	2.75	109
Lazy G Wash	0.58	4
Twin Peaks Wash	0.81	5
Sharman Wash	0.98	8
Coyote Pass Wash	0.5	4
Kelley Road Wash	0.35	3
Totals	**17.84**	**296**

Gavilan Peak Planning Area Cont.

- Undefined
  - Single Thread Channels — 28 — NA
  -
  -

❖ Erosion Hazards	Miles	Area of Erosion Hazard
➢ Defined	NA	NA
▪		

❖ **Flood and Erosion Issues**

- Roadway flooding at wash crossings because size of culverts are small or there is on culvert structure.
- Culverts are filled with sediment
- Structures in the floodplain — 66
-

Lone Mt. Planning Area

- **Jurisdiction/Agency/Community Coordination**
  - Maricopa County
  - City of Phoenix
  - BLM

- **Land Ownership**

	Square Miles	Acres	Percent of Ownership
BLM	0.2	99	4.5
BOR	0	20	0.9
County	0	0	0
Game and Fish	0	0	0
Parks and Rec.	0	0	0
Private	0.2	145	6.7
State Trust	3.0	1921	87.9
Tonto N.F.	0	0	0
Totals	**3.4**	**2186**	**100**

- **Planning Documents, Regulations, Ordinance**

Maricopa County Eye to the Future 2020	Applicable
New River Area Plan	Not Applicable
County Hillside Ordinance	Not Applicable
Floodplain Regulations	Applicable
MAG Desert Spaces	Applicable
MAG Transportation Plan	Applicable
BLM Bradshaw-Harquahala DEIS	Applicable
COP City of Phoenix General Plan	Applicable
Sonoran Preserve Master Plan	Applicable
COP Grading and Drainage Ordinance	Applicable
COP FH-Flood Hazard and Erosion Management District	Applicable
COP Development Standards of General Applicability	Applicable
COP Desert Character Overlay Districts	Good Guidance
COP North Black Canyon Overlay District	Good Guidance
Peoria's General Plan	Not Applicable
Peoria's Loop 303 Specific Area Plan	Not Applicable
Peoria's Hillside Development Overlay District	Not Applicable

Lone Mt. Planning Area Cont.

- **Infrastructure**
  - Roadway
    - City of Phoenix — Proposed
  - Gas — No Known Conflicts
  - Power — No Known Conflicts
  - Water — No Known Conflicts
  - CAP — Potential Conflicts

Existing Drainage Infrastructure	**Number of Elements**
Dip Sections	0
Culverts	0
Culverts with Sediment	0
Bridges	0
Stock Tanks	0
Levees	0
Dams	0
Spur Dikes	0
Spillways	0
Channels	0
Bank Protection	0
Retention/Detention	0

Flooding Hazards	**Length (Miles)**	**Area of Floodplain (acres)**
Defined		
None	0	0
Totals	**0**	**0**
Undefined	15	NA
Single Thread Channels		

Erosion Hazards	**Miles**	**Area of Erosion Hazard**
Defined	NA	NA

- **Flood and Erosion Issues**

Lower Deadman Planning Area

- **Jurisdiction/Agency/Community Coordination**
  - Maricopa County
  - City of Phoenix
  - Arizona Game and Fish
  - BLM
  - Black Canyon Trail Coalition

- **Land Ownership**

	Square Miles	Acres	Percent of Ownership
BLM	0.8	534	4.0
BOR	0	0	0
County	0	0	0
Game and Fish	2.6	1645	12.4
Parks and Rec.	0	0	0
Private	3.6	2322	17.4
State Trust	13.8	8809	66.2
Tonto N.F.	0	0	0
Totals	**20.8**	**3712**	**100**

- **Planning Documents, Regulations, Ordinance**

Maricopa County Eye to the Future 2020	Applicable
New River Area Plan	NA
County Hillside Ordinance	NA
Floodplain Regulations	Applicable
MAG Desert Spaces	Applicable
MAG Transportation Plan	Applicable
BLM Bradshaw-Harquahala DEIS	Applicable
COP City of Phoenix General Plan	Applicable
Sonoran Preserve Master Plan	Applicable
COP Grading and Drainage Ordinance	Applicable
COP FH-Flood Hazard and Erosion Management District	Applicable
COP Development Standards of General Applicability	Applicable
COP Desert Character Overlay Districts	Good Guidance
COP North Black Canyon Overlay District	Good Guidance
Peoria's General Plan	NA
Peoria's Loop 303 Specific Area Plan	NA
Peoria's Hillside Development Overlay District	NA
Peoria's Floodplain Management Code	NA

Lower Deadman Planning Area Cont.

- **Infrastructure**
  - Roadway
    - ADOT — 303/SR74/I17
    - MCDOT — Improved
    - City of Phoenix — Proposed
    - Private — Unimproved
    - Not Maintained — Private
  - Gas — Potential Conflicts
  - Power — Potential Conflicts
  - Water — Potential Conflicts

- **Existing Drainage Infrastructure**

	Number of Elements
Dip Sections	1
Culverts	4
Culverts with Sediment	0
Bridges	2
Stock Tanks	10
Levees	0
Dams	0
Spur Dikes	0
Spillways	0
Channels	0
Bank Protection	0
Retention/Detention	Residential

- **Flooding Hazards**

	Length (Miles)	**Area of Floodplain (acres)**
Defined		
Deadman Wash	7.8	859
Deadman Wash Trib. 1	3.7	354
Deadman Wash Trib. 2	2.9	349
Deadman Wash Trib. 2A	1.7	157
Totals	**16.1**	**1719**
Undefined		
Single Thread Channels	38	NA

- **Erosion Hazards**

	Miles	**Area of Erosion Hazard**
Defined		
Deadman Wash	7.8	930
Totals	**7.8**	**930**

Lower Deadman Planning Area Cont.

- **Flood and Erosion Issues**
  - Roadway flooding at wash crossings because size of culverts are small or there is on culvert structure.

New River Dam Planning Area

- **Jurisdiction/Agency/Community Coordination**
  - Maricopa County
  - City of Peoria
  - BLM

- **Land Ownership**

	Square Miles	Acres	Percent of Ownership
BLM	0	22	0.7
BOR	0	5	0.2
County	0.9	555	18.1
Game and Fish	0	0	0
Parks and Rec.	3.7	0	0
Private	0.1	2394	78
State Trust	0	94	3.1
Tonto N.F.	0	0	0
Totals	**4.8**	**3069**	**100.0%**

- **Planning Documents, Regulations, Ordinance**

Maricopa County Eye to the Future 2020	Applicable
New River Area Plan	NA
County Hillside Ordinance	NA
Floodplain Regulations	Applicable
MAG Desert Spaces	Applicable
MAG Transportation Plan	Applicable
BLM Bradshaw-Harquahala DEIS	Applicable
COP City of Phoenix General Plan	NA
Sonoran Preserve Master Plan	NA
COP Grading and Drainage Ordinance	Applicable
COP FH-Flood Hazards and Erosion Management District	NA
COP Development Standards of General Applicability	NA
COP Desert Character Overlay Districts	Good Guidance
COP North Black Canyon Overlay District	Good Guidance
Peoria's General Plan	Applicable
Peoria's Loop 303 Specific Area Plan	Applicable
Peoria's Hillside Development Overlay District	Applicable
Peoria's Floodplain Management Code	Applicable

New River Dam Planning Area Cont.

- **Environmental**
  - Sonoran desert habitat
  - Xeroriparian habitat
  - Small mesquite Basques
  - Valuable wildlife corridor
  - Numerous stock tanks
- **Infrastructure**
  - Roadway
    - None
  - Gas — No Conflicts
  - Power — No Conflicts
  - Water — No Conflicts
  - CAP — Potential Conflicts
- **Existing Drainage Infrastructure**

	Number of Elements
Dip Sections	0
Culverts	2
Culverts with Sediment	0
Bridges	0
Stock Tanks	0
Levees	1
Dams	1
Spur Dikes	0
Spillways	1
Channels	0
Bank Protection	0
Retention/Detention	Residential

- **Flooding Hazards**

	Length (Miles)	**Area of Floodplain (acres)**
Defined		
Impoundment Area	2	1822
Totals	**2**	**1750**
Undefined		
Single Thread Channels	NA	NA

- **Erosion Hazards**

	Miles	**Area of Erosion Hazard**
Defined		
New River	2	1183
Totals	2	1183

New River Dam Planning Area Cont.

- **Flood and Erosion Issues**

New River (Lower) Planning Area

- **Jurisdiction/Agency/Community Coordination**
  - Maricopa County
  - City of Phoenix
  - City of Peoria
  - BLM
  - Black Canyon Trail Coalition

- **Land Ownership**

	Square Miles	Acres	Percent of Ownership
BLM	0.3	187	2.2
BOR	0.1	49	0.6
County	0.3	202	2.3
Game and Fish	0	0	0
Parks and Rec.	0	0	0
Private	2.4	1505	17.4
State Trust	10.5	6690	77.5
Tonto N.F.	0	0	0
Totals	**13.5**	**8366**	**100**

- **Planning Documents, Regulations, Ordinance**

Maricopa County Eye to the Future 2020	Applicable
New River Area Plan	NA
County Hillside Ordinance	NA
Floodplain Regulations	Applicable
MAG Desert Spaces	Applicable
MAG Transportation Plan	Applicable
BLM Bradshaw-Harquahala DEIS	Applicable
COP City of Phoenix General Plan	Applicable
Sonoran Preserve Master Plan	Applicable
COP Grading and Drainage Ordinance	Applicable
COP FH-Flood Hazard and Erosion Management District	Applicable
COP Development Standards of General Applicability	Applicable
COP Desert Character Overlay Districts	Good Guidance
COP North Black Canyon Overlay District	Good Guidance
Peoria's General Plan	Applicable
Peoria's Loop 303 Specific Area Plan	Applicable
Peoria's Hillside Development Overlay District	Applicable
Peoria's Floodplain Management Code	Applicable

New River (Lower) Planning Area Cont.

- **Environmental**
  - Sonoran desert habitat
  - Xeroriparian habitat
  - Small mesquite Basques
  - Valuable wildlife corridor
  - Numerous stock tanks
- **Infrastructure**
  - Roadway
    - ADOT — 303/SR74
    - MCDOT — New River Road
    - City of Phoenix — Proposed
    - City of Peoria — Proposed
  - Gas — Potential Conflicts
  - Power — Potential Conflicts
  - Water — Potential Conflicts

Existing Drainage Infrastructure	**Number of Elements**
Dip Sections	0
Culverts	2
Culverts with Sediment	0
Bridges	2
Stock Tanks	0
Levees	0
Dams	0
Spur Dikes	4
Spillways	0
Channels	0
Bank Protection	Two Locations
Retention/Detention	0

Flooding Hazards	**Length (Miles)**	**Area of Floodplain (acres)**
Defined		
New River Main Stem	16	4405
Totals	**16**	**4405**
Undefined		
Single Thread Channels	NA	NA

New River (Lower) Planning Area Cont.

❖ **Erosion Hazards**

	Miles	Area of Erosion Hazard
➢ Defined		
▪ New River	16	4693
▪ **Totals**	**16**	**4693**

❖ **Flood and Erosion Issues**

- ➢ Sand and Gravel
- ➢ Braided Flow
- ➢ Flow Over Roadway
- ➢ Floodplain limits inconstant with Future Land Use
- ➢ Flow spits potential avulsions
- ➢ Roadway flooding at wash crossings because size of culverts are small or there is on culvert structure.

Rock Springs Planning Area

- **Jurisdiction/Agency/Community Coordination**
  - Maricopa County
  - New River/Desert Hills Community Association
  - Desert Foothills Land Trust
  - BLM

- **Land Ownership**

	Square Miles	Acres	Percent of Ownership
BLM	2	1274	19%
BOR	0	0	
County	0	0	
Game and Fish	0	0	
Parks and Rec.	0	0	
Private	0.8	492	7%
State Trust	7.8	4967	74%
Totals	**10.5**	**6733**	**100.0%**

- **Planning Documents, Regulations, Ordinance**

Maricopa County Eye to the Future 2020	Applicable
New River Area Plan	Applicable
County Hillside Ordinance	Applicable
Floodplain Regulations	Applicable
MAG Desert Spaces	Applicable
MAG Transportation Plan	Applicable
BLM Bradshaw-Harquahala DEIS	Applicable
COP City of Phoenix General Plan	NA
Sonoran Preserve Master Plan	NA
COP Grading and Drainage Ordinance	NA
COP FH-Flood Hazard and Erosion Management District	NA
COP Development Standards of General Applicability	NA
COP Desert Character Overlay Districts	Good Guidance
COP North Black Canyon Overlay District	Good Guidance
Peoria's General Plan	NA
Peoria's Loop 303 Specific Area Plan	NA
Peoria's Hillside Development Overlay District	NA
Peoria's Floodplain Management Code	NA

Rock Springs Planning Area Cont.

- **Infrastructure**
  - Roadway
    - ADOT — I-17
    - MCDOT — Unimproved
    - Private — Unimproved
    - Not Maintained — Forest Service
  - Gas — Potential Conflicts
  - Power — Potential Conflicts
  - Water

- **Existing Drainage Infrastructure**

	Number of Elements
Dip Sections	2
Culverts	28
Culverts with Sediment	3
Bridges	0
Stock Tanks	1
Levees	
Dams	
Spur Dikes	
Spillways	
Channels	
Bank Protection	
Retention/Detention	

- **Flooding Hazards**

	Length (Miles)	Area of Floodplain (acres)
Defined		
New River	10.6	548
Black Wash	1.3	13
Totals	**11.9**	**561**
Undefined		
Single Thread Channels	37	NA

- **Erosion Hazards**

	Miles	Area of Erosion Hazard
Defined	NA	NA

- **Flood and Erosion Issues**
  -
  -
  -

Sweat Canyon Planning Area

- **Jurisdiction/Agency/Community Coordination**
  - Maricopa County
  - City of Phoenix
  - BLM
  - Black Canyon Trail Coalition

- **Land Ownership**

	Square Miles	Acres	Percent of Ownership
BLM	3.5	2225	22.3
BOR	0	0	0
County	0	0	0
Game and Fish	0	0	0
Parks and Rec.	0	0	0
Private	0.1	84	0.8
State Trust	12.0	7682	76.9
Tonto N.F.	0	0	0
Totals	**15.6**	**9992**	**100.0%**

- **Planning Documents, Regulations, Ordinance**

Maricopa County Eye to the Future 2020	Applicable
New River Area Plan	NA
County Hillside Ordinance	NA
Floodplain Regulations	Applicable
MAG Desert Spaces	Applicable
MAG Transportation Plan	Applicable
BLM Bradshaw-Harquahala DEIS	Applicable
COP City of Phoenix General Plan	Applicable
Sonoran Preserve Master Plan	NA
COP Grading and Drainage Ordinance	Applicable
COP FH-Flood Hazard and Erosion Management District	Applicable
COP Development Standards of General Applicability	Applicable
COP Desert Character Overlay Districts	Good Guidance
COP North Black Canyon Overlay District	Good Guidance
Peoria's General Plan	NA
Peoria's Loop 303 Specific Area Plan	NA
Peoria's Hillside Development Overlay District	NA
Peoria's Floodplain Management Code	NA

Sweat Canyon Planning Area Cont.

- **Infrastructure**
  - Roadway
    - ADOT — Proposed New River Freeway
    - MCDOT — New River Road
    - City of Phoenix — Proposed
    - Private — Unimproved
    - Not Maintained — Private
  - Gas — Potential Conflicts
  - Power — Potential Conflicts
  - Water — Potential Conflicts

- **Existing Drainage Infrastructure**

	Number of Elements
Dip Sections	1
Culverts	0
Culverts with Sediment	0
Bridges	0
Stock Tanks	1
Levees	0
Dams	0
Spur Dikes	0
Spillways	0
Channels	0
Bank Protection	0
Retention/Detention	0

- **Flooding Hazards**

	Length (Miles)	**Area of Floodplain (acres)**
Defined		
Sweat Canyon	10.6	267
Doe Peak	4.7	180
South Fork Doe Peak	1.04	20
East fork Doe Peak	0.6	8
Totals	**16.9**	**476**
Undefined		
Single Thread Channels	54	NA

- **Erosion Hazards**

	Miles	**Area of Erosion Hazard**
Defined	NA	NA

Sweat Canyon Planning Area Cont.

- **Flood and Erosion Issues**
  - Flooding at Roadway Dip Sections
  -

Upper Deadman Planning Area

- **Jurisdiction/Agency/Community Coordination**
  - Maricopa County
  - New River/Desert Hills Community Association
  - Desert Foothills Land Trust

- **Land Ownership**

	Square Miles	Acres	Percent of Ownership
BLM	0	0	0
BOR	0	0	0
County	0	0	0
Game and Fish	0	0	0
Parks and Rec.	0	0	0
Private	1.4	900	24.3
State Trust	4.4	2811	75.7
Tonto N.F.	0	0	0
Totals	**5.8**	**3712**	**100.0%**

- **Planning Documents, Regulations, Ordinance**

Maricopa County Eye to the Future 2020	Applicable
New River Area Plan	Applicable
County Hillside Ordinance	Applicable
Floodplain Regulations	Applicable
MAG Desert Spaces	Applicable
MAG Transportation Plan	Applicable
BLM Bradshaw-Harquahala DEIS	NA
COP City of Phoenix General Plan	NA
Sonoran Preserve Master Plan	Applicable
COP Grading and Drainage Ordinance	NA
COP FH-Flood Hazard and Erosion Management District	NA
COP Development Standards of General Applicability	NA
COP Desert Character Overlay Districts	NA
COP North Black Canyon Overlay District	NA
Peoria's General Plan	NA
Peoria's Loop 303 Specific Area Plan	NA
Peoria's Hillside Development Overlay District	NA
Peoria's Floodplain Management Code	NA

Upper Deadman Planning Area Cont.

- **Infrastructure**
  - Roadway
    - ADOT — I17
    - MCDOT — Unimproved
    - Not Maintained — Private
  - Gas — None
  - Power — None
  - Water — None

Existing Drainage Infrastructure	**Number of Elements**
Dip Sections	1
Culverts	5
Culverts with Sediment	0
Bridges	0
Stock Tanks	0
Levees	0
Dams	0
Spur Dikes	0
Spillways	0
Channels	0
Bank Protection	0
Retention/Detention	0

Flooding Hazards	**Length (Miles)**	**Area of Floodplain (acres)**
Defined		
Jenny Lin Wash	0.6	6.9
Totals	**0.6**	**8**
Undefined		
Single Thread Channels	31	NA

Erosion Hazards	**Miles**	**Area of Erosion Hazard**
Defined	NA	NA

- **Flood and Erosion Issues**
  - Structures In Floodplain — 4
  - Flooding at Roadway Dip Sections
  - Access issues during runoff events

New River (Upper) Planning Area

- **Jurisdiction/Agency/Community Coordination**
  - Maricopa County
  - New River/Desert Hills Community Association
  - Desert Foothills Land Trust
  - BLM

- **Land Ownership**

	Square Miles	Acres	Percent of Ownership
BLM	0.2	130	14.1
BOR	0	0	0
County	0	0	0
Game and Fish	0	0	0
Parks and Rec.	0	0	0
Private	0.5	290	31.5
State Trust	0.8	500	54.4
Tonto N.F.	0	0	0
Totals	**1.4**	**921**	**100**

- **Planning Documents, Regulations, Ordinance**

Maricopa County Eye to the Future 2020	Applicable
New River Area Plan	Applicable
County Hillside Ordinance	Applicable
Floodplain Regulations	Applicable
MAG Desert Spaces	Applicable
MAG Transportation Plan	Applicable
BLM Bradshaw-Harquahala DEIS	Applicable
COP City of Phoenix General Plan	NA
Sonoran Preserve Master Plan	NA
COP Grading and Drainage Ordinance	NA
COP FH-Flood Hazard and Erosion Management District	NA
COP Development Standards of General Applicability	NA
COP Desert Character Overlay Districts	Good Guidance
COP North Black Canyon Overlay District	Good Guidance
Peoria's General Plan	NA
Peoria's Loop 303 Specific Area Plan	NA
Peoria's Hillside Development Overlay District	NA
Peoria's Floodplain Management Code	NA

New River (Upper) Planning Area Cont.

- **Environmental**
  - Sonoran desert habitat
  - Xeroriparian habitat
  - Small mesquite Basques
  - Valuable wildlife corridor
  - Numerous stock tanks

- **Infrastructure**
  - Roadway
    - ADOT — I17
    - MCDOT — Improved and Unimproved
    - Private — Unimproved
    - Not Maintained — Private
  - Gas — Potential Conflicts
  - Power — Potential Conflicts
  - Water

- **Existing Drainage Infrastructure**

	Number of Elements
Dip Sections	2
Culverts	1
Culverts with Sediment	0
Bridges	4
Stock Tanks	0
Levees	2
Dams	0
Spur Dikes	0
Spillways	0
Channels	0
Bank Protection	At Levees and Bridges
Retention/Detention	0

- **Flooding Hazards**

	Length (Miles)	Area of Floodplain (acres)
Defined		
New River	7.2	548
Totals	**7.2**	**548**
Undefined		
Single Thread Channels	NA	NA

New River (Upper) Planning Area Cont.

❖ Erosion Hazards	Miles	Area of Erosion Hazard
➢ Defined		
▪ New River	7.2	566
▪ **Totals**	**7.2**	**566**

❖ **Flood and Erosion Issues**

- ➢ Structures In Floodplain — 5
- ➢ Flooding at Roadway Dip Sections
- ➢ Access issues during runoff events.

West Tributaries Planning Area

- **Jurisdiction/Agency/Community Coordination**
  - Maricopa County
  - City of Phoenix
  - City of Peoria

- **Land Ownership**

	Square Miles	Acres	Percent of Ownership
BLM	0.8	543	5.8
BOR	0	0	0
County	0	0	0
Game and Fish	0	0	0
Parks and Rec.	0	0	0
Private	0.6	395	4.2
State Trust	13.3	8484	90.0
Tonto N.F.	0	0	0
Totals	**14.7**	**9422**	**100**

- **Planning Documents, Regulations, Ordinance**

Maricopa County Eye to the Future 2020	Applicable
New River Area Plan	NA
County Hillside Ordinance	NA
Floodplain Regulations	Applicable
MAG Desert Spaces	Applicable
MAG Transportation Plan	Applicable
BLM Bradshaw-Harquahala DEIS	Applicable
COP City of Phoenix General Plan	Applicable
Sonoran Preserve Master Plan	NA
COP Grading and Drainage Ordinance	Applicable
COP FH-Flood Hazard and Erosion Management District	Applicable
COP Development Standards of General Applicability	Applicable
COP Desert Character Overlay Districts	Good Guidance
COP North Black Canyon Overlay District	Good Guidance
Peoria's General Plan	Applicable
Peoria's Loop 303 Specific Area Plan	Applicable
Peoria's Hillside Development Overlay District	Applicable
Peoria's Floodplain Management Code	Applicable

West Tributaries Planning Area Cont.

- **Infrastructure**
  - Roadway
    - ADOT — 303/SR74
    - MCDOT — New River Road
    - City of Phoenix — Proposed
    - City of Peoria — Proposed
    - Private — Unimproved
    - Not Maintained — Private
  - Gas — Potential Conflicts
  - Power — Potential Conflicts
  - Water — Potential Conflicts
  - CAP Canal — Potential Conflicts

- **Existing Drainage Infrastructure**

	Number of Elements
Dip Sections	10
Culverts	7
Culverts with Sediment	0
Bridges	0
Stock Tanks	0
Levees	0
Dams	0
Spur Dikes	0
Spillways	0
Channels	0
Bank Protection	0
Retention/Detention	0

- **Flooding Hazards**

Defined	Length (miles)	Area of Floodplain (acres)
NRW5	2.63	71
NRW10	1.95	52
NRW15	1.13	30
NRW20	1.05	88
NRW25	0.87	23
NRW30	2.06	41
NRW35	0.99	10
NRW40	0.69	6
NRW45	1.21	23
NRW50	2.24	48
NRW55-A, B, C D, E,	2.25	114
NR55T-5, -10	3.3	72
NR55T-15	2.1	33
NR55T 20	1.5	16

West Tributaries Planning Area Cont.

❖ Flooding Hazards Cont.	Length	Area of Floodplain
▪ NR55T 25	1.1	46
▪ NR55T 30	.7	18
▪ **Totals**	**25.8**	**693**

❖ **Flooding Hazards Cont.**

▪

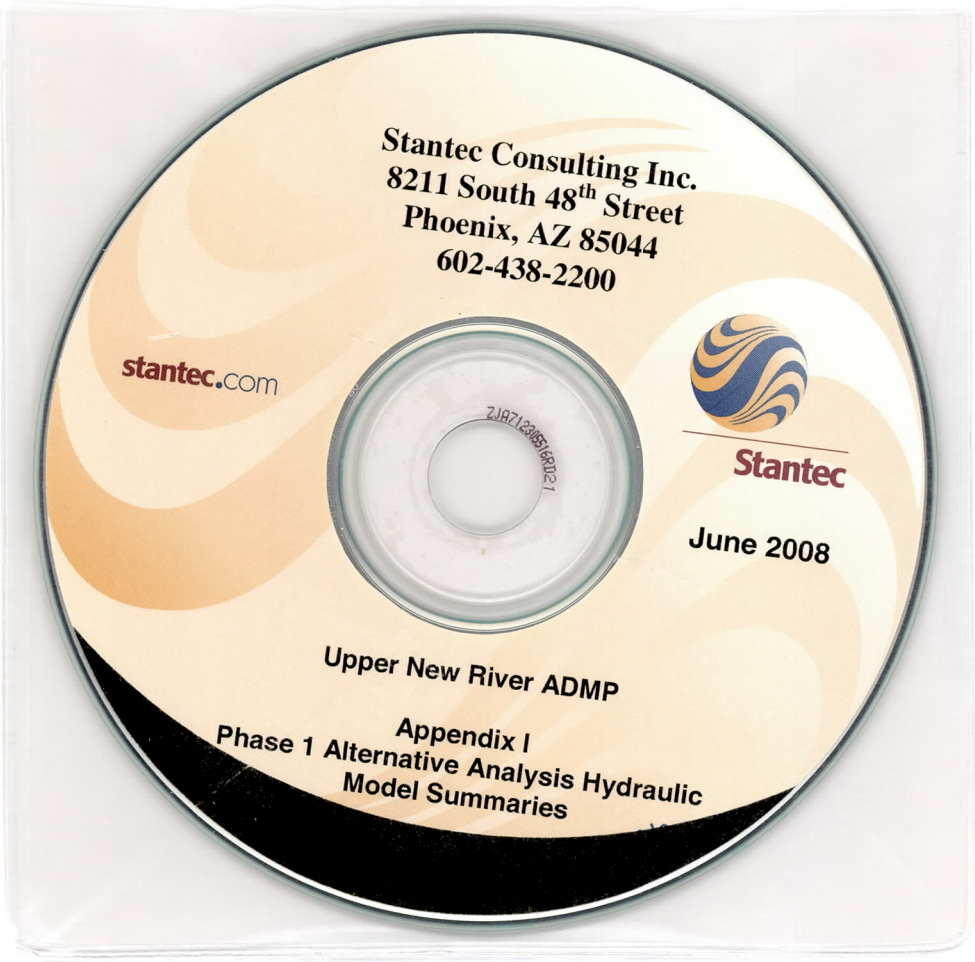
➢ Undefined

▪ Single Thread Channels	26	NA
▪		
▪		

❖ Erosion Hazards	Miles	Area of Erosion Hazard
➢ Defined	NA	NA
▪		

❖ **Flood and Erosion Issues**

➢ Flooding at Roadway Dip Sections



Appendix I

Phase 1 Alternative Analysis Hydraulic Model Summaries

Appendix J

Phase 2 Alternative Analysis HEC-1 and HEC-RAS models

Appendix K

Phase 2 Opinion of Probable Construction Cost

New River Downstream of I-17 Planning Area Alternative 1

Opinion of Probable Construction Cost

Alternative 1 - Channel Option

Item	Unit of measure	Quantity	Unit Price	Total
Clear & Grub	acre	379	$1,500	$569,200
Backfill	cu yd	42,595	$12	$511,136
Dumped Riprap	cu yd	73,507	$80	$5,880,576
Filter Fabric	sq foot	238,359	$2	$476,718
Excavation	cu yd	2,250,902	$12	$27,010,824
Hydroseed	acre	379	$3,000	$1,138,399
Landscape Aesthetic Fill	cu yd	111,885	$12	$1,342,620
Plantings	acre	369	$5,000	$1,842,510
Right of Way	acre	379	$50,000	$18,973,323
NR Bridge 1	sq foot	40,960	$90	$3,686,400
NR Bridge 2	sq foot	44,800	$90	$4,032,000
NR Bridge 3	sq foot	41,600	$90	$3,744,000
SC Bridge 1	sq foot	32,680	$90	$2,941,200
SC Bridge 2	sq foot	49,440	$90	$4,449,600
SC Bridge 3	sq foot	56000	$90	$5,040,000
			Subtotal	$81,638,506
			20% Contingency	$16,327,701
Sweat Canyon Levee				$10,937,087
			Total	$108,903,294
Reclaimed Floodplain Property	acre	977	$50,000	-$48,850,000
Potential Sand and Gravel Resource Benefit				-$27,010,824
			Probable Cost Total	$33,042,470

Alternative 1 - Levee Option

Item	Unit of measure	Quantity	Unit Price	Total
Clear & Grub	acre	35	$1,500	$53,152
Levee Backfill	cu yd	239,924	$12	$2,879,088
Dumped Riprap	cu yd	163,438	$80	$13,075,012
Filter Fabric	sq foot	387,936	$2	$775,871
Hydroseed	acre	35	$3,000	$106,304
Landscape Aesthetic Fill	cu yd	60,339	$12	$724,074
Plantings	acre	24	$5,000	$122,351
Right of Way	acre	35	$50,000	$1,771,738
NR Bridge 1	sq foot	40,960	$90	$3,686,400
NR Bridge 2	sq foot	44,800	$90	$4,032,000
NR Bridge 3	sq foot	46,720	$90	$4,204,800
SC Bridge 1	sq foot	32,680	$90	$2,941,200
SC Bridge 2	sq foot	49,440	$90	$4,449,600
SC Bridge 3	sq foot	56,000	$90	$5,040,000
			Subtotal	$43,861,591
			20% Contingency	$8,772,318
Sweat Canyon Levee				$10,937,087
			Total	$63,570,996
Reclaimed Floodplain Property	acre	973	$50,000	-$48,650,000
			Probable Cost Total	$14,920,996

New River Downstream of I-17 Planning Area-Alternative 2

Opinion of Probable Construction Cost

Alternative 2 - Levee Option

Item	Unit of measure	Quantity	Unit Price	Total
Clear & Grub	acre	31	$1,500	$46,783
Levee Backfill	cu yd	188,877	$12	$2,266,529
Dumped Riprap	cu yd	108,698	$80	$8,695,824
Filter Fabric	sq foot	340,574	$2	$681,148
Excavation	cu yd	0	$12	$0
Hydroseed	acre	31	$3,000	$93,565
Landscape Aesthetic Fill	cu yd	49,800	$12	$597,595
Plantings	acre	21	$5,000	$106,911
Right of Way	acre	31	$50,000	$1,559,424
NR Bridge 1	sq foot	40,960	$90	$3,686,400
NR Bridge 2	sq foot	44,800	$90	$4,032,000
NR Bridge 3	sq foot	41,680	$90	$3,751,200
SC Bridge 1	sq foot	32,680	$90	$2,941,200
SC Bridge 2	sq foot	49,440	$90	$4,449,600
SC Bridge 3	sq foot	56,000	$90	$5,040,000
			Subtotal	$37,948,180
			20% Contingency	$7,589,636
Sweat Canyon Levee				$10,937,087
			Total	$56,474,902
Reclaimed Floodplain Property	acre	1,095	$50,000	-$54,750,000
			Probable Cost Total	$1,724,902

Alternative 2 - Channel Option

Item	Unit of measure	Quantity	Unit Price	Total
Clear & Grub	acre	346	$1,500	$518,723
Backfill	cu yd	26,851	$12	$322,218
Dumped Riprap	cu yd	76,531	$80	$6,122,502
Filter Fabric	sq foot	201,884	$2	$403,768
Excavation	cu yd	3,038,757	$12	$36,465,084
Hydroseed	acre	346	$3,000	$1,037,445
Landscape Aesthetic Fill	cu yd	102,041	$12	$1,224,489
Plantings	acre	336	$5,000	$1,680,044
Right of Way	acre	346	$50,000	$17,290,758
NR Bridge 1	sq foot	40,960	$90	$3,686,400
NR Bridge 2	sq foot	44,800	$90	$4,032,000
NR Bridge 3	sq foot	41,680	$90	$3,751,200
SC Bridge 1	sq foot	32,680	$90	$2,941,200
SC Bridge 2	sq foot	49,440	$90	$4,449,600
SC Bridge 3	sq foot	56,000	$90	$5,040,000
			Subtotal	$88,965,432
			20% Contingency	$17,793,086
Sweat Canyon Levee				$10,937,087
			Total	$117,695,605
Reclaimed Floodplain Property	acre	1,095	$50,000	-$54,750,000
Potential Sand and Gravel Resource Benefit				-$36,465,084
			Probable Cost Total	$26,480,521

New River Downstream of I-17 Planning Area - Alternative 3

Opinion of Probable Construction Cost

Alternative 3 - Levees

Item	Unit of measure	Quantity	Unit Price	Total
Clear & Grub	acre	7	$1,500	$10,254
Levee Backfill	cu yd	17,381	$12	$208,572
Dumped Riprap	cu yd	21,468	$80	$1,717,475
Filter Fabric	sq foot	82,564	$2	$165,127
Excavation	cu yd		$12	$0
Hydroseed	acre	7	$3,000	$20,507
Landscape Aesthetic Fill	cu yd	4,162	$12	$49,940
Plantings	acre	5	$5,000	$22,521
Right of Way	acre	7	$50,000	$341,787
NR Bridge 1	sq foot	40,960	$90	$3,686,400
NR Bridge 2	sq foot	44,800	$90	$4,032,000
NR Bridge 3	sq foot	74,320	$90	$6,688,800
SC Bridge 1	sq foot	32,680	$90	$2,941,200
SC Bridge 2	sq foot	49,440	$90	$4,449,600
SC Bridge 3	sq foot	56000	$90	$5,040,000
			Subtotal	$29,374,183
			20% Contingency	$5,874,837
Sweat Canyon Levee				$10,937,087
			Total	$46,186,106
Reclaimed Floodplain Property	acre	777	$50,000	-$38,850,000
			Probable Cost Total	$7,336,106

New River Upstream of I-17 Planning Area - Alternative 4

Opinion of Probable Construction Cost

Alterntive 4

Item	Unit	Quantity	Unit Price	Total
Clear and Grub	acre	716	$1,500	$1,074,642
Levee Backfill	cu yd	428,119	$12	$5,137,422
Dumped Riprap	cu yd	99,205	$80	$7,936,380
Filter Fabric	sq foot	346,011	$2	$692,023
Hydroseed	acre	716	$3,000	$2,149,284
Landscape Aesthetic Fill	cu yd	150,593	$12	$1,807,112
Plantings	acre	715	$5,000	$3,576,217
Right of Way - Levee	acre	30	$50,000	$1,521,401
Right of Way - Basin	acre	686	$50,000	$34,300,000
Basin Outlets	each	4	$147,250	$589,000
Structural Concrete	cu yd	8,587	$670	$5,753,513
NR Bridge 1	sq foot	31,800	$90	$2,862,000
NR Bridge 2	sq foot	39,680	$90	$3,571,200
NR Bridge 3	sq foot	72,000	$90	$6,480,000
SC Bridge 1	sq foot	32,680	$90	$2,941,200
SC Bridge 2	sq foot	49,440	$90	$4,449,600
SC Bridge 3	sq foot	56000	$90	$5,040,000
			Subtotal	$89,880,995
			20% Contingency	$17,976,199
Sweat Canyon Levee				$10,937,087
			Total	$118,800,000
Reclaimed Floodplain Property	acre	432	$50,000	-$21,600,000
			Probable Total Cost	$97,200,000

Lower Deadman Planning Area

Opinion of Probable Construction Cost

Alternative 1A - without Detention, Structural (w/ landscape aesthetic fill and plantings)
Description: Dip section raised and bridge added

Item	Unit of measure	Quantity	Price/unit		Total
Clear & Grub	acre	0.8	$1,500	$	1,180.69
Backfill	cu yd	2591.0	$12	$	31,092.20
Dumped Riprap	cu yd	459.9	$80	$	36,795.92
Filter Fabric	sq foot	659.1	$2	$	1,318.23
Excavation	cu yd	136.9	$12	$	1,643.07
Hydroseed	acre	0.8	$3,000	$	2,361.38
Landscape Aesthetic Fill	cu yd	43.9	$12	$	526.59
Plantings	acre	0.6	$5,000	$	2,925.53
Right of Way	acre	0.8	$50,000	$	39,356.29
Roadway	foot	1804.6	$200	$	360,920.00
Bridge	sq foot	24782.3	$90	$	2,230,410.00
			Subtotal	$	2,708,529.90
			20% Contingency	$	541,705.98
				$	-
			Total	$	3,250,235.88
Reclaimed Floodplain Property1	acre	0	$50,000	$	-
			Probable Total Cost	$	3,250,235.88

Alternative 1B - with Detention, Structural (w/ landscape aesthetic fill and plantings)
Description: Dip section raised and bridge added

Item	Unit of measure	Quantity	Price/unit	Total
Clear & Grub	acre	0	$1,500	$0
Backfill	cu yd	2,967	$12	$35,600
Dumped Riprap	cu yd	429	$80	$34,339
Filter Fabric	sq foot	528	$2	$1,056
Excavation	cu yd	1,370	$12	$16,441
Hydro-seed	acre	41	$3,000	$122,261
Landscape Aesthetic Fill	cu yd	28	$12	$338
Plantings	acre	41	$5,000	$202,758
Right of Way	acre	41	$50,000	$2,037,677
Riprap	cu yd	2,500	$80	$200,000
Roadway	foot	1,996	$200	$399,130
Bridge	sq foot	16,549	$90	$1,489,410
Retention Basin Excavation	cu yd	550,000	$12	$6,600,000
			Subtotal	$11,139,008
			20% Contingency	$2,227,802
			Total	$13,366,810
Reclaimed Floodplain Property1	acre	0	$50,000	$0
			Probable Total Cost	$13,366,810

Lower Deadman Planning Area

Opinion of Probable Construction Cost

Alternative 2A - without detention, Soft Structural (w/ aesthetic fill and plantings)
Description: Channelization, bridge added, and roadway raised

Item	Unit of measure	Quantity	Unit Price	Total
Clear & Grub	acre	105	$1,500	$158,179
Backfill	cu yd	13,805	$12	$165,659
Dumped Riprap	cu yd	19,508	$80	$1,560,634
Filter Fabric	sq foot	91,088	$2	$182,175
Excavation	cu yd	733,474	$12	$8,801,691
Hydroseed	acre	105	$3,000	$316,358
Landscape Aesthetic Fill	cu yd	26,926	$12	$323,115
Plantings	acre	100	$5,000	$499,240
Right of Way	acre	105	$50,000	$5,272,631
Roadway	foot	566	$200	$113,228
Bridge	sq foot	22,436	$90	$2,019,225
Grade Control Structure	cu yd	223	$670	$149,410
			Subtotal	$19,561,544
			20% Contingency	$3,912,309
			Total	$23,473,853
Reclaimed Floodplain Property[1]	acre		$50,000	$0
			Probable Total Cost	$23,473,853

Alternative 2B - with Detention, Soft Structural (w/ aesthetic fill and plantings)
Description: Channelization, bridge added, and roadway raised

Item	Unit of measure	Quantity	Unit Price	Total
Clear & Grub	acre	117	$1,500	$175,726
Backfill	cu yd	15,363	$12	$184,361
Dumped Riprap	cu yd	16,781	$80	$1,342,461
Filter Fabric	sq foot	86,305	$2	$172,609
Excavation	cu yd	492,867	$12	$5,914,402
Hydroseed	acre	117	$3,000	$351,453
Landscape Aesthetic Fill	cu yd	28,965	$12	$347,579
Plantings	acre	112	$5,000	$557,732
Right of Way	acre	117	$50,000	$5,857,548
Roadway	foot	662	$200	$132,462
Bridge	sq foot	14,408	$90	$1,296,750
Grade Control Structure	cu yd	156	$670	$104,520
Retention Basin Excavation	cu yd	550,000	$12	$6,600,000
Riprap	cu yd	2,500	$80	$200,000
			Subtotal	$23,237,604
			20% Contingency	$4,647,521
			Total	$27,885,124
Reclaimed Floodplain Property[1]	acre		$50,000	$0
			Probable Total Cost	$27,885,124

Gavilan Peak Planning Area

Opinion of Probable Construction and Acquisition Cost

Alternative 2 - Floodprone Property Assistance Program

Item	Unit	Quantity	Unit Price	Total
Parcel Acquisition	LS	24	$175,000.00	$4,200,000.00
Demolition	LS	24	$25,000.00	$600,000.00
Relocation Cost	LS	24	$32,500.00	$780,000.00
			Total	$5,580,000.00

Alternative 3 - Levee

Item	Unit	Quantity	Unit Price	Total
Clear and Grub	acre	9.9	$1,500	$14,801
Levee Backfill	cu yds	61,340	$12	$736,085
Dumped Riprap	cu yds	27,358	$80	$2,188,601
Filter Fabric	sq feet	84,865	$2	$169,730
Hydroseed	acre	9.9	$3,000	$29,601
Landscape Aesthetic Fill	cu yds	33,518	$12	$402,210
Plantings	acre	7.6	$5,000	$38,061
Right of Way - Levee	acre	9.9	$50,000	$493,358
Right of Way - Additional	acre	6.3	$50,000	$315,000
Bridge 1 (NR Rd over Gavilan Wash)	sq feet	6000	$90	$540,000
Bridge 2 (NR Rd over Table Mesa Wash)	sq feet	6000	$90	$540,000
			Subtotal	$5,467,448
			20% Contingency	$1,093,490
			Total	$6,600,000
Reclaimed Floodplain Property	acre	31	$50,000	-$1,550,000
			Probable Total Cost	$5,050,000

New River Upstream of I-17 Old Stage Coach Road Reach

Opinion of Probable Construction/Acquisition Cost

Alternative 1 - Levee

Item	Unit of measure	Quantity	Unit Price	Total
Clear & Grub	acre	11	$1,500	$16,158
Levee Backfill	cu yd	31,832	$12	$381,984
Dumped Riprap	cu yd	25,417	$80	$2,033,341
Filter Fabric	sq foot	51,027	$2	$102,053
Excavation	cu yd	0	$12	$0
Hydroseed	acre	11	$3,000	$32,316
Landscape Aesthetic Fill	cu yd	6,240	$12	$74,883
Plantings	acre	9	$5,000	$46,110
Right of Way	acre	11	$50,000	$538,603
			Subtotal	$3,225,448
			20% Contingency	$645,090
			Total	$3,870,537
Reclaimed Floodplain Property	acre	0	$50,000	$0
		Probable Cost Total		$3,870,537

Alternative 2- Channel

Item	Unit of measure	Quantity	Unit Price	Total
Clear & Grub	acre	47	$1,500	$71,180
Fill	cu yd	0	$12	$0
Dumped Riprap	cu yd	10,511	$80	$840,916
Filter Fabric	sq foot	27,695	$2	$55,389
Excavation	cu yd	219,802	$12	$2,637,624
Hydroseed	acre	47	$3,000	$142,360
Plantings	acre	46	$5,000	$231,463
Right of Way	acre	47	$50,000	$2,372,663
			Subtotal	$6,351,595
			20% Contingency	$1,270,319
			Total	$7,621,914
Reclaimed Floodplain Property	acre	31	$50,000	-$1,550,000
		Probable Cost Total		$6,071,914

Alternative 3 - Floodprone Property Assistance Program

Item	Unit	Quantity	Unit Price	Total
Parcel Acquisition	LS	16	$175,000	$2,800,000
Demolition	LS	16	$25,000	$400,000
Relocation Cost	LS	16	$32,500	$520,000
			Total	$3,720,000

Appendix L

Evaluation Criteria Data

Evaluation Assumptions

Alternative Evaluation Public Safety Assumptions

Consequences of Failure Assumption:

- Evaluate alternative as if the watershed is fully developed

Floodplain Area / Erosion Hazard Zone Assumptions:

- Applies only to existing delineated floodplains and erosion hazard zones
- Impacts to floodplains or erosion hazards zones that lie within lands designated as Desert Sonoran Preserve are not considered

No. of Structures Removed from Floodway

- Disregarded this criteria

No Action Alternative Assumption:

- Flood control structures will be constructed as part of the normal development process

FPAP Alternative Assumption:

- Not all individuals within the floodplain / floodway would want to participate but the number who would is greater than 50%

New River Below I-17 Levees:

- Levees have a lesser impact on river mechanics than channels (note Pat that we recommend that the figures illustrating adverse impacts no be given out to others as they require explanations)

Alternatives Evaluation Implementation Assumptions

- We determined that the ADMP Guidelines alternative would be scored the same for all planning areas since the benefits, costs and mechanisms for implementation would be essentially the same.

- We determined that the No Action alternative would be scored the same for all planning areas since the benefits, costs and mechanisms for implementation would be essentially the same. NOTE: We actually talked through every planning area to confirm these 2 conclusions ADMP Guidelines and No Action) and kept agreeing on them.

- The FPAP scored high because it is an existing program...if it is not funded then it would score much lower.

- The key element of the "channel versus levee" alternatives (including the 1A versus 1B, etc. scenarios) was the fact that levees requires much less riparian and JD disturbance...thus much easier to permit. Particularly it was felt it was much easier to permit levees because of the mitigation ratio multiplying factor; reported to recently be as high as 3 to 5 by members of the group. Therefore the reclaimed land value was higher than for the channels. Also a key assumption of the group was that there was no channelization disturbance required; therefore riparian or JD disturbance under the levee options was essentially non-existent except for any levee footprint but we assumed they were "elevated" on the overbank and any erosion protection would be the trenched or buried kind...from the overbank thus staying out of the JD. Maintenance of channels versus levees was essentially considered the same since both are required...a good assumption considering it is a cost issue primarily and we had no costs.

- In the Lower Deadman planning area the retention basin also scored lower because of 404 permitting considerations.In the New River below I-17 it scored higher because the permitting would be done by the miners as a cost of doing business.

Alternative Evaluations Scenery Resource Assumptions

ADMP Guidelines

- Assumes that ADMP Development Guidelines will be developed and implemented
  - Trail standards/connections – culverts, bridge (underpass/overpass)
  - Encroachment into floodplain treatment (Re-vegetate or Mitigate)
  - Adjacency to development – Transition / Buffer (Setbacks/ Easements)
  - Road/Bridge crossings
  - Maintaining riparian and vegetated area
  - Preserve wildlife habitats/ sonoran and other wilderness areas
  - Slope requirements/Transition to natural grade
  - Mining standards (Restoration and revegetation)
  - Trails along O & M roads - Ensure that some ROW is allotted outside of required buffer for trail usage

No Action

- FEMA – Standards/Guidelines
  - Does not assume meeting 404 requirements / mitigation
  - Areas may not be utilized for recreation / open space
  - Areas disturbed may not be revegetated – simple off site mitigation may be utilized in lieu of on site mitigation
  - Will not include areas for recreation/ open space
  - May not consider impacts to natural resources
  - Assumes natural open spaces are removed

Non-Structural

- Buy-Outs
  - Assumes that reclaimed floodplain will meet some form of development guidelines City/County
  - Properties purchased must comply with vegetation requirements/ rehabilitation

Structural

- *Levees*
  - More compatible with flood protection methods recommended for channels and basins
  - Easier to implement trail system
  - Assumes less damage to surroundings and high scenic integrity areas due to the 'footprint' being less
  - Assumes matching structure to existing grade
  - Easier to revegetate than channel and basin
- *Channels*
  - Assumes severe impact to flood protection method of the solutions
  - Larger 'Foot Print' and hence most destruction to natural riparian areas and other natural features – narrows corridor
  - Difficult to revegetate up to necessary compatibility
  - Loss of open space/recreation opportunities for passive recreation

- *Basins*
  - Most severe impact to flood protection method of the solutions
  - Assumes online basins and hence suitable for only passive recreation as opposed to active recreation
  - Revegetation and mitigation is difficult to obtain

Gavilan Peak

- *Levees*
  - Areas taken out of the FEMA are mostly existing houses
  - Assumes that trail connections with levee can be maintianed
  - FEMA reclamation means natural open space is removed

New River Upstream of I-17

- *Levee*
  - Assumes road will be built on levee
  - Compatible to Scenic integrity
  - Maintains trail opportunity
  - Increases opportunity for future implementation for regional trail
- *Channel*
  - Removes existing vegetation
  - Impacts open space

New River Downstream of I-17

- Assumes level 2 attainment
- High Scenic Integrity areas removed
- Assumes passive recreation

Lower Dead Man Wash

- Assuming this is within Hwy. 74 scenic corridor (where does it end/begin)
- Impact to Scenic Integrity / Removes Scenic integrity
- Becomes class 3 incorporating Semi-hard with aesthetic treatment within a suburban setting
- Assumes that drop structures will be utilized in the solution

Assumptions & Recommendations/Design Guidelines
for the Alternatives Evaluation Process
Made by the Natural Resources Group
January 9, 2008

Assumptions:

1. Culverts installed under two lane roads for this project would not change existing conditions or affect wildlife movement negatively or positively
2. ADMP guidelines do not impact WUS.
3. Waters of the US – we added a neutral number to the rankings to consider the unknowns.
4. No Action alternative was "worse" than ADMP guidelines with respect to affects on natural resources.
5. FPAP – we assumed the additional vegetation would be planted after the structures were removed; therefore, wildlife habitat would improve.
6. Gavilan Peak Levee:
    a. Wildlife corridor characteristics could improve because levee would provide protection/isolation to the wildlife in the wash; also vegetation along the levee would be planted.
    b. No fencing would be installed.
7. New River above I-17
    a. Levee – would not impact wildlife corridors; neutral.
    b. Channelization: assume that vegetation would be pruned, removed, i.e., maintained, therefore the wildlife habitat quality of the corridor/New River would be degraded.
8. New River below I-17:
    a. Upland Habitat: We gave the affects to the upland habitat a neutral number of 5 b/c the affects were unknown.
    b. Basins: We assumed that we didn't know the end use of them (e.g., active recreation or passive?, GW recharge?, wildlife habitat enhancement?, etc.)
    c. Basins 2-3: Gave the grade control a 6
    d. Basins: We assumed that the inlets and outlets/weirs are natural materials with boulders and pools.
    e. Basins and Levees: We assumed soft slopes and no fencing.
    f. No Action alternative: There were many unknowns. No Action does not equal non-structural.
9. Deadman Wash:
    a. Bridge alternatives under SR 74 improve the wildlife corridors.

Recommendations:

1. ADMP guidelines would include a riparian ordinance (e.g., similar to the Pima County ordinance) and an upland vegetation ordinance (e.g., retain 20% of upland vegetation); exact verbiage to be provided later.

2. Where applicable, affects to wildlife corridors will adhere to or be modified to comply with the Maricopa County Wildlife Linkages report that will be produced later this winter.
3. For the FPAP, vegetation will be planted along the banks of the wash/stream to prevent bank erosion; also additional vegetation will be planted where the structures were.
4.

Lessons Learned

1. Impacts to riparian habitat: For future evaluations, we need to look at the % of impact instead of the absolute number of acres since most alternatives vary in a scale of magnitude (as we did for the WUS).
2. Any time there is an evaluation of impacts whether they be to riparian, upland or WUS, they need to be based on % of impact

Evaluation Criteria

Paired Comparison Matrix **Criteria:**		**Preference**	**Preference**	**Preference**	**Preference**	**Score**	
						Value	**Total**
A.	Public Safety and Flood Hazard Mitigation	A or B A	A or C A	A or D A	A or E A/E	**3.5**	35
B.	Scenery Resources	B or C B	B or D D	B or E B/E		**1.5**	15
C.	Recreation & Open Space	C or D D	C or E C/E			**0.5**	5
D.	Natural Resources	D or E D/E				**2.5**	25
E.	Implementation					**2**	20

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Scenery Resources Criteria

No.	Sub-Category	Sub-Category Weighting	Sub-Category Score and Scoring Descriptions	
			Score	Description
	Constraints			
1	Degree to which Alternative is compatible with Scenic Resources	7	10	100% of alternative acres are compatible with scenery resources as recommended in the composite scenery resources compatiblity analysis.
			9	90% - 99%
			8	80% - 89%
			7	70% - 79%
			6	60% - 69%
			5	50% - 59%
			4	40% - 49%
			3	30% - 39%
			2	20% - 29%
			1	10% - 19%
	Opportunities			
2	Utilize flood control projects to improve and restore landscapes with visual disturbances to a condition that is complementary to the valued character of the surrounding landscape.	3	10	100% of alternative acres identified as "low scenic integrity" that should be improved through implementatin of the alternative.
			9	90% - 99%
			8	80% - 89%
			7	70% - 79%
			6	60% - 69%
			5	50% - 59%
			4	40% - 49%
			3	30% - 39%
			2	20% - 29%
			1	10% - 19%
	Total Sub-Category Weighting	**10**		

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Recreation And Open Space Resources Criteria

No.	Sub-Category	Sub-Category Weighting	Sub-Category Score and Scoring Descriptions	
			Score	Description
	Constraints			
1	Degree to which Alternative is compatible with Existing Recreation and Open Space Resources	6	10	100% of alternative acres are compatible with recreation and open space resources as recommended in the recreation and open space resources compatiblity analysis.
			9	90% - 99%
			8	80% - 89%
			7	70% - 79%
			6	60% - 69%
			5	50% - 59%
			4	40% - 49%
			3	30% - 39%
			2	20% - 29%
			1	10% - 19%
	Opportunties			
2	Maximize opportunities to meet future needs for passive and active recreation.	2	10	Alternative with highest acres of new parks and recreation opportunties incorporated into solution
			1	Alternative with least acres of new parks and recreation opportunites incorporated.
3	Maximize opportunities to implement the Maricopa Regional Trail Master Plan and meet local community need for trails.	2	10	Alternative with greatest length of trails incorporated into solution
			1	Alternative with least length of trails incorporated into solution
	Total Sub-Category Weighting	**10**		

Natural Resources Sub-Criteria

No.	Sub-Category	Sub-Category Weighting	Sub-Category Score and Scoring Descriptions	
			Score	Description
1	**Impact to Riparian Habitat** - Streamside habitat, including ephemeral washes; stock tanks; mesquite bosques.	3.5		*Linear Impact*
			9	*Improves >500 yards of streamside habitat*
			8	*Improves 100-500 yards of streamside habitat*
			7	*Improves 50-100 yards of streamside habitat*
			6	*Improves <50 yards of streamside habitat*
			5	No impact positively or negatively
			4	< 50 yards of impact
			3	50 - 100 yards of impact
			2	100 - 500 yards of impact
			1	> 500 yards of impact
				Acres of Moderate to High Value Habitat Impact (High plant species diversity; plant structure and foliage volume; canopy cover; stem density and size of plot.)
			9	*Improves >5 acres of habitat*
			8	*Improves 3-5 acres of habitat*
			7	*Improves 1/2-3 acres of habitat*
			6	*Improves <1/2 acre of habitat*
			5	No impact positively or negatively
			4	< 1/2 acre of impact
			3	1/2 - 3 acres of impact
			2	3 - 5 acres of impact
			1	> 5 acres of impact.

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Natural Resources Sub-Criteria Cont.

No.	Sub-Category	Sub-Category Weighting	Sub-Category Score and Scoring Descriptions	
			Score	Description
2	**Impact to Wildlife Corridors** - Areas of dense vegetation and cover that are utilized for wildlife movement.	3		<u>*Linear Impact*</u>
			9	*Improves >500 yards of wildlife corridor*
			8	*Improves 100-500 yards of wildlife corridor*
			7	*Improves 50-100 yards of wildlife corridor*
			6	*Improves <50 yards of wildlife corridor*
			5	No impact positively or negatively
			4	< 50 yards of impact
			3	50 - 100 yards of impact
			2	100 - 500 yards of impact
			1	> 500 yards of impact
				<u>*Slopes of Structures*</u>
				NOTE: Any structure eliminates posibility of a 10 or 9
			8	> 4:1 slopes
			4	3:1 slopes
			1	< 3:1 slopes
				<u>*Character of Grade Control Structures*</u>
				NOTE: Any structure eliminates posibility of a 10 or 9
			8	Natural materials with boulders and pools, >4:1 slopes
			6	Natural materials with boulders and pools, 3:1 slopes
			4	Natural materials with boulders and pools, 2:1 slopes
			2	Concrete only and > 4:1 slopes
			1	Concrete only and < 4:1 slopes.

Natural Resources Sub-Criteria Cont.

No.	Sub-Category	Sub-Category Weighting	Sub-Category Score and Scoring Descriptions	
			Score	**Description**
2 Cont.				*Culverts*
			8	*No change to wildlife movement pathways*
			7	Same as below with nooks or ledges for use by bats, swallows, owls, etc.
			6	Every species will use; (Tools: length to width ratio; daylighting medians; natural bottoms or side paths; wide angle wing-walls.)
			4	All species except larger mammals will use
			1	Only smaller mammals and reptiles will use.
				Safety or Exclusion Fencing
			9	No fencing installed
			6	Fencing installed but is wildlife friendly design
			3	Restricts wildlife movement but not from important areas of habitat, or feeding or watering sites
			1	Not wildlife friendly, fragments habitat and travel corridors
3	**Impact to Waters of the U.S.** - Federally regulated, jurisdictional ordinary high water mark of rivers and washes.	2.5		*Acres of Impact Using ratio: "Acres of Impact\Acres of JD Waters"*
			9	None
			6	< 10%
			3	10 - 30%
			2	30 - 50%
			1	> 50%.

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Natural Resources Sub-Criteria Cont.

No.	Sub-Category	Sub-Category Weighting	Sub-Category Score and Scoring Descriptions	
			Score	Description
4	**Impact to Upland Habitat** - Upland habitat with palo verde, ironwood, and cactus forest and stands of brittlebush, bursage and creosote.	1		<u>*Acres of Disturbance*</u>
			9	*Improves >10 acres of upland habitat*
			8	*Improves 5-10 acres of upland habitat*
			7	*Improves 1-5 acres of upland habitat*
			6	*Improves <1 acre of upland habitat*
			5	No impact positively or negatively
			4	< 1 acre of disturbance
			3	1 - 5 acres of disturbance
			2	5 - 10 acres of disturbance
			1	> 10 acres of disturbance
	Total Sub-Category Weighting	**10**		

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Public Safety and Flood Hazard Mitigation Sub-Criteria

No.	Sub-Category	Sub-Category Weighting	Sub-Category Score and Scoring Descriptions	
			Score	Description
1	**Solve Existing Flood Hazards** - Remove existing structures from the 100-year floodplain / floodway or reduce the potential for damage to existing structures due to lateral migration, bank erosion, flow breakouts, sediment deposition or local scour while providing / maintaining emergency access to existing facilities Note sedimentation is defined as the process of transport, erosion and deposition of sediment	4.5		*River Mechanics*
			10	No change to "natural" channel hydraulics and by inference sedimentation aspects and mitigation of existing human induced adverse channel hydraulic and sedimentation conditions
			7.75	Local / isolated impacts to "natural" channel hydraulics and by inference sedimentation aspects and mitigation of existing human induced adverse channel hydraulic and sedimentation conditions
			5.5	No change to the existing channel hydraulics and sedimentation aspects
			3.25	Local / isolated impact to "natural" channel hydraulics and by inference sedimentation aspects without mitigation of existing human induced adverse channel hydraulic and sedimentation aspects
			1	Regional / reach-wide impact to "natural" channel hydraulics and by inference sedimentation aspects without mitigation of existing human induced adverse channel hdyraulic and sedimentation aspects
				Level of Protection (i.e. 10-yr, 50-yr, etc.)
			10	Regional / reach-wide improvement in the level of protection provided with no reduction anywhere
			7.75	Only local / isolated improvement in the level of protection provided with no change elsewhere
			5.5	No change in the level of protection provided
			3.25	Only local / isolated reduction in the level of protection
			1	Regional / reach-wide reduction in the level of protection provided with no increase anywhere

Public Safety and Flood Hazard Mitigation Sub-Criteria Cont.

No.	Sub-Category	Sub-Category Weighting	Sub-Category Score and Scoring Descriptions	
			Score	Description
1 Cont.				*Emergency Access*
			10	Regional / reach-wide reduction in inaccessible areas during the 100-year event with no increase anywhere
			7.75	Only local / isolated reduction in inaccessible areas during the 100-year event with no increase elsewhere
			5.5	No change in the inaccesible areas during the 100-year flood event
			3.25	Only local / isolated increase in inaccessible areas during the 100-year event with no reduction elsewhere
			1	Regional / reach-wide increase in inaccessible areas during the 100-year event with no reduction anywhere
				Floodplain Area / Erosion Hazard Zone
			10	Regional / reach-wide decrease in floodplain area and erosion hazard zone with no increase anywhere
			7.75	Only local / isolated decrease in floodplain area and erosion hazard zone with no increase anywhere
			5.5	No change in the floodplain area and erosion hazard zone
			3.25	Only local / isolated increase in floodplain area and erosion hazard zone with no reduction elsewhere
			1	Regional / reach-wide increase in floodplain area and erosion hazard zone with no reduction anywhere

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Public Safety and Flood Hazard Mitigation Sub-Criteria Cont.

No.	Sub-Category	Sub-Category Weighting	Sub-Category Score and Scoring Descriptions	
			Score	Description
1 Cont.				*Number of Structures removed from Floodplain*
			10	All structures removed from the floodplain
			7.75	50% reduction in the number of structures located within the floodplain with no new structures added
			5.5	No change in the number of structures located within the floodpalain
			3.25	10% increase in the number of structures located within the floodplain
			1	Greater than 25% increase in the number of structures located within the floodplain
				Number of Structures removed from Floodway
			10	All structures removed from the floodway
			7.75	50% reduction in the number of structures located within the floodway with no new structures added
			5.5	No change in the number of structures located within the floodway
			3.25	10% increase in the number of structures located within the floodway
			1	Greater than 25% increase in the number of structures located within the floodway

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Public Safety and Flood Hazard Mitigation Sub-Criteria Cont.

No.	Sub-Category	Sub-Category Weighting	Sub-Category Score and Scoring Descriptions	
			Score	Description
2	**Adverse Consequences/Consequences of Failure (Risk) -** Presents potential for an attractive nuisance; failure of the alternative, increase in the risk of loss of life and damage to property Note: An attractive nuisance is any inherently hazardous object (typically man-made) or condition of property that can be expected to attract children to investigate or play	3.5		*Attractive Nuisance*
			10	No features present potential for an attractive nuisance or all features can accommodate managed public recreational activities or allow for protection from public
			7.75	Most features do not present potential for an attractive nuisance or can accommodate managed public recreational activities or allow for protection from public
			5.5	Some features present potential for an attractive nuisance that cannot accommodate managed public recreational activities or allow for protection from public access
			3.25	Most features present potential for an attractive nuisance that cannot accommodate managed public recreational activities or do not allow for protection from public access
			1	All features present potential for an attractive nuisance that cannot accommodate managed public recreational activities or do not allow for protection from public access

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Public Safety and Flood Hazard Mitigation Sub-Criteria Cont.

No.	Sub-Category	Sub-Category Weighting	Sub-Category Score and Scoring Descriptions	
			Score	Description
2 Cont.	Note: It is assumed that all alternatives satisfy a minimum "design" criteria and / or management standard of the 100-year flood			*Pobability of Failure*
			10	Requires little maintenance, monitoring, management and / or operational attention
			5.5	Requires regular mainatenance, monitoring, management and / or operational attention
			1	Requires continual / constant maintenace, monitoring, management and / or operational attention
				Consequences of failure
			5.5	Only economic "damage"
			3	Property and ecomonmic damage
			1	Loss of life, property and economic damage
3	**Protect Future Development -** Provides opportunity for the maximization of developable property.	2		*Reclaimed Floodplain Area / Erosion Hazard Zone*
			10	100% reduction in floodplain area
			7.75	50% reduction in floodplain area
			5.5	No change in floodplain area
			3.25	50% increase in floodplain area
			1	100% increase in floodplain area
	Total Sub-Category Weighting	**10**		

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Implementation Criteria

No.	Sub-Category	Sub-Category Weighting	Sub-Category Score and Scoring Descriptions	
			Score	Description
1	**Multiple Funding Sources**	1.2	10	The alternative has a high probability of funding participation with FCDMC by at least one other agency/entity.
			7	The alternative has a high probability of only being funded by another agency(s) without FCDMC participation.
			5.5	The alternative has a high probability of being funded solely by FCDMC.
			1	The alternative has a low probability of being funded by FCDMC or any other agency.
2	**Complexity of Implementation**	2.2	10	The alternative is relatively simple to implement when considering land ownership, physical constraints and number and types of IGA's or MOU's required.
			5.5	The alternative is average in difficulty to implement when considering land ownership, physical constraints and number and types of IGA's or MOU's required.
			1	The alternative is relatively difficult to implement when considering land ownership, physical constraints and number and types of IGA's or MOU's required.

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Implementation Criteria Cont.

No.	Sub-Category	Sub-Category Weighting	Sub-Category Score and Scoring Descriptions	
			Score	Description
3	Community Acceptance	1	10	The alternative has the support of at least one organized citizens group composed of the public living within the watershed.
			7	The alternative has been suggested by at least one member of the public living within the watershed.
			5.5	No public comment or input from an organized citizens group living in the watershed was received
			3	The alternative has been negatively referred to by at least one member of the public living within the watershed.
			1	The alternative does not have the support of at least organized citizens group compose of the public living within the watershed.
4	Stakeholder Acceptance This element evaluates whether we can expect stakeholders to support, approve and adopt the alternative. Consider the criteria each individual stakeholder will utilize to evaluate each alternative, i.e. regulatory, permitting, funding participation, etc. and the likelihood that they support the alternative. Additionally this element considers the general consensus of the multiple stakeholders for such support, approval and adoption of the alternative.	1.8	10	Approval by stakeholder consensus
			5.5	No input reported from stakeholders
			1	Disapproval by stakeholder consensus

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Implementation Criteria Cont.				
No.	**Sub-Category**	**Sub-Category Weighting**	**Sub-Category Score and Scoring Descriptions**	
			Score	**Description**
5	**Compatibility with other Agency Plans** This element ranks how well an alternative accommodates other Agency Plans (i.e., land use, parks, trails, transportation, etc.). Accommodating other Agency Plans has a positive effect on gaining consensus towards a preferred alternative. Each alternative should be ranked relative to each other as to how effectively the alternative accommodates other Agency Plans. The more an alternative accommodates other Agency Plans the higher the score	1.6	10	The alternative is compatible with all known applicable adopted agency plans.
			5.5	The alternative is compatible with approximately 50% of known applicable adopted agency plans.
			1	The alternative is not compatible with all known applicable adopted agency plans.

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Implementation Criteria Cont.

No.	Sub-Category	Sub-Category Weighting	Sub-Category Score and Scoring Descriptions	
			Score	Description
6	**Regulatory Permitting** This element evaluates the level of difficulty or complexity for local, state and federal permitting required for an alternative. Regulatory permitting can make an alternative less desirable or less feasible if creates increased cost, project delays, insurmountable mitigation requirements, or a denial of the permit. Alternatives should be evaluated as to the relative difficulty or complexity in gaining the necessary regulatory permits that lead to successful implementation. An alternative that has the least relative difficulty or complexity in gaining regulatory permits receives the higher score. Each alternative should be ranked relative to each other.	1.5	10	The alternative is relatively simple to permit through all known regulatory systems.
			5.5	The alternative is average in ability to permit through all known regulatory systems.
			1	The alternative is relatively difficult to permit through all known regulatory systems.

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Implementation Criteria Cont.

No.	Sub-Category	Sub-Category Weighting	Sub-Category Score and Scoring Descriptions	
			Score	Description
7	**Timing & Phasing** This element evaluates whether there are meaningful opportunities to phase the alternative or elements of the alternative. The public safety and flood hazard mitigation alternatives might be implemented however the accompanying aesthetics and recreational elements might have the ability to be deferred. The opportunity for phasing improves the overall implementation of the more critical functions of the alternative.	0.7	10	The alternative either does not need phasing due to relatively high benefit/ cost or because it is relatively simple to implement the critical functions in one phase.
			7	The alternative has elements that are compatible with a multiple phasing approach
			5.5	The alternative has elements that are compatible with a multiple phasing approach but is such low benefit/cost
			1	The alternative can not be phased due to constraints from either external conditions or elements of the alternative itself.
	Total Sub-Category Weighting	**10**		

Evaluation Information Sheets

Upper New River ADMP Evaluation Information Summary

Planning Area	Alternative	Impacted Riparian Area		Impacted Wildlife Corridor					Waters of the U.S.			Impacts to Upland Habitat	Impacts to Floodplain		
										Impacted Waters of the U.S.						
		Linear	Area	Linear	Slope of Structures	Grade Control	Culvert or Bridges	Fencing	Total Waters of the US	Area	Ratio (Impacted/ total waters of the US)	Area of Disturbance	Area Removed From FEMA Floodplain	Area Removed From FLO-2D Floodplain	Area Added to Floodplain
		(feet)	(acres)	(ft)	(h/v)				Acres	(acres)		(acres)	(acres)	(acres)	(acres)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Gavilan Peak	Alternative 1 - ADMP Guidelines	Assume minor or no impact		Assume minor or no impact					107	NA	NA	Assume minor or no impact	NA	NA	NA
	Alternative 4 - No Action Alternative	No Planned Approach to Impact or Mitigation		No Planned Approach to Impact or Mitigation					107	NA	NA	No Planed Approached to Impact or Mitigation	NA	NA	NA
	Alternative 2 - Non Structural Gavilan Peak Wash (FPAP)	Assume minor or no impact		Assume minor or no impact					47	NA	NA	Assume minor or no impact	NA	NA	NA
	Alternative 3 - Structural Alternative (levees)	> 500 yards of impact	8	> 500 yards of impact	3:1 to 6:1	NA	Every Species Will Use	Wildlife Friendly	47	8	17%	Assume minor or no impact	31	NA	NA
New River Above-17	Alternative 1 - Levee along Old Stagecoach Rd. (Roadway Embankment)	> 500 yards of impact	11	> 500 yards of impact	3:1 to 6:1	NA	NA	NA	74	11	15%	Assume minor or no impact	0	NA	NA
	Alternative 2 - Channelization adjacent to Old Stagecoach Rd	> 500 yards of impact	74	> 500 yards of impact	3:1 to 6:1	NA	NA	NA	74	41	55%	Assume minor or no impact	31	NA	NA
	Alternative 3 - Floodprone Property Assistance Program	Assume minor or no impact		Assume minor or no impact					74	0	NA	Assume minor or no impact	0	NA	NA
	Alternative 4 - Vegetation Alternative Maintenance has been eliminated	NA	NA	Vegetation Maintenance Alternative has been eliminated					NA	NA	NA	Assume minor or no impact	NA	NA	NA
	Alternative 5 - ADMP Guidelines	Assume minor or no impact		Assume minor or no impact					588	NA	NA	ND	NA	NA	NA
	Alternative 6 - No Action	No Planned Approach to Impact or Mitigation		No Planned Approach to Impact or Mitigation					588	NA	NA	ND	NA	NA	NA

Upper New River ADMP Evaluation Information Summary

Planning Area	Alternative	Impacted Riparian Area		Impacted Wildlife Corridor					Waters of the U.S.			Impacts to Upland Habitat	Impacts to Floodplain		
										Impacted Waters of the U.S.						
		Linear	Area	Linear	Slope of Structures	Grade Control	Culvert or Bridges	Fencing	Total Waters of the US	Area	Ratio (Impacted/ total waters of the US)	Area of Disturbance	Area Removed From FEMA Floodplain	Area Removed From FLO-2D Floodplain	Area Added to Floodplain
		(feet)	(acres)	(ft)	(h/v)				Acres	(acres)		(acres)	(acres)	(acres)	(acres)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
New River Below I-17	Alternative 1-Levee, Option	> 500 yards of impact	35	> 500 yards of impact	3:1 to 6:1	NA	Every Species Will Use	Wildlife Friendly	4056	71	2%	973	973	1114	NA
	Alternative 1-Channel Option	> 500 yards of impact	206	> 500 yards of impact	3:1 to 6:1	NA	Every Species Will Use	Wildlife Friendly	4056	272	7%	977	977	1114	NA
	Alternative 2-Levee Option	> 500 yards of impact	35	> 500 yards of impact	3:1 to 6:1	Natural materials with boulders and pools, >4:1 slopes	Every Species Will Use	Wildlife Friendly	4056	67	2%	1029	1029	1285	NA
	Alternative 2-Channel Option	> 500 yards of impact	218	> 500 yards of impact	3:1 to 6:1	Natural materials with boulders and pools, >4:1 slopes	Every Species Will Use	Wildlife Friendly	4056	259	6%	1029	1029	1285	NA
	Alternative 3-Levee Option	100 - 500 yards of impact	0.9	100 - 500 yards of impact	3:1 to 6:1	NA	Every Species Will Use	Wildlife Friendly	4056	38.5	1%	777	777	677	NA
	Alternative 4-Retention Basin	> 500 yards of impact	14	> 500 yards of impact	3:1 to 6:1	NA	Every Species Will Use	Wildlife Friendly	4056	716	18%	1078	1078	1114	215

Upper New River ADMP Evaluation Information Summary

Planning Area	Alternative	Impacted Riparian Area		Impacted Wildlife Corridor					Waters of the U.S.			Impacts to Upland Habitat	Impacts to Floodplain		
										Impacted Waters of the U.S.						
		Linear	Area	Linear	Slope of Structures	Grade Control	Culvert or Bridges	Fencing	Total Waters of the US	Area	Ratio (Impacted/ total waters of the US)	Area of Disturbance	Area Removed From FEMA Floodplain	Area Removed From FLO-2D Floodplain	Area Added to Floodplain
		(feet)	(acres)	(ft)	(h/v)				Acres	(acres)		(acres)	(acres)	(acres)	(acres)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Lower Deadman Planning Area	Alternative 1A	50 - 100 yards of impact	1	Assume minor or no impact					1055	0	0%	NA	0	NA	NA
	Alternative 1B	> 500 yards of impact	183	> 500 yards of impact	3:1 to 6:1	NA	Every Species Will Use	Wildlife Friendly	1055	37	4%	NA	136	NA	NA
	Alternative 2 A	> 500 yards of impact	303	> 500 yards of impact	3:1 to 6:1	Natural materials with boulders and pools, >4:1 slopes	Every Species Will Use	Wildlife Friendly	1055	78	7%	NA	202	NA	NA
	Alternative 2 B	> 500 yards of impact	437	> 500 yards of impact	3:1 to 6:1	Natural materials with boulders and pools, >4:1 slopes	Every Species Will Use	Wildlife Friendly	1055	115	11%	NA	334	NA	NA
	Alternative 3 - ADMP Guidelines	Assume minor or no impact		Assume minor or no impact					1055	NA	NA	ND	NA	NA	NA
	Alternative 4 - No Action	No Planned Approach to Impact or Mitigation		No Planned Approach to Impact or Mitigation					1055	NA	NA	ND	NA	NA	NA
Lone Mountain, Upper Deadman, New River Dam, Rock Springs, Sweat Canyon, & West Tributaries Planning Areas	Alternative 3 - ADMP Guidelines	Assume minor or no impact		Assume minor or no impact					NA	NA	NA	ND	NA	NA	NA
	Alternative 4 - No Action	No Planned Approach to Impact or Mitigation		No Planned Approach to Impact or Mitigation					NA	NA	NA	ND	NA	NA	NA

GAVILAN PEAK PLANNING AREA

Existing Flood and Erosion Hazard Issues

- FEMA Effective 100-year Floodplain
- Twenty-eight properties have a primary residence structure located within the floodplain. Three of these structures are located within the floodway. Twenty-two of these are located along Gavilan Peak Wash, downstream of New River Road, and two of those 22 are located in the floodway.
- Flooding at roadway dip sections and culverted wash crossings with insufficient capacity to convey the 100-year flow
- Property egress limitations during frequent flooding events
- Average floodplain widths along FEMA delineated washes:
  - Gavilan Peak Wash – 550 ft
  - Tributaries – 100 ft
- Typical channel velocity ranges between 5 and 10 fps

Flood Mitigation Solutions Considered

The Gavilan Planning Area is a watershed and watercourse planning area. The watershed planning effort considers two alternatives, an ADMP guidelines alternative and a FEMA regulatory guidelines alternative. ADMP guidelines developed as part of the ADMP provided a uniform approach to flood hazard mitigation and protection/enhancement of natural resources. FEMA regulatory guidelines provide an approach to flood hazard mitigation, however the approach may not be a uniform and the approach may not take into consideration impact to natural resources.

The watercourse planning element considers Gavilan Peak Wash. The improvement reach commences approximately 100 feet upstream of New River Road and extends to the confluence with New River. Both structural and non-structural alternatives are proposed for this reach of Gavilan Peak Wash to mitigate identified flood hazards. The type and distribution of structural elements are depicted on the attached figures. Areas within the Gavilan Peak Wash Floodplain where no structural elements are depicted are non-structural reaches.

Watershed

Alternative 1 – ADMP Guidelines

Watershed will be allowed to develop according to land use plan. Watercourses within the planning area will be managed through ADMP Guidelines. Flood mitigation solutions include:

- Develop a flood warning response plan for residents
- Develop an emergency access plan for residents
- Develop and manage flood and erosion hazards with regionally specific guidelines and ordinances
- Floodprone Property Assistance Program (FPAP)

Alternative 4 – No Action Alternative-(FEMA Regulatory Solutions)

Watercourse

The majority of existing flooding hazards are concentrated along Gavilan Peak Wash downstream of New River Road. Flood mitigation solutions specific to this reach include:

Alternative 2 -Non-Structural (Gavilan Peak Wash)

- Floodprone Property Assistance Program – voluntary program providing financial assistance for flood proofing of existing structures located within the floodplain or property acquisition for existing structures located within the floodway
  - Elevation of the primary residence structure for the 20 structures located within the floodplain fringe
  - Property acquisition for the two structures located within the floodway

Alternative 3 –Soft Structural

- Levee
  - Structures located within floodplain and floodway protected with approximately 1.2 miles of levee located primarily on the river right (north bank) generally following the floodway boundary.
  - Existing roadway grades and culverts improved or replaced with bridges to convey 100-year discharge without overtopping road
  - Acquisition of properties with access cut-off by levee
  - Acquisition of drainage easements across properties impacted by increased water surface elevations but not protected by levee
  - Acquisition of right-of-way for levee
  - Optional elements
    - Landscape fill and grading
    - Vegetative planting

Benefits/Limitations/Impacts Realized from Considered Alternatives

Alternative 1

Benefits:

- A flood warning plan defines actions that residents would take during a flood event to minimize the potential for loss of life
- An emergency access plan defines routes that provide all weather access to developed areas for both residents and emergency response teams, identifies and prioritizes infrastructure improvements to support access to developed areas and minimizes the potential for loss of life.
- Regionally specific guidelines and ordinances:
  - Provide guidance concerning the extent and severity of flooding and erosion hazards
  - Provide regulations to help residents minimize the occurrence of losses, hazards and conditions adversely affecting the public health, safety and general welfare that might result from a flooding event.

  - Environmentally sensitive. Provide opportunity to maintain existing riparian resource
  - Provides opportunity to accommodate multi-use recreational trails
  - Alternative is consistent with land use plan
- Floodprone Property Assistance Program:
  - Removes structures from the floodway
  - Provides financial assistance to those who cannot afford flood proofing to "remove" structures from the floodplain
  - Environmentally sensitive. Provides opportunity to maintain existing riparian resource

Limitations:

- Flood warning plan:
  - Does not protect structures from flood and erosion hazards
  - Flashy nature of the watershed response requires predictive approach for flood warning
  - Must be coupled with other management elements to address future development issues
  - Opportunity to reclaim floodplain for development is diminished.
- Emergency access plan:
  - Does not protect structures from flood and erosion hazards
  - Must be coupled with other management elements to address future development issues
  - Opportunity to reclaim floodplain for development is diminished.
- Regionally specific guidelines and ordinances:
  - Could require that all landowners within a specific flood hazard area participate to mitigate flood hazard. Some landowners may not be able to participate.
  - Opportunity to reclaim floodplain for development is diminished.
- Floodprone Property Assistance Program
  - Voluntary program
  - Must be coupled with other management elements to address future development issues
  - Does not guarantee that lending institutions will not require flood insurance for structures removed from the floodplain through an elevation certificate process

Collective Impacts:

- Riparian Habitat
  - Linear = No Impact
  - Acres of Moderate to High Value Habitat = No Impact
- Wildlife Corridors
  - Linear Impact = No Impact
  - Slope of Structures = Assume 3:1 to 6:1
  - Grade Control structures = Assume natural with max 4:1 slopes
  - Culverts = Assume all species but mammals
  - Fencing = No Impact
- Impact to Waters of the U.S.
  - Acres of Impact = Assume no Impact

  - Ratio of acres of impact/total Waters of the U.S. = Assume no Impact
- Impacts to Upland Habitat = Assume no Impact
  - Acres of Disturbance = Assume no Impact
- Impacts to Floodplain
  - Acres of Impact (Area removed from Floodplain) = Assume no Impact

Alternative 2 - Floodprone Property Assistance Program

Benefits:

- Floodprone Property Assistance Program:
  - Removes structures from the floodway
  - Provides financial assistance to those who cannot afford flood proofing to "remove" structures from the floodplain
  - Environmentally sensitive. Provides opportunity to maintain existing riparian resource

Limitations:

- Floodprone Property Assistance Program:
  - Voluntary program
  - Must be coupled with other management elements to address future development issues
  - Does not guarantee that lending institutions will not require flood insurance for structures removed from the floodplain through an elevation certificate process

Collective Impacts:

- Riparian Habitat
  - Linear = No Impact
  - Acres of Moderate to High Value habitat = No Impact
- Wildlife Corridors
  - Linear Impact = No Impact
  - Slope of Structures = No Impact
  - Grade Control structures = No Impact
  - Culverts = No Impact
  - Fencing = No Impact
- Impact to Water of the U.S.
  - Acres of impact = No Impact
  - Ratio of acres of impact/total Water of the U.S.
- Impacts to Upland Habitat
  - Acres of Disturbance = No Impact
- Impacts to Floodplain
  - Acres of Impact (Area removed from Floodplain) = No Impact

Alternative 3 – Soft Structural

Benefits:

- Improved access along New River Road
- Removal of structures within the floodway and floodplain fringe
- Protects against erosion hazards.

Limitations:

- Requires maintenance and operation plan
- FEMA certification process must be satisfied
- Increase in flow depths and velocities
- 404 permit required
- Limits access to private property within the levee
- Limits access to properties on opposite side of wash

Collective Impacts:

- Riparian Habitat
  - Linear = > than 500 yards
  - Acres of Moderate to High Value habitat = 8
- Wildlife Corridors
  - Linear Impact = > than 500 yards
  - Slope of Structures = 3:1 to 6:1
  - Grade Control structures = NA
  - Culverts = Bridges- Every Species will use
  - Fencing = Wildlife frinedly
- Impact to Water of the U.S.
  - Acres of impact = 47
  - Ratio of acres of impact/total Water of the U.S. = 17%
- Impacts to Upland Habitat
  - Acres of Disturbance = Assume no Impact
- Impacts to Floodplain
  - Acres of Impact (Area removed from Floodplain) = 31

Alternative 4 - No Action

The no-action (do nothing) alternative provides flood control management based on current federal, state, and local floodplain management regulations that allow encroachment into the floodway fringe. Typically under current regulations, encroachments into the floodway fringe are allowed in a piecemeal fashion without taking into consideration the effect of the encroachment or collective encroachments on the entire watercourse.

Benefits:

- Provides the opportunity to mitigate flood hazard on a parcel by parcel basis

Limitations:

- Opportunity to develop a uniform design or plan to mitigated flood hazards is limited
- Opportunity to incorporate multi-use recreation facilities is limited
- Opportunity to maintain or enhance environmental resources is limited

Collective Impacts:

- Riparian Habitat
  - Linear = Piecemeal/Undeterminable
  - Acres of Moderate to High Value habitat = Piecemeal/Undeterminable
- Wildlife Corridors

  - Linear Impact = Piecemeal/Undeterminable
  - Slope of Structures = Piecemeal/Undeterminable
  - Grade Control structures =
  - Culverts = Piecemeal/Undeterminable
  - Fencing = Piecemeal/Undeterminable
- Impact to Water of the U.S.
  - Acres of impact = Piecemeal/Undeterminable
  - Ratio of acres of impact/total Water of the U.S. = Piecemeal/Undeterminable
- Impacts to Upland Habitat
  - Acres of Disturbance = Piecemeal/Undeterminable
- Impacts to Floodplain
  - Acres of Impact (Area removed from Floodplain) = Piecemeal/Undeterminable

LONE MOUNTAIN, UPPER DEADMAN, NEW RIVER DAM, ROCK SPRINGS, SWEAT CANYON, & WEST TRIBUTARIES PLANNING AREAS

Existing Flood and Erosion Hazard Issues

- FEMA Effective 100-year Floodplain
- Undefined 100-year floodplains
- Flooding at roadway dip sections and culvert wash crossings with insufficient capacity to convey the 100-year flow

Flood Mitigation Solutions Considered

Communities develop drainage ordinances, policies, and standards with the intent to mitigate/minimize flooding impacts due to urbanization of a watershed. The purpose of these regulations is to minimize the occurrence of losses, hazards and conditions adversely affecting the public health, safety and general welfare that might result from flooding caused by the surface runoff of rainfall.

The planning areas are predominately undeveloped; therefore a regional watershed approach is taken to mitigate potential flood and erosion hazards due to urbanization.

The watershed planning effort considers two alternatives, an ADMP guidelines alternative and a FEMA regulatory guidelines alternative. ADMP guidelines developed as part of the ADMP provided a uniform approach to flood hazard mitigation and protection/enhancement of natural resources. FEMA regulatory guidelines provide an approach to flood hazard mitigation, however the approach may not be a uniform and the approach may not take into consideration impact to natural resources.

Alternative 1

ADMP Guidelines – Non Structural and Soft Structural

Watershed will be allowed to develop according to land use plan. Watercourses within the planning area will be managed through ADMP Guidelines. Flood mitigation solutions include:

- Develop and manage flood and erosion hazards through regionally specific guidelines and ordinances
- Promote and continue sound floodplain management.

Benefits/Limitations Realized from Considered Alternatives

Benefits:

- Regionally specific guidelines and ordinances
  - Provide guidance concerning the extent and severity of flooding and erosion hazards

- Provide regulations to help residents minimize the occurrence of losses, hazards and conditions adversely affecting the public health, safety and general welfare that might result from a flooding event.
- Environmentally sensitive. Provide opportunity to maintain existing riparian resource
- Provide opportunity to accommodate multi-use recreational trails
- Alternative is consistent with land use plan

Limitations:

- Regionally specific guidelines and ordinances
  - Could require that all landowners within a specific flood hazard area participate to mitigate flood hazard. Some landowners may not be able to participate.
  - Opportunity to reclaim floodplain for development is diminished.

Collective Impacts:

- Riparian Habitat
  - Linear = No Impact
  - Acres of Moderate to High Value Habitat = No Impact
- Wildlife Corridors
  - Linear Impact = No Impact
  - Slope of Structures = Assume 3:1 to 6:1
  - Grade Control structures = Assume natural with max 4:1 slopes
  - Culverts = Assume all species but mammals
  - Fencing = No Impact
- Impact to Waters of the U.S.
  - Acres of Impact = Assume no Impact
  - Ratio of acres of impact/total Waters of the U.S. = Assume no Impact
- Impacts to Upland Habitat = Assume no Impact
  - Acres of Disturbance = Assume no Impact
- Impacts to Floodplain
  - Acres of Impact (Area removed from Floodplain) = Assume no Impact
  - Ratio of acres removed to total floodplain area = Assume no Impact

Alternative 2 - No Action

The no-action (do nothing) alternative provides flood control management based on current federal, state, and local floodplain management regulations that allow encroachment into the floodway fringe. Typically under current regulations, encroachments into the floodway fringe are allowed in a piecemeal fashion without taking into consideration the effect of the encroachment or collective encroachments on the entire watercourse.

Benefits:

- Provides the opportunity to mitigate flood hazard on a parcel by parcel basis

Limitations:

- Opportunity to develop a uniform design or plan to mitigated flood hazards is limited
- Opportunity to incorporate multi-use recreation facilities is limited
- Opportunity to maintain or enhance environmental resources is limited

Collective Impacts:

- Riparian Habitat
  - Linear = Piecemeal/Undeterminable
  - Acres of Moderate to High Value habitat = Piecemeal/Undeterminable
- Wildlife Corridors
  - Linear Impact = Piecemeal/Undeterminable
  - Slope of Structures = Piecemeal/Undeterminable
  - Grade Control structures =
  - Culverts = Piecemeal/Undeterminable
  - Fencing = Piecemeal/Undeterminable
- Impact to Water of the U.S.
  - Acres of impact = Piecemeal/Undeterminable
  - Ratio of acres of impact/total Water of the U.S. = Piecemeal/Undeterminable
- Impacts to Upland Habitat
  - Acres of Disturbance = Piecemeal/Undeterminable
- Impacts to Floodplain
  - Acres of Impact (Area removed from Floodplain) = Piecemeal/Undeterminable
  - Ratio of acres removed to total floodplain area = Piecemeal/Undeterminable

LOWER DEADMAN WASH PLANNING AREA

Existing Flood and Erosion Hazard Issues

- FEMA Effective 100-year Floodplain
- Erosion hazard boundary
- SR 74 is used by the public for ingress and egress to the area. The roadway includes one 48" culvert crossing, which does not have the capacity to carry flood flows. Flood flows currently cross over SR 74 in depths greater than one foot, posing a hazard to the public and emergency vehicles.
- Unpredictable flow paths upstream of SR 74
- Floodplain width varies between approximately 500 ft and 2,390 ft. Average width is approximately 1,390 ft
- Existing Flows for the 100-year event:
  - Near SR 74 – 9,940 cfs
  - Near the confluence with New River – 10,340 cfs
- Channel velocity ranges between 2 and 12 fps. Average channel velocity is approximately 6 fps
- Existing structures in floodplain:
  - Crossing at I-17 includes bridges for the highway and on and off ramps
  - Crossing at SR 74 includes on 48" culvert and dip crossing
  - Crossing for the Correctional Facility road includes 72", 40" x 26" and 36" pipes

Flood Mitigation Solutions Considered

The Lower Deadman Planning Area is a watercourse and watershed planning area. The watercourse planning element considers Dead Man Wash commencing approximately 200 feet downstream of the Carefree Highway and extending upstream of the crossing of I17. Both structural and non-structural alternatives are proposed for Deadman Wash to mitigate flooding at the Carefree Highway. The type and distribution of structural elements are depicted on the attached figures. Areas within the Deadman Wash Floodplain where no structural elements are depicted are non-structural reaches.

The watershed planning effort considers two alternatives, an ADMP guidelines alternative and a FEMA regulatory guidelines alternative. ADMP guidelines developed as part of the ADMP provided a uniform approach to flood hazard mitigation and protection/enhancement of natural resources. FEMA regulatory guidelines provide an approach to flood hazard mitigation, however the approach may not be a uniform and the approach may not take into consideration impact to natural resources.

Watercourse Planning Element (Deadman Wash crossing of SR 74

Alternatives 1 and 2:

- Spur Levee and no retention (Alternative 1a)
  - Keeping the existing culvert on the east side of Deadman Wash

  - Constructing a bridge on the west side
- Spur Levee with retention (Alternative 1b)
  - Keeping the existing culvert on the east side of Deadman Wash
  - Constructing a bridge on the west side
  - Constructing a basin on the upstream side of I-17
- Channelization/Levee and no retention (Alternative 2a)
  - Constructing a channel to carry all flow to the east side
  - Replacing the existing culvert with a bridge
- Channelization/Levee with retention (Alternative 2b)
  - Constructing a channel to carry all flow to the east side
  - Replacing the existing culvert with a bridge
  - Constructing a basin on the upstream side of I-17

Watershed

Alternative 3 -ADMP Guidelines:

Watershed will be allowed to develop according to land use plans. Watercourses within the planning area will be managed through ADMP Guidelines. Flood mitigation solutions include:

- Develop and manage flood and erosion hazards with regionally specific guidelines and ordinances
- Promote and continue with sound floodplain management

Alternative 4 – No Action (FEMA Regulatory Solutions)

Benefits/Limitations Realized from Considered Alternatives

Alternatives 1 and 2 - (Deadman Wash crossing of SR 74)

Benefits:

- For each alternative the Deadman Wash crossing at SR 74 can safely be used by the public and emergency vehicles during the 100-year event.

Limitations:

- Requires maintenance and operation plan
- FEMA certification process must be satisfied
- Increase in flow depths and velocities
- 404 permit required

Collective Impacts:

Alternative 1a:

- Riparian Habitat
  - Linear = 50-100 yards
  - Acres of Moderate to High Value habitat =1
- Wildlife Corridors
  - Linear Impact = No Impact
  - Slope of Structures = NA
  - Grade Control structures = NA
  - Culverts/Bridges = No Change to Wildlife movement.
  - Fencing = Assume No Impact

- Impact to Water of the U.S.
  - Acres of impact = 0
  - Ratio of acres of impact/total Water of the U.S. = NA
- Impacts to Upland Habitat
  - Acres of Disturbance = No Impact
- Impacts to Floodplain
  - Acres of Impact (Area removed from Floodplain) =0

Alternative 1b:

- Riparian Habitat
  - Linear = > 500-yards
  - Acres of Moderate to High Value habitat = 183
- Wildlife Corridors
  - Linear Impact = No Impact
  - Slope of Structures = 3:1 to 6:1
  - Grade Control structures = NA
  - Culverts/Bridges = No Change to Wildlife movement.
  - Fencing = Assume No Impact
- Impact to Water of the U.S.
  - Acres of impact = 37
  - Ratio of acres of impact/total Water of the U.S. = 4
- Impacts to Upland Habitat
  - Acres of Disturbance = No Impact
- Impacts to Floodplain
  - Acres of Impact (Area removed from Floodplain) = 136

Alternative 2 a:

- Riparian Habitat
  - Linear = > 500 yards
  - Acres of Moderate to High Value habitat = 303
- Wildlife Corridors
  - Linear Impact = No Impact
  - Slope of Structures = 3:1 to 6:1
  - Grade Control structures = Natural Materials, 4:1 sidelslopes
  - Culverts/Bridges = No Change to Wildlife movement.
  - Fencing = Assume No Impact
- Impact to Water of the U.S.
  - Acres of impact = 78
  - Ratio of acres of impact/total Water of the U.S. = 7
- Impacts to Upland Habitat
  - Acres of Disturbance = No Impact
- Impacts to Floodplain
  - Acres of Impact (Area removed from Floodplain) = 202

Alternative 2b:

- Riparian Habitat
  - Linear = > 500 yards

  - Acres of Moderate to High Value habitat = 437
- Wildlife Corridors
  - Linear Impact = No Impact
  - Slope of Structures = 3:1 to 6:1
  - Grade Control structures = NA
  - Culverts/Bridges = No Change to Wildlife movement.
  - Fencing = Assume No Impact
- Impact to Water of the U.S.
  - Acres of impact = 115
  - Ratio of acres of impact/total Water of the U.S. = 11
- Impacts to Upland Habitat
  - Acres of Disturbance = No Impact
- Impacts to Floodplain
  - Acres of Impact (Area removed from Floodplain) = 334

Alternative 3 – ADMP Guidelines

Benefits:

- Alternative provides guidance concerning the extent and severity of flooding and erosion hazards.
- Provides regulations to help residents minimize the occurrence of losses, hazards and conditions adversely affecting the public health, safety and general welfare that might result from a flooding event.
- Regionally specific guidelines and ordinances:
  - Provide guidance concerning the extent and severity of flooding and erosion hazards
  - Provide regulations to help residents to minimize the occurrence of losses, hazards, and conditions adversely affecting the public health, safety, and general welfare that might result from a flooding event.
  - Environmentally sensitive. Provide an opportunity to maintain existing riparian resource
  - Provide opportunity to accommodate multi-use recreational trails
  - Alternative is consistent with land use plan

Limitations:

- Regionally specific guidelines and ordinances
  - Could require that all landowners within a specific flood hazard area participate to mitigate flood hazard. Some landowners may not be able to participate.
  - Opportunity to reclaim floodplain for development is diminished.

Collective Impacts:

- Riparian Habitat
  - Linear = No Impact
  - Acres of Moderate to High Value Habitat = No Impact
- Wildlife Corridors
  - Linear Impact = No Impact
  - Slope of Structures = Assume 3:1

  - Grade Control structures = Assume natural with max 3:1 slopes
  - Culverts = Assume all species but mammals
  - Fencing = No Impact
- Impact to Waters of the U.S.
  - Acres of Impact = Assume no Impact
  - Ratio of acres of impact/total Waters of the U.S. = Assume no Impact
- Impacts to Upland Habitat = Assume no Impact
  - Acres of Disturbance = Assume no Impact
- Impacts to Floodplain
  - Acres of Impact (Area removed from Floodplain) = Assume no Impact
  - Ratio of acres removed to total floodplain area = Assume no Impact

Alternative 4 - No Action

The no-action (do nothing) alternative provides flood control management based on current federal, state, and local floodplain management regulations that allow encroachment into the floodway fringe. Typically under current regulations, encroachments into the floodway fringe are allowed in a piecemeal fashion without taking into consideration the effect of the encroachment or collective encroachments on the entire watercourse.

Benefits:

- Provides the opportunity to mitigate flood hazard on a parcel by parcel basis.

Limitations:

- Opportunity to develop a uniform design or plan to mitigated flood hazards is limited.
- Opportunity to incorporate multi-use recreation facilities is limited.
- Opportunity to maintain or enhance environmental resources is limited.

Collective Impacts:

- Riparian Habitat
  - Linear = Piecemeal/Undeterminable
  - Acres of Moderate to High Value habitat = Piecemeal/Undeterminable
- Wildlife Corridors
  - Linear Impact = Piecemeal/Undeterminable
  - Slope of Structures = Piecemeal/Undeterminable
  - Grade Control structures =
  - Culverts = Piecemeal/Undeterminable
  - Fencing = Piecemeal/Undeterminable
- Impact to Water of the U.S.
  - Acres of impact = Piecemeal/Undeterminable
  - Ratio of acres of impact/total Water of the U.S. = Piecemeal/Undeterminable
- Impacts to Upland Habitat
  - Acres of Disturbance = Piecemeal/Undeterminable
- Impacts to Floodplain

- Acres of Impact (Area removed from Floodplain) = Piecemeal/Undeterminable
- Ratio of acres removed to total floodplain area = Piecemeal/Undeterminable

NEW RIVER DOWNSTREAM OF I-17

The New River Downstream of I-17 Planning Area takes into consideration New River below I-17 to the New River Dam impoundment area. The New River segment includes New River, the West Split, Middle Split and East Split of New River and the reach of Sweat Canyon below New River Road.

Existing Flood and Erosion Hazard Issues

- FEMA Effective 100-year Floodplain
- Erosion hazard boundary
- Residential structures within floodplain and erosion hazard zones
- Flow break out at three different locations:
  - Along the west bank of New River at the West Split located approximately three and half miles downstream of I-17. Flow draining to the West Split ultimately combines with flow from Sweat Canyon.
  - Along the east bank of New River approximately 2 miles upstream of SR 74
  - Along the east bank of Sweat Canyon approximately one mile downstream of New River Road
- Distributive area just upstream of SR 74:
  - Invert of New River channel at the west bridge is approximately 10 feet lower than the invert at the east bridge. The east channel will have a tendency to laterally migrate to the west, resulting in changes to flow quantity, depth and velocities.
  - The area upstream of the east bridges is mapped by FEMA as the East Split. Flow paths in the area between the East Split and New River are complex and not easily defined.
- Flooding at roadway/wash crossings:
  - Sweat Canyon Wash at New River Road
  - New River at SR 74 (Based on two dimensional hydraulic models)
- Single thread to braided channel to distributary flow
- Floodplain widths:
  - New River – maximum 4,000ft, minimum 440 ft, average 1,700 ft
  - Sweat Canyon – maximum 2,550 ft, minimum 540 ft, average 1220 ft
- Existing flows for the 100-year event:
  - New River near SR 74 – 34,411 cfs
  - Sweat Canyon near New River Road – 14,180 cfs
  - West Split just downstream of New River Main Stem Split – 6,622 cfs
  - Combined West Split and Sweat Canyon near the confluence with New River – 17,148 cfs
- Existing structures in floodplain
  - Sweat Canyon crosses New River Road at a dip section
  - New River crosses SR 74 in two bridges and one culvert
  - Three existing sand and gravel pits are located within the study area
- Floodplain limits are inconsistent with Land Use Elements

Flood Mitigation Solutions Considered

The New River below I17 Planning Area is a watercourse planning area for New River and reaches of Sweat Canyon below New River road. Structural and non structural alternatives are proposed. The type and distribution of structural alternatives that are proposed are depicted on the attached figures. Areas within the floodplain limits where no structures are depicted define nonstructural limits. Alternative 5 a No-Action alternative assumes that there will not be a planned approach to watershed management.

Alternative 1

Non Structural Solutions

Watercourse reach retains its natural condition and appearance, and is managed through regulatory solutions that do not require capital improvement funds. Non Structural solutions are applied to reaches where structural solutions are not required to mitigate identified flood hazards. Solutions include:

- Promote and continue sound floodplain management such as:
  - Floodplain Delineations
  - Erosion Hazard Delineations
- Provide development guidelines to reduce flooding and erosion risk to new development.

Structural Solutions

- Levee Option-this option provides levees that prevent flow break out to the West Split from New River and Sweat Canyon Wash, and from New River to the Deadman Wash Watershed. The alignments of the levees along the main stem of New River convey flow through the East Split to the SR 74 east bridge. Levee alignments along the east bank of Sweat Canyon Wash and the west bank of New River (reach below Sweat Canyon) convey flow to the SR 74 west bridge.

- Levee/Channel Option-this option is similar to the Levee Option with the exception that a channel is proposed instead of levees along a portion of the river. The channel would replace the levee for a reach of New River commencing at the SR 74 east bridge and extending upstream for approximately 2.3 miles.

Alternative 2

Non Structural Solutions

- Similar to Alternative 1.

Structural Solutions

- Levee Option-this option is similar to Alternative 1-Levee Option with the exception that flow within the main stem of New River is conveyed to the West Split of New River and combined with Sweat Canyon Wash. The New River and Sweat Canyon runoff is then conveyed to the SR 74 west bridge.

- Levee/Channel Option-this option is similar to Alternative 1-Channel/Levee Option with the exception that flow within the main stem of New River is conveyed to the West Branch of New River where it combines with Sweat Canyon Wash flow. The combined New River and Sweat Canyon runoff is conveyed to the SR 74 west bridge.

Alternative 3

Non Structural Solutions

- Similar to Alternative 1.

Structural Solutions

- Levee Option-this option provides levees that prevent flow break out to the West Split from New River and Sweat Canyon Wash, and flow break out from New River to the Deadman Wash watershed. Existing drainage patterns directly upstream of SR 74 are not mitigated.

Alternative 4

Non Structural Solutions

- Similar to Alternative 1

Structural Solutions

- This alternative is similar to Alternative 2 in that all flow in New River passes SR 74 through the western bridge. The difference is that four regional off-line basins are located strategically along New River to prevent flow break out into to the west. The off-line basins also serve to reduce peak discharges in New River which in turn reduces flow depths and velocities while preserving low flow conditions.

Alternative 5

No Action Alternative-(FEMA Regulatory Solutions)

Benefits/Limitations Realized from Considered Alternatives

Alternative 1

Non Structural Reach

Benefits:

- Alternative provides guidance concerning the extent and severity of flooding and erosion hazards.
- Provides regulations to help residents to minimize the occurrence of losses, hazards and conditions adversely affecting the public health, safety and general welfare that might result from a flooding event.
- Environmentally sensitive. Provides opportunity to maintain existing riparian resource.
- Provides opportunity to accommodate multi-use recreational trails.
- Alternative is consistent with land use plan.

Limitations:

- Opportunity to reclaim floodplain for development is diminished.

Soft Structural Reach

Benefits:

- Unpredictable flow paths are eliminated, reducing flood hazards
- Flow break outs are eliminated
- Provides opportunity to accommodate multi-use recreational trails

- Alternative is consistent with land use plan
- 973 acres of floodplain are reclaimed for development

Limitations:

- Channels and levees will require maintenance to a greater degree than non structural reaches.
- Requires maintenance and operation plan
- FEMA certification process must be satisfied
- 404 permit required

Collective Impacts

Levee Option:

- Riparian Habitat
  - Linear = > 500 yards
  - Acres of Moderate to High Value habitat = 35
- Wildlife Corridors
  - Linear Impact = No Impact
  - Slope of Structures = 3:1 to 6:1
  - Grade Control structures = NA
  - Culverts/Bridges = No Change to Wildlife movement.
  - Fencing = Assume No Impact
- Impact to Water of the U.S.
  - Acres of impact = 71
  - Ratio of acres of impact/total Water of the U.S. = 2%
- Impacts to Upland Habitat
  - Acres of Disturbance = 973
- Impacts to Floodplain
  - Acres of Impact (Area removed from Floodplain) = 973 (FEMA)/1114 (FLO-2D)

Channel Option:

- Riparian Habitat
  - Linear = > 500 yards
  - Acres of Moderate to High Value habitat = 206)
- Wildlife Corridors
  - Linear Impact = No Impact
  - Slope of Structures = 3:1 to 6:1
  - Grade Control structures = NA
  - Culverts/Bridges = No Change to Wildlife movement.
  - Fencing = Assume No Impact
- Impact to Water of the U.S.
  - Acres of impact = 272
  - Ratio of acres of impact/total Water of the U.S. = 6%
- Impacts to Upland Habitat
  - Acres of Disturbance = 977
- Impacts to Floodplain
  - Acres of Impact (Area removed from Floodplain) = 977 (FEMA)/1114 (FLO-2D)

Alternative 2

Non Structural

Benefits:

- Same as for Alternative 1

Limitations:

- Same as for Alternative 1

Soft Structural

Benefits:

- Same as for Alternative 1 with the exception of the floodplain area reclaimed
- 1,050 acres of floodplain are reclaimed for development

Limitations:

- Channels and levees will require maintenance to a greater degree than non structural reaches.
- FEMA certification process must be satisfied

Collective Impacts

Levee Option:

- Riparian Habitat
  - Linear = >500 yards
  - Acres of Moderate to High Value habitat = 35
- Wildlife Corridors
  - Linear Impact = No Impact
  - Slope of Structures = 3:1 to 6:1
  - Grade Control structures = NA
  - Culverts/Bridges = No Change to Wildlife movement.
  - Fencing = Assume No Impact
- Impact to Water of the U.S.
  - Acres of impact = 67
  - Ratio of acres of impact/total Water of the U.S. = 2%
- Impacts to Upland Habitat
  - Acres of Disturbance = 1029
- Impacts to Floodplain
  - Acres of Impact (Area removed from Floodplain) = 1029 (FEMA)/1285 (FLO-2D)

Channel Option:

- Riparian Habitat
  - Linear = > 500-yards
  - Acres of Moderate to High Value habitat = 218
- Wildlife Corridors
  - Linear Impact = No Impact
  - Slope of Structures = 3:1 to 6:1
  - Grade Control structures = Assume Natural Material with access ramps, 4:1 side slopes
  - Culverts/Bridges = No Change to Wildlife movement.

- Fencing = Assume No Impact
- Impact to Water of the U.S.
  - Acres of impact = 259
  - Ratio of acres of impact/total Water of the U.S. = 6%
- Impacts to Upland Habitat
  - Acres of Disturbance = 1029
- Impacts to Floodplain
  - Acres of Impact (Area removed from Floodplain) = 1029 (FEMA)/1285 (FLO-2D)

Alternative 3

Non Structural

Benefits:

- Same as for Alternative 1, however non structural reaches are greater in size and extent than for Alternatives 1 and 2.

Limitations:

- Same as for Alternatives 1 and 2

Soft Structural

Benefits:

- Eliminates West Split
- Eliminates flow break out to Deadman Wash Watershed
- 796 acres of floodplain are reclaimed for development

Limitations:

- Distributive area just upstream of SR 74 is not mitigated
- Less reclaimed floodplain areas than Alternatives 1 and 2
- Alternative is not consistent with land use plan
- FEMA certification process must be satisfied

Collective Impacts

Levee:

- Riparian Habitat
  - Linear = 100-500 yards
  - Acres of Moderate to High Value habitat = 0.9
- Wildlife Corridors
  - Linear Impact = No Impact
  - Slope of Structures = 3:1 to 6:1
  - Grade Control structures = NA
  - Culverts/Bridges = No Change to Wildlife movement.
  - Fencing = Assume No Impact
- Impact to Water of the U.S.
  - Acres of impact = 38
  - Ratio of acres of impact/total Water of the U.S. = 1%
- Impacts to Upland Habitat
  - Acres of Disturbance = 777
- Impacts to Floodplain

- Acres of Impact (Area removed from Floodplain) = 777 (FEMA)/677 (FLO-2D)

Alternative 4

Non Structural

- Same as for Alternative 1

Benefits:

Limitations:

- Same as for Alternative 1

Soft Structural

Benefits:

- Same as for Alternative 1 with the exception of floodplain area reclaimed
- Outlet structures could be sized such that flow released from basin is consistent with flow released from New River Dam. This would maintain the same 100-year ponding limits under full build-out conditions within the watershed.
- Basins can serve as hubs or focal points of a regional multi-use recreational system.
- Basins and levees are off-set from the main channel preserving the existing environmental and landscape character.

Limitations:

- Basins and outlet structures along with the Sweat Canyon levees require an operation and maintenance plan. New River Dam operation plan should be modified to incorporate the operation of the regional detention basins.
- Levees along Sweat Canyon will require FEMA certification.

Collective Impacts

- Riparian Habitat
  - Linear = >500 yards
  - Acres of Moderate to High Value habitat = 14
- Wildlife Corridors
  - Linear Impact = No Impact
  - Slope of Structures = 3:1 to 6:1
  - Grade Control structures = NA
  - Culverts/Bridges = Every Species Will Use
  - Fencing = Assume No Impact
- Impact to Water of the U.S.
  - Acres of impact = 716
  - Ratio of acres of impact/total Water of the U.S. = 18%
- Impacts to Upland Habitat
  - Acres of Disturbance = 1078
- Impacts to Floodplain
  - Acres of Impact (Area removed from Floodplain) = 1078 (FEMA)/1114 (FLO-2D)

Alternative 5

The no-action (do nothing) alternative provides flood control management based on current federal, state, and local floodplain management regulations that allow encroachment into the

floodway fringe. Typically under current regulations, encroachments into the floodway fringe are allowed in a piecemeal fashion without taking into consideration the effect of the encroachment or collective encroachments on the entire watercourse.

Benefits:

- Provides the opportunity to mitigate flood hazard on a parcel by parcel basis.

Limitations:

- Opportunity to develop a uniform design or plan to mitigated flood hazards is limited
- Opportunity to incorporate multi-use recreation facilities is limited
- Opportunity to maintain or enhance environmental resources is limited

Collective Impacts:

- Riparian Habitat
  - Linear = Piecemeal/Undeterminable
  - Acres of Moderate to High Value habitat = Piecemeal/Undeterminable
- Wildlife Corridors
  - Linear Impact = Piecemeal/Undeterminable
  - Slope of Structures = Piecemeal/Undeterminable
  - Grade Control structures =
  - Culverts = Piecemeal/Undeterminable
  - Fencing = Piecemeal/Undeterminable
- Impact to Water of the U.S.
  - Acres of impact = Piecemeal/Undeterminable
  - Ratio of acres of impact/total Water of the U.S. = Piecemeal/Undeterminable
- Impacts to Upland Habitat
  - Acres of Disturbance = Piecemeal/Undeterminable
- Impacts to Floodplain
  - Acres of Impact (Area removed from Floodplain) = Piecemeal/Undeterminable
  - Ratio of acres removed to total floodplain area = Piecemeal/Undeterminable

NEW RIVER UPSTREAM OF I-17

Existing Flood and Erosion Hazard Issues

- FEMA Effective 100-year Floodplain
- Erosion hazard boundary
- Residential structures within floodplain and erosion hazard zones
- Flooding at roadway dip sections
- Property egress limitations during frequent flooding events
- Existing flow diversion structure is failing
- Single thread to braided channel
- Floodplain width varies between approximately 150 ft and 950ft. Average width is approximately 650ft
- 100-year peak discharge ranges from 32,000 cfs to 33,400 cfs
- Channel velocity ranges between 8 fps and 22 fps Average channel velocity is approximately 15 fps

Flood Mitigation Solutions Considered

The New River Upstream I-17 Planning Area is a watercourse planning area for New River. structural and non structural alternatives are proposed. Structural alternatives are proposed along the reach adjacent to Old Stage Road where as a non-structural approach is proposed for the rest of New River.

New River adjacent to Old Stage Road

Below list alternatives developed to mitigated egress issues along Old Stage Road adjacent to New River

Alternatives with Structural Elements

- Alternative 1 - Re-construct Old Stage Road as a levee
  - Old Stage Road would provide egress during frequent flooding events
- Alternative 2 - Channelization adjacent to Old Stage Road to improve conveyance capacity of New River channel to reduce flooding on Old Stage Road.
- Alternative 3 - Floodprone Property Assistance Program
  - Floodproof homes
- Alternative 4 - Alternatives Based on Operation and Maintenance to Remove or Reduce Vegetation from the New River Channel
  - Improve conveyance capacity of the New River channel, which could reduce the floodplain
    - *Alternative rejected because flood hazard would not be reduced*

New River Upstream of I17 to Forest Service Boundary excluding the reach adjacent to Old Stage Road

The alternatives below are developed for reaches of New River upstream of I17 excluding the reach adjacent to Old Stage Road.

Alternative 5 -ADMP Guidelines

- Develop a Flood Warning Response plan for residents
- Promote and continue sound floodplain management
- Provide existing property owners with guidelines to reduce their flooding and erosion risk
- Floodprone Property Assistance Program
  - Voluntary Program
  - Acquire homes in high hazard areas within New River Floodplain
  - Floodproof homes

Alternative 6

No Action Alternative-(FEMA Regulatory Solutions)

Benefits/Limitations Realized from Considered Alternatives

Alternative 1 – Levee:

Benefits:

- Provides egress to parcels above Old Stage Road crossing of New River during flood events

Limitations:

- Although the alternative provides flood protection, it may not remove property from the 100-year floodplain.
- Does not benefit structures located to the west of Old Stage Coach Road.in the New River
- Requires maintenance and operation plan

Collective Impacts:

- Riparian Habitat
  - Linear = > 500 yards
  - Acres of Moderate to High Value habitat = 11
- Wildlife Corridors
  - Linear Impact = No Impact
  - Slope of Structures = 3:1 to 6:1
  - Grade Control structures = NA
  - Culverts/Bridges = No Change to Wildlife movement.
  - Fencing = Assume No Impact
- Impact to Water of the U.S.
  - Acres of impact = 11
  - Ratio of acres of impact/total Water of the U.S. = 15
- Impacts to Upland Habitat
  - Acres of Disturbance = No Impact
- Impacts to Floodplain
  - Acres of Impact (Area removed from Floodplain) = 0

Alternative 2 – Channelization:

Benefits:

- Provides egress to parcels above Old Stage Road crossing of New River

Limitations:

- Although the alternative provides flood protection, it may not remove property from the 100-year floodplain
- Does not benefit structures in high flood hazard areas
- Requires maintenance and operation plan
- FEMA certification process must be satisfied
- 404 permit required

Collective Impacts:

- Riparian Habitat
  - Linear = > 500 yards
  - Acres of Moderate to High Value habitat = 74
- Wildlife Corridors
  - Linear Impact = No Impact
  - Slope of Structures = 3:1 to 6:1
  - Grade Control structures = NA
  - Culverts/Bridges = No Change to Wildlife movement.
  - Fencing = Assume No Impact
- Impact to Water of the U.S.
  - Acres of impact = 74
  - Ratio of acres of impact/total Water of the U.S. = 55
- Impacts to Upland Habitat
  - Acres of Disturbance = No Impact
- Impacts to Floodplain
  - Acres of Impact (Area removed from Floodplain) =31

Alternative 3 - Floodprone Property Assistance Program:

Benefits:

- Provides flood mitigation on a parcel per parcel basis

Limitations:

- This alternative alone would not facilitate property egress. Alternative 3 would need to be incorporated into Alternatives 1 or 2.
- Some landowners may not be able to participate.

Collective Impacts:

- Riparian Habitat
  - Linear = No Impact
  - Acres of Moderate to High Value habitat = No Impact
- Wildlife Corridors
  - Linear Impact = No Impact
  - Slope of Structures = 3:1

  - Grade Control structures = NA
  - Culverts/Bridges = No Change to Wildlife movement.
  - Fencing = Assume No Impact
- Impact to Water of the U.S.
  - Acres of impact = 0
  - Ratio of acres of impact/total Water of the U.S. = NA
- Impacts to Upland Habitat
  - Acres of Disturbance = No Impact
- Impacts to Floodplain
  - Acres of Impact (Area removed from Floodplain) = 0

Alternative 4 - Eliminated

Alternative 5 - ADMP Guidelines:

Benefits:

- Alternative provides guidance concerning the extent and severity of flooding and erosion hazards.
- Provides regulations to help residents minimize the occurrence of losses, hazards and conditions adversely affecting the public health, safety and general welfare that might result from a flooding event.
- Regionally specific guidelines and ordinances:
  - Provide guidance concerning the extent and severity of flooding and erosion hazards
  - Provide regulations to help residents to minimize the occurrence of losses, hazards, and conditions adversely affecting the public health, safety, and general welfare that might result from a flooding event.
  - Environmentally sensitive. Provide an opportunity to maintain existing riparian resource
  - Provide opportunity to accommodate multi-use recreational trails
  - Alternative is consistent with land use plan

Limitations:

- Regionally specific guidelines and ordinances
  - Could require that all landowners within a specific flood hazard area participate to mitigate flood hazard. Some landowners may not be able to participate.

Collective Impacts:

- Riparian Habitat
  - Linear = No Impact
  - Acres of Moderate to High Value Habitat = No Impact
- Wildlife Corridors
  - Linear Impact = No Impact
  - Slope of Structures = Assume 3:1
  - Grade Control structures = Assume natural with max 3:1 slopes
  - Culverts = Assume all species but mammals

  - Fencing = No Impact
- Impact to Waters of the U.S.
  - Acres of Impact = Assume no Impact
  - Ratio of acres of impact/total Waters of the U.S. = Assume no Impact
- Impacts to Upland Habitat = Assume no Impact
  - Acres of Disturbance = Assume no Impact
- Impacts to Floodplain
  - Acres of Impact (Area removed from Floodplain) = Assume no Impact
  - Ratio of acres removed to total floodplain area = Assume no Impact
  - Opportunity to reclaim floodplain for development is diminished.

Alternative 6 – No Action

The no-action (do nothing) alternative provides flood control management based on current federal, state, and local floodplain management regulations that allow encroachment into the floodway fringe. Typically under current regulations, encroachments into the floodway fringe are allowed in a piecemeal fashion without taking into consideration the effect of the encroachment or collective encroachments on the entire watercourse.

Benefits:

- Provides the opportunity to mitigate flood hazard on a parcel by parcel basis

Limitations:

- Opportunity to develop a uniform design or plan to mitigated flood hazards is limited
- Opportunity to incorporate multi-use recreation facilities is limited
- Opportunity to maintain or enhance environmental resources is limited

Collective Impacts:

- Riparian Habitat
  - Linear = Piecemeal/Undeterminable
  - Acres of Moderate to High Value habitat = Piecemeal/Undeterminable
- Wildlife Corridors
  - Linear Impact = Piecemeal/Undeterminable
  - Slope of Structures = Piecemeal/Undeterminable
  - Grade Control structures =
  - Culverts = Piecemeal/Undeterminable
  - Fencing = Piecemeal/Undeterminable
- Impact to Water of the U.S.
  - Acres of impact = Piecemeal/Undeterminable
  - Ratio of acres of impact/total Water of the U.S. = Piecemeal/Undeterminable
- Impacts to Upland Habitat
  - Acres of Disturbance = Piecemeal/Undeterminable
- Impacts to Floodplain
  - Acres of Impact (Area removed from Floodplain) = Piecemeal/Undeterminable

- Ratio of acres removed to total floodplain area = Piecemeal/Undeterminable

Limitations

- Alternative 1 - Levee:
- Alternative 2 – Channelization:
- Alternative 3 - Floodprone Assistance Program:
- Alternative 4 – *Eliminated*

- Alternative 5 - ADMP Guidelines:

UPPER NEW RIVER ADMP ALTERNATIVE EVALUATION CRITERIA

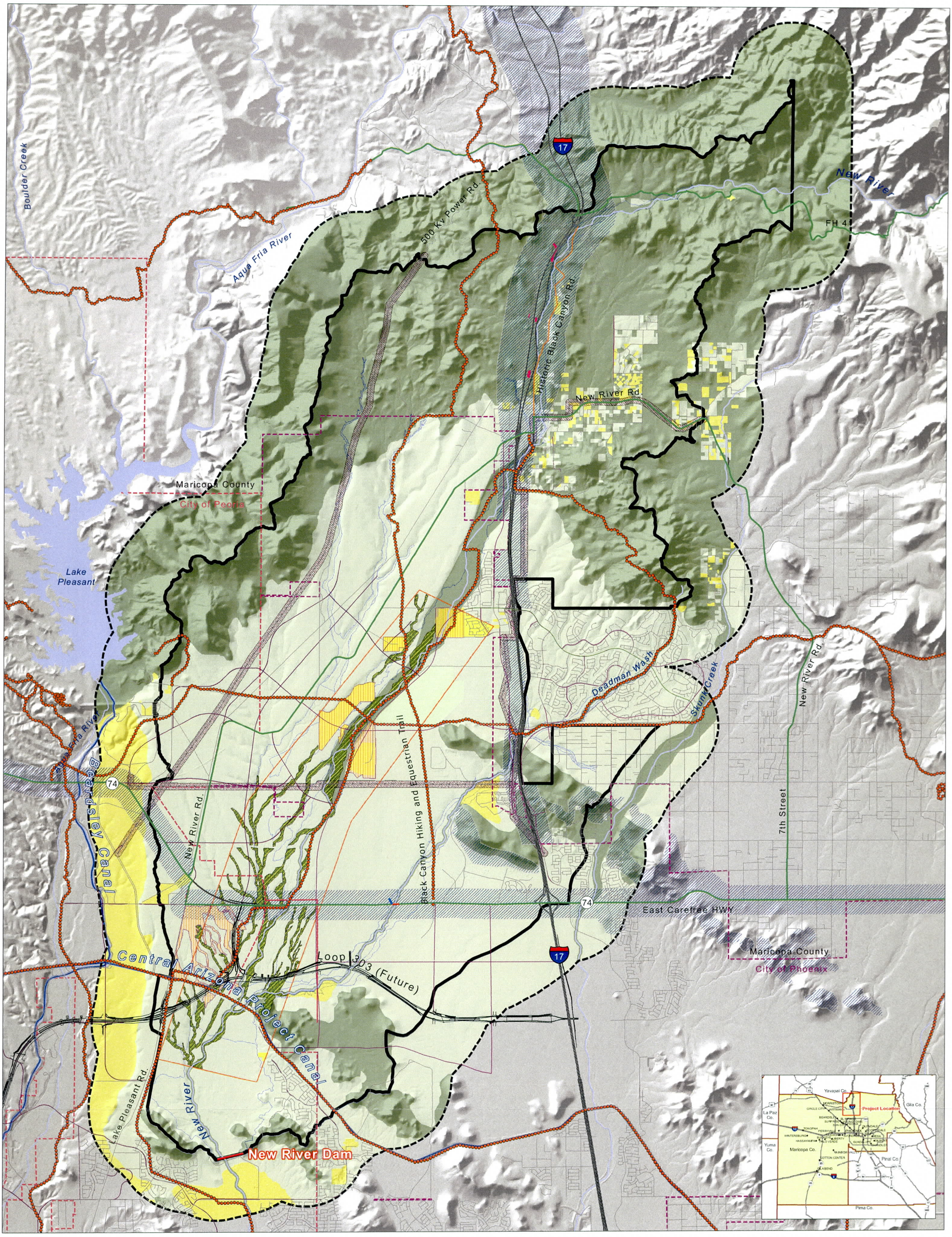
ALTERNATIVES	SCENERY RESOURCES CRITERIA					RECREATION RESOURCES CRITERIA			
	SUB-CATEGORY					SUB-CATEGORY			
	CONSTRAINTS	OPPORTUNITIES				CONSTRAINTS	OPPORTUNITIES		
		Positive Impact	Negative Impact				Positive Impact		Negative Impact
			Factor A		Factor B		Factor A	Factor B	
	(% of Impact)	(% of Impact)	S. Hwy 74 (LF/AC)	N. Hwy 74 (LF/AC)	(LF/Acreage)	(% of Impact)	(Linear Feet)	(LF/Acreages	(Acreage)
NEW RIVER BELOW I-17									
ALTERNATIVE 1 - LEVEE	20-25% Impact	100 % potential for restoration of low scenic integrity areas associated with the structural solutions (Approx. 135 LF)	No Impact to High SI Areas within floodplain		9,389 LF impact to High SI Areas	0 % impact	15,010 LF	16,311 LF of Local Trail possible	No Impact
ALTERNATIVE 1 - CHANNEL	30-35% Impact	100 % potential for restoration of low scenic integrity areas associated with the structural solutions (Approx. 135 LF)	No Impact to High SI Areas within floodplain		839 LF & 63 Ac impact to High SI Areas	0 % impact	15,203 LF	16,311 LF of Local Trail possible	No Impact
ALTERNATIVE 2 - LEVEE	15-20 % Impact	100 % potential for restoration of low scenic integrity areas associated with the structural solutions (Approx. 135 LF)	12-15 Ac Impact to High SI Areas within floodplain		7,460 LF impact to High SI Areas	0 % impact	16,060 LF	16,311 LF of Local Trail possible	Potential loss of 135-140 Ac of floodplain
ALTERNATIVE 2 - CHANNEL	35-40 % Impact	100 % potential for restoration of low scenic integrity areas associated with the structural solutions (Approx. 135 LF)	12-15 Ac Impact to High SI Areas within floodplain		839 LF & 93 Ac impact to High SI Areas	0 % impact	15,991 LF	16,311 LF of Local Trail possible	Potential loss of 135-140 Ac of floodplain
ALTERNATIVE 3 - LEVEE	5-10 % Impact	100 % potential for restoration of low scenic integrity areas associated with the structural solutions (Approx. 135 LF)	No Impact to High SI Areas within floodplain		839 LF impact to High SI Areas and adjacency to some other High SI Areas	0 % impact	5,260 LF	16,311 LF of Local Trail possible	No Impact
ALTERNATIVE 4 - REGIONAL DETENTION	35-40 % Impact	100 % potential for restoration of low scenic of integrity areas associated with the structural solutions (Approx. 135 LF & 12.25 Ac)	No Impact to High SI Areas within floodplain		13,612 LF impact to High SI and to areas designated as Class I 119 Ac impact to High SI Areas and 105 Ac impact to areas designated as Class I	0 % impact	23,583 LF	16,311 LF of Local Trail possible & 644 Ac of Local parks within the basins	No Impact
For the Alternatives mentioned above...all alternatives considered; No action (FEMA regulation), ADMP guidelines (Structural/Non-Structural), and No Action									
NEW RIVER ABOVE I-17									
ALTERNATIVE 1- LEVEE	90-95 % Impact	–	–		3,642 LF impact to areas designated as Class I	0 % impact	Good Potential if Regional Trail along Historic Black Canyon Rd.	–	–
ALTERNATIVE 2 - CHANNEL	Approx. 100% Impact	–	–		39.60 Ac impact to areas designated as Class I	0 % impact	Good Potential if Regional Trail along Historic Black Canyon Rd.	–	–
For the Alternatives mentioned above...all alternatives considered; No action (FEMA regulation), ADMP guidelines (Structural/Non-Structural), and No Action									
GAVILAN PEAK PLANNING AREA									
ALTERNATIVE 3 - LEVEE	20-25% Impact	–	–		1,597 LF impact to areas designated as Class I	0 % impact	Good Potential if Regional Trail if extended along New River Road	–	–
For the Alternatives mentioned above...all alternatives considered; No action (FEMA regulation), ADMP guidelines (Structural/Non-Structural), and No Action									
DEADMAN WASH PLANNING AREA									
ALTERNATIVE 1A	0 % Impact	–	–		–	0 % impact	–	–	–
ALTERNATIVE 1B	35-40 % Impact	–	–		14 Ac impact to areas designated as Class I	0 % impact	2,715 LF	Potential for 35 Ac of local park	–
ALTERNATIVE 2A	10-15 % Impact	–	–		8.50 Ac impact to areas designated as Class I	0 % impact	6,290 LF	–	–
ALTERNATIVE 2B	35-40 % Impact	–	–		22.50 Ac impact to areas designated as Class I	0 % impact	9,005 LF	Potential for 35 Ac of local park	–

For the Alternatives mentioned above...all alternatives considered; No action (FEMA regulation), ADMP guidelines (Structural/Non-Structural), and No Action

NOTES

For the Alternatives mentioned above...all alternatives considered; No action (FEMA regulation), ADMP guidelines (Structural/Non-Structural), and No Action

Scenic Resource Evaluation Data



LEGEND

EXISTING SCENIC RESOURCE COMPATIBILITY RATINGS

- Compatibility Class 1
- Compatibility Class 2
- Compatibility Class 3

Compatibility Classes						
Compatibility Class 1	Non-Structural					
Compatibility Class 2	Non-Structural	Soft				
Compatibility Class 3	Non-Structural	Soft	Semi-Soft			
Compatibility Class 4	Non-Structural	Soft	Semi-Soft	Hard w/ Aesthetic Treatment		
Compatibility Class 5	Non-Structural	Soft	Semi-Soft	Hard w/ Aesthetic Treatment	Semi-Hard	
Compatibility Class 6	Non-Structural	Soft	Semi-Soft	Hard w/ Aesthetic Treatment	Semi-Hard	Hard
Incompatible						

Compatibility Levels
C= Complimentary and Compatible
IC= Not Complimentary or Compatible

SCENIC INTEGRITY

- High Scenic Integrity
- Low Scenic Integrity
- Scenic Routes
- Power Corridor - 300ft Buffer

OTHER FEATURES

- Eco-Cultural Sites
- Historic Black Canyon Road
- Scenic Route
- Regional Trails
- Future Roadway

Alternatives

Deadman Wash

- Alt 1A - Levee
- Alt 1B - Bridge

Miles
0 0.25 0.5 1

N

REFERENCE FEATURES:

- Project Boundary
- Project Buffer Area (1 mi.)
- Focus Area
- Interstate Highway
- Important Roads
- Other Roads
- Powerlines
- Dams
- Drainages
- Canals
- Lakes
- Peoria City Limits
- Phoenix City Limits

PREPARED BY: EDAW | AECOM

DATE: September 2007
January 2008

Flood Control District of Maricopa County
2801 W. Durango St.
Phoenix, AZ 85009

Upper New River Area Drainage Master Plan

FCD 2005CO20

Level 1 Alternatives Existing Scenic Resource Opportunities & Constraints Assessment

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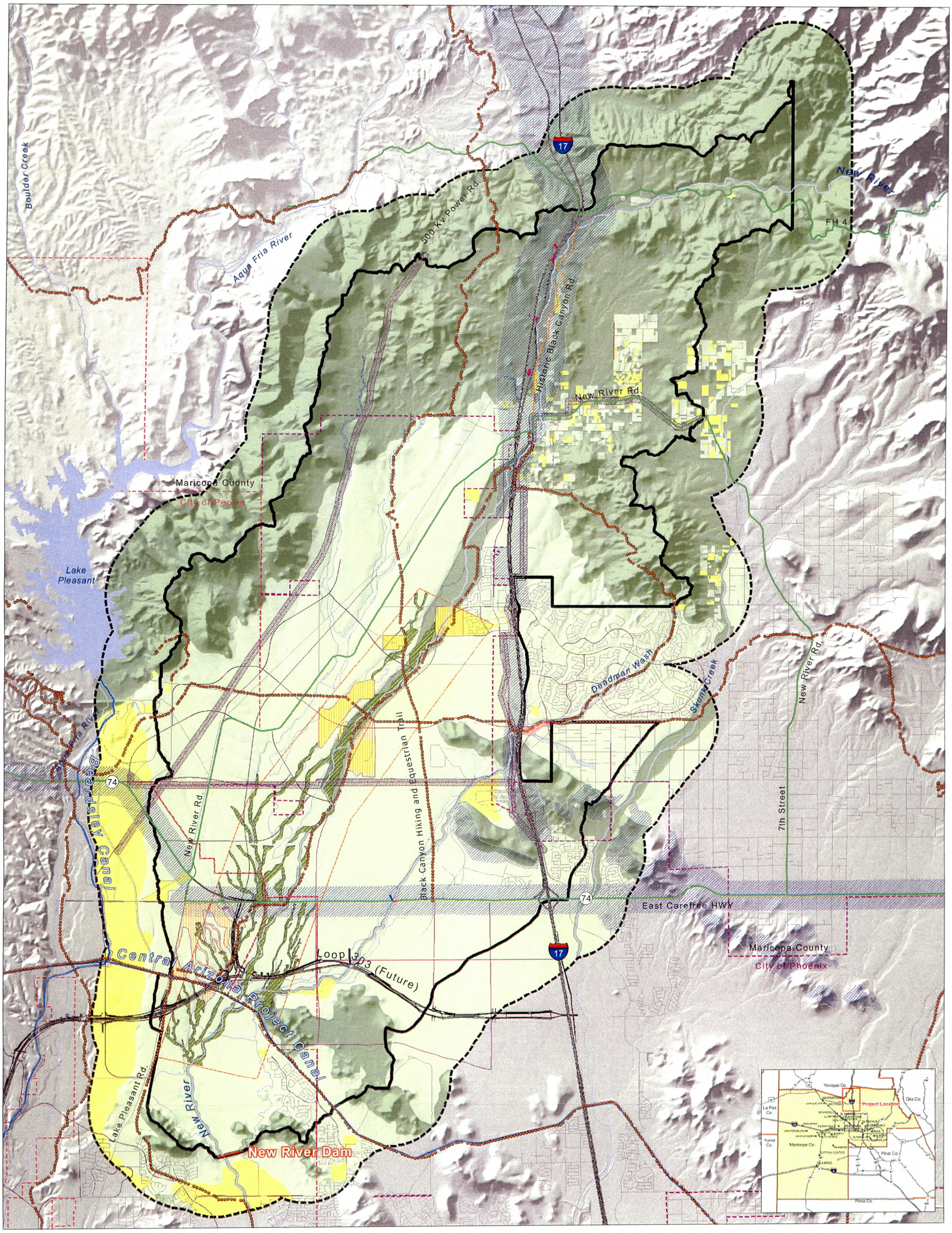

LEGEND

EXISTING SCENIC RESOURCE COMPATIBILITY RATINGS

- Compatibility Class 1
- Compatibility Class 2
- Compatibility Class 3

Compatibility Classes						
Compatibility Class 1	Non-Structural					
Compatibility Class 2	Non-Structural	Soft				
Compatibility Class 3	Non-Structural	Soft	Semi-Soft			
Compatibility Class 4	Non-Structural	Soft	Semi-Soft	Hard w/ Aesthetic Treatment		
Compatibility Class 5	Non-Structural	Soft	Semi-Soft	Hard w/ Aesthetic Treatment	Semi-Hard	
Compatibility Class 6	Non-Structural	Soft	Semi-Soft	Hard w/ Aesthetic Treatment	Semi-Hard	Hard

Compatibility Levels
C= Complimentary and Compatible
NC= Not Complimentary or Competible

SCENIC INTEGRITY

- High Scenic Integrity
- Low Scenic Integrity
- Scenic Routes
- Power Corridor - 300ft Buffer

OTHER FEATURES

- Eco-Cultural Sites
- Historic Black Canyon Road
- Scenic Route
- Regional Trails
- Future Roadway

Alternatives

Deadman Wash

- Alt 1B - Levee
- Alt 1B - Bridge
- Alt 1B - Retention Basin

Miles
0 0.25 0.5 1

N

REFERENCE FEATURES:

- Project Boundary
- Project Buffer Area (1 mi.)
- Focus Area
- Interstate Highway
- Important Roads
- Other Roads
- Powerlines
- Dams
- Drainages
- Canals
- Lakes
- Peoria City Limits
- Phoenix City Limits

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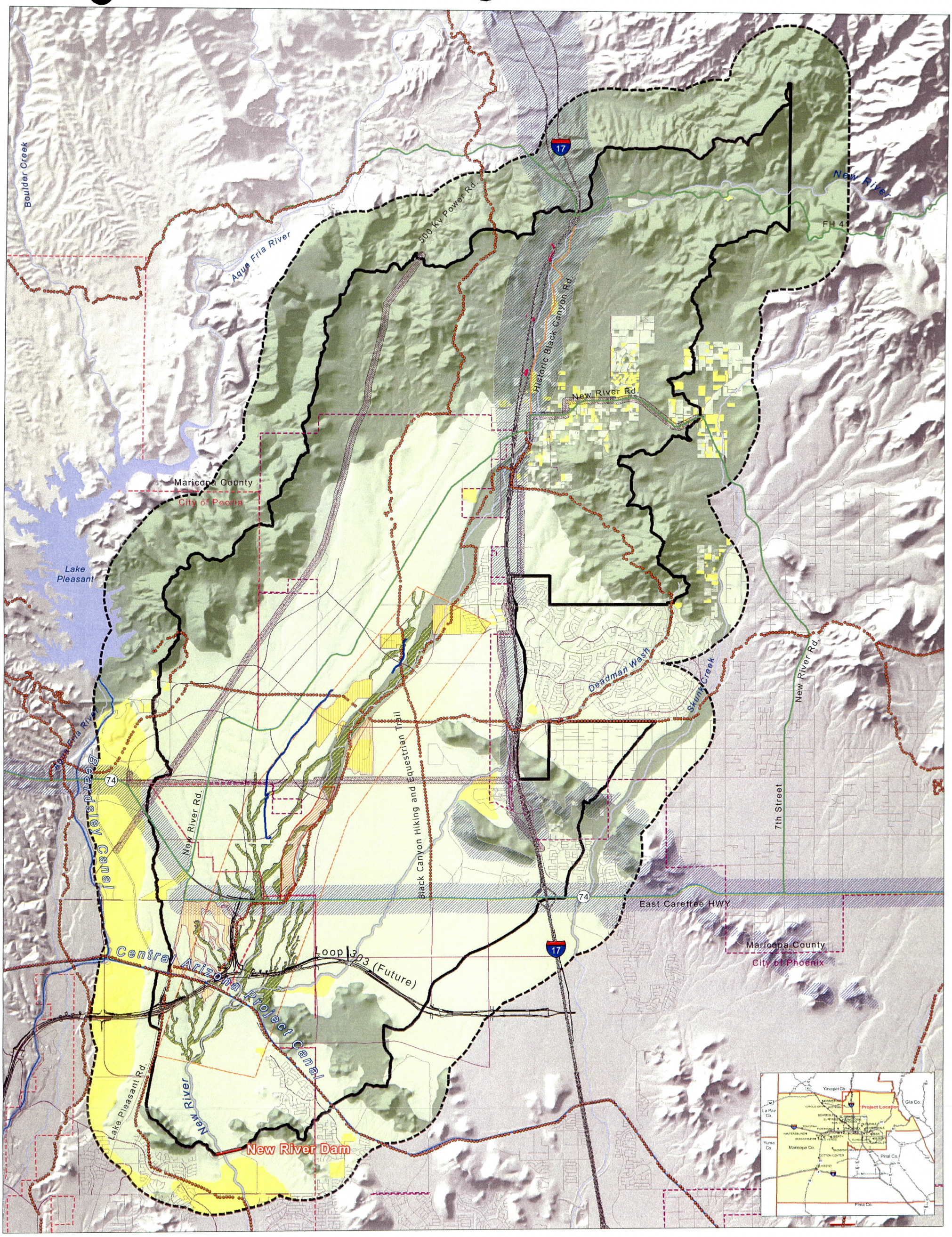

LEGEND

EXISTING SCENIC RESOURCE COMPATIBILITY RATINGS

- Compatibility Class 1
- Compatibility Class 2
- Compatibility Class 3

	Compatibility Classes					
Compatibility Class 1	Non-Structural					
Compatibility Class 2	Non-Structural	Soft				
Compatibility Class 3	Non-Structural	Soft	Semi-Soft			
Compatibility Class 4	Non-Structural	Soft	Semi-Soft	Hard w/ Aesthetic Treatment		
Compatibility Class 5	Non-Structural	Soft	Semi-Soft	Hard w/ Aesthetic Treatment	Semi-Hard	
Compatibility Class 6 (Exemption)	Non-Structural	Soft	Semi-Soft	Hard w/ Aesthetic Treatment	Semi-Hard	Hard

Compatibility Levels
C= Compatibility and Conducive
C= Not Compatibility or Detrimental

SCENIC INTEGRITY

- High Scenic Integrity
- Low Scenic Integrity
- Scenic Routes
- Power Corridor - 300ft Buffer

OTHER FEATURES

- Eco-Cultural Sites
- Historic Black Canyon Road
- Scenic Route
- Regional Trails
- Future Roadway

Alternatives

- Alt 1 West Levee
- Alt 1 - Channel

Miles
0 0.25 0.5 1

N

REFERENCE FEATURES:

- Project Boundary
- Project Buffer Area (1 mi.)
- Focus Area
- Interstate Highway
- Important Roads
- Other Roads
- Powerlines
- Dams
- Drainages
- Canals
- Lakes
- Peoria City Limits
- Phoenix City Limits

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DATE: September 2007

Flood Control District of Maricopa County
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Phoenix, AZ 85009

Upper New River Area Drainage Master Plan

FCD 2005CO20

Level 1 Alternatives Existing Scenic Resource Opportunities & Constraints Assessment

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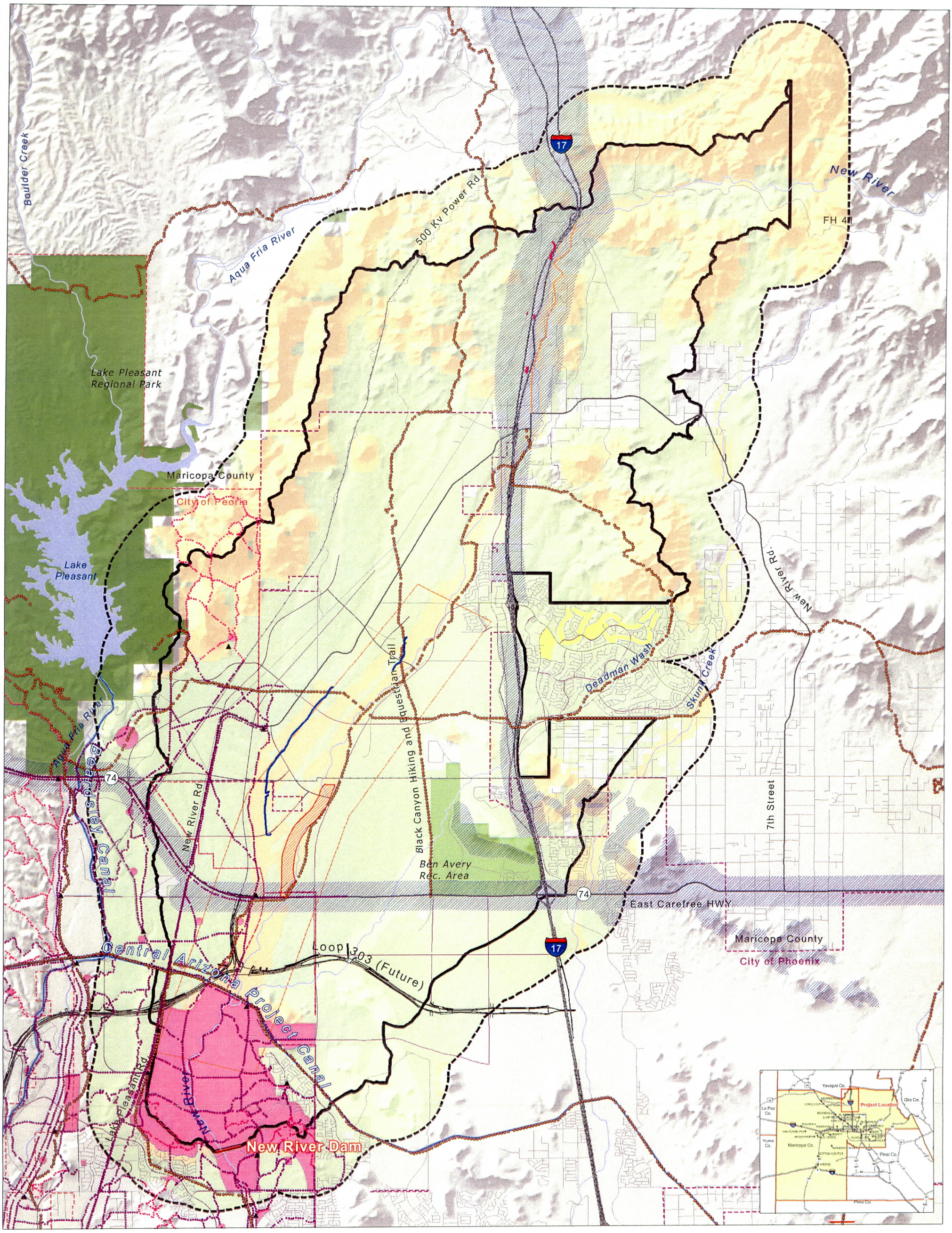

LEGEND

- Peoria Trailheads
- Peoria Trails
- Peoria Back-country Trails
- Regional Trails
- Future Roadway

Recreation (1 mile & Adjacent)

- County Regional Parks
- County Regional Recreation Areas
- City Regional Parks
- City Mountain Preserves
- County Open Spaces & Retention Areas
- County Open Spaces & Conservation Areas
- County Parks
- Local Parks & Golf Courses
- Proposed Peoria Parks

Scenic Integrity

- Scenic Routes

Other Features

- HistoricRd
- EcoCultural

Alternatives

- Alt 1 West Levee
- Alt 1 - Channel

Miles
0 0.25 0.5 1

N

REFERENCE FEATURES:

- Project Boundary
- Project Buffer Area (1 mi.)
- Focus Area
- Interstate Highway
- Important Roads
- Other Roads
- Powerlines
- Dams
- Drainages
- Canals
- Lakes
- Peoria City Limits
- Phoenix City Limits

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DATE September 2007

Flood Control District of Maricopa County
2801 W. Durango St.
Phoenix, AZ 85009

Upper New River Area Drainage Master Plan

FCD 2005CO20

Level 1 Alternatives Recreation and Open Space Resources Assessment

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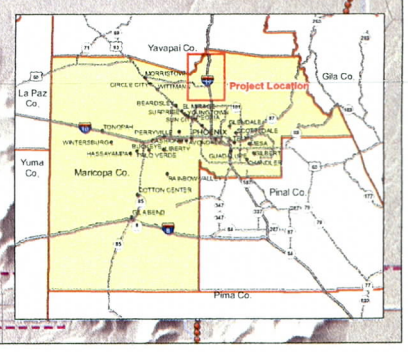
Stantec

Boulder Creek
Agua Fria River
500 Kv Power Rd.
17
New River
FH 4
Historic Black Canyon Rd.
New River Rd.
Maricopa County
City of Peoria
Lake Pleasant
Deadman Wash
Skunk Creek
New River Rd.
Agua Fria River
Beardsley Canal
74
New River Rd.
Black Canyon Hiking and Equestrian Trail
7th Street
74
East Carefree HWY
Central Arizona Project Canal
Loop 303 (Future)
17
Maricopa County
City of Phoenix
Lake Pleasant Rd
New River
New River Dam



LEGEND

EXISTING SCENIC RESOURCE COMPATIBILITY RATINGS

- Compatibility Class 1
- Compatibility Class 2
- Compatibility Class 3

Compatibility Classes						
Compatibility Class 1	Non-Structural					
Compatibility Class 2	Non-Structural	Soft				
Compatibility Class 3	Non-Structural	Soft	Semi-Soft			
Compatibility Class 4	Non-Structural	Soft	Semi-Soft	Hard w/ Aesthetic Treatment		
Compatibility Class 5	Non-Structural	Soft	Semi-Soft	Hard w/ Aesthetic Treatment	Semi-Hard	
Compatibility Class 6	Non-Structural	Soft	Semi-Soft	Hard w/ Aesthetic Treatment	Semi-Hard	Hard
Accounting						

Compatibility Levels
C= Complimentary and Compatible
XC= Not Complimentary or Compatible

SCENIC INTEGRITY

- High Scenic Integrity
- Low Scenic Integrity
- Scenic Routes
- Power Corridor - 300ft Buffer

OTHER FEATURES

- Eco-Cultural Sites
- Historic Black Canyon Road
- Scenic Route
- Regional Trails
- Future Roadway

Alternatives

- Alt 1 East Levee
- Alt 1 West Levee

0 0.25 0.5 1 Miles

N

REFERENCE FEATURES:

- Project Boundary
- Project Buffer Area (1 mi.)
- Focus Area
- Interstate Highway
- Important Roads
- Other Roads
- Powerlines
- Dams
- Drainages
- Canals
- Lakes
- Peoria City Limits
- Phoenix City Limits

PREPARED BY: EDAW | AECOM

DATE: September 2007
January 2008

Flood Control District of Maricopa County
2801 W. Durango St.
Phoenix, AZ 85009

Upper New River Area Drainage Master Plan

FCD 2005CO20

Level 1 Alternatives Existing Scenic Resource Opportunities & Constraints Assessment

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Phoenix, AZ U.S.A. 85044

feet

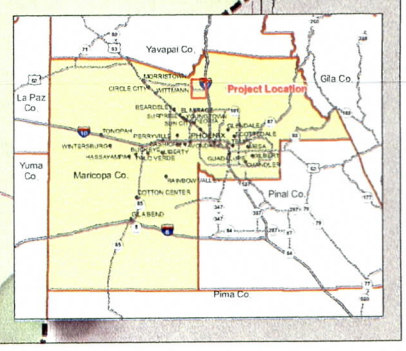
New River Rd.

Black Canyon Hiking and Equestrian Trail

Loop 303 (Future)

Central Arizona Project Canal

Rd.



LEGEND

EXISTING SCENIC RESOURCE COMPATIBILITY RATINGS

- Compatibility Class 1
- Compatibility Class 2
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Compatibility Classes	Non-Structural	Soft	Semi-Soft	Hard w/ Aesthetic Treatment	Semi-Hard	Hard
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Incompatible						

Compatibility Levels
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SCENIC INTEGRITY

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- Power Corridor - 300ft Buffer

OTHER FEATURES

- Eco-Cultural Sites
- Historic Black Canyon Road
- Scenic Route
- Regional Trails
- Future Roadway

Alternatives

- Alt 1 - Levees

0 0.25 0.5 N

REFERENCE FEATURES:

- Project Boundary
- Project Buffer Area (1 mi.)
- Focus Area
- Interstate Highway
- Important Roads
- Other Roads
- Powerlines
- Dams
- Drainages
- Canals
- Lakes
- Peoria City Limits
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PREPARED BY: EDAW AECOM

DATE: September 2007

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Phoenix, AZ 85009

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FCD 2005CO20

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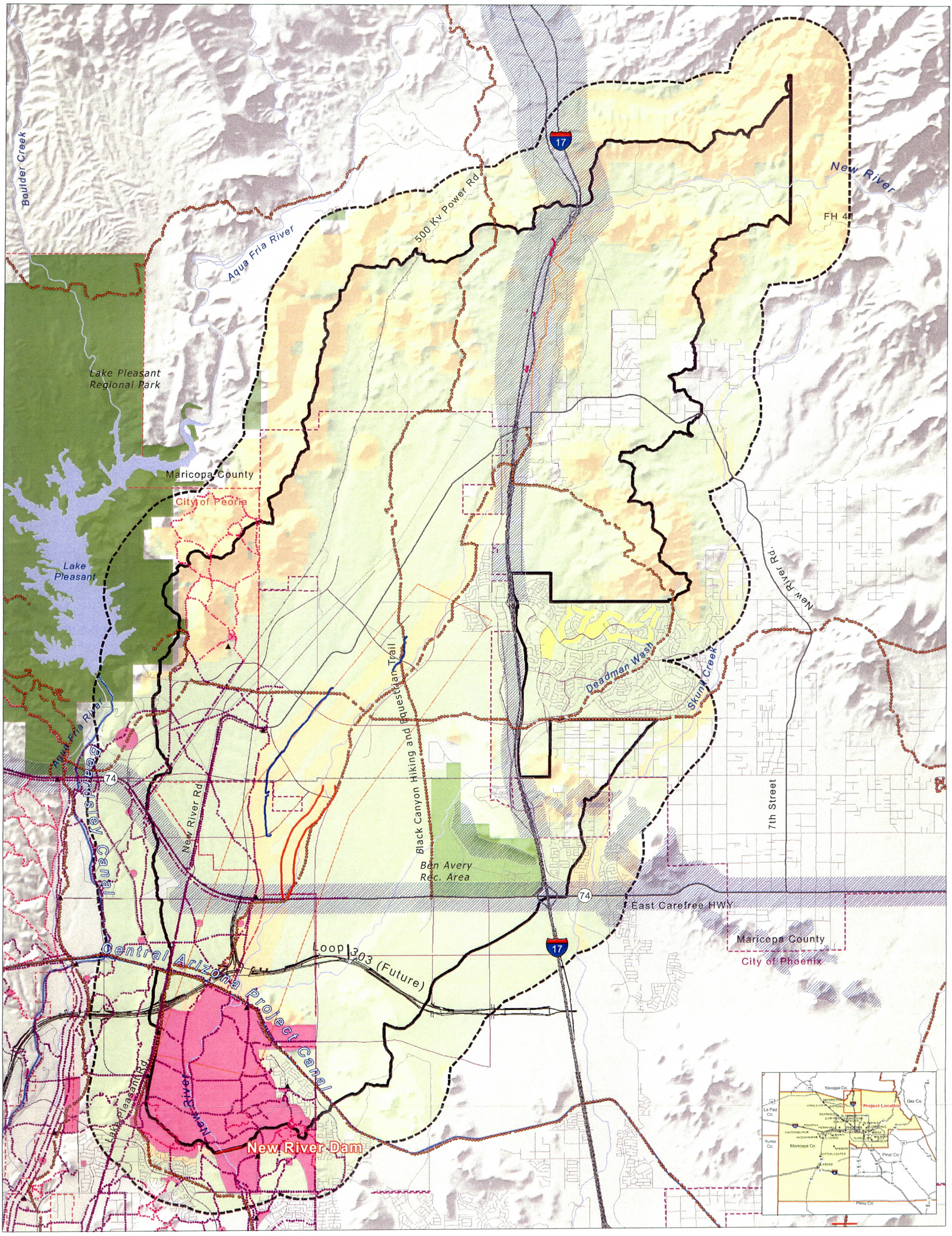

LEGEND

- Peoria Trailheads
- Peoria Trails
- Peoria Back-country Trails
- Regional Trails
- Future Roadway

Recreation (1 mile & Adjacent)

- County Regional Parks
- County Regional Recreation Areas
- City Regional Parks
- City Mountain Preserves
- County Open Spaces & Retention Areas
- County Open Spaces & Conservation Areas
- County Parks
- Local Parks & Golf Courses
- Proposed Peoria Parks

Scenic Integrity

- Scenic Routes

Other Features

- HistoricRd
- EcoCultural

Alternatives

- Alt 1 East Levee
- Alt 1 West Levee

Miles
0 0.25 0.5 1

N

REFERENCE FEATURES:

- Project Boundary
- Project Buffer Area (1 mi.)
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Level 1 Alternatives Recreation and Open Space Resources Assessment

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feet

New River Rd

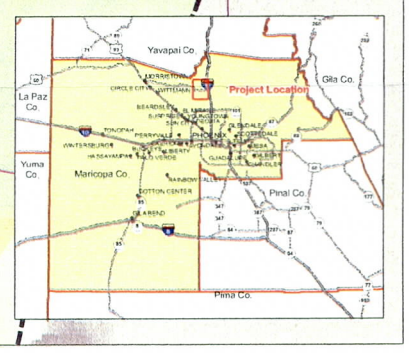
Black Canyon Hiking and Equestrian Trail

Ben Avery Rec. Area

Loop 303 (Future)

ntral Arizona Project Canal

ant Rd.



LEGEND

- Peoria Trailheads
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- Regional Trails
- Future Roadway

Recreation (1 mile & Adjacent)

- County Regional Parks
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- City Regional Parks
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- County Open Spaces & Conservation Areas
- County Parks
- Local Parks & Golf Courses
- Proposed Peoria Parks

Scenic Integrity

- Scenic Routes

Other Features

- HistoricRd
- EcoCultural

Alternatives

- Alt 1 - Levees

0 0.25 0.5 N

REFERENCE FEATURES:

- Project Boundary
- Project Buffer Area (1 mi.)
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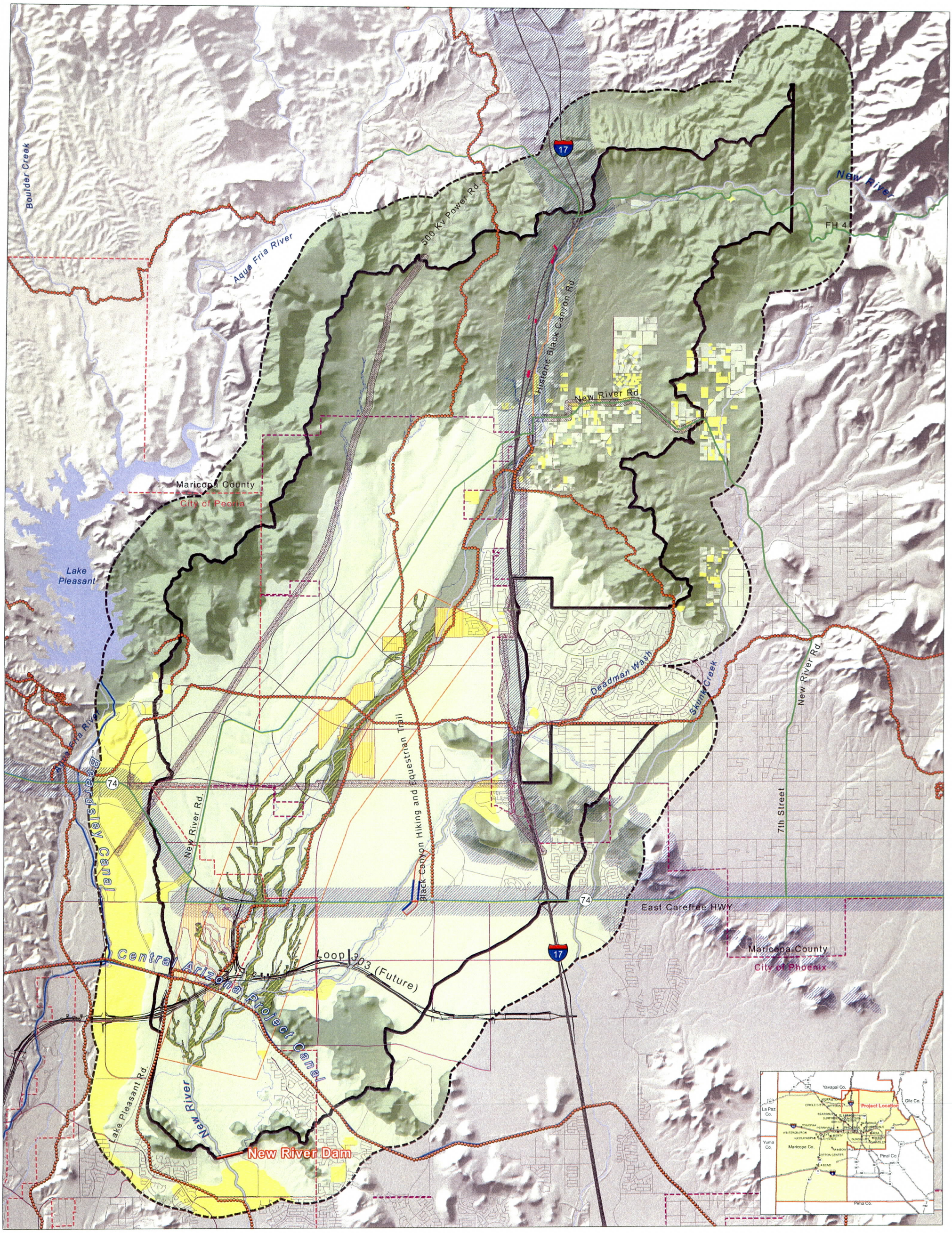

LEGEND

EXISTING SCENIC RESOURCE COMPATIBILITY RATINGS

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- Compatibility Class 2
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Compatibility Classes						
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Incompatible						

Compatibility Levels
#1 Complementary and Compatible
#2 Not Complementary or Compatible

SCENIC INTEGRITY

- High Scenic Integrity
- Low Scenic Integrity
- Scenic Routes
- Power Corridor - 300ft Buffer

OTHER FEATURES

- Eco-Cultural Sites
- Historic Black Canyon Road
- Scenic Route
- Regional Trails
- Future Roadway

Alternatives

Deadman Wash

- Alt 2A - Levee
- Alt 2A - Grade Control Structure
- Alt 2A - Bridge

Miles
0 0.25 0.5 1

N

REFERENCE FEATURES:

- Project Boundary
- Project Buffer Area (1 mi.)
- Focus Area
- Interstate Highway
- Important Roads
- Other Roads
- Powerlines
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- Drainages
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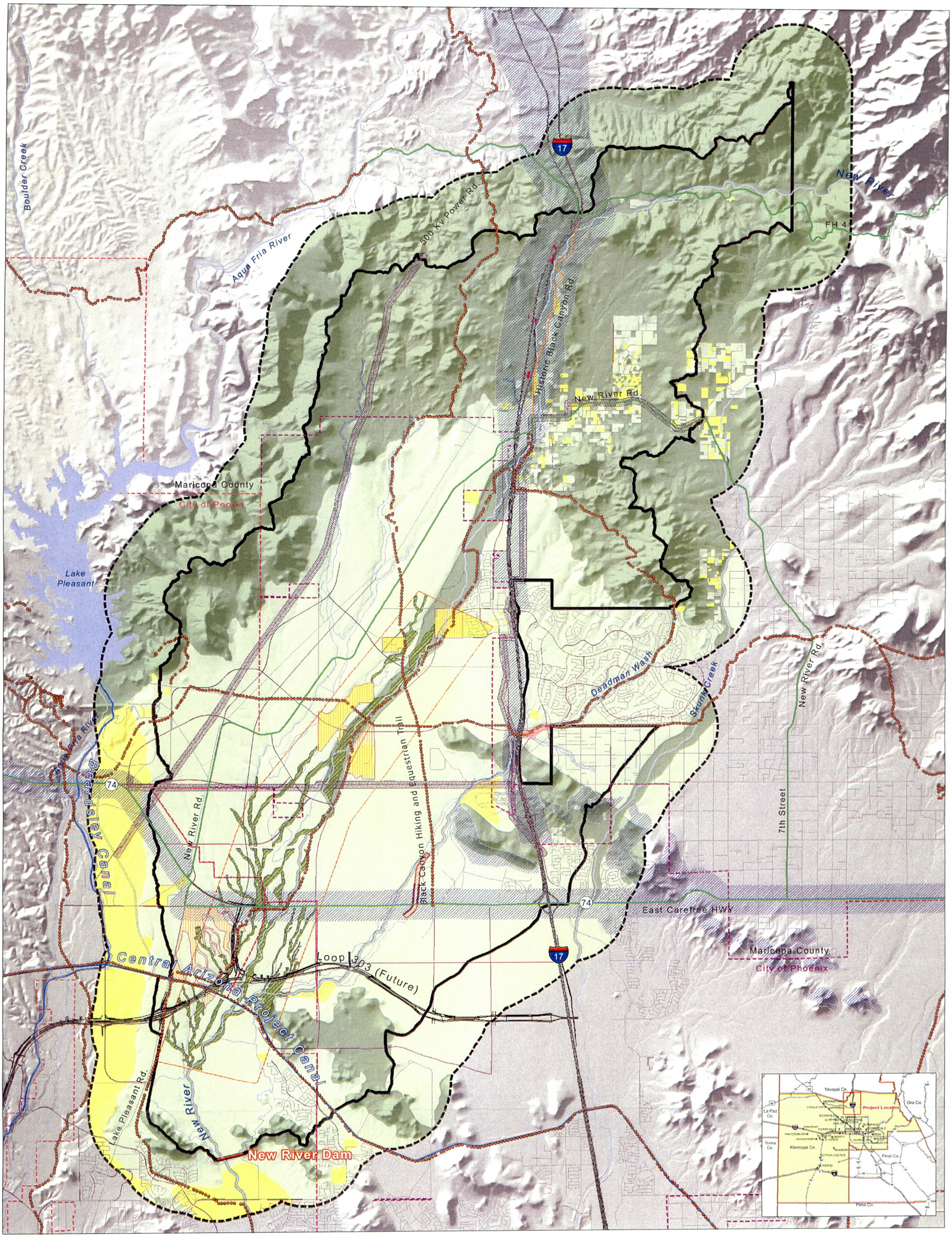

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Compatibility Classes	Non-Structural	Soft	Semi-Soft	Hard w/ Aesthetic Treatment	Semi-Hard	Hard
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Incompatible						

Compatibility Levels
C= Complementary and Compatible
NC= Not Complementary or Compatible

SCENIC INTEGRITY

- High Scenic Integrity
- Low Scenic Integrity
- Scenic Routes
- Power Corridor - 300ft Buffer

OTHER FEATURES

- Eco-Cultural Sites
- Historic Black Canyon Road
- Scenic Route
- Regional Trails
- Future Roadway

Alternatives

Deadman Wash

- Alt 2 B - Levee
- Alt 2B - Channel
- Alt 2 B - Grade Control Structure
- Alt 2B - Retention Basin

0 0.25 0.5 1 Miles

N

REFERENCE FEATURES:

- Project Boundary
- Project Buffer Area (1 mi.)
- Focus Area
- Interstate Highway
- Important Roads
- Other Roads
- Powerlines
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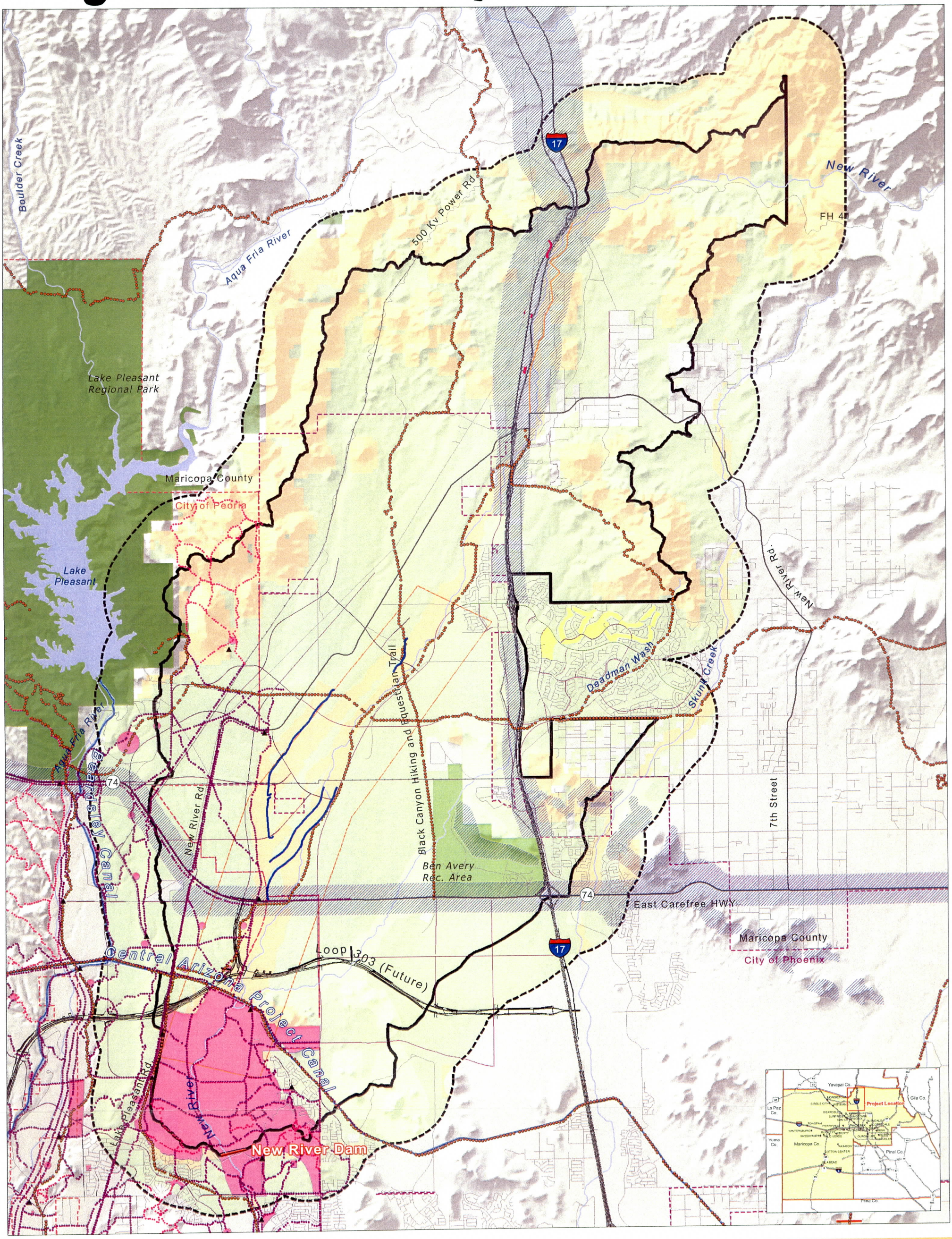

LEGEND

- Peoria Trailheads
- Peoria Trails
- Peoria Back-country Trails
- Regional Trails
- Future Roadway

Recreation (1 mile & Adjacent)

- County Regional Parks
- County Regional Recreation Areas
- City Regional Parks
- City Mountain Preserves
- County Open Spaces & Retention Areas
- County Open Spaces & Conservation Areas
- County Parks
- Local Parks & Golf Courses
- Proposed Peoria Parks

Scenic Integrity

- Scenic Routes

Other Features

- HistoricRd
- EcoCultural

Alternatives

- Alt 2 - Levees

0 0.25 0.5 1 Miles

N

REFERENCE FEATURES:

- Project Boundary
- Project Buffer Area (1 mi.)
- Focus Area
- Interstate Highway
- Important Roads
- Other Roads
- Powerlines
- Dams
- Drainages
- Canals
- Lakes
- Peoria City Limits
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Level 1 Alternatives Recreation and Open Space Resources Assessment

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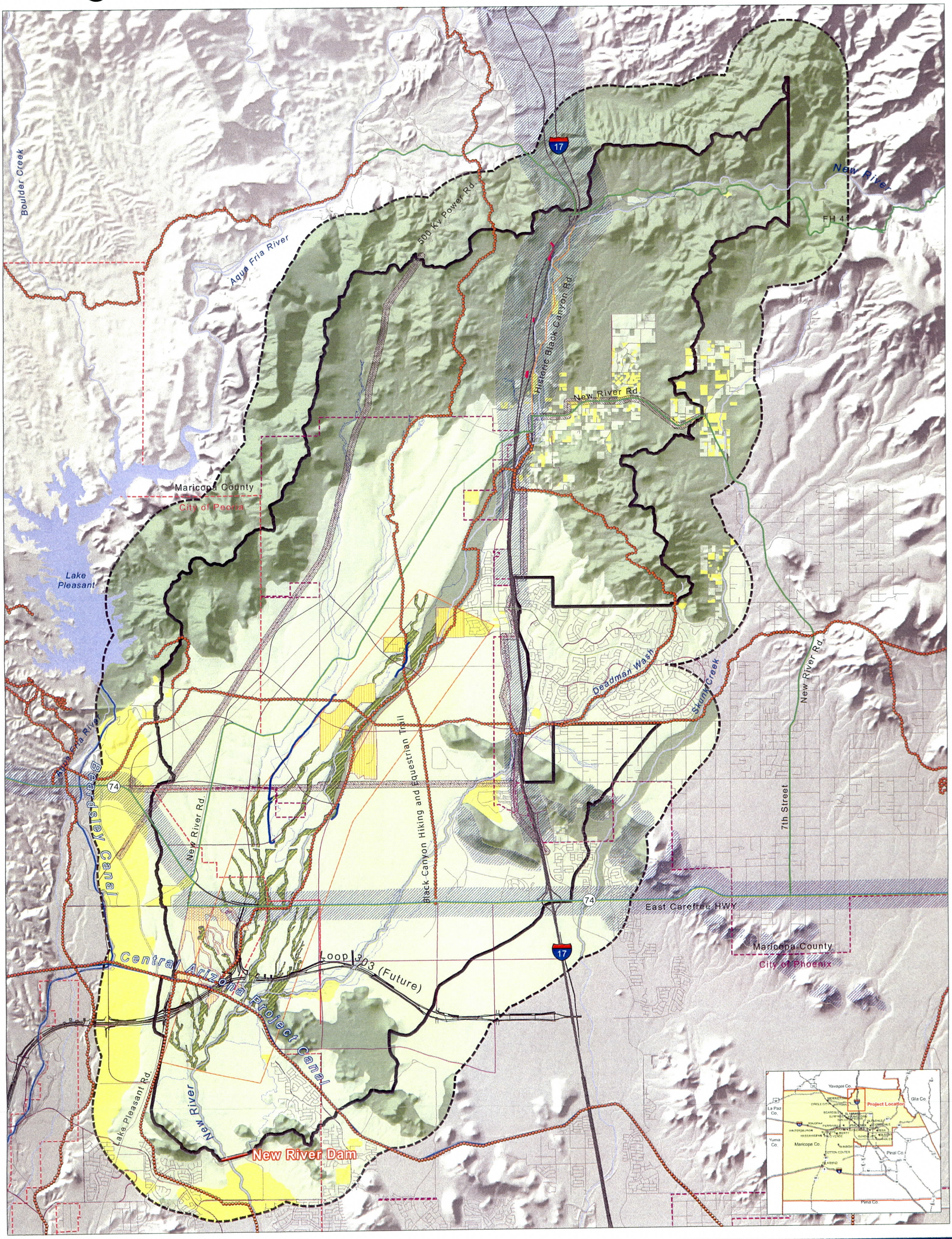

LEGEND

EXISTING SCENIC RESOURCE COMPATIBILITY RATINGS

- Compatibility Class 1
- Compatibility Class 2
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Compatibility Classes	Non-Structural	Soft	Semi-Soft	Hard w/ Aesthetic Treatment	Semi-Hard	Hard
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Compatibility Levels
C= Compatibility and Consistent
NC= Not Consistent/Incompatibility or Compatibles

SCENIC INTEGRITY

- High Scenic Integrity
- Low Scenic Integrity
- Scenic Routes
- Power Corridor - 300ft Buffer

OTHER FEATURES

- Eco-Cultural Sites
- Historic Black Canyon Road
- Scenic Route
- Regional Trails
- Future Roadway

Alternatives

- Alt 3 - Levees

0 0.25 0.5 1 Miles

N

REFERENCE FEATURES:

- Project Boundary
- Project Buffer Area (1 mi.)
- Focus Area
- Interstate Highway
- Important Roads
- Other Roads
- Powerlines
- Dams
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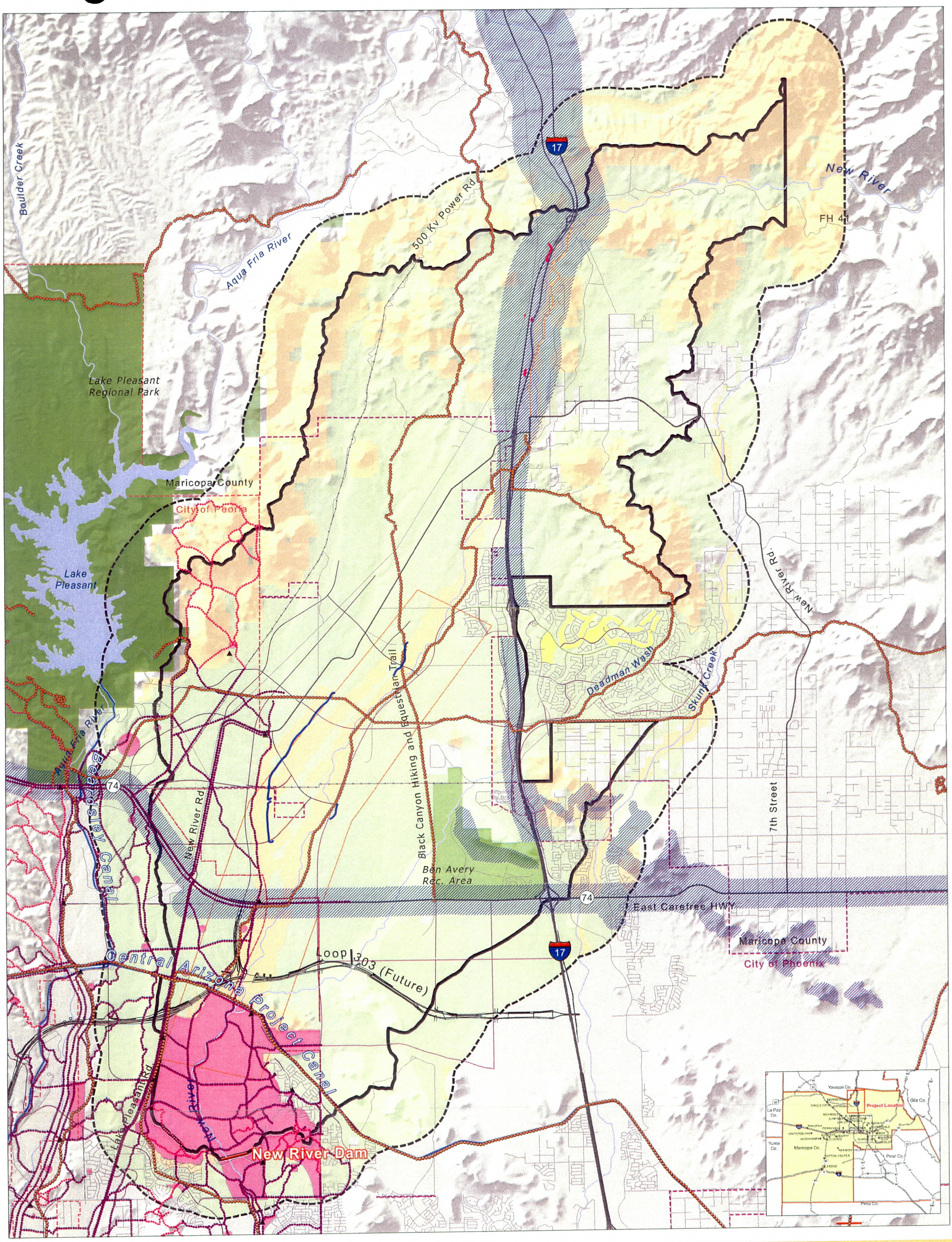

LEGEND

- Peoria Trailheads
- Peoria Trails
- Peoria Back-country Trails
- Regional Trails
- Future Roadway

Recreation (1 mile & Adjacent)

- County Regional Parks
- County Regional Recreation Areas
- City Regional Parks
- City Mountain Preserves
- County Open Spaces & Retention Areas
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- County Parks
- Local Parks & Golf Courses
- Proposed Peoria Parks

Scenic Integrity

- Scenic Routes

Other Features

- HistoricRd
- EcoCultural

Alternatives

- Alt 3 - Levees

Miles
0 0.25 0.5 1

N

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Boulder Creek
Agua Fria River
500 Kv Power Rd
17
New River
FH 4
Historic Black Canyon Rd.
New River Rd.
Maricopa County
City of Peoria
Lake Pleasant
Deadman Wash
Skunk Creek
New River Rd.
Agua Fria River
74
Beardsley Canal
New River Rd.
Black Canyon Hiking and Equestrian Trail
7th Street
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East Carefree HWY
Maricopa County
City of Phoenix
17
Loop 303 (Future)
Central Arizona Project Canal
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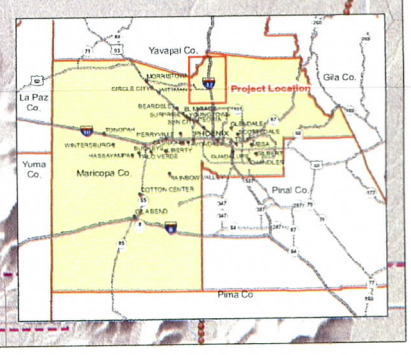
New River
New River Dam



LEGEND

EXISTING SCENIC RESOURCE COMPATIBILITY RATINGS

- Compatibility Class 1
- Compatibility Class 2
- Compatibility Class 3

SCENIC INTEGRITY

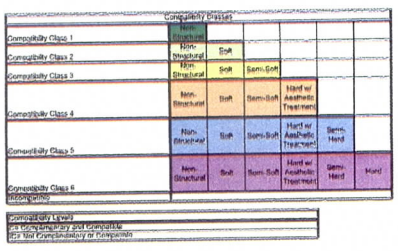
- High Scenic Integrity
- Low Scenic Integrity
- Scenic Routes
- Power Corridor - 300ft Buffer

OTHER FEATURES

- Eco-Cultural Sites
- Historic Black Canyon Road
- Scenic Route
- Regional Trails
- Future Roadway

Alternatives

- Alt 4 - Levee
- Alt 4 - Embankment
- Alt4 - Detention Basins



Miles
0 0.25 0.5 1

N

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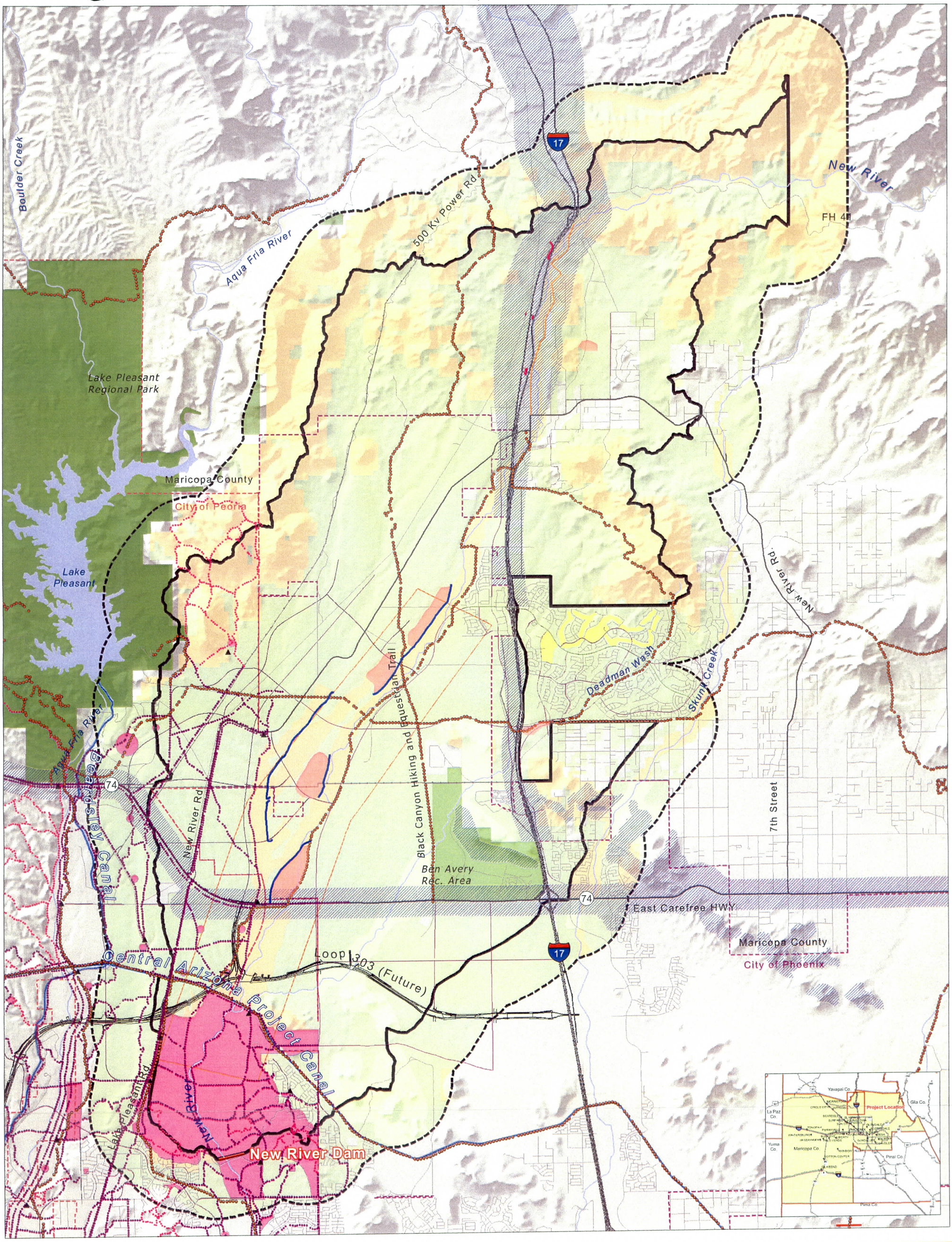

LEGEND

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Recreation (1 mile & Adjacent)

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- County Open Spaces & Conservation Areas
- County Parks
- Local Parks & Golf Courses
- Proposed Peoria Parks

Scenic Integrity

- Scenic Routes

Other Features

- HistoricRd
- EcoCultural

Alternatives

- Alt 4 - Detention Basin
- Alt 4 - Embankment
- Alt 4 - Levee

Miles
0 0.25 0.5 1

N

REFERENCE FEATURES:

- Project Boundary
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