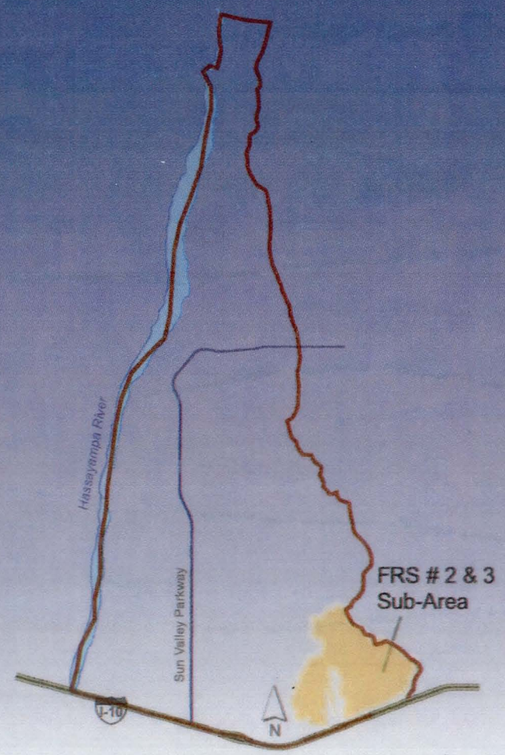
BOOK 23 OF 30

Sun Valley Area Drainage Master Plan



Step 3

Recommended Alternative Report

Volume 7

PART 3 OF 3

BUCKEYE FRS #2 & #3 SUB-AREA

December 2006

A211.224

Memorandum JE Fuller/ Hydrology & Geomorphology, Inc.

DATE: May 8, 2007

TO: Bing Zhao, PE, PhD/FCDMC

FROM: Jon Fuller, PE

RE: Sun Valley ADMP – Corridor Wall Concept Sketch

CC: Valerie Swick/FCDMC

The concept sketch shown in the Sun Valley ADMP final reports inaccurately depicts toe-down measured from the base of the flood wall. In fact, toe-down was measured from the channel invert as shown in the sketch below. A corrected sketch is provided below.

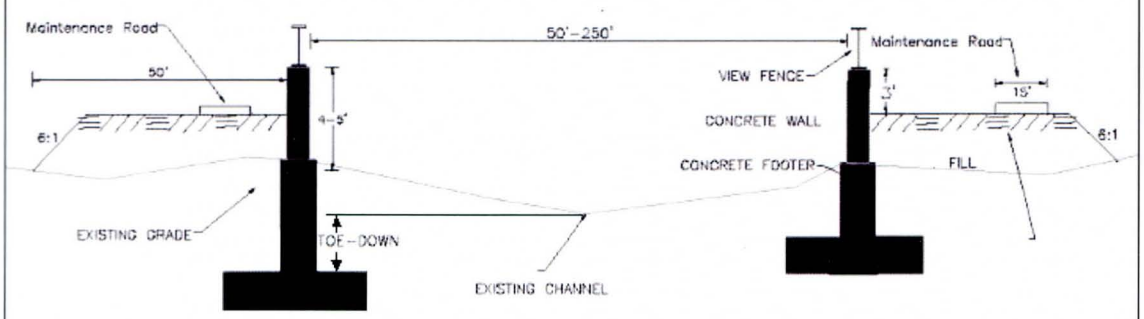


Figure 28 Example Of Typical Floodwall And Corridor

SUN VALLEY AREA DRAINAGE MASTER PLAN

STEP 3 RECOMMENDED ALTERNATIVE REPORT
BUCKEYE FRS #2 & #3 SUB-AREA
VOLUME 7

Flood Control District of Maricopa County

Registered Professional Engineer (Civil)
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TED W. LEHMAN
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ARIZONA U.S.A.

JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC.

C.L. WILLIAMS CONSULTING, INC.

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EDAW

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Richard H. French, Ph.D., P.E.

December 2006

TABLE OF CONTENTS

1 ABSTRACT / EXECUTIVE SUMMARY 5

2 INTRODUCTION 6

2.1 Report Organization 6

2.2 Project Background 6

2.3 Authority for Study 8

2.4 Location of Study Area 8

3 ADMP PROCESS 8

3.1 Process Overview 8

3.2 Scenery Resource Assessment 10

3.3 Cultural Resource Assessment 10

3.3.1 *Cultural Resource Impacts In The FRS No. 2 & 3 Sub-Area* 11

3.3.2 *Implementation Prerequisites* 11

3.4 Stakeholder and Public Involvement 11

4 DESCRIPTION OF RECOMMENDED ALTERNATIVE FOR FRS NO. 2 & 3 SUB-AREA . 12

5 STEP 3 CONCEPT DESIGN APPROACH 13

5.1 Data Collection 13

5.1.1 *Field Survey Information* 13

5.1.2 *Mapping* 13

5.1.3 *Aerial Photographs* 13

5.1.4 *Sediment Gradations* 13

5.2 Process Overview and Summary of Design Criteria 14

5.3 General Procedure Outline 14

5.4 Hydrology 14

5.5 Sediment Yield 14

5.6 Aesthetic Treatment Requirements 15

5.6.1 *Selection of Structure Types* 15

5.6.2 *Flood Protection Methods* 15

5.6.3 *Landscape Themes* 16

5.6.4 *Landscape Theme Plant Palettes* 18

5.6.5 *Landscape Design Guidelines* 18

5.7 On-line Detention Basins 19

5.7.1 *Design Considerations* 19

5.7.2 *Inlet Design Concepts* 20

5.7.3 *Discussion of Inlet Concepts* 23

5.7.4 *Inlet Concept Example for Fan System 13* 24

5.7.5 *Inlet Concept Example for Fan System 3* 24

5.7.6 *Summary of Inlet Design Concepts for Fan Systems in the FRS No. 2 & 3 Sub-area* 25

5.7.7 *Outlet Design Concepts* 25

5.8 Aesthetic Treatments for Detention Basins 26

5.8.1 *Design Guidelines* 26

5.8.2 *Summary of Detention Basin Design Guidelines for Landscape Aesthetics* 27

5.9 On-line Basin Design Procedure 29

5.10 Walled-Levee Corridors 29

5.10.1 *Design Considerations* 29

5.10.2 *Hydraulics* 30

5.10.3 *Equilibrium Slope* 30

5.10.4 *Scour and Toe Protection* 31

5.10.5 *Floodwalls* 32

5.10.6 *Drop Structures* 34

5.11 Aesthetic Treatments of Walled-Levee Corridors 34

5.11.1 *Floodwalls* 34

5.11.2 *Drop Structures* 35

5.11.3 *Design Guidelines for Landscape Aesthetic Treatment* 35

5.12 Walled-Levee Corridor Design Procedure 36

5.13 Recreation and Multiple-Use 37

5.13.1 *FRS No. 2 & 3 Sub-area* 37

6 FRS NO. 2 & 3 SUB-AREA & FAN SYSTEM SPECIFIC DESIGN CONSIDERATIONS ... 38

6.1 Skyline Fan System 39

6.2 Fan System 10, 11, & 20 39

7 STEP 3 COST ESTIMATES 39

7.1 Design Cost Estimates **39**
7.1.1 Land Cost *40*
7.1.2 Construction Cost *40*
7.1.3 Landscaping Cost *40*
7.1.4 Maintenance Cost *40*
7.2 Aesthetic Treatment Costs **40**
8 SKYLINE FAN SYSTEM DESIGN SUMMARY **41**
9 FAN SYSTEM 10, 11, & 20 DESIGN SUMMARY **42**
10 MAINTENANCE PLAN **42**
11 IMPLEMENTATION PLAN **42**
12 SUMMARY FOR THE FRS NO. 2 & 3 SUB-AREA **42**
13 RECOMMENDATIONS FOR FUTURE REFINEMENT OF THE CONCEPT DESIGNS **45**
14 REFERENCES **45**

LIST OF FIGURES

Figure 1 Example Of Sun Valley Piedmont In The Wagner Sub-Area 5
Figure 2 View Of Skyline Fan In The FRS No. 2 & 3 Sub-Area 5
Figure 3 Location Of Study Area 7
Figure 4 Future Developments In The ADMP Study Area 7
Figure 5 Alternatives Development Process 8
Figure 6 Comparison Of Active Fan Area For Fan 36 - 1954 Vs. 2005 9
Figure 7 Fan Area Classification 9
Figure 8 Sun Valley ADMP Sub-Areas 12
Figure 9 Buckeye FRS No. 2 & 3 Sub-area Fan Systems 13
Figure 10 Buckeye FRS No. 2 & 3 Sub-area Recommended Alternative and Landscape Character 17
Figure 11 Concept Plan View Of On-Line Basin For Fan System 3, Wagner Sub-Area 19
Figure 12 Concept Plan View Of An On-Line Basin 19
Figure 13 Concept Profile View Of On-Line Basins With Aesthetic Treatments 19
Figure 14 Riprap Spillway 21
Figure 15 Stepped Drop Structure – Skimming Flow 21
Figure 16 Stepped Drop Structure – Nappe Flow 21
Figure 17 Example of Stepped Boulder Drop Structure 22
Figure 18 Baffle Chute 22
Figure 19 Stilling Basins 23
Figure 20 Conceptual Terraced Inlet Rendering 23
Figure 21 Example Terraced Inlet Concept Profile For Fan System 3, Wagner Sub-Area 24
Figure 22 Typical Detail For On-Line Basin Outlet Structure 25
Figure 23 Planimetric View Of On-Line Detention Basin With Landscape Design Features 26
Figure 24 Concept Cross Section Of Basin Buffer Area With Landscape Design Features 26
Figure 25 Plan View Of Landscape Design Features For Basin Buffer Area 27
Figure 26 Development Of 25-Year & 50-Year Ratios For SVADMP 29
Figure 27 Concept Cross Section For Leveed Corridor With Walls & Aesthetic Treatments 29
Figure 28 Oblique View Of Walled-Levee Corridor With Aesthetic Treatments 30
Figure 29 Example Of Typical Floodwall And Corridor 33
Figure 30 Concept Profile View Of Walled-Levee Corridor 34
Figure 31 Buffer Area Detail With Landscape Aesthetic Features 35
Figure 32 Conceptual Cross Section of a Stepped Boulder Drop 36
Figure 33 Recommended Alternative And Multiple-Use Opportunities in the FRS No. 2 & 3 Sub-area 38
Figure 34 Recommended Alternative Features For FRS No. 2 & 3 Sub-Area 38
Figure 35 FEMA Floodplains, Recommended Alternative, And Benefited Area 44

LIST OF TABLES

Table 1 SVADMP Stakeholders 11
Table 2 Summary Of Design Criteria For Step 3 Recommended Alternatives 14
Table 3 Plant Palettes for Natural Sonoran Desert Theme 18
Table 4 Design Data For Fan System 3 Basin Inlet 24
Table 5 Summary Of Inlet Design Concepts For FRS No. 2 & 3 Sub-Area 25
Table 6 Flood Wall Typical Section Properties 33
Table 7 Fan System 10, 11, & 20 – Active Alluvial Fan Area And Land Ownership 39
Table 8 Summary Of Unit Costs 40
Table 9 Design Cost Summary – Skyline Fan System 41
Table 10 Aesthetic Treatment Differential Costs Summary – Skyline Fan System 41
Table 11 Summary Of FRS No. 2 & 3 Sub-Area Costs For Recommended Alternative 42

LIST OF APPENDICES

Appendix A: Design Analyses – Skyline Fan System

Appendix B: Fan System 10, 11, & 20

Appendix C: Miscellaneous Additional Materials

ENCLOSED DATA DISC INCLUDES:

- Digital Copy of Report in PDF Format
- GIS Shapefiles of Project Elements
- Excel Files of Design Analyses
- HEC-1 Model Files
- HY8 Model Files

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1 ABSTRACT / EXECUTIVE SUMMARY

The Sun Valley Area Drainage Master Plan (SVADMP) is a regional flood control master plan developed for a 180 square mile area in western Maricopa County. The area lies between the White Tank Mountains and the Hassayampa River mostly within the Town of Buckeye. The mountains drain on to a large sloping alluvial area of coalescing alluvial fans, or bajada (Figure 1). Alluvial fans are sloping, fan-shaped landforms created over long periods of time by the deposition of sediment. Alluvial fan landforms are commonly located at the base of mountain ranges in the arid and semi-arid American Southwest.

Figure 1 Example Of Sun Valley Piedmont In The Wagner Sub-Area

The highly dynamic nature of alluvial fan flooding presents significant challenges for the design of engineered flood control measures. The designed drainage infrastructure must effectively and efficiently convey 100-year discharges without creating unwanted sediment deposition or erosion. Further complexity is added as flood hazards change in type and severity with geographic position on the fan.

Structural and non-structural alternatives were refined and costs estimated as part of the Step 3 Recommended Alternative development for the Sun Valley Area Drainage Master Plan (SVADMP). This is the final step of a three-step process to develop a drainage master plan for the Sun Valley area. Four flood control alternative strategies were identified in Step 1 of the ADMP process. Those four strategies were further refined and evaluated in Step 2. The refined alternatives included both non-structural and environmentally friendly, structural flood control measures that are designed to be complementary to the visual character of the study area. Step 3 is a further refinement of the plan elements and cost estimates of the recommended alternative resulting from the Step 2 evaluation process. Special attention has been given to maximizing non-structural, floodplain management approaches along the preferred corridor alignments. Stakeholders and the public have been consulted as to their feedback in an attempt to incorporate existing and imminent developer plans into the drainage master plan for the Sun Valley area. Concept implementation and maintenance plans are also provided with the Step 3 Recommended Alternative.

Figure 2 View Of Skyline Fan In The FRS No. 2 & 3 Sub-Area

In order to achieve the refinement of the recommended alternative, the study area which had been divided into seven geographic sub-areas in Step 2, was further broken up into individual alluvial fan systems. Figure 2 shows an example of the Skyline Fan System in the FRS No. 2 & 3 sub-area. This report presents the results for the Buckeye FRS No. 2 & 3 sub-area and its two alluvial fan systems; Fan System 10, 11, & 20 and the Skyline Fan System. The other sub-areas within the ADMP study area are presented in separate similar reports. Step 3 of the ADMP concentrated on refinement of the design and cost estimates of the on-line detention basins at the fan apices as well as the use of walled-levee corridors for the conveyance of floodwater downstream. Non-structural, floodplain management approaches were incorporated wherever possible.

The results for the FRS No. 2 & 3 sub-area include three on-line detention basins, 1.9 miles of walled-levee corridors, and 123 acres of non-structural set-aside area. The total right of way area needed for the two FRS No. 2 & 3 fan systems is 249 acres, of which 89 acres are already owned by the Flood Control District. The estimated total cost of the recommended alternative for the FRS No. 2 & 3 sub-area is $35.5 million. Implementation is suggested such that the apex detention basins are constructed first for any given fan system. The non-structural approach for Fan System 10, 11, & 20 is strictly a floodplain management approach. No costs are attributed to the recommended alternative for Fan System 10, 11, & 20. Funding will likely come through a combination of cost-sharing from public and private sources including possible impact fees associated with new master planned communities in the area.

2 INTRODUCTION

2.1 Report Organization

The Step 3 Recommended Alternative Report is presented in seven (7) volumes similar to the Step 2 report. Volume 1 provides an overview of the ADMP, explains the ADMP process, and summarizes the recommended alternative for each sub-area and the entire study area. Volume 1 also provides a discussion of general area-wide flood control issues and potential solutions as well as specific issues and potential solutions for the area north of the Central Arizona Project Canal. The so-called North of CAP sub-area is included in Volume 1 for two reasons: first, the sub-area is not dominated by large alluvial fans like the piedmont sub-areas in the remainder of the study area; second, the recommendations for the North of CAP sub-area are predominantly non-structural in nature.

Volumes 2 through 7 present the recommended alternatives for the piedmont sub-areas as follows:

2) CAP (Volume 2),

3) Wagner Wash (Volume 3),

4) Hassayampa River (Volume 4),

5) White Tank Wash (Volume 5),

6) Buckeye FRS #1 (Volume 6), and

7) Buckeye FRS #2 & #3 (this volume).

Volumes 2 through 7 also include site specific data, hydraulic analyses, and cost estimates. It is intended that each Volume of the Step 3 report be able to stand alone so that a reader, such as an interested stakeholder, unfamiliar with the ADMP, or uninterested in other sub-areas, can understand the overall study as well as the details of an individual sub-area of particular interest to them. Excessive detail associated with the design calculations are left out of Volume 1 in order to provide a more digestible document for the reader interested in the Recommended Alternatives Analysis as a whole.

The advantages of this type of report organization are:

- The reduction of reproducible materials required for interested users or stakeholders.
- It provides a condensed overview of the ADMP process and the Recommended Alternative.
- It narrows the focus to a specific sub-area while still providing an overall comprehensive summary of the Step 3 process and recommended alternative descriptions.

2.2 Project Background

The Sun Valley area, located in western Maricopa County, Arizona, is presently experiencing the first stages of accelerated urbanization (Figure 3). Future development is anticipated to occur on the largely undisturbed alluvial fans and piedmont surfaces comprising the western slope of the White Tank Mountains (Figure 4). The upland areas and adjacent watershed drain to the Hassayampa River to the west and the Buckeye Flood Retarding Structure (FRS) Numbers 1, 2, & 3 along Interstate 10 to the south.

The purpose of the Sun Valley Area Drainage Master Plan (SVADMP) is to develop a conceptual drainage plan to serve as a roadmap that jurisdictional authorities and developers can use in planning flood control measures to mitigate flood hazards up to the 100-year event in the area. The SVADMP incorporates development plans for the area and jurisdictional drainage policies to develop a preferred regional flood control solution.

The major objectives of the project include the following:

- Plan regional flood hazard mitigation;
- Preparation of approximate alluvial fan floodplain delineations, meeting Federal Emergency Management Agency (FEMA) and Flood Control District of Maricopa County (District) standards, for those alluvial fans in the study area not previously delineated (presented in six separate Technical Data Notebooks);
- Coordination between the ADMP regional flood control measures and the design of drainage features within the master planned community developments within the study area;
- Preparation of preliminary design of flood control facilities in areas not within master planned communities; and,
- Design flood control solutions to complement the character and preserve the beauty of the natural desert landscapes of the study area and achieve consistency with the Flood Control District's *Policy for the Aesthetic Treatment and Landscaping of Flood Control Projects* (FCDMC, 1993).

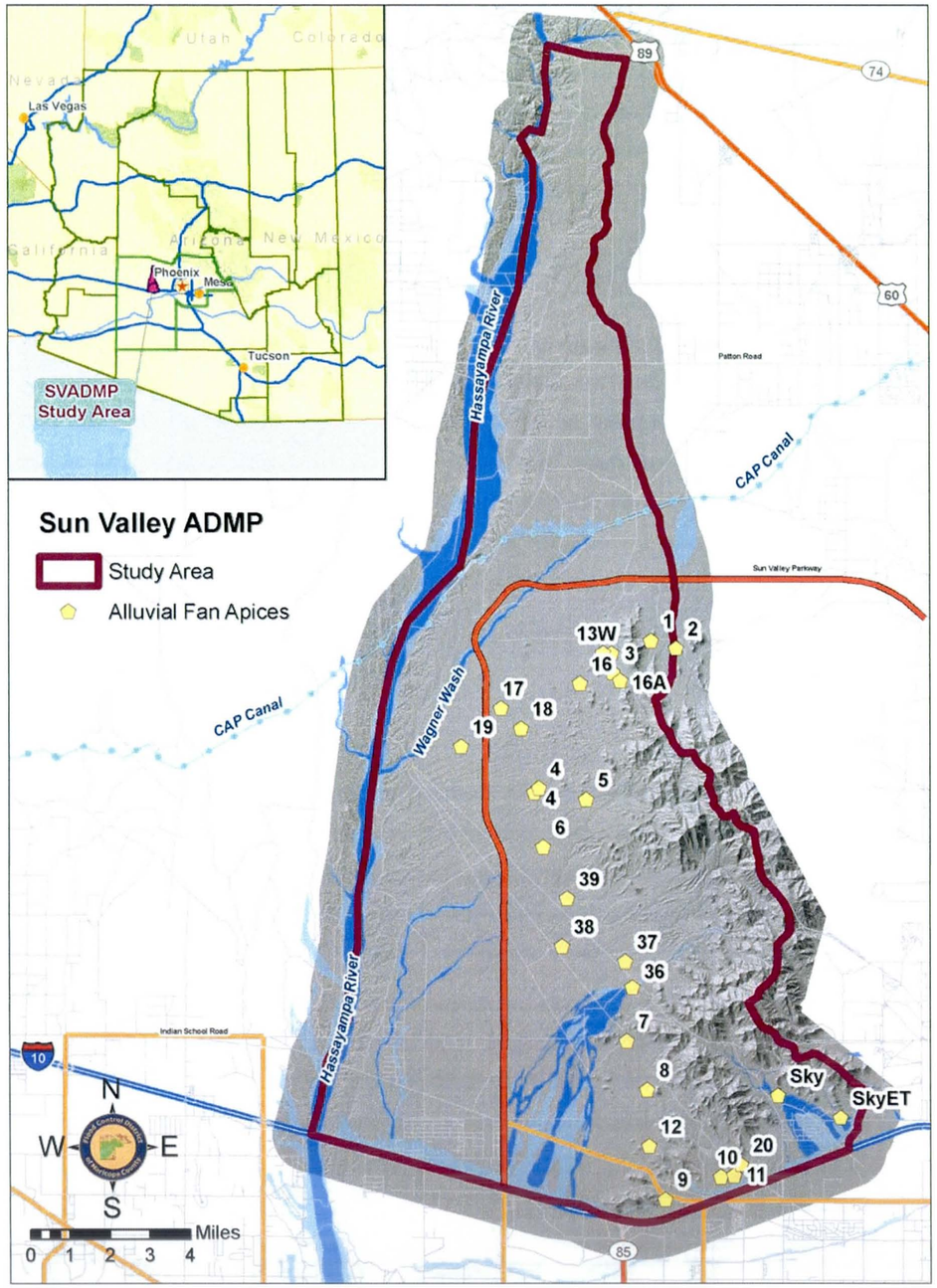

Figure 3 Location Of Study Area

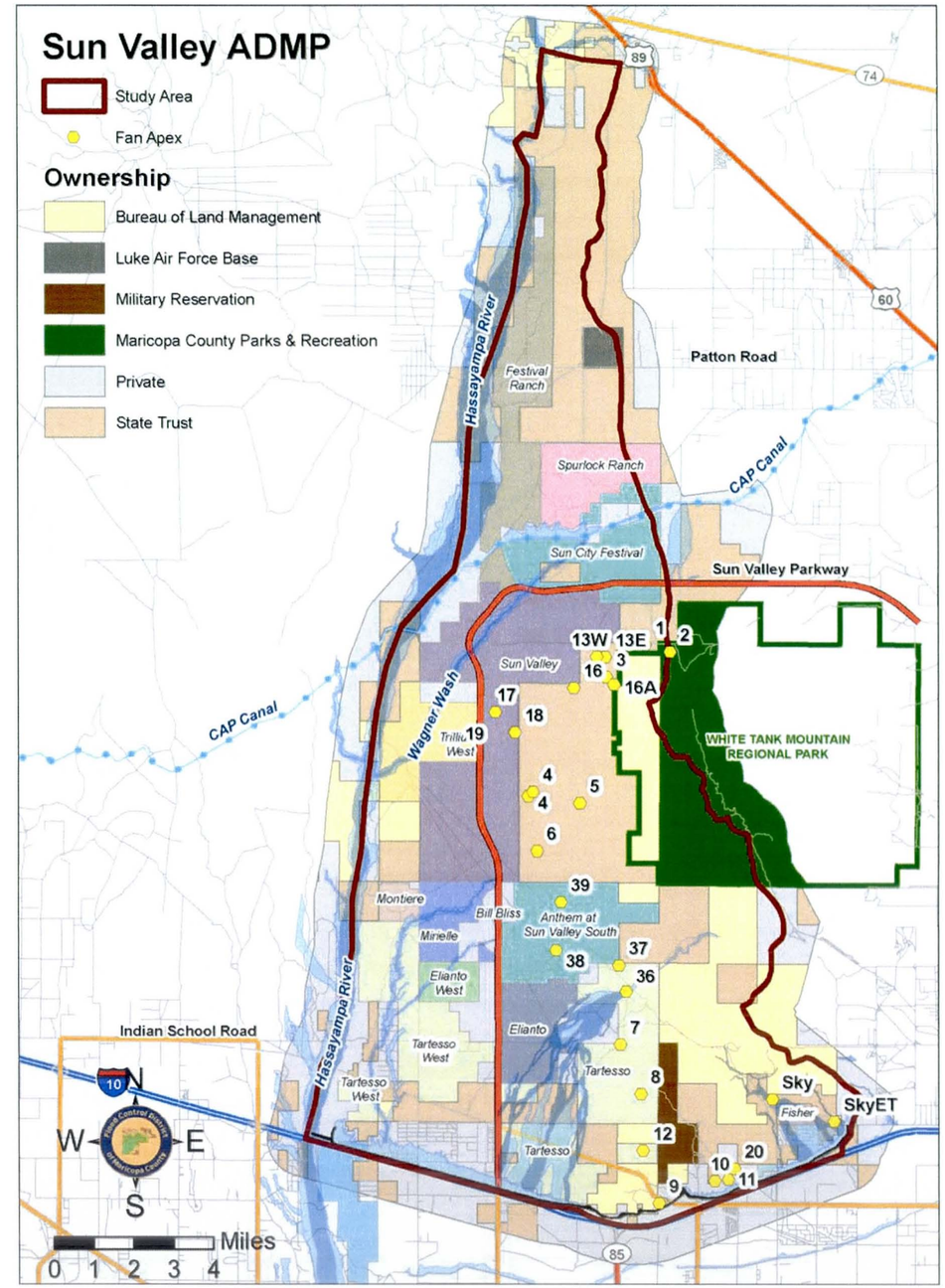

Figure 4 Future Developments In The ADMP Study Area

Previously, the Phase I Buckeye/Sun Valley Area Drainage Master Study (ADMS), conducted by PBS&J, documented and analyzed existing conditions and identified drainage and flooding problems in the study area for the purpose of initial formulation of flood protection alternatives. The Phase II Sun Valley Area Drainage Master Plan builds on the Phase I findings by employing a 3-step process with the goal of developing a Recommended Alternative, consisting of both environmentally friendly structural and non-structural measures, to address flood hazards in the study area. Figure 5 shows a flowchart illustrating the SVADMP alternatives development process.

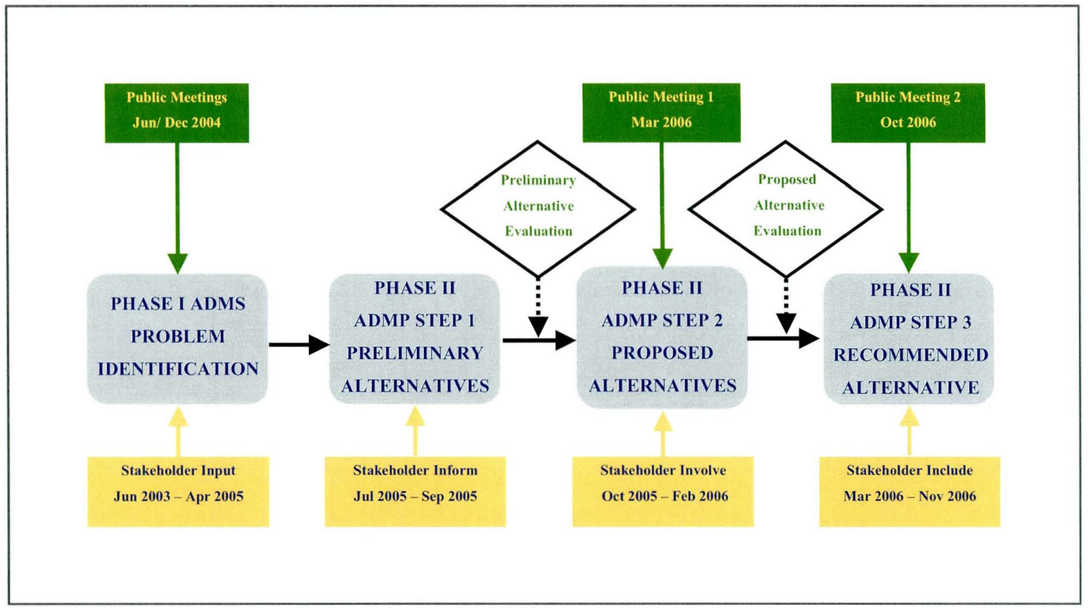

Figure 5 Alternatives Development Process

This report is part of the Phase II ADMP Step 3 Recommended Alternative process which focuses on further refinement of the recommendations of the Step 2 Proposed Alternatives Analysis (JEF, 2006b). The purpose of this study is to present the Step 3 Recommended Alternative for the FRS No. 2 & 3 sub-area in support of the SVADMP.

Based on the recommendations resulting from Step 2 process, the conceptual design of regional, whole-fan solutions were developed. The recommended alternative for the FRS 2 & 3 sub-area was based on the B4-3 Alternative from Step 2. It is composed of three large, on-line detention basins near the alluvial fan apices and walled-levee corridors downstream to Buckeye FRS No. 3 for Skyline Fan System and a non-structural approach (Alternative A) for Fan System 10, 11, & 20. Cost estimates are also provided. The costs include engineering design, major construction items, right-of-way acquisition, major utility relocations, landscape aesthetic treatment requirements, and maintenance costs for a 50-year design life.

2.3 Authority for Study

The current study was authorized by the Flood Control District of Maricopa County (District) under contract FCD 2004C049 as part of the scope of services for the SVADMP. The Town of Buckeye, Arizona was an important project participant. The ADMP was performed by JE Fuller/ Hydrology & Geomorphology, Inc., with subconsultants C.L. Williams Consulting, Inc., Logan Simpson Design, Inc., AMEC Earth & Environmental, EDAW Inc., and Richard H. French, Ph.D., P.E.

2.4 Location of Study Area

Figure 3 shows the location of the study area. The study area has a total watershed area of 183 square miles. Most of the study area is located within the Town of Buckeye. The study area is bounded by the White Tank Mountains and the Trilby Wash watershed on the east, the Hassayampa River on the west, the Buckeye Flood Retarding Structures on the south, and Gates Road to the north. The watercourses within the study area are all tributaries to the Hassayampa River or the Buckeye Flood Retarding Structures, except Fan 2 in the CAP sub-area, which is a tributary to Trilby Wash. The corridors in the FRS No. 2 & 3 sub-area are tributaries to Buckeye Flood Retarding Structures No. 2 and No. 3. The Skyline Fan System drains to FRS No. 3 while Fan System 10, 11, & 20 drains to FRS No. 2.

3 ADMP Process

3.1 Process Overview

The highly dynamic nature of alluvial fan flooding presents significant challenges for the design of engineered flood control measures. The designed drainage infrastructure must effectively and efficiently convey 100-year discharges without creating unwanted sediment aggradation or degradation. Further complexity is added as flood hazards change in type and severity with geographic position on the fan whether the area of interest is located at the apex, mid-fan, or near the outfall; and if the flood event is less than the 100-year event.

Known problems associated with alluvial fan flooding include spatial uncertainty of the flow distribution, lack of containment within the relatively flat topographic relief laterally across the fan, avulsive movement of defined flow paths, flooding along undefined flow paths, sheet flooding, distributary flow, scour, and landform aggradation. In addition, steep channel slopes between fan apices and fan toes result in high flow velocities with the energy to move significant volumes of sediment and debris during large floods. Figure 6 shows an example of widespread channel avulsion on Fan 36 in the FRS No. 1 sub-area. A large flood in August 1951 created all the bright colored new channels seen in the aerial photo from 1954.

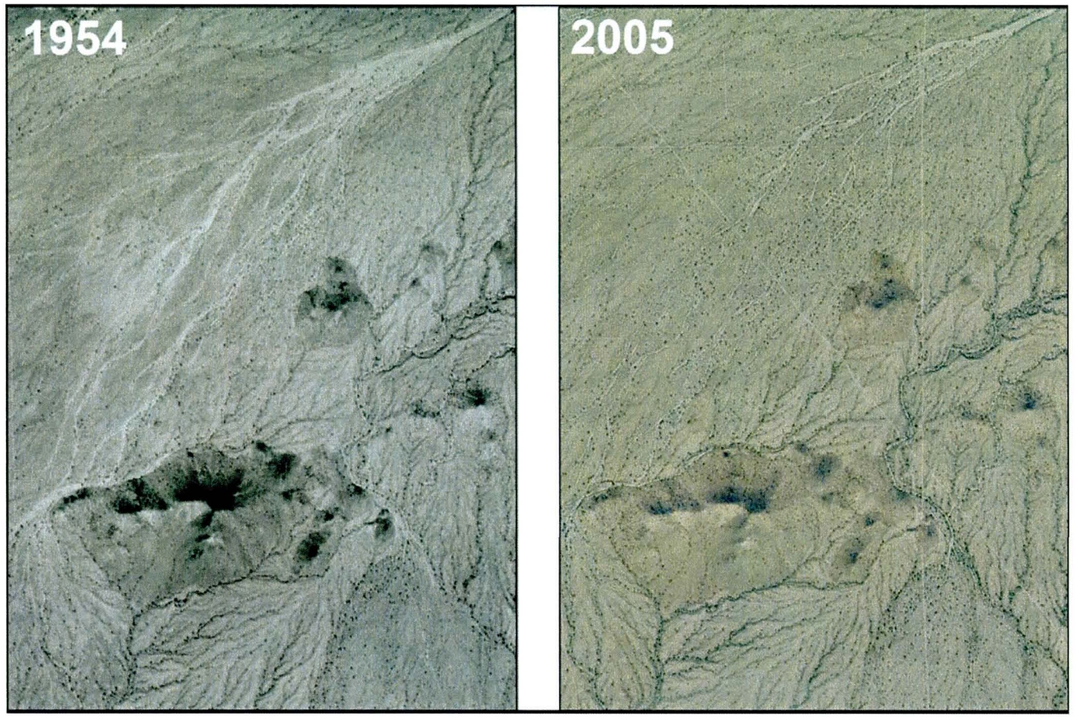

Figure 6 Comparison Of Active Fan Area For Fan 36 - 1954 Vs. 2005

The Step 1 Preliminary Alternatives Evaluation (JEF, 2006a) presented the outline for the alternatives to be analyzed as part of the Step 2 Proposed Alternatives Evaluation (JEF, 2006b) and refined during the Step 3 Recommended Alternatives process. The Step 1 Preliminary Alternatives Evaluation process identified five areas within each fan starting from upstream to downstream: 1) Apex, 2) Up Fan, 3) Parkway, 4) Down Fan, and 5) Outfall (see Figure 7). Flooding and drainage characteristics vary for each of these component areas of the alluvial fan landform. This classification permits the design process to identify potential flood control measures specific to each of these areas which, in combination, comprise a whole-fan solution. Whole-fan solutions were preferred because they provide a regional flood control system which acts as a major trunk system for the adjacent watersheds. The trunk system is designed to convey runoff and sediment inflows from the apex plus that generated from the fan surface itself. Note that most, but not all, of the alluvial fans considered in this study have all the five component areas. However, the overall design considerations are similar for all the fans.

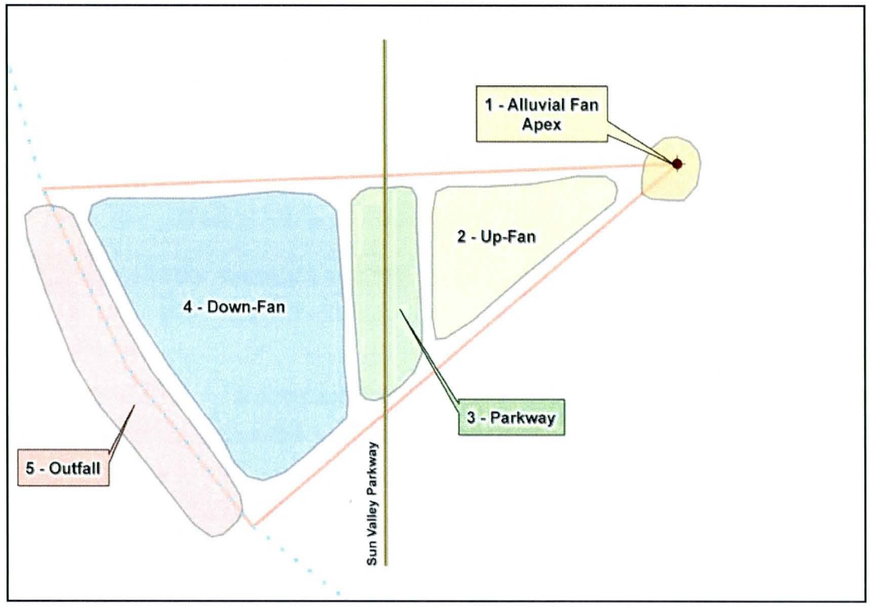

Figure 7 Fan Area Classification

The Step 1 process identified the following design strategies: 1) Conveyance, 2) Storage, 3) Management, and 4) No Measure. These strategies apply to each of the five areas starting from the apex to the outfall and formed the basis of the Preliminary Alternatives. Four major alternatives were identified based on these strategies: Alternative A, Alternative B, Alternative C, and Alternative D. These four alternatives consist of different selections of strategies for each of the different areas from apex to outfall. Each alternative can be described as a particular set of strategies applicable to different areas of the fan. Those four alternatives were considered as part of the Step 2 Proposed Alternatives Evaluation process.

The Alternatives A, B, C, and D formulated in the Step 2 process consisted of particular combinations of detention basins, conveyance corridors, developer-planned drainage improvements, and 'no measure' options applied to different areas of the alluvial fan starting upstream at the apex to the downstream outfall. During the Step 2 process, Alternative B was further subdivided into five similar, but unique alternatives named B1, B2, B3, B4, and B5. This was done to evaluate: 1) the influence of size and type of the apex basin on the design of the downfan system; 2) different channel cross-section types; and 3) various channel alignments.

The result of the Step 2 Proposed Alternatives Evaluation was the selection of a preference for large on-line detention basins (Alternative B1) with leveed downstream corridors. In addition, where multiple alignments were possible, a greater number of paths was preferred to fewer for connectivity and environmental reasons (Alternative B4-3). For the FRS No. 2 & 3 sub-area, different alternatives were selected for each Fan System. For the Skyline Fan

System, Alternative B4-3 was selected for refinement. Alternative A, a fully non-structural alternative, was selected for Fan System 10, 11, & 20.

In addition to the selection of large, on-line basins with multiple corridors, the Step 2 alternatives evaluation also identified a number of items for consideration in the refinement of the recommended alterative for Step 3 for the FRS No. 2 & 3 sub-area. The recommendations were based on input received during the development of the proposed alternatives, the team evaluation process, and input from stakeholders and the public.

- There is a need to balance earthwork by project. For Step 3, a project will be considered the apex-to-outfall system for an individual alluvial fan (or fan complex if hydraulically connected, referred to as 'fan system' in this report).
- Existing channel conveyance should be quantified and incorporated into the recommended alternative designs. This could result in the elimination of some levee/wall reaches where the existing conveyance is adequate or natural lateral containment exists on one or more sides of the corridor. This will also maximize the use of non-structural or nearly non-structural reach management elements.
- The required aesthetic treatments should be included explicitly in the hydrologic and hydraulic design.
- Incorporate the specific sediment data collected in Step 2 into the design calculations.
- Identify the area benefited using the Stage 3 delineations.
- Refine the design details including riprap sizing calculations and the evaluation of basin inlet structures (e.g., energy dissipaters, collection dikes/ ditches, off-line basin outlet structures, etc.)
- Refine the hydrologic models to include more HEC-1 subreaches, ideally one subreach per design reach.
- Discretize the quantities and costs by individual fan system (by "project").

All of these items have been incorporated into the Step 3 refinements as discussed in the remainder of this report. The refinements and designs of the other sub-areas are presented in separate reports (Volumes 2 – 6).

In addition to the recommendations for Step 3 above, a Value Engineering (VE) process was undertaken by the District external to the ADMP project team at the end of Step 2. The VE process identified the following items for the refinement of the recommended alternative in the FRS No. 2 & 3 sub-area which are also addressed in this report:

- Consider the use of floodwalls rather than earthen levees wherever possible
- Design to the higher end of the range of hydraulic constraints for the leveed corridors
- Optimize the toe-down to grade control relationship

The use of floodwalls was recommended based on the significant cost savings identified in the Step 2 reports. As will be discussed further in the design discussion (see Section 5), the Step 2 hydraulic design targeted a hydraulic depth of one foot and a velocity range of 4 to 6 feet per second. The VE suggestion was to design to the higher end of the velocity range. To accomplish this, the Step 3 design will allow hydraulic depths up to two feet. The toe-down to grade control relationship is further refined in Step 3 through the use of a sediment transport capacity continuity approach to the equilibrium slope assessment for the selection of grade control spacing.

During the Step 3 process, it was recognized that with the migration to a concrete floodwall containment strategy for the levee corridors, the balancing of earthwork objective identified in Step 2 was not feasible. That is, for many fan systems, the excavation requirements far outweigh the fill needs. Therefore, material disposal from the detention basin excavation will be necessary for most of the fan systems.

3.2 Scenery Resource Assessment

The scope of work for the ADMP specifically states that the recommended alternative be "environmentally friendly and blend with the natural landscape of the study area following the District's *Policy for the Aesthetic Treatment and Landscaping of Flood Control Projects*". An assessment of the scenic resources, including landscape character, scenic quality, and viewshed sensitivity was undertaken as part of this study (LSD, 2006) utilizing information and guidelines provided by the Flood Control District. The data from this assessment was used to identify a range of flood protection methods that would be compatible with the visual character of the settings of the study area. This data was also used to identify a variety of landscape design themes that could be applied to flood control projects proposed within the study area. The recommended alternative presented in Sections 4 and 5 directly incorporates aesthetic features to ensure that the proposed alternative meet these objectives. In addition, the cost estimates also include the costs associated with the aesthetic and landscaping treatment requirements of the recommended alternative including structure enhancements, additional right of way requirements, grading design requirements, and landscape plantings.

3.3 Cultural Resource Assessment

A separate cultural resource assessment overview was provided in *An Archeological Resource Overview Of The Sun Valley ADMP Area Of West - Central Maricopa County, Arizona* (SAS, 2005). Archival research was the principal tool of that investigation, but it has also included some fieldwork. Together they revealed no fewer than 80 cultural resource investigations have previously been completed across the project area. They began in 1882 and are of six different types. Significantly, 53 of them are prior intensive field surveys that thoroughly examined roughly 8,842 acres, or 11.7 percent, of the area.

The project inventory of resources consisted of 77 individual sites, all but 23 of which have been disturbed or totally destroyed. They include 17 prehistoric sites, 1 prehistoric-historic site, 58 historic sites, and 1 modern site, which dates 1981-present. The prehistoric sites date A.D. 400-1450 and represent only one unidentifiable and two identifiable cultural themes: residential life and natural resource exploitation, that are attributable to both the Hohokam and the Patayan Indians. The historic sites date exclusively to the Arizona Territorial (1863-1912) and Statehood (1912-1952) phases, and represent nine cultural themes: canal irrigation, community growth and

development, farming, homesteading, mining, railway transportation, ranching, roadway transportation, and trash deposition.

3.3.1 Cultural Resource Impacts In The FRS No. 2 & 3 Sub-Area

Though no intensive field survey work has yet ever been undertaken in the FRS No. 2 & 3 sub-area., none of the proposed construction activities themselves are expected to impact directly any known archeological sites. However, previous reconnaissance work here does indicate that four archeological sites do occur near one of the proposed construction features. That is, AZ T:10:4 ASU is located only about 125 feet north of the main Skyline Fan channel. Farther south, AZ T:10:2, 5, and 6 ASU are all situated 400-3,000 feet west of this same channel and within the floodplain area immediately upstream from FRS #2&3.

All four cultural resources of within this sub-area have previously been discussed by SAS (2005, pp. 42-45, Figure 12, Table 5). All of them are prehistoric sites and represent only a rather limited variety of local resource exploitation activities. Arizona T:10:2 ASU and AZ T:10:5 ASU are undated Hohokam sites containing boulder metates, a rock ring, and sparse scatters of pottery sherds and lithic artifacts. Contrastingly, AZ T:10:4 ASU and AZ T:10:6 ASU are Patayan or mixed Patayan-Hohokam sites dating between A.D. 1150 and 1450. The exclusive surface features there are limited to sparse sherd and lithic artifact scatters.

3.3.2 Implementation Prerequisites

Absolutely no land disturbance activities associated with the construction of any of the proposed construction features of this sub-area should be allowed without having first implemented all pertinent archeological compliance guidelines of the State of Arizona and the United States government. Such guidelines would strongly suggest several relevant recommendations: 1) an updated site records check should be made of all proposed project impact areas, 2) an intensive (100%) field survey should be conducted at all of those same features, 3) no construction impact should be allowed at AZ T:10:4 ASU, 4) all potential indirect impacts should be evaluated at sites AZ T:10:2, 5, and 6 ASU, and, if necessary, 5) established government criteria should be used to assess the archeological significance of all four of these concerned prehistoric sites.

3.4 Stakeholder and Public Involvement

The District and ADMP project team conducted an extensive stakeholder and public involvement process as part of the ADMP. Stakeholders included in the process are listed in Table 1. The stakeholder process included Stakeholder Workgroup meetings as well as numerous individual meetings with stakeholders and the project team. The project team received input and maintained two-way communication with stakeholders to ensure clear understanding of the nature of the recommended alternative and study's progress. Ultimately, the close interaction of the project team and stakeholders had a significant impact on the nature of the recommended alternative for the SVADMP including the selection of walled-levee corridors and the location of the preferred corridor alignments.

Table 1 SVADMP Stakeholders

Agencies / Public Entities	Development/ Developers/ Engineers
FCDMC	Capitol Pacific Homes/ CVL
Town of Buckeye	Sun Valley South (West)/ Communities Southwest/ WRG
ADEQ	Festival Ranch/ Lyle Anderson/ WRG
ADOT	Skyline Wash/ Fisher-Williams / PDC
AZ Game & Fish	Elianto/ Lennar/ CVL
ASLD	Anthem/ Pulte/ CMX
AWDR	Tartesso/ Stardust/ DEA
Bureau of Land Management	Tartesso West/ Stardust/ DEA
Bureau of Reclamation	Spurlock Ranch/ Glen Spurlock /
CAP	Sun City Festival/ Pulte/ CVL
Luke Air Force Base	SunCor Arizona
MCDOT	Trillium West/ Gateway/ DEA
MC Parks	Sun Valley/ Vistoso/ Erie & Assoc
NRCS	
Palo Verde Power Plant (APS & SRP)	
US Fish & Wildlife	
Western Power Authority	
White Tanks Concerned Citizens	

4 DESCRIPTION OF RECOMMENDED ALTERNATIVE FOR FRS NO. 2 & 3 SUB-AREA

Flood control alternatives for the SVADMP area included both structural and non-structural solutions. Given the landscape compatibility assessment, non-structural solutions are generally preferred whenever possible. However, for the areas impacted by active alluvial fans, the degree, extent, and uncertainties associated with the flood hazards are considered too extreme to make fully non-structural alternatives feasible. Therefore, for the areas impacted by large active alluvial fan flooding, structural measures are central to the recommended flood control alternative.

In Step 2, the study area was divided geographically into seven sub-areas to focus the attention of appropriate structural or non-structural flood control alternatives for the study area. This sub-area division was also used in Step 3.

1) North of CAP (Volume 1)
2) CAP (Volume 2),
3) Wagner Wash (Volume 3),
4) Hassayampa River (Volume 4),
5) White Tank Wash (Volume 5),
6) Buckeye FRS #1 (Volume 6), and
7) Buckeye FRS #2 & #3 (this volume).

The sub-areas are based on the outfall locations and the fans discharging to a particular outfall location. For example, fans that drain to FRS No. 2 & 3 are included in the FRS No. 2 & 3 sub-area. The sub-areas also represent the hydrologic watershed for the particular outfall location. The sub-area boundaries are shown in Figure 8.

This report presents the details of the Step 3 Recommended Alternative for the FRS No. 2 & 3 sub-area. Volume 1 provides an overview of the Step 3 Recommended Alternative for the entire study area. Additional details for the other five alluvial fan sub-areas south of the CAP Canal are presented in separate companion reports (Step 3, Volumes 2 – 6). This organization is analogous to that used in the Step 2 presentation.

Within the FRS No. 2 & 3 sub-area, two "fan systems" were further differentiated (Figure 9). These fan systems are presented in separate sections within the remainder of this report and summarized as a whole at the end of this report. The two fan systems within the FRS No. 2 & 3 sub-area are:

- Skyline Fan System which addresses Skyline Fan and SkyET Fan
- Fan System 10, 11 & 20 which addresses Fans 10, 11, & 20

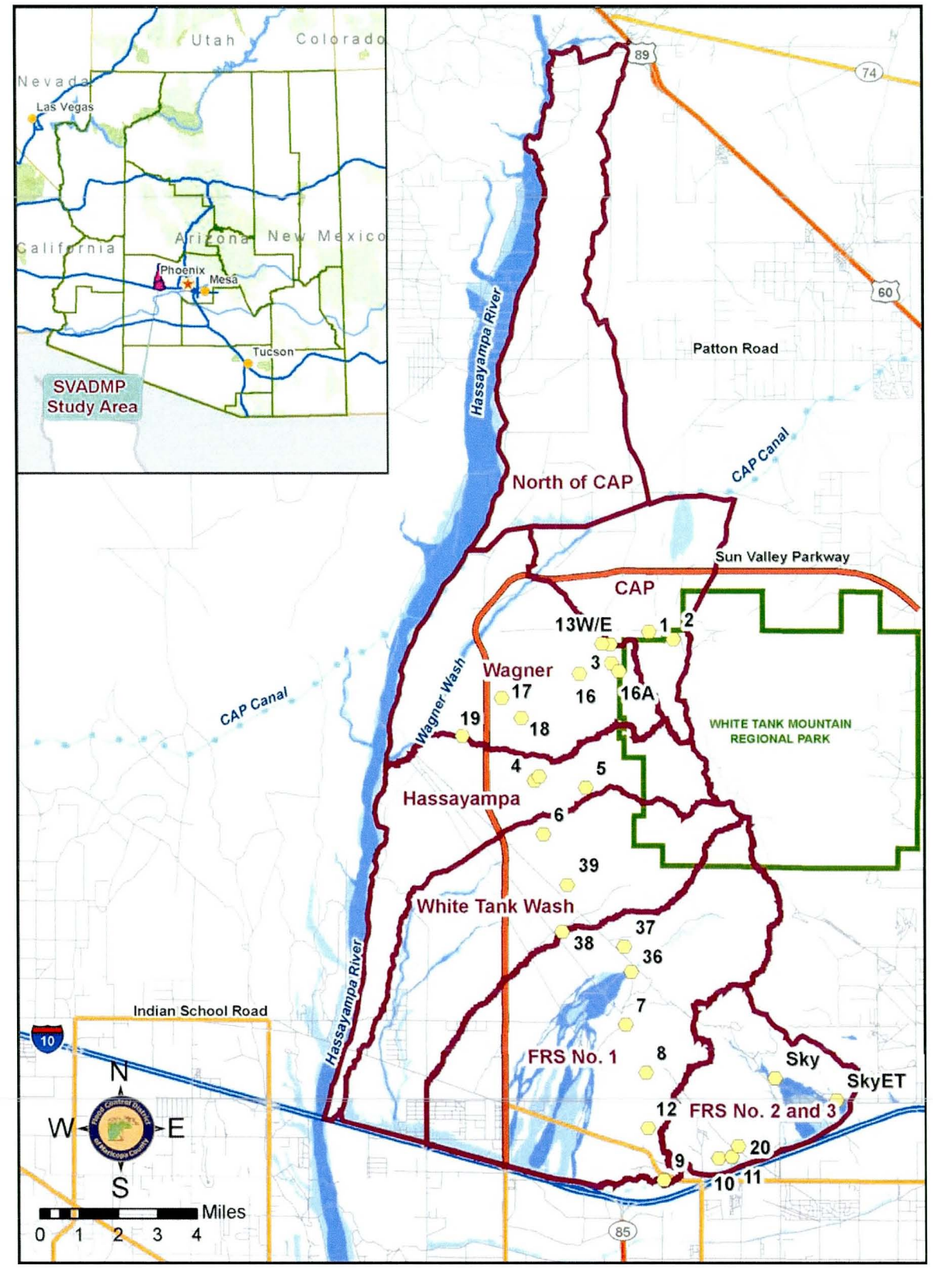

Figure 8 Sun Valley ADMP Sub-Areas

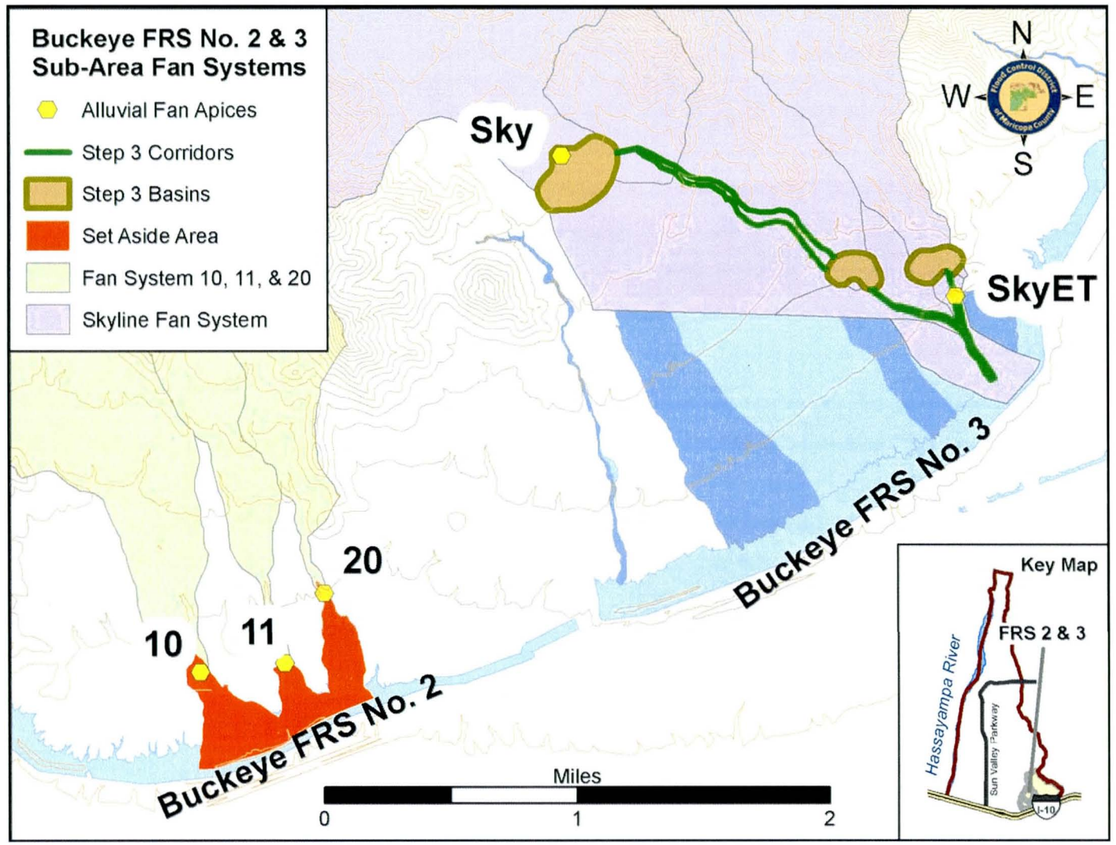

Figure 9 Buckeye FRS No. 2 & 3 Sub-area Fan Systems

The recommended alternative for the FRS No. 2 & 3 sub-area was refined from Alternative B4-3 and Alternative A in Step 2. Alternative B4-3 was refined for the Skyline Fan System, while Alternative A was selected for Fan System 10, 11, & 20. The recommended alternative for the Skyline Fan System is comprised of three large, on-line detention basins and walled-levee corridors downstream to Buckeye Flood Retarding Structure No. 3. The walled-levee corridors provide a path not only for the detention basin outflows, but also serve as a trunk system to which the downstream tributary watersheds may also deliver storm water. The Fan System 10, 11, & 20 recommended alternative is comprise of a strictly non-structural approach of floodplain management of the active alluvial fan areas.

Additional details of each component of the recommended alternative and their design are provided in the following sections.

5 STEP 3 CONCEPT DESIGN APPROACH

The details of the design procedure for the recommended alternative are presented in this section. The recommended alternative location, typical sections, and planimetric layout for each fan system are presented in Section 5 and 6 and Appendices A – B. The design approach used a combination of HEC-1 modeling, normal-depth hydraulics, and GIS through an Excel spreadsheet interface. The conceptual planimetric layout sheets for all elements of the fan system components are provided in Appendices A – B. Available data and analyses from Step 2 were used whenever appropriate. Additional modifications and data sources are also described below. This discussion is largely identical for each sub-area report. However, distinct elements not utilized in a given sub-area (e.g. off-line basins) are not included if not needed.

5.1 Data Collection

5.1.1 Field Survey Information

Refer to the Flood Control District of Maricopa County (District) for field survey information associated with the 10-foot topographic mapping used in the current study.

5.1.2 Mapping

The District provided 10-foot contour mapping and DTM data for use in the hydrologic and hydraulic calculations. That work was done under separate contract for the District in 2000/2001. The flight dates of that mapping were 12-16-00, 12-17-00, and 12-27-00. A triangulated irregular network (TIN) was developed in ArcGIS software using the 10-ft mass points and breaklines. The TIN and the contours were used to obtain all the elevation data used in this study. It was noted in the use of this topographic data that many wash bottoms were incorrectly shown as ridges rather than valleys. This phenomenon was more prevalent on the relatively low relief downfan areas. These ridges were removed manually from the cross sections used in the design process as described in Section 5.

5.1.3 Aerial Photographs

The Flood Control District provided aerial photographs for use in the GIS applications. The photo dates are November 2004.

5.1.4 Sediment Gradations

Sediment gradations used in this study are based on data collected at 38 locations throughout the SVADMP study area (Location of samples shown on map in Appendix C). A plot of the sediment gradations for all of the samples collected is also provided in Appendix C. Examination of these data suggested relatively little variation in sediment sizes across the study area. Therefore, an average sediment gradation was taken from 38 samples for use in

the sediment transport analyses for the recommended alternative for all fan systems including those in the FRS No. 2 & 3 sub-area.

The following values were therefore selected for the sediment gradation parameters:

D50 = 0.7 mm D16 = 0.17 mm D65 = 1.2 mm

D84 = 2.7 mm D90 = 4 mm

5.2 Process Overview and Summary of Design Criteria

The following sections provide a brief overview of the design procedures for each structure type in the recommended alternative for the FRS No. 2 & 3 sub-area. Table 2 shows a summary of the important design criteria used for the on-line detention basins and walled-levee corridors. These were refined from the Step 2 process based on the selection of a floodwall corridor containment structure and the input of the external value engineering team. All structures are designed for the maximum peak flow or volume from the 100-year 6-hour or 24-hour event.

Table 2 Summary Of Design Criteria For Step 3 Recommended Alternatives

Apex Treatment	Basin Geometry Criteria	Downstream Channel	Hydraulic Criteria	External Wall Height
On-line Basin; 10% outflow	Average Z = 6:1; D < 12 ft	floodwall	4 - 5 ft levee height; ≤ 6 ft/s; 3 ft min. freeboard	≤ 3 feet

Additional details on the design associated with each structural element are discussed in the following sections with additional details also provided in Section 5 and Appendices A – B.

5.3 General Procedure Outline

The general design procedure was similar to that used in Step 2. The following outline describes that procedure:

- Identify the fan apex/upstream area location and the preferred channel alignment from the apex to the outfall. These were derived from Step 2 and additional input received from stakeholders following the end of Step 2.
- Design an on-line basin near the apex location using the following criterion: Peak Outflow ≈ 10% Peak Inflow. Start with the Step 2 basin volume and outlet sizes.
- Route flow from on-line basin to Buckeye FRS No. 3 by designing a walled-levee natural channel corridor along the preferred channel alignment (See section 5.12).

5.4 Hydrology

The design of the walled-levee corridors as well the detention basins are based on the 100-year storm. HEC-1 modeling was used to determine the peak discharges as well as the flow volume passing through the designed structures. The existing conditions hydrology model was used for the estimation of peak discharges for the design. The flows computed from the existing conditions model are higher than the future conditions model (JEF, 2006c). Thus, the use of existing conditions discharges represents a more conservative design approach. In addition, the specific phasing of future development is unknown. As a result, it was deemed prudent to be conservative and use the existing conditions hydrology to ensure effective continuous functioning of the recommended flood control system as the area develops.

The HEC-1 models developed for each sub-area in Step 2 were divided into separate models for each fan system. These models were modified to incorporate the basin and channel features associated with the recommended alternative for the 100-year 24-hour and 100-year 6-hour storms. For the purpose of the design, the maximum of the values obtained from the 24-hour and 6-hour results was used to ensure adequate functionality under 6-hour and 24-hour storm scenarios. This means that the design analyses sometimes use the 6-hour value and vice-versa depending on whichever is larger.

The procedure to estimate peak flow and flow volume was iterative in nature. The iteration steps can be briefly described as follows:

- Change in structure dimensions affects the HEC-1 model
- Change in the HEC-1 model affects discharges/volumes
- Change in discharges affects structure dimensions

The HEC-1 models used here were modified from the Step 2 Proposed Alternatives models for the FRS No. 2 & 3 sub-area (JEF, 2006c). The HEC-1 models were refined to provide design peak flows at more locations than the Step 2 models. Nevertheless, some of the long open channel sections were treated as single routing reaches in HEC-1. These reaches were divided into approximately 1000-foot reaches for the hydraulic design. The design discharges and volumes for each 1000-foot reach were estimated using a linear weighting between the upstream and downstream concentration points modeled in HEC-1. This simplified procedure facilitated refined design of multiple channel segments without the need for excessive subdivision of the HEC-1 model.

5.5 Sediment Yield

Sediment contributions from the watershed draining to the on-line detention basins were estimated using a sediment yield approach. The sediment yield was estimated assuming a 3-year maintenance period plus a single 100-year event. The MUSLE method as outlined in the Arizona Department of Water Resources' *Design Manual for Engineering Analysis of Fluvial Systems* (1985; hereafter, "ADWR Manual") and the Albuquerque Metropolitan

Arroyo Flood Control Authority (AMAFCA) *Sediment and Erosion Design Guide* (AMAFCA, 1994) was used to compute the average annual sediment yield and the 100-year single event sediment yield for the subbasin(s) contributing to each on-line detention basin. Each on-line detention basin design sheet in Appendix A contains the MUSLE parameters, calculations, and results for each basin. Peak discharges, runoff volumes, soil, and land use parameters were estimated from the hydrology data. The 10-foot DTM was used to derive the other watershed geometries needed for the MUSLE computations. The total sediment volume estimated was added to the required design volume for each detention basin. The design sediment volumes are provided on the basin design sheets for each basin in the appendix for each fan system.

5.6 Aesthetic Treatment Requirements

In order to ensure that the proposed flood control structures are compatible with the landscape character of the study area, incorporation of landscape architectural design as an integral part of the structural design is required. In 1993, the District adopted a "Policy for the Aesthetic Treatment and Landscaping of Flood Control Projects". This policy aims at planning and designing flood control projects that are compatible with the visual character of the adjacent landscape. In addition, the policy aims to integrate recreational opportunities into the planning and design of flood control facilities.

Utilizing the information from the Scenic Resource Assessment (SRA) (LSD, 2006), incorporation of aesthetic features in the project components of the Sun Valley ADMP generally followed a four-step approach to achieve context sensitivity with the visual environment, to the extent possible. The four steps are outlined below and briefly described.

1. Selection of structure types to maximize context sensitivity
2. Selection of flood protection methods (semi-soft structural method and hard structural method with aesthetic treatment) that are most compatible with the character of the landscape
3. Application of most appropriate landscape design theme
4. Development of context sensitive landscape design guidelines

5.6.1 Selection of Structure Types

During the development of the recommended alternative, consideration was given to the selection of flood control structure types that most lend themselves to adaptation of their topographic form to the landforms of the study area. The flood storage basins contained in the plan are a structure type that can be designed to mimic the landforms of the piedmont. The walled-levee corridors that are recommended for stormwater conveyance is a hard structural solution that will have relatively low visual impact and can be adapted to the existing landforms of the sub-area, while preserving the natural character of the existing wash corridors. The recommended alternative minimizes the use of large scale excavated channels and flood retarding structures that have a lower capability to be designed to blend with the landforms of the sub-area. The recommended alternative also completely avoids the use of heavily armored (concrete lined) structures that would be completely out of context with the landscape settings of the sub-area.

5.6.2 Flood Protection Methods

The Flood Control District has identified six general flood control methods that are routinely evaluated for use on flood projects throughout the County. The selection of flood control methods is driven by the engineering requirements for reducing the risk of flooding and the Scenery Resource Assessment (SRA) prepared for the project (LSD, 2006). The FRS No. 2 & 3 sub-area employs the non-structural, semi-soft structural, and hard structural with aesthetic treatment flood protection methods. A brief overview of each is provided below. Detailed descriptions of all the flood control methods are provided in The Step 3, Volume 1 report prepared for the Sun Valley ADMP. The descriptions are taken from the Flood Protection Methods, Scenery and Recreation Resource Assessment for Maricopa County report (FCDMC, 2006).

<u>Non-Structural Method</u>

The non-structural method of flood protection employs the use of regulatory mechanisms such as erosion control setback zones and zoning regulations as mechanisms for providing flood protection. This method is characterized by an absence of structural elements or features for flood protection. Exceptions may include provision of low standard road facilities for carrying out flood control monitoring, operations and maintenance activities. Natural drainage features such as rivers, washes, and arroyos perform the function of storm water conveyance. This method will usually complement and achieve context sensitivity with the visual character of most landscape settings.

<u>Semi-Soft Structural Method</u>

The semi-soft structural method includes construction of large-scale flood control facilities constructed predominantly of earthen materials. The overall form of the superstructure is designed to emulate the character of natural landforms found in the surrounding landscape (Character Type). Structural components such as grade control structures, energy dissipaters, low flow features, inlets and outlets may be visually evident but their overall form, color, texture and materials usage is designed to remain visually subordinate to and complement the valued character of the landscape settings in which they are located through careful placement, materials usage, and landscape architectural design.

<u>Hard Structural Method with Aesthetic Treatment</u>

The hard structural method with aesthetic treatment includes construction of large-scale flood control structures with superstructures that are fully or partially concrete lined. Structural components are also typically constructed of hardened (concrete) materials. It incorporates landscape design themes, features and materials that complement the valued character of urban and industrial landscape settings. Examples of aesthetic treatments include gracefully meandering the overall form of the superstructure, use of color, textural patterns, rustication techniques, urban art, other architectural embellishments and landscape plantings to establish visual and cultural context sensitivity primarily within urban and industrial settings.

The primary approach will be to utilize naturalistic, free form land shapes and informal arrangements of plant materials reflective of the study area flora in the design of the proposed storage basins within the FRS No. 2 & 3 sub-

area. The hard structural with aesthetic treatment method, as employed within the sub-area, will preserve a large amount of the existing natural desert within the walled-levee corridors and, with the architectural treatment proposed for the hard structural elements, will achieve context sensitivity within the surrounding visual environment. As a component of both flood control approaches, landscaped buffer zones and berming will be used around and adjacent to improvements such as basins and corridors to help reduce their visual impact. The setback buffer areas also provide the opportunity to develop multi-use trails and other recreational facilities in conjunction with maintenance roads along basin perimeters and channel corridors. The overall approach will be to reduce the hard engineered appearance of the features to maintain a high level of context sensitivity with the existing and future land use and landscape character in the Sun Valley ADMP area.

In some situations hard structural components will be required to provide the proper level of flood protection and meet the long term maintenance needs of the improvements. The structures used in the recommended alternative include:

- Flood containment walls – Concrete walls at edges of corridors to contain the design flood flows within the drainage corridor.
- Drop structures – Structures that are built within the flood corridors, perpendicular to the flow direction to control the longitudinal slope and flow velocities over an extended period of time.
- Inlet structures – Structures built at the location where the flood flows enter a detention basin and must withstand and dissipate the energy from high volume and high velocity flows to protect the basin from major damage.
- Outlet structures – built at the location of the outlet pipe which drains the detention basins at controlled rates.

The hard structural components while not a dominant visual element of the entire flood control solution are an essential part of the long-term success of the system. Through careful design and placement of the structures, the overall flood control method will be maintained as a semi-soft or hard structural with aesthetic treatment method. The design of hard structural features will include the use of architectural or design elements on the constructed features to reduce their visual impacts. Architectural treatments will include the use of integral color concrete, form liners for texture, use of natural materials, and form modifications to enable the structures to more fully fit the natural contours and landforms of the study area. The use of integral color and form liners in the construction of concrete features would help reduce the visual impacts by incorporating the colors and textures of the natural landscape. Special attention will be paid to use of enhancements in areas of high visibility and public use, such as near intersections, pedestrian access nodes into corridors or basins that would be multiple use areas for recreation facilities.

An overall landscape theme would be applied to the design of the structural features as well as the landscape improvements. The SRA (LSD, 2006) report identified the landscape themes most compatible with the character of the landscape setting of the Sun Valley area. A landscape theme defines the distinctive characteristics of the local landscape setting and establishes the general framework for designing landscape architectural elements that would be consistent with that setting. The theme application as incorporated into the design components would include approaches such as, the selection of colors and textures that can be found in the local landscape, minimizing strong contrasts to existing landforms and selecting plant material that has been identified for the theme.

The development of comprehensive design guidelines is the final step in achieving context sensitivity. The design guidelines describe the methods and criteria for designing the project components in multiple locations and applications so that they are sensitive to the local landscape setting. Detailed design guidelines are provided in each sub-area report and are refined if needed to reflect the design themes for each sub-area.

A brief discussion of the design approach is included in the discussion of each structural component. The aesthetic treatments result in additional costs to the project. The cost differential for the required aesthetic treatments is presented in Section 7, 8, & 12.

5.6.3 Landscape Themes

During the Scenery Resource Assessment, a variety of landscape design themes were identified for possible application to flood control structures based on an analysis of existing, historic, and planned future landscape character. Landscape design themes are unifying concepts that establish the overall visual design concept and serve as the basis for establishing design guidelines that govern landform grading, plant palettes, use of color, etc. for flood control structures in different settings.. The themes were developed as a framework to help integrate flood control components into the existing natural setting and allow flexibility for coordination with the master planned communities developing in the Sun Valley ADMP area. Because flood control components will occur in multiple landscape character areas, the two main themes identified were further divided into sub-themes specific to the landscape character units. Figure 10 shows the recommended alternative located on the existing landscape character units for the FRS No. 2 & 3 sub-area. The theme to be used is outlined below and is discussed in more detail in the Scenery Multi-use Data Collection and Analysis Report (LSD, 2006) prepared for this project. The report also identifies several sub-themes appropriate for the Sun Valley ADMP area. Incorporation of sub-theme elements will be coordinated with the planned communities for consistency with their proposed aesthetic development.

In the Buckeye FRS No. 2 & 3 sub-area, only the Natural Sonoran Desert Theme is recommended for use in the development of flood control facilities of the recommended alternative. The recommended basins are located high on the Bajada and should the design should be sensitive to this location. The general approach to designing facilities with this theme is identified below and specific design guidelines are contained within the individual facility sections. As the flood control facilities move through the different landscape character units in the Sun Valley planning area, the designs will incorporate specific features of the character units to assure context sensitivity with the adjacent area.

The flood control facilities in the FRS No. 2 & 3 sub-area cross the Bajada character unit (Figure 10). Incorporation of the theme elements to make the facilities sensitive to each character unit is provided below.

5.6.3.1 Natural Sonoran Desert Theme

The natural Sonoran Desert theme is based on reinforcing the relatively undisturbed, pastoral landscape of the Sun Valley ADMP area. Landscaping and revegetation will be accomplished with Sonoran desert native species, specifically those in the Sun Valley area. It will also preserve the existing character, help extend it into future development areas, and provide connectivity to preserved wash corridors and into the White Tank Mountains.

The Natural Sonoran Desert theme should incorporate forms, colors, and textures of natural desert into required structural components. Landscape designs should create topography and landforms similar to the surrounding character units and utilize plants, boulders and ground cover in ways that mimic character units. Figure 12 and Figure 28 show conceptual sketches of the Natural Sonoran Desert theme applied to a basin and channel respectively. Application of the specific character unit themes will be subtle variations of the main theme and are not shown because of the conceptual nature of the sketches.

5.6.3.1.1 Natural Sonoran Desert Bajada Sub-Theme

In the Bajada character unit, the Natural Sonoran Desert Theme will include landscape contour grading, use of berms and low flow washes to mimic the adjacent undulating character of the Bajada landforms. Rock and boulder features will be used to help relate flood control structures to the more frequent occurrence of rock outcroppings in the Bajada. Landscape vegetation will include increased use of mixed cacti especially the saguaro as well as higher density of trees such as palo verde and ironwood.

The Natural Sonoran Desert theme incorporates forms, colors, and textures of natural desert into required structural components. Landscape designs will create topography similar to the immediate surrounding area of the character units and will utilize plants, boulders and ground cover in ways that mimic adjacent areas. Applying themes is this way will result in a drainage corridor that extends from FRS No. 2 & 3 to the White Tank Mountains that has a high level of context sensitivity with the surrounding area over its entire length.

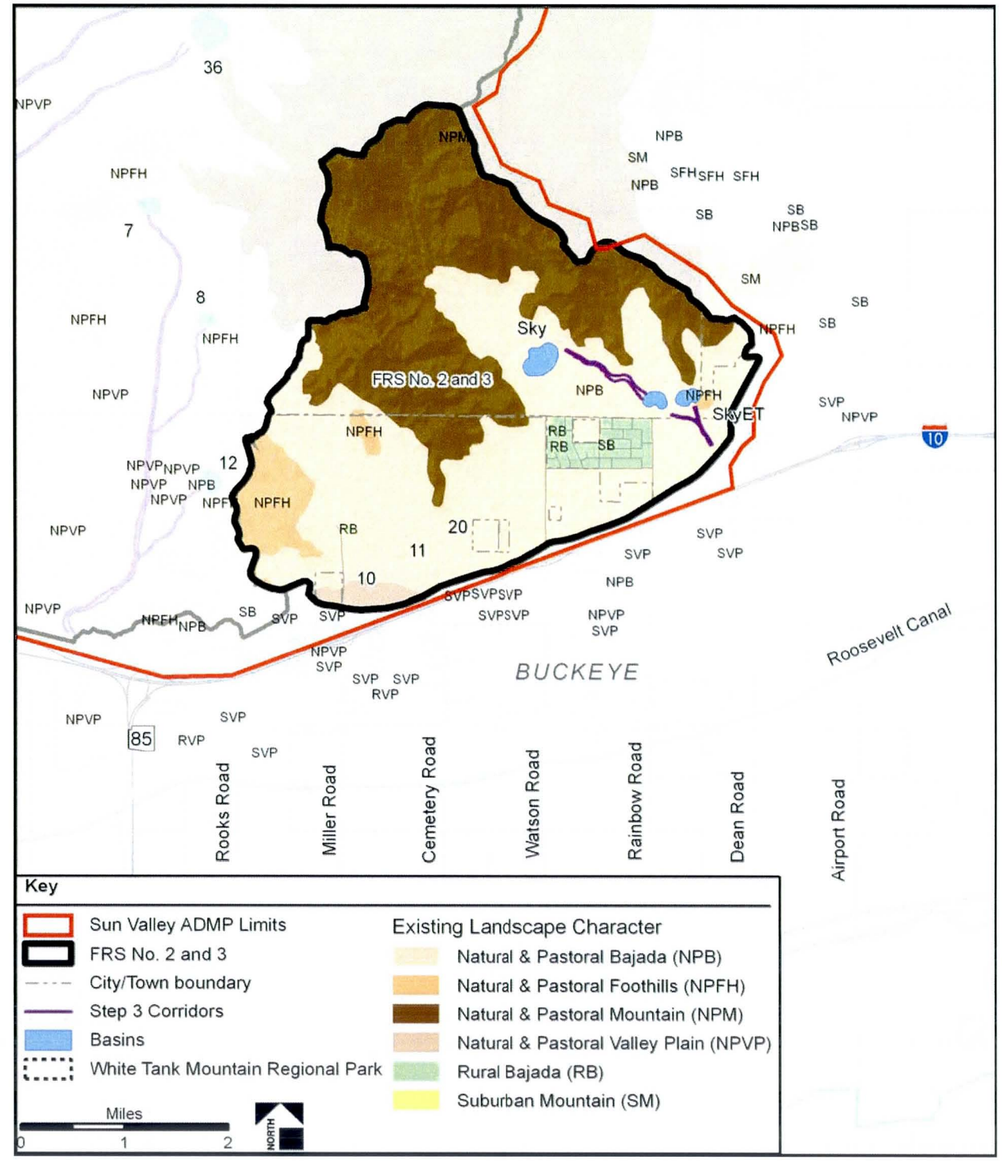

Figure 10 Buckeye FRS No. 2 & 3 Sub-area Recommended Alternative and Landscape Character

5.6.4 Landscape Theme Plant Palettes

Preliminary plant palettes have been developed for application of each theme. The plant list for the Buckeye FRS No. 2 & 3 sub-area includes only plants for the Natural Sonoran Desert Theme. Table 3 shows the most appropriate plants that will be used based on the character unit in which the flood control facility occurs. The final plant list developed for a design will consider the immediate context of the facility.

Table 3 Plant Palettes for Natural Sonoran Desert Theme

		Character Units			
		River	Valley Plains	Bajada	Foothills
Trees					
Cercidium floridum	Blue Palo Verde	X	X	X	X
Cercidium microphyllum	Foothills Palo Verde			X	X
Chilopsis linearis	Desert Willow	X	X	X	
Olneya tesota	Ironwood	X	X	X	X
Prosopis velutina	Velvet Mesquite	X	X	X	X
Shrubs					
Acacia greggii	Catclaw Acacia	X	X	X	
Ambrosia ambrosioides	Giant Bursage	X	X	X	
Ambrosia deltoidea	Bursage	X	X	X	X
Anisacanthus thurberi	Desert Honeysuckle	X	X	X	X
Bebbia juncea	Sweetbush		X	X	
Calliandra eriophylla	Fairy Duster	X	X	X	
Canotia holacantha	Crucifixion Thorn		X	X	X
Celtis pallida	Desert Hackberry	X	X	X	
Dodonaea viscosa	Hopbush		X	X	X
Encelia farinosa	Brittlebush	X	X	X	X
Ephedra trifurca	Mormon Tea		X	X	X
Ericameria laricifolia	Turpentine Bush	X	X	X	X
Eriogonum fasciculatum	Flattop Buckwheat		X	X	
Hymenoclea salsola	Burro Brush		X	X	
Hyptis emoryi	Desert Lavender	X	X	X	
Larrea tridentata	Creosote Bush		X	X	
Lotus rigidus	Deer Vetch		X	X	X
Lycium fremontii	Thornbush		X	X	X
Simmondsia chinensis	Jojoba		X	X	X
Trixis californica	Trixis		X	X	X
Zizyphus obtusifolia	Greythorn		X	X	X
Herbaceous Perennials					
Aristida purpurea	Purple Threeawn		X	X	
Baileya multiradiata	Desert Marigold		X	X	X
Erigeron divergens	Fleabane Daisy	X	X	X	
Melampodium leucanthum	Blackfoot Daisy	X	X	X	X
Penstemon parryi	Parry's Penstemon	X	X	X	
Penstemon pseudospectabilis	Canyon Penstemon	X	X	X	
Senna covesii	Desert Senna		X	X	X
Sphaeralcea ambigua	Globemallow	X	X	X	X
Verbena gooddingii	Goodding's Verbena	X	X	X	X
Accents					
Agave chrysantha	Golden-flowered Agave			X	X
Agave murpheyi	Hohokam Agave			X	X
Asclepias subulata	Desert Milkweed			X	X
Carnegiea gigantea	Saguaro		X	X	X
Dasylirion wheeleri	Desert Spoon			X	X
Fouquieria splendens	Ocotillo	X	X	X	X
Nolina bigelovii	Beargrass		X	X	X
Opuntia acanthocarpa	Buckhorn Cholla		X	X	X
Opuntia bigelovii	Teddybear Cholla		X	X	X
Opuntia engelmannii	Desert Prickly Pear		X	X	X
Yucca baccata	Banana Yucca			X	X
Yucca elata	Soaptree Yucca			X	X

5.6.5 Landscape Design Guidelines

The development of comprehensive design guidelines is the final step in achieving context sensitivity. The design guidelines are a prescription that identifies the methods and criteria to ensure achievement of the landscape design themes. The design guidelines are specified in the following sections of this report. A brief description of the design approach is included in the discussion of each structural component.

5.7 On-line Detention Basins

5.7.1 Design Considerations

The on-line detention basin for each fan system was located just upstream of the fan apex where flows begin to spread out unpredictably into numerous smaller channels. The basin volume is created entirely through excavation and designed to be entirely below existing ground. Constant side slopes of 6:1 were assumed to simplify the hydraulic design of the basins and represent an average condition between the steeper and shallower slopes needed to produce the aesthetic treatment objectives.

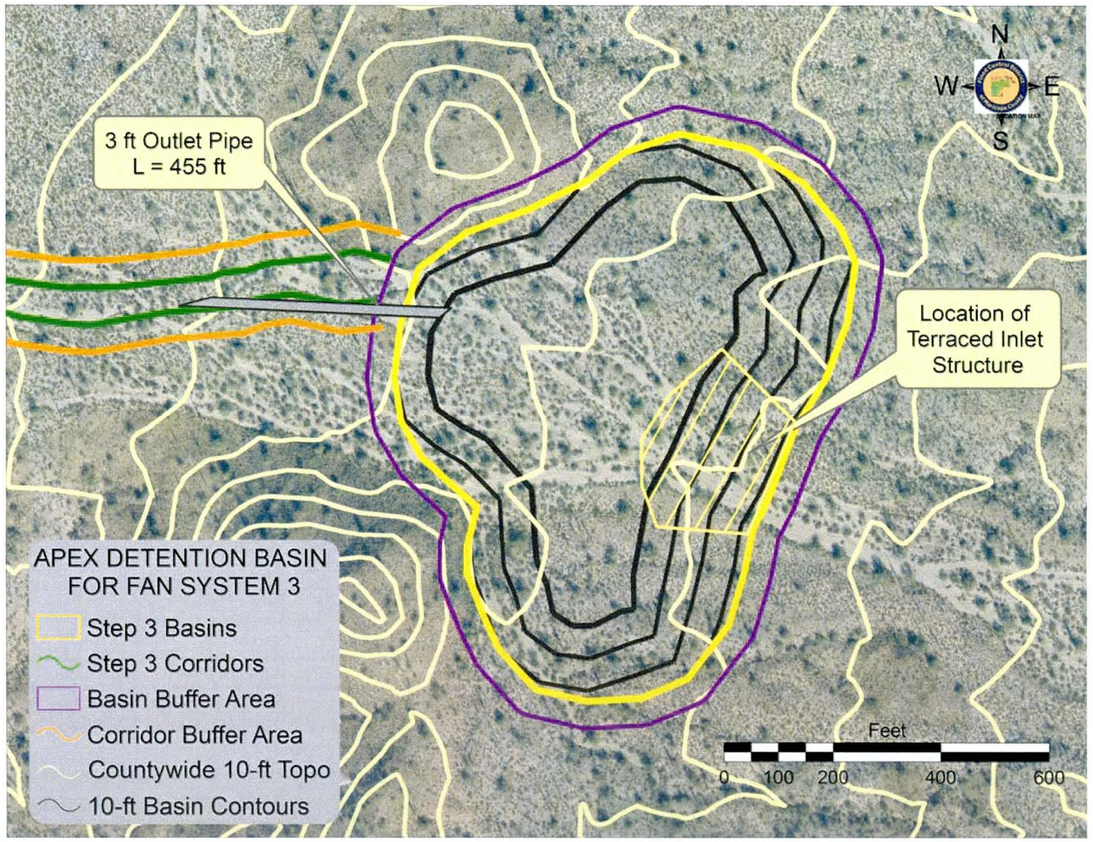

Figure 11 Concept Plan View Of On-Line Basin For Fan System 3, Wagner Sub-Area

Figure 11 shows the concept plan view of the on-line basin for Fan System 3, in the Wagner sub-area, on an aerial photo of the area with the existing topography as an example. Figure 12 and Figure 13 show a generic concept basin with the landscape aesthetic treatments.

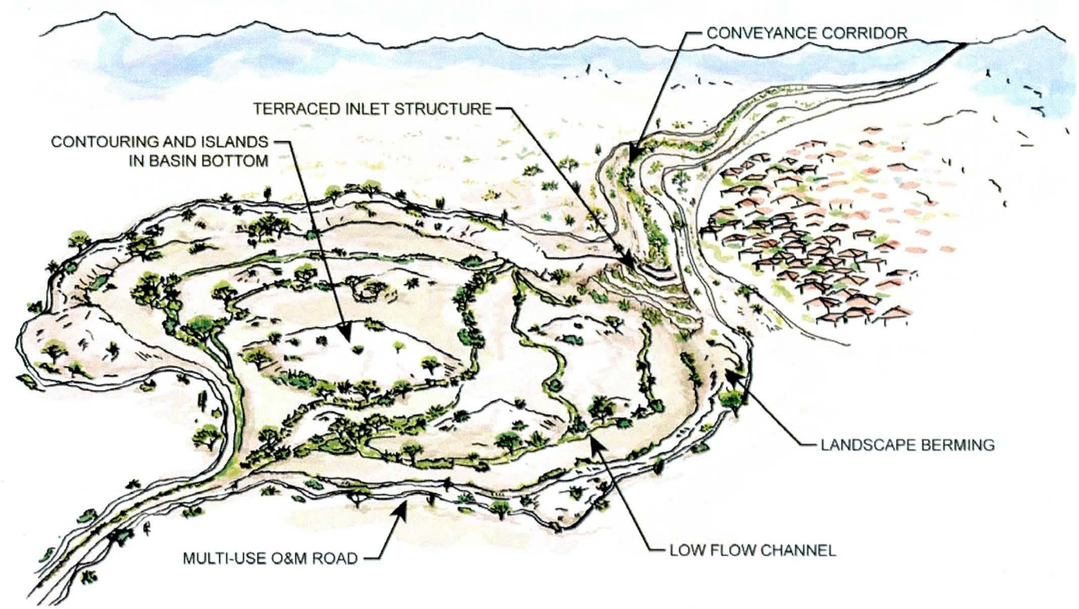

Figure 12 Concept Plan View Of An On-Line Basin

The basins were designed to have a peak outflow of approximately 10% of the peak inflow. Ten percent of the peak flow approximates the 2-year flow. Pipe outlets were designed to drain the basins. The Fan 3 basin, for example, requires a 3-foot diameter pipe and discharges about 100 cfs during the 100-year event. Sediment yield from the upstream watershed was estimated using MUSLE according to the approach laid out in the ADWR & AMAFCA Manuals (1985; 1994). The design basin volume includes space for three average year's sediment plus one 100-year event volume.

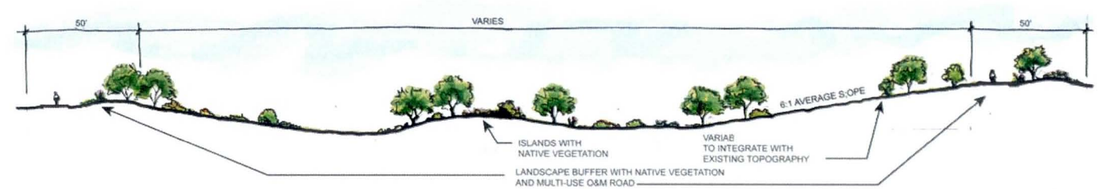

Figure 13 Concept Profile View Of On-Line Basins With Aesthetic Treatments

The basins were designed to be no greater than 12 ft in depth including one foot for freeboard. Average side slopes of 6H:1V were used to represent the average of variations between 8H:1V to 4H:1V needed to meet the

aesthetic treatment requirements. One foot of freeboard was applied to accommodate the flow volume as well the sediment volume. A stage-storage relationship was calculated from the 10-foot digital terrain model in GIS based on the irregular top shape and an average side slope of 6H:1V. The stage-discharge relation was computed using HY8 assuming a circular pipe outlet with a side-tapered inlet, and a pipe slope of 0.005. In addition, the stage-storage relation was modified to subtract the estimated sediment yield from the design basin volume from the bottom end of the curve to evaluate the adequacy of the basin design volume. The resulting relationships were entered into the HEC-1 models using SE-SV-SQ records. The HEC-1 model was then run to estimate the peak volume stored in the basin (including the design sediment volume). Basin dimensions were then resized as necessary to hold this maximum volume at peak flow as predicted by HEC-1 such that the resultant peak outflow discharge was about 10 percent of the peak inflow discharge. The process was repeated in an iterative fashion until a satisfactory design was achieved.

5.7.2 Inlet Design Concepts

Various hydraulic inlet structures were assessed to accommodate discharge into the on-line detention basins. The inlet structure design objectives include: public safety, hydraulic performance, aesthetics, cost, and maintenance requirements with an emphasis on blending the facility into the landscape character. Some of the alternatives assessed may not meet all of the design requirements for a particular fan system. Selection of the inlet design concept for each specific fan system could vary depending on the inflow discharge, approach depth, and other site constraints.

Given the basin depths and local topographic slope, the vertical drop from the entering channel invert to the basin bottom ranges from 20 to 60 feet. Erosion protection will be necessary to prevent headcutting and channel degradation for the fan reaches above the basins during flow events. There are two strategies to reduce the erosion potential of flows entering the basin. The first is the use of an energy dissipater structure along the drop. The second is a lined spillway with a stilling basin at the bottom to dissipate the energy immediately below the drop. Some combination of the two strategies is also a possibility.

Three types of energy dissipaters were considered for this assessment and include: a riprap lined spillway, stepped drop structure, and a baffle chute. Lined spillways include the use of concrete or roller compacted concrete (RCC). Stilling basins considered include the USBR Types II, III, IV, and a straight drop basin. The various structure assessments are discussed in the following sections. It should also be noted that all of these energy dissipation structures will also require some kind of additional downstream scour protection in the transition from the structure back to the natural riverbed or soil material. Guidelines for the computation of this additional scour are provided in Pemberton and Lara (1984).

5.7.2.1 Riprap-lined spillways

Riprap-lined spillways consist of dumped riprap on top of a gravel filter and/or geotextile fabric (see Figure 14). Typical spillway sections are trapezoidal normal to the basin side slope. A cut-off wall would be necessary upstream of the spillway to promote an even flow distribution down the spillway and to prevent degradation upstream. A relatively small riprap-lined sloped stilling basin would be required at the bottom of the spillway and would likely serve as the initial sediment trap for the basin. Riprap-lined spillways can provide sufficient energy dissipation for relatively low flow depths down the spillway. The suitability of riprap depends on the size, D_{50}, 100-year design unit discharge, q (cfs/ft), and the spillway slope. One conservative method for designing riprap-lined spillways can be established with the following relationship (Abt, 1991):

$$q = 0.052 D_{50}^{1.79} S^{-0.77}$$

Using a safety factor of 1.5, the safe maximum slope of 4H:1V, and a D_{50} of 18 inches, the maximum unit discharge that is recommended is approximately 13 cfs/ft. Using this unit discharge for a 40 foot wide channel would limit the total design discharge to approximately 500 cfs. As shown in this example, this application would be limited to fans with smaller design discharges or if measures were taken to distribute the flow into a wider spillway. The riprap depth is usually 2-3 times the D_{50}. Large diameter riprap availability is limited in Arizona; therefore, a material source should be identified prior to design. Construction of riprap spillways is fairly straight forward; however, material and construction inspection would be essential to ensure the quality of the material and stability of the structure. Rock color, texture, and arrangement could be selected so as to minimize visual impacts of the inlet spillway.

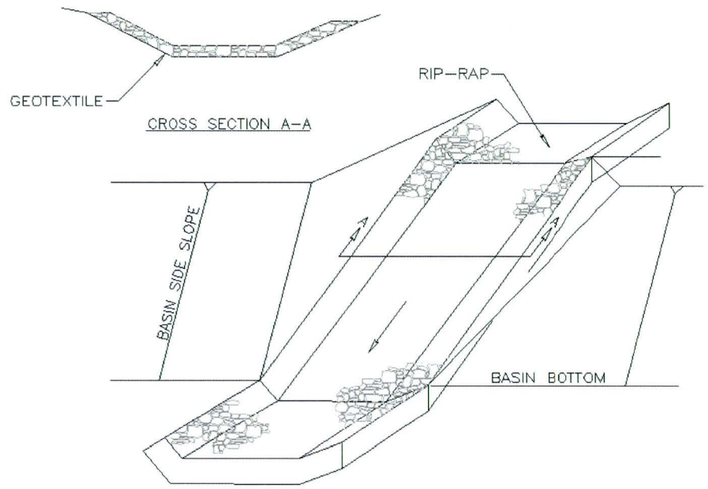

Figure 14 Riprap Spillway

5.7.2.2 Stepped drop structures

Stepped drop structures consist of hardened steps that dissipate energy as flow drops down each step (see Figure 15 & Figure 16). Stepped drop structures are constructed of concrete, RCC, soil cement, or gabions, but can also be constructed of large boulders (Figure 17). Stepped drop structures promote two energy dissipating flow conditions: Nappe flow and Skimming flow.

Nappe flow is when the step height, tread width, to critical depth relationship permits a free-falling nappe and hydraulic jump on each step. Skimming flow occurs when the steps are overcome by flow depth resulting in recirculating vortices and air entrainment. The relationship at which the flow condition is between the nappe and skimming flow regimes is shown by the following equation (Chanson, 1994):

$$\frac{y_c}{h} = 1.057 - 0.465 * \frac{h}{l}$$

where y_c is the critical depth, h is the step height, and l is the tread width.

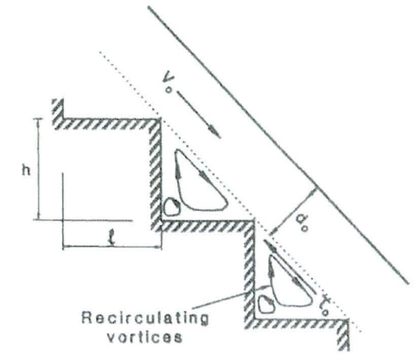

Figure 15 Stepped Drop Structure – Skimming Flow

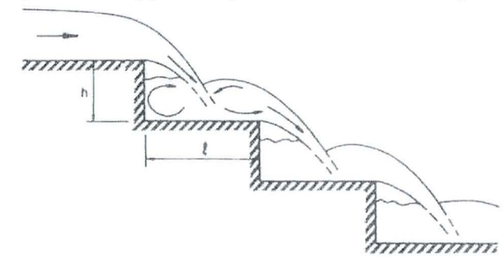

Figure 16 Stepped Drop Structure – Nappe Flow

If a flow condition was in between flow regimes, an increase in y_c would initiate the skimming flow regime. Steps designed for nappe flow are generally much larger and more costly than steeper sloped steps designed for skimming flow (Frizell, 2006). Steps large enough to permit nappe flow may be a public safety concern as well. Given basin side-slopes between 4H:1V and 8H:1V, the flow regime will more than likely be limited to skimming flow. Well established hydraulic design guidelines for stepped drop structures do not exist. Therefore a stepped drop structure design would require research and a careful analysis of the structure to ensure stability, flow containment, and adequate reduction in residual energy at the bottom of the drop. The step height and tread width should be established to accommodate maintenance, accessibility, and public safety.

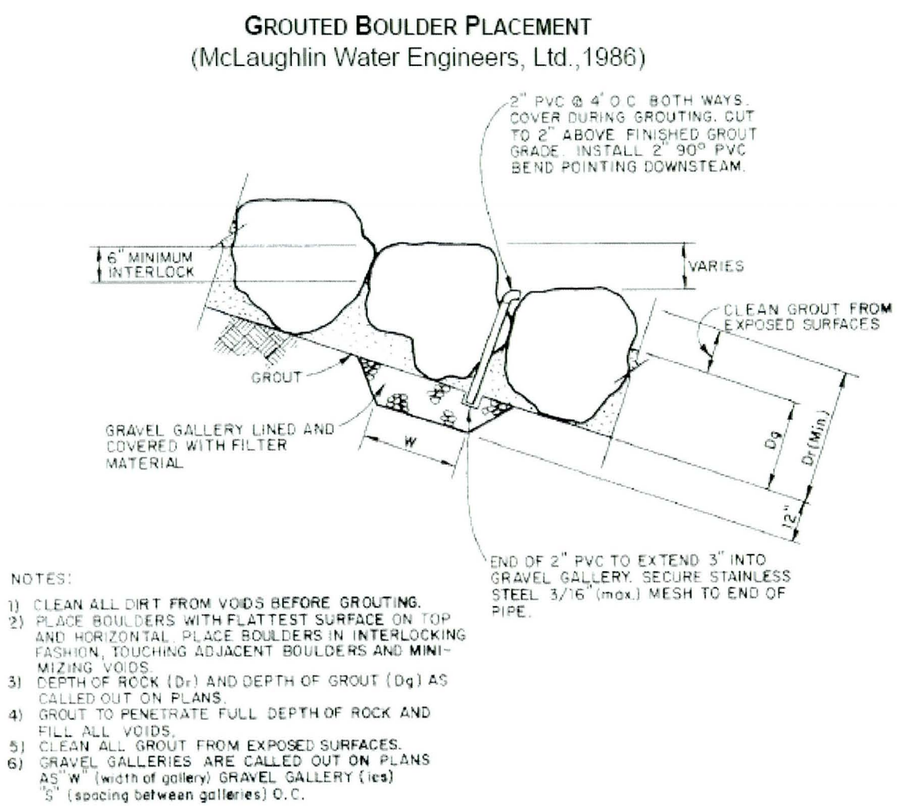

Figure 17 Example of Stepped Boulder Drop Structure (source: Figure 7.19 from FCDMC, 2003a)

5.7.2.3 Baffle Chute

Baffle chutes have a concrete rectangular or trapezoidal section normal to the basin side slope. The alternating baffles dissipate energy of flow down the slope of the chute (Figure 18). A channel narrowing transition may be desirable upstream of the chute to minimize the width of the structure. Baffle chutes are the most effective means of dissipating energy down a slope and are used extensively on spillways throughout the world. Hydraulic design and analysis methods are documented in the USBR Engineering Monograph No. 25 (Peterka, 1984). Baffle chutes are one of the most cost effective methods for dissipating energy down the basin drop; however, they are not very aesthetically appealing. Potential modification of the baffles to use natural materials such as very large rock emplaced in concrete with steel could provide acceptable aesthetic treatment of such structures.

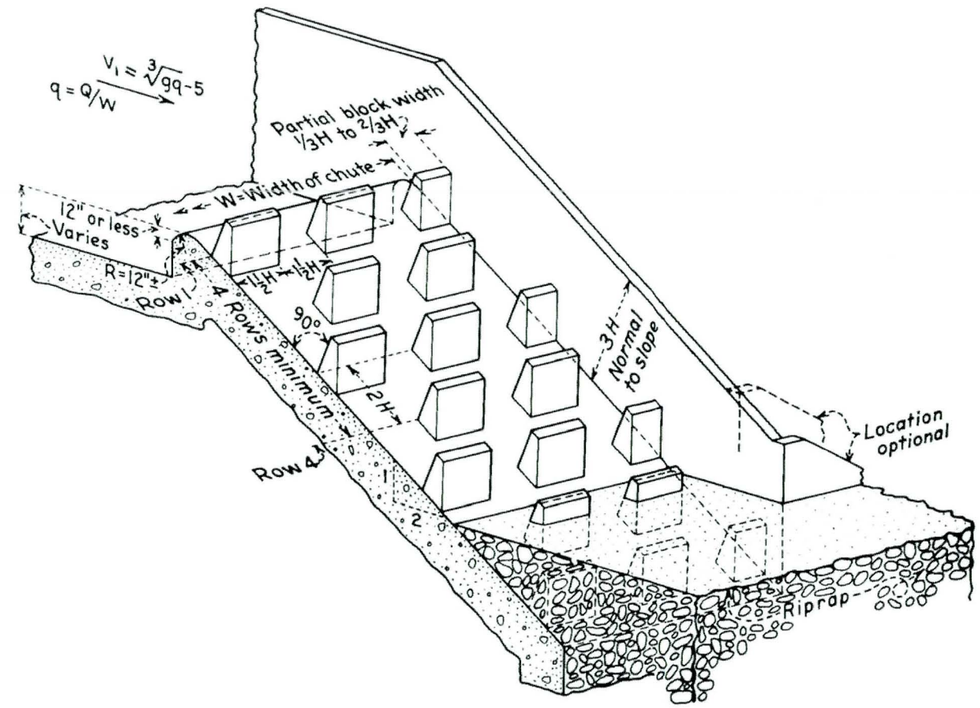

Figure 18 Baffle Chute

5.7.2.4 Lined Spillways

As discussed previously, lined spillways include the use of concrete or RCC and must be designed to consider abrasion due to sediment-laden flow at a very high velocity. Smooth lined spillways have been known to attract juvenile activities, such as skateboarding, that may raise public safety concerns.

5.7.2.5 Stilling Basins

Stilling basins should be used in conjunction with lined spillways to dissipate energy at the basin bottom. It is expected that only hard basins would be practical given the expected velocity and energy of flows at the bottom of the spillway. Stilling basin types considered include the USBR Types II, III, IV, and a straight drop basin, all made of formed concrete as shown in Figure 19. Stilling basins are also constructed out of gabions. Stilling basins are very effective at dissipating energy at the bottom of a spillway and are used extensively throughout the world. Hydraulic design and analysis methods are documented in the HEC-14 manual (FHWA, 1983).

Stilling basins are a cost effective method for dissipating energy down the basin drop; however, they are not very aesthetically appealing and may also raise public safety concerns.

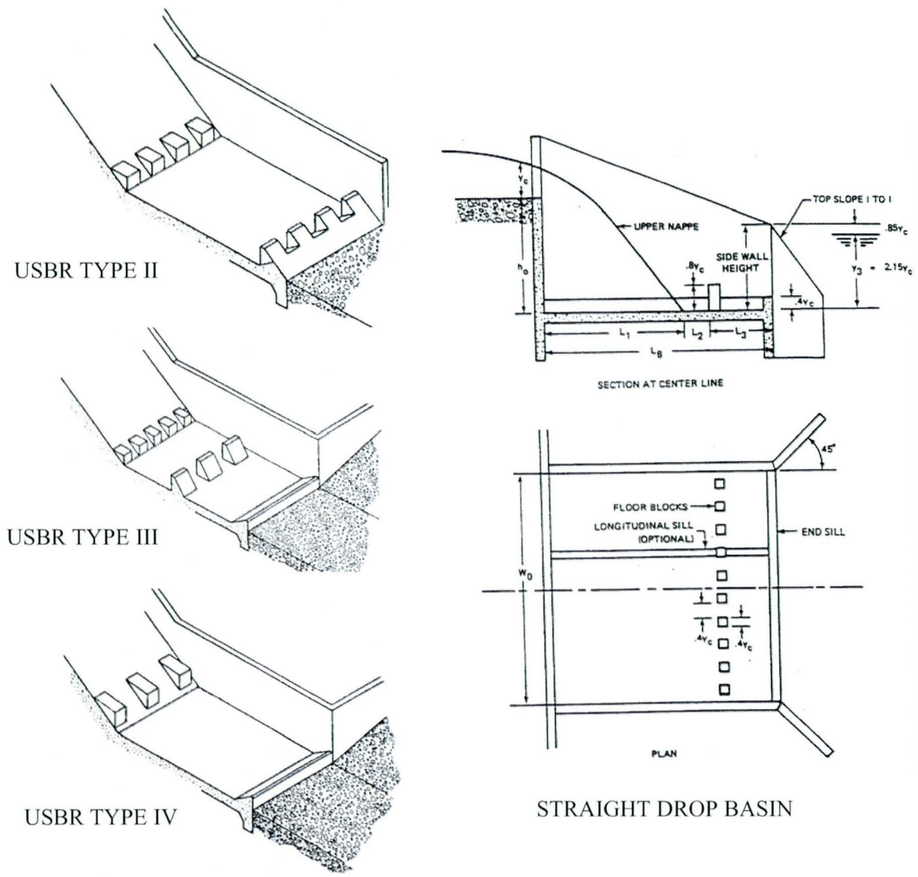

Figure 19 Stilling Basins

5.7.3 Discussion of Inlet Concepts

No non-structural inlet alternatives are recommended given the magnitude of the design discharges. The use of riprap lined spillways is limited by the design unit discharge. The remaining alternatives are therefore limited to hard material types with aesthetic treatment. Given the goal of blending the basin inlet structure into the natural landscape character, various features could be added to hard structures to enhance the appearance such as adding color pigments to concrete, texturing techniques, curvilinear designs, and/or integrating boulders into the structure. The selection and placement of vegetation would also be crucial in softening the appearance of the facilities. Creative inlet geometry could be considered to accommodate additional landscape character to the basins and allow for softer structural alternatives.

For example, the inlet drop could be divided into multiple stepped drops of curved tiers or terraces to spread the flow width to accommodate a riprap spillway and/or allow for more flexibility in landscaping options. Figure 20 depicts a conceptual terraced inlet with integrated landscaping along the facility. As shown in Figure 21, the terrace lengths increase and/or vary as they go down the drop. If the width of flow down each terrace can be successfully increased, the unit discharge over each drop would be reduced allowing for the use of a riprap spillway if desired. Alternately, the terrace steps could be constructed of stepped boulder drops such as those outlined in Chapter 7 of the District's Hydraulics Design Manual (FCDMC, 2003). Stepped boulder drops are considered the preferred aesthetic treatment for drop structures in the ADMP. A notch should be created in each structure to provide a low flow path for frequent flows to focus regular maintenance in a concentrated area. The use of the terraced inlet concept could allow for plantings on the intermediate terraces which would help to screen the engineered structures associated with the drops and stilling basins. The selection of inlet structure alternatives will depend on the inlet channel width, design discharge, and basin layout.

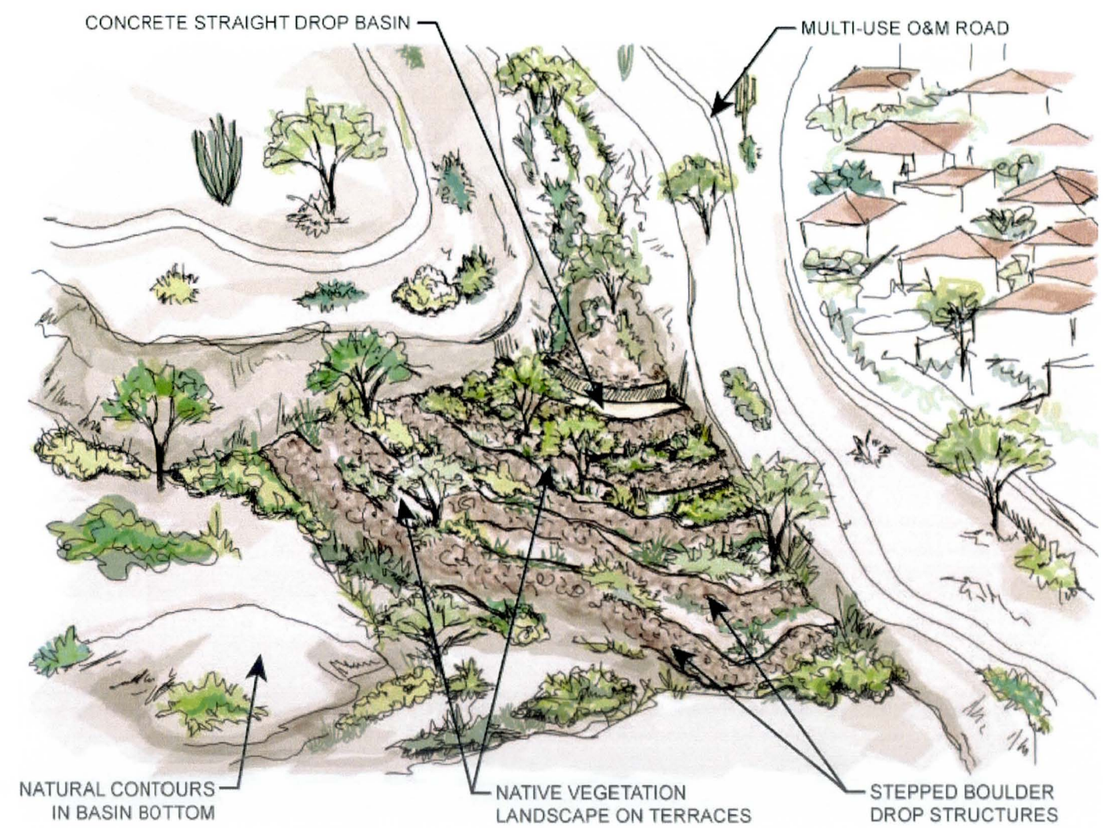

Figure 20 Conceptual Terraced Inlet Rendering

The following two sections present inlet concepts for Fan Systems 13 and 3 by way of example. Similar decision making could be applied to each specific on-line basin when design and implementation of each system move forward following Step 3.

5.7.4 Inlet Concept Example for Fan System 13

5.7.4.1 Example for Fan 13E

A riprap spillway is recommended with a width of 30 feet to match the existing channel width. A concrete cut-off wall should be constructed at the upper lip of the spillway to provide a sill for even flow distribution down the spillway. The D_{50} required will be 18 inches. Assuming a 26 foot drop and the maximum basin side slope of 4H:1V, the length of the spillway will be about 100 feet. An additional 10 feet of riprap at the bottom of the spillway on the basin floor is recommended to minimize the potential for scour hole development. The minimum depth of the riprap spillway should be a minimum of 2 times the D_{50} for a total of 3 feet. The riprap should be laid on top of a 6 inch gravel layer on top of a non-woven geotextile fabric.

5.7.4.2 Example for Fan 13W

A riprap spillway is recommended with a width of 45 feet. A concrete cut-off wall should be constructed at the upper lip of the spillway to provide a sill for even flow distribution down the spillway. The D_{50} required will be 18 inches. Assuming a 26 foot drop and the maximum basin side slope of 4H:1V, the length of the spillway will be 100 feet. An additional 10 feet of riprap at the bottom of the spillway on the basin floor is recommended to minimize the potential for scour hole development. The minimum depth of the riprap spillway should be a minimum of 2 times the D_{50} of 18" for a total of 3 feet. The riprap should be laid on top of a 6 inch gravel layer on top of a non-woven geotextile fabric.

5.7.5 Inlet Concept Example for Fan System 3

Conceptual design for the Fan 3 inlet structure was developed using the menu of alternatives previously discussed. The detention basin layout for Fan 3 is presented in Figure 11. The existing channel width and 100-year discharge for Fan 3 is shown in Table 4. The computed unit discharge is also shown to determine if a riprap spillway is a consideration.

Table 4 Design Data For Fan System 3 Basin Inlet

Fan Reach	100-year Q (cfs)	Channel Width (ft)	Unit Discharge, q (cfs/ft)
3	818	40	20.5

The predominant channel width for Fan System 3 is too narrow to consider a riprap spillway. Therefore, the use of another structural alternative will be necessary and the terraced approach will be considered. An arced 5-foot straight drop basin will be used on the first terrace to dissipate energy and spread the flow out to a width of at least 70 feet to allow for a riprap spillway on the remaining drops.

The recommended alternative for Fan System 3 is an arced terrace facility with seven drops of about 5 feet as shown in Figure 21. The first drop would consist of an arced 5-foot straight drop basin with an arc length of 50 feet at the top of the drop and an arc length of 70 feet at the bottom end sill. The remaining drops would consist of a riprap spillway with increasing widths ascending down the terraces. A concrete cut-off wall should be constructed at the upper lip of each spillway to provide a sill for even flow distribution down the spillway. The D_{50} required will be 18 inches. A 20 foot sloped stilling basin is recommended on Terrace 2 to further distribute the flow across the entire terrace. An additional 10 feet of riprap at the bottom of the spillway on Terraces 3 - 6 and on the basin floor is recommended to minimize the potential for scour hole development. Additional terrace width is recommended on Terraces 2 – 6 to provide room for landscaping to help blend the facility into the natural surroundings. The minimum depth of each riprap spillway should be a minimum of 2 times the D_{50} of 18" for a total of 3 feet. The riprap should be laid on top of a 6 inch gravel layer on top of a non-woven geotextile fabric.

The use of the terraced inlet concept could allow for plantings on the intermediate terraces which would help to screen the engineered structures associated with the drops and stilling basins. It should also be noted that the intermediate riprap drops could be replaced with stepped boulder drops or straight concrete drops similar to the first terrace if preferred.

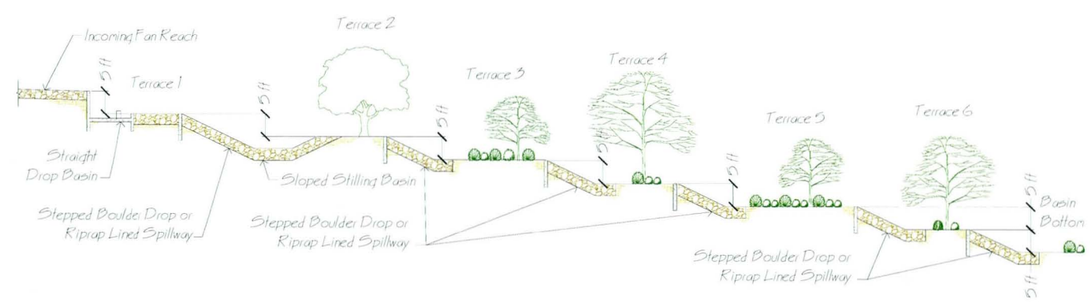

Figure 21 Example Terraced Inlet Concept Profile For Fan System 3, Wagner Sub-Area

5.7.6 Summary of Inlet Design Concepts for Fan Systems in the FRS No. 2 & 3 Sub-area

Table 5 shows a summary of the inlet design concepts and hydraulic decision parameters for each on-line detention basin.

Table 5 Summary Of Inlet Design Concepts For FRS No. 2 & 3 Sub-Area

Detention Basin	Q100 (cfs)	Upstream Channel Width (ft)	Unit Discharge (cfs/ft)	Inlet Height (ft)	Selected Inlet Type	Number of Inlets	Number of Steps for Terraced Inlets
RRW1	3196	90	35.5	37	Terraced	1	8
RRW2B	1348	50	27	28	Riprap lined spillway	1	
RRX1A	853	42	20.3	31	Terraced	1	7

It is anticipated that the inlets for the Skyline Fan System 4 and 5 detention basins will follow the model presented for Fan System 3 for the basins at the apices (RRW1 at Sky apex and RRX1A at SkyET apex), that is, a multiple step, terraced inlet structure due to the relatively high inflow discharges. The second in-series basin (RRW2B) has sufficiently low discharges to accommodate a riprap-lined spillway. Basin RRW2B will also require a second smaller riprap spillway for a tributary inlet. Approximately 6 to 8 steps will be required to drop flow safely into the bottom of the detention basins for the terraced inlets at RRW1 and RRX1A.

5.7.7 Outlet Design Concepts

The design concept for the outlets of the on-line detention basins are circular pipes. Reinforced concrete pipes will drain the detention basins to the downstream walled-levee corridor. Inlets will require trash racks to prevent clogging. Inlet headwalls will conform to the basin slope. Figure 22 shows an example of what a basin outlet structure might look like. The outlet pipes will be buried and exit downstream of the detention basin such that the pipe has sufficient slope to adequately discharge flows and maintain an inlet control hydraulic condition. The downstream outlet of the pipes will require scour protection. Riprap is proposed to serve this purpose.

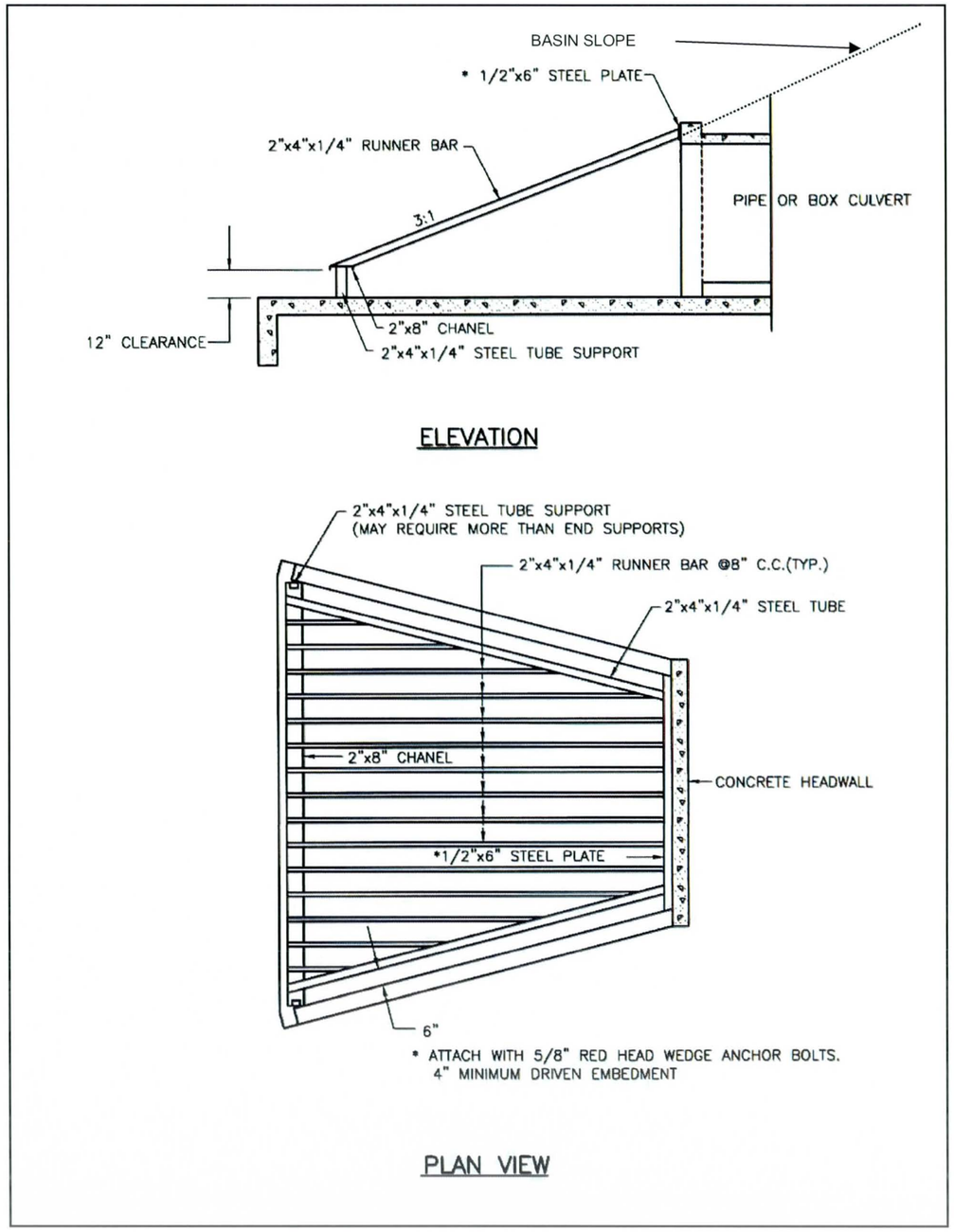

Figure 22 Typical Detail For On-Line Basin Outlet Structure

5.8 Aesthetic Treatments for Detention Basins

5.8.1 Design Guidelines

The aesthetic treatments for the detention basins include landscape contour grading, slope warping, a buffer area around the basins, and architectural enhancements to inlet and outlet structures. The detention basins to control flood flows from the alluvial fans will be areas of disturbance ranging from about 7 acres to about 83 acres. The basin will be adjusted in final design to best fit the topography of the surrounding landscape of each site. Side slopes will be warped to create an overall organic form that mimics the topographic form of the surrounding landscape. The side slopes of the basins will vary from a maximum of 4:1 to a minimum of about 8:1. The slopes of the basins will be landscaped and seeded using native Sonoran Desert plants. Plant material will be arranged to achieve a natural appearance. Figure 23 shows an example plan view of a basin with the landscape aesthetic design features.

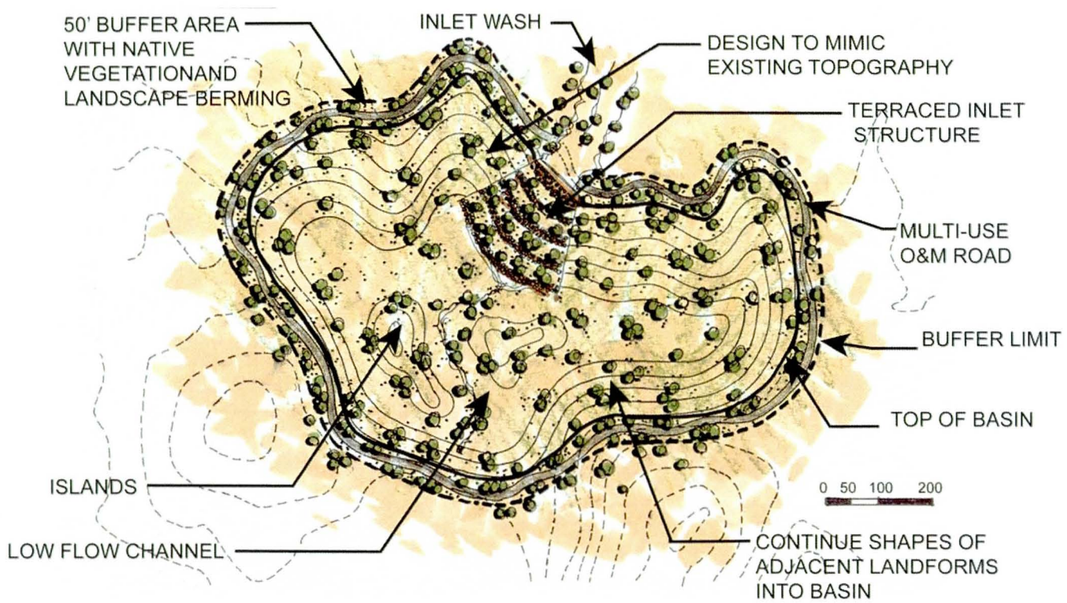

Figure 23 Planimetric View Of On-Line Detention Basin With Landscape Design Features

The bottoms of the basins will undulate to mimic the character of the surrounding landscape. The grading will create a low flow channel from the inlet structure to the outlet of the basin to direct the small flows from frequent events through a simulated natural wash.

A landscaped buffer area of 50' around the perimeter of the basins will be provided to create a visual transition with the surrounding landscape (Figure 24). The buffer area will incorporate landscape berming, vegetative planting and a meandering multi-purpose O&M road to provide open space access and visual integration with future development (Figure 25). The buffer will also provide the necessary area required to provide grading for a transition from the basin to the existing landscape or future development.

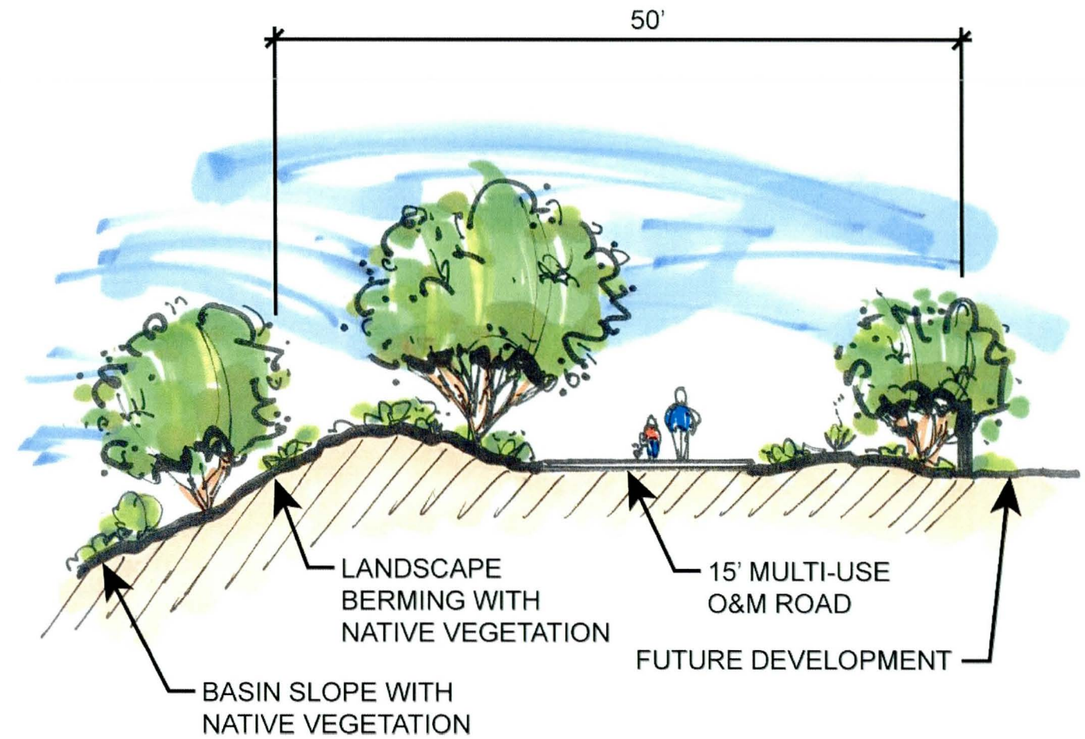

Figure 24 Concept Cross Section Of Basin Buffer Area With Landscape Design Features

The inlet structures for wash flows into the basins present challenges to the aesthetic design of the features because of the high volume of flows in many of the washes. The natural slope of the existing landscape causes average slope heights of about 30 feet up to a maximum of about 60 feet at the inlet of the washes into the basins on the uphill side of the basin. The preferred approach to developing the structural inlet components will be to develop a series of terraces that allow the flow into the basin to occur over several smaller drops of approximately four to six feet. Terraces will also be used to visually reduce the apparent height of the back slopes of the basins by limiting the slope height of any single slope to about 15-20 feet. The inlet structure terraces will range from approximately 10 feet wide to 30 feet wide. After the first one or two drops the energy of the flow should be dissipated enough to allow landscaping and revegetation on the terraces to reduce the visual impact of the structures. The landscape could be subject to some damage during the largest storm events, but once established, should recover similar to the surrounding native desert. In cases where a hard structural with aesthetic treatment solution approach would best

meet the requirement for flood control, integral color, form liners for texture would be used to reduce visibility of the feature.

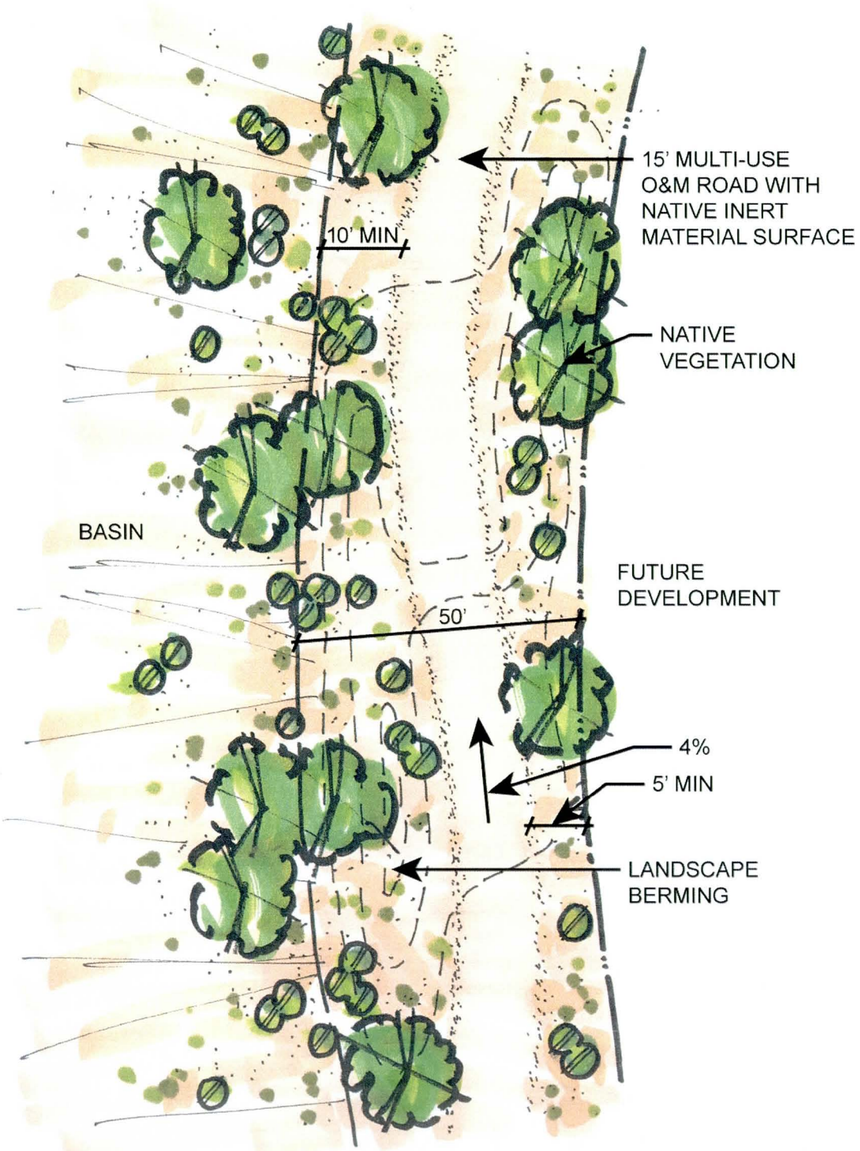

Figure 25 Plan View Of Landscape Design Features For Basin Buffer Area

In the basins with tall slopes on the uphill side, further detailing will be done during the design phase to analyze ways to reduce the visual height of the slopes. In the conceptual designs, these basins would have a reduced level of context sensitivity as compared to the basins that have slopes 35' high or less. Based on current development trends and the planned communities that are under way in the Sun Valley area, future adjacent development will include a substantial number of two-story homes that will reach heights of 25' or more. The final design of the basins should include slopes and structures that are generally in scale with the adjacent homes so that the flood control structures can be as sensitive to the local context as possible. In some situations, close coordination with adjacent development may allow the slopes above the flood detention level to be used for other purposes, such as permanent park improvements or other development associated with the planned community, including residences or other structures.

For the purpose of estimating the aesthetic treatment differential cost estimates, the average side slopes of the basins without aesthetic treatment were increased from 6H:1V to 4H:1V. Although the total storage volume was assumed unchanged, the land area requirements are less for the steeper side slopes. In addition, the setback area of 50 feet around the perimeter of the detention basins was removed. Finally, additional costs were included for architectural enhancements to the inlet and outlet structures which are assumed to be 20% of total cost for the inlet structure and 5% for the outlet structure.

5.8.2 Summary of Detention Basin Design Guidelines for Landscape Aesthetics

The detention basins in the recommended alternative are currently in undisturbed desert areas but most will eventually be adjacent to different types of residential or mixed-use developments. The development will be of various character types including low-density desert neighborhoods and moderate-density, production housing and commercial sites of the various planned area developments. Mature mesquite, palo verde, and ironwood trees and a variety of cacti including saguaros, are prevalent in the native desert areas. Vegetation varies in species composition depending on the landscape character unit. The detention basins occur in the Natural/Pastoral Bajada character unit. The detailed design guidelines below have been developed to help reduce the visual intrusion in the landscape as the basins are developed in the existing natural desert and also to allow them to become open space amenities for future residents of the Sun Valley ADMP area.

Perimeter

- Provide a 50-foot landscaped buffer area between the top of the basin and adjacent development.
- Place the operation and maintenance (O&M) road within the buffer area and design to allow for multiple uses such as walking and biking.
    - Avoid cross slopes over 3% and longitudinal slopes over 4%.
    - Establish the finish grade of the road surface no higher than 2 inches above the adjacent landscape areas.

- Construct O&M road with native inert material as the finished surface. Material will be stabilized with a polymer stabilizing product.

- Design the O&M road to be curvilinear to mimic the organic basin configuration.
- Construct landscape berming in the buffer area to blend with the natural landforms of the Bajada character unit.
- Minimize disturbance of native vegetation, especially large trees, in the buffer zone to the extent possible.
- Supplement the existing vegetation in the buffer zone to provide a landscape setting for the multi-use O&M road and to blend the vegetation of the basin into the adjacent landscape.
- Provide ADA accessible grades on all road surfaces.

Configuration

- Design the configuration of the basins to minimize height of cut slopes.
- Design the overall form of the basin to be freeform to blend with the natural topography and reduce visibility and apparent size of the basin.
- Warp and vary side slope ratios from 4:1 to 8:1 in a form to mimic the existing topography. Mix of slopes be approximately: 25%–4:1, 40% –6:1, 8:1-25%, and shallower than 8:1–10%.
- Design basins with irregularly shaped terraces so that the height of any single slope does not exceed 10 vertical feet.
    - Design landscape on terraces to mimic native vegetation patterns.
- Create natural, rounded transitions from side slopes to basin bottom.
- Over-excavate basin bottom areas to a depth of one (1) foot and plate with topsoil and desert varnish.
- Design basin bottom to be irregular and undulating, to mimic the natural topography of the area surrounding the site.
    - Create islands of landscape area in the basin bottom that are above the low flow conditions.
- Round top of basin side slopes and blend grading into berming in the buffer area.
- Develop the low flow drainage feature in the basin bottom to mimic local small washes.

Pre-Construction Activities

- Stockpile rock with desert varnish from all disturbance areas.
- Stockpile topsoil from a minimum of 4-12" depth.

Vegetation

- Use Sonoran desert plant material from the Natural Sonoran Desert Theme plant list provided in Section 5.6.4
    - Plant list will include plants identified as appropriate for the Bajada character unit.
    - Select specific species native to the basin location to respond to the context of the landscape character around the basin.
- Salvage native plants including saguaro and small cactus species, and maintain for replanting in the landscape.
- Design the buffer landscape to transition the density, type, size, form, color, and texture of the plant material with the species found in the surrounding landscape.
- Locate vegetation along both sides of the O&M road to break the view of the line of the road alignment and to provide shade.
- Locate trees in the landscape to maintain view corridors to mountains and nearby landforms.
- Trees, shrubs, and ground covers should be arranged in an irregular pattern along the sides, bottom, and top of the basin side slopes to complement the character of the surrounding natural landscape.
- Consider views from the areas above and below the basin when considering the placement and organization of plant material to reduce the apparent size of the basin.
- Install temporary irrigation system to establish plant material or use tall pot plant material.

Inlet Structures

- Design terraced inlet structures with stepped boulder drop structures between terraces. Drop structures will use native desert boulders as much as possible.
- Design the structures to use the materials, shapes, colors and textures that blend with the surrounding desert.
- Colors of materials should not have a light reflective value of more than 5% above the adjacent soil and vegetation values.
- Landscape the terraces of the structure with native species in patterns that mimic the surrounding landscape.

Outlet Structures

- Design structures with natural materials and/or integral color concrete to blend with the surrounding landscape.
- Design structures using form liners to provide textures to blend with the surrounding landscape.
- Design headwalls with slopes to follow the proposed grading of the basin slopes.
- Construct grates and metal components of structures with Corten or other steel that will develop a natural weathered color.

5.9 On-line Basin Design Procedure

The on-line detention basins were designed using the following general procedure:

- Determine the upstream sediment yield using MUSLE (see Section 5.5).
- Revise the Step 2 stage-storage discharge relationships using the irregular form basins. Stage-volume relationships derived from the 10-ft DTM in GIS assuming side slopes average 6H:1V. Freeboard was fixed at 1 foot. These parameters determine the total volume provided as well as total head available to achieve the 10% outflow objective. The total sediment for the 3-year maintenance period was removed from the lower portion of the computed stage-volume relationship; that is, the total sediment volume was subtracted from the total excavated stage-storage curve before the curve was input into HEC-1 for the hydrograph storage routing.
- Compute stage-discharge relationship using HY8 to target 10% outflow objective.
- Update the stage-storage-outflow relation in HEC-1 6-hour and 24-hour models.
- Run the 6-hour and 24-hour HEC-1 models.
- Obtain the maximum peak flow volume and peak stage from HEC-1 results.
- Compare results with the designed basin volume and basin depth (includes freeboard and sediment) to see if they are adequate. That is, the total basin depth should be less than 12 feet. The volume and depth are considered adequate if the combination of sediment, runoff, and freeboard fit within the basin.
- Modify basin dimensions and outlet structure parameters, and repeat the process until the basin volume and depth are adequate.

Calculations are provided in the appendix for each fan system.

5.10 Walled-Levee Corridors

5.10.1 Design Considerations

The walled-levee corridors were designed to act as a regional flood control trunk system and were sized to include local drainage as well as sediment from the adjacent watershed area. As part of the Step 3 design process, four discharge values are analyzed to ensure the applicability of the design to a range of flows. The four flows are simply ratios of the 100-year peak flows: 10%, 30%, 75% and 100%. The 10% flow can be expected to approximately represent the 2-year flow, 30% represent the 5 to 10-year flow, and 75% represent the 50-year flow. These ratios were selected based on guidance in the District's draft Hydrology Manual (2003). Figure 26 shows a plot of the ratios from the District Manual along with the 25-year and 50-year ratios selected for use in the ADMP. The discharge ratios were also used in the sediment yield analyses.

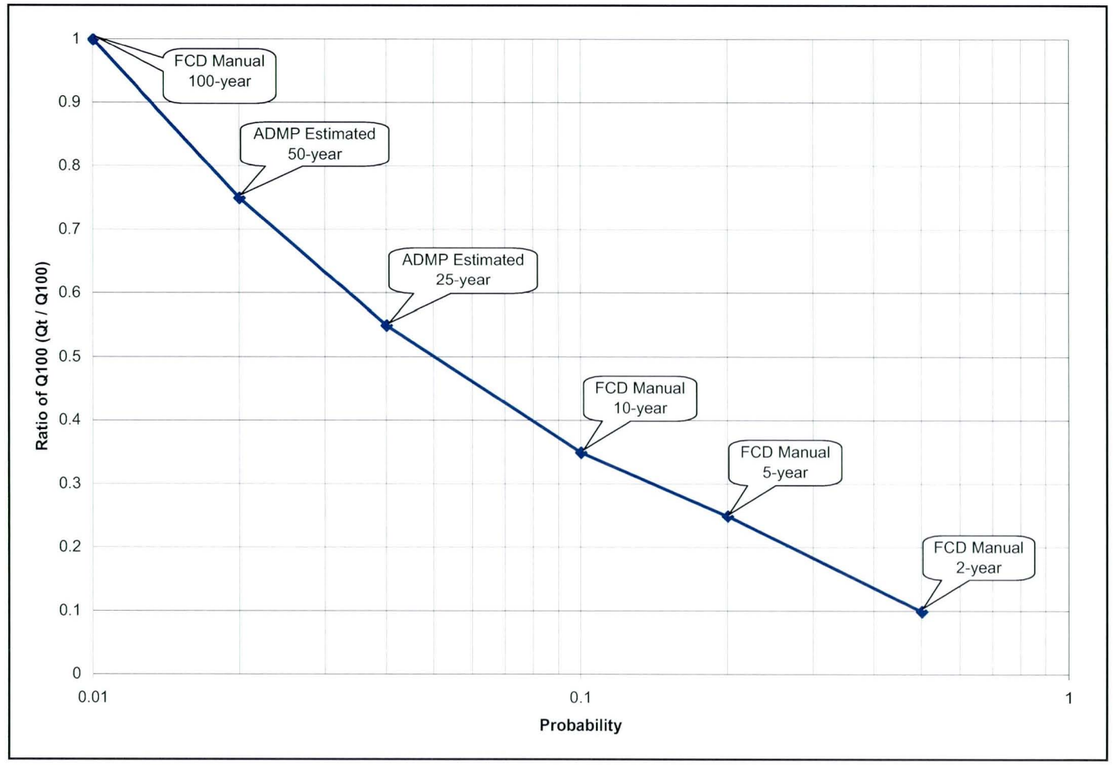

Figure 26 Development Of 25-Year & 50-Year Ratios For SVADMP

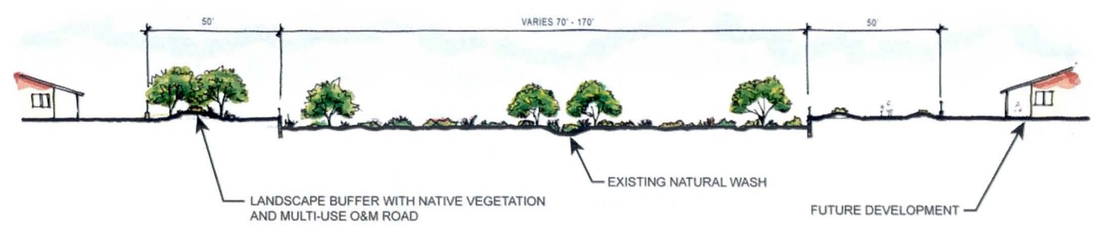

Figure 27 Concept Cross Section For Leveed Corridor With Walls & Aesthetic Treatments

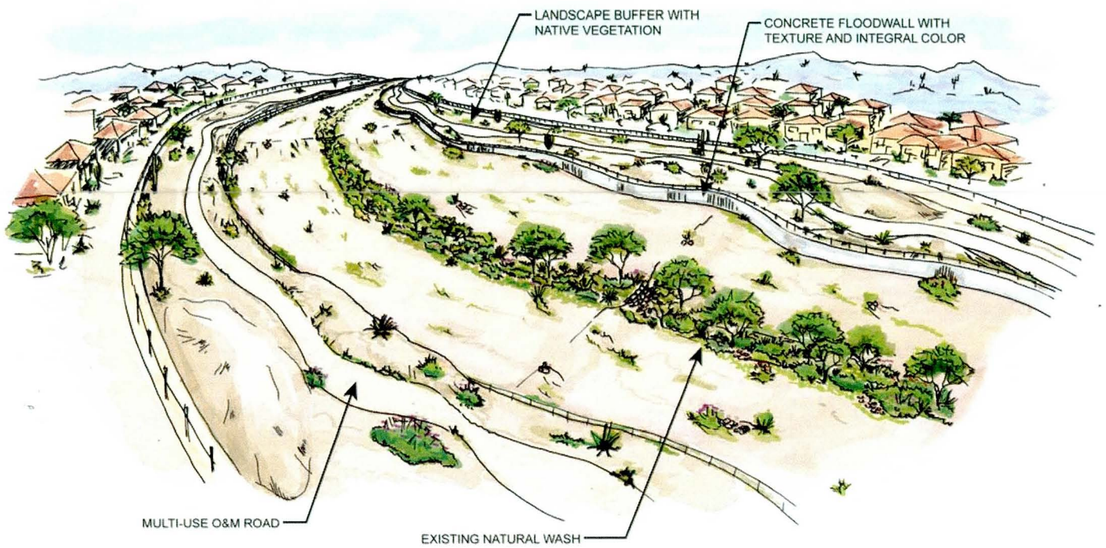

Figure 28 Oblique View Of Walled-Levee Corridor With Aesthetic Treatments

The walled-levee corridors were generally designed for subcritical flow with Froude numbers less than 0.86. Subcritical flows result in flows with lesser velocity and are favorable from public safety point of view. However, for some cross sections, the existing natural channel widths, slopes, and/or depths do not allow this criterion to be met.

Velocity within the walled-levee corridors was designed to be no greater than 6 ft/sec for the 100-year discharge and about 4 ft/sec for the 5 to 10-year discharge. Average flow depth in the corridors was restricted to 2 feet unless the velocity or Froude number requirement could not be met simultaneously. The minimum freeboard for the walled-levee corridors was set to meet the FEMA freeboard requirement of 3 feet for the concept designs.

Figure 27 shows a conceptual cross section of the walled-levee corridor. Figure 28 shows an oblique rendering of an example corridor reach.

5.10.2 Hydraulics

The hydraulics for the walled-levee corridors were performed using Manning's equation (normal-depth assumption). This was done using visual basic macros within an Excel spreadsheet environment. The numerical calculations were performed using the Newton-Raphson method for rapid convergence. In cases where the Newton-Raphson method failed to converge, the bisection method was adopted to ensure accurate results.

Channel geometry data were taken from a digital terrain model based on the 10-foot topography. A Manning's n-value of 0.045 was used for all cross sections. Analyses were performed to ensure adequate conveyance and freeboard for the estimated flow rates at each cross section. Freeboard was assumed to be a minimum of 3 feet for all cross sections.

5.10.3 Equilibrium Slope

The equilibrium slope is defined as the slope at which the channel bed is in equilibrium. It is interpreted as the slope the channel would evolve into, provided continuous flows for a long period of time and provides an idea as to what the long-term channel slope could become.

Following methods were used in Step 3:

- Meyer-Peter, Muller (MPM) for clear water reaches immediately downstream of the on-line detention basins
- ADWR approach for live bed reaches

Equilibrium slope is defined as the slope which causes the channel's sediment transport capacity to equal the incoming sediment supply (ADWR, 1985). If the slope is too steep, channel velocities will be high and net erosion will occur. If the slope is too flat, channel velocities will be low and net deposition will occur. The equilibrium slope is the slope that the undisturbed, natural channel will tend towards over the long term. While there are philosophical and practical problems with applying equilibrium slope concepts to ephemeral streams with variable channel geometry and high flash flood potential, or streams where the natural hydrology has been altered by urbanization, equilibrium slope equations provide a useful order-of-magnitude assessment of the likelihood of vertical channel adjustments.

Design reach-averaged data required for application of the equilibrium slope equations to the study area were derived from the following sources:

- Hydraulic data – normal-depth computations
- Hydrologic data - HEC-1 modeling and area weighting
- Topographic data – 10-foot contour data and DTM

Most equilibrium slope equations are based on the mean annual flood, the "channel-forming," or "bankfull" discharge. On many perennial alluvial streams, particularly in humid climates, the mean annual flood and the channel-forming and bankfull discharges are nearly equivalent. However, on ephemeral streams where flow events are rare, the channel-forming discharge is often difficult to determine. The ADWR Manual suggests use of the 5- to 10-year flow rate to predict expected slope adjustments in ephemeral watercourses like those in the SVADMP study area. Based on ratios of the 100-year flow rate in the District's Hydrology Manual (2003), a value of 30% of the 100-year flow was used to compute equilibrium slope for the corridors in the recommended alternative.

5.10.3.1 Meyer-Peter, Muller Equation

Equilibrium slope for clear water reaches was estimated using the Meyer-Peter, Muller (1948) equation which is based on the incipient motion theory, or the point of initiation of sediment transport. The equation is given by:

$$S_L = K_{mpm} (Q/Q_{bf}) (n_s/D_{90}^{1/6})^{3/2} D / d$$

Where:

S_L = Stable slope (ft/ft)

K_{mpm} = 0.19

Q/Q_{bf} = Ratio of total flow to flow over the channel

Q_{bf} = Dominant discharge (cfs)

n_s = Manning's n for the stream bed

D_{90} = Bed sediment diameter for which 90 percent is smaller (mm)

D = Mean sediment diameter (mm)

d = Channel depth (ft)

The resulting slope was used to compute grade control requirements for the leveed corridors immediately downstream of the on-line detention basins.

5.10.3.2 Sediment Transport Capacity

The sediment transport capacity was used to estimate of the rate of sediment transport. The sediment transport capacity can be used to ensure adequate sediment continuity and provides channel sediment trend when compared with the inflowing sediment transport load. The Zeller-Fullerton equation from the ADWR Manual was used to compute sediment transport capacity for the design corridor reaches. The Zeller-Fullerton Equation is a total bed-material discharge equation, and is formulated as follows:

$$Q_s = 0.0064\, n^{1.77} V^{4.32} G^{0.45} Y_h^{-0.30} D_{50}^{-0.61}$$

Where:

Q_s = sediment discharge rate (cfs)

n = Manning's roughness coefficient, channel

V = mean channel velocity (ft/s)

G = gradation coefficient

Y_h = hydraulic depth, channel (ft)

D_{50} = median bed sediment size (mm)

Hydraulic data required to apply the Zeller-Fullerton equation were obtained from the normal-depth hydraulic calculations for each design reach and corridor tributary. The gradation coefficient and D50 were based on the average sediment gradation curve described in Section 5.1.4.

Geometry for the corridor tributaries was estimated from the aerial photographs and 10-foot topography. Tributary slope was measured from the contours approaching the corridor confluence. Cross sections were approximated as rectangular with channel width estimated from the aerial photographs. Channel depths were estimated based on the computed normal-depth velocity. Velocities were targeted to approximately 4 feet per second which were considered appropriate for bankfull depths for these tributary reaches (Moody et al., 2003).

The sediment transport capacity values were used to compute equilibrium slope for live bed reaches based on the sediment transport continuity approach outlined in the ADWR Manual. Sediment transport capacity was computed for each design reach as well as significant tributaries to the leveed corridors.

5.10.4 Scour and Toe Protection

The toe-down for the floodwalls was estimated using scour calculation procedures outlined in the ADWR Manual. The following equation for depth of scour in a stream is given in the ADWR Manual:

$$Z_t = 1.3\,(Z_{deg} + Z_{ls} + Z_{gs} + Z_{bs} + Z_i + \tfrac{1}{2} h_a) \qquad \text{(ADWR Eq. 5.28)}$$

where:

Z_t = Design scour depth (ft)

Z_{deg} = Long-term degradation (ft)

Z_{ls} = Local scour depth (ft)

Z_{gs} = General scour depth (ft)

Z_{bs} = Bend scour depth (ft)

Z_i = Low-flow incisement depth (ft)

h_a = Anti-dune height (ft)

1.3 = Safety factor to account for non-uniform flow distribution

Long term degradation, Z_{deg}, was assumed to be controlled by the grade control structures which have a design drop height of 3 feet. Therefore, an average long-term degradation was taken to be 1.5 feet for the purposes of computing toe-down requirements. Consequently, actual long term degradation at a given point could be more or less than 1.5 feet.

Local scour, Z_{ls} , was assumed to be zero for the purposes of the average design scour depth. However, the actual design would need to consider local scour in locations of abrupt transitions, where facilities such as maintenance access ramps protrude into the corridor, or other locations such as roadway crossings.

General scour, Z_{gs}, is the component of scour that represents the mobile portion of the bed-material of the channel bottom. General scour was estimated using the following equation (Zeller, 1981):

$$Z_{gs} = Y_{max} [(0.0685 V_m^{0.8})/(Y_h^{0.4} S_e^{0.3})-1]$$

where:

Z_{gs} = General scour depth (ft)
V_m = Average velocity of flow at design discharge (ft/sec)
Y_{max} = Maximum depth of flow at design discharge (ft)
Y_h = Hydraulic depth of flow at design discharge, (ft)
S_e = Energy slope (ft/ft)

Where Z_{gs} was determined to be negative, the general scour component was assumed to be zero.

Bend scour, Z_{bs}, occurs on the outside of bends in a stream channel, and is caused by spiral transverse currents. Bend scour was estimated using the following equation:

$$Z_{bs} = 0.0685\, Y_{max}\, V_m^{0.8}\, Y_h^{-0.4}\, S_e^{-0.3}\, (\, 2.1\, [\sin^2(\alpha/2)/\cos\alpha]^{0.2} - 1)$$

where:

Z_{bs} = Bend-scour component of total scour depth (ft), and
= 0 when $r_c/T > 10.0$, or $\alpha < 17.8^o$
= computed value when $0.5 < r_c/T < 10.0$, or $17.8^o < \alpha < 60^o$
= computed value when $\alpha = 60^o$ when $r_c/T < 0.5$, or $\alpha > 60^o$
Y_{max} = Maximum depth of flow immediately upstream of the bend (ft)
V_m = Average velocity of flow immediately upstream of the bend (ft/sec)
Y_h = Hydraulic depth of flow immediately upstream of the bend (ft)
S_e = Energy slope immediately upstream of the bend (ft/ft)
α = Angle formed by the projection of the channel centerline from the point of curvature to a point which meets a line tangent to the outer bank of the channel (degrees)
r_c = radius of curvature along centerline of channel (ft)
T = channel top width (ft)

The bend angle was computed from the arccosine of the reciprocal of the sinuosity. A sinuosity of 1.1 was assumed for all design reaches.

The low-flow incisement depth, Z_i, was taken as 2.0 feet for all design reaches. This generalization was based on field observations of existing low flow channels in the area which were seen to range between one and two feet throughout the ADMP study area. Therefore, a value of two feet was selected for the purposes of estimating scour depth for the concept design and costing of the floodwalls.

Anti-dune height, h_a, is the component of scour caused by movement of dune shaped bed forms along the bottom of the channel. The anti-dune height was estimated using the following equation:

$$h_a = 0.027\, V_m^2$$

where:

V_m = Average velocity of flow at design discharge (ft/sec)

Scour depth below drop structures was estimated using the following equation from Pemberton & Lara (1984):

$$D_s = 4.7\, h^{0.2}\, q^{0.57} / d_{90}^{0.32} - d_m$$

where:

D_s = Scour depth below downstream water surface (m)
h = Drop height (m)
q = Unit discharge ($m^3/s/m$)
d_{90} = Bed material size for which 90% of the sample is finer (mm)
d_m = downstream mean water depth

5.10.5 Floodwalls

Where the existing topographic relief and/or the natural channel does not contain the design flow rate, conveyance is provided by floodwalls. While a typical floodwall design is being presented within this concept report, only a coordinated effort between a variety of disciplines including geotechnical engineers, structural engineers and hydraulic engineers will ensure that engineering, economic, and safety considerations are integrated into the overall final design.

The preliminary floodwall design for this project had to account for the following constraints:

- The floodwall had to be extended below the total scour depth anticipated within the channel.
- The floodwall had to have a minimum of 3 feet of freeboard above the maximum computed water surface.
- On the protected side, the maximum of three (3) feet above the final grade could be left exposed. Backfill will be placed to achieve this requirement.
- In no case will the resisting-side earth pressure exceed one-half the passive pressure as calculated using unfactored shear strengths for overturning and bearing capacity and structural design (EM 1110-2-2502).

In addition to the above constraints, several other key assumptions were in the conceptual design of the floodwalls as follows.

1) The backfill will consist of a homogenous layer of clean, non-cohesive soil (c = 0).
2) The resisting side force will be zero for overturning and bearing capacity analyses and for structural design.
3) For any given scenario, the wall will be at at-rest (stable).
4) The ground water will be below the backfill.
5) Runoff generated by the watersheds on the protected side of the wall would be conveyed around the structure such that it will create a surcharge pressure on the opposite side of the wall.

Once the constraints and assumptions were identified, the process of designing the floodwall was undertaken. Using the hydraulics of the channels and the total scour estimates previously discussed, the initial step in the process was to calculate the total height of the proposed floodwall for each cross-section. The height of the wall was taken to be the sum of the scour depth plus the flow depth plus the freeboard amount. The result was rounded to the nearest larger full foot.

The next step was to estimate height of the fill that would be placed above the base of the floodwall. This height has to account for both the adjusted total scour and any additional fill needed to raise the grade such that only three (3) feet of wall could be left exposed on the protected side.

Given the typical wall height of 4 to 5 feet (including the 3 feet of freeboard) and the similar hydraulic design criteria for the cross sections, the range of potential basic floodwall design of nine to fourteen feet was selected. It was also determined that the fill added above the scour depth could either be 1 foot or 2 feet. An intermediate value of 1.5 feet of fill was incorporated into the designs.

From these simple relationships, six separate wall design scenarios were created. In so doing the need for design as unique wall segments for each cross-section was eliminated. It should be noted that in reality, each of these scenarios could be expanded to account for the different flood stages, with the extremes being a completely dry channel that has been scoured to its maximum potential or a channel conveying flow at the maximum flood stage. For the concept designs associated with the ADMP, a conservative approach was taken assuming that the structural loading on the wall would come from the fill on both sides of the wall, plus the loading caused by the 100-year storm event.

The conceptual floodwalls were generated using the assumptions presented in the U.S. Army Corps of Engineers Publication EM 1110-2-2502 *Engineering and Design of Retaining and Flood Walls* supplemented with the *Design Manual for Retrofitting Flood-prone Residential Structures* (FEMA, 1986). In addition, several basic design standards based on past design were also used to complete the design. The typical cross-section along with the basic design criteria for each of the above scenarios is presented on Figure 29.

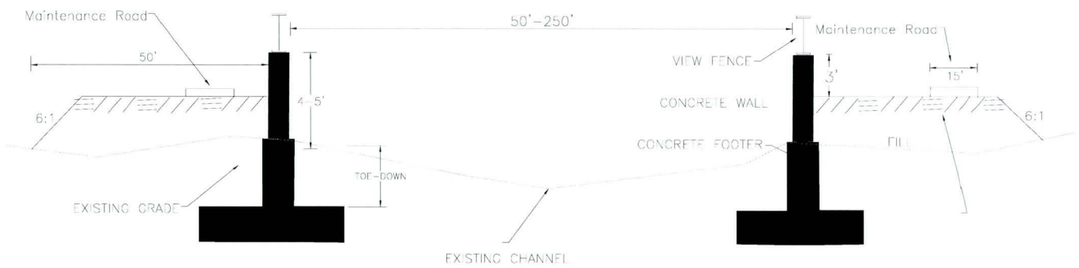

Figure 29 Example Of Typical Floodwall And Corridor

Upon completion of the design, the cost per linear foot was determined. This analysis will serve to provide a means to estimate the preliminary costs for the materials for the construction of the floodwalls. The unit costs are based on past projects bids and could vary considerably from future values. As the reinforcing rebar could not be designed at this phase, a standard price ratio of 15% of the wall cost was used as a base value. A summary table of the costs is provided below. Additional discussion of the cost estimates for the recommended alternative is found in Section 7.

Table 6 Flood Wall Typical Section Properties

(from "Computer Program Users Manual for the Nonstructural Evaluation Program", USCOE, Nov. 1992)												
Wall	Base			Batter			Area		Total	LF	Steel	Total
Height	Toe	Heel	Thickness	Base	Top	length	Base	Wall	Area	Cost	Cost	Unit Cost
A	*C*	*D*	*F*	*E*	*G*	*A-F*	*sf*	*sf*	*cy / lf*	*$155 / cy*	*15%*	*$ / LF wall*
9.0	1.5	2.94	1.08	1.08	1.00	7.92	4.8	8.2	0.48	$75	$11	$86
10.0	1.6	3.22	1.17	1.17	1.00	8.83	5.6	9.6	0.56	$87	$13	$100
11.0	1.89	3.78	1.33	1.33	1.10	9.67	7.5	11.7	0.71	$111	$17	$127
12.0	2.00	4.00	1.50	1.50	1.25	10.50	9.0	14.4	0.87	$135	$20	$155
13.0	2.15	4.30	1.55	1.55	1.28	11.45	10.0	16.2	0.97	$150	$23	$173
14.0	2.28	4.56	1.67	1.67	1.38	12.33	11.4	18.8	1.12	$174	$26	$200

*Note: All wall variables are in feet

In addition to the above costs, a cost of $7 per square foot of wall was added to allow for the use of form liners for aesthetic treatment of the wall surfaces.

5.10.6 Drop Structures

Drop structures are included to limit long-term degradation where necessary. The on-line detention basins collect both sediment and flow volume. As a result, the on-line detention basins also function as sedimentation traps near the fan apices. The result is relatively clear water discharges immediately downstream of the detention basins. Drop structures will be required to limit degradation of the channel in these reaches. Downstream tributaries deliver sediment to the corridors. The inflowing sediment provides supply to offset the reduction in supply due to the on-line detention basin. Clear water conditions were assumed to prevail for the first one or two design sections (generally 1000 to 2000 feet) or until the first tributary enters the corridor.

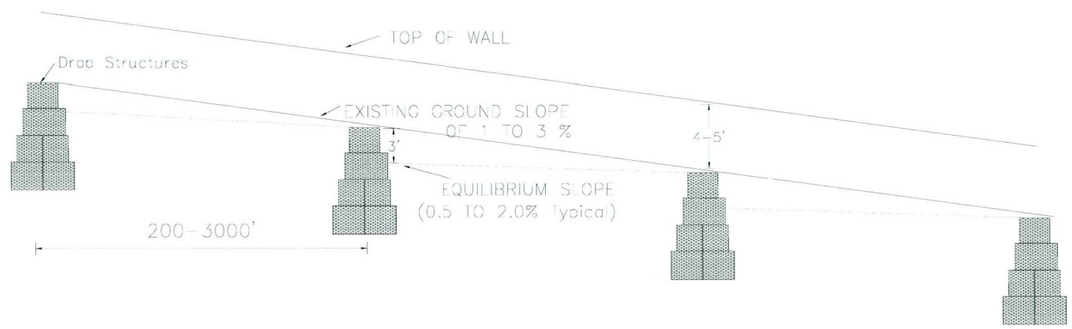

Figure 30 Concept Profile View Of Walled-Levee Corridor

The drop structures were designed to be three feet high and spaced accordingly. This size provides a reasonable height from multiple-use and visual scale points of view. Grade control structures were assumed to be made of buried gabions for the purposes of the cost estimates. The number and spacing of drop structures was determined by using the difference between the existing slope and the anticipated long-term slope for the leveed corridors. Costs were estimated using the fractional number of structures computed for each design reach. The placement of the actual drop structures are shown on the design maps based approximately on the spacing computed rather than strictly on the total number. Therefore, the number of drop structures shown on the maps does not necessarily match the number used in the cost estimates exactly. Figure 30 shows the concept profile view of the leveed channel corridor with the buried grade control structures and the anticipated long-term, or equilibrium, slope.

It is suggested that a grade control structure be placed at the downstream end of the corridor at its outlet at the FRS pool to prevent headcutting into the corridor. Similarly, vertical downcutting of tributaries to the corridor should be prevented by placing grade control structures for the corridor just downstream of significant tributary confluences. Elsewhere, it is anticipated that transportation and utility crossings will provide most of the required grade control needs. Scour below the drop structures should be estimated using the scour equation from Pemberton and Lara (1984) shown in Section 5.10.4. The total height of the drop structures should include this estimated scour depth.

5.11 Aesthetic Treatments of Walled-Levee Corridors

5.11.1 Floodwalls

The design approach for flood control corridors will retain most of the natural character of the existing wash. The use of walls to contain the design flood flows will minimize the disturbance of the area adjacent to the wash corridor but will require the following aesthetic treatments to blend these structures into the landscape. These features will include but not be limited to:

- the use of form liners to add texture to the wall surface;
- the use of integral color in the concrete to blend with the surrounding landscape;
- horizontal undulation to reduce the rigid look of the walls and to avoid major vegetation when possible;
- limit interior wall height to 5 feet whenever possible through meandering the wall with the existing topography;
- installation of trees in a random pattern along the interior base of the walls to reduce their visibility;
- and vertical undulation with the existing terrain to reduce the rigid engineering aspect of the walls and emulate the gently undulating character of the surrounding terrain.

While the walled levee approach is a hard structural with aesthetic treatment method of flood control, the minimal disturbance to the natural wash combined with full implementation of the above listed aesthetic features will result in a structure that is fully context sensitive with the surrounding visual environment.

The walled-levee corridors include a setback area of 35 ft along each side of the conveyance corridor to provide visual screening as well as recreational and/or environmental benefits. This is in addition to 15 feet added for a maintenance road on each side. If flow and freeboard containment can be achieved by natural ground, the maintenance road and setback area are provided within the freeboard area above the 100-year water surface elevation.

It should also be noted that the selection of a walled natural corridor with relatively low floodwalls is integral to the recommended alternative. While the internal wall height was limited to about five feet on average, the external wall height was limited to three feet through the use of backfill behind the floodwall outside the flood channel. This will further reduce the visual impact of the wall structures upon adjacent land use areas and will increase opportunities for public viewing into the wash corridor open space and the mountain uplands forming the scenic back drop.

The costs associated with the color, form liners, backfill, and setback area right of way were considered the differential costs required to meet the aesthetic treatment policy requirements. Landscaping of the setback area was also assumed to be required. These costs were computed for comparison with the District's cost guidelines for aesthetic treatment of flood control facilities.

5.11.2 Drop Structures

The planned flows in the drainage corridors will require drop structures to control long-term degradation of the channel. Large boulders will be used as part of the structural design to reduce the visual impact of the structures. If suitable materials for stepped boulder drops are not readily available, concrete with architectural design treatments may be an acceptable alternative. Seeding and revegetation upstream and downstream of the structures will help reestablish native vegetation after construction and further reduce the visual affect to the landscape. A 10% increase in the length of the drop structures was applied for the purpose of assessing the differential cost for the required aesthetic treatments.

5.11.3 Design Guidelines for Landscape Aesthetic Treatment

The walled-levee corridors are located in areas where the natural desert vegetation is mostly undisturbed, but will be in areas of moderately intense development in the future. The corridors in the FRS No. 2 & 3 Sub-area are situated within two landscape character units, the Valley Plains and the Bajada (Figure 10). The corridors will serve as the unifying element that would create an organic pattern of elements connecting the adjacent developments to other major trail corridors. The landscape design of the corridors will include plants from the Natural Sonoran Desert Plant list in Section 5.6.4. The aesthetic design guidelines and criteria for the corridors include developing the corridors in meandering forms, incorporating a multi-use O&M road, using native vegetation along the corridor that is specific to the adjacent character unit, and using stepped boulder drop structures for channel grade control. Figure 31 shows a cross section of a flood wall and adjacent buffer area with the landscape aesthetic treatments. The detailed landscape aesthetic design guidelines are listed below. They have been developed to help reduce the visual effects of the corridors as they are developed in the existing natural desert and also to allow them to become open space amenities for future residents of the Sun Valley ADMP area.

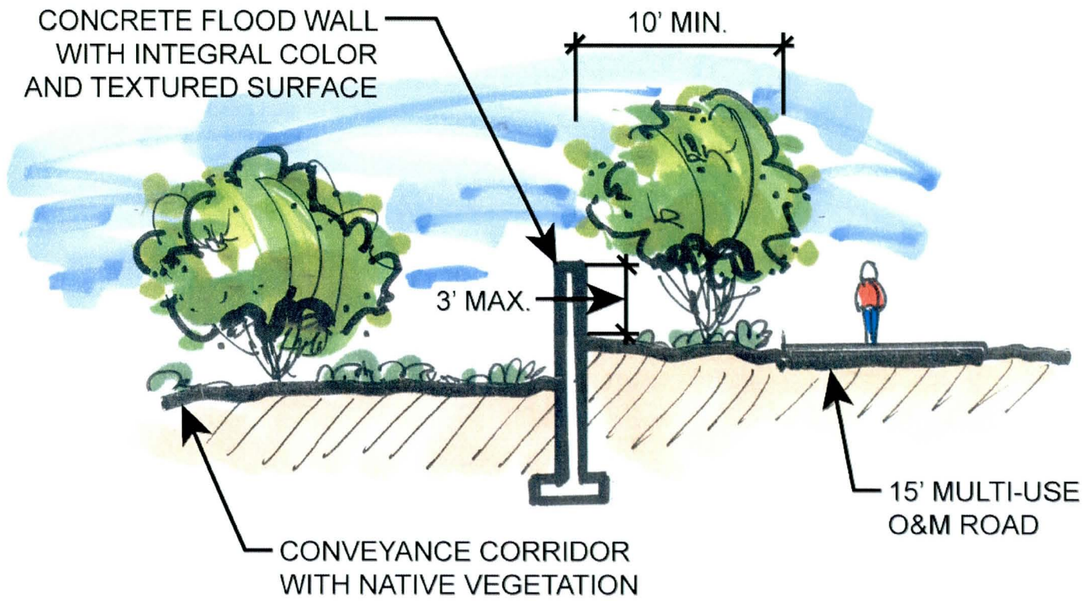

Figure 31 Buffer Area Detail With Landscape Aesthetic Features

Design and Configuration

- Design the corridor to follow the existing wash and be freeform to blend with the natural topography and vegetation patterns.
- Meander the corridor alignment in an irregular pattern, generally following the existing wash in the corridor. The wash should always remain approximately in the middle one-third of the overall corridor.
- Provide a 50-foot landscaped buffer area between the corridor and adjacent development.
- The curvilinear floodwall should be designed with color and texture borrowed from natural landscape and to tie into and blend with natural landforms
- The operation and maintenance (O&M) road will be placed within the buffer area and should be designed to allow for multiple uses such as walking and biking. Avoid cross slopes over 3% and establish final road surface no higher than 2 inches above the adjacent landscape areas.
- Design the grades for all roads to meet ADA standards.
- Place rocks and boulders randomly and in groupings in the landscape buffer and other disturbed areas to blend with the existing patterns of the adjacent desert.

Multi-purpose O&M Road

- Gracefully meander the O&M road and maintain a minimum distance of 10 feet from the edge of the O&M road to the floodwall and a minimum of 5' from the back edge of the buffer zone.
- In areas where floodwalls are not used to control flood flows, the O&M road should be located sensitively in the natural desert to minimize vegetation and landform disturbance.

- Construct O&M road with native inert material obtained from within the study area as the finished surface.

Vegetation

- Preserve existing native desert vegetation and landforms to the maximum extent possible.
- Salvage native plant material including but not limited to; small cacti species (cholla, barrel cactus and prickly pear), saguaro, ocotillo and yuccas and replant on site.
- Use plant material from the Natural Sonoran Desert Plant list provided in Section 5.6.4.
    - Use plants appropriate for the Bajada character unit in the locations of the corridor where it is within those character units.
    - Select specific species native to the corridor location to respond to the context of the surrounding landscape character.
- Transition the density, type, size, form, color, and texture of the plant material to integrate with the plants used in adjacent development. Use transition plantings in the buffer zone only.
- Prune trees adjacent to the multi-use O&M road to allow pedestrians to pass underneath their canopies. Avoid using plant material with notable thorns or those plants considered hazardous to pedestrians adjacent to the multi-use O&M road.
- Design tree plantings in informal arrangements that mimic natural vegetation patterns, while maintaining views of the surrounding mountains and other landscape focal points within the study area.
- Design the placement of trees, shrubs, ground covers, using irregular patterns to mimic adjacent desert areas.
- Install irrigation system to maintain and establish plant material or use tall container planting methods.

Pre-Construction Activities

- Stockpile rock with desert varnish from all disturbance areas.
- Stockpile topsoil from a minimum of 4-12" depth.

Flood Walls

- Use integral colored material and surface treatments that are borrowed from the adjacent desert to blend with the surroundings.
- Place trees randomly near base of walls on interior of corridor to reduce visibility of the walls.
- Design walls with horizontal undulation to reduce the rigid look of the walls and to avoid major vegetation when possible.
- Design walls to limit interior height to 5 feet whenever possible through meandering with the existing topography.
- Design walls with vertical undulation with the existing terrain to reduce the rigid engineering aspect of the walls.
- Design wall to have a maximum vertical height of 3 feet on the exterior side.

Drop Structures

- Use natural boulders to develop stepped drop structures for the final design of the grade control in the corridor (Figure 32).
- Meander stepped drop structures horizontally to reduce linear design when structures become exposed.

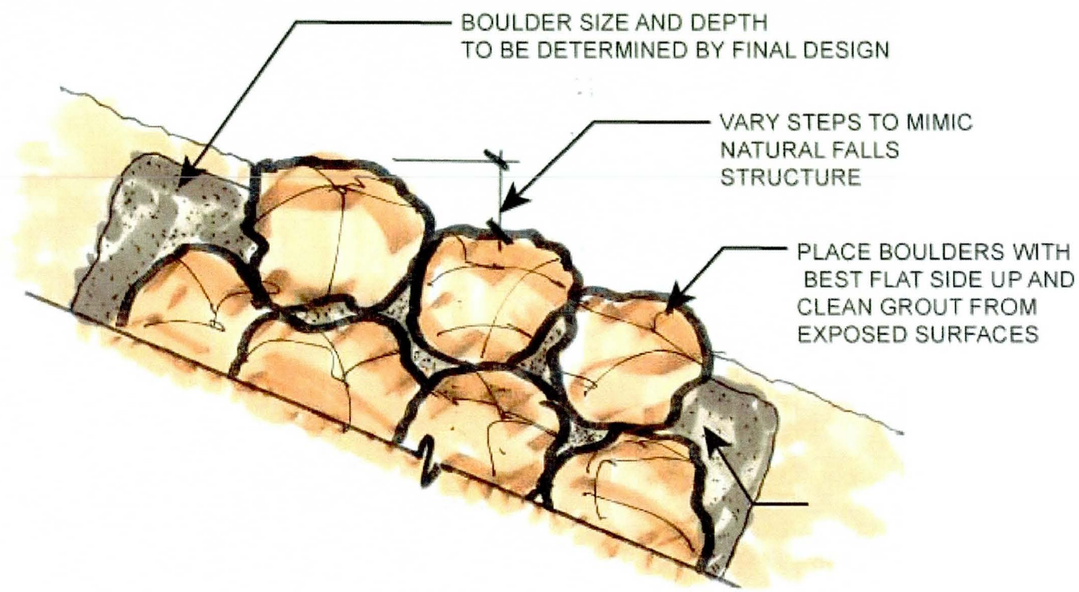

Figure 32 Conceptual Cross Section of a Stepped Boulder Drop

5.12 Walled-Levee Corridor Design Procedure

The walled-levee corridors were designed using the following general procedure:

- Identify the channel alignment.
- Cut cross sections from the 10-ft DTM at approximately 1000 foot intervals.
- Edit cross-section to correct DTM errors in wash bottom areas, if necessary.
- Determine the length and existing slope along the proposed alignment for each cross section.
- Select Manning's n values. A value of 0.045 is assumed for all the leveed corridors.
- Determine sediment gradation parameters such as D_{50}, etc.
- Identify the upstream and downstream concentration points from the HEC-1 model. The HEC-1 model KK IDs for these components are identified and appropriate weighting factors are applied to arrive at the 100-year peak flow for each cross section.
- Identify the upstream reaches and any tributaries that bring sediment flow into the channel. Determine sediment flux entering channel from these upstream channels using the Zeller-Fullerton equation.

- Establish an initial width and depth of the leveed corridor based on the initial Step 2 results and examination of the aerial photograph and cross section plot. Depth of flow in the cross section is targeted at less than or equal to 2 feet and velocity less than or equal to 6 feet per second. In addition, the velocity for the 30% ratio flow should be approximately 4 feet per second.
- Revise the HEC-1 routing reaches to approximate the design widths of the cross sections within the routing reach.
- Run the 6-hour and 24-hour HEC-1 models.
- Check the hydraulic criteria for each design cross section with the revised discharges. Modify the floodwall stationing as necessary and then revise the HEC-1 routing reaches as necessary and rerun the HEC-1 models. Verify that the results meet the hydraulic design criteria, including minimum freeboard requirements.
- Determine the equilibrium slope (see section 5.10.3) for the selected cross-section using the ADWR Manual approach.
- Determine the number of drop structures needed (see section 5) using the length of the channel, existing slope, and the equilibrium slope estimate. A 3-foot drop height is assumed for all drop structures.
- Determine the toe down required for the floodwalls. The toe down is based on the computed scour depth (see section 5.10.4).
- Perform cost estimates (see section 7.1) to arrive at the land cost, construction cost, landscaping cost and maintenance cost. The channel costs are estimated for the following: (a) land cost for the channel area, (b) land cost for the maintenance road, (c) land cost for the setback buffer area, (d) floodwall height including freeboard and scour depth, e) floodwall backfill, and f) drop structures using gabions.

Calculations are provided in the appendix for each fan system.

5.13 Recreation and Multiple-Use

Information from the Town of Buckeye, Maricopa County and other planning organizations was utilized to identify multiple-use and recreation opportunities. Within the study area, numerous multi-use opportunities could be developed in conjunction with existing and planned recreation facilities. A map of the proposed recreation facilities in the Sun Valley Study area is provided in the Volume 1 report. While most all the proposed corridors could be developed with multi-use trails, the ones located in proximity to planned major trails should be developed as major corridors for regional planning purposes as they are consistent with the proposed corridors of Buckeye and/or Maricopa County Regional Park Trail. The coordination of flood control facilities with local recreation plans will contribute to the integration of regional and local open space systems.

5.13.1 FRS No. 2 & 3 Sub-area

The major trail corridors in the FRS No. 2 & 3 sub-area are located along the power lines that cross the sub-area and through the central part of the sub-area in an east-west direction (Figure 33). The corridors for the Sky and Sky ET fan systems are not aligned with major trial corridors. However, the planned corridors and basins are strategically located to serve as regional open space corridors linking White Tank Mountain Regional Park with FRS No. 3, No.2, and No.1 and continuing on to the Hassayampa River. An extension of the corridors upslope of the Sky basin will be required to extend the corridor to the other major trail corridors that provide access to the natural mountain park proposed by the Town of Buckeye. The corridor extensions will be coordinated with the future master planned community in this area and could eventually lead to a trail system that connects into the County's White Tank Mountain Regional Park.

All flood control basins and corridors in this sub-area will be developed according to the Natural Sonoran Desert Theme. If specific open space plans for the adjacent master planned communities would introduce active recreation facilities, the use of the Semi Natural Desert Adapted Park theme should be coordinated with the development so that transitions can be made with the landscape design of the community.

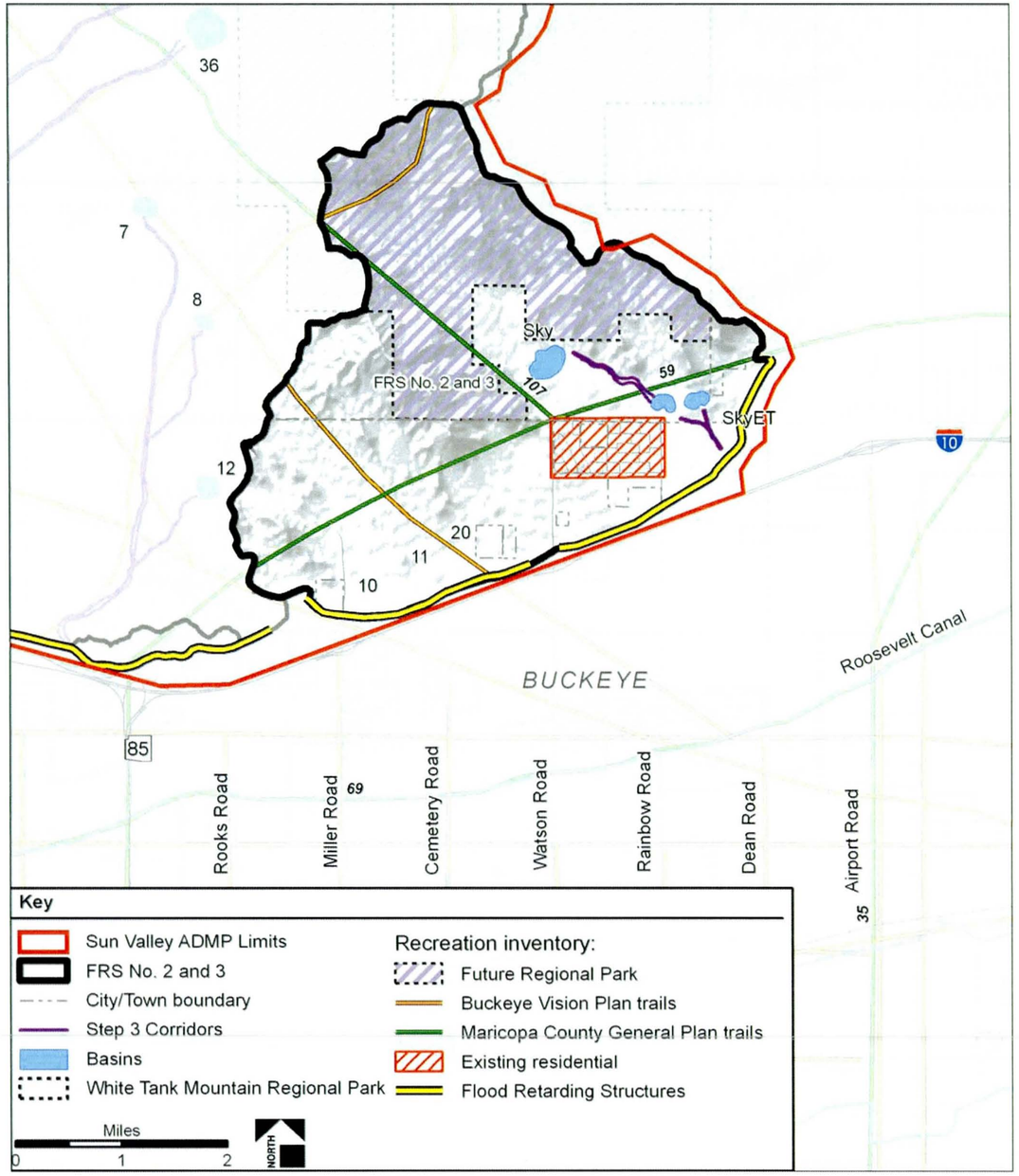

Figure 33 Recommended Alternative And Multiple-Use Opportunities in the FRS No. 2 & 3 Sub-area

6 FRS No. 2 & 3 Sub-area & Fan System Specific Design Considerations

The FRS No. 2 & 3 sub-area is located on the southern slope of the White Tank Mountains. One major and four minor alluvial fans drain the White Tank Mountains spreading out briefly before being captured by the Buckeye Flood Retarding Structures. The major alluvial fan, Skyline Fan, also has an inset area of significant instability located on its southeastern side. The Skyline Fan System drains into Buckeye FRS No. 3 while Fans 10, 11, and 20 drain to Buckeye FRS No. 2. Buckeye Flood Retarding Structures No. 2 and 3 are long earthen dams. They are drained by small diameter pipe outlets. FRS No. 3 drains to FRS No. 2. In the event of flows in excess of the design capacities, emergency spillways serve to discharge these additional flows. The emergency spillway for FRS No. 3 exits on its east end, while FRS No. 2 spills to the west.

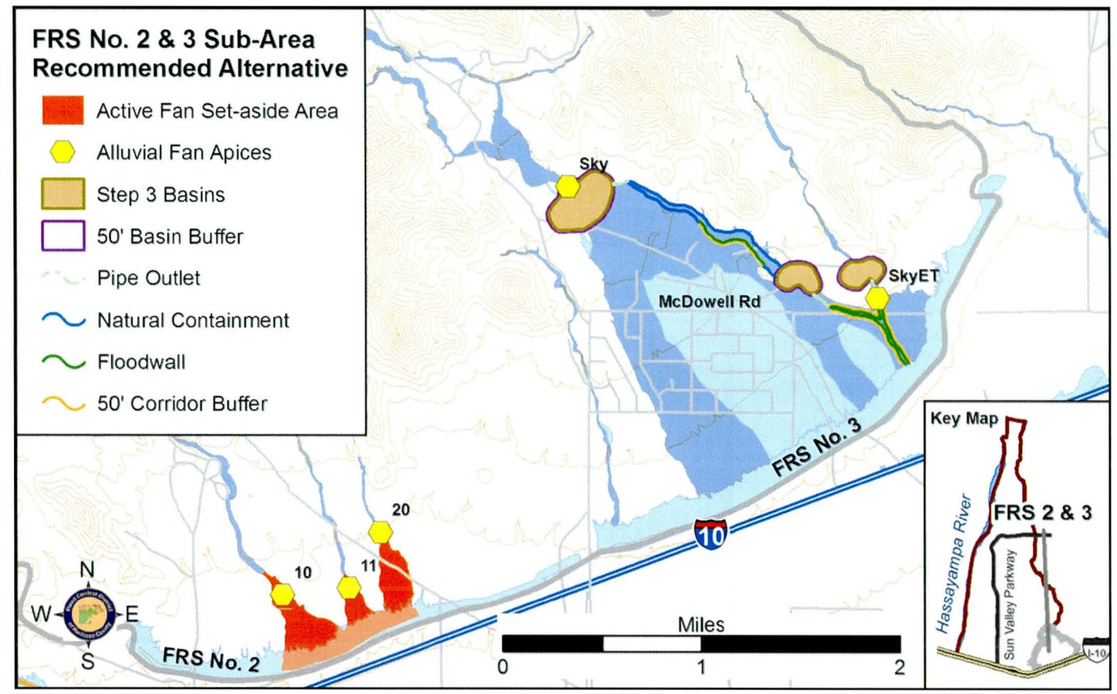

Figure 34 Recommended Alternative Features For FRS No. 2 & 3 Sub-Area

Additional details associated with each fan system within the FRS No. 2 & 3 sub-area are provided in the following sections. The conceptual planimetric layout for each fan system is shown in Figure 34. Larger scale, more detailed layout sheets are found in the appendix for each fan system.

6.1 Skyline Fan System

The Skyline Fan System is composed of three on-line detention basins and 1.9 miles of downstream corridors a half mile of which is naturally contained. The basin at the apex of the Skyline Fan (RRW1) will be approximately 43 acres at the top of the basin and will average eleven feet deep to retain the required 234 acre feet of storage from the drainage area to this fan. The slope of the existing grade will create a height of approximately 36 feet on the uphill side of the basin. A terraced inlet spillway structures with 6 to 8 steps will be needed to collect inflows from Skyline Wash as it enters the basin.

The outflow from the RRW1 basin is contained within the existing downstream wash corridor for about one half mile before the walled levee corridor leads to another on-line detention basin (RRW2B). The length of walled-levee corridor is between the two basins is about one mile. About 7 drop structures would be required to control grade in this reach of the corridor.

The second basin in the Skyline Fan System, RRW2B, will be about 15 acres in top area and will average 10.5 feet in depth. Its total storage volume will be 69 acre feet. The RRW2B basin will drain via two five foot diameter pipes to a walled-leveed corridor. About 1500 feet downstream of RRW2B, the corridor is joined by the outflows from the third Skyline Fan System detention basin, RRX1A. The combined outflows flow about another quarter mile until they outlet into the flood pool of Buckeye FRS No. 3.

The RRX1A basin controls the SkyET alluvial fan just upstream of its apex. The basin has a top area of about 15 acres and will retain about 50 acre feet at the peak of the 100-year flood.

The height of the walls along the Skyline Fan System corridors would range from about four feet to about five feet as the depth of flow varies along the corridor where flows are not naturally contained. Backfill will be needed along much of floodwall to meet the landscape aesthetic treatment objectives. The backfill needed is about 7 ac-ft, which is significantly less than the 1300 ac-ft of total excavation required for the detention basins.

6.2 Fan System 10, 11, & 20

The recommended alternative for Fans 10, 11, and 20 is fully non-structural. Active alluvial fan areas have been delineated for these fans. Table 7 shows a breakdown of the active alluvial fan acreage and land ownership for Fans 10, 11, and 20. The data show that the Flood Control District already possesses the majority of active fan area for these fans. The remaining private land is relatively small in area and therefore a major structural solution for this fan system is not recommended.

Table 7 Fan System 10, 11, & 20 – Active Alluvial Fan Area And Land Ownership

FAN ID	STAGE III Zone	Acres	Owner	% of Land
10	AFUFD	7.6	FCDMC	12.8
10	AFUFD	5.2	FCDMC	8.7
10	AFHH	36.3	FCDMC	61.2
Subtotal		49.1		82.7
10	AFHH	9.0	ASLD	15.1
10	AFHH	1.3	Private - Garretson	2.2
Fan 10 Total		59.4		100.0
11	AFHH	24.1	FCDMC	85.4
11	AFHH	4.1	Private - Garretson	14.6
Fan 11 Total		28.2		100.0
20	AFUFD	4.8	FCDMC	13.6
20	AFHH	10.7	FCDMC	30.0
Subtotal		15.5		43.6
20	AFHH	7.4	State of Arizona	20.7
20	AFHH	2.1	Private - Thomas	6.0
20	AFHH	10.5	Private - Garretson	29.6
Fan 20 Total		35.5		100.0
Total FCDMC		88.6		**72.0**
Total Private		18.1		14.7
Total State		16.3		13.3
Grand Total		123.0		100.0

7 STEP 3 COST ESTIMATES

7.1 Design Cost Estimates

The costs of the recommended alternative were estimated by establishing unit costs for the various design components. The total cost for each component was obtained by multiplying the quantities associated with each design element with the unit costs. The cost components considered in the design are: 1) Land Cost, 2) Construction Cost, 3) Landscaping Cost, and 4) Maintenance Cost.

The four cost components were estimated for each cost category. A summation of all cost components provides the total cost for the particular channel or basin. The costs for all design elements (channels, basins, and dikes) are totaled to provide the total cost for the recommended alternative.

The procedures adopted in estimating the cost for each component are presented below. The details of the calculations performed are presented in Appendix A & B. The summary of the unit costs for all the components is presented in Table 8.

7.1.1 Land Cost

The land cost is the second largest cost component after construction cost. The land cost was estimated using a unit cost of $100,000 per acre. The land areas considered in the estimates are: 1) the on-line basin footprint and set back area, 2) the leveed channel area between the floodwalls and the adjacent maintenance road and setback area.

7.1.2 Construction Cost

The construction costs were estimated mainly based on unit costs for materials and excavation costs. The unit material cost includes all costs associated with material fully constructed in place. For example, a unit cost of $85 per cubic yard for gabions for drop structures includes the cost of material as well the cost of constructing the drop structure. A contingency cost of 25% was applied to the estimated construction cost. Similarly, the cost for the engineering design is set at 5% of the construction cost. The sum of the construction cost, contingency cost and the design cost provides the total construction cost.

7.1.3 Landscaping Cost

The landscaping costs were also applied as unit costs for the cost categories where landscaping is needed. The landscaping costs were based on "per area" unit cost with the areas estimated using the design parameters. A landscaping cost of $0.50 per square foot was assumed. Landscaping costs were applied only to the disturbed elements of the design components. For example, the surface area of the backfill behind the floodwalls was assumed to require landscaping. Similarly, the interior slopes of the detention basins were assumed to require landscaping.

7.1.4 Maintenance Cost

The maintenance costs are based on a 3-year maintenance cycle. The costs are estimated for a design life of 50 years. The costs include maintenance costs for a period of 50 years assuming that maintenance will be performed every 3 years.

7.2 Aesthetic Treatment Costs

In order to ensure that the proposed structural flood control measures are compatible with the future landscape character of the area, some modifications to the engineering design were required. The additional costs will be incurred to ensure that the proposed structural flood control measures conform with the future landscape character of the Sun Valley area and meet the aesthetic treatment requirements. The additional costs were estimated based on increased land area, construction, landscaping, and maintenance requirements for the enhanced structures. Details of the computation of the aesthetic treatment costs are provided in the appendix and summarized in Section 12.

Table 8 Summary Of Unit Costs

	Construction Units	Construction Cost	Landscape Units	Landscape Cost	Maintenance Units	3 Year Maintenance Cost
Levee						
Fill	cu. Yd	$ 7.00	sq. Yd	$ 9.00	sq. Yd	$ 0.70
9 ft Floodwall	LF	$ 144	sq. Yd	$ -	sq. Yd	$ 4.50
10 ft Floodwall	LF	$ 168	sq. Yd	$ -	sq. Yd	$ 4.50
11 ft Floodwall	LF	$ 210	sq. Yd	$ -	sq. Yd	$ 4.50
12 ft Floodwall	LF	$ 256	sq. Yd	$ -	sq. Yd	$ 4.50
13 ft Floodwall	LF	$ 286	sq. Yd	$ -	sq. Yd	$ 4.50
14 ft Floodwall	LF	$ 331	sq. Yd	$ -	sq. Yd	$ 4.50
Toe Protection						
Riprap	cu. Yd	$ 75.00	sq. Yd	$ -	sq. Yd	$ 1.50
Gabions	cu. Yd	$ 85.00	sq. Yd	$ -	sq. Yd	$ 1.70
Soil Cement	cu. Yd	$ 50.00	sq. Yd	$ -	sq. Yd	$ 1.50
Concrete	cu. Yd	$ 155.00	sq. Yd	$ -	sq. Yd	$ 2.35
Levee Lining						
Riprap	cu. Yd	$ 75.00	sq. Yd	$ -	sq. Yd	$ 1.25
Drop Structure						
Riprap	cu. Yd	$ 75.00	sq. Yd	$ -	sq. Yd	$ 2.00
Gabions	cu. Yd	$ 85.00	sq. Yd	$ -	sq. Yd	$ 2.25
Soil Cement	cu. Yd	$ 75.00	sq. Yd	$ -	sq. Yd	$ 3.00
Concrete	cu. Yd	$ 155.00	sq. Yd	$ -	sq. Yd	$ 2.50
Basin Inlet						
Riprap	cu. Yd	$ 75.00	sq. Yd	$ -	sq. Yd	$ 2.00
Concrete	cu. Yd	$ 155.00	sq. Yd	$ -	sq. Yd	$ 2.50
Outlet Pipes						
24" RGRCP	LF	$ 55.00	sq. Yd	$ -		$ 0.55
30" & 36" RGRCP	LF	$ 82.00	sq. Yd	$ -		$ 1.20
42" & 48" RGRCP	LF	$ 160.00	sq. Yd	$ -		$ 2.40
54" & 60" RGRCP	LF	$ 183.00	sq. Yd	$ -		$ 2.75
Channel						
Excavated Channel	$ 10.00	cu. Yd	sq. Yd	$ 9.00	sq. Yd	$ 0.50
Basin						
Excavated Basin	$ 4.00	cu. Yd	sq. Yd	$ 9.00	sq. Yd	$ 0.50

Note: Includes aesthetic treatment costs where applicable.

8 SKYLINE FAN SYSTEM DESIGN SUMMARY

The recommended alternative for the Skyline Fan System in the FRS No. 2 & 3 sub-area of SVADMP was developed and refined in Step 3 of the ADMP process. The alternative includes both non-structural and environmentally friendly and aesthetically compatible structural flood control measures. Engineering and aesthetic treatment costs were also estimated for all of the proposed structural components of the recommended alternative. The recommended alternative was arrived at by a collaborative effort of the project team, stakeholders, and the public. The result for the Skyline Fan System is three on-line detention basins. The basins drain to 1.9 miles of walled-levee corridor confined by poured concrete floodwalls. The floodwalls are buffered by 50 foot areas which include area for maintenance and multiple use access along both sides of the corridor.

A design summary of all the components of the recommended alternative for the Skyline Fan System is presented below. Table 9 shows a summary of the total cost estimates. Table 10 shows a summary of the differential costs for the aesthetic treatment requirements and landscaping.

The estimated total cost of the recommended alternative for the Skyline Fan System is $35.5 million including right of way, construction, aesthetic treatments, and 50 years' maintenance. The three basins costs were estimated at $28.3 million. The walled-levee corridors were estimated at $7.2 million.

The additional costs associated with the landscape aesthetic requirements were also estimated. The results indicate that the aesthetic treatment requirements are about 19 percent of the total cost.

Additional details of the design calculations, hydrologic models, and cost estimates are provided in Appendix A.

Table 9 Design Cost Summary – Skyline Fan System

					Design Geometry			Costs (in $1000)				
Structure ID	Flow Rate (cfs)	ROW Area (acres)	Exc. Vol. (ac. ft)	Fill Vol. (ac. ft)	Length (ft; mi)	ROW Width (ft)	Depth (ft)	Land Cost	Const. Cost	Lndscp Cost	50-Yr Maint. Cost	Total Cost
RRW1	3196	48.5	829.2	0.0	NA	NA	11.0	$ 4,850	$ 8,078	$ 1,057	$ 2,542	$ 16,527
H1W1W2A_2	469	1.2	0.0	0.0	0.135	73	2.7	$ 120	$ -	$ -	$ 0	$ 120
H1W1W2A_1	469	1.8	0.0	0.0	0.098	154	1.9	$ 180	$ -	$ -	$ 1	$ 181
H1W2AW2B_	648	4.0	0.0	0.0	0.246	135	2.2	$ 400	$ 22	$ -	$ 1	$ 422
H1W2AW2B_	869	5.1	0.0	0.8	0.189	226	1.8	$ 510	$ 180	$ 25	$ 101	$ 816
H1W2AW2B_	1090	5.8	0.0	0.8	0.189	256	1.8	$ 580	$ 187	$ 25	$ 99	$ 891
H1W2AW2B_	1310	4.9	0.0	0.0	0.127	321	2.6	$ 490	$ 91	$ -	$ 2	$ 583
RRW2B	1348	18.6	218.8	0.0	NA	NA	10.5	$ 1,860	$ 2,901	$ 406	$ 937	$ 6,104
H1W2BW2C_	360	4.8	0.0	4.2	0.277	146	1.6	$ 480	$ 560	$ 73	$ 297	$ 1,410
H1W2BW2C_	360	3.1	0.0	0.6	0.161	156	1.7	$ 310	$ 275	$ 28	$ 129	$ 742
RRX1A	853	18.3	257.4	0.0	NA	NA	10.0	$ 1,830	$ 2,443	$ 398	$ 1,036	$ 5,707
H1X1AW2C_	76	4.9	0.0	1.2	0.229	181	0.4	$ 490	$ 339	$ 37	$ 160	$ 1,026
H1W2CW2D_	454	4.8	0.0	0.3	0.232	171	1.8	$ 480	$ 385	$ 18	$ 122	$ 1,005
	TOTAL	125.8	1305.4	7.9				$ 12,580	$ 15,462	$ 2,066	$ 5,426	**$ 35,534**
All Channels		40.4	0.0	7.9	1.9			$ 4,040	$ 2,040	$ 205	$ 911	$ 7,196
All Online Basins		85.4	1305.4	0.0				$ 8,540	$ 13,422	$ 1,861	$ 4,515	$ 28,338

Table 10 Aesthetic Treatment Differential Costs Summary – Skyline Fan System

		Aesthetic Treatment Cost Differentials				
Structure ID	Total Cost	Land Cost (%)	Construction Cost (%)	Landscape Cost (%)	Maintenance Cost (%)	Total AT Cost (% of Total Cost)
RRW1	$ 16,527	15%	1%	100%	12%	13%
H1W1W2A_2	$ 120	0%	0%	0%	10%	0%
H1W1W2A_1	$ 181	0%	0%	0%	10%	0%
H1W2AW2B_4	$ 422	0%	8%	0%	10%	1%
H1W2AW2B_3	$ 816	16%	21%	100%	65%	27%
H1W2AW2B_2	$ 891	14%	20%	100%	66%	25%
H1W2AW2B_1	$ 583	0%	1%	0%	6%	0%
RRW2B	$ 6,104	24%	4%	100%	17%	19%
H1W2BW2C_2	$ 1,410	48%	24%	100%	64%	48%
H1W2BW2C_1	$ 742	45%	20%	100%	56%	42%
RRX1A	$ 5,707	24%	2%	100%	17%	19%
H1X1AW2C_1	$ 1,026	39%	20%	100%	59%	40%
H1W2CW2D_1	$ 1,005	42%	17%	100%	38%	35%
	$ 35,534	20%	4%	100%	22%	19%

9 FAN SYSTEM 10, 11, & 20 DESIGN SUMMARY

The recommended alternative for Fan System 10, 11, & 20 in the FRS No. 2 & 3 sub-area of SVADMP is a fully non-structural flood control approach. The recommended alternative was arrived at by a collaborative effort of the project team, stakeholders, and the public. The total active fan area is about 123 acres. Table 7 summarizes the land ownership of the active fan areas for Fans 10, 11, and 20. Seventy-two percent of this acreage is already owned by the Flood Control District.

10 MAINTENANCE PLAN

The primary maintenance concerns for the recommended alternative for the FRS No. 2 & 3 sub-area are the maintenance cycle, funding, and operation responsibilities. As discussed in the cost estimates, a maintenance period of 3 years and a design life of 50 years were assumed. Maintenance also includes regular, periodic and post-storm monitoring of all the flood control facilities. Monitoring includes periodic physical inspections as well as instrumentation of hydraulic performance (e.g. stream/rain gauges). If monitoring indicates the occurrence of a large storm or flood, the entire system should be inspected to verify the post-storm condition of the facilities. There is one item of special note with respect to sediment maintenance of the on-line detention basins. Given the long-term clear water discharge condition downstream of the basin, it is suggested that sediment removed from the basin be moved to the downstream channel to help offset the long-term sediment deficit in this reach. Finally, in order to ensure long-term safe performance of the proposed facilities, funding and execution of the monitoring and maintenance needs to be provided by a public entity. A more detailed discussion of maintenance can be found in Appendix B of Volume 1 of the Step 3 Report in the Preliminary Maintenance Plan.

11 IMPLEMENTATION PLAN

The implementation plan for the recommended alternative involves funding, phasing, and responsibility. While the funds may come from a creative blend of public and private sources, the specifics of such a funding plan are beyond the scope of the ADMP. Given the large dollar amounts associated with these projects, funding will likely come from multiple sources including possible impact fees, various improvement districts, and multiple public agencies.

It is suggested in general that the on-line apex detention basins be constructed first. This will provide for significant protection of the downstream area as the walled-levee corridors are constructed with future development of the area. The large on-line basins provide storage of about 80 percent of the 100-year event for most fan systems.

Any projects constructed to control alluvial fan flooding most likely will require publicly-backed maintenance schemes. For a more detailed discussion of implementation see Appendix A of Volume 1 of the Step 3 Report; Implementation and Stakeholder Involvement Summary. Therein lay more details regarding stakeholder involvement during the ADMP as well as information regarding possible temporal phasing needs and cost sharing opportunities.

12 SUMMARY FOR THE FRS NO. 2 & 3 SUB-AREA

The recommended alternative for the FRS No. 2 & 3 sub-area of the SVADMP was developed and refined in Step 3 of the ADMP process. The alternative includes both non-structural and environmentally friendly and aesthetically compatible structural flood control measures. Engineering and aesthetic treatment costs were also estimated for all of the proposed structural components of the recommended alternative. The recommended alternative was arrived at by a collaborative effort of the project team, stakeholders, and the public.

Table 11 presents a summary of the cost estimates and right-of-way requirements for the recommended alternative for the FRS No. 2 & 3 sub-area. The recommended alternative for the overall sub-area is comprised of about 1.9 miles of walled-levee corridors. The total right of way requirements for the whole sub-area are about 249 acres including about 85 acres for three detention basins and 123 acres of non-structural set-aside area. The Flood Control District already owns about 89 of these acres. The total costs for the FRS No. 2 & 3 sub-area are estimated at about $35.5 million. These costs include right of way, construction, landscaping, and maintenance for a 50-year period. No costs are attributed to the recommended alternative for Fan System 10, 11, & 20. The estimated construction costs are the largest component of the total estimated costs.

Table 11 Summary Of FRS No. 2 & 3 Sub-Area Costs For Recommended Alternative

		Costs (in millions of $)					Cost Percentages			
Fan System	ROW Area (ac)	Land (ROW)	Constr.	Lndscp.	50-Yr Maint.	Total Cost	Land %	Const. %	Lndscp. %	50-Yr Maint. %
SKYLINES	125.8	$12.580	$ 15.462	$ 2.066	$ 5.426	$ 35.534	35%	44%	6%	15%
TOTAL	125.8	$12.580	$ 15.462	$ 2.066	$ 5.426	**$ 35.5**	35%	44%	6%	15%

The landscaping and other aesthetic treatment costs for the FRS No. 2 & 3 sub-area averaged about 19 percent of the recommended alternative costs. This percentage includes about 6 percent for landscaping. The remaining 13 percent is for other aesthetic treatments including additional right of way, integral color, form liners, and additional excavation. The landscaping costs are about half of the District's maximum cost guidelines at about $20,000 per acre. Of the remaining aesthetic treatment costs, about $2.5 million are for additional right of way requirements. The total ROW cost is estimated at about $12.6 million. The District's additional right of way cost ceiling for aesthetic treatment is 30 percent. Therefore, the additional ROW for the recommended alternative lies below the cost ceiling ($2.5 / ($12.6 - $2.5) = 25 %). The total construction costs for the recommended alternative are estimated at about $15.5 million. The portion of the costs attributable to the aesthetic treatment components was estimated at about $0.6

million. This is well within the 4 to 10 percent cost ceiling provided in Table 2 of the District's Policy for Aesthetic Treatment and Landscaping of Flood Control Projects.

Figure 35 shows the recommended alternative for the FRS No. 2 & 3 sub-area. In addition, the existing alluvial fan floodplains are also shown in Figure 35. It can be seen from examination of Figure 35 that a number of benefits would be derived to the FRS No. 2 & 3 sub-area as a result of the implementation of the ADMP recommended alternative. Specifically, the presence of the on-line detention basins eliminates the alluvial fan uncertainty from the flood hazards downstream of the detention basins. The elimination of alluvial fan uncertainty would allow future infrastructure in the area to be designed using conventional engineering analytic approaches and reduce the need for potentially redundant systems downstream. In particular, transportation crossings and underground utilities could be sized for just the downstream contributing drainage area without need to anticipate potential channel instability from the alluvial fan(s) upstream.

Another benefit would be the reduction of the downstream floodplain from that shown in Figure 35. Although detailed redelineation of the post-ADMP floodplain is beyond the scope of the current contract, it is anticipated that most of the Skyline Wash and Skyline ET floodplain will be eliminated.

Finally, in addition to the elimination of alluvial fan uncertainty, the ADMP recommended alternative provides a trunk system to which the downstream development could deliver tributary drainage. A trunk system provides a regional flood control facility that provides controlled connectivity from the alluvial fan apices to the piedmont outfall at the Buckeye FRS No. 3 floodpool.

The non-structural solution of floodplain management for Fan System 10, 11, & 20 will prevent future damages or unsafe development in that portion of the sub-area.

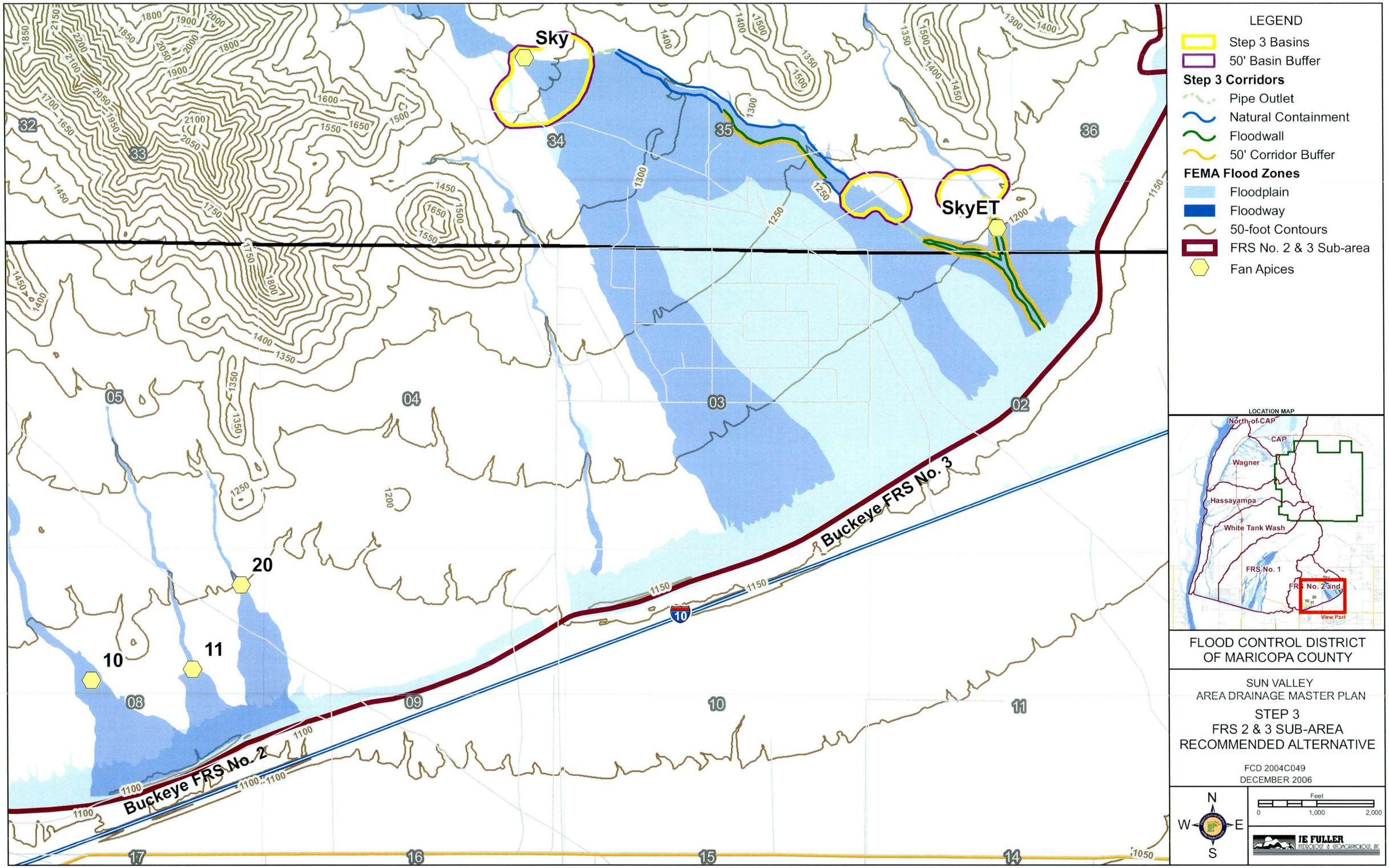

Figure 35 FEMA Floodplains, Recommended Alternative, and Benefited Area

13 RECOMMENDATIONS FOR FUTURE REFINEMENT OF THE CONCEPT DESIGNS

While working on the ADMP, the project team put together a list of things that need to be considered for future refinement of the concept design. The following is a bullet list of these recommendations:

- More detailed topographic information
- More cross sections that are site specific for hydraulically complex locations and that are spaced closer together
- Reevaluate existing channel capacity with new topography and cross section spacing
- Environmental permitting
- Cut/fill balance (including project phasing to make balance make sense)
- Use of roadway crossings and construction disturbance areas for grade control locations
- Site specific geotechnical analysis for construction.
- Incorporation of 50' buffer area into development plans
- Resolution of potential excavation issues such as depth to bedrock
- Consideration of access issues for basin and channel maintenance
- Construction phasing issues relative to urbanization schedule and flood control needs
- Refinement of structure design based on material available such as large rock for stepped boulder drops
- Right-of-way acquisition for facilities needs to occur immediately so that development does not interfere
- Site specific design of floodwalls should be pursued
- Operation and maintenance issues need to be addressed. A publicly-backed entity will be required to assume these responsibilities.

It should be emphasized that the critical elements of the Sun Valley ADMP are the preferred flood control methods, (i.e. on-line detention basins near the alluvial fan apices with downstream flood containment corridors), the alignments selected for the walled-levee flood containment corridors (selected with specific input and coordination with the area stakeholders) and the continued floodplain management of Wagner and White Tank Wash. Site specific details of the detention basins and the corridors can and should be reevaluated prior to going forward with preliminary and final design. Given more detailed answers to some of the above items, the specifics of the engineering design of individual fan systems or fan system components, and their costs, are likely to change. For example, walled-levees may give way to no floodwalls given more specific topographic depiction of existing channel capacity. The specific sizing of individual detention basins could be optimized to reflect the more accurate depiction of the existing downstream capacity. The concept plans presented in this ADMP report should be considered just that – concepts.

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Appendix A

Design Analyses

Skyline Fan System

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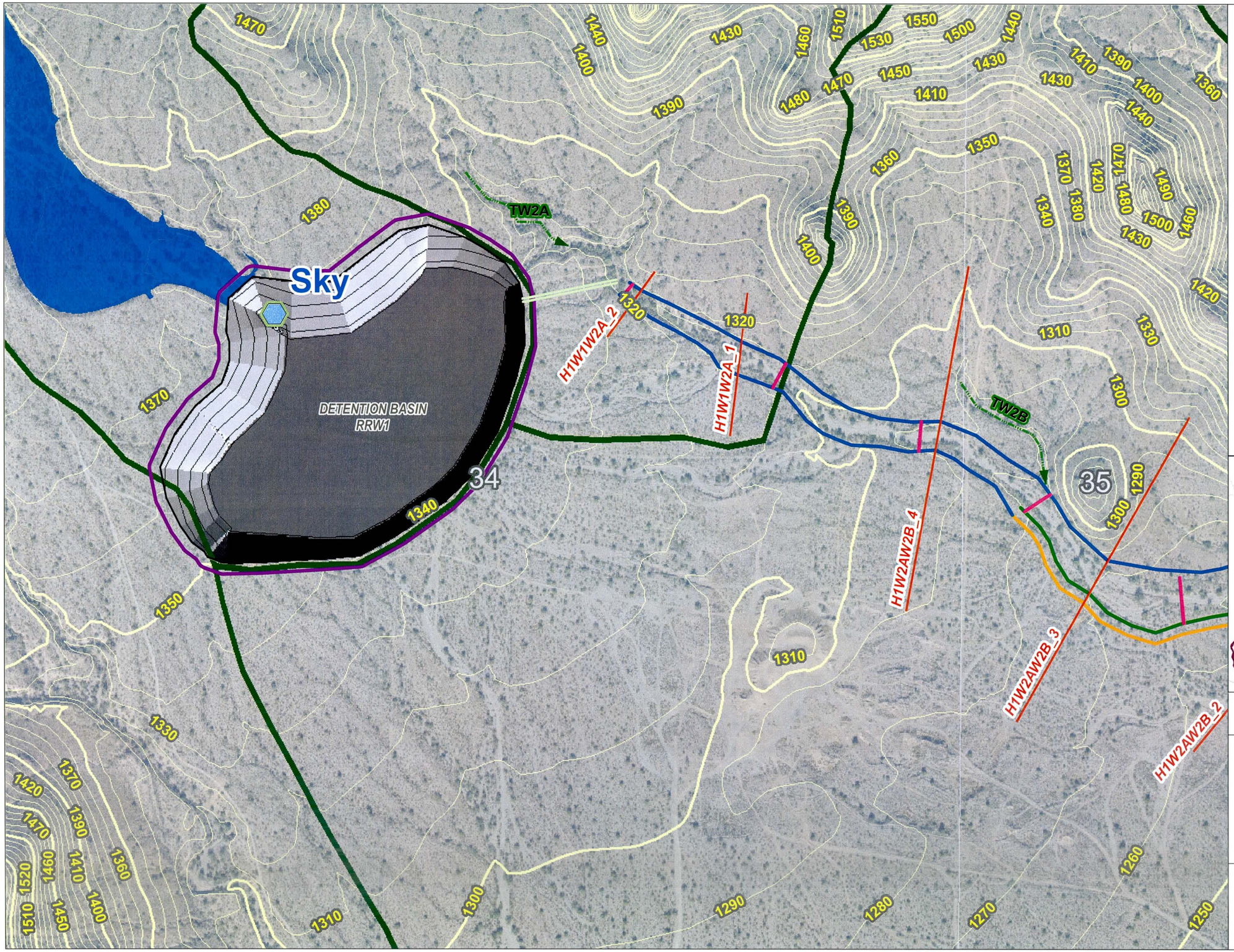


LEGEND

- Step 3 Basins
- 50' Basin Buffer

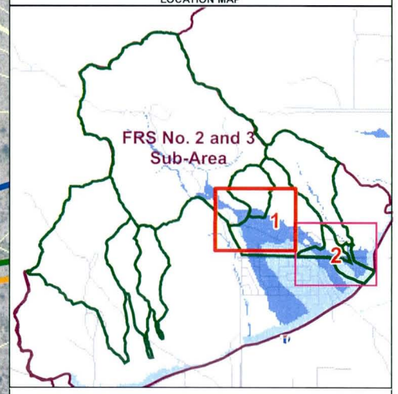
Step 3 Corridors

- Floodwall
- No Floodwall
- Basin Outlet Pipe
- 50' Corridor Buffer
- Grade Control Structure

FEMA Flood Zones

- Floodway Fringe
- Floodway
- Subbasin Boundaries
- Cross Section
- Countywide 10-ft Topo
- Trib. Sed. Supply Reaches
- White Tank Mtn Park
- Fan Apices

LOCATION MAP



FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY

SUN VALLEY
AREA DRAINAGE MASTER PLAN
STEP 3 - FRS 2 & 3 SUB-AREA
SKYLINE FAN SYSTEM
RECOMMENDED ALTERNATIVE

SHEET 1 OF 2

FCD 2004C049
DECEMBER 2006

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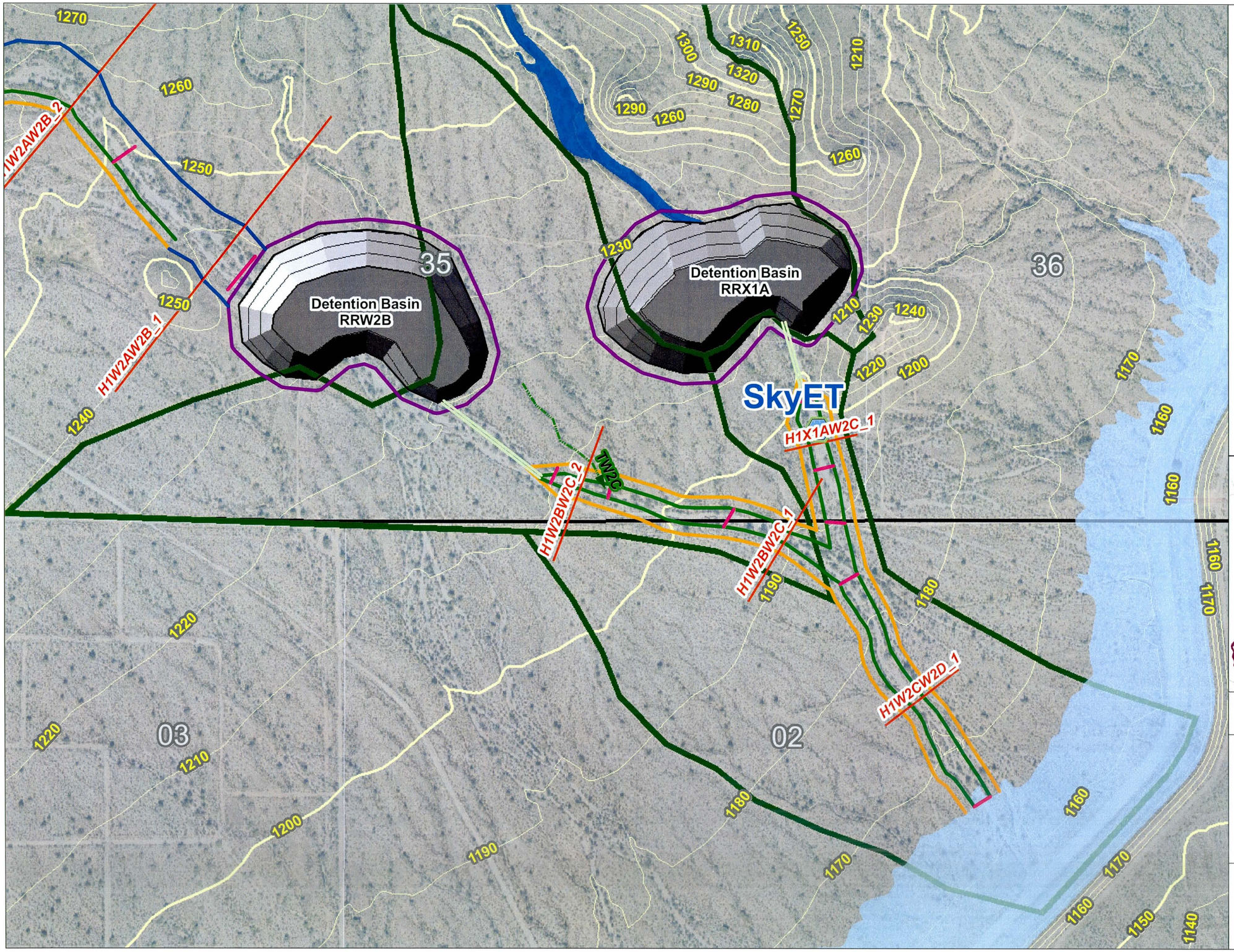

LEGEND

- Step 3 Basins
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Step 3 Corridors

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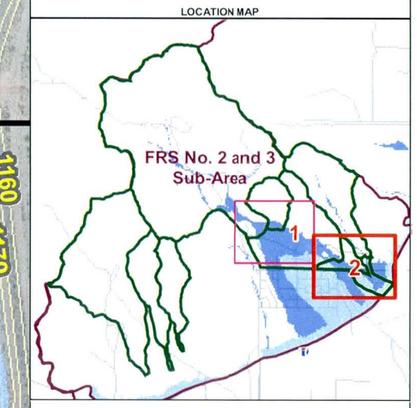
LOCATION MAP



FLOOD CONTROL DISTRICT
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SHEET 2 OF 2

FCD 2004C049

DECEMBER 2006

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Costs Summary

Structure ID	Type	Flow Rate (cfs)	ROW Area (acres)	Excavation Volume (ac. ft)	Fill Volume (ac. ft)	Design Geometry: Length (Dike-ft Channel-miles)	Design Geometry: ROW Width (ft)	Design Geometry: Depth (ft)	Costs (in $1000): Land Cost	Costs (in $1000): Construction Cost	Costs (in $1000): Landscaping Cost	Costs (in $1000): 50-Year Maintenance Cost	Costs (in $1000): Total Cost	Cost Percentages: Land Cost %	Cost Percentages: Construction Cost %	Cost Percentages: Landscaping Cost %	Cost Percentages: 50-Yr Maintenance Cost %	Cost Percentages: % of Fan System Total Cost	Aesthetic Treatment Land Cost Percentage	Aesthetic Treatment Construction Cost Percentage	Aesthetic Treatment Landscaping Cost Percentage	Aesthetic Treatment Maintenance Cost Percentage	Aesthetic Treatment Cost (% of Total Cost)
RRW1	Online Basin	3196	48.5	829.2	0.0	NA	NA	11.0	$ 4,850	$ 8,078	$ 1,057	$ 2,542	$ 16,527	29%	49%	6%	15%	47%	15%	1%	100%	12%	13%
H1W1W2A_2	Walled-Levee Corridor	469	1.2	0.0	0.0	0.135	73	2.7	$ 120	$ -	$ -	$ 0	$ 120	100%	0%	0%	0%	0%	0%	0%	0%	10%	0%
H1W1W2A_1	Walled-Levee Corridor	469	1.8	0.0	0.0	0.098	154	1.9	$ 180	$ -	$ -	$ 1	$ 181	100%	0%	0%	0%	1%	0%	0%	0%	10%	0%
H1W2AW2B_4	Walled-Levee Corridor	648	4.0	0.0	0.0	0.246	135	2.2	$ 400	$ 22	$ -	$ 1	$ 422	95%	5%	0%	0%	1%	0%	8%	0%	10%	1%
H1W2AW2B_3	Walled-Levee Corridor	869	5.1	0.0	0.8	0.189	226	1.8	$ 510	$ 180	$ 25	$ 101	$ 816	63%	22%	3%	12%	2%	16%	21%	100%	65%	27%
H1W2AW2B_2	Walled-Levee Corridor	1090	5.8	0.0	0.8	0.189	256	1.8	$ 580	$ 187	$ 25	$ 99	$ 891	65%	21%	3%	11%	3%	14%	20%	100%	66%	25%
H1W2AW2B_1	Walled-Levee Corridor	1310	4.9	0.0	0.0	0.127	321	2.6	$ 490	$ 91	$ -	$ 2	$ 583	84%	16%	0%	0%	2%	0%	1%	0%	6%	0%
RRW2B	Online Basin	1348	18.6	218.8	0.0	NA	NA	10.5	$ 1,860	$ 2,901	$ 406	$ 937	$ 6,104	30%	48%	7%	15%	17%	24%	4%	100%	17%	19%
H1W2BW2C_2	Walled-Levee Corridor	360	4.8	0.0	4.2	0.277	146	1.6	$ 480	$ 560	$ 73	$ 297	$ 1,410	34%	40%	5%	21%	4%	48%	24%	100%	64%	48%
H1W2BW2C_1	Walled-Levee Corridor	360	3.1	0.0	0.6	0.161	156	1.7	$ 310	$ 275	$ 28	$ 129	$ 742	42%	37%	4%	17%	2%	45%	20%	100%	56%	42%
RRX1A	Online Basin	853	18.3	257.4	0.0	NA	NA	10.0	$ 1,830	$ 2,443	$ 398	$ 1,036	$ 5,707	32%	43%	7%	18%	16%	24%	2%	100%	17%	19%
H1X1AW2C_1	Walled-Levee Corridor	76	4.9	0.0	1.2	0.229	181	0.4	$ 490	$ 339	$ 37	$ 160	$ 1,026	48%	33%	4%	16%	3%	39%	20%	100%	59%	40%
H1W2CW2D_1	Walled-Levee Corridor	454	4.8	0.0	0.3	0.232	171	1.8	$ 480	$ 385	$ 18	$ 122	$ 1,005	48%	38%	2%	12%	3%	42%	17%	100%	38%	35%
		TOTAL	125.8	1305.4	7.9				$ 12,580	$ 15,462	$ 2,066	$ 5,426	**$ 35,534**	35%	44%	6%	15%	100%	20%	4%	100%	22%	19%
All Channels			40.4	0.0	7.9	1.9			$ 4,040	$ 2,040	$ 205	$ 911	$ 7,196	56%	28%	3%	13%	20%					
All Online Basins			85.4	1305.4	0.0				$ 8,540	$ 13,422	$ 1,861	$ 4,515	$ 28,338	30%	47%	7%	16%	80%					
All Offline Basins			0.0	0.0	0.0				$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%					
All Dikes			0.0	0.0	0.0	0			$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%					
Channel Cost per mile (in $1000)			$3,822		Basins Cost per ac. ft. (in $1000)				$21.71														

Hydrology - 6-hr Storm HEC1 Model Results

KK CARD	Type	Peak Flow	Peak Stage (ft)	Peak Storage	Time	Cum.Area (sq. miles)	MAX. Average Flow (cfs)				MAX. Average Rainfall Depth (Inches)				Total Runoff Volume (ac. ft)			
							6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR
W1	BASIN	2527			4.5	4.05	494	124	41	18	1.134	1.139	1.139	1.139	245	246	246	246
RRW1	STORAGE	368	8.2	185.75	5.7	4.05	296	123	41	18	0.679	1.13	1.139	1.139	147	244	246	246
W1W2A	ROUTE	368	101.5	2.16	5.8	4.05	296	123	41	18	0.679	1.13	1.139	1.139	147	244	246	246
W2A	BASIN	525			4	0.28	47	12	4	2	1.528	1.529	1.529	1.529	23	23	23	23
CW2A	COMBINE	368			5.7	4.34	311	131	44	19	0.667	1.122	1.132	1.132	154	260	262	262
W2AW2B	ROUTE	366	100.6	10.55	6	4.34	308	130	44	19	0.66	1.118	1.128	1.128	153	259	261	261
W2B	BASIN	1411			4	0.86	116	29	10	4	1.257	1.258	1.258	1.258	58	58	58	58
CW2B	COMBINE	875			4.1	5.19	367	148	50	21	0.656	1.058	1.067	1.067	182	293	296	296
RRW2B	STORAGE	326	7.3	48.09	7.2	5.19	304	148	50	21	0.544	1.058	1.067	1.067	151	293	296	296
W2BW2C	ROUTE	326	101.3	3.5	7.3	5.19	304	148	50	21	0.544	1.058	1.067	1.067	151	293	296	296
W2C	BASIN	333			4	0.12	17	4	1	1	1.307	1.307	1.307	1.307	9	9	9	9
CW2CR	COMBINE	326			7.3	5.32	304	151	51	22	0.531	1.053	1.062	1.062	151	299	301	301
X1A	BASIN	853			4.2	0.7	109	27	9	4	1.459	1.462	1.462	1.462	54	54	54	54
RRX1A	STORAGE	76	8	44.9	5.3	0.7	64	27	9	4	0.855	1.449	1.462	1.462	32	54	54	54
X1AW2C	ROUTE	76	100.4	0.87	5.4	0.7	64	27	9	4	0.853	1.449	1.462	1.462	32	54	54	54
CW2C	COMBINE	373			6.9	6.01	347	167	56	24	0.536	1.032	1.04	1.04	172	331	334	334
W2CW2D	ROUTE	373	101.2	2.72	7	6.01	346	167	56	24	0.536	1.032	1.04	1.04	172	331	334	334
W2D	BASIN	347			4	0.12	16	4	1	1	1.264	1.264	1.264	1.264	8	8	8	8
CW2D	COMBINE	373			7	6.13	346	169	57	25	0.525	1.027	1.035	1.035	172	336	339	339
S800	BASIN	595			4.2	0.43	74	18	6	3	1.588	1.591	1.591	1.591	36	37	37	37
S810	BASIN	1355			4.4	1.61	225	56	19	8	1.302	1.304	1.304	1.304	112	112	112	112
S820	BASIN	533			4.2	0.36	66	16	5	2	1.683	1.689	1.689	1.689	33	33	33	33

Hydrology - 24-hr Storm HEC1 Model Results

KK CARD	Type	Peak Flow	Peak Stage (ft)	Peak Storage	Time	Cum.Area (sq. miles)	MAX. Average Flow (cfs)				MAX. Average Rainfall Depth (Inches)				Total Runoff Volume (ac. ft)			
							6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR
W1	BASIN	3196			12.4	4.05	525	140	47	20	1.205	1.287	1.288	1.288	261	278	278	278
RRW1	STORAGE	388	8.6	199.89	13.7	4.05	317	137	47	20	0.726	1.254	1.288	1.288	157	271	278	278
W1W2A	ROUTE	388	101.6	2.23	13.7	4.05	316	137	47	20	0.726	1.254	1.288	1.288	157	271	278	278
W2A	BASIN	419			12	0.28	38	10	3	1	1.259	1.343	1.344	1.344	19	20	20	20
CW2A	COMBINE	469			12.1	4.34	336	146	50	22	0.72	1.253	1.286	1.286	166	290	298	298
W2AW2B	ROUTE	391	100.7	11.02	12.4	4.34	332	146	50	22	0.712	1.252	1.286	1.286	165	290	298	298
W2B	BASIN	1305			12	0.86	103	26	9	4	1.111	1.147	1.147	1.147	51	52	52	52
CW2B	COMBINE	1348			12	5.19	414	171	58	25	0.742	1.223	1.254	1.254	206	339	347	347
RRW2B	STORAGE	360	8	54.61	15.1	5.19	340	171	58	25	0.608	1.223	1.254	1.254	169	339	347	347
W2BW2C	ROUTE	360	101.4	3.73	15.2	5.19	340	171	58	25	0.608	1.222	1.254	1.254	168	339	347	347
W2C	BASIN	264			12	0.12	15	4	1	1	1.093	1.093	1.093	1.093	7	7	7	7
CW2CR	COMBINE	360			15.2	5.32	340	174	60	26	0.594	1.218	1.248	1.248	168	345	354	354
X1A	BASIN	729			12.2	0.7	93	25	8	4	1.24	1.323	1.323	1.323	46	49	49	49
RRX1A	STORAGE	69	7	37.5	13.3	0.7	57	24	8	4	0.763	1.291	1.323	1.323	28	48	49	49
X1AW2C	ROUTE	68	100.4	0.81	13.4	0.7	57	24	8	4	0.761	1.291	1.323	1.323	28	48	49	49
CW2C	COMBINE	420			14.9	6.01	394	197	67	29	0.609	1.218	1.249	1.249	195	391	401	401
W2CW2D	ROUTE	420	101.2	2.92	14.9	6.01	394	197	67	29	0.609	1.218	1.249	1.249	195	391	401	401
W2D	BASIN	272			12	0.12	14	3	1	0	1.063	1.063	1.063	1.063	7	7	7	7
CW2D	COMBINE	496			12	6.13	394	200	68	30	0.597	1.213	1.243	1.243	195	397	407	407
S800	BASIN	474			12.2	0.43	61	16	5	2	1.313	1.421	1.422	1.422	30	33	33	33
S810	BASIN	1387			12.3	1.61	209	54	18	8	1.212	1.259	1.259	1.259	104	108	108	108
S820	BASIN	423			12.2	0.36	56	16	5	2	1.432	1.647	1.649	1.649	28	32	32	32

Channels Summary

		Design Geometry						Hydraulics									Sedimentation				
Structure ID	Type	Initial Slope (ft/ft)	Long-term Slope (ft/ft)	Length (stor ft; chl-mi)	Width (ft)	Depth (ft)	Chnl Mannings n	Flow Rate (cfs)	Wetted Perimeter (ft)	Wetted XS Area (ft)	Hydraulic Radius (ft)	Hydraulic Depth (ft)	Flow Depth (ft)	Top Width (ft)	Velocity (ft/s)	Froude Number	Incoming Clear Water?	Incoming Sediment Discharge (cfs)	Channel Sediment Discharge Capacity (cfs)	Toe Protection/Scour Depth (ft)	Drop structure Distance (ft)
H1W1W2A_2	Walled-Levee Corridor	0.0123	0.0184	0.14	72	2.7	0.045	469	45.2	84.3	1.9	1.9	2.7	45	5.6	0.71	No	1.2	0.7	5.5	N/A
H1W1W2A_1	Walled-Levee Corridor	0.0123	0.0194	0.10	153	1.9	0.045	469	114.2	122.1	1.1	1.1	1.9	114	3.8	0.65	No	0.7	0.4	5.1	N/A
H1W2AW2B_4	Walled-Levee Corridor	0.0170	0.0070	0.25	134	2.2	0.045	648	77.5	115.2	1.5	1.5	2.2	77	5.6	0.81	No	0.4	1.3	5.5	300
H1W2AW2B_3	Walled-Levee Corridor	0.0160	0.0227	0.19	175	1.8	0.045	869	145.4	180.0	1.2	1.2	1.8	144	4.8	0.76	No	1.9	1.2	5.2	N/A
H1W2AW2B_2	Walled-Levee Corridor	0.0159	0.0125	0.19	205	1.8	0.045	1090	150.1	209.2	1.4	1.4	1.8	149	5.2	0.77	No	1.2	1.7	5.3	885
H1W2AW2B_1	Walled-Levee Corridor	0.0159	0.0135	0.13	320	2.6	0.045	1310	220.3	272.4	1.2	1.2	2.6	220	4.8	0.76	No	1.7	2.3	5.4	1243
H1W2BW2C_2	Walled-Levee Corridor	0.0171	0.0453	0.28	45	1.6	0.045	360	47.9	66.7	1.4	1.5	1.6	45	5.4	0.78	No	2.3	0.6	5.3	N/A
H1W2BW2C_1	Walled-Levee Corridor	0.0168	0.0236	0.16	55	1.7	0.045	360	57.0	71.9	1.3	1.3	1.7	55	5.0	0.77	No	0.9	0.5	5.3	N/A
H1X1AW2C_1	Walled-Levee Corridor	0.0163	0.0083	0.23	80	0.4	0.045	76	80.6	32.8	0.4	0.4	0.4	80	2.3	0.64	Yes	0.0	0.0	4.7	375
H1W2CW2D_1	Walled-Levee Corridor	0.0170	0.0148	0.23	70	1.8	0.045	454	71.5	90.1	1.3	1.3	1.8	70	5.0	0.78	No	0.6	0.7	5.3	1359

Basins Summary

			Design Geometry				Hydraulics						Sedimentation	
Structure ID	Type	Adjacent Topo. Slope (ft/ft)	Top Area (acres)	Perimeter (ft)	Depth (ft)	Storage Volume Provided	Peak Storage (ac. Ft)	Total Vol. Entering Basin (ac. ft)	Peak Inflow into Basin (cfs)	Peak flow d/s of Basin (cfs)	Peak Stage (ft)	Available Freeboard (ft)	Sediment Volume (ac. ft)	Sediment Depth (ft)
RRW1	Online Basin	0.0211	42.5	5259	11.0	240.7	199.9	278.0	3196	388	8.6	1.0	34.1	1.4
RRW2B	Online Basin	0.0238	14.9	3251	10.5	69.3	54.6	347.0	1348	360	8.0	1.2	9.1	1.3
RRX1A	Online Basin	0.0286	14.6	3207	10.0	52.5	44.9	54.0	853	76	8.0	1.0	4.9	1.0

Online Basin

Structure ID	RRW1	HEC1 ID	RRW1

Design Sediment Yield (MUSLE) Ys = Rw * K * LS * C * P

Rw, Storm Energy Runoff Factor; Rw = a(V*q)^b

Drainage Area =	4.05 sq. mi.
Area Contributing Sediment =	4.05 sq. mi.

Recurrence Interval	Ratios	Volume, V (ac-ft)	Flow Peak (cfs)	a	b	Rw
Q-2	0.1	28	320	95	0.56	15451
Q-5	0.25	70	799	95	0.56	43118
Q-10	0.35	97	1119	95	0.56	62853
Q-25	0.55	153	1758	95	0.56	104274
Q-50	0.75	209	2397	95	0.56	147583
Q-100	1	278	3196	95	0.56	203689

K, Soil Erodibility Factor: Table 14, Camp, 1986

Soil Map Unit	K	% of Basin
100	0.02	74%
98	0.17	23.6%
3	0.16	2.1%
Weighted K Factor:	0.06	

C, Cover and Management Factor; Figures 5-7, SCS Ag. Handbook #537

Cover Type	% of Basin	Canopy Factor	Mulch Factor	Root Factor	Composite C Factor	Weighted C Factor
	100	0.90	0.90	0.40	0.32	0.32
			Composite Weighted C Factor=			0.324

LS, Topographic Factor; LS = ((L/72.6)^n)*(0.065+0.0454*S+0.0065*S^2)

Slope Lengths:	200	ft	(Basin Average)
Slope Angles:	33.6	%	(Basin Average)
n =	0.5		
Eq'n B.4 ADWR Manual, Appendix B			
LS =	14.82		

P, Erosion Control Factor

No Practice, Natural or Regulated	
Weighted P for Contributing Watershed	1

Weighted Average Annual Sediment Yield

Recurrence Interval	Rw	K	LS	C	P	Ys (tons)	Unit Ys (AF/sq.mi)
Q-2	15451	0.06	14.82	0.32	1.00	4328	0.45
Q-5	43118	0.06	14.82	0.32	1.00	12078	1.24
Q-10	62853	0.06	14.82	0.32	1.00	17606	1.81
Q-25	104274	0.06	14.82	0.32	1.00	29209	3.01
Q-50	147583	0.06	14.82	0.32	1.00	41341	4.26
Q-100	203689	0.06	14.82	0.32	1.00	57058	5.88
Weighted Average Annual Sediment Yield:						8200	0.85

Total Sediment Yield Volume (ac. ft)	34.1	Sediment Depth in Basin	1.4 ft

Geometry

Topography slope (ft/ft)	0.021
Side Slope (?H:1V) (ft/ft)	6
Total Depth (ft)	11
Freeboard (ft)	1
Top Perimeter (ft)	5258.9
Top Area (acres)	42.5
Bottom elevation (ft)	1324.2
Adjacent Buffer Width (ft)	50.0

Allocated Storage Volume (ac. ft)	240.7
Total Available Volume (ac. ft) (incl. Freeboard)	305.7
Total Excavation Volume (ac. ft)	829.2

Basin Outlet

Diameter	5.00	ft
Invert Elevation	0.00	ft
Number of pipes	2	

Stage-Storage-Discharge

Elevation	0	2	4	5	6	7	8	9	10	11
Volume	0.00	16.02	68.52	95.72	123.52	151.92	180.82	210.52	240.72	271.62
Outflow	0.0	56.6	167.7	210.8	255.6	312.7	361.3	403.3	440.2	476.9

HEC1 Results

	6-hr Event	24-hr Event	Maximum
Total Flow Volume entering Basin (ac. ft)	246.0	278	278.0
Peak Inflow (cfs)	2527	3196	3196.0
Peak Outflow (cfs)	368	388	388.0
Stage at Peak Outflow (ft)	8.2	8.6	8.6
Volume at Peak Outflow (ac. ft)	185.8	199.89	199.9

Volume Check

Total Volume needed	234.0	ac. ft
Total Volume Provided	240.7	ac. ft
Volume OK?	Yes	

Stage Check

Depth Needed	11.0	ft
Depth Provided	11	ft
Depth OK?	Yes	

Cost Estimates

Storage Basin Excavation	Design	Aesthetic Trtmt.
Excavation Volume (cu Yd)	1337776	0
Excavated Area (sq. Yd)	205700.0	6427.5
Adjacent Buffer Area (sq. Yd)	29216.1	

Inlet	Terraced	Riprap-lined
Average Inlet Height (ft)	37	
Average Inlet Length (ft)	350	
Total Width of all inlets (ft)	325	
Material Thickness (ft)	0.5	3.0
Total Inlet Area (sq. Yd)	13975	0
Total Material Volume (cu. Yd)	2329.2	0
Unit Cost	$ 155.00	$ 75.00
Total Cost	$ 361,026	$ -

Outlet		
Outlet Type	Pipe	
(None, Riprap Weir, Concrete Weir, Pipe)		
Pipe Length	685	ft
Unit Cost	$ 183.00	per ft
Cost per outlet	$ 250,710	
Other Cost	$ -	
Total Cost	$ 250,710	
Outlet Area	133	sq. Yd

Structure Cost

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Basin		1,337,776	cu. Yd	$ 4.00	$ 5,351,104	234,916	sq. Yd	$ 4.50	$ 1,057,122	234,916	sq. Yd	$ 8.33	$ 1,957,634
Inlet					$ 361,026				$ -				$ 582,292
Outlet	Pipe	2	EA	$ 250,710	$ 501,420	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217
Other					$ -				$ -				$ -
		Total without Contingency & Engineering Design Cost			$ 6,213,550			Total	$ 1,057,122			Total	$ 2,542,143
		Contingency Cost (25% of Construction Cost)			$ 1,553,388								
		Engineering Design Cost (5% of Construction Cost)			$ 310,678								
		Total Construction Cost			$ 8,077,615								

Structure Aesthetic Treatment Cost

Basin - Aesthetic Treatment		1,337,776	cu. Yd	$ -	$ -	234,916	sq. Yd	$ 4.50	$ 1,057,122	22,789	sq. Yd	$ 8.33	$ 189,905
Inlet - Aesthetic Treatment (20%Inlet)					$ 72,205				$ -				$ 116,458
Outlet -Aesthetic Treatment (5% Outlet)					$ 25,071	133	sq. Yd	$ -	$ -				$ 111
Other					$ -	0			$ -				$ -
		Total without Contingency & Engineering Design Cost			$ 97,276			Total	$ 1,057,122			Total	$ 306,474
		Contingency Cost (25% of Construction Cost)			$ 24,319								
		Engineering Design Cost (5% of Construction Cost)			$ 4,864								
		Total Construction Cost			$ 126,459								
Total Structure Aesthetic Trtmt Cost	$ 1,490,056												

Land Cost

Land Cost Component	Area (acre)	Unit Cost	Cost
Misc. Right of Way		$100,000	$ -
Adjacent Buffer Area	6.0	$100,000	$ 600,000
Basin	42.5	$100,000	$ 4,250,000
Other		$100,000	$ -
Total	48.5	$100,000	$ 4,850,000

Total Land Related Aes. Trtmt Cost	$ 732,800

Total Cost	$ 16,526,880

Total Aesthetic Treatment Cost	$ 2,222,855

Total ROW Cost	$ 4,850,000

JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC.

Walled-Levee Corridor

Structure ID	H1W1W2A

HEC1 ID	W1W2A

Cutline ID	2

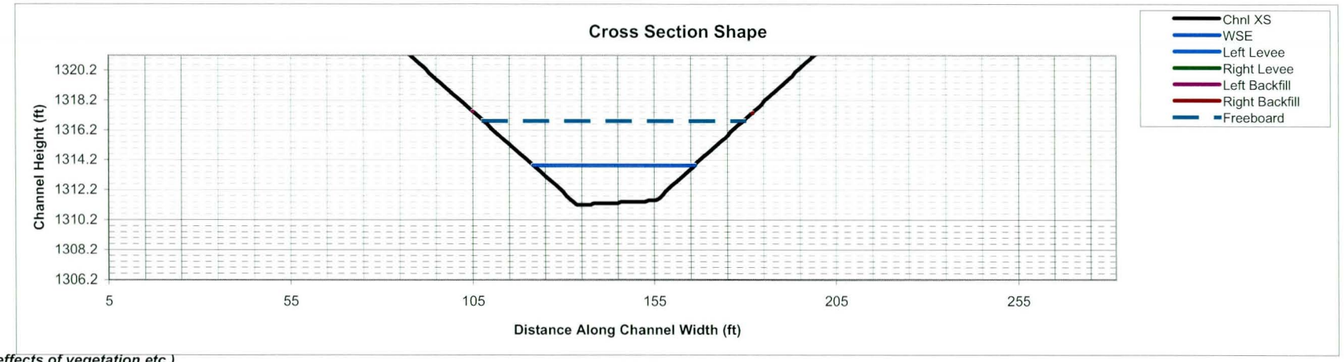
Longitundal Geometry

Length	714.1	ft
Initial Channel Slope	0.0123	ft/ft
Long-term (Equilibrium) Chnl Slope	0.0184	ft/ft

Levee

Left Levee Type	Wall	Right Levee Type	Wall
Left Levee Station (ft)	105	Right Levee Station (ft)	182
Left Adjacent Buffer Width (ft)	0	Right Adjacent Buffer Width (ft)	0
Left Channel Limit Station (ft)	108	Right Channel Limit Station (ft)	180

Channel XS Geometry



Mannings n (includes effects of vegetation etc.)

Location	Initial	Long-term
Mannings n	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	CW2A									TOTAL
HEC1 Peak-Flow	469									
Weighting Factor	1.00									
Flow into Channel	469									469

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Flow Topwidth (ft)	Hydraulic Radius (ft)	Hydraulic Depth (ft)	Froude Number
47	28.0	17.5	1311.2	1312.0	2.7	0.8	27.9	0.6	0.6	0.60
141	33.7	36.4	1311.2	1312.7	3.9	1.5	33.4	1.1	1.1	0.65
352	42.0	68.9	1311.2	1313.5	5.1	2.3	41.5	1.6	1.7	0.70
469	45.2	84.3	1311.2	1313.9	5.6	2.7	44.6	1.9	1.9	0.71

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Flow Topwidth (ft)	Hydraulic Radius (ft)	Hydraulic Depth (ft)	Froude Number
47	27.5	15.4	1311.2	1312.0	3.0	0.8	27.3	0.6	0.6	0.72
141	32.3	31.7	1311.2	1312.5	4.4	1.3	32.0	1.0	1.0	0.79
352	39.9	59.8	1311.2	1313.3	5.9	2.1	39.4	1.5	1.5	0.84
469	43.0	73.3	1311.2	1313.6	6.4	2.4	42.5	1.7	1.7	0.86

Sediment Data

D16 (mm)	0.17	G	3.99
D50 (mm)	0.7		
D65 (mm)	1.2		
D84 (mm)	2.7		
D90 (mm)	4		

Inflowing Sediment Load from U/S Reaches

Dominant Discharge (cfs)	Sediment Inflow (cfs) Contributions from Upstream (Identified using Structure ID)									TOTAL
	TW2A									
141	1.23									1.23

Maximum Permissible Velocity

Channel Lining	Natural - Fine Gravel

Discharge (cfs)	FHWA Max. Permissible Velocity Table
47	Stable
141	Stable
352	Erosive
469	Erosive

FHWA Max. Permissible Velocity (ft/s)	5

Equilibrium Slope Calculations

Dominant Discharge	141	cfs
Clear Water	No	
Total Incoming Sediment Load	1.226	cfs
Initial Chnl Sediment Capacity	0.686	cfs
Long-term Equilibrium Slope (ADWR)	0.0184	

Drop Structures

Design Slope	0.0184	ft/ft
Total Drop Needed	0.0	ft
Height of Drop Structure	3	ft
No. of Drop Structures	0.00	
Distance between Structures	N/A	ft

Total Scour Calculations: Zt = 1.3(Zgs + 1/2ha + Zdeg + Zbs + Zi)

Discharge	Sinuosity	Bend	Max. Depth	Hyd. Depth	Avg Vel	Slope	General Scour	Antidune Wave Height	LongTerm Scour	Bend Scour	Low Flow Incision	Total
Q (cfs)		Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)	Se	Zgs (ft)	ha (ft)	Zdeg (ft)	Zbs (ft)	Zi (ft)	Zt (ft)
469	1.1	24.6	2.7	1.9	5.6	0.0123	-0.6	0.8	1.5	0.3	2.0	5.5

Cost Estimates

Channel Characteristics

Channel Length (ft)	714
Channel Limit-Left Station (ft)	108
Channel Limit-Right Station (ft)	180
Channel Width (ft)	72

Levee

Left Levee Length (ft)	714
Left Levee Top Width (ft)	0.5
Left Levee Height (ft)	0
Right Levee Length (ft)	714
Right Levee Top Width (ft)	0.5
Right Levee Height (ft)	0

Left Levee Surface Area (sq. Yd)	0
Left Levee Volume (cu. Yd)	0
Right Levee Surface Area (sq. Yd)	0
Right Levee Volume (cu. Yd)	0
Total Levee Surface Area (sq. Yd)	0
Total Levee Volume (cu. Yd)	0

Levee Fill

Left Levee Fill Buffer Width (ft)	50
Left Levee Fill Slope (ft/ft)	6
Left Levee Fill ROW Width (ft)	0
Left Levee Fill Surface Area (sq. ft)	0
Left Levee Fill XS area (sq. ft)	0
Left Levee Fill Volume (cu. Yd)	0
Right Levee Fill Buffer Width (ft)	50
Right Levee Fill Slope (ft/ft)	6
Right Levee Fill ROW Width (ft)	0
Right Levee Fill Surface Area (sq. ft)	0
Right Levee Fill XS area (sq. ft)	0
Right Levee Fill Volume (cu. Yd)	0
Total Levee Fill Surface Area (sq. ft)	0
Total Levee Fill Volume (cu Yd)	0

Drop Structures

Structure Type	Gabions	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length (ft)	72	
Aesthetic Treatment Ratio	1.1	
Structure Thickness (ft)	1	
Drop Height (ft)	3	
Scour Depth (ft)	8.1	
Structure Height (ft)	11.1	
Number of Structures	0.00	
	Design	Aesthetic Trtmt.
Volume per structure (cu.Yd)	29.68	2.97
Unit Cost (per cu. Yd)	$ 85.00	$ 85.00
Other Cost	$ -	$ -
Cost per structure	$ 2,523	$ 252
Area per structure (sq. Yd)	8	1
Total Area (cu. Yd)	0	0

Structure Cost

Structure Type		Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Wall Material Cost	Wall	714	ft	$ -	$ -	0	cu. Yd	$ -	$ -	0	cu. Yd	$ -	$ -
Wall Surface Cost	Wall	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ 75.00	$ -
Adjacent Levee Fill	Fill	0	cu. Yd	$ 7.00	$ -	0	sq. Yd	$ 4.50	$ -	0	sq. Yd	$ 11.67	$ -
Wall Material Aesthetic Treatment Cost	Wall	0	cu. Yd	$ -	$ -	0	cu. Yd	$ -	$ -	0	cu. Yd	$ -	$ -
Wall Surface Aesthetic Trtmt. Cost	Wall	0	sq. Yd	$ 63.00	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Drop Structures	Gabions	0	EA	$ 2,522.80	$ -	8	sq. Yd	$ -	$ -	8	sq. Yd	$ 37.50	$ 300
Other					$ -				$ -				$ -
		Total without Contingency & Engineering Design Cost			$ -			Total	$ -			Total	$ 300
		Contingency Cost (25% of Construction Cost)			$ -								
		Engineering Design Cost (5% of Construction Cost)			$ -								
		Total Construction Cost			$ -								
Wall Material Aesthetic Treatment Cost	Wall	0	cu. Yd	$ -	$ -	0	cu. Yd	$ -	$ -	0	cu. Yd	$ -	$ -
Wall Surface Aesthetic Trtmt. Cost	Wall	0	sq. Yd	$ 63.00	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Adj. Levee Fill Aesthetic Trmt. Cost	Fill	0	cu. Yd	$ 7.00	$ -	0	sq. Yd	$ 4.50	$ -	0	sq. Yd	$ 11.67	$ -
Drop Structures Aesthetic Trtmt. Cost	Gabions	0	EA	$ 252.45	$ -	8	sq. Yd	$ -	$ -	1	sq. Yd	$ 37.50	$ 30
Other					$ -				$ -				$ -
		Total without Contingency & Engineering Design Cost			$ -			Total	$ -			Total	$ 30
		Contingency Cost (25% of Construction Cost)			$ -								
		Engineering Design Cost (5% of Construction Cost)			$ -								
		Total Construction Cost			$ -								

Total Structure Aesthetic Trtmt Cost	$ 30

Land Cost

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
Adjacent Buffer Area	0	0	$100,000	$ -
Maintenance Access	0	0	$100,000	$ -
Channel	72	1.2	$100,000	$ 120,000
Levee	1	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	73	1.2		$ 120,000

Total Land Related Aes. Trtmt Cost	$ -

Total Cost	$ 120,300	Total Aesthetic Treatment Cost	$ 30	Total Right of Way Cost	$ 120,000

Walled-Levee Corridor

Structure ID	H1W1W2A	HEC1 ID	W1W2A	Cutline ID	1

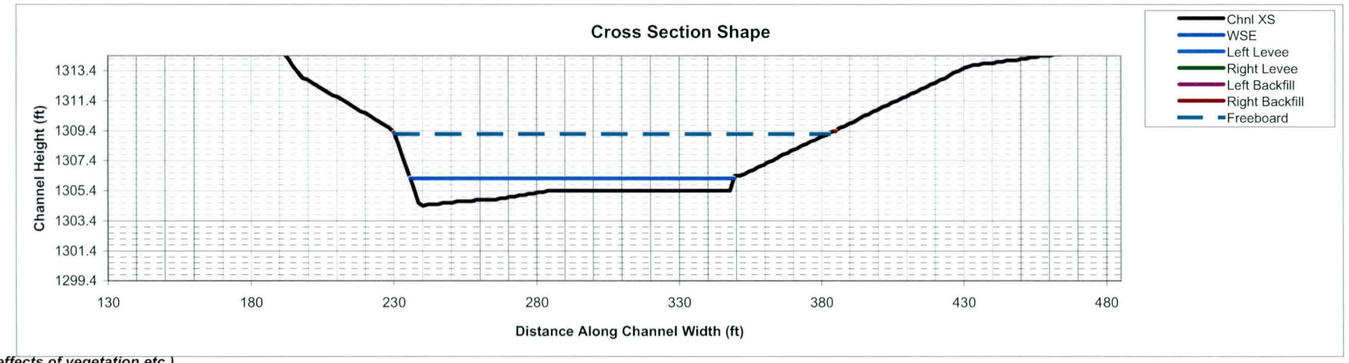
Longitundal Geometry

Length	515.4	ft
Initial Channel Slope	0.0123	ft/ft
Long-term (Equilibrium) Chnl Slope	0.0194	ft/ft

Levee

Left Levee Type	Wall	Right Levee Type	Wall
Left Levee Station (ft)	230	Right Levee Station (ft)	385
Left Adjacent Buffer Width (ft)	0	Right Adjacent Buffer Width (ft)	0
Left Channel Limit Station (ft)	230	Right Channel Limit Station (ft)	383

Channel XS Geometry



Mannings n (includes effects of vegetation etc.)

Location	Initial	Long-term
Mannings n	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	CW2A									TOTAL
HEC1 Peak-Flow	469									
Weighting Factor	1.00									
Flow into Channel	469									469

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Flow Topwidth (ft)	Hydraulic Radius (ft)	Hydraulic Depth (ft)	Froude Number
47	111.0	30.3	1304.4	1305.4	1.5	1.0	110.7	0.3	0.3	0.52
141	112.0	58.8	1304.4	1305.7	2.4	1.3	111.5	0.5	0.5	0.58
352	113.5	102.5	1304.4	1306.1	3.4	1.7	112.9	0.9	0.9	0.63
469	114.2	122.1	1304.4	1306.3	3.8	1.9	113.5	1.1	1.1	0.65

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Flow Topwidth (ft)	Hydraulic Radius (ft)	Hydraulic Depth (ft)	Froude Number
47	110.8	26.4	1304.4	1305.4	1.8	1.0	110.6	0.2	0.2	0.64
141	111.7	51.3	1304.4	1305.6	2.7	1.2	111.3	0.5	0.5	0.71
352	113.1	89.3	1304.4	1306.0	3.9	1.6	112.5	0.8	0.8	0.78
469	113.7	106.3	1304.4	1306.1	4.4	1.7	113.0	0.9	0.9	0.80

Sediment Data

D16 (mm)	0.17	G	3.99
D50 (mm)	0.7		
D65 (mm)	1.2		
D84 (mm)	2.7		
D90 (mm)	4		

Inflowing Sediment Load from U/S Reaches

Dominant Discharge (cfs)	Sediment Inflow (cfs) Contributions from Upstream (Identified using Structure ID)									TOTAL
	H1W1W2A_2									
141	0.69									0.69

Maximum Permissible Velocity

Channel Lining	Natural - Fine Gravel
Discharge (cfs)	**FHWA Max. Permissible Velocity Table**
47	Stable
141	Stable
352	Stable
469	Stable

FHWA Max. Permissible Velocity (ft/s)	5

Equilibrium Slope Calculations

Dominant Discharge	141	cfs
Clear Water	No	
Total Incoming Sediment Load	0.686	cfs
Initial Chnl Sediment Capacity	0.358	cfs
Long-term Equilibrium Slope (ADWR)	0.0194	

Drop Structures

Design Slope	0.0194	ft/ft
Total Drop Needed	0.0	ft
Height of Drop Structure	3	ft
No. of Drop Structures	0.00	
Distance between Structures	N/A	ft

Total Scour Calculations: Zt = 1.3(Zgs + 1/2ha + Zdeg + Zbs + Zi)

Discharge	Sinuosity	Bend	Max. Depth	Hyd. Depth	Avg Vel	Slope	General Scour	Antidune Wave Height	LongTerm Scour	Bend Scour	Low Flow Incision	Total
Q (cfs)		Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)	Se	Zgs (ft)	ha (ft)	Zdeg (ft)	Zbs (ft)	Zi (ft)	Zt (ft)
469	1.1	24.6	1.9	1.1	3.8	0.0123	-0.5	0.4	1.5	0.2	2.0	5.1

Cost Estimates

Channel Characteristics

Channel Length (ft)	515
Channel Limit-Left Station (ft)	230
Channel Limit-Right Station (ft)	383
Channel Width (ft)	153

Levee

Left Levee Length (ft)	515
Left Levee Top Width (ft)	0.5
Left Levee Height (ft)	0
Right Levee Length (ft)	515
Right Levee Top Width (ft)	0.5
Right Levee Height (ft)	0

Left Levee Surface Area (sq. Yd)	0
Left Levee Volume (cu. Yd)	0
Right Levee Surface Area (sq. Yd)	0
Right Levee Volume (cu. Yd)	0
Total Levee Surface Area (sq. Yd)	0
Total Levee Volume (cu. Yd)	0

Levee Fill

Left Levee Fill Buffer Width (ft)	50
Left Levee Fill Slope (ft/ft)	6
Left Levee Fill ROW Width (ft)	0
Left Levee Fill Surface Area (sq. ft)	0
Left Levee Fill XS area (sq. ft)	0
Left Levee Fill Volume (cu. Yd)	0
Right Levee Fill Buffer Width (ft)	50
Right Levee Fill Slope (ft/ft)	6
Right Levee Fill ROW Width (ft)	0
Right Levee Fill Surface Area (sq. ft)	0
Right Levee Fill XS area (sq. ft)	0
Right Levee Fill Volume (cu. Yd)	0
Total Levee Fill Surface Area (sq. ft)	0
Total Levee Fill Volume (cu Yd)	0

Drop Structures

Structure Type	Gabions	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length (ft)	153	
Aesthetic Treatment Ratio	1.1	
Structure Thickness (ft)	1	
Drop Height (ft)	3	
Scour Depth (ft)	4.7	
Structure Height (ft)	7.7	
Number of Structures	0.00	
	Design	Aesthetic Trtmt.
Volume per structure (cu.Yd)	43.65	4.37
Unit Cost (per cu. Yd)	$ 85.00	$ 85.00
Other Cost	$ -	$ -
Cost per structure	$ 3,710	$ 371
Area per structure (sq. Yd)	17	2
Total Area (cu. Yd)	0	0

Structure Cost

Structure Type	Structure Type	Construction Quantity	Construction Units	Construction Unit Cost	Construction Cost Subtotal	Landscape Quantity	Landscape Units	Landscape Unit Cost	Landscape Cost	Maintenance Quantity	Maintenance Units	Maintenance Unit Cost	Maintenance Cost
Wall Material Cost	Wall	515	ft	$ -	$ -	0	cu. Yd	$ -	$ -	0	cu. Yd	$ -	$ -
Wall Surface Cost	Wall	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ 75.00	$ -
Adjacent Levee Fill	Fill	0	cu. Yd	$ 7.00	$ -	0	sq. Yd	$ 4.50	$ -	0	sq. Yd	$ 11.67	$ -
Wall Material Aesthetic Treatment Cost	Wall	0	cu. Yd	$ -	$ -	0	cu. Yd	$ -	$ -	0	cu. Yd	$ -	$ -
Wall Surface Aesthetic Trtmt. Cost	Wall	0	sq. Yd	$ 63.00	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Drop Structures	Gabions	0	EA	$ 3,710.25	$ -	17	sq. Yd	$ -	$ -	17	sq. Yd	$ 37.50	$ 638
Other					$ -				$ -				$ -
		Total without Contingency & Engineering Design Cost			$ -			Total	$ -			Total	$ 638
		Contingency Cost (25% of Construction Cost)			$ -								
		Engineering Design Cost (5% of Construction Cost)			$ -								
		Total Construction Cost			$ -								
Wall Material Aesthetic Treatment Cost	Wall	0	cu. Yd	$ -	$ -	0	cu. Yd	$ -	$ -	0	cu. Yd	$ -	$ -
Wall Surface Aesthetic Trtmt. Cost	Wall	0	sq. Yd	$ 63.00	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Adj. Levee Fill Aesthetic Trmt. Cost	Fill	0	cu. Yd	$ 7.00	$ -	0	sq. Yd	$ 4.50	$ -	0	sq. Yd	$ 11.67	$ -
Drop Structures Aesthetic Trtmt. Cost	Gabions	0	EA	$ 371.45	$ -	17	sq. Yd	$ -	$ -	2	sq. Yd	$ 37.50	$ 64
Other					$ -				$ -				$ -
		Total without Contingency & Engineering Design Cost			$ -			Total	$ -			Total	$ 64
		Contingency Cost (25% of Construction Cost)			$ -								
		Engineering Design Cost (5% of Construction Cost)			$ -								
		Total Construction Cost			$ -								

Total Structure Aesthetic Trtmt Cost	$ 64

Land Cost

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
Adjacent Buffer Area	0	0	$100,000	$ -
Maintenance Access	0	0	$100,000	$ -
Channel	153	1.8	$100,000	$ 180,000
Levee	1	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	154	1.8		$ 180,000

Total Land Related Aes. Trtmt Cost	$ -

Total Cost	$ 180,638	Total Aesthetic Treatment Cost	$ 64	Total Right of Way Cost	$ 180,000

Walled-Levee Corridor

Structure ID	H1W2AW2B	HEC1 ID	W2AW2B	Cutline ID	4

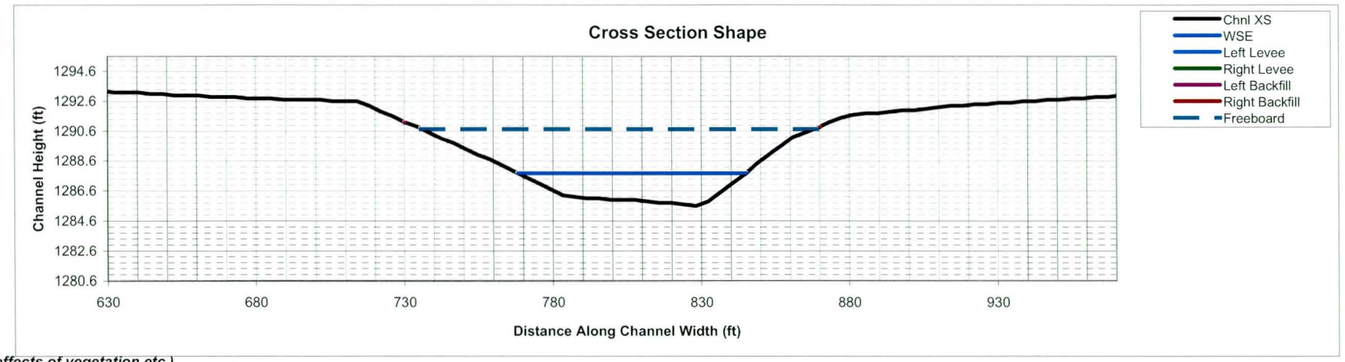
Longitundal Geometry

Length	1299.8	ft
Initial Channel Slope	0.0170	ft/ft
Long-term (Equilibrium) Chnl Slope	0.0070	ft/ft

Levee

Left Levee Type	Wall	Right Levee Type	Wall
Left Levee Station (ft)	730	Right Levee Station (ft)	870
Left Adjacent Buffer Width (ft)	0	Right Adjacent Buffer Width (ft)	0
Left Channel Limit Station (ft)	735	Right Channel Limit Station (ft)	869

Channel XS Geometry



Mannings n (includes effects of vegetation etc.)

Location	Initial	Long-term
Mannings n	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	CW2B	CW2A								TOTAL
HEC1 Peak-Flow	1348	469								
Weighting Factor	0.20	0.80								
Flow into Channel	275	373								648

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Flow Topwidth (ft)	Hydraulic Radius (ft)	Hydraulic Depth (ft)	Froude Number
65	54.0	25.0	1285.6	1286.4	2.6	0.8	53.9	0.5	0.5	0.67
194	61.7	51.1	1285.6	1286.9	3.8	1.3	61.6	0.8	0.8	0.74
486	72.9	94.6	1285.6	1287.5	5.1	1.9	72.7	1.3	1.3	0.79
648	77.5	115.2	1285.6	1287.8	5.6	2.2	77.2	1.5	1.5	0.81

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Flow Topwidth (ft)	Hydraulic Radius (ft)	Hydraulic Depth (ft)	Froude Number
65	56.5	33.3	1285.6	1286.6	1.9	1.0	56.4	0.6	0.6	0.45
194	66.4	68.7	1285.6	1287.2	2.8	1.6	66.3	1.0	1.0	0.49
486	80.1	128.2	1285.6	1288.0	3.8	2.4	79.9	1.6	1.6	0.53
648	85.5	156.4	1285.6	1288.3	4.1	2.7	85.2	1.8	1.8	0.54

Sediment Data

D16 (mm)	0.17	G	3.99
D50 (mm)	0.7		
D65 (mm)	1.2		
D84 (mm)	2.7		
D90 (mm)	4		

Inflowing Sediment Load from U/S Reaches

Dominant Discharge (cfs)	Sediment Inflow (cfs) Contributions from Upstream (Identified using Structure ID)									TOTAL
	H1W1W2A_1									
194	0.36									0.36

Maximum Permissible Velocity

Channel Lining	Natural - Fine Gravel

Discharge (cfs)	FHWA Max. Permissible Velocity Table
65	Stable
194	Stable
486	Erosive
648	Erosive

FHWA Max. Permissible Velocity (ft/s)	5

Equilibrium Slope Calculations

Dominant Discharge	194	cfs
Clear Water	No	
Total Incoming Sediment Load	0.358	cfs
Initial Chnl Sediment Capacity	1.285	cfs
Long-term Equilibrium Slope (ADWR)	0.0070	

Drop Structures

Design Slope	0.0070	ft/ft
Total Drop Needed	13.0	ft
Height of Drop Structure	3	ft
No. of Drop Structures	4.33	
Distance between Structures	300	ft

Total Scour Calculations: Zt = 1.3(Zgs + 1/2ha + Zdeg + Zbs + Zi)

Discharge	Sinuosity	Bend	Max. Depth	Hyd. Depth	Avg Vel	Slope	General Scour	Antidune Wave Height	LongTerm Scour	Bend Scour	Low Flow Incision	Total
Q (cfs)		Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)	Se	Zgs (ft)	ha (ft)	Zdeg (ft)	Zbs (ft)	Zi (ft)	Zt (ft)
648	1.1	24.6	2.2	1.5	5.6	0.0170	-0.5	0.9	1.5	0.3	2.0	5.5

Cost Estimates

Channel Characteristics

Channel Length (ft)	1300
Channel Limit-Left Station (ft)	735
Channel Limit-Right Station (ft)	869
Channel Width (ft)	134

Levee

Left Levee Length (ft)	1300
Left Levee Top Width (ft)	0.5
Left Levee Height (ft)	0
Right Levee Length (ft)	1300
Right Levee Top Width (ft)	0.5
Right Levee Height (ft)	0

Left Levee Surface Area (sq. Yd)	0
Left Levee Volume (cu. Yd)	0
Right Levee Surface Area (sq. Yd)	0
Right Levee Volume (cu. Yd)	0
Total Levee Surface Area (sq. Yd)	0
Total Levee Volume (cu. Yd)	0

Levee Fill

Left Levee Fill Buffer Width (ft)	50
Left Levee Fill Slope (ft/ft)	6
Left Levee Fill ROW Width (ft)	0
Left Levee Fill Surface Area (sq. ft)	0
Left Levee Fill XS area (sq. ft)	0
Left Levee Fill Volume (cu. Yd)	0
Right Levee Fill Buffer Width (ft)	50
Right Levee Fill Slope (ft/ft)	6
Right Levee Fill ROW Width (ft)	0
Right Levee Fill Surface Area (sq. ft)	0
Right Levee Fill XS area (sq. ft)	0
Right Levee Fill Volume (cu. Yd)	0
Total Levee Fill Surface Area (sq. ft)	0
Total Levee Fill Volume (cu Yd)	0

Drop Structures

Structure Type	Gabions	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length (ft)	134	
Aesthetic Treatment Ratio	1.1	
Structure Thickness (ft)	1	
Drop Height (ft)	3	
Scour Depth (ft)	6.1	
Structure Height (ft)	9.1	
Number of Structures	4.33	
	Design	Aesthetic Trtmt.
Volume per structure (cu.Yd)	45.33	4.53
Unit Cost (per cu. Yd)	$ 85.00	$ 85.00
Other Cost	$ -	$ -
Cost per structure	$ 3,853	$ 385
Area per structure (sq. Yd)	15	1
Total Area (cu. Yd)	64	0

Structure Type	Structure Cost													
		Construction				Landscape				Maintenance				
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Wall Material Cost	Wall	1,300	ft	$ -	$ -	0	cu. Yd	$ -	$ -	0	cu. Yd	$ -	$ -
Wall Surface Cost	Wall	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ 75.00	$ -
Adjacent Levee Fill	Fill	0	cu. Yd	$ 7.00	$ -	0	sq. Yd	$ 4.50	$ -	0	sq. Yd	$ 11.67	$ -
Wall Material Aesthetic Treatment Cost	Wall	0	cu. Yd	$ -	$ -	0	cu. Yd	$ -	$ -	0	cu. Yd	$ -	$ -
Wall Surface Aesthetic Trtmt. Cost	Wall	0	sq. Yd	$ 63.00	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Drop Structures	Gabions	4	EA	$ 3,853.05	$ 16,684	15	sq. Yd	$ -	$ -	15	sq. Yd	$ 37.50	$ 558
Other					$ -				$ -				$ -
		Total without Contingency & Engineering Design Cost			$ 16,684			Total	$ -			Total	$ 558
		Contingency Cost (25% of Construction Cost)			$ 4,171								
		Engineering Design Cost (5% of Construction Cost)			$ 834								
		Total Construction Cost			$ 21,689								
Wall Material Aesthetic Treatment Cost	Wall	0	cu. Yd	$ -	$ -	0	cu. Yd	$ -	$ -	0	cu. Yd	$ -	$ -
Wall Surface Aesthetic Trtmt. Cost	Wall	0	sq. Yd	$ 63.00	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Adj. Levee Fill Aesthetic Trmt. Cost	Fill	0	cu. Yd	$ 7.00	$ -	0	sq. Yd	$ 4.50	$ -	0	sq. Yd	$ 11.67	$ -
Drop Structures Aesthetic Trtmt. Cost	Gabions	4	EA	$ 385.05	$ 1,667	15	sq. Yd	$ -	$ -	1	sq. Yd	$ 37.50	$ 56
Other					$ -				$ -				$ -
		Total without Contingency & Engineering Design Cost			$ 1,667			Total	$ -			Total	$ 56
		Contingency Cost (25% of Construction Cost)			$ 417								
		Engineering Design Cost (5% of Construction Cost)			$ 83								
		Total Construction Cost			$ 2,167								
Total Structure Aesthetic Trtmt Cost	$ 2,223												

Land Cost

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
Adjacent Buffer Area	0	0	$100,000	$ -
Maintenance Access	0	0	$100,000	$ -
Channel	134	4	$100,000	$ 400,000
Levee	1	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	135	4		$ 400,000

Total Land Related Aes. Trtmt Cost	$ -

Total Cost	$ 422,247	Total Aesthetic Treatment Cost	$ 2,223	Total Right of Way Cost	$ 400,000

JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC.

Sub-area: FRS 2 & 3, Skyline Fan System
Walled-Levee Corridor Structure ID: H1W2AW2B, Cutline ID: 4

Walled-Levee Corridor

Structure ID	H1W2AW2B	HEC1 ID	W2AW2B	Cutline ID	3

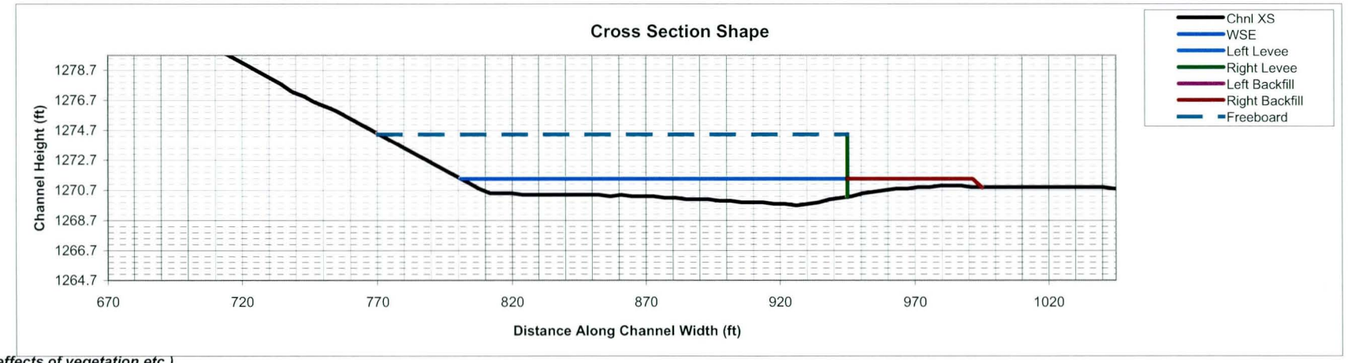
Longitundal Geometry

Length	1000.0	ft
Initial Channel Slope	0.0160	ft/ft
Long-term (Equilibrium) Chnl Slope	0.0227	ft/ft

Levee

Left Levee Type	Wall	Right Levee Type	Wall
Left Levee Station (ft)	770	Right Levee Station (ft)	945
Left Adjacent Buffer Width (ft)	0	Right Adjacent Buffer Width (ft)	50
Left Channel Limit Station (ft)	770	Right Channel Limit Station (ft)	945

Channel XS Geometry



Mannings n (includes effects of vegetation etc.)

Location	Initial	Long-term
Mannings n	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	CW2B	CW2A								TOTAL
HEC1 Peak-Flow	1348	469								
Weighting Factor	0.46	0.54								
Flow into Channel	614	255								869

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Flow Topwidth (ft)	Hydraulic Radius (ft)	Hydraulic Depth (ft)	Froude Number
87	133.4	43.7	1269.7	1270.5	2.0	0.8	133.2	0.3	0.3	0.61
261	137.9	85.6	1269.7	1270.8	3.0	1.1	137.4	0.6	0.6	0.68
652	143.1	150.5	1269.7	1271.3	4.3	1.6	142.0	1.1	1.1	0.74
869	145.4	180.0	1269.7	1271.5	4.8	1.8	144.1	1.2	1.2	0.76

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Flow Topwidth (ft)	Hydraulic Radius (ft)	Hydraulic Depth (ft)	Froude Number
87	123.6	38.1	1269.7	1270.5	2.3	0.8	123.3	0.3	0.3	0.72
261	137.1	76.9	1269.7	1270.8	3.4	1.1	136.5	0.6	0.6	0.80
652	141.9	135.0	1269.7	1271.2	4.8	1.5	140.9	1.0	1.0	0.87
869	144.0	161.4	1269.7	1271.4	5.4	1.7	142.8	1.1	1.1	0.89

Sediment Data

D16 (mm)	0.17	G	3.99
D50 (mm)	0.7		
D65 (mm)	1.2		
D84 (mm)	2.7		
D90 (mm)	4		

Inflowing Sediment Load from U/S Reaches

Dominant Discharge (cfs)	Sediment Inflow (cfs) Contributions from Upstream (Identified using Structure ID)									TOTAL
	H1W2AW2B_4	TW2B								
261	1.29	0.65								1.94

Maximum Permissible Velocity

Channel Lining	Natural - Fine Gravel
Discharge (cfs)	**FHWA Max. Permissible Velocity Table**
87	Stable
261	Stable
652	Stable
869	Stable

FHWA Max. Permissible Velocity (ft/s)	5

Equilibrium Slope Calculations

Dominant Discharge	261	cfs
Clear Water	No	
Total Incoming Sediment Load	1.938	cfs
Initial Chnl Sediment Capacity	1.193	cfs
Long-term Equilibrium Slope (ADWR)	0.0227	

Drop Structures

Design Slope	0.0227	ft/ft
Total Drop Needed	0.0	ft
Height of Drop Structure	3	ft
No. of Drop Structures	0.00	
Distance between Structures	N/A	ft

Total Scour Calculations: Zt = 1.3(Zgs + 1/2ha + Zdeg + Zbs + Zi)

Discharge	Sinuosity	Bend	Max. Depth	Hyd. Depth	Avg Vel	Slope	General Scour	Antidune Wave Height	LongTerm Scour	Bend Scour	Low Flow Incision	Total
Q (cfs)		Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)	Se	Zgs (ft)	ha (ft)	Zdeg (ft)	Zbs (ft)	Zi (ft)	Zt (ft)
869	1.1	24.6	1.8	1.2	4.8	0.0160	-0.4	0.6	1.5	0.2	2.0	5.2

Cost Estimates

Channel Characteristics

Channel Length (ft)	1000
Channel Limit-Left Station (ft)	770
Channel Limit-Right Station (ft)	945
Channel Width (ft)	175

Levee

Left Levee Length (ft)	1000
Left Levee Top Width (ft)	0.5
Left Levee Height (ft)	0
Right Levee Length (ft)	1000
Right Levee Top Width (ft)	0.5
Right Levee Height (ft)	4.2

Left Levee Surface Area (sq. Yd)	0
Left Levee Volume (cu. Yd)	0
Right Levee Surface Area (sq. Yd)	467
Right Levee Volume (cu. Yd)	78
Total Levee Surface Area (sq. Yd)	467
Total Levee Volume (cu. Yd)	78

Levee Fill

Left Levee Fill Buffer Width (ft)	50
Left Levee Fill Slope (ft/ft)	6
Left Levee Fill ROW Width (ft)	0
Left Levee Fill Surface Area (sq. ft)	0
Left Levee Fill XS area (sq. ft)	0
Left Levee Fill Volume (cu. Yd)	0
Right Levee Fill Buffer Width (ft)	50
Right Levee Fill Slope (ft/ft)	6
Right Levee Fill ROW Width (ft)	50
Right Levee Fill Surface Area (sq. ft)	50000
Right Levee Fill XS area (sq. ft)	33.7
Right Levee Fill Volume (cu. Yd)	1248
Total Levee Fill Surface Area (sq. ft)	50000
Total Levee Fill Volume (cu Yd)	1248

Drop Structures

Structure Type	Gabions	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length (ft)	175	
Aesthetic Treatment Ratio	1.1	
Structure Thickness (ft)	1	
Drop Height (ft)	3	
Scour Depth (ft)	5.9	
Structure Height (ft)	8.9	
Number of Structures	0.00	
	Design	Aesthetic Trtmt.
Volume per structure (cu.Yd)	57.62	5.76
Unit Cost (per cu. Yd)	$ 85.00	$ 85.00
Other Cost	$ -	$ -
Cost per structure	$ 4,898	$ 490
Area per structure (sq. Yd)	19	2
Total Area (cu. Yd)	0	0

Structure Type	Structure Cost													
		Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Wall Material Cost	Wall	1,000	ft	$ 100	$ 100,480	78	cu. Yd	$ -	$ -	78	cu. Yd	$ -	$ -
Wall Surface Cost	Wall	467	sq. Yd	$ -	$ -	467	sq. Yd	$ -	$ -	467	sq. Yd	$ 75.00	$ 35,025
Adjacent Levee Fill	Fill	1,248	cu. Yd	$ 7.00	$ 8,736	5,556	sq. Yd	$ 4.50	$ 25,000	5,556	sq. Yd	$ 11.67	$ 64,815
Wall Material Aesthetic Treatment Cost	Wall	78	cu. Yd	$ -	$ -	78	cu. Yd	$ -	$ -	78	cu. Yd	$ -	$ -
Wall Surface Aesthetic Trtmt. Cost	Wall	467	sq. Yd	$ 63.00	$ 29,421	467	sq. Yd	$ -	$ -	467	sq. Yd	$ -	$ -
Drop Structures	Gabions	0	EA	$ 4,897.70	$ -	19	sq. Yd	$ -	$ -	19	sq. Yd	$ 37.50	$ 729
Other					$ -				$ -				$ -
		Total without Contingency & Engineering Design Cost			$ 138,637			Total	$ 25,000			Total	$ 100,569
		Contingency Cost (25% of Construction Cost)			$ 34,659								
		Engineering Design Cost (5% of Construction Cost)			$ 6,932								
		Total Construction Cost			$ 180,228								
Wall Material Aesthetic Treatment Cost	Wall	78	cu. Yd	$ -	$ -	78	cu. Yd	$ -	$ -	78	cu. Yd	$ -	$ -
Wall Surface Aesthetic Trtmt. Cost	Wall	467	sq. Yd	$ 63.00	$ 29,421	467	sq. Yd	$ -	$ -	467	sq. Yd	$ -	$ -
Adj. Levee Fill Aesthetic Trmt. Cost	Fill	1,248	cu. Yd	$ 7.00	$ 8,736	5,556	sq. Yd	$ 4.50	$ 25,000	5,556	sq. Yd	$ 11.67	$ 64,815
Drop Structures Aesthetic Trtmt. Cost	Gabions	0	EA	$ 489.60	$ -	19	sq. Yd	$ -	$ -	2	sq. Yd	$ 37.50	$ 73
Other					$ -				$ -				$ -
		Total without Contingency & Engineering Design Cost			$ 38,157			Total	$ 25,000			Total	$ 64,888
		Contingency Cost (25% of Construction Cost)			$ 9,539								
		Engineering Design Cost (5% of Construction Cost)			$ 1,908								
		Total Construction Cost			$ 49,604								
Total Structure Aesthetic Trtmt Cost	$ 139,492												

Land Cost

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
Adjacent Buffer Area	35	0.8	$100,000	$ 80,000
Maintenance Access	15	0.3	$100,000	$ 30,000
Channel	175	4	$100,000	$ 400,000
Levee	1	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	226	5.1		$ 510,000

Total Land Related Aes. Trtmt Cost	$ 80,000

Total Cost	$ 815,797

Total Aesthetic Treatment Cost	$ 219,492

Total Right of Way Cost	$ 510,000

Walled-Levee Corridor

Structure ID	H1W2AW2B

HEC1 ID	W2AW2B

Cutline ID	2

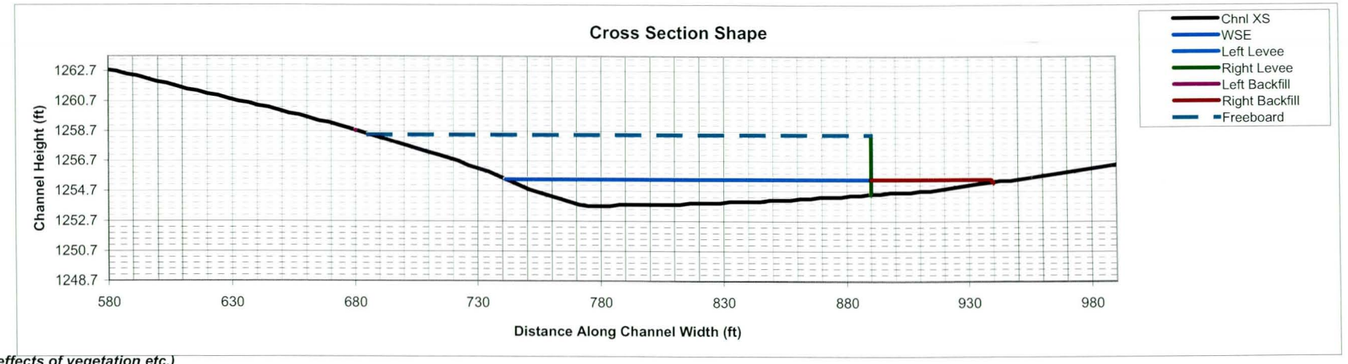
Longitundal Geometry

Length	1000.0	ft
Initial Channel Slope	0.0159	ft/ft
Long-term (Equilibrium) Chnl Slope	0.0125	ft/ft

Levee

Left Levee Type	Wall	Right Levee Type	Wall
Left Levee Station (ft)	680	Right Levee Station (ft)	890
Left Adjacent Buffer Width (ft)	0	Right Adjacent Buffer Width (ft)	50
Left Channel Limit Station (ft)	685	Right Channel Limit Station (ft)	890

Channel XS Geometry



Mannings n (includes effects of vegetation etc.)

Location	Initial	Long-term
Mannings n	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	CW2B	CW2A								TOTAL
HEC1 Peak-Flow	1348	469								
Weighting Factor	0.71	0.29								
Flow into Channel	952	138								1090

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Flow Topwidth (ft)	Hydraulic Radius (ft)	Hydraulic Depth (ft)	Froude Number
109	120.6	48.1	1253.7	1254.4	2.3	0.7	120.5	0.4	0.4	0.63
327	138.5	98.4	1253.7	1254.7	3.3	1.0	138.2	0.7	0.7	0.69
818	146.7	174.4	1253.7	1255.3	4.7	1.6	145.8	1.2	1.2	0.76
1090	150.1	209.2	1253.7	1255.5	5.2	1.8	149.0	1.4	1.4	0.77

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Flow Topwidth (ft)	Hydraulic Radius (ft)	Hydraulic Depth (ft)	Froude Number
109	127.0	52.8	1253.7	1254.4	2.1	0.7	127.0	0.4	0.4	0.56
327	139.7	106.1	1253.7	1254.8	3.1	1.1	139.3	0.8	0.8	0.62
818	148.0	188.2	1253.7	1255.4	4.3	1.7	147.1	1.3	1.3	0.68
1090	151.7	225.9	1253.7	1255.6	4.8	1.9	150.5	1.5	1.5	0.69

Sediment Data

D16 (mm)	0.17	G	3.99
D50 (mm)	0.7		
D65 (mm)	1.2		
D84 (mm)	2.7		
D90 (mm)	4		

Inflowing Sediment Load from U/S Reaches

Dominant Discharge (cfs)	Sediment Inflow (cfs) Contributions from Upstream (Identified using Structure ID)									TOTAL
	H1W2AW2B_3									
327	1.19									1.19

Maximum Permissible Velocity

Channel Lining	Natural - Fine Gravel

Discharge (cfs)	FHWA Max. Permissible Velocity Table
109	Stable
327	Stable
818	Stable
1090	Erosive

FHWA Max. Permissible Velocity (ft/s)	5

Equilibrium Slope Calculations

Dominant Discharge	327	cfs
Clear Water	No	
Total Incoming Sediment Load	1.193	cfs
Initial Chnl Sediment Capacity	1.681	cfs
Long-term Equilibrium Slope (ADWR)	0.0125	

Drop Structures

Design Slope	0.0125	ft/ft
Total Drop Needed	3.4	ft
Height of Drop Structure	3	ft
No. of Drop Structures	1.13	
Distance between Structures	885	ft

Total Scour Calculations: Zt = 1.3(Zgs + 1/2ha + Zdeg + Zbs + Zi)

Discharge	Sinuosity	Bend	Max. Depth	Hyd. Depth	Avg Vel	Slope	General Scour	Antidune Wave Height	LongTerm Scour	Bend Scour	Low Flow Incision	Total
Q (cfs)		Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)	Se	Zgs (ft)	ha (ft)	Zdeg (ft)	Zbs (ft)	Zi (ft)	Zt (ft)
1090	1.1	24.6	1.8	1.4	5.2	0.0159	-0.4	0.7	1.5	0.2	2.0	5.3

Cost Estimates

Channel Characteristics

Channel Length (ft)	1000
Channel Limit-Left Station (ft)	685
Channel Limit-Right Station (ft)	890
Channel Width (ft)	205

Levee

Left Levee Length (ft)	1000
Left Levee Top Width (ft)	0.5
Left Levee Height (ft)	0
Right Levee Length (ft)	1000
Right Levee Top Width (ft)	0.5
Right Levee Height (ft)	4

Left Levee Surface Area (sq. Yd)	0
Left Levee Volume (cu. Yd)	0
Right Levee Surface Area (sq. Yd)	444
Right Levee Volume (cu. Yd)	74
Total Levee Surface Area (sq. Yd)	444
Total Levee Volume (cu. Yd)	74

Levee Fill

Left Levee Fill Buffer Width (ft)	50
Left Levee Fill Slope (ft/ft)	6
Left Levee Fill ROW Width (ft)	0
Left Levee Fill Surface Area (sq. ft)	0
Left Levee Fill XS area (sq. ft)	0
Left Levee Fill Volume (cu. Yd)	0
Right Levee Fill Buffer Width (ft)	50
Right Levee Fill Slope (ft/ft)	6
Right Levee Fill ROW Width (ft)	50
Right Levee Fill Surface Area (sq. ft)	50000
Right Levee Fill XS area (sq. ft)	34.8
Right Levee Fill Volume (cu. Yd)	1289
Total Levee Fill Surface Area (sq. ft)	50000
Total Levee Fill Volume (cu Yd)	1289

Drop Structures

Structure Type	Gabions	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length (ft)	205	
Aesthetic Treatment Ratio	1.1	
Structure Thickness (ft)	1	
Drop Height (ft)	3	
Scour Depth (ft)	6.3	
Structure Height (ft)	9.3	
Number of Structures	1.13	
	Design	Aesthetic Trtmt.
Volume per structure (cu.Yd)	70.24	7.02
Unit Cost (per cu. Yd)	$ 85.00	$ 85.00
Other Cost	$ -	$ -
Cost per structure	$ 5,970	$ 597
Area per structure (sq. Yd)	23	2
Total Area (cu. Yd)	26	0

Structure Type	Structure Cost												
		Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Wall Material Cost	Wall	1,000	ft	$ 100	$ 100,480	74	cu. Yd	$ -	$ -	74	cu. Yd	$ -	$ -
Wall Surface Cost	Wall	444	sq. Yd	$ -	$ -	444	sq. Yd	$ -	$ -	444	sq. Yd	$ 75.00	$ 33,300
Adjacent Levee Fill	Fill	1,289	cu. Yd	$ 7.00	$ 9,023	5,556	sq. Yd	$ 4.50	$ 25,000	5,556	sq. Yd	$ 11.67	$ 64,815
Wall Material Aesthetic Treatment Cost	Wall	74	cu. Yd	$ -	$ -	74	cu. Yd	$ -	$ -	74	cu. Yd	$ -	$ -
Wall Surface Aesthetic Trtmt. Cost	Wall	444	sq. Yd	$ 63.00	$ 27,972	444	sq. Yd	$ -	$ -	444	sq. Yd	$ -	$ -
Drop Structures	Gabions	1	EA	$ 5,970.40	$ 6,747	23	sq. Yd	$ -	$ -	23	sq. Yd	$ 37.50	$ 854
Other					$ -				$ -				$ -
		Total without Contingency & Engineering Design Cost			$ 144,221			Total	$ 25,000			Total	$ 98,969
		Contingency Cost (25% of Construction Cost)			$ 36,055								
		Engineering Design Cost (5% of Construction Cost)			$ 7,211								
		Total Construction Cost			$ 187,488								
Wall Material Aesthetic Treatment Cost	Wall	74	cu. Yd	$ -	$ -	74	cu. Yd	$ -	$ -	74	cu. Yd	$ -	$ -
Wall Surface Aesthetic Trtmt. Cost	Wall	444	sq. Yd	$ 63.00	$ 27,972	444	sq. Yd	$ -	$ -	444	sq. Yd	$ -	$ -
Adj. Levee Fill Aesthetic Trmt. Cost	Fill	1,289	cu. Yd	$ 7.00	$ 9,023	5,556	sq. Yd	$ 4.50	$ 25,000	5,556	sq. Yd	$ 11.67	$ 64,815
Drop Structures Aesthetic Trtmt. Cost	Gabions	1	EA	$ 596.70	$ 674	23	sq. Yd	$ -	$ -	2	sq. Yd	$ 37.50	$ 85
Other					$ -				$ -				$ -
		Total without Contingency & Engineering Design Cost			$ 37,669			Total	$ 25,000			Total	$ 64,900
		Contingency Cost (25% of Construction Cost)			$ 9,417								
		Engineering Design Cost (5% of Construction Cost)			$ 1,883								
		Total Construction Cost			$ 48,970								

Total Structure Aesthetic Trtmt Cost	$ 138,870

Land Cost

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
Adjacent Buffer Area	35	0.8	$100,000	$ 80,000
Maintenance Access	15	0.3	$100,000	$ 30,000
Channel	205	4.7	$100,000	$ 470,000
Levee	1	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	256	5.8		$ 580,000

Total Land Related Aes. Trtmt Cost	$ 80,000

Total Cost	$ 891,457

Total Aesthetic Treatment Cost	$ 218,870

Total Right of Way Cost	$ 580,000

Walled-Levee Corridor

Structure ID	H1W2AW2B	HEC1 ID	W2AW2B	Cutline ID	1

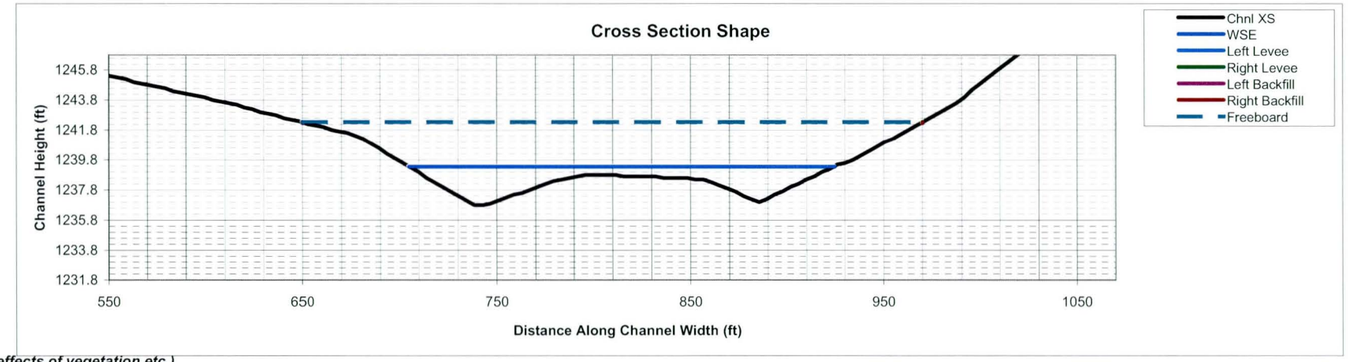
Longitundal Geometry

Length	671.1	ft
Initial Channel Slope	0.0159	ft/ft
Long-term (Equilibrium) Chnl Slope	0.0135	ft/ft

Levee

Left Levee Type	Wall	Right Levee Type	Wall
Left Levee Station (ft)	650	Right Levee Station (ft)	970
Left Adjacent Buffer Width (ft)	0	Right Adjacent Buffer Width (ft)	0
Left Channel Limit Station (ft)	650	Right Channel Limit Station (ft)	970

Channel XS Geometry



Mannings n (includes effects of vegetation etc.)

Location	Initial	Long-term
Mannings n	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	CW2B	CW2A								TOTAL
HEC1 Peak-Flow	1348	469								
Weighting Factor	0.96	0.04								
Flow into Channel	1289	21								1310

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Flow Topwidth (ft)	Hydraulic Radius (ft)	Hydraulic Depth (ft)	Froude Number
131	79.6	45.5	1236.8	1237.9	2.9	1.1	79.5	0.6	0.6	0.67
393	130.6	107.3	1236.8	1238.5	3.7	1.7	130.4	0.8	0.8	0.71
983	214.4	226.7	1236.8	1239.2	4.3	2.4	214.2	1.1	1.1	0.74
1310	220.3	272.4	1236.8	1239.4	4.8	2.6	220.0	1.2	1.2	0.76

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Flow Topwidth (ft)	Hydraulic Radius (ft)	Hydraulic Depth (ft)	Froude Number
131	82.0	48.4	1236.8	1238.0	2.7	1.2	81.9	0.6	0.6	0.62
393	153.2	120.1	1236.8	1238.6	3.3	1.8	153.0	0.8	0.8	0.65
983	216.1	238.9	1236.8	1239.2	4.1	2.4	215.9	1.1	1.1	0.69
1310	222.1	287.0	1236.8	1239.5	4.6	2.7	221.8	1.3	1.3	0.71

Sediment Data

D16 (mm)	0.17	G	3.99
D50 (mm)	0.7		
D65 (mm)	1.2		
D84 (mm)	2.7		
D90 (mm)	4		

Inflowing Sediment Load from U/S Reaches

Dominant Discharge (cfs)	Sediment Inflow (cfs) Contributions from Upstream (Identified using Structure ID)									TOTAL
	H1W2AW2B_2									
393	1.68									1.68

Maximum Permissible Velocity

Channel Lining	Natural - Fine Gravel
Discharge (cfs)	**FHWA Max. Permissible Velocity Table**
131	Stable
393	Stable
983	Stable
1310	Stable

FHWA Max. Permissible Velocity (ft/s)	5

Equilibrium Slope Calculations

Dominant Discharge	393	cfs
Clear Water	No	
Total Incoming Sediment Load	1.681	cfs
Initial Chnl Sediment Capacity	2.309	cfs
Long-term Equilibrium Slope (ADWR)	0.0135	

Drop Structures

Design Slope	0.0135	ft/ft
Total Drop Needed	1.6	ft
Height of Drop Structure	3	ft
No. of Drop Structures	0.54	
Distance between Structures	1243	ft

Total Scour Calculations: Zt = 1.3(Zgs + 1/2ha + Zdeg + Zbs + Zi)

Discharge	Sinuosity	Bend	Max. Depth	Hyd. Depth	Avg Vel	Slope	General Scour	Antidune Wave Height	LongTerm Scour	Bend Scour	Low Flow Incision	Total
Q (cfs)		Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)	Se	Zgs (ft)	ha (ft)	Zdeg (ft)	Zbs (ft)	Zi (ft)	Zt (ft)
1310	1.1	24.6	2.6	1.2	4.8	0.0159	-0.6	0.6	1.5	0.3	2.0	5.4

Cost Estimates

Channel Characteristics

Channel Length (ft)	671
Channel Limit-Left Station (ft)	650
Channel Limit-Right Station (ft)	970
Channel Width (ft)	320

Levee

Left Levee Length (ft)	671
Left Levee Top Width (ft)	0.5
Left Levee Height (ft)	0.1
Right Levee Length (ft)	671
Right Levee Top Width (ft)	0.5
Right Levee Height (ft)	0.1

Left Levee Surface Area (sq. Yd)	7
Left Levee Volume (cu. Yd)	1
Right Levee Surface Area (sq. Yd)	7
Right Levee Volume (cu. Yd)	1
Total Levee Surface Area (sq. Yd)	14
Total Levee Volume (cu. Yd)	2

Levee Fill

Left Levee Fill Buffer Width (ft)	50
Left Levee Fill Slope (ft/ft)	6
Left Levee Fill ROW Width (ft)	0
Left Levee Fill Surface Area (sq. ft)	0
Left Levee Fill XS area (sq. ft)	0
Left Levee Fill Volume (cu. Yd)	0
Right Levee Fill Buffer Width (ft)	50
Right Levee Fill Slope (ft/ft)	6
Right Levee Fill ROW Width (ft)	0
Right Levee Fill Surface Area (sq. ft)	0
Right Levee Fill XS area (sq. ft)	0
Right Levee Fill Volume (cu. Yd)	0
Total Levee Fill Surface Area (sq. ft)	0
Total Levee Fill Volume (cu Yd)	0

Drop Structures

Structure Type	Gabions	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length (ft)	320	
Aesthetic Treatment Ratio	1.1	
Structure Thickness (ft)	1	
Drop Height (ft)	3	
Scour Depth (ft)	5.6	
Structure Height (ft)	8.6	
Number of Structures	0.54	
	Design	Aesthetic Trtmt.
Volume per structure (cu.Yd)	102.02	10.20
Unit Cost (per cu. Yd)	$ 85.00	$ 85.00
Other Cost	$ -	$ -
Cost per structure	$ 8,672	$ 867
Area per structure (sq. Yd)	36	4
Total Area (cu. Yd)	19	0

Structure Type	Structure Cost													
		Construction				Landscape				Maintenance				
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Wall Material Cost	Wall	671	ft	$ 96	$ 64,416	2	cu. Yd	$ -	$ -	2	cu. Yd	$ -	$ -
Wall Surface Cost	Wall	14	sq. Yd	$ -	$ -	14	sq. Yd	$ -	$ -	14	sq. Yd	$ 75.00	$ 1,050
Adjacent Levee Fill	Fill	0	cu. Yd	$ 7.00	$ -	0	sq. Yd	$ 4.50	$ -	0	sq. Yd	$ 11.67	$ -
Wall Material Aesthetic Treatment Cost	Wall	2	cu. Yd	$ -	$ -	2	cu. Yd	$ -	$ -	2	cu. Yd	$ -	$ -
Wall Surface Aesthetic Trtmt. Cost	Wall	14	sq. Yd	$ 63.00	$ 882	14	sq. Yd	$ -	$ -	14	sq. Yd	$ -	$ -
Drop Structures	Gabions	1	EA	$ 8,671.70	$ 4,683	36	sq. Yd	$ -	$ -	36	sq. Yd	$ 37.50	$ 1,333
Other					$ -				$ -				$ -
		Total without Contingency & Engineering Design Cost			$ 69,981			Total	$ -			Total	$ 2,383
		Contingency Cost (25% of Construction Cost)			$ 17,495								
		Engineering Design Cost (5% of Construction Cost)			$ 3,499								
		Total Construction Cost			$ 90,975								
Wall Material Aesthetic Treatment Cost	Wall	2	cu. Yd	$ -	$ -	2	cu. Yd	$ -	$ -	2	cu. Yd	$ -	$ -
Wall Surface Aesthetic Trtmt. Cost	Wall	14	sq. Yd	$ 63.00	$ 882	14	sq. Yd	$ -	$ -	14	sq. Yd	$ -	$ -
Adj. Levee Fill Aesthetic Trmt. Cost	Fill	0	cu. Yd	$ 7.00	$ -	0	sq. Yd	$ 4.50	$ -	0	sq. Yd	$ 11.67	$ -
Drop Structures Aesthetic Trtmt. Cost	Gabions	1	EA	$ 867.00	$ 468	36	sq. Yd	$ -	$ -	4	sq. Yd	$ 37.50	$ 133
Other					$ -				$ -				$ -
		Total without Contingency & Engineering Design Cost			$ 1,350			Total	$ -			Total	$ 133
		Contingency Cost (25% of Construction Cost)			$ 338								
		Engineering Design Cost (5% of Construction Cost)			$ 68								
		Total Construction Cost			$ 1,755								
Total Structure Aesthetic Trtmt Cost	$ 1,889												

Land Cost

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
Adjacent Buffer Area	0	0	$100,000	$ -
Maintenance Access	0	0	$100,000	$ -
Channel	320	4.9	$100,000	$ 490,000
Levee	1	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	321	4.9		$ 490,000

Total Land Related Aes. Trtmt Cost	$ -

Total Cost	$ 583,358

Total Aesthetic Treatment Cost	$ 1,889

Total Right of Way Cost	$ 490,000

JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC.

Sub-area: FRS 2 & 3, Skyline Fan System
Walled-Levee Corridor Structure ID: H1W2AW2B, Cutline ID: 1

Online Basin

Structure ID	RRW2B

HEC1 ID	RRW2B

Design Sediment Yield (MUSLE) Ys = Rw * K * LS * C * P

Rw, Storm Energy Runoff Factor; Rw = a(V*q)^b

Drainage Area =	5.19 sq. mi.
Area Contributing Sediment =	5.19 sq. mi.

Recurrence Interval	Ratios	Volume, V (ac-ft)	Flow Peak (cfs)	a	b	Rw
Q-2	0.1	35	135	95	0.56	10788
Q-5	0.25	87	337	95	0.56	30104
Q-10	0.35	121	472	95	0.56	43882
Q-25	0.55	191	741	95	0.56	72802
Q-50	0.75	260	1011	95	0.56	103039
Q-100	1	347	1348	95	0.56	142211

K, Soil Erodibility Factor: Table 14, Camp, 1986

Soil Map Unit	K	% of Basin
100	0.02	33%
98	0.17	26.8%
3	0.16	39.9%
Weighted K Factor:	0.12	

C, Cover and Management Factor; Figures 5-7, SCS Ag. Handbook #537

Cover Type	% of Basin	Canopy Factor	Mulch Factor	Root Factor	Composite C Factor	Weighted C Factor
	100	0.90	0.90	0.40	0.32	0.32
			Composite Weighted C Factor=			0.324

LS, Topographic Factor; LS = ((L/72.6)^n)*(0.065+0.0454*S+0.0065*S^2)

Slope Lengths:	200	ft	(Basin Average)
Slope Angles:	12.8	%	(Basin Average)
n =	0.5		
Eq'n B.4 ADWR Manual, Appendix B			
LS =	2.84		

P, Erosion Control Factor

No Practice, Natural or Regulated	
Weighted P for Contributing Watershed	1

Weighted Average Annual Sediment Yield

Recurrence Interval	Rw	K	LS	C	P	Ys (tons)	Unit Ys (AF/sq.mi)
Q-2	10788	0.12	2.84	0.32	1.00	1152	0.09
Q-5	30104	0.12	2.84	0.32	1.00	3214	0.26
Q-10	43882	0.12	2.84	0.32	1.00	4686	0.38
Q-25	72802	0.12	2.84	0.32	1.00	7773	0.63
Q-50	103039	0.12	2.84	0.32	1.00	11002	0.88
Q-100	142211	0.12	2.84	0.32	1.00	15185	1.22
Weighted Average Annual Sediment Yield:						2182	0.18

Total Sediment Yield Volume (ac. ft)	9.1

Sediment Depth in Basin	1.3 ft

Geometry

Topography slope (ft/ft)	0.024
Side Slope (?H:1V) (ft/ft)	6
Total Depth (ft)	10.5
Freeboard (ft)	1
Top Perimeter (ft)	3251.4
Top Area (acres)	14.9
Bottom elevation (ft)	1209.3
Adjacent Buffer Width (ft)	50.0

Allocated Storage Volume (ac. ft)	69.3
Total Available Volume (ac. ft) (incl. Freeboard)	88.6
Total Excavation Volume (ac. ft)	218.8

Basin Outlet

Diameter	5.00	ft
Invert Elevation	0.00	ft
Number of pipes	2	

Stage-Storage-Discharge

Elevation	0	1	2	3	5	7	8	9	10	11
Volume	0.00	0.00	4.83	12.33	28.23	45.63	54.83	64.43	74.43	84.73
Outflow	0.0	28.3	56.6	111.3	210.8	312.7	361.3	403.3	440.2	476.9

HEC1 Results

	6-hr Event	24-hr Event	Maximum
Total Flow Volume entering Basin (ac. ft)	296.0	347	347.0
Peak Inflow (cfs)	875	1348	1348.0
Peak Outflow (cfs)	326	360	360.0
Stage at Peak Outflow (ft)	7.3	8	8.0
Volume at Peak Outflow (ac. ft)	48.1	54.61	54.6

Volume Check

Total Volume needed	63.7	ac. ft
Total Volume Provided	69.3	ac. ft

Volume OK?	Yes

Stage Check

Depth Needed	10.3	ft
Depth Provided	10.5	ft

Depth OK?	Yes

Cost Estimates

Storage Basin Excavation	Design	Aesthetic Trtmt.
Excavation Volume (cu Yd)	352997	0
Excavated Area (sq. Yd)	72116.0	3793.3
Adjacent Buffer Area (sq. Yd)	18063.3	

Inlet	Terraced	Riprap-lined
Average Inlet Height (ft)		28
Average Inlet Length (ft)		165
Total Width of all inlets (ft)		295
Material Thickness (ft)	0.5	3.0
Total Inlet Area (sq. Yd)	0	5485.7
Total Material Volume (cu. Yd)	0	5485.7
Unit Cost	$ 155.00	$ 75.00
Total Cost	$ -	$ 411,428

Outlet		
Outlet Type	Pipe	
(None, Riprap Weir, Concrete Weir, Pipe)		
Pipe Length	558	ft
Unit Cost	$ 183.00	per ft
Cost per outlet	$ 204,228	
Other Cost	$ -	
Total Cost	$ 204,228	
Outlet Area	133	sq. Yd

Structure Cost

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Basin		352,997	cu. Yd	$ 4.00	$ 1,411,988	90,179	sq. Yd	$ 4.50	$ 405,807	90,179	sq. Yd	$ 8.33	$ 751,494
Inlet					$ 411,428				$ -				$ 182,857
Outlet	Pipe	2	EA	$ 204,228	$ 408,456	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217
Other					$ -				$ -				$ -
		Total without Contingency & Engineering Design Cost			$ 2,231,872			Total	$ 405,807			Total	$ 936,568
		Contingency Cost (25% of Construction Cost)			$ 557,968								
		Engineering Design Cost (5% of Construction Cost)			$ 111,594								
		Total Construction Cost			$ 2,901,433								

Structure Aesthetic Treatment Cost

Basin - Aesthetic Treatment		352,997	cu. Yd	$ -	$ -	90,179	sq. Yd	$ 4.50	$ 405,807	14,270	sq. Yd	$ 8.33	$ 118,917
Inlet - Aesthetic Treatment (20%Inlet)					$ 82,286				$ -				$ 36,571
Outlet -Aesthetic Treatment (5% Outlet)					$ 20,423	133	sq. Yd	$ -	$ -				$ 111
Other					$ -	0			$ -				$ -
		Total without Contingency & Engineering Design Cost			$ 102,708			Total	$ 405,807			Total	$ 155,599
		Contingency Cost (25% of Construction Cost)			$ 25,677								
		Engineering Design Cost (5% of Construction Cost)			$ 5,135								
		Total Construction Cost			$ 133,521								
Total Structure Aesthetic Trtmt Cost	$ 694,926												

Land Cost

Land Cost Component	Area (acre)	Unit Cost	Cost
Misc. Right of Way		$100,000	$ -
Adjacent Buffer Area	3.7	$100,000	$ 370,000
Basin	14.9	$100,000	$ 1,490,000
Other		$100,000	$ -
Total	18.6	$100,000	$ 1,860,000

Total Land Related Aes. Trtmt Cost	$ 448,374

Total Cost	$ 6,103,807	Total Aesthetic Treatment Cost	$ 1,143,300	Total ROW Cost	$ 1,860,000

Walled-Levee Corridor

Structure ID	H1W2BW2C

HEC1 ID	W2BW2C

Cutline ID	2

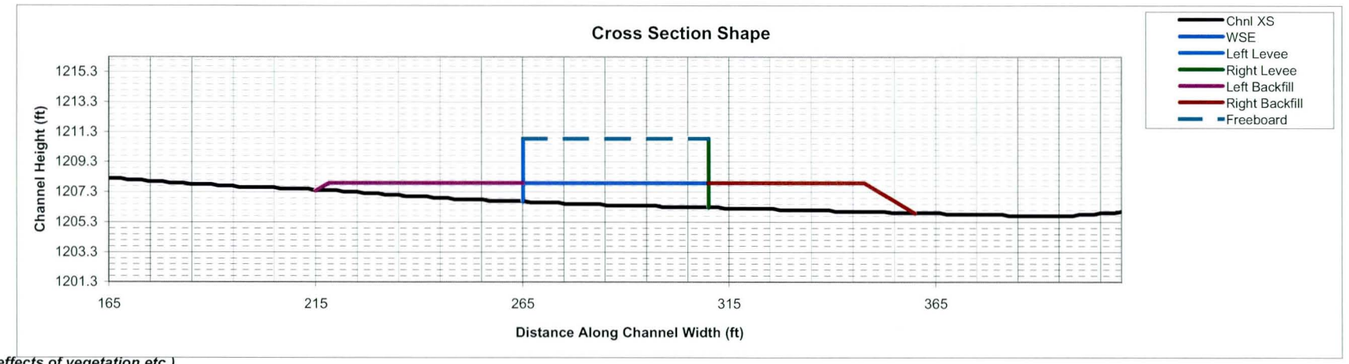
Longitundal Geometry

Length	1461.2	ft
Initial Channel Slope	0.0171	ft/ft
Long-term (Equilibrium) Chnl Slope	0.0453	ft/ft

Levee

Left Levee Type	Wall	Right Levee Type	Wall
Left Levee Station (ft)	265	Right Levee Station (ft)	310
Left Adjacent Buffer Width (ft)	50	Right Adjacent Buffer Width (ft)	50
Left Channel Limit Station (ft)	265	Right Channel Limit Station (ft)	310

Channel XS Geometry



Mannings n (includes effects of vegetation etc.)

Location	Initial	Long-term
Mannings n	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	CW2CR	RRW2B								TOTAL
HEC1 Peak-Flow	360	360								
Weighting Factor	0.42	0.58								
Flow into Channel	151	209								360

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Flow Topwidth (ft)	Hydraulic Radius (ft)	Hydraulic Depth (ft)	Froude Number
36	45.6	16.4	1206.3	1206.8	2.2	0.5	45.0	0.4	0.4	0.64
108	46.3	31.9	1206.3	1207.2	3.4	0.9	45.0	0.7	0.7	0.71
270	47.4	55.9	1206.3	1207.7	4.8	1.4	45.0	1.2	1.2	0.76
360	47.9	66.7	1206.3	1207.9	5.4	1.6	45.0	1.4	1.5	0.78

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Flow Topwidth (ft)	Hydraulic Radius (ft)	Hydraulic Depth (ft)	Froude Number
36	45.4	12.2	1206.3	1206.7	2.9	0.4	45.0	0.3	0.3	0.99
108	46.0	23.8	1206.3	1207.0	4.5	0.7	45.0	0.5	0.5	1.10
270	46.7	41.5	1206.3	1207.4	6.5	1.1	45.0	0.9	0.9	1.19
360	47.1	49.4	1206.3	1207.5	7.3	1.2	45.0	1.1	1.1	1.22

Sediment Data

D16 (mm)	0.17	G	3.99
D50 (mm)	0.7		
D65 (mm)	1.2		
D84 (mm)	2.7		
D90 (mm)	4		

Inflowing Sediment Load from U/S Reaches

Dominant Discharge (cfs)	Sediment Inflow (cfs) Contributions from Upstream (Identified using Structure ID)									TOTAL
	H1W2AW2B_1									
108	2.31									2.31

Maximum Permissible Velocity

Channel Lining	Natural - Fine Gravel
Discharge (cfs)	**FHWA Max. Permissible Velocity Table**
36	Stable
108	Stable
270	Stable
360	Erosive

FHWA Max. Permissible Velocity (ft/s)	5

Equilibrium Slope Calculations

Dominant Discharge	108	cfs
Clear Water	No	
Total Incoming Sediment Load	2.309	cfs
Initial Chnl Sediment Capacity	0.589	cfs
Long-term Equilibrium Slope (ADWR)	0.0453	

Drop Structures

Design Slope	0.0453	ft/ft
Total Drop Needed	0.0	ft
Height of Drop Structure	3	ft
No. of Drop Structures	0.00	
Distance between Structures	N/A	ft

Total Scour Calculations: Zt = 1.3(Zgs + 1/2ha + Zdeg + Zbs + Zi)

Discharge	Sinuosity	Bend	Max. Depth	Hyd. Depth	Avg Vel	Slope	General Scour	Antidune Wave Height	LongTerm Scour	Bend Scour	Low Flow Incision	Total
Q (cfs)		**Angle (deg)**	**Ymax (ft)**	**Yh (ft)**	**Vm (ft/s)**	**Se**	**Zgs (ft)**	**ha (ft)**	**Zdeg (ft)**	**Zbs (ft)**	**Zi (ft)**	**Zt (ft)**
360	1.1	24.6	1.6	1.5	5.4	0.0171	-0.4	0.8	1.5	0.2	2.0	5.3

Cost Estimates

Channel Characteristics

Channel Length (ft)	1461
Channel Limit-Left Station (ft)	265
Channel Limit-Right Station (ft)	310
Channel Width (ft)	45

Levee

Left Levee Length (ft)	1461
Left Levee Top Width (ft)	0.5
Left Levee Height (ft)	4.2
Right Levee Length (ft)	1461
Right Levee Top Width (ft)	0.5
Right Levee Height (ft)	4.6

Left Levee Surface Area (sq. Yd)	682
Left Levee Volume (cu. Yd)	114
Right Levee Surface Area (sq. Yd)	747
Right Levee Volume (cu. Yd)	124
Total Levee Surface Area (sq. Yd)	1429
Total Levee Volume (cu. Yd)	238

Levee Fill

Left Levee Fill Buffer Width (ft)	50
Left Levee Fill Slope (ft/ft)	6
Left Levee Fill ROW Width (ft)	50
Left Levee Fill Surface Area (sq. ft)	73058
Left Levee Fill XS area (sq. ft)	44.8
Left Levee Fill Volume (cu. Yd)	2424
Right Levee Fill Buffer Width (ft)	50
Right Levee Fill Slope (ft/ft)	6
Right Levee Fill ROW Width (ft)	50
Right Levee Fill Surface Area (sq. ft)	73350
Right Levee Fill XS area (sq. ft)	79.5
Right Levee Fill Volume (cu. Yd)	4302
Total Levee Fill Surface Area (sq. ft)	146408
Total Levee Fill Volume (cu Yd)	6726

Drop Structures

Structure Type	Gabions	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length (ft)	45	
Aesthetic Treatment Ratio	1.1	
Structure Thickness (ft)	1	
Drop Height (ft)	3	
Scour Depth (ft)	7.1	
Structure Height (ft)	10.1	
Number of Structures	0.00	
	Design	Aesthetic Trtmt.
Volume per structure (cu.Yd)	16.84	1.68
Unit Cost (per cu. Yd)	$ 85.00	$ 85.00
Other Cost	$ -	$ -
Cost per structure	$ 1,431	$ 143
Area per structure (sq. Yd)	5	1
Total Area (cu. Yd)	0	0

Structure Type	Structure Cost													
		Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Wall Material Cost	Wall	1,461	ft	$ 201	$ 293,602	238	cu. Yd	$ -	$ -	238	cu. Yd	$ -	$ -
Wall Surface Cost	Wall	1,429	sq. Yd	$ -	$ -	1,429	sq. Yd	$ -	$ -	1,429	sq. Yd	$ 75.00	$ 107,175
Adjacent Levee Fill	Fill	6,726	cu. Yd	$ 7.00	$ 47,082	16,233	sq. Yd	$ 4.50	$ 73,050	16,233	sq. Yd	$ 11.67	$ 189,389
Wall Material Aesthetic Treatment Cost	Wall	238	cu. Yd	$ -	$ -	238	cu. Yd	$ -	$ -	238	cu. Yd	$ -	$ -
Wall Surface Aesthetic Trtmt. Cost	Wall	1,429	sq. Yd	$ 63.00	$ 90,027	1,429	sq. Yd	$ -	$ -	1,429	sq. Yd	$ -	$ -
Drop Structures	Gabions	0	EA	$ 1,431.40	$ -	5	sq. Yd	$ -	$ -	5	sq. Yd	$ 37.50	$ 188
Other					$ -				$ -				$ -
		Total without Contingency & Engineering Design Cost			$ 430,711			Total	$ 73,050			Total	$ 296,751
		Contingency Cost (25% of Construction Cost)			$ 107,678								
		Engineering Design Cost (5% of Construction Cost)			$ 21,536								
		Total Construction Cost			$ 559,924								
Wall Material Aesthetic Treatment Cost	Wall	238	cu. Yd	$ -	$ -	238	cu. Yd	$ -	$ -	238	cu. Yd	$ -	$ -
Wall Surface Aesthetic Trtmt. Cost	Wall	1,429	sq. Yd	$ 63.00	$ 90,027	1,429	sq. Yd	$ -	$ -	1,429	sq. Yd	$ -	$ -
Adj. Levee Fill Aesthetic Trmt. Cost	Fill	6,726	cu. Yd	$ 7.00	$ 47,082	16,233	sq. Yd	$ 4.50	$ 73,050	16,233	sq. Yd	$ 11.67	$ 189,389
Drop Structures Aesthetic Trtmt. Cost	Gabions	0	EA	$ 142.80	$ -	5	sq. Yd	$ -	$ -	1	sq. Yd	$ 37.50	$ 19
Other					$ -				$ -				$ -
		Total without Contingency & Engineering Design Cost			$ 137,109			Total	$ 73,050			Total	$ 189,408
		Contingency Cost (25% of Construction Cost)			$ 34,277								
		Engineering Design Cost (5% of Construction Cost)			$ 6,855								
		Total Construction Cost			$ 178,242								

Total Structure Aesthetic Trtmt Cost	$ 440,699

Land Cost

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
Adjacent Buffer Area	70	2.3	$100,000	$ 230,000
Maintenance Access	30	1	$100,000	$ 100,000
Channel	45	1.5	$100,000	$ 150,000
Levee	1	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	146	4.8		$ 480,000

Total Land Related Aes. Trtmt Cost	$ 230,000

Total Cost	$ 1,409,726

Total Aesthetic Treatment Cost	$ 670,699

Total Right of Way Cost	$ 480,000

JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC.

Walled-Levee Corridor

Structure ID	H1W2BW2C

HEC1 ID	W2BW2C

Cutline ID	1

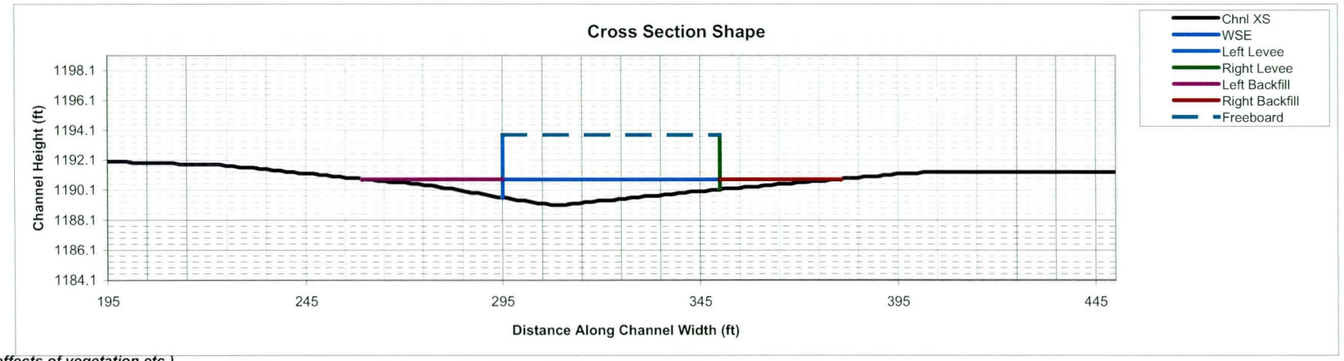
Longitundal Geometry

Length	848.2	ft
Initial Channel Slope	0.0168	ft/ft
Long-term (Equilibrium) Chnl Slope	0.0236	ft/ft

Levee

Left Levee Type	Wall	Right Levee Type	Wall
Left Levee Station (ft)	295	Right Levee Station (ft)	350
Left Adjacent Buffer Width (ft)	50	Right Adjacent Buffer Width (ft)	50
Left Channel Limit Station (ft)	295	Right Channel Limit Station (ft)	350

Channel XS Geometry



Mannings n (includes effects of vegetation etc.)

Location	Initial	Long-term
Mannings n	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	CW2CR	RRW2B								TOTAL
HEC1 Peak-Flow	360	360								
Weighting Factor	0.85	0.15								
Flow into Channel	306	54								360

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Flow Topwidth (ft)	Hydraulic Radius (ft)	Hydraulic Depth (ft)	Froude Number
36	41.0	15.8	1189.1	1189.8	2.3	0.7	40.7	0.4	0.4	0.64
108	55.7	34.6	1189.1	1190.2	3.1	1.1	55.0	0.6	0.6	0.69
270	56.6	60.3	1189.1	1190.6	4.5	1.5	55.0	1.1	1.1	0.75
360	57.0	71.9	1189.1	1190.8	5.0	1.7	55.0	1.3	1.3	0.77

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Flow Topwidth (ft)	Hydraulic Radius (ft)	Hydraulic Depth (ft)	Froude Number
36	40.2	14.2	1189.1	1189.7	2.5	0.6	40.1	0.4	0.4	0.75
108	55.1	31.1	1189.1	1190.1	3.5	1.0	54.5	0.6	0.6	0.81
270	56.4	54.4	1189.1	1190.5	5.0	1.4	55.0	1.0	1.0	0.88
360	56.8	64.8	1189.1	1190.7	5.6	1.6	55.0	1.1	1.2	0.90

Sediment Data

D16 (mm)	0.17	G	3.99
D50 (mm)	0.7		
D65 (mm)	1.2		
D84 (mm)	2.7		
D90 (mm)	4		

Inflowing Sediment Load from U/S Reaches

Dominant Discharge (cfs)	Sediment Inflow (cfs) Contributions from Upstream (Identified using Structure ID)									TOTAL
	H1W2BW2C_2	TW2C								
108	0.59	0.27								0.86

Maximum Permissible Velocity

Channel Lining	Natural - Fine Gravel

Discharge (cfs)	FHWA Max. Permissible Velocity Table
36	Stable
108	Stable
270	Stable
360	Erosive

FHWA Max. Permissible Velocity (ft/s)	5

Equilibrium Slope Calculations

Dominant Discharge	108	cfs
Clear Water	No	
Total Incoming Sediment Load	0.860	cfs
Initial Chnl Sediment Capacity	0.531	cfs
Long-term Equilibrium Slope (ADWR)	0.0236	

Drop Structures

Design Slope	0.0236	ft/ft
Total Drop Needed	0.0	ft
Height of Drop Structure	3	ft
No. of Drop Structures	0.00	
Distance between Structures	N/A	ft

Total Scour Calculations: Zt = 1.3(Zgs + 1/2ha + Zdeg + Zbs + Zi)

Discharge	Sinuosity	Bend	Max. Depth	Hyd. Depth	Avg Vel	Slope	General Scour	Antidune Wave Height	LongTerm Scour	Bend Scour	Low Flow Incision	Total
Q (cfs)		Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)	Se	Zgs (ft)	ha (ft)	Zdeg (ft)	Zbs (ft)	Zi (ft)	Zt (ft)
360	1.1	24.6	1.7	1.3	5.0	0.0168	-0.4	0.7	1.5	0.2	2.0	5.3

Cost Estimates

Channel Characteristics

Channel Length (ft)	848
Channel Limit-Left Station (ft)	295
Channel Limit-Right Station (ft)	350
Channel Width (ft)	55

Levee

Left Levee Length (ft)	848
Left Levee Top Width (ft)	0.5
Left Levee Height (ft)	4.2
Right Levee Length (ft)	848
Right Levee Top Width (ft)	0.5
Right Levee Height (ft)	3.7

Left Levee Surface Area (sq. Yd)	396
Left Levee Volume (cu. Yd)	66
Right Levee Surface Area (sq. Yd)	349
Right Levee Volume (cu. Yd)	58
Total Levee Surface Area (sq. Yd)	745
Total Levee Volume (cu. Yd)	124

Levee Fill

Left Levee Fill Buffer Width (ft)	50
Left Levee Fill Slope (ft/ft)	6
Left Levee Fill ROW Width (ft)	35.4
Left Levee Fill Surface Area (sq. ft)	30025
Left Levee Fill XS area (sq. ft)	19.6
Left Levee Fill Volume (cu. Yd)	616
Right Levee Fill Buffer Width (ft)	50
Right Levee Fill Slope (ft/ft)	6
Right Levee Fill ROW Width (ft)	30.5
Right Levee Fill Surface Area (sq. ft)	25869
Right Levee Fill XS area (sq. ft)	11.3
Right Levee Fill Volume (cu. Yd)	355
Total Levee Fill Surface Area (sq. ft)	55894
Total Levee Fill Volume (cu Yd)	971

Drop Structures

Structure Type	Gabions	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length (ft)	55	
Aesthetic Treatment Ratio	1.1	
Structure Thickness (ft)	1	
Drop Height (ft)	3	
Scour Depth (ft)	6.1	
Structure Height (ft)	9.1	
Number of Structures	0.00	
	Design	Aesthetic Trtmt.
Volume per structure (cu.Yd)	18.62	1.86
Unit Cost (per cu. Yd)	$ 85.00	$ 85.00
Other Cost	$ -	$ -
Cost per structure	$ 1,583	$ 158
Area per structure (sq. Yd)	6	1
Total Area (cu. Yd)	0	0

Structure Type	Structure Cost												
		Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Wall Material Cost	Wall	848	ft	$ 187	$ 158,165	124	cu. Yd	$ -	$ -	124	cu. Yd	$ -	$ -
Wall Surface Cost	Wall	745	sq. Yd	$ -	$ -	745	sq. Yd	$ -	$ -	745	sq. Yd	$ 75.00	$ 55,875
Adjacent Levee Fill	Fill	971	cu. Yd	$ 7.00	$ 6,797	6,209	sq. Yd	$ 4.50	$ 27,942	6,209	sq. Yd	$ 11.67	$ 72,441
Wall Material Aesthetic Treatment Cost	Wall	124	cu. Yd	$ -	$ -	124	cu. Yd	$ -	$ -	124	cu. Yd	$ -	$ -
Wall Surface Aesthetic Trtmt. Cost	Wall	745	sq. Yd	$ 63.00	$ 46,935	745	sq. Yd	$ -	$ -	745	sq. Yd	$ -	$ -
Drop Structures	Gabions	0	EA	$ 1,582.70	$ -	6	sq. Yd	$ -	$ -	6	sq. Yd	$ 37.50	$ 229
Other					$ -				$ -				$ -
		Total without Contingency & Engineering Design Cost			$ 211,897			Total	$ 27,942			Total	$ 128,545
		Contingency Cost (25% of Construction Cost)			$ 52,974								
		Engineering Design Cost (5% of Construction Cost)			$ 10,595								
		Total Construction Cost			$ 275,466								
Wall Material Aesthetic Treatment Cost	Wall	124	cu. Yd	$ -	$ -	124	cu. Yd	$ -	$ -	124	cu. Yd	$ -	$ -
Wall Surface Aesthetic Trtmt. Cost	Wall	745	sq. Yd	$ 63.00	$ 46,935	745	sq. Yd	$ -	$ -	745	sq. Yd	$ -	$ -
Adj. Levee Fill Aesthetic Trmt. Cost	Fill	971	cu. Yd	$ 7.00	$ 6,797	6,209	sq. Yd	$ 4.50	$ 27,942	6,209	sq. Yd	$ 11.67	$ 72,441
Drop Structures Aesthetic Trtmt. Cost	Gabions	0	EA	$ 158.10	$ -	6	sq. Yd	$ -	$ -	1	sq. Yd	$ 37.50	$ 23
Other					$ -				$ -				$ -
		Total without Contingency & Engineering Design Cost			$ 53,732			Total	$ 27,942			Total	$ 72,464
		Contingency Cost (25% of Construction Cost)			$ 13,433								
		Engineering Design Cost (5% of Construction Cost)			$ 2,687								
		Total Construction Cost			$ 69,852								
Total Structure Aesthetic Trtmt Cost	$ 170,257												

Land Cost

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
Adjacent Buffer Area	70	1.4	$100,000	$ 140,000
Maintenance Access	30	0.6	$100,000	$ 60,000
Channel	55	1.1	$100,000	$ 110,000
Levee	1	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	156	3.1		$ 310,000

Total Land Related Aes. Trtmt Cost	$ 140,000

Total Cost	$ 741,953	Total Aesthetic Treatment Cost	$ 310,257	Total Right of Way Cost	$ 310,000

Online Basin

Structure ID	RRX1A

HEC1 ID	RRX1A

Design Sediment Yield (MUSLE) Ys = Rw * K * LS * C * P

Rw, Storm Energy Runoff Factor; Rw = a(V*q)^b

Drainage Area =	0.7 sq. mi.
Area Contributing Sediment =	0.7 sq. mi.

Recurrence Interval	Ratios	Volume, V (ac-ft)	Flow Peak (cfs)	a	b	Rw
Q-2	0.1	5	85	95	0.56	2946
Q-5	0.25	14	213	95	0.56	8220
Q-10	0.35	19	299	95	0.56	11983
Q-25	0.55	30	469	95	0.56	19879
Q-50	0.75	41	640	95	0.56	28136
Q-100	1	54	853	95	0.56	38833

K, Soil Erodibility Factor: Table 14, Camp, 1986

Soil Map Unit	K	% of Basin
100	0.02	74%
3	0.16	2.6%
98	0.17	23.6%
Weighted K Factor:	0.06	

C, Cover and Management Factor; Figures 5-7, SCS Ag. Handbook #537

Cover Type	% of Basin	Canopy Factor	Mulch Factor	Root Factor	Composite C Factor	Weighted C Factor
	100	0.90	0.90	0.40	0.32	0.32
			Composite Weighted C Factor=			0.324

LS, Topographic Factor; LS = ((L/72.6)^n)*(0.065+0.0454*S+0.0065*S^2)

Slope Lengths:	200	ft	(Basin Average)
Slope Angles:	28.7	%	(Basin Average)
n =	0.5		
Eq'n B.4 ADWR Manual, Appendix B			
LS =	11.16		

P, Erosion Control Factor

No Practice, Natural or Regulated	
Weighted P for Contributing Watershed	1

Weighted Average Annual Sediment Yield

Recurrence Interval	Rw	K	LS	C	P	Ys (tons)	Unit Ys (AF/sq.mi)
Q-2	2946	0.06	11.16	0.32	1.00	628	0.37
Q-5	8220	0.06	11.16	0.32	1.00	1753	1.05
Q-10	11983	0.06	11.16	0.32	1.00	2555	1.52
Q-25	19879	0.06	11.16	0.32	1.00	4239	2.53
Q-50	28136	0.06	11.16	0.32	1.00	5999	3.58
Q-100	38833	0.06	11.16	0.32	1.00	8280	4.94
Weighted Average Annual Sediment Yield:						1190	0.71

Total Sediment Yield Volume (ac. ft)	4.9

Sediment Depth in Basin	1 ft

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Geometry

Topography slope (ft/ft)	0.029
Side Slope (?H:1V) (ft/ft)	6
Total Depth (ft)	10
Freeboard (ft)	1
Top Perimeter (ft)	3206.6
Top Area (acres)	14.6
Bottom elevation (ft)	1188.2
Adjacent Buffer Width (ft)	50.0

Allocated Storage Volume (ac. ft)	52.5
Total Available Volume (ac. ft) (incl. Freeboard)	65.4
Total Excavation Volume (ac. ft)	257.4

Basin Outlet

Diameter	3.00	ft
Invert Elevation	0.00	ft
Number of pipes	1	

Stage-Storage-Discharge

Elevation	0	2	4	5	6	7	8	9	10	11
Volume	0.00	5.65	17.45	23.75	30.45	37.45	44.85	52.45	60.45	68.85
Outflow	0.0	18.6	41.0	51.5	61.4	68.9	76.3	83.1	89.1	90.7

HEC1 Results

	6-hr Event	24-hr Event	Maximum
Total Flow Volume entering Basin (ac. ft)	54.0	49	54.0
Peak Inflow (cfs)	853	729	853.0
Peak Outflow (cfs)	76	69	76.0
Stage at Peak Outflow (ft)	8.0	7	8.0
Volume at Peak Outflow (ac. ft)	44.9	37.5	44.9

Volume Check

Total Volume needed	49.8	ac. ft
Total Volume Provided	52.5	ac. ft

Volume OK?	Yes

Stage Check

Depth Needed	10.0	ft
Depth Provided	10	ft

Depth OK?	Yes

Cost Estimates

Storage Basin Excavation	Design	Aesthetic Trtmt.
Excavation Volume (cu Yd)	415272	0
Excavated Area (sq. Yd)	70664.0	3562.9
Adjacent Buffer Area (sq. Yd)	17814.4	

Inlet	Terraced	Riprap-lined
Average Inlet Height (ft)	31	
Average Inlet Length (ft)	220	
Total Width of all inlets (ft)	255	
Material Thickness (ft)	0.5	3.0
Total Inlet Area (sq. Yd)	7111.7	0
Total Material Volume (cu. Yd)	1185.3	0
Unit Cost	$ 155.00	$ 75.00
Total Cost	$ 183,722	$ -

Outlet		
Outlet Type	Pipe	
(None, Riprap Weir, Concrete Weir, Pipe)		
Pipe Length	424	ft
Unit Cost	$ 82.00	per ft
Cost per outlet	$ 34,768	
Other Cost	$ -	
Total Cost	$ 34,768	
Outlet Area	133	sq. Yd

Structure Cost

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Basin		415,272	cu. Yd	$ 4.00	$ 1,661,088	88,478	sq. Yd	$ 4.50	$ 398,153	88,478	sq. Yd	$ 8.33	$ 737,320
Inlet					$ 183,722				$ -				$ 296,321
Outlet	Pipe	1	EA	$ 34,768	$ 34,768	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217
Other					$ -				$ -				$ -
		Total without Contingency & Engineering Design Cost			$ 1,879,578			Total	$ 398,153			Total	$ 1,035,858
		Contingency Cost (25% of Construction Cost)			$ 469,894								
		Engineering Design Cost (5% of Construction Cost)			$ 93,979								
		Total Construction Cost			$ 2,443,451								

Structure Aesthetic Treatment Cost

Basin - Aesthetic Treatment		415,272	cu. Yd	$ -	$ -	88,478	sq. Yd	$ 4.50	$ 398,153	14,252	sq. Yd	$ 8.33	$ 118,763
Inlet - Aesthetic Treatment (20%Inlet)					$ 36,744				$ -				$ 59,264
Outlet -Aesthetic Treatment (5% Outlet)					$ 1,738	133	sq. Yd	$ -	$ -				$ 111
Other					$ -	0			$ -				$ -
		Total without Contingency & Engineering Design Cost			$ 38,483			Total	$ 398,153			Total	$ 178,138
		Contingency Cost (25% of Construction Cost)			$ 9,621								
		Engineering Design Cost (5% of Construction Cost)			$ 1,924								
		Total Construction Cost			$ 50,028								
Total Structure Aesthetic Trtmt Cost	$ 626,319												

Land Cost

Land Cost Component	Area (acre)	Unit Cost	Cost
Misc. Right of Way		$100,000	$ -
Adjacent Buffer Area	3.7	$100,000	$ 370,000
Basin	14.6	$100,000	$ 1,460,000
Other		$100,000	$ -
Total	18.3	$100,000	$ 1,830,000

Total Land Related Aes. Trtmt Cost	$ 443,614

Total Cost	$ 5,707,461

Total Aesthetic Treatment Cost	$ 1,069,932

Total ROW Cost	$ 1,830,000

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Walled-Levee Corridor

Structure ID	H1X1AW2C

HEC1 ID	X1AW2C

Cutline ID	1

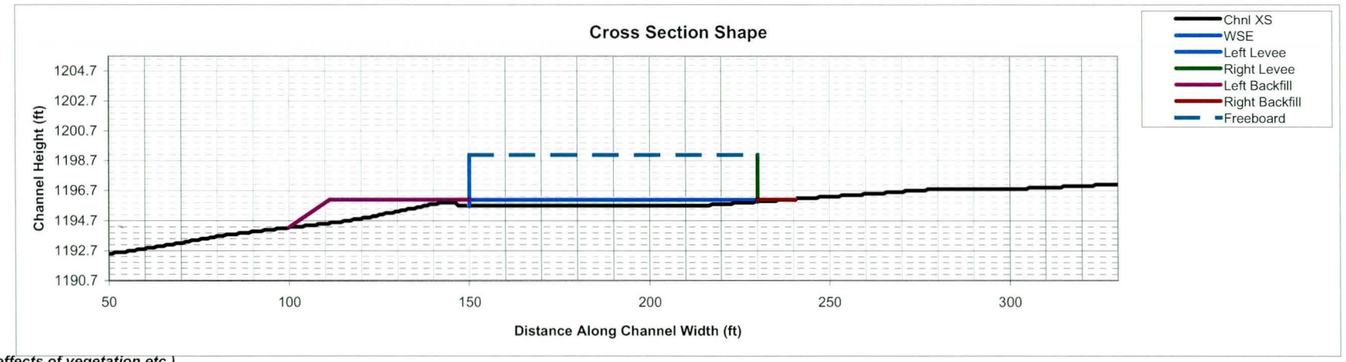
Longitundal Geometry

Length	1207.8	ft
Initial Channel Slope	0.0163	ft/ft
Long-term (Equilibrium) Chnl Slope	0.0083	ft/ft

Levee

Left Levee Type	Wall	Right Levee Type	Wall
Left Levee Station (ft)	150	Right Levee Station (ft)	230
Left Adjacent Buffer Width (ft)	50	Right Adjacent Buffer Width (ft)	50
Left Channel Limit Station (ft)	150	Right Channel Limit Station (ft)	230

Channel XS Geometry



Mannings n (includes effects of vegetation etc.)

Location	Initial	Long-term
Mannings n	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	RRX1A									TOTAL
HEC1 Peak-Flow	76									
Weighting Factor	1.00									
Flow into Channel	76									76

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Flow Topwidth (ft)	Hydraulic Radius (ft)	Hydraulic Depth (ft)	Froude Number
8	72.9	7.9	1195.7	1195.8	1.0	0.1	72.7	0.1	0.1	0.51
23	79.2	15.8	1195.7	1195.9	1.4	0.2	79.0	0.2	0.2	0.57
57	80.5	27.5	1195.7	1196.1	2.1	0.4	80.0	0.3	0.3	0.62
76	80.6	32.8	1195.7	1196.1	2.3	0.4	80.0	0.4	0.4	0.64

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Flow Topwidth (ft)	Hydraulic Radius (ft)	Hydraulic Depth (ft)	Froude Number
8	73.1	9.7	1195.7	1195.8	0.8	0.1	73.0	0.1	0.1	0.38
23	79.7	19.4	1195.7	1196.0	1.2	0.3	79.4	0.2	0.2	0.42
57	80.6	33.8	1195.7	1196.1	1.7	0.4	80.0	0.4	0.4	0.46
76	80.8	40.2	1195.7	1196.2	1.9	0.5	80.0	0.5	0.5	0.47

Sediment Data

D16 (mm)	0.17	G	3.99
D50 (mm)	0.7		
D65 (mm)	1.2		
D84 (mm)	2.7		
D90 (mm)	4		

Inflowing Sediment Load from U/S Reaches

Dominant Discharge (cfs)	Sediment Inflow (cfs) Contributions from Upstream (Identified using Structure ID)									TOTAL
23										0.00

Maximum Permissible Velocity

Channel Lining	Natural - Fine Gravel
Discharge (cfs)	**FHWA Max. Permissible Velocity Table**
8	Stable
23	Stable
57	Stable
76	Stable

FHWA Max. Permissible Velocity (ft/s)	5

Equilibrium Slope Calculations

Dominant Discharge	23	cfs
Clear Water	Yes	
Total Incoming Sediment Load	0.000	cfs
Initial Chnl Sediment Capacity	0.038	cfs
Long-term Equilibrium Slope (MPM)	0.0083	

Drop Structures

Design Slope	0.0083	ft/ft
Total Drop Needed	9.7	ft
Height of Drop Structure	3	ft
No. of Drop Structures	3.22	
Distance between Structures	375	ft

Total Scour Calculations: Zt = 1.3(Zgs + 1/2ha + Zdeg + Zbs + Zi)

Discharge	Sinuosity	Bend	Max. Depth	Hyd. Depth	Avg Vel	Slope	General Scour	Antidune Wave Height	LongTerm Scour	Bend Scour	Low Flow Incision	Total
Q (cfs)		Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)	Se	Zgs (ft)	ha (ft)	Zdeg (ft)	Zbs (ft)	Zi (ft)	Zt (ft)
76	1.1	24.6	0.4	0.4	2.3	0.0163	-0.1	0.1	1.5	0.0	2.0	4.7

Cost Estimates

Channel Characteristics

Channel Length (ft)	1208
Channel Limit-Left Station (ft)	150
Channel Limit-Right Station (ft)	230
Channel Width (ft)	80

Levee

Left Levee Length (ft)	1208
Left Levee Top Width (ft)	0.5
Left Levee Height (ft)	3.4
Right Levee Length (ft)	1208
Right Levee Top Width (ft)	0.5
Right Levee Height (ft)	3.1

Left Levee Surface Area (sq. Yd)	456
Left Levee Volume (cu. Yd)	76
Right Levee Surface Area (sq. Yd)	416
Right Levee Volume (cu. Yd)	69
Total Levee Surface Area (sq. Yd)	872
Total Levee Volume (cu. Yd)	145

Levee Fill

Left Levee Fill Buffer Width (ft)	50
Left Levee Fill Slope (ft/ft)	6
Left Levee Fill ROW Width (ft)	50
Left Levee Fill Surface Area (sq. ft)	60632
Left Levee Fill XS area (sq. ft)	41.3
Left Levee Fill Volume (cu. Yd)	1848
Right Levee Fill Buffer Width (ft)	50
Right Levee Fill Slope (ft/ft)	6
Right Levee Fill ROW Width (ft)	10.5
Right Levee Fill Surface Area (sq. ft)	12682
Right Levee Fill XS area (sq. ft)	0.9
Right Levee Fill Volume (cu. Yd)	40
Total Levee Fill Surface Area (sq. ft)	73314
Total Levee Fill Volume (cu Yd)	1888

Drop Structures

Structure Type	Gabions	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length (ft)	80	
Aesthetic Treatment Ratio	1.1	
Structure Thickness (ft)	1	
Drop Height (ft)	3	
Scour Depth (ft)	1.9	
Structure Height (ft)	4.9	
Number of Structures	3.22	
	Design	Aesthetic Trtmt.
Volume per structure (cu.Yd)	14.62	1.46
Unit Cost (per cu. Yd)	$ 85.00	$ 85.00
Other Cost	$ -	$ -
Cost per structure	$ 1,243	$ 124
Area per structure (sq. Yd)	9	1
Total Area (cu. Yd)	29	0

Structure Cost

Structure Type		Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Wall Material Cost	Wall	1,208	ft	$ 156	$ 188,491	145	cu. Yd	$ -	$ -	145	cu. Yd	$ -	$ -
Wall Surface Cost	Wall	872	sq. Yd	$ -	$ -	872	sq. Yd	$ -	$ -	872	sq. Yd	$ 75.00	$ 65,400
Adjacent Levee Fill	Fill	1,888	cu. Yd	$ 7.00	$ 13,216	8,120	sq. Yd	$ 4.50	$ 36,542	8,120	sq. Yd	$ 11.67	$ 94,739
Wall Material Aesthetic Treatment Cost	Wall	145	cu. Yd	$ -	$ -	145	cu. Yd	$ -	$ -	145	cu. Yd	$ -	$ -
Wall Surface Aesthetic Trtmt. Cost	Wall	872	sq. Yd	$ 63.00	$ 54,936	872	sq. Yd	$ -	$ -	872	sq. Yd	$ -	$ -
Drop Structures	Gabions	3	EA	$ 1,242.70	$ 4,001	9	sq. Yd	$ -	$ -	9	sq. Yd	$ 37.50	$ 333
Other					$ -				$ -				$ -
		Total without Contingency & Engineering Design Cost			$ 260,644			Total	$ 36,542			Total	$ 160,472
		Contingency Cost (25% of Construction Cost)			$ 65,161								
		Engineering Design Cost (5% of Construction Cost)			$ 13,032								
		Total Construction Cost			$ 338,837								
Wall Material Aesthetic Treatment Cost	Wall	145	cu. Yd	$ -	$ -	145	cu. Yd	$ -	$ -	145	cu. Yd	$ -	$ -
Wall Surface Aesthetic Trtmt. Cost	Wall	872	sq. Yd	$ 63.00	$ 54,936	872	sq. Yd	$ -	$ -	872	sq. Yd	$ -	$ -
Adj. Levee Fill Aesthetic Trmt. Cost	Fill	1,888	cu. Yd	$ 7.00	$ 13,216	8,120	sq. Yd	$ 4.50	$ 36,542	8,120	sq. Yd	$ 11.67	$ 94,739
Drop Structures Aesthetic Trtmt. Cost	Gabions	3	EA	$ 124.10	$ 400	9	sq. Yd	$ -	$ -	1	sq. Yd	$ 37.50	$ 33
Other					$ -				$ -				$ -
		Total without Contingency & Engineering Design Cost			$ 68,552			Total	$ 36,542			Total	$ 94,772
		Contingency Cost (25% of Construction Cost)			$ 17,138								
		Engineering Design Cost (5% of Construction Cost)			$ 3,428								
		Total Construction Cost			$ 89,117								

Total Structure Aesthetic Trtmt Cost	$ 220,431

Land Cost

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
Adjacent Buffer Area	70	1.9	$100,000	$ 190,000
Maintenance Access	30	0.8	$100,000	$ 80,000
Channel	80	2.2	$100,000	$ 220,000
Levee	1	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	181	4.9		$ 490,000

Total Land Related Aes. Trtmt Cost	$ 190,000

Total Cost	$ 1,025,851	Total Aesthetic Treatment Cost	$ 410,431	Total Right of Way Cost	$ 490,000

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Sub-area: FRS 2 & 3, Skyline Fan System
Walled-Levee Corridor Structure ID: H1X1AW2C, Cutline ID: 1

Walled-Levee Corridor

Structure ID	H1W2CW2D	HEC1 ID	W2CW2D	Cutline ID	1

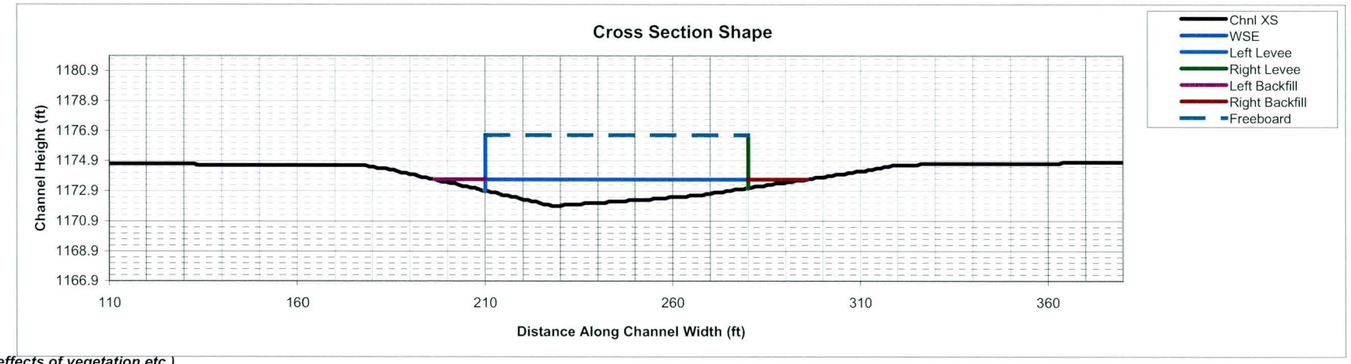
Longitundal Geometry

Length	1223.1	ft
Initial Channel Slope	0.0170	ft/ft
Long-term (Equilibrium) Chnl Slope	0.0148	ft/ft

Levee

Left Levee Type	Wall	Right Levee Type	Wall
Left Levee Station (ft)	210	Right Levee Station (ft)	280
Left Adjacent Buffer Width (ft)	50	Right Adjacent Buffer Width (ft)	50
Left Channel Limit Station (ft)	210	Right Channel Limit Station (ft)	280

Channel XS Geometry



Mannings n (includes effects of vegetation etc.)

Location	Initial	Long-term
Mannings n	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	CW2D	CW2C								TOTAL
HEC1 Peak-Flow	496	420								
Weighting Factor	0.44	0.56								
Flow into Channel	220	234								454

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Flow Topwidth (ft)	Hydraulic Radius (ft)	Hydraulic Depth (ft)	Froude Number
45	53.9	20.2	1171.9	1172.6	2.2	0.7	53.8	0.4	0.4	0.65
136	69.0	43.1	1171.9	1173.0	3.2	1.1	68.8	0.6	0.6	0.70
341	71.1	75.7	1171.9	1173.5	4.5	1.6	70.0	1.1	1.1	0.76
454	71.5	90.1	1171.9	1173.7	5.0	1.8	70.0	1.3	1.3	0.78

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Flow Topwidth (ft)	Hydraulic Radius (ft)	Hydraulic Depth (ft)	Froude Number
45	54.2	21.1	1171.9	1172.7	2.1	0.8	54.2	0.4	0.4	0.61
136	69.3	45.1	1171.9	1173.0	3.0	1.1	69.1	0.6	0.7	0.66
341	71.2	78.9	1171.9	1173.5	4.3	1.6	70.0	1.1	1.1	0.72
454	71.6	94.0	1171.9	1173.7	4.8	1.8	70.0	1.3	1.3	0.73

Sediment Data

D16 (mm)	0.17	G	3.99
D50 (mm)	0.7		
D65 (mm)	1.2		
D84 (mm)	2.7		
D90 (mm)	4		

Inflowing Sediment Load from U/S Reaches

Dominant Discharge (cfs)	Sediment Inflow (cfs) Contributions from Upstream (Identified using Structure ID)									TOTAL
	H1W2BW2C_1	H1X1AW2C_1								
136	0.53	0.04								0.57

Maximum Permissible Velocity

Channel Lining	Natural - Fine Gravel

Discharge (cfs)	FHWA Max. Permissible Velocity Table
45	Stable
136	Stable
341	Stable
454	Erosive

FHWA Max. Permissible Velocity (ft/s)	5

Equilibrium Slope Calculations

Dominant Discharge	136	cfs
Clear Water	No	
Total Incoming Sediment Load	0.569	cfs
Initial Chnl Sediment Capacity	0.696	cfs
Long-term Equilibrium Slope (ADWR)	0.0148	

Drop Structures

Design Slope	0.0148	ft/ft
Total Drop Needed	2.7	ft
Height of Drop Structure	3	ft
No. of Drop Structures	0.90	
Distance between Structures	1359	ft

Total Scour Calculations: Zt = 1.3(Zgs + 1/2ha + Zdeg + Zbs + Zi)

Discharge	Sinuosity	Bend	Max. Depth	Hyd. Depth	Avg Vel	Slope	General Scour	Antidune Wave Height	LongTerm Scour	Bend Scour	Low Flow Incision	Total
Q (cfs)		Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)	Se	Zgs (ft)	ha (ft)	Zdeg (ft)	Zbs (ft)	Zi (ft)	Zt (ft)
454	1.1	24.6	1.8	1.3	5.0	0.0170	-0.4	0.7	1.5	0.2	2.0	5.3

Cost Estimates

Channel Characteristics

Channel Length (ft)	1223
Channel Limit-Left Station (ft)	210
Channel Limit-Right Station (ft)	280
Channel Width (ft)	70

Levee

Left Levee Length (ft)	1223
Left Levee Top Width (ft)	0.5
Left Levee Height (ft)	3.8
Right Levee Length (ft)	1223
Right Levee Top Width (ft)	0.5
Right Levee Height (ft)	3.6

Left Levee Surface Area (sq. Yd)	516
Left Levee Volume (cu. Yd)	86
Right Levee Surface Area (sq. Yd)	489
Right Levee Volume (cu. Yd)	82
Total Levee Surface Area (sq. Yd)	1005
Total Levee Volume (cu. Yd)	168

Levee Fill

Left Levee Fill Buffer Width (ft)	50
Left Levee Fill Slope (ft/ft)	6
Left Levee Fill ROW Width (ft)	13.3
Left Levee Fill Surface Area (sq. ft)	16267
Left Levee Fill XS area (sq. ft)	5.4
Left Levee Fill Volume (cu. Yd)	245
Right Levee Fill Buffer Width (ft)	50
Right Levee Fill Slope (ft/ft)	6
Right Levee Fill ROW Width (ft)	15.8
Right Levee Fill Surface Area (sq. ft)	19325
Right Levee Fill XS area (sq. ft)	4.8
Right Levee Fill Volume (cu. Yd)	217
Total Levee Fill Surface Area (sq. ft)	35592
Total Levee Fill Volume (cu Yd)	462

Drop Structures

Structure Type	Gabions	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length (ft)	70	
Aesthetic Treatment Ratio	1.1	
Structure Thickness (ft)	1	
Drop Height (ft)	3	
Scour Depth (ft)	5.9	
Structure Height (ft)	8.9	
Number of Structures	0.90	
	Design	Aesthetic Trtmt.
Volume per structure (cu.Yd)	23.17	2.32
Unit Cost (per cu. Yd)	$ 85.00	$ 85.00
Other Cost	$ -	$ -
Cost per structure	$ 1,969	$ 197
Area per structure (sq. Yd)	8	1
Total Area (cu. Yd)	7	0

Structure Type	Structure Cost													
		Construction				Landscape				Maintenance				
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Wall Material Cost	Wall	1,223	ft	$ 187	$ 228,108	168	cu. Yd	$ -	$ -	168	cu. Yd	$ -	$ -
Wall Surface Cost	Wall	1,005	sq. Yd	$ -	$ -	1,005	sq. Yd	$ -	$ -	1,005	sq. Yd	$ 75.00	$ 75,375
Adjacent Levee Fill	Fill	462	cu. Yd	$ 7.00	$ 3,234	3,954	sq. Yd	$ 4.50	$ 17,795	3,954	sq. Yd	$ 11.67	$ 46,134
Wall Material Aesthetic Treatment Cost	Wall	168	cu. Yd	$ -	$ -	168	cu. Yd	$ -	$ -	168	cu. Yd	$ -	$ -
Wall Surface Aesthetic Trtmt. Cost	Wall	1,005	sq. Yd	$ 63.00	$ 63,315	1,005	sq. Yd	$ -	$ -	1,005	sq. Yd	$ -	$ -
Drop Structures	Gabions	1	EA	$ 1,969.45	$ 1,773	8	sq. Yd	$ -	$ -	8	sq. Yd	$ 37.50	$ 292
Other					$ -				$ -				$ -
		Total without Contingency & Engineering Design Cost			$ 296,430			Total	$ 17,795			Total	$ 121,801
		Contingency Cost (25% of Construction Cost)			$ 74,107								
		Engineering Design Cost (5% of Construction Cost)			$ 14,821								
		Total Construction Cost			$ 385,358								
Wall Material Aesthetic Treatment Cost	Wall	168	cu. Yd	$ -	$ -	168	cu. Yd	$ -	$ -	168	cu. Yd	$ -	$ -
Wall Surface Aesthetic Trtmt. Cost	Wall	1,005	sq. Yd	$ 63.00	$ 63,315	1,005	sq. Yd	$ -	$ -	1,005	sq. Yd	$ -	$ -
Adj. Levee Fill Aesthetic Trmt. Cost	Fill	462	cu. Yd	$ 7.00	$ 3,234	3,954	sq. Yd	$ 4.50	$ 17,795	3,954	sq. Yd	$ 11.67	$ 46,134
Drop Structures Aesthetic Trtmt. Cost	Gabions	1	EA	$ 197.20	$ 177	8	sq. Yd	$ -	$ -	1	sq. Yd	$ 37.50	$ 29
Other					$ -				$ -				$ -
		Total without Contingency & Engineering Design Cost			$ 66,726			Total	$ 17,795			Total	$ 46,163
		Contingency Cost (25% of Construction Cost)			$ 16,682								
		Engineering Design Cost (5% of Construction Cost)			$ 3,336								
		Total Construction Cost			$ 86,744								

Total Structure Aesthetic Trtmt Cost	$ 150,703

Land Cost

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
Adjacent Buffer Area	70	2	$100,000	$ 200,000
Maintenance Access	30	0.8	$100,000	$ 80,000
Channel	70	2	$100,000	$ 200,000
Levee	1	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	171	4.8		$ 480,000

Total Land Related Aes. Trtmt Cost	$ 200,000

Total Cost	$ 1,004,954	Total Aesthetic Treatment Cost	$ 350,703	Total Right of Way Cost	$ 480,000

JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC.

Sub-area: FRS 2 & 3, Skyline Fan System
Walled-Levee Corridor Structure ID: H1W2CW2D, Cutline ID: 1

```
1***************************************                        ***************************************
 *                                     *                        *                                     *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1) *                        *   U.S. ARMY CORPS OF ENGINEERS      *
 *              JUN   1998             *                        *   HYDROLOGIC ENGINEERING CENTER     *
 *           VERSION 4.1               *                        *         609 SECOND STREET           *
 *                                     *                        *       DAVIS, CALIFORNIA 95616       *
 *  RUN DATE   20DEC06  TIME  22:00:42 *                        *           (916) 756-1104            *
 *                                     *                        *                                     *
 ***************************************                        ***************************************


                  X     X  XXXXXXX  XXXXX          X
                  X     X  X        X     X       XX
                  X     X  X        X              X
                  XXXXXXX  XXXX     X       XXXXX  X
                  X     X  X        X              X
                  X     X  X        X     X        X
                  X     X  XXXXXXX  XXXXX         XXX


      THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

      THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
      THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
      NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
      DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
      KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM


1                                 HEC-1 INPUT                                         PAGE  1

   LINE       ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

     1        ID   HYDROLOGY FOR STEP 3 RECOMMENDED ALTERNATIVE FOR SUN VALLEY ADMP
     2        ID       - SKYLINE WASH FAN SYSTEM
     3        ID
     4        ID   SUN VALLEY AREA DRAINAGE MASTER PLAN (SVADMP) - FCD 2004C049
     5        ID   JE FULLER / HYDROLOGY & GEOMORPHOLOGY, INC.
     6        ID   MODELER: TED LEHMAN
     7        ID   FILENAME: SKY6.DAT
     8        ID
     9        ID   100-YEAR 6-HOUR MODEL
    10        ID   EXISTING CONDITIONS - WITH RECOMMENDED ALTERNATIVE ELEMENTS
    11        ID            MODELED AREA = 8.5 SQ. MILES
    12        ID
    13        ID   GREEN-AMPT LOSS METHOD
    14        ID
    15        ID   S-GRAPH UNIT HYDROGRAPHS
    16        ID     - MOUNTAIN
    17        ID     - DESERT/RANGELAND
    18        ID
    19        ID   NORMAL-DEPTH CHANNEL ROUTING
    20        ID
    21        ID   LAND USE DATA FROM EXAMINATION OF SLOPE FROM 10-FT DTM TO DISTINGUISH
    22        ID     - UNDEVELOPED DESERT RANGELAND (NDR) - SLOPES < 5 %
    23        ID     - HILLSLOPES, SONORAN DESERT (NHS) - SLOPES 5 - 10 %
    24        ID     - MOUNTAIN TERRAIN (NMT) - SLOPES > 10 %
    25        ID
    26        ID   SOILS DATA FROM FCDMC GIS DATABASE (RECEIVED FROM FCDMC JULY 2005)
    27        IT       5  1JAN99    1200    2000
    28        IN      15
    29        IO       3
              *DIAGRAM
              *
    30        JD   3.196  0.1000
    31        PC   0.000   0.008   0.016   0.025   0.033   0.041   0.050   0.058   0.066   0.074
    32        PC   0.087   0.099   0.118   0.138   0.216   0.377   0.834   0.911   0.931   0.950
    33        PC   0.962   0.972   0.983   0.991   1.000
    34        JD   3.181  0.5000
    35        PC   0.000   0.008   0.016   0.025   0.033   0.041   0.050   0.058   0.066   0.074
    36        PC   0.087   0.099   0.118   0.138   0.216   0.377   0.834   0.911   0.931   0.950
    37        PC   0.962   0.972   0.983   0.991   1.000
    38        JD   3.120     2.8
    39        PC   0.000   0.009   0.016   0.025   0.034   0.042   0.051   0.059   0.068   0.077
    40        PC   0.088   0.101   0.121   0.164   0.253   0.451   0.694   0.836   0.900   0.938
    41        PC   0.950   0.963   0.975   0.988   1.000
    42        JD   2.950    16.0
    43        PC   0.000   0.015   0.020   0.030   0.048   0.063   0.076   0.090   0.105   0.119
    44        PC   0.135   0.152   0.175   0.222   0.304   0.472   0.670   0.796   0.868   0.912
    45        PC   0.946   0.960   0.973   0.987   1.000
              *

    46        KK      W1   BASIN
    47        KM        Compute runoff from subbasin W1
    48        BA   4.054
    49        LG    0.25    0.35    3.95    0.40       7
    50        UI     320     352    1022    1585    2126    2444    3094    3528    2240    1909
    51        UI    1727    1521    1333    1181     959     814     756     676     530     444
1                                 HEC-1 INPUT                                         PAGE  2

   LINE       ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

    52        UI     396     348     308     245     245     171     156     157     158      74
    53        UI      61      62      61      62      61      62      61      62      61       0
    54        UI       0       0       0       0       0       0       0       0       0       0
    55        ZW                   C=FLOW
              *

    56        KK    RRW1 STORAGE
    57        KM   PROPOSED DETENTION BASIN
    58        KM    ROUTE RUNOFF FROM SUBBASIN W1 THROUGH PROPOSED DETENTION BASIN
    59        KM    STRUCTURE ID:RRW1
    60        KM    OUTLET BASED ON ASSUMED 2 pipe(s), dia: 5 ft
    61        RS       1    STOR      -1
    62        SV     0.0    16.0    68.5    95.7   123.5   151.9   180.8   210.5   240.7   271.6
    63        SE     0.0     2.0     4.0     5.0     6.0     7.0     8.0     9.0    10.0    11.0
    64        SQ     0.0    56.6   167.7   210.8   255.6   312.7   361.3   403.3   440.2   476.9
    65        ZW                   C=FLOW
              *

    66        KK   W1W2A   ROUTE
    67        KM   PROPOSED CHANNEL
    68        KM    ROUTE OUTFLOW FROM RRW1 TO CW2A
    69        KM    Slope=(1330.0 - 1301.0) / 1524.0
    70        RS       1    FLOW      -1
    71        RC   0.045   0.045   0.045  1524.0   0.019   104.5
    72        RX     0.0     0.0     0.0     0.0    40.0    40.0    40.0    40.0
    73        RY   104.5   100.0   100.0   100.0   100.0   100.0   100.0   104.5
    74        ZW                   C=FLOW
              *

    75        KK     W2A   BASIN
    76        KM        Compute runoff from subbasin W2A
    77        BA   0.283
    78        LG    0.25    0.35    3.95    0.40       7
    79        UI      73     274     479     425     280     202     137     102      65      49
    80        UI      33      26      12      11      10      10       0       0       0       0
              *

    81        KK    CW2A COMBINE
    82        KM        Combine runoff from W2A w/ routed outflows from Skyline Fan detention ba
    83        HC       2
    84        ZW                   C=FLOW
              *

    85        KK  W2AW2B   ROUTE
    86        KM   PROPOSED CHANNEL
    87        KM    ROUTE COMBINED FLOWS FROM CW2A TO CW2B
    88        KM    & SECOND DETENTION BASIN AT INSET FAN APEX
    89        KM    Slope=(1301.0 - 1236.0) / 3971.0
    90        RS       3    FLOW      -1
    91        RC   0.045   0.045   0.045  3971.0   0.016   104.5
    92        RX     0.0     0.0     0.0     0.0   180.0   180.0   180.0   180.0
    93        RY   104.5   100.0   100.0   100.0   100.0   100.0   100.0   104.5
    94        ZW                   C=FLOW
              *
1                                 HEC-1 INPUT                                         PAGE  3

   LINE       ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

    95        KK     W2B   BASIN
    96        KM        Compute runoff from subbasin W2B
    97        BA   0.858
    98        LG    0.32    0.35    3.78    0.45       3
    99        UI     291    1105    1793    1107     806     515     359     226     156      98
   100        UI      69      36      35      36       0       0       0       0       0       0
              *

   101        KK    CW2B COMBINE
   102        KM        Combine runoff from W2B routed flows from CW2A
   103        HC       2
   104        ZW                   C=FLOW
              *

   105        KK   RRW2B STORAGE
   106        KM   PROPOSED DETENTION BASIN
   107        KM    ROUTE COMBINED FLOW THROUGH PROPOSED DETENTION BASIN AT INSET FAN ON EAST SI
   108        KM    STRUCTURE ID:RRW2B
   109        KM    OUTLET BASED ON ASSUMED 2 pipe(s), dia: 5 ft
   110        RS       1    STOR      -1
   111        SV     0.0     0.0     4.8    12.3    28.2    45.6    54.8    64.4    74.4    84.7
   112        SE     0.0     1.0     2.0     3.0     5.0     7.0     8.0     9.0    10.0    11.0
   113        SQ     0.0    28.3    56.6   111.3   210.8   312.7   361.3   403.3   440.2   476.9
   114        ZW                   C=FLOW
              *

   115        KK  W2BW2C   ROUTE
   116        KM   PROPOSED CHANNEL
   117        KM    ROUTE OUTFLOW FROM RRW2B TO CONFLUENCE WITH OUTFLOW FROM RRX1A
   118        KM    Slope=(1222.0 - 1184.0) / 2321.0
   119        RS       1    FLOW      -1
   120        RC   0.045   0.045   0.045  2321.0   0.016   104.5
   121        RX     0.0     0.0     0.0     0.0    50.0    50.0    50.0    50.0
   122        RY   104.5   100.0   100.0   100.0   100.0   100.0   100.0   104.5
   123        ZW                   C=FLOW
              *

   124        KK     W2C   BASIN
   125        KM        Compute runoff from subbasin W2C
   126        BA   0.124
   127        LG    0.35    0.35    3.81    0.44       0
   128        UI     162     437     232      85      29      11       0       0       0       0
              *
```

```
  129          KK  CW2CR COMBINE
  130          KM       Combine runoff from W2C with routed outflows from 2nd detention basin.
  131          HC      2
               *
1                                        HEC-1 INPUT                                          PAGE  4

 LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


  132          KK    X1A   BASIN
  133          KM       Compute runoff from subbasin X1A
  134          BA  0.696
  135          LG   0.25    0.35    3.95    0.40       7
  136          UI     77     178     386     545     733     756     483     413     347     286
  137          UI    223     183     157     119      95      84      60      56      38      38
  138          UI     30      15      15      15      15      15      15       0       0       0
  139          ZW                C=FLOW
               *

  140          KK  RRX1A STORAGE
  141          KM  PROPOSED DETENTION BASIN
  142          KM   ROUTE RUNOFF FROM X1A THROUGH PROPOSED DETENTION BASIN
  143          KM   STRUCTURE ID:RRX1A
  144          KM   OUTLET BASED ON ASSUMED 1 pipe(s), dia: 3 ft
  145          RS      1    STOR      -1
  146          SV    0.0     5.7    17.5    23.8    30.5    37.5    44.9    52.5    60.5    68.9
  147          SE    0.0     2.0     4.0     5.0     6.0     7.0     8.0     9.0    10.0    11.0
  148          SQ    0.0    18.6    41.0    51.5    61.4    68.9    76.3    83.1    89.1    90.7
  149          ZW                C=FLOW
               *

  150          KK  X1AW2C   ROUTE
  151          KM  PROPOSED CHANNEL
  152          KM   ROUTE OUTFLOW FROM RRX1A TO CONFLUENCE WITH PROPOSED NEW CHANNEL FROM RRW2B
  153          KM   Slope=(1205.0 - 1184.0) / 1208.0
  154          RS      1    FLOW      -1
  155          RC  0.045   0.045   0.045  1208.0   0.017   104.5
  156          RX    0.0     0.0     0.0     0.0    80.0    80.0    80.0    80.0
  157          RY  104.5   100.0   100.0   100.0   100.0   100.0   100.0   104.5
  158          ZW                C=FLOW
               *

  159          KK   CW2C COMBINE
  160          KM       Combine routed outflow from SkyET detention basin with
  161          KM       combined flows at CW2CR.
  162          HC      2
  163          ZW                C=FLOW
               *

  164          KK  W2CW2D   ROUTE
  165          KM  PROPOSED CHANNEL
  166          KM   ROUTE COMBINED FLOW TO FRS NO. 3 VIA PROPOSED NEW CHANNEL
  167          KM   Slope=(1184.0 - 1160.0) / 1456.0
  168          RS      1    FLOW      -1
  169          RC  0.045   0.045   0.045  1456.0   0.016   104.5
  170          RX    0.0     0.0     0.0     0.0    70.0    70.0    70.0    70.0
  171          RY  104.5   100.0   100.0   100.0   100.0   100.0   100.0   104.5
  172          ZW                C=FLOW
               *
1                                        HEC-1 INPUT                                          PAGE  5

 LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


  173          KK    W2D   BASIN
  174          KM       Compute runoff from subbasin W2D
  175          BA  0.120
  176          LG   0.35    0.35    4.15    0.44       0
  177          UI    279     464     139      35       0       0       0       0       0       0
               *

  178          KK   CW2D COMBINE
  179          KM       Combine runoff from W2D with routed flows from CW2C.
  180          HC      2
               *

  181          KK   S800   BASIN
  182          KM       Compute runoff from subbasin 800
  183          BA  0.431
  184          LG   0.27    0.35    4.60    0.34       9
  185          UI     49     118     252     353     489     442     297     255     213     170
  186          UI    134     113      92      69      57      48      38      29      24      25
  187          UI     12       9      10       9      10       9      10       0       0       0
               *

  188          KK   S810   BASIN
  189          KM       Compute runoff from subbasin 810
  190          BA  1.607
  191          LG   0.30    0.35    4.65    0.32       4
  192          UI    140     200     493     790     997    1196    1589    1066     843     750
  193          UI    668     569     489     397     336     309     256     202     176     155
  194          UI    130     106     102      68      68      69      46      27      27      27
  195          UI     26      27      27      27      27       0       0       0       0       0
               *

  196          KK   S820   BASIN
  197          KM       Compute runoff from subbasin S820.  Runoff to Fan 20 apex.
  198          BA  0.362
  199          LG   0.25    0.35    4.35    0.40      18
  200          UI     45     123     260     348     490     307     248     208     166     125
  201          UI    105      83      61      51      39      33      23      22      15       8
  202          UI      9       8       9       9       0       0       0       0       0       0
  203          ZZ
1
                 SCHEMATIC DIAGRAM OF STREAM NETWORK
 INPUT
 LINE      (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

 NO.       (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

  46          W1
               V
               V
  56        RRW1
               V
               V
  66       W1W2A
               .
               .
  75           .         W2A
               .           .
               .           .
  81        CW2A............
               V
               V
  85       W2AW2B
               .
               .
  95           .         W2B
               .           .
               .           .
 101        CW2B............
               V
               V
 105       RRW2B
               V
               V
 115       W2BW2C
               .
               .
 124           .         W2C
               .           .
               .           .
 129       CW2CR............
               .
               .
 132           .         X1A
               .           V
               .           V
 140           .       RRX1A
               .           V
               .           V
 150           .       X1AW2C
               .           .
               .           .
 159        CW2C............
               V
               V
 164       W2CW2D
               .
               .
 173           .         W2D
               .           .
               .           .
 178        CW2D............
               .
               .
 181           .         S800
               .           .
               .           .
 188           .           .         S810
               .           .           .
               .           .           .
 196           .           .           .         S820

 (***) RUNOFF ALSO COMPUTED AT THIS LOCATION
1*****************************************                                    ************************************
 *                                       *                                    *                                  *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                                    *   U.S. ARMY CORPS OF ENGINEERS   *
 *              JUN   1998               *                                    *  HYDROLOGIC ENGINEERING CENTER   *
 *            VERSION 4.1                *                                    *        609 SECOND STREET         *
 *                                       *                                    *     DAVIS, CALIFORNIA 95616      *
 *  RUN DATE   20DEC06  TIME  22:00:42   *                                    *        (916) 756-1104            *
 *                                       *                                    *                                  *
 *****************************************                                    ************************************

                                HYDROLOGY FOR STEP 3 RECOMMENDED ALTERNATIVE FOR SUN VALLEY ADMP
                                    - SKYLINE WASH FAN SYSTEM

                                SUN VALLEY AREA DRAINAGE MASTER PLAN (SVADMP) - FCD 2004C049
                                JE FULLER / HYDROLOGY & GEOMORPHOLOGY, INC.
                                MODELER: TED LEHMAN
                                FILENAME: SKY6.DAT

                                100-YEAR 6-HOUR MODEL
                                EXISTING CONDITIONS - WITH RECOMMENDED ALTERNATIVE ELEMENTS
```

```
                    MODELED AREA = 8.5 SQ. MILES

              GREEN-AMPT LOSS METHOD

              S-GRAPH UNIT HYDROGRAPHS
                - MOUNTAIN
                - DESERT/RANGELAND

              NORMAL-DEPTH CHANNEL ROUTING

              LAND USE DATA FROM EXAMINATION OF SLOPE FROM 10-FT DTM TO DISTINGUISH
                - UNDEVELOPED DESERT RANGELAND (NDR) - SLOPES < 5 %
                - HILLSLOPES, SONORAN DESERT (NHS) - SLOPES 5 - 10 %
                - MOUNTAIN TERRAIN (NMT) - SLOPES > 10 %

              SOILS DATA FROM FCDMC GIS DATABASE (RECEIVED FROM FCDMC JULY 2005)

29 IO      OUTPUT CONTROL VARIABLES
                IPRNT          3  PRINT CONTROL
                IPLOT          0  PLOT CONTROL
                QSCAL         0.  HYDROGRAPH PLOT SCALE

28 IN      TIME DATA FOR INPUT TIME SERIES
                JXMIN         15  TIME INTERVAL IN MINUTES
               JXDATE     1JAN99  STARTING DATE
               JXTIME       1200  STARTING TIME

   IT      HYDROGRAPH TIME DATA
                NMIN          5  MINUTES IN COMPUTATION INTERVAL
               IDATE     1JAN99  STARTING DATE
               ITIME       1200  STARTING TIME
                  NQ       2000  NUMBER OF HYDROGRAPH ORDINATES
              NDDATE     8JAN99  ENDING DATE
              NDTIME       1035  ENDING TIME
               ICENT         19  CENTURY MARK

          COMPUTATION INTERVAL     .08 HOURS
               TOTAL TIME BASE  166.58 HOURS

     ENGLISH UNITS
          DRAINAGE AREA          SQUARE MILES
          PRECIPITATION DEPTH    INCHES
          LENGTH, ELEVATION      FEET
          FLOW                   CUBIC FEET PER SECOND
          STORAGE VOLUME         ACRE-FEET
          SURFACE AREA           ACRES
          TEMPERATURE            DEGREES FAHRENHEIT

30 JD      INDEX STORM NO. 1
                STRM       3.20  PRECIPITATION DEPTH
                TRDA        .10  TRANSPOSITION DRAINAGE AREA

31 PI        PRECIPITATION PATTERN
               .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
               .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
               .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
               .00       .00       .00       .01       .01       .01       .01       .01       .01       .03
               .03       .03       .05       .05       .05       .15       .15       .15       .03       .03
               .03       .01       .01       .01       .01       .01       .01       .00       .00       .00
               .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
               .00       .00

34 JD      INDEX STORM NO. 2
                STRM       3.18  PRECIPITATION DEPTH
                TRDA        .50  TRANSPOSITION DRAINAGE AREA

35 PI        PRECIPITATION PATTERN
               .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
               .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
               .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
               .00       .00       .00       .01       .01       .01       .01       .01       .01       .03
               .03       .03       .05       .05       .05       .15       .15       .15       .03       .03
               .03       .01       .01       .01       .01       .01       .01       .00       .00       .00
               .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
               .00       .00

38 JD      INDEX STORM NO. 3
                STRM       3.12  PRECIPITATION DEPTH
                TRDA       2.80  TRANSPOSITION DRAINAGE AREA

39 PI        PRECIPITATION PATTERN
               .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
               .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
               .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
               .00       .00       .00       .01       .01       .01       .01       .01       .01       .03
               .03       .03       .07       .07       .07       .08       .08       .08       .05       .05
               .05       .02       .02       .02       .01       .01       .01       .00       .00       .00
               .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
               .00       .00

42 JD      INDEX STORM NO. 4
                STRM       2.95  PRECIPITATION DEPTH
                TRDA      16.00  TRANSPOSITION DRAINAGE AREA

43 PI        PRECIPITATION PATTERN
               .01       .01       .00       .00       .00       .00       .00       .00       .00       .01
               .01       .01       .00       .01       .00       .00       .00       .00       .00       .00
               .00       .00       .01       .00       .00       .00       .00       .01       .01       .01
               .01       .01       .01       .01       .01       .01       .02       .02       .02       .03
               .03       .03       .06       .06       .06       .07       .07       .07       .04       .04
               .04       .02       .02       .02       .01       .01       .01       .01       .01       .01
               .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
               .00       .00

*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

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              *            *
46 KK         *     W1     *      BASIN
              *            *
              **************
                        Compute runoff from subbasin W1

           SUBBASIN RUNOFF DATA

48 BA        SUBBASIN CHARACTERISTICS
                TAREA        4.05  SUBBASIN AREA

49 LG        GREEN AND AMPT LOSS RATE
                STRTL         .25  STARTING LOSS
                  DTH         .35  MOISTURE DEFICIT
                 PSIF        3.95  WETTING FRONT SUCTION
                XKSAT         .40  HYDRAULIC CONDUCTIVITY
                RTIMP        7.00  PERCENT IMPERVIOUS AREA

47 UI        INPUT UNITGRAPH,  39 ORDINATES,  VOLUME = 1.00
                320.0     352.0    1022.0    1585.0    2126.0    2444.0    3094.0    3528.0    2240.0    1909.0
               1727.0    1521.0    1333.0    1181.0     959.0     814.0     756.0     676.0     530.0     444.0
                396.0     348.0     308.0     245.0     245.0     171.0     156.0     157.0     158.0      74.0
                 61.0      62.0      61.0      62.0      61.0      62.0      61.0      62.0      61.0
                                                                   ***

     ***            ***            ***            ***            ***

                     HYDROGRAPH AT STATION       W1
                   TRANSPOSITION AREA       .1 SQ MI

   TOTAL RAINFALL =    3.20, TOTAL LOSS =    1.66, TOTAL EXCESS =    1.54

  PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+    4200.      4.42       669.        168.         56.          24.
                      (INCHES)     1.534       1.538       1.538       1.538
                       (AC-FT)      332.        333.        333.        333.

                     CUMULATIVE AREA =    4.05 SQ MI

     ***            ***            ***            ***            ***

                     HYDROGRAPH AT STATION       W1
                   TRANSPOSITION AREA       .5 SQ MI

   TOTAL RAINFALL =    3.18, TOTAL LOSS =    1.65, TOTAL EXCESS =    1.53

  PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+    4169.      4.42       663.        166.         55.          24.
                      (INCHES)     1.522       1.526       1.526       1.526
                       (AC-FT)      329.        330.        330.        330.

                     CUMULATIVE AREA =    4.05 SQ MI

     ***            ***            ***            ***            ***

                     HYDROGRAPH AT STATION       W1
                   TRANSPOSITION AREA      2.8 SQ MI

   TOTAL RAINFALL =    3.12, TOTAL LOSS =    1.92, TOTAL EXCESS =    1.20

  PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+    2693.      4.50       522.        131.         44.          19.
                      (INCHES)     1.198       1.203       1.203       1.203
                       (AC-FT)      259.        260.        260.        260.

                     CUMULATIVE AREA =    4.05 SQ MI

     ***            ***            ***            ***            ***

                     HYDROGRAPH AT STATION       W1
                   TRANSPOSITION AREA     16.0 SQ MI

   TOTAL RAINFALL =    2.95, TOTAL LOSS =    2.05, TOTAL EXCESS =     .90

  PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
```

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                          (CFS)
+    1909.      4.50                  391.        98.         33.          14.
                        (INCHES)      .897       .903        .903         .903
                         (AC-FT)      194.        195.        195.         195.

                        CUMULATIVE AREA =    4.05 SQ MI

    -----DSS---ZOPEN:  Existing File Opened,  File: SKY6.DSS
                      Unit:  71;  DSS Version: 6-JG
 -----DSS---ZWRITE Unit  71; Vers.   60:  //W1/FLOW/01JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   60:  //W1/FLOW/02JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   60:  //W1/FLOW/03JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   60:  //W1/FLOW/04JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   60:  //W1/FLOW/05JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   60:  //W1/FLOW/06JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   60:  //W1/FLOW/07JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   60:  //W1/FLOW/08JAN1999/5MIN//
       ***            ***            ***            ***            ***


                        INTERPOLATED HYDROGRAPH AT       W1

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+     2527.      4.50                  494.        124.         41.          18.
                        (INCHES)     1.134       1.139       1.139        1.139
                         (AC-FT)      245.        246.        246.         246.

                        CUMULATIVE AREA =    4.05 SQ MI


 *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


            **************
            *            *
   56 KK    *      RRW1  *      STORAGE
            *            *
            **************
                          PROPOSED DETENTION BASIN
                           ROUTE RUNOFF FROM SUBBASIN W1 THROUGH PROPOSED DETENTION BASIN
                           STRUCTURE ID:RRW1
                           OUTLET BASED ON ASSUMED 2 pipe(s), dia: 5 ft

              HYDROGRAPH ROUTING DATA

   61 RS          STORAGE ROUTING
                       NSTPS           1  NUMBER OF SUBREACHES
                        ITYP        STOR  TYPE OF INITIAL CONDITION
                      RSVRIC       -1.00  INITIAL CONDITION
                           X         .00  WORKING R AND D COEFFICIENT

   62 SV            STORAGE          .0      16.0      68.5      95.7     123.5     151.9     180.8     210.5     240.7     271.6


   63 SE          ELEVATION         .00      2.00      4.00      5.00      6.00      7.00      8.00      9.00     10.00     11.00


   64 SQ          DISCHARGE          0.       57.      168.      211.      256.      313.      361.      403.      440.      477.


                                                                  ***
       ***            ***            ***            ***            ***


                        HYDROGRAPH AT STATION     RRW1
                      TRANSPOSITION AREA       .1 SQ MI

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+      462.      5.75                  388.        166.         56.          24.
                        (INCHES)      .889       1.524       1.538        1.538
                         (AC-FT)      192.        329.        333.         333.

 PEAK STORAGE   TIME                          MAXIMUM AVERAGE STORAGE
                                     6-HR       24-HR       72-HR    166.58-HR
+  (AC-FT)      (HR)
      259.      5.75                  203.         79.         26.          11.

  PEAK STAGE    TIME                          MAXIMUM AVERAGE STAGE
                                     6-HR       24-HR       72-HR    166.58-HR
+   (FEET)      (HR)
     10.61      5.75                 8.74        4.02        1.36          .59

                        CUMULATIVE AREA =    4.05 SQ MI


       ***            ***            ***            ***            ***


                        HYDROGRAPH AT STATION     RRW1
                      TRANSPOSITION AREA       .5 SQ MI

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+      460.      5.75                  385.        165.         55.          24.
                        (INCHES)      .883       1.512       1.526        1.526
                         (AC-FT)      191.        327.        330.         330.

 PEAK STORAGE   TIME                          MAXIMUM AVERAGE STORAGE
                                     6-HR       24-HR       72-HR    166.58-HR
+  (AC-FT)      (HR)
      257.      5.75                  202.         78.         26.          11.

  PEAK STAGE    TIME                          MAXIMUM AVERAGE STAGE
                                     6-HR       24-HR       72-HR    166.58-HR
+   (FEET)      (HR)
     10.53      5.75                 8.68        3.99        1.35          .58

                        CUMULATIVE AREA =    4.05 SQ MI


       ***            ***            ***            ***            ***


                        HYDROGRAPH AT STATION     RRW1
                      TRANSPOSITION AREA      2.8 SQ MI

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+      386.      5.75                  312.        130.         44.          19.
                        (INCHES)      .714       1.193       1.203        1.203
                         (AC-FT)      154.        258.        260.         260.

 PEAK STORAGE   TIME                          MAXIMUM AVERAGE STORAGE
                                     6-HR       24-HR       72-HR    166.58-HR
+  (AC-FT)      (HR)
      198.      5.75                  154.         58.         19.           8.

  PEAK STAGE    TIME                          MAXIMUM AVERAGE STAGE
                                     6-HR       24-HR       72-HR    166.58-HR
+   (FEET)      (HR)
      8.59      5.75                 7.04        3.20        1.08          .47

                        CUMULATIVE AREA =    4.05 SQ MI


       ***            ***            ***            ***            ***


                        HYDROGRAPH AT STATION     RRW1
                      TRANSPOSITION AREA     16.0 SQ MI

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+      300.      5.75                  239.         98.         33.          14.
                        (INCHES)      .549        .897        .903         .903
                         (AC-FT)      119.        194.        195.         195.

 PEAK STORAGE   TIME                          MAXIMUM AVERAGE STORAGE
                                     6-HR       24-HR       72-HR    166.58-HR
+  (AC-FT)      (HR)
      146.      5.75                  112.         41.         14.           6.

  PEAK STAGE    TIME                          MAXIMUM AVERAGE STAGE
                                     6-HR       24-HR       72-HR    166.58-HR
+   (FEET)      (HR)
      6.78      5.75                 5.58        2.51         .84          .36

                        CUMULATIVE AREA =    4.05 SQ MI

 -----DSS---ZWRITE Unit  71; Vers.   60:  //RRW1/FLOW/01JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   60:  //RRW1/FLOW/02JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   60:  //RRW1/FLOW/03JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   60:  //RRW1/FLOW/04JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   60:  //RRW1/FLOW/05JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   60:  //RRW1/FLOW/06JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   60:  //RRW1/FLOW/07JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   60:  //RRW1/FLOW/08JAN1999/5MIN//
       ***            ***            ***            ***            ***


                        INTERPOLATED HYDROGRAPH AT     RRW1

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+      368.      5.75                  296.        123.         41.          18.
                        (INCHES)      .679       1.130       1.139        1.139
                         (AC-FT)      147.        244.        246.         246.

                        CUMULATIVE AREA =    4.05 SQ MI


 *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***
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                **************
                *            *
 66 KK          *     W1W2A  *        ROUTE
                *            *
                **************
                          PROPOSED CHANNEL
                           ROUTE OUTFLOW FROM RRW1 TO CW2A
                           Slope=(1330.0 - 1301.0) / 1524.0

              HYDROGRAPH ROUTING DATA

 70 RS          STORAGE ROUTING
                      NSTPS            1  NUMBER OF SUBREACHES
                       ITYP         FLOW  TYPE OF INITIAL CONDITION
                      RSVRIC       -1.00  INITIAL CONDITION
                           X         .00 WORKING R AND D COEFFICIENT

 71 RC          NORMAL DEPTH CHANNEL
                        ANL         .045  LEFT OVERBANK N-VALUE
                       ANCH         .045  MAIN CHANNEL N-VALUE
                        ANR         .045  RIGHT OVERBANK N-VALUE
                      RLNTH        1524.  REACH LENGTH
                        SEL        .0190  ENERGY SLOPE
                      ELMAX        104.5  MAX. ELEV. FOR STORAGE/OUTFLOW CALCULATION

                                  CROSS-SECTION DATA
                         --- LEFT OVERBANK --- + ------ MAIN CHANNEL ------- + --- RIGHT OVERBANK ---
 73 RY        ELEVATION    104.50    100.00    100.00    100.00    100.00    100.00    100.00    104.50
 72 RX        DISTANCE        .00       .00       .00       .00     40.00     40.00     40.00     40.00

                                                   ***

                                  COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

          STORAGE        .00       .33       .66       .99      1.33      1.66      1.99      2.32      2.65      2.98
          OUTFLOW        .00     16.49     52.14    102.08    164.24    237.32    320.36    412.64    513.55    622.60
        ELEVATION     100.00    100.24    100.47    100.71    100.95    101.18    101.42    101.66    101.89    102.13

          STORAGE       3.31      3.65      3.98      4.31      4.64      4.97      5.30      5.63      5.97      6.30
          OUTFLOW     739.34    863.41    994.48   1132.23   1276.41   1426.76   1583.05   1745.07   1912.64   2085.56
        ELEVATION     102.37    102.61    102.84    103.08    103.32    103.55    103.79    104.03    104.26    104.50


*** WARNING *** MODIFIED PULS ROUTING MAY BE NUMERICALLY UNSTABLE FOR OUTFLOWS BETWEEN      413. TO     2086.
                THE ROUTED HYDROGRAPH SHOULD BE EXAMINED FOR OSCILLATIONS OR OUTFLOWS GREATER THAN PEAK INFLOWS.
                THIS CAN BE CORRECTED BY DECREASING THE TIME INTERVAL OR INCREASING STORAGE (USE A LONGER REACH.)

     ***            ***            ***            ***            ***

                      HYDROGRAPH AT STATION    W1W2A
                    TRANSPOSITION AREA       .1 SQ MI

  PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+     462.      5.75       387.       166.        56.         24.
                       (INCHES)      .888      1.524       1.538       1.538
                        (AC-FT)      192.       329.        333.        333.

 PEAK STORAGE   TIME                       MAXIMUM AVERAGE STORAGE
                                     6-HR       24-HR       72-HR    166.58-HR
+  (AC-FT)      (HR)
        2.      5.75         2.         1.          0.          0.

  PEAK STAGE    TIME                        MAXIMUM AVERAGE STAGE
                                     6-HR       24-HR       72-HR    166.58-HR
+   (FEET)      (HR)
    101.77      5.75    101.59     100.85      100.29      100.13

                      CUMULATIVE AREA =    4.05 SQ MI

     ***            ***            ***            ***            ***

                      HYDROGRAPH AT STATION    W1W2A
                    TRANSPOSITION AREA       .5 SQ MI

  PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+     460.      5.75       385.       165.        55.         24.
                       (INCHES)      .883      1.512       1.526       1.526
                        (AC-FT)      191.       327.        330.        330.

 PEAK STORAGE   TIME                       MAXIMUM AVERAGE STORAGE
                                     6-HR       24-HR       72-HR    166.58-HR
+  (AC-FT)      (HR)
        2.      5.75         2.         1.          0.          0.

  PEAK STAGE    TIME                        MAXIMUM AVERAGE STAGE
                                     6-HR       24-HR       72-HR    166.58-HR
+   (FEET)      (HR)
    101.77      5.75    101.58     100.84      100.29      100.12

                      CUMULATIVE AREA =    4.05 SQ MI

     ***            ***            ***            ***            ***

                      HYDROGRAPH AT STATION    W1W2A
                    TRANSPOSITION AREA      2.8 SQ MI

  PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+     386.      5.83       311.       130.        44.         19.
                       (INCHES)      .714      1.193       1.203       1.203
                        (AC-FT)      154.       258.        260.        260.

 PEAK STORAGE   TIME                       MAXIMUM AVERAGE STORAGE
                                     6-HR       24-HR       72-HR    166.58-HR
+  (AC-FT)      (HR)
        2.      5.75         2.         1.          0.          0.

  PEAK STAGE    TIME                        MAXIMUM AVERAGE STAGE
                                     6-HR       24-HR       72-HR    166.58-HR
+   (FEET)      (HR)
    101.59      5.83    101.39     100.72      100.25      100.11

                      CUMULATIVE AREA =    4.05 SQ MI

     ***            ***            ***            ***            ***

                      HYDROGRAPH AT STATION    W1W2A
                    TRANSPOSITION AREA     16.0 SQ MI

  PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+     300.      5.83       239.        98.        33.         14.
                       (INCHES)      .549       .896       .903        .903
                        (AC-FT)      119.       194.        195.        195.

 PEAK STORAGE   TIME                       MAXIMUM AVERAGE STORAGE
                                     6-HR       24-HR       72-HR    166.58-HR
+  (AC-FT)      (HR)
        2.      5.75         2.         1.          0.          0.

  PEAK STAGE    TIME                        MAXIMUM AVERAGE STAGE
                                     6-HR       24-HR       72-HR    166.58-HR
+   (FEET)      (HR)
    101.36      5.83    101.18      100.60      100.20      100.09

                      CUMULATIVE AREA =    4.05 SQ MI

-----DSS---ZWRITE Unit  71; Vers.   60:  //W1W2A/FLOW/01JAN1999/5MIN//
-----DSS---ZWRITE Unit  71; Vers.   60:  //W1W2A/FLOW/02JAN1999/5MIN//
-----DSS---ZWRITE Unit  71; Vers.   60:  //W1W2A/FLOW/03JAN1999/5MIN//
-----DSS---ZWRITE Unit  71; Vers.   60:  //W1W2A/FLOW/04JAN1999/5MIN//
-----DSS---ZWRITE Unit  71; Vers.   60:  //W1W2A/FLOW/05JAN1999/5MIN//
-----DSS---ZWRITE Unit  71; Vers.   60:  //W1W2A/FLOW/06JAN1999/5MIN//
-----DSS---ZWRITE Unit  71; Vers.   60:  //W1W2A/FLOW/07JAN1999/5MIN//
-----DSS---ZWRITE Unit  71; Vers.   60:  //W1W2A/FLOW/08JAN1999/5MIN//
     ***            ***            ***            ***            ***


                      INTERPOLATED HYDROGRAPH AT    W1W2A

  PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+     368.      5.83       296.       123.        41.         18.
                       (INCHES)      .679      1.130       1.139       1.139
                        (AC-FT)      147.       244.        246.        246.

                      CUMULATIVE AREA =    4.05 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

                **************
                *            *
 75 KK          *       W2A  *        BASIN
                *            *
                **************
                                Compute runoff from subbasin W2A

              SUBBASIN RUNOFF DATA

 77 BA            SUBBASIN CHARACTERISTICS
                        TAREA         .28  SUBBASIN AREA

 78 LG            GREEN AND AMPT LOSS RATE
                        STRTL         .25  STARTING LOSS
                          DTH         .35  MOISTURE DEFICIT
                         PSIF        3.95  WETTING FRONT SUCTION
                        XKSAT         .40  HYDRAULIC CONDUCTIVITY
                        RTIMP        7.00  PERCENT IMPERVIOUS AREA
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 76 UI          INPUT UNITGRAPH,  16 ORDINATES,  VOLUME = 1.00
                     73.0     274.0     479.0     425.0     280.0     202.0     137.0     102.0      65.0      49.0
                     33.0      26.0      12.0      11.0      10.0      10.0
                                                                  ***

     ***            ***            ***            ***            ***

                      HYDROGRAPH AT STATION      W2A
                     TRANSPOSITION AREA       .1 SQ MI

    TOTAL RAINFALL =    3.20, TOTAL LOSS =    1.66, TOTAL EXCESS =    1.54

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                        (CFS)
+     527.      4.08                  47.         12.          4.           2.
                     (INCHES)      1.536       1.537       1.537        1.537
                      (AC-FT)        23.         23.         23.          23.

                     CUMULATIVE AREA =     .28 SQ MI

     ***            ***            ***            ***            ***

                      HYDROGRAPH AT STATION      W2A
                     TRANSPOSITION AREA       .5 SQ MI

    TOTAL RAINFALL =    3.18, TOTAL LOSS =    1.65, TOTAL EXCESS =    1.53

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                        (CFS)
+     523.      4.08                  46.         12.          4.           2.
                     (INCHES)      1.524       1.525       1.525        1.525
                      (AC-FT)        23.         23.         23.          23.

                     CUMULATIVE AREA =     .28 SQ MI

     ***            ***            ***            ***            ***

                      HYDROGRAPH AT STATION      W2A
                     TRANSPOSITION AREA      2.8 SQ MI

    TOTAL RAINFALL =    3.12, TOTAL LOSS =    1.92, TOTAL EXCESS =    1.20

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                        (CFS)
+     289.      4.17                  37.          9.          3.           1.
                     (INCHES)      1.200       1.202       1.202        1.202
                      (AC-FT)        18.         18.         18.          18.

                     CUMULATIVE AREA =     .28 SQ MI

     ***            ***            ***            ***            ***

                      HYDROGRAPH AT STATION      W2A
                     TRANSPOSITION AREA     16.0 SQ MI

    TOTAL RAINFALL =    2.95, TOTAL LOSS =    2.05, TOTAL EXCESS =     .90

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                        (CFS)
+     202.      4.17                  27.          7.          2.           1.
                     (INCHES)       .900        .902        .902         .902
                      (AC-FT)        14.         14.         14.          14.

                     CUMULATIVE AREA =     .28 SQ MI

     ***            ***            ***            ***            ***


                     INTERPOLATED HYDROGRAPH AT      W2A

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                        (CFS)
+     525.      4.08                  47.         12.          4.           2.
                     (INCHES)      1.528       1.529       1.529        1.529
                      (AC-FT)        23.         23.         23.          23.

                     CUMULATIVE AREA =     .28 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

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                 *            *
 81 KK           *     CW2A   *     COMBINE
                 *            *
                 **************
                                  Combine runoff from W2A w/ routed outflows from Skyline Fan detention ba

 83 HC          HYDROGRAPH COMBINATION
                     ICOMP          2  NUMBER OF HYDROGRAPHS TO COMBINE
                                                                  ***

     ***            ***            ***            ***            ***

                      HYDROGRAPH AT STATION     CW2A
                     TRANSPOSITION AREA       .1 SQ MI

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                        (CFS)
+     601.      4.17                 411.        178.         60.          26.
                     (INCHES)       .882       1.523       1.538        1.538
                      (AC-FT)       204.        352.        356.         356.

                     CUMULATIVE AREA =    4.34 SQ MI

     ***            ***            ***            ***            ***

                      HYDROGRAPH AT STATION     CW2A
                     TRANSPOSITION AREA       .5 SQ MI

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                        (CFS)
+     597.      4.17                 409.        176.         59.          26.
                     (INCHES)       .876       1.511       1.526        1.526
                      (AC-FT)       203.        350.        353.         353.

                     CUMULATIVE AREA =    4.34 SQ MI

     ***            ***            ***            ***            ***

                      HYDROGRAPH AT STATION     CW2A
                     TRANSPOSITION AREA      2.8 SQ MI

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                        (CFS)
+     388.      5.75                 329.        139.         47.          20.
                     (INCHES)       .706       1.193       1.203        1.203
                      (AC-FT)       163.        276.        278.         278.

                     CUMULATIVE AREA =    4.34 SQ MI

     ***            ***            ***            ***            ***

                      HYDROGRAPH AT STATION     CW2A
                     TRANSPOSITION AREA     16.0 SQ MI

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                        (CFS)
+     302.      5.75                 252.        104.         35.          15.
                     (INCHES)       .541        .896        .903         .903
                      (AC-FT)       125.        207.        209.         209.

                     CUMULATIVE AREA =    4.34 SQ MI

 -----DSS---ZWRITE Unit  71; Vers.   60:  //CW2A/FLOW/01JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   60:  //CW2A/FLOW/02JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   60:  //CW2A/FLOW/03JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   60:  //CW2A/FLOW/04JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   60:  //CW2A/FLOW/05JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   60:  //CW2A/FLOW/06JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   60:  //CW2A/FLOW/07JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   60:  //CW2A/FLOW/08JAN1999/5MIN//
     ***            ***            ***            ***            ***


                     INTERPOLATED HYDROGRAPH AT      CW2A

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                        (CFS)
+     368.      5.75                 311.        131.         44.          19.
                     (INCHES)       .667       1.122       1.132        1.132
                      (AC-FT)       154.        260.        262.         262.

                     CUMULATIVE AREA =    4.34 SQ MI
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*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

            **************
            *            *
 85 KK      *   W2AW2B   *        ROUTE
            *            *
            **************
                         PROPOSED CHANNEL
                          ROUTE COMBINED FLOWS FROM CW2A TO CW2B
                          & SECOND DETENTION BASIN AT INSET FAN APEX
                          Slope=(1301.0 - 1236.0) / 3971.0

              HYDROGRAPH ROUTING DATA

 90 RS          STORAGE ROUTING
                      NSTPS            3  NUMBER OF SUBREACHES
                       ITYP         FLOW  TYPE OF INITIAL CONDITION
                     RSVRIC        -1.00  INITIAL CONDITION
                          X          .00 WORKING R AND D COEFFICIENT

 91 RC          NORMAL DEPTH CHANNEL
                        ANL         .045  LEFT OVERBANK N-VALUE
                       ANCH         .045  MAIN CHANNEL N-VALUE
                        ANR         .045  RIGHT OVERBANK N-VALUE
                      RLNTH        3971.  REACH LENGTH
                        SEL        .0160  ENERGY SLOPE
                      ELMAX        104.5  MAX. ELEV. FOR STORAGE/OUTFLOW CALCULATION

                                  CROSS-SECTION DATA
                         --- LEFT OVERBANK --- + ------ MAIN CHANNEL ------- + --- RIGHT OVERBANK ---
 93 RY        ELEVATION    104.50    100.00    100.00    100.00    100.00    100.00    100.00    104.50
 92 RX        DISTANCE        .00       .00       .00       .00    180.00    180.00    180.00    180.00

                                                  ***

                                  COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

          STORAGE        .00      3.89      7.77     11.66     15.55     19.43     23.32     27.20     31.09     34.98
          OUTFLOW        .00     68.29    216.61    425.39    686.50    994.90   1347.01   1740.09   2171.94   2640.74
        ELEVATION     100.00    100.24    100.47    100.71    100.95    101.18    101.42    101.66    101.89    102.13

          STORAGE      38.86     42.75     46.64     50.52     54.41     58.29     62.18     66.07     69.95     73.84
          OUTFLOW    3144.93   3683.18   4254.31   4857.26   5491.08   6154.92   6848.00   7569.59   8319.03   9095.70
        ELEVATION     102.37    102.61    102.84    103.08    103.32    103.55    103.79    104.03    104.26    104.50


*** WARNING *** MODIFIED PULS ROUTING MAY BE NUMERICALLY UNSTABLE FOR OUTFLOWS BETWEEN     1347. TO     9096.
                THE ROUTED HYDROGRAPH SHOULD BE EXAMINED FOR OSCILLATIONS OR OUTFLOWS GREATER THAN PEAK INFLOWS.
                THIS CAN BE CORRECTED BY DECREASING THE TIME INTERVAL OR INCREASING STORAGE (USE A LONGER REACH.)

      ***             ***             ***             ***             ***

                        HYDROGRAPH AT STATION   W2AW2B
                      TRANSPOSITION AREA       .1 SQ MI

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+     509.      4.33       408.        178.         60.          26.
                       (INCHES)      .874       1.523       1.538       1.538
                        (AC-FT)      202.        352.        356.        356.

 PEAK STORAGE   TIME                         MAXIMUM AVERAGE STORAGE
                                     6-HR       24-HR       72-HR    166.58-HR
+  (AC-FT)      (HR)
        4.      4.33         4.          2.          1.          0.

  PEAK STAGE    TIME                          MAXIMUM AVERAGE STAGE
                                     6-HR       24-HR       72-HR    166.58-HR
+   (FEET)      (HR)
    100.79      4.33    100.69      100.36      100.12      100.05

                        CUMULATIVE AREA =    4.34 SQ MI

      ***             ***             ***             ***             ***

                        HYDROGRAPH AT STATION   W2AW2B
                      TRANSPOSITION AREA       .5 SQ MI

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+     504.      4.33       405.        176.         59.          26.
                       (INCHES)      .868       1.511       1.526       1.526
                        (AC-FT)      201.        350.        353.        353.

 PEAK STORAGE   TIME                         MAXIMUM AVERAGE STORAGE
                                     6-HR       24-HR       72-HR    166.58-HR
+  (AC-FT)      (HR)
        4.      4.33         4.          2.          1.          0.

  PEAK STAGE    TIME                          MAXIMUM AVERAGE STAGE
                                     6-HR       24-HR       72-HR    166.58-HR
+   (FEET)      (HR)
    100.78      4.33    100.68      100.36      100.12      100.05

                        CUMULATIVE AREA =    4.34 SQ MI

      ***             ***             ***             ***             ***

                        HYDROGRAPH AT STATION   W2AW2B
                      TRANSPOSITION AREA      2.8 SQ MI

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+     388.      6.00       327.        139.         47.          20.
                       (INCHES)      .701       1.193       1.203       1.203
                        (AC-FT)      162.        276.        278.        278.

 PEAK STORAGE   TIME                         MAXIMUM AVERAGE STORAGE
                                     6-HR       24-HR       72-HR    166.58-HR
+  (AC-FT)      (HR)
        4.      6.00         3.          2.          1.          0.

  PEAK STAGE    TIME                          MAXIMUM AVERAGE STAGE
                                     6-HR       24-HR       72-HR    166.58-HR
+   (FEET)      (HR)
    100.67      6.00    100.60      100.31      100.10      100.04

                        CUMULATIVE AREA =    4.34 SQ MI

      ***             ***             ***             ***             ***

                        HYDROGRAPH AT STATION   W2AW2B
                      TRANSPOSITION AREA     16.0 SQ MI

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+     302.      6.00       250.        104.         35.          15.
                       (INCHES)      .537        .896        .903        .903
                        (AC-FT)      124.        207.        209.        209.

 PEAK STORAGE   TIME                         MAXIMUM AVERAGE STORAGE
                                     6-HR       24-HR       72-HR    166.58-HR
+  (AC-FT)      (HR)
        3.      6.00         3.          1.          0.          0.

  PEAK STAGE    TIME                          MAXIMUM AVERAGE STAGE
                                     6-HR       24-HR       72-HR    166.58-HR
+   (FEET)      (HR)
    100.57      6.00    100.51      100.25      100.08      100.04

                        CUMULATIVE AREA =    4.34 SQ MI

 -----DSS---ZWRITE Unit  71; Vers.   60:  //W2AW2B/FLOW/01JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   60:  //W2AW2B/FLOW/02JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   60:  //W2AW2B/FLOW/03JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   60:  //W2AW2B/FLOW/04JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   60:  //W2AW2B/FLOW/05JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   60:  //W2AW2B/FLOW/06JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   60:  //W2AW2B/FLOW/07JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   60:  //W2AW2B/FLOW/08JAN1999/5MIN//
      ***             ***             ***             ***             ***


                        INTERPOLATED HYDROGRAPH AT   W2AW2B

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+     366.      6.00       308.        130.         44.          19.
                       (INCHES)      .660       1.118       1.128       1.128
                        (AC-FT)      153.        259.        261.        261.

                        CUMULATIVE AREA =    4.34 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

            **************
            *            *
 95 KK      *     W2B    *        BASIN
            *            *
            **************
                                 Compute runoff from subbasin W2B

              SUBBASIN RUNOFF DATA

 97 BA          SUBBASIN CHARACTERISTICS
                      TAREA         .86  SUBBASIN AREA

 98 LG          GREEN AND AMPT LOSS RATE
                      STRTL         .32  STARTING LOSS
                        DTH         .35  MOISTURE DEFICIT
```

```
                    PSIF        3.78  WETTING FRONT SUCTION
                   XKSAT         .45  HYDRAULIC CONDUCTIVITY
                   RTIMP        3.00  PERCENT IMPERVIOUS AREA

 96 UI          INPUT UNITGRAPH,  14 ORDINATES,  VOLUME = 1.00
                   291.0    1105.0    1793.0    1107.0     806.0     515.0     359.0     226.0     156.0      98.0
                    69.0      36.0      35.0      36.0

                                                                  ***

     ***            ***            ***            ***            ***

                     HYDROGRAPH AT STATION      W2B
                    TRANSPOSITION AREA       .1 SQ MI

    TOTAL RAINFALL =    3.20, TOTAL LOSS =    1.82, TOTAL EXCESS =    1.38

  PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                  (CFS)
+    1679.      4.08                127.         32.         11.          5.
                (INCHES)          1.373       1.374       1.374       1.374
                 (AC-FT)           63.         63.         63.         63.

                CUMULATIVE AREA =     .86 SQ MI

     ***            ***            ***            ***            ***

                     HYDROGRAPH AT STATION      W2B
                    TRANSPOSITION AREA       .5 SQ MI

    TOTAL RAINFALL =    3.18, TOTAL LOSS =    1.82, TOTAL EXCESS =    1.36

  PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                  (CFS)
+    1668.      4.08                126.         31.         10.          5.
                (INCHES)          1.361       1.362       1.362       1.362
                 (AC-FT)           62.         62.         62.         62.

                CUMULATIVE AREA =     .86 SQ MI

     ***            ***            ***            ***            ***

                     HYDROGRAPH AT STATION      W2B
                    TRANSPOSITION AREA      2.8 SQ MI

    TOTAL RAINFALL =    3.12, TOTAL LOSS =    2.09, TOTAL EXCESS =    1.03

  PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                  (CFS)
+     849.      4.08                 95.         24.          8.          3.
                (INCHES)          1.029       1.030       1.030       1.030
                 (AC-FT)           47.         47.         47.         47.

                CUMULATIVE AREA =     .86 SQ MI

     ***            ***            ***            ***            ***

                     HYDROGRAPH AT STATION      W2B
                    TRANSPOSITION AREA     16.0 SQ MI

    TOTAL RAINFALL =    2.95, TOTAL LOSS =    2.23, TOTAL EXCESS =     .72

  PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                  (CFS)
+     570.      4.08                 66.         17.          6.          2.
                (INCHES)           .715        .716        .716        .716
                 (AC-FT)           33.         33.         33.         33.

                CUMULATIVE AREA =     .86 SQ MI

     ***            ***            ***            ***            ***

                    INTERPOLATED HYDROGRAPH AT      W2B

  PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                  (CFS)
+    1411.      4.08                116.         29.         10.          4.
                (INCHES)          1.257       1.258       1.258       1.258
                 (AC-FT)           58.         58.         58.         58.

                CUMULATIVE AREA =     .86 SQ MI
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*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

                 **************
                 *            *
 101 KK          *     CW2B   *      COMBINE
                 *            *
                 **************
                                  Combine runoff from W2B routed flows from CW2A

 103 HC          HYDROGRAPH COMBINATION
                      ICOMP           2  NUMBER OF HYDROGRAPHS TO COMBINE
                                                                  ***

     ***            ***            ***            ***            ***

                     HYDROGRAPH AT STATION     CW2B
                    TRANSPOSITION AREA       .1 SQ MI

  PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                  (CFS)
+    1770.      4.17                515.        209.         70.         30.
                (INCHES)           .921       1.497       1.511       1.511
                 (AC-FT)          255.        415.        419.        419.

                CUMULATIVE AREA =    5.19 SQ MI

     ***            ***            ***            ***            ***

                     HYDROGRAPH AT STATION     CW2B
                    TRANSPOSITION AREA       .5 SQ MI

  PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                  (CFS)
+    1756.      4.17                511.        207.         70.         30.
                (INCHES)           .914       1.485       1.499       1.499
                 (AC-FT)          253.        411.        415.        415.

                CUMULATIVE AREA =    5.19 SQ MI

     ***            ***            ***            ***            ***

                     HYDROGRAPH AT STATION     CW2B
                    TRANSPOSITION AREA      2.8 SQ MI

  PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                  (CFS)
+     991.      4.17                403.        163.         55.         24.
                (INCHES)           .721       1.164       1.174       1.174
                 (AC-FT)          200.        323.        325.        325.

                CUMULATIVE AREA =    5.19 SQ MI

     ***            ***            ***            ***            ***

                     HYDROGRAPH AT STATION     CW2B
                    TRANSPOSITION AREA     16.0 SQ MI

  PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                  (CFS)
+     663.      4.17                301.        121.         41.         18.
                (INCHES)           .538        .865        .872        .872
                 (AC-FT)          149.        240.        242.        242.

                CUMULATIVE AREA =    5.19 SQ MI

 -----DSS---ZWRITE Unit  71; Vers.   60:  //CW2B/FLOW/01JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   60:  //CW2B/FLOW/02JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   60:  //CW2B/FLOW/03JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   60:  //CW2B/FLOW/04JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   60:  //CW2B/FLOW/05JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   60:  //CW2B/FLOW/06JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   60:  //CW2B/FLOW/07JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   60:  //CW2B/FLOW/08JAN1999/5MIN//
     ***            ***            ***            ***            ***

                    INTERPOLATED HYDROGRAPH AT      CW2B

  PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                  (CFS)
+     875.      4.17                367.        148.         50.         21.
                (INCHES)           .656       1.058       1.067       1.067
                 (AC-FT)          182.        293.        296.        296.
```

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                    CUMULATIVE AREA =    5.19 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

          **************
          *            *
105 KK    *    RRW2B   *      STORAGE
          *            *
          **************
                    PROPOSED DETENTION BASIN
                     ROUTE COMBINED FLOW THROUGH PROPOSED DETENTION BASIN AT INSET FAN ON EAST SI
                     STRUCTURE ID:RRW2B
                     OUTLET BASED ON ASSUMED 2 pipe(s), dia: 5 ft

            HYDROGRAPH ROUTING DATA

110 RS        STORAGE ROUTING
                  NSTPS          1  NUMBER OF SUBREACHES
                   ITYP       STOR  TYPE OF INITIAL CONDITION
                  RSVRIC     -1.00  INITIAL CONDITION
                       X       .00 WORKING R AND D COEFFICIENT

111 SV          STORAGE        .0       .0      4.8     12.3     28.2     45.6     54.8     64.4     74.4     84.7

112 SE        ELEVATION       .00     1.00     2.00     3.00     5.00     7.00     8.00     9.00    10.00    11.00

113 SQ        DISCHARGE        0.      28.      57.     111.     211.     313.     361.     403.     440.     477.

                                                          ***

     ***           ***           ***           ***           ***

                    HYDROGRAPH AT STATION    RRW2B
                   TRANSPOSITION AREA       .1 SQ MI

 PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                    6-HR       24-HR       72-HR    166.58-HR
+   (CFS)      (HR)
                          (CFS)
+     427.     7.33         411.        209.         70.         30.
                      (INCHES)       .736       1.497       1.511       1.511
                       (AC-FT)       204.        415.        419.        419.

 PEAK STORAGE  TIME                     MAXIMUM AVERAGE STORAGE
                                    6-HR       24-HR       72-HR    166.58-HR
+  (AC-FT)     (HR)
       71.     7.33          67.         30.         10.          4.

  PEAK STAGE   TIME                       MAXIMUM AVERAGE STAGE
                                    6-HR       24-HR       72-HR    166.58-HR
+   (FEET)     (HR)
      9.64     7.33        9.22        4.96        1.70         .75

                    CUMULATIVE AREA =    5.19 SQ MI

     ***           ***           ***           ***           ***

                    HYDROGRAPH AT STATION    RRW2B
                   TRANSPOSITION AREA       .5 SQ MI

 PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                    6-HR       24-HR       72-HR    166.58-HR
+   (CFS)      (HR)
                          (CFS)
+     425.     7.33         409.        207.         70.         30.
                      (INCHES)       .731       1.485       1.499       1.499
                       (AC-FT)       203.        411.        415.        415.

 PEAK STORAGE  TIME                     MAXIMUM AVERAGE STORAGE
                                    6-HR       24-HR       72-HR    166.58-HR
+  (AC-FT)     (HR)
       70.     7.33          66.         30.         10.          4.

  PEAK STAGE   TIME                       MAXIMUM AVERAGE STAGE
                                    6-HR       24-HR       72-HR    166.58-HR
+   (FEET)     (HR)
      9.58     7.33        9.16        4.94        1.88         .99

                    CUMULATIVE AREA =    5.19 SQ MI

     ***           ***           ***           ***           ***

                    HYDROGRAPH AT STATION    RRW2B
                   TRANSPOSITION AREA      2.8 SQ MI

 PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                    6-HR       24-HR       72-HR    166.58-HR
+   (CFS)      (HR)
                          (CFS)
+     356.     7.25         333.        163.         55.         24.
                      (INCHES)       .596       1.164       1.174       1.174
                       (AC-FT)       165.        323.        325.        325.

 PEAK STORAGE  TIME                     MAXIMUM AVERAGE STORAGE
                                    6-HR       24-HR       72-HR    166.58-HR
+  (AC-FT)     (HR)
       54.     7.25          49.         22.          7.          3.

  PEAK STAGE   TIME                       MAXIMUM AVERAGE STAGE
                                    6-HR       24-HR       72-HR    166.58-HR
+   (FEET)     (HR)
      7.89     7.25        7.42        3.98        1.61         .92

                    CUMULATIVE AREA =    5.19 SQ MI

     ***           ***           ***           ***           ***

                    HYDROGRAPH AT STATION    RRW2B
                   TRANSPOSITION AREA     16.0 SQ MI

 PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                    6-HR       24-HR       72-HR    166.58-HR
+   (CFS)      (HR)
                          (CFS)
+     272.     7.17         252.        121.         41.         18.
                      (INCHES)       .450        .865        .872        .872
                       (AC-FT)       125.        240.        242.        242.

 PEAK STORAGE  TIME                     MAXIMUM AVERAGE STORAGE
                                    6-HR       24-HR       72-HR    166.58-HR
+  (AC-FT)     (HR)
       39.     7.17          35.         15.          5.          2.

  PEAK STAGE   TIME                       MAXIMUM AVERAGE STAGE
                                    6-HR       24-HR       72-HR    166.58-HR
+   (FEET)     (HR)
      6.19     7.17        5.80        3.01        1.00         .43

                    CUMULATIVE AREA =    5.19 SQ MI

 -----DSS---ZWRITE Unit  71; Vers.   59:  //RRW2B/FLOW/01JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   59:  //RRW2B/FLOW/02JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   59:  //RRW2B/FLOW/03JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   59:  //RRW2B/FLOW/04JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   59:  //RRW2B/FLOW/05JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   59:  //RRW2B/FLOW/06JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   59:  //RRW2B/FLOW/07JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   59:  //RRW2B/FLOW/08JAN1999/5MIN//
     ***           ***           ***           ***           ***


                 INTERPOLATED HYDROGRAPH AT    RRW2B

 PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                    6-HR       24-HR       72-HR    166.58-HR
+   (CFS)      (HR)
                          (CFS)
+     326.     7.25         304.        148.         50.         21.
                      (INCHES)       .544       1.058       1.067       1.067
                       (AC-FT)       151.        293.        296.        296.

                 CUMULATIVE AREA =    5.19 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

          **************
          *            *
115 KK    *   W2BW2C   *       ROUTE
          *            *
          **************
                    PROPOSED CHANNEL
                     ROUTE OUTFLOW FROM RRW2B TO CONFLUENCE WITH OUTFLOW FROM RRX1A
                     Slope=(1222.0 - 1184.0) / 2321.0

            HYDROGRAPH ROUTING DATA

119 RS        STORAGE ROUTING
                  NSTPS          1  NUMBER OF SUBREACHES
                   ITYP       FLOW  TYPE OF INITIAL CONDITION
                  RSVRIC     -1.00  INITIAL CONDITION
                       X       .00 WORKING R AND D COEFFICIENT

120 RC        NORMAL DEPTH CHANNEL
                    ANL       .045  LEFT OVERBANK N-VALUE
                   ANCH       .045  MAIN CHANNEL N-VALUE
                    ANR       .045  RIGHT OVERBANK N-VALUE
                  RLNTH      2321.  REACH LENGTH
                    SEL      .0160  ENERGY SLOPE
                  ELMAX      104.5  MAX. ELEV. FOR STORAGE/OUTFLOW CALCULATION

                              CROSS-SECTION DATA
                     --- LEFT OVERBANK --- + ------ MAIN CHANNEL ------- + --- RIGHT OVERBANK ---
122 RY      ELEVATION    104.50    100.00    100.00    100.00    100.00    100.00    100.00    104.50
121 RX      DISTANCE        .00       .00       .00       .00     50.00     50.00     50.00     50.00
```

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                                        ***

                                COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

          STORAGE      .00      .63     1.26     1.89     2.52     3.15     3.79     4.42     5.05     5.68
          OUTFLOW      .00    18.93    59.90   117.37   188.98   273.27   369.17   475.86   592.66   719.02
        ELEVATION   100.00   100.24   100.47   100.71   100.95   101.18   101.42   101.66   101.89   102.13

          STORAGE     6.31     6.94     7.57     8.20     8.83     9.46    10.10    10.73    11.36    11.99
          OUTFLOW   854.46   998.56  1150.95  1311.29  1479.28  1654.65  1837.14  2026.52  2222.58  2425.11
        ELEVATION   102.37   102.61   102.84   103.08   103.32   103.55   103.79   104.03   104.26   104.50


*** WARNING *** MODIFIED PULS ROUTING MAY BE NUMERICALLY UNSTABLE FOR OUTFLOWS BETWEEN     1837. TO     2425.
                THE ROUTED HYDROGRAPH SHOULD BE EXAMINED FOR OSCILLATIONS OR OUTFLOWS GREATER THAN PEAK INFLOWS.
                THIS CAN BE CORRECTED BY DECREASING THE TIME INTERVAL OR INCREASING STORAGE (USE A LONGER REACH.)

     ***            ***            ***            ***            ***

                     HYDROGRAPH AT STATION   W2BW2C
                   TRANSPOSITION AREA       .1 SQ MI

  PEAK FLOW     TIME                      MAXIMUM AVERAGE FLOW
                                   6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                             (CFS)
+     427.      7.42          411.        209.         70.          30.
                         (INCHES)      .736       1.496       1.511        1.511
                          (AC-FT)      204.        415.        419.         419.

 PEAK STORAGE   TIME                     MAXIMUM AVERAGE STORAGE
                                   6-HR       24-HR       72-HR    166.58-HR
+  (AC-FT)      (HR)
       4.      7.25                4.          2.          1.           0.

  PEAK STAGE    TIME                      MAXIMUM AVERAGE STAGE
                                   6-HR       24-HR       72-HR    166.58-HR
+   (FEET)      (HR)
   101.55      7.42           101.51      100.93      100.32       100.14

                     CUMULATIVE AREA =    5.19 SQ MI


     ***            ***            ***            ***            ***

                     HYDROGRAPH AT STATION   W2BW2C
                   TRANSPOSITION AREA       .5 SQ MI

  PEAK FLOW     TIME                      MAXIMUM AVERAGE FLOW
                                   6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                             (CFS)
+     425.      7.42          409.        207.         70.          30.
                         (INCHES)      .731       1.484       1.499        1.499
                          (AC-FT)      203.        411.        415.         415.

 PEAK STORAGE   TIME                     MAXIMUM AVERAGE STORAGE
                                   6-HR       24-HR       72-HR    166.58-HR
+  (AC-FT)      (HR)
       4.      7.33                4.          2.          1.           0.

  PEAK STAGE    TIME                      MAXIMUM AVERAGE STAGE
                                   6-HR       24-HR       72-HR    166.58-HR
+   (FEET)      (HR)
   101.54      7.42           101.51      100.92      100.32       100.14

                     CUMULATIVE AREA =    5.19 SQ MI


     ***            ***            ***            ***            ***

                     HYDROGRAPH AT STATION   W2BW2C
                   TRANSPOSITION AREA      2.8 SQ MI

  PEAK FLOW     TIME                      MAXIMUM AVERAGE FLOW
                                   6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                             (CFS)
+     356.      7.33          333.        163.         55.          24.
                         (INCHES)      .596       1.164       1.174        1.174
                          (AC-FT)      165.        323.        325.         325.

 PEAK STORAGE   TIME                     MAXIMUM AVERAGE STORAGE
                                   6-HR       24-HR       72-HR    166.58-HR
+  (AC-FT)      (HR)
       4.      7.25                4.          2.          1.           0.

  PEAK STAGE    TIME                      MAXIMUM AVERAGE STAGE
                                   6-HR       24-HR       72-HR    166.58-HR
+   (FEET)      (HR)
   101.39      7.33           101.33      100.78      100.27       100.12

                     CUMULATIVE AREA =    5.19 SQ MI


     ***            ***            ***            ***            ***

                     HYDROGRAPH AT STATION   W2BW2C
                   TRANSPOSITION AREA     16.0 SQ MI

  PEAK FLOW     TIME                      MAXIMUM AVERAGE FLOW
                                   6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                             (CFS)
+     272.      7.25          252.        121.         41.          18.
                         (INCHES)      .450       .865        .872         .872
                          (AC-FT)      125.        240.        242.         242.

 PEAK STORAGE   TIME                     MAXIMUM AVERAGE STORAGE
                                   6-HR       24-HR       72-HR    166.58-HR
+  (AC-FT)      (HR)
       3.      7.17                3.          2.          1.           0.

  PEAK STAGE    TIME                      MAXIMUM AVERAGE STAGE
                                   6-HR       24-HR       72-HR    166.58-HR
+   (FEET)      (HR)
   101.18      7.25           101.12      100.65      100.22       100.09

                     CUMULATIVE AREA =    5.19 SQ MI

 -----DSS---ZWRITE Unit  71; Vers.   59:  //W2BW2C/FLOW/01JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   59:  //W2BW2C/FLOW/02JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   59:  //W2BW2C/FLOW/03JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   59:  //W2BW2C/FLOW/04JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   59:  //W2BW2C/FLOW/05JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   59:  //W2BW2C/FLOW/06JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   59:  //W2BW2C/FLOW/07JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   59:  //W2BW2C/FLOW/08JAN1999/5MIN//
      ***            ***            ***            ***            ***


                     INTERPOLATED HYDROGRAPH AT   W2BW2C

  PEAK FLOW     TIME                      MAXIMUM AVERAGE FLOW
                                   6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                             (CFS)
+     326.      7.33          304.        148.         50.          21.
                         (INCHES)      .544       1.058       1.067        1.067
                          (AC-FT)      151.        293.        296.         296.

                     CUMULATIVE AREA =    5.19 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

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          *            *
124 KK    *     W2C    *      BASIN
          *            *
          **************
                        Compute runoff from subbasin W2C

             SUBBASIN RUNOFF DATA

126 BA         SUBBASIN CHARACTERISTICS
                    TAREA         .12  SUBBASIN AREA

127 LG         GREEN AND AMPT LOSS RATE
                    STRTL         .35  STARTING LOSS
                      DTH         .35  MOISTURE DEFICIT
                     PSIF        3.81  WETTING FRONT SUCTION
                    XKSAT         .44  HYDRAULIC CONDUCTIVITY
                    RTIMP         .00  PERCENT IMPERVIOUS AREA

125 UI         INPUT UNITGRAPH,   6 ORDINATES,  VOLUME = 1.00
                   162.0     437.0     232.0      85.0      29.0      11.0
                                                                      ***

     ***            ***            ***            ***            ***

                     HYDROGRAPH AT STATION      W2C
                   TRANSPOSITION AREA       .1 SQ MI

   TOTAL RAINFALL =    3.20, TOTAL LOSS =    1.88, TOTAL EXCESS =    1.31

  PEAK FLOW     TIME                      MAXIMUM AVERAGE FLOW
                                   6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                             (CFS)
+     334.      4.00           17.          4.          1.           1.
                         (INCHES)     1.309       1.309       1.309        1.309
                          (AC-FT)       9.          9.          9.           9.

                     CUMULATIVE AREA =     .12 SQ MI


     ***            ***            ***            ***            ***

                     HYDROGRAPH AT STATION      W2C
                   TRANSPOSITION AREA       .5 SQ MI

   TOTAL RAINFALL =    3.18, TOTAL LOSS =    1.88, TOTAL EXCESS =    1.30

  PEAK FLOW     TIME                      MAXIMUM AVERAGE FLOW
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                                        6-HR       24-HR       72-HR    166.58-HR
+   (CFS)        (HR)
                                  (CFS)
+     332.       4.00                 17.          4.          1.           1.
                              (INCHES)      1.297       1.297       1.297        1.297
                               (AC-FT)        9.          9.          9.           9.

                              CUMULATIVE AREA =     .12 SQ MI

      ***             ***             ***             ***             ***

                              HYDROGRAPH AT STATION      W2C
                             TRANSPOSITION AREA      2.8 SQ MI

     TOTAL RAINFALL =    3.12, TOTAL LOSS =    2.16, TOTAL EXCESS =     .96

  PEAK FLOW     TIME                            MAXIMUM AVERAGE FLOW
                                        6-HR       24-HR       72-HR    166.58-HR
+   (CFS)        (HR)
                                  (CFS)
+     147.       4.00                 13.          3.          1.           0.
                              (INCHES)       .960        .960        .960         .960
                               (AC-FT)        6.          6.          6.           6.

                              CUMULATIVE AREA =     .12 SQ MI

      ***             ***             ***             ***             ***

                              HYDROGRAPH AT STATION      W2C
                             TRANSPOSITION AREA     16.0 SQ MI

     TOTAL RAINFALL =    2.95, TOTAL LOSS =    2.30, TOTAL EXCESS =     .65

  PEAK FLOW     TIME                            MAXIMUM AVERAGE FLOW
                                        6-HR       24-HR       72-HR    166.58-HR
+   (CFS)        (HR)
                                  (CFS)
+      98.       4.00                  9.          2.          1.           0.
                              (INCHES)       .646        .646        .646         .646
                               (AC-FT)        4.          4.          4.           4.

                              CUMULATIVE AREA =     .12 SQ MI

      ***             ***             ***             ***             ***

                              INTERPOLATED HYDROGRAPH AT      W2C

  PEAK FLOW     TIME                            MAXIMUM AVERAGE FLOW
                                        6-HR       24-HR       72-HR    166.58-HR
+   (CFS)        (HR)
                                  (CFS)
+     333.       4.00                 17.          4.          1.           1.
                              (INCHES)      1.307       1.307       1.307        1.307
                               (AC-FT)        9.          9.          9.           9.

                              CUMULATIVE AREA =     .12 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


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            *            *
 129 KK     *     CW2CR  *      COMBINE
            *            *
            **************
                              Combine runoff from W2C with routed outflows from 2nd detention basin.

 131 HC          HYDROGRAPH COMBINATION
                       ICOMP           2  NUMBER OF HYDROGRAPHS TO COMBINE
                                                                  ***

      ***             ***             ***             ***             ***

                              HYDROGRAPH AT STATION    CW2CR
                             TRANSPOSITION AREA      .1 SQ MI

  PEAK FLOW     TIME                            MAXIMUM AVERAGE FLOW
                                        6-HR       24-HR       72-HR    166.58-HR
+   (CFS)        (HR)
                                  (CFS)
+     427.       7.42                411.        213.         72.          31.
                              (INCHES)       .718       1.492       1.506        1.506
                               (AC-FT)      204.        423.        427.         427.

                              CUMULATIVE AREA =    5.32 SQ MI

      ***             ***             ***             ***             ***

                              HYDROGRAPH AT STATION    CW2CR
                             TRANSPOSITION AREA      .5 SQ MI

  PEAK FLOW     TIME                            MAXIMUM AVERAGE FLOW
                                        6-HR       24-HR       72-HR    166.58-HR
+   (CFS)        (HR)
                                  (CFS)
+     425.       7.42                409.        212.         71.          31.
                              (INCHES)       .714       1.480       1.494        1.494
                               (AC-FT)      203.        420.        424.         424.

                              CUMULATIVE AREA =    5.32 SQ MI

      ***             ***             ***             ***             ***

                              HYDROGRAPH AT STATION    CW2CR
                             TRANSPOSITION AREA      2.8 SQ MI

  PEAK FLOW     TIME                            MAXIMUM AVERAGE FLOW
                                        6-HR       24-HR       72-HR    166.58-HR
+   (CFS)        (HR)
                                  (CFS)
+     356.       7.33                333.        166.         56.          24.
                              (INCHES)       .582       1.159       1.169        1.169
                               (AC-FT)      165.        329.        332.         332.

                              CUMULATIVE AREA =    5.32 SQ MI

      ***             ***             ***             ***             ***

                              HYDROGRAPH AT STATION    CW2CR
                             TRANSPOSITION AREA     16.0 SQ MI

  PEAK FLOW     TIME                            MAXIMUM AVERAGE FLOW
                                        6-HR       24-HR       72-HR    166.58-HR
+   (CFS)        (HR)
                                  (CFS)
+     272.       7.25                252.        123.         41.          18.
                              (INCHES)       .440        .860        .867         .867
                               (AC-FT)      125.        244.        246.         246.

                              CUMULATIVE AREA =    5.32 SQ MI

      ***             ***             ***             ***             ***


                              INTERPOLATED HYDROGRAPH AT    CW2CR

  PEAK FLOW     TIME                            MAXIMUM AVERAGE FLOW
                                        6-HR       24-HR       72-HR    166.58-HR
+   (CFS)        (HR)
                                  (CFS)
+     326.       7.33                304.        151.         51.          22.
                              (INCHES)       .531       1.053       1.062        1.062
                               (AC-FT)      151.        299.        301.         301.

                              CUMULATIVE AREA =    5.32 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


            **************
            *            *
 132 KK     *      X1A   *       BASIN
            *            *
            **************
                              Compute runoff from subbasin X1A

                 SUBBASIN RUNOFF DATA

 134 BA            SUBBASIN CHARACTERISTICS
                        TAREA         .70  SUBBASIN AREA

 135 LG            GREEN AND AMPT LOSS RATE
                        STRTL         .25  STARTING LOSS
                          DTH         .35  MOISTURE DEFICIT
                         PSIF        3.95  WETTING FRONT SUCTION
                        XKSAT         .40  HYDRAULIC CONDUCTIVITY
                        RTIMP        7.00  PERCENT IMPERVIOUS AREA

 133 UI            INPUT UNITGRAPH,  27 ORDINATES,  VOLUME = 1.00
                        77.0     178.0     386.0     545.0     733.0     756.0     483.0     413.0     347.0     286.0
                       223.0     183.0     157.0     119.0      95.0      84.0      60.0      56.0      38.0      38.0
                        30.0      15.0      15.0      15.0      15.0      15.0      15.0
                                                                                   ***

      ***             ***             ***             ***             ***

                              HYDROGRAPH AT STATION      X1A
                             TRANSPOSITION AREA      .1 SQ MI

     TOTAL RAINFALL =    3.20, TOTAL LOSS =    1.66, TOTAL EXCESS =    1.54

  PEAK FLOW     TIME                            MAXIMUM AVERAGE FLOW
                                        6-HR       24-HR       72-HR    166.58-HR
+   (CFS)        (HR)
```

```
                          (CFS)
+     929.      4.25                115.        29.        10.         4.
                         (INCHES)   1.534     1.536     1.536     1.536
                          (AC-FT)    57.        57.        57.        57.

                         CUMULATIVE AREA =     .70 SQ MI

      ***            ***            ***            ***            ***

                         HYDROGRAPH AT STATION      X1A
                       TRANSPOSITION AREA       .5 SQ MI

    TOTAL RAINFALL =   3.18, TOTAL LOSS =   1.65, TOTAL EXCESS =   1.53

  PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                    6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+     923.      4.25                114.        29.        10.         4.
                         (INCHES)   1.521     1.524     1.524     1.524
                          (AC-FT)    56.        57.        57.        57.

                         CUMULATIVE AREA =     .70 SQ MI

      ***            ***            ***            ***            ***

                         HYDROGRAPH AT STATION      X1A
                       TRANSPOSITION AREA      2.8 SQ MI

    TOTAL RAINFALL =   3.12, TOTAL LOSS =   1.92, TOTAL EXCESS =   1.20

  PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                    6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+     563.      4.33                 90.        22.         7.         3.
                         (INCHES)   1.198     1.201     1.201     1.201
                          (AC-FT)    44.        45.        45.        45.

                         CUMULATIVE AREA =     .70 SQ MI

      ***            ***            ***            ***            ***

                         HYDROGRAPH AT STATION      X1A
                       TRANSPOSITION AREA     16.0 SQ MI

    TOTAL RAINFALL =   2.95, TOTAL LOSS =   2.05, TOTAL EXCESS =    .90

  PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                    6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+     396.      4.33                 67.        17.         6.         2.
                         (INCHES)    .898      .902      .902      .902
                          (AC-FT)    33.        33.        33.        33.

                         CUMULATIVE AREA =     .70 SQ MI

 -----DSS---ZWRITE Unit  71; Vers.   59:  //X1A/FLOW/01JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   59:  //X1A/FLOW/02JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   59:  //X1A/FLOW/03JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   59:  //X1A/FLOW/04JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   59:  //X1A/FLOW/05JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   59:  //X1A/FLOW/06JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   59:  //X1A/FLOW/07JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   59:  //X1A/FLOW/08JAN1999/5MIN//
      ***            ***            ***            ***            ***

                         INTERPOLATED HYDROGRAPH AT      X1A

  PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                    6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+     853.      4.25                109.        27.         9.         4.
                         (INCHES)   1.459     1.462     1.462     1.462
                          (AC-FT)    54.        54.        54.        54.

                         CUMULATIVE AREA =     .70 SQ MI


 *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


            **************
            *            *
  140 KK    *     RRX1A  *      STORAGE
            *            *
            **************
                        PROPOSED DETENTION BASIN
                         ROUTE RUNOFF FROM X1A THROUGH PROPOSED DETENTION BASIN
                         STRUCTURE ID:RRX1A
                         OUTLET BASED ON ASSUMED 1 pipe(s), dia: 3 ft
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                    HYDROGRAPH ROUTING DATA

  145 RS          STORAGE ROUTING
                       NSTPS          1  NUMBER OF SUBREACHES
                        ITYP       STOR  TYPE OF INITIAL CONDITION
                       RSVRIC     -1.00  INITIAL CONDITION
                            X       .00 WORKING R AND D COEFFICIENT

  146 SV            STORAGE        .0      5.7     17.5     23.8     30.5     37.5     44.9     52.5     60.5     68.9

  147 SE          ELEVATION      .00     2.00     4.00     5.00     6.00     7.00     8.00     9.00    10.00    11.00

  148 SQ           DISCHARGE       0.      19.      41.      52.      61.      69.      76.      83.      89.      91.

                                                                                  ***

      ***            ***            ***            ***            ***

                         HYDROGRAPH AT STATION    RRX1A
                       TRANSPOSITION AREA       .1 SQ MI

  PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                    6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+      78.      5.33                 67.        28.        10.         4.
                         (INCHES)    .889     1.522     1.536     1.536
                          (AC-FT)    33.        56.        57.        57.

  PEAK STORAGE  TIME                        MAXIMUM AVERAGE STORAGE
                                    6-HR       24-HR       72-HR    166.58-HR
+  (AC-FT)      (HR)
      47.       5.33                 36.        13.         5.         2.

  PEAK STAGE    TIME                        MAXIMUM AVERAGE STAGE
                                    6-HR       24-HR       72-HR    166.58-HR
+   (FEET)      (HR)
      8.27      5.33                 6.75       2.89        .97        .42

                         CUMULATIVE AREA =     .70 SQ MI

      ***            ***            ***            ***            ***

                         HYDROGRAPH AT STATION    RRX1A
                       TRANSPOSITION AREA       .5 SQ MI

  PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                    6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+      78.      5.33                 66.        28.        10.         4.
                         (INCHES)    .884     1.510     1.524     1.524
                          (AC-FT)    33.        56.        57.        57.

  PEAK STORAGE  TIME                        MAXIMUM AVERAGE STORAGE
                                    6-HR       24-HR       72-HR    166.58-HR
+  (AC-FT)      (HR)
      47.       5.33                 36.        13.         4.         2.

  PEAK STAGE    TIME                        MAXIMUM AVERAGE STAGE
                                    6-HR       24-HR       72-HR    166.58-HR
+   (FEET)      (HR)
      8.22      5.33                 6.70       2.87        .97        .42

                         CUMULATIVE AREA =     .70 SQ MI

      ***            ***            ***            ***            ***

                         HYDROGRAPH AT STATION    RRX1A
                       TRANSPOSITION AREA      2.8 SQ MI

  PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                    6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+      67.      5.33                 55.        22.         7.         3.
                         (INCHES)    .734     1.192     1.201     1.201
                          (AC-FT)    27.        44.        45.        45.

  PEAK STORAGE  TIME                        MAXIMUM AVERAGE STORAGE
                                    6-HR       24-HR       72-HR    166.58-HR
+  (AC-FT)      (HR)
      36.       5.33                 27.        10.         3.         1.

  PEAK STAGE    TIME                        MAXIMUM AVERAGE STAGE
                                    6-HR       24-HR       72-HR    166.58-HR
+   (FEET)      (HR)
      6.75      5.33                 5.40       2.24        .75        .33

                         CUMULATIVE AREA =     .70 SQ MI

      ***            ***            ***            ***            ***
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                    HYDROGRAPH AT STATION    RRX1A
                  TRANSPOSITION AREA     16.0 SQ MI

  PEAK FLOW     TIME                      MAXIMUM AVERAGE FLOW
                                   6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+      55.      5.33                43.         17.          6.           2.
                        (INCHES)    .576        .895        .902         .902
                         (AC-FT)     21.         33.         33.          33.

 PEAK STORAGE   TIME                      MAXIMUM AVERAGE STORAGE
                                   6-HR       24-HR       72-HR    166.58-HR
+  (AC-FT)      (HR)
      26.       5.33                 19.          7.          2.           1.

  PEAK STAGE    TIME                      MAXIMUM AVERAGE STAGE
                                   6-HR       24-HR       72-HR    166.58-HR
+   (FEET)      (HR)
     5.33       5.33                4.22        1.69         .57          .24

                    CUMULATIVE AREA =     .70 SQ MI

 -----DSS---ZWRITE Unit  71; Vers.   59:  //RRX1A/FLOW/01JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   59:  //RRX1A/FLOW/02JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   59:  //RRX1A/FLOW/03JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   59:  //RRX1A/FLOW/04JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   59:  //RRX1A/FLOW/05JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   59:  //RRX1A/FLOW/06JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   59:  //RRX1A/FLOW/07JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   59:  //RRX1A/FLOW/08JAN1999/5MIN//
      ***            ***            ***            ***            ***


                    INTERPOLATED HYDROGRAPH AT    RRX1A

  PEAK FLOW     TIME                      MAXIMUM AVERAGE FLOW
                                   6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+      76.      5.33                64.         27.          9.           4.
                        (INCHES)    .855       1.449       1.462        1.462
                         (AC-FT)     32.         54.         54.          54.

                    CUMULATIVE AREA =     .70 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


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          **************
          *            *
150 KK    *   X1AW2C   *        ROUTE
          *            *
          **************
                     PROPOSED CHANNEL
                      ROUTE OUTFLOW FROM RRX1A TO CONFLUENCE WITH PROPOSED NEW CHANNEL FROM RRW2B
                      Slope=(1205.0 - 1184.0) / 1208.0

             HYDROGRAPH ROUTING DATA

154 RS          STORAGE ROUTING
                     NSTPS           1  NUMBER OF SUBREACHES
                      ITYP        FLOW  TYPE OF INITIAL CONDITION
                    RSVRIC       -1.00  INITIAL CONDITION
                         X         .00 WORKING R AND D COEFFICIENT

155 RC          NORMAL DEPTH CHANNEL
                       ANL        .045  LEFT OVERBANK N-VALUE
                      ANCH        .045  MAIN CHANNEL N-VALUE
                       ANR        .045  RIGHT OVERBANK N-VALUE
                     RLNTH       1208.  REACH LENGTH
                       SEL       .0170  ENERGY SLOPE
                      ELMAX       104.5  MAX. ELEV. FOR STORAGE/OUTFLOW CALCULATION

                                CROSS-SECTION DATA
                     --- LEFT OVERBANK --- + ------ MAIN CHANNEL ------- + --- RIGHT OVERBANK ---
157 RY       ELEVATION    104.50    100.00    100.00    100.00    100.00    100.00    100.00    104.50
156 RX       DISTANCE        .00       .00       .00       .00     80.00     80.00     80.00     80.00

                                          ***

                                COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

        STORAGE        .00       .53      1.05      1.58      2.10      2.63      3.15      3.68      4.20      4.73
        OUTFLOW        .00     31.25     99.02    194.25    313.14    453.32    613.10    791.17    986.47   1198.12
      ELEVATION     100.00    100.24    100.47    100.71    100.95    101.18    101.42    101.66    101.89    102.13

        STORAGE       5.25      5.78      6.31      6.83      7.36      7.88      8.41      8.93      9.46      9.98
        OUTFLOW    1425.38   1667.58   1924.15   2194.57   2478.37   2775.13   3084.45   3405.98   3739.39   4084.35
      ELEVATION     102.37    102.61    102.84    103.08    103.32    103.55    103.79    104.03    104.26    104.50

*** WARNING *** MODIFIED PULS ROUTING MAY BE NUMERICALLY UNSTABLE FOR OUTFLOWS BETWEEN      453. TO     4084.
                THE ROUTED HYDROGRAPH SHOULD BE EXAMINED FOR OSCILLATIONS OR OUTFLOWS GREATER THAN PEAK INFLOWS.
                THIS CAN BE CORRECTED BY DECREASING THE TIME INTERVAL OR INCREASING STORAGE (USE A LONGER REACH.)
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      ***            ***            ***            ***            ***

                    HYDROGRAPH AT STATION   X1AW2C
                  TRANSPOSITION AREA       .1 SQ MI

  PEAK FLOW     TIME                      MAXIMUM AVERAGE FLOW
                                   6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+      78.      5.42                66.         28.         10.           4.
                        (INCHES)    .887       1.522       1.536        1.536
                         (AC-FT)     33.         56.         57.          57.

 PEAK STORAGE   TIME                      MAXIMUM AVERAGE STORAGE
                                   6-HR       24-HR       72-HR    166.58-HR
+  (AC-FT)      (HR)
       1.       5.33                  1.          0.          0.           0.

  PEAK STAGE    TIME                      MAXIMUM AVERAGE STAGE
                                   6-HR       24-HR       72-HR    166.58-HR
+   (FEET)      (HR)
  100.40       5.42                100.36      100.18      100.06       100.03

                    CUMULATIVE AREA =     .70 SQ MI

      ***            ***            ***            ***            ***

                    HYDROGRAPH AT STATION   X1AW2C
                  TRANSPOSITION AREA       .5 SQ MI

  PEAK FLOW     TIME                      MAXIMUM AVERAGE FLOW
                                   6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+      78.      5.42                66.         28.         10.           4.
                        (INCHES)    .882       1.510       1.524        1.524
                         (AC-FT)     33.         56.         57.          57.

 PEAK STORAGE   TIME                      MAXIMUM AVERAGE STORAGE
                                   6-HR       24-HR       72-HR    166.58-HR
+  (AC-FT)      (HR)
       1.       5.33                  1.          0.          0.           0.

  PEAK STAGE    TIME                      MAXIMUM AVERAGE STAGE
                                   6-HR       24-HR       72-HR    166.58-HR
+   (FEET)      (HR)
  100.40       5.42                100.36      100.17      100.06       100.03

                    CUMULATIVE AREA =     .70 SQ MI

      ***            ***            ***            ***            ***

                    HYDROGRAPH AT STATION   X1AW2C
                  TRANSPOSITION AREA      2.8 SQ MI

  PEAK FLOW     TIME                      MAXIMUM AVERAGE FLOW
                                   6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+      67.      5.50                55.         22.          7.           3.
                        (INCHES)    .732       1.192       1.201        1.201
                         (AC-FT)     27.         44.         45.          45.

 PEAK STORAGE   TIME                      MAXIMUM AVERAGE STORAGE
                                   6-HR       24-HR       72-HR    166.58-HR
+  (AC-FT)      (HR)
       1.       5.50                  1.          0.          0.           0.

  PEAK STAGE    TIME                      MAXIMUM AVERAGE STAGE
                                   6-HR       24-HR       72-HR    166.58-HR
+   (FEET)      (HR)
  100.36       5.50                100.32      100.14      100.05       100.02

                    CUMULATIVE AREA =     .70 SQ MI

      ***            ***            ***            ***            ***

                    HYDROGRAPH AT STATION   X1AW2C
                  TRANSPOSITION AREA     16.0 SQ MI

  PEAK FLOW     TIME                      MAXIMUM AVERAGE FLOW
                                   6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+      55.      5.50                43.         17.          6.           2.
                        (INCHES)    .573        .895        .902         .902
                         (AC-FT)     21.         33.         33.          33.

 PEAK STORAGE   TIME                      MAXIMUM AVERAGE STORAGE
                                   6-HR       24-HR       72-HR    166.58-HR
+  (AC-FT)      (HR)
       1.       5.42                  1.          0.          0.           0.

  PEAK STAGE    TIME                      MAXIMUM AVERAGE STAGE
                                   6-HR       24-HR       72-HR    166.58-HR
+   (FEET)      (HR)
  100.32       5.50                100.28      100.11      100.04       100.02
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                    CUMULATIVE AREA =     .70 SQ MI

 -----DSS---ZWRITE Unit  71; Vers.   59:  //X1AW2C/FLOW/01JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   59:  //X1AW2C/FLOW/02JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   59:  //X1AW2C/FLOW/03JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   59:  //X1AW2C/FLOW/04JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   59:  //X1AW2C/FLOW/05JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   59:  //X1AW2C/FLOW/06JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   59:  //X1AW2C/FLOW/07JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   59:  //X1AW2C/FLOW/08JAN1999/5MIN//
      ***            ***            ***            ***            ***


                    INTERPOLATED HYDROGRAPH AT   X1AW2C

  PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                         (CFS)
+      76.      5.42                 64.         27.          9.           4.
                       (INCHES)     .853       1.449       1.462        1.462
                        (AC-FT)     32.         54.         54.          54.

                    CUMULATIVE AREA =     .70 SQ MI


 *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


            **************
            *            *
  159 KK    *     CW2C   *      COMBINE
            *            *
            **************
                            Combine routed outflow from SkyET detention basin with
                            combined flows at CW2CR.

  162 HC          HYDROGRAPH COMBINATION
                       ICOMP           2  NUMBER OF HYDROGRAPHS TO COMBINE
                                                                  ***
      ***            ***            ***            ***            ***
                                                  ***
      ***            ***            ***            ***            ***

                      HYDROGRAPH AT STATION     CW2C
                     TRANSPOSITION AREA       .1 SQ MI

  PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                         (CFS)
+     497.      6.92                477.        242.         81.          35.
                       (INCHES)     .738       1.495       1.510        1.510
                        (AC-FT)     237.        480.        484.         484.

                     CUMULATIVE AREA =    6.01 SQ MI

      ***            ***            ***            ***            ***

                      HYDROGRAPH AT STATION     CW2C
                     TRANSPOSITION AREA       .5 SQ MI

  PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                         (CFS)
+     495.      6.92                474.        240.         81.          35.
                       (INCHES)     .733       1.483       1.498        1.498
                        (AC-FT)     235.        476.        480.         480.

                     CUMULATIVE AREA =    6.01 SQ MI

      ***            ***            ***            ***            ***

                      HYDROGRAPH AT STATION     CW2C
                     TRANSPOSITION AREA      2.8 SQ MI

  PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                         (CFS)
+     415.      6.92                388.        188.         63.          27.
                       (INCHES)     .599       1.163       1.173        1.173
                        (AC-FT)     192.        373.        376.         376.

                     CUMULATIVE AREA =    6.01 SQ MI

      ***            ***            ***            ***            ***

                      HYDROGRAPH AT STATION     CW2C
                     TRANSPOSITION AREA     16.0 SQ MI

  PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                         (CFS)
+     318.      6.92                294.        140.         47.          20.
                       (INCHES)     .455        .864        .871         .871
                        (AC-FT)     146.        277.        279.         279.

                     CUMULATIVE AREA =    6.01 SQ MI

 -----DSS---ZWRITE Unit  71; Vers.   59:  //CW2C/FLOW/01JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   59:  //CW2C/FLOW/02JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   59:  //CW2C/FLOW/03JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   59:  //CW2C/FLOW/04JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   59:  //CW2C/FLOW/05JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   59:  //CW2C/FLOW/06JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   59:  //CW2C/FLOW/07JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   59:  //CW2C/FLOW/08JAN1999/5MIN//
      ***            ***            ***            ***            ***


                    INTERPOLATED HYDROGRAPH AT     CW2C

  PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                         (CFS)
+     373.      6.92                347.        167.         56.          24.
                       (INCHES)     .536       1.032       1.040        1.040
                        (AC-FT)     172.        331.        334.         334.

                    CUMULATIVE AREA =    6.01 SQ MI


 *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


            **************
            *            *
  164 KK    *   W2CW2D   *        ROUTE
            *            *
            **************
                            PROPOSED CHANNEL
                             ROUTE COMBINED FLOW TO FRS NO. 3 VIA PROPOSED NEW CHANNEL
                             Slope=(1184.0 - 1160.0) / 1456.0

                    HYDROGRAPH ROUTING DATA

  168 RS          STORAGE ROUTING
                       NSTPS           1  NUMBER OF SUBREACHES
                        ITYP        FLOW  TYPE OF INITIAL CONDITION
                       RSVRIC       -1.00  INITIAL CONDITION
                           X         .00 WORKING R AND D COEFFICIENT

  169 RC          NORMAL DEPTH CHANNEL
                         ANL        .045  LEFT OVERBANK N-VALUE
                        ANCH        .045  MAIN CHANNEL N-VALUE
                         ANR        .045  RIGHT OVERBANK N-VALUE
                       RLNTH       1456.  REACH LENGTH
                         SEL       .0160  ENERGY SLOPE
                       ELMAX       104.5  MAX. ELEV. FOR STORAGE/OUTFLOW CALCULATION

                                   CROSS-SECTION DATA
                          --- LEFT OVERBANK --- + ------ MAIN CHANNEL ------- + --- RIGHT OVERBANK ---
  171 RY        ELEVATION    104.50    100.00    100.00    100.00    100.00    100.00    100.00    104.50
  170 RX        DISTANCE        .00       .00       .00       .00     70.00     70.00     70.00     70.00
                                                                      ***

                                   COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

                 STORAGE        .00       .55      1.11      1.66      2.22      2.77      3.32      3.88      4.43      4.99
                 OUTFLOW        .00     26.52     84.01    164.75    265.52    384.28    519.58    670.31    835.55   1014.55
               ELEVATION     100.00    100.24    100.47    100.71    100.95    101.18    101.42    101.66    101.89    102.13

                 STORAGE       5.54      6.10      6.65      7.20      7.76      8.31      8.87      9.42      9.97     10.53
                 OUTFLOW    1206.67   1411.33   1628.05   1856.37   2095.89   2346.25   2607.10   2878.13   3159.07   3449.63
               ELEVATION     102.37    102.61    102.84    103.08    103.32    103.55    103.79    104.03    104.26    104.50

 *** WARNING *** MODIFIED PULS ROUTING MAY BE NUMERICALLY UNSTABLE FOR OUTFLOWS BETWEEN      670. TO     3450.
                THE ROUTED HYDROGRAPH SHOULD BE EXAMINED FOR OSCILLATIONS OR OUTFLOWS GREATER THAN PEAK INFLOWS.
                THIS CAN BE CORRECTED BY DECREASING THE TIME INTERVAL OR INCREASING STORAGE (USE A LONGER REACH.)

      ***            ***            ***            ***            ***

                      HYDROGRAPH AT STATION   W2CW2D
                     TRANSPOSITION AREA       .1 SQ MI

  PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                         (CFS)
+     497.      6.92                477.        242.         81.          35.
                       (INCHES)     .738       1.495       1.510        1.510
                        (AC-FT)     237.        480.        484.         484.

  PEAK STORAGE  TIME                        MAXIMUM AVERAGE STORAGE
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                                        6-HR       24-HR       72-HR    166.58-HR
+  (AC-FT)      (HR)
       3.      6.83                      3.          2.          1.           0.

  PEAK STAGE    TIME                            MAXIMUM AVERAGE STAGE
                                        6-HR       24-HR       72-HR    166.58-HR
+   (FEET)      (HR)
    101.38      6.92                  101.35      100.82      100.28       100.12

                          CUMULATIVE AREA =    6.01 SQ MI


      ***             ***             ***             ***             ***

                          HYDROGRAPH AT STATION   W2CW2D
                        TRANSPOSITION AREA       .5 SQ MI

  PEAK FLOW     TIME                            MAXIMUM AVERAGE FLOW
                                        6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                                      (CFS)
+     495.      6.92                    474.        240.         81.          35.
                                   (INCHES)       .733       1.483       1.498        1.498
                                    (AC-FT)       235.        476.        480.         480.

 PEAK STORAGE   TIME                           MAXIMUM AVERAGE STORAGE
                                        6-HR       24-HR       72-HR    166.58-HR
+  (AC-FT)      (HR)
       3.      6.83                      3.          2.          1.           0.

  PEAK STAGE    TIME                            MAXIMUM AVERAGE STAGE
                                        6-HR       24-HR       72-HR    166.58-HR
+   (FEET)      (HR)
    101.38      6.92                  101.34      100.82      100.28       100.12

                          CUMULATIVE AREA =    6.01 SQ MI


      ***             ***             ***             ***             ***

                          HYDROGRAPH AT STATION   W2CW2D
                        TRANSPOSITION AREA      2.8 SQ MI

  PEAK FLOW     TIME                            MAXIMUM AVERAGE FLOW
                                        6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                                      (CFS)
+     415.      7.00                    387.        188.         63.          27.
                                   (INCHES)       .599       1.163       1.173        1.173
                                    (AC-FT)       192.        373.        376.         376.

 PEAK STORAGE   TIME                           MAXIMUM AVERAGE STORAGE
                                        6-HR       24-HR       72-HR    166.58-HR
+  (AC-FT)      (HR)
       3.      6.83                      3.          2.          1.           0.

  PEAK STAGE    TIME                            MAXIMUM AVERAGE STAGE
                                        6-HR       24-HR       72-HR    166.58-HR
+   (FEET)      (HR)
    101.24      7.00                  101.19      100.70      100.24       100.10

                          CUMULATIVE AREA =    6.01 SQ MI


      ***             ***             ***             ***             ***

                          HYDROGRAPH AT STATION   W2CW2D
                        TRANSPOSITION AREA     16.0 SQ MI

  PEAK FLOW     TIME                            MAXIMUM AVERAGE FLOW
                                        6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                                      (CFS)
+     318.      7.00                    294.        140.         47.          20.
                                   (INCHES)       .455        .864        .871         .871
                                    (AC-FT)       146.        277.        279.         279.

 PEAK STORAGE   TIME                           MAXIMUM AVERAGE STORAGE
                                        6-HR       24-HR       72-HR    166.58-HR
+  (AC-FT)      (HR)
       2.      7.00                      2.          1.          0.           0.

  PEAK STAGE    TIME                            MAXIMUM AVERAGE STAGE
                                        6-HR       24-HR       72-HR    166.58-HR
+   (FEET)      (HR)
    101.05      7.00                  101.00      100.57      100.19       100.08

                          CUMULATIVE AREA =    6.01 SQ MI

 -----DSS---ZWRITE Unit  71; Vers.   59:  //W2CW2D/FLOW/01JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   59:  //W2CW2D/FLOW/02JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   59:  //W2CW2D/FLOW/03JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   59:  //W2CW2D/FLOW/04JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   59:  //W2CW2D/FLOW/05JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   59:  //W2CW2D/FLOW/06JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   59:  //W2CW2D/FLOW/07JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   59:  //W2CW2D/FLOW/08JAN1999/5MIN//
      ***             ***             ***             ***             ***
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                          INTERPOLATED HYDROGRAPH AT   W2CW2D

  PEAK FLOW     TIME                            MAXIMUM AVERAGE FLOW
                                        6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                                      (CFS)
+     373.      7.00                    346.        167.         56.          24.
                                   (INCHES)       .536       1.032       1.040        1.040
                                    (AC-FT)       172.        331.        334.         334.

                          CUMULATIVE AREA =    6.01 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

            **************
            *            *
 173 KK     *     W2D    *       BASIN
            *            *
            **************
                                Compute runoff from subbasin W2D

                SUBBASIN RUNOFF DATA

 175 BA           SUBBASIN CHARACTERISTICS
                        TAREA         .12  SUBBASIN AREA

 176 LG           GREEN AND AMPT LOSS RATE
                        STRTL         .35  STARTING LOSS
                          DTH         .35  MOISTURE DEFICIT
                         PSIF        4.15  WETTING FRONT SUCTION
                        XKSAT         .44  HYDRAULIC CONDUCTIVITY
                        RTIMP         .00  PERCENT IMPERVIOUS AREA

 174 UI           INPUT UNITGRAPH,   4 ORDINATES,  VOLUME =  .99
                     279.0     464.0     139.0      35.0
                                                                  ***

      ***             ***             ***             ***             ***

                          HYDROGRAPH AT STATION      W2D
                        TRANSPOSITION AREA       .1 SQ MI

    TOTAL RAINFALL =    3.20, TOTAL LOSS =    1.91, TOTAL EXCESS =    1.28

  PEAK FLOW     TIME                            MAXIMUM AVERAGE FLOW
                                        6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                                      (CFS)
+     347.      4.00                     16.          4.          1.           1.
                                   (INCHES)      1.265       1.265       1.265        1.265
                                    (AC-FT)        8.          8.          8.           8.

                          CUMULATIVE AREA =     .12 SQ MI


      ***             ***             ***             ***             ***

                          HYDROGRAPH AT STATION      W2D
                        TRANSPOSITION AREA       .5 SQ MI

    TOTAL RAINFALL =    3.18, TOTAL LOSS =    1.91, TOTAL EXCESS =    1.27

  PEAK FLOW     TIME                            MAXIMUM AVERAGE FLOW
                                        6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                                      (CFS)
+     345.      4.00                     16.          4.          1.           1.
                                   (INCHES)      1.254       1.254       1.254        1.254
                                    (AC-FT)        8.          8.          8.           8.

                          CUMULATIVE AREA =     .12 SQ MI


      ***             ***             ***             ***             ***

                          HYDROGRAPH AT STATION      W2D
                        TRANSPOSITION AREA      2.8 SQ MI

    TOTAL RAINFALL =    3.12, TOTAL LOSS =    2.19, TOTAL EXCESS =     .93

  PEAK FLOW     TIME                            MAXIMUM AVERAGE FLOW
                                        6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                                      (CFS)
+     145.      4.00                     12.          3.          1.           0.
                                   (INCHES)       .917        .917        .917         .917
                                    (AC-FT)        6.          6.          6.           6.

                          CUMULATIVE AREA =     .12 SQ MI


      ***             ***             ***             ***             ***

                          HYDROGRAPH AT STATION      W2D
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                    TRANSPOSITION AREA     16.0 SQ MI

     TOTAL RAINFALL =    2.95, TOTAL LOSS =    2.34, TOTAL EXCESS =     .61

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                         (CFS)
+     96.       4.00                  8.          2.          1.           0.
                       (INCHES)     .605        .605        .605         .605
                        (AC-FT)       4.          4.          4.           4.

                       CUMULATIVE AREA =     .12 SQ MI

      ***            ***            ***            ***            ***


                       INTERPOLATED HYDROGRAPH AT      W2D

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                         (CFS)
+    347.       4.00                 16.          4.          1.           1.
                       (INCHES)    1.264       1.264       1.264        1.264
                        (AC-FT)       8.          8.          8.           8.

                       CUMULATIVE AREA =     .12 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


            **************
            *            *
 178 KK     *     CW2D   *      COMBINE
            *            *
            **************
                                Combine runoff from W2D with routed flows from CW2C.

 180 HC          HYDROGRAPH COMBINATION
                      ICOMP           2  NUMBER OF HYDROGRAPHS TO COMBINE
                                                                  ***

      ***            ***            ***            ***            ***

                       HYDROGRAPH AT STATION     CW2D
                    TRANSPOSITION AREA       .1 SQ MI

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                         (CFS)
+    650.       4.00                 478.        246.         83.          36.
                       (INCHES)     .724       1.491       1.505        1.505
                        (AC-FT)     237.        488.        492.         492.

                       CUMULATIVE AREA =    6.13 SQ MI

      ***            ***            ***            ***            ***

                       HYDROGRAPH AT STATION     CW2D
                    TRANSPOSITION AREA       .5 SQ MI

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                         (CFS)
+    645.       4.00                 475.        244.         82.          35.
                       (INCHES)     .720       1.479       1.493        1.493
                        (AC-FT)     236.        484.        488.         488.

                       CUMULATIVE AREA =    6.13 SQ MI

      ***            ***            ***            ***            ***

                       HYDROGRAPH AT STATION     CW2D
                    TRANSPOSITION AREA      2.8 SQ MI

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                         (CFS)
+    415.       7.00                 387.        191.         64.          28.
                       (INCHES)     .587       1.158       1.168        1.168
                        (AC-FT)     192.        379.        382.         382.

                       CUMULATIVE AREA =    6.13 SQ MI

      ***            ***            ***            ***            ***

                       HYDROGRAPH AT STATION     CW2D
                    TRANSPOSITION AREA     16.0 SQ MI

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                         (CFS)
+    318.       7.00                 294.        142.         48.          21.
                       (INCHES)     .446        .859        .866         .866
                        (AC-FT)     146.        281.        283.         283.

                       CUMULATIVE AREA =    6.13 SQ MI

      ***            ***            ***            ***            ***


                       INTERPOLATED HYDROGRAPH AT      CW2D

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                         (CFS)
+    373.       7.00                 346.        169.         57.          25.
                       (INCHES)     .525       1.027       1.035        1.035
                        (AC-FT)     172.        336.        339.         339.

                       CUMULATIVE AREA =    6.13 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


            **************
            *            *
 181 KK     *     S800   *      BASIN
            *            *
            **************
                                Compute runoff from subbasin 800

                SUBBASIN RUNOFF DATA

 183 BA           SUBBASIN CHARACTERISTICS
                       TAREA         .43  SUBBASIN AREA

 184 LG           GREEN AND AMPT LOSS RATE
                       STRTL         .27  STARTING LOSS
                         DTH         .35  MOISTURE DEFICIT
                        PSIF        4.60  WETTING FRONT SUCTION
                       XKSAT         .34  HYDRAULIC CONDUCTIVITY
                       RTIMP        9.00  PERCENT IMPERVIOUS AREA

 182 UI           INPUT UNITGRAPH,  27 ORDINATES,  VOLUME = 1.00
                      49.0     118.0     252.0     353.0     489.0     442.0     297.0     255.0     213.0     170.0
                     134.0     113.0      92.0      69.0      57.0      48.0      38.0      29.0      24.0      25.0
                      12.0       9.0      10.0       9.0      10.0       9.0      10.0
                                                                      ***

      ***            ***            ***            ***            ***

                       HYDROGRAPH AT STATION     S800
                    TRANSPOSITION AREA       .1 SQ MI

     TOTAL RAINFALL =    3.20, TOTAL LOSS =    1.59, TOTAL EXCESS =    1.60

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                         (CFS)
+    598.       4.25                  74.         19.          6.           3.
                       (INCHES)    1.599       1.602       1.602        1.602
                        (AC-FT)      37.         37.         37.          37.

                       CUMULATIVE AREA =     .43 SQ MI

      ***            ***            ***            ***            ***

                       HYDROGRAPH AT STATION     S800
                    TRANSPOSITION AREA       .5 SQ MI

     TOTAL RAINFALL =    3.18, TOTAL LOSS =    1.59, TOTAL EXCESS =    1.59

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                         (CFS)
+    594.       4.25                  74.         18.          6.           3.
                       (INCHES)    1.587       1.589       1.589        1.589
                        (AC-FT)      36.         37.         37.          37.

                       CUMULATIVE AREA =     .43 SQ MI

      ***            ***            ***            ***            ***

                       HYDROGRAPH AT STATION     S800
                    TRANSPOSITION AREA      2.8 SQ MI
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      TOTAL RAINFALL =    3.12, TOTAL LOSS =    1.84, TOTAL EXCESS =    1.28

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+     366.      4.33                  59.         15.          5.          2.
                        (INCHES)    1.280       1.283       1.283       1.283
                         (AC-FT)     29.         30.         30.         30.

                        CUMULATIVE AREA =     .43 SQ MI


      ***             ***             ***             ***             ***

                        HYDROGRAPH AT STATION     S800
                       TRANSPOSITION AREA     16.0 SQ MI

      TOTAL RAINFALL =    2.95, TOTAL LOSS =    1.96, TOTAL EXCESS =     .99

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+     262.      4.33                  46.         11.          4.          2.
                        (INCHES)     .985        .989        .989        .989
                         (AC-FT)     23.         23.         23.         23.

                        CUMULATIVE AREA =     .43 SQ MI

      ***             ***             ***             ***             ***


                        INTERPOLATED HYDROGRAPH AT     S800

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+     595.      4.25                  74.         18.          6.          3.
                        (INCHES)    1.588       1.591       1.591       1.591
                         (AC-FT)     36.         37.         37.         37.

                        CUMULATIVE AREA =     .43 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


            **************
            *            *
188 KK      *     S810   *        BASIN
            *            *
            **************
                                Compute runoff from subbasin 810

                SUBBASIN RUNOFF DATA

190 BA            SUBBASIN CHARACTERISTICS
                        TAREA        1.61  SUBBASIN AREA

191 LG            GREEN AND AMPT LOSS RATE
                        STRTL         .30  STARTING LOSS
                          DTH         .35  MOISTURE DEFICIT
                         PSIF        4.65  WETTING FRONT SUCTION
                        XKSAT         .32  HYDRAULIC CONDUCTIVITY
                        RTIMP        4.00  PERCENT IMPERVIOUS AREA

189 UI            INPUT UNITGRAPH,  35 ORDINATES,  VOLUME = 1.00
                      140.0     200.0     493.0     790.0     997.0    1196.0    1589.0    1066.0     843.0     750.0
                      668.0     569.0     489.0     397.0     336.0     309.0     256.0     202.0     176.0     155.0
                      130.0     106.0     102.0      68.0      68.0      69.0      46.0      27.0      27.0      27.0
                       26.0      27.0      27.0      27.0      27.0
                                                                                  ***

      ***             ***             ***             ***             ***

                        HYDROGRAPH AT STATION     S810
                       TRANSPOSITION AREA       .1 SQ MI

      TOTAL RAINFALL =    3.20, TOTAL LOSS =    1.67, TOTAL EXCESS =    1.53

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+    1786.      4.42                 264.         66.         22.         10.
                        (INCHES)    1.526       1.528       1.528       1.528
                         (AC-FT)     131.        131.        131.        131.

                        CUMULATIVE AREA =    1.61 SQ MI

      ***             ***             ***             ***             ***

                        HYDROGRAPH AT STATION     S810
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                       TRANSPOSITION AREA       .5 SQ MI

      TOTAL RAINFALL =    3.18, TOTAL LOSS =    1.66, TOTAL EXCESS =    1.52

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+    1773.      4.42                 262.         65.         22.          9.
                        (INCHES)    1.513       1.515       1.515       1.515
                         (AC-FT)     130.        130.        130.        130.

                        CUMULATIVE AREA =    1.61 SQ MI

      ***             ***             ***             ***             ***

                        HYDROGRAPH AT STATION     S810
                       TRANSPOSITION AREA      2.8 SQ MI

      TOTAL RAINFALL =    3.12, TOTAL LOSS =    1.91, TOTAL EXCESS =    1.21

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+    1156.      4.42                 208.         52.         17.          7.
                        (INCHES)    1.201       1.204       1.204       1.204
                         (AC-FT)     103.        103.        103.        103.

                        CUMULATIVE AREA =    1.61 SQ MI

      ***             ***             ***             ***             ***

                        HYDROGRAPH AT STATION     S810
                       TRANSPOSITION AREA     16.0 SQ MI

      TOTAL RAINFALL =    2.95, TOTAL LOSS =    2.04, TOTAL EXCESS =     .91

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+     825.      4.42                 156.         39.         13.          6.
                        (INCHES)     .901        .905        .905        .905
                         (AC-FT)     77.         78.         78.         78.

                        CUMULATIVE AREA =    1.61 SQ MI

      ***             ***             ***             ***             ***


                        INTERPOLATED HYDROGRAPH AT     S810

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+    1355.      4.42                 225.         56.         19.          8.
                        (INCHES)    1.302       1.304       1.304       1.304
                         (AC-FT)     112.        112.        112.        112.

                        CUMULATIVE AREA =    1.61 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


            **************
            *            *
196 KK      *     S820   *        BASIN
            *            *
            **************
                                Compute runoff from subbasin S820.  Runoff to Fan 20 apex.

                SUBBASIN RUNOFF DATA

198 BA            SUBBASIN CHARACTERISTICS
                        TAREA         .36  SUBBASIN AREA

199 LG            GREEN AND AMPT LOSS RATE
                        STRTL         .25  STARTING LOSS
                          DTH         .35  MOISTURE DEFICIT
                         PSIF        4.35  WETTING FRONT SUCTION
                        XKSAT         .40  HYDRAULIC CONDUCTIVITY
                        RTIMP       18.00  PERCENT IMPERVIOUS AREA

197 UI            INPUT UNITGRAPH,  24 ORDINATES,  VOLUME = 1.00
                       45.0     123.0     260.0     348.0     490.0     307.0     248.0     208.0     166.0     125.0
                      105.0      83.0      61.0      51.0      39.0      33.0      23.0      22.0      15.0       8.0
                        9.0       8.0       9.0       9.0
                                                                                  ***

      ***             ***             ***             ***             ***
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                    HYDROGRAPH AT STATION     S820
                   TRANSPOSITION AREA       .1 SQ MI

     TOTAL RAINFALL =    3.20, TOTAL LOSS =    1.49, TOTAL EXCESS =    1.70

  PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                   6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+     536.      4.25                66.         17.          6.          2.
                         (INCHES)  1.694       1.699       1.699       1.699
                          (AC-FT)    33.         33.         33.         33.

                    CUMULATIVE AREA =     .36 SQ MI


       ***            ***            ***            ***            ***

                    HYDROGRAPH AT STATION     S820
                   TRANSPOSITION AREA       .5 SQ MI

     TOTAL RAINFALL =    3.18, TOTAL LOSS =    1.49, TOTAL EXCESS =    1.69

  PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                   6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+     533.      4.25                65.         16.          5.          2.
                         (INCHES)  1.681       1.686       1.686       1.686
                          (AC-FT)    32.         33.         33.         33.

                    CUMULATIVE AREA =     .36 SQ MI


       ***            ***            ***            ***            ***

                    HYDROGRAPH AT STATION     S820
                   TRANSPOSITION AREA      2.8 SQ MI

     TOTAL RAINFALL =    3.12, TOTAL LOSS =    1.72, TOTAL EXCESS =    1.40

  PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                   6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+     328.      4.25                54.         14.          5.          2.
                         (INCHES)  1.388       1.394       1.394       1.394
                          (AC-FT)    27.         27.         27.         27.

                    CUMULATIVE AREA =     .36 SQ MI


       ***            ***            ***            ***            ***

                    HYDROGRAPH AT STATION     S820
                   TRANSPOSITION AREA     16.0 SQ MI

     TOTAL RAINFALL =    2.95, TOTAL LOSS =    1.84, TOTAL EXCESS =    1.11

  PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                   6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+     234.      4.25                43.         11.          4.          2.
                         (INCHES)  1.101       1.108       1.108       1.108
                          (AC-FT)    21.         21.         21.         21.

                    CUMULATIVE AREA =     .36 SQ MI


       ***            ***            ***            ***            ***


                    INTERPOLATED HYDROGRAPH AT     S820

  PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                   6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+     533.      4.25                66.         16.          5.          2.
                         (INCHES)  1.683       1.689       1.689       1.689
                          (AC-FT)    33.         33.         33.         33.

                    CUMULATIVE AREA =     .36 SQ MI

1
                                   RUNOFF SUMMARY
                             FLOW IN CUBIC FEET PER SECOND
                           TIME IN HOURS,  AREA IN SQUARE MILES

                                     PEAK   TIME OF     AVERAGE FLOW FOR MAXIMUM PERIOD      BASIN     MAXIMUM     TIME OF
        OPERATION       STATION      FLOW    PEAK                                           AREA      STAGE     MAX STAGE
+                                                                6-HOUR     24-HOUR     72-HOUR

        HYDROGRAPH AT
+                            W1     2527.    4.50        494.        124.         41.       4.05

        ROUTED TO
+                          RRW1      368.    5.75        296.        123.         41.       4.05

        ROUTED TO
+                          W1W2A     368.    5.83        296.        123.         41.       4.05

        HYDROGRAPH AT
+                           W2A      525.    4.08         47.         12.          4.        .28

        2 COMBINED AT
+                           CW2A     368.    5.75        311.        131.         44.       4.34

        ROUTED TO
+                         W2AW2B     366.    6.00        308.        130.         44.       4.34

        HYDROGRAPH AT
+                           W2B     1411.    4.08        116.         29.         10.        .86

        2 COMBINED AT
+                           CW2B     875.    4.17        367.        148.         50.       5.19

        ROUTED TO
+                          RRW2B     326.    7.25        304.        148.         50.       5.19

        ROUTED TO
+                         W2BW2C     326.    7.33        304.        148.         50.       5.19

        HYDROGRAPH AT
+                           W2C      333.    4.00         17.          4.          1.        .12

        2 COMBINED AT
+                          CW2CR     326.    7.33        304.        151.         51.       5.32

        HYDROGRAPH AT
+                           X1A      853.    4.25        109.         27.          9.        .70

        ROUTED TO
+                          RRX1A      76.    5.33         64.         27.          9.        .70

        ROUTED TO
+                         X1AW2C      76.    5.42         64.         27.          9.        .70

        2 COMBINED AT
+                           CW2C     373.    6.92        347.        167.         56.       6.01

        ROUTED TO
+                         W2CW2D     373.    7.00        346.        167.         56.       6.01

        HYDROGRAPH AT
+                           W2D      347.    4.00         16.          4.          1.        .12

        2 COMBINED AT
+                           CW2D     373.    7.00        346.        169.         57.       6.13

        HYDROGRAPH AT
+                           S800     595.    4.25         74.         18.          6.        .43

        HYDROGRAPH AT
+                           S810    1355.    4.42        225.         56.         19.       1.61

        HYDROGRAPH AT
+                           S820     533.    4.25         66.         16.          5.        .36


 *** NORMAL END OF HEC-1 ***


      -----DSS---ZCLOSE Unit:  71,   File: SKY6.DSS
                Pointer Utilization:   .31
                Number of Records:    104
                File Size:    191.5  Kbytes
                Percent Inactive:    .0
```

```
1****************************************
 *                                       *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
 *              JUN   1998               *
 *            VERSION 4.1                *
 *                                       *
 * RUN DATE   20DEC06   TIME  22:00:43   *
 *                                       *
 *****************************************

 ***************************************
 *                                     *
 *   U.S. ARMY CORPS OF ENGINEERS      *
 *   HYDROLOGIC ENGINEERING CENTER     *
 *        609 SECOND STREET            *
 *      DAVIS, CALIFORNIA 95616        *
 *         (916) 756-1104              *
 *                                     *
 ***************************************

               X     X  XXXXXXX   XXXXX          X
               X     X  X        X     X        XX
               X     X  X        X               X
               XXXXXXX  XXXX     X       XXXXX   X
               X     X  X        X               X
               X     X  X        X     X         X
               X     X  XXXXXXX   XXXXX         XXX

   THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

   THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
   THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
   NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
   DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
   KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

1                                   HEC-1 INPUT                                         PAGE  1

 LINE      ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

   1       ID   HYDROLOGY FOR STEP 3 RECOMMENDED ALTERNATIVE FOR SUN VALLEY ADMP
   2       ID       - SKYLINE WASH FAN SYSTEM
   3       ID
   4       ID   SUN VALLEY AREA DRAINAGE MASTER PLAN (SVADMP) - FCD 2004C049
   5       ID   JE FULLER / HYDROLOGY & GEOMORPHOLOGY, INC.
   6       ID   MODELER: TED LEHMAN
   7       ID   FILENAME: SKY24.DAT
   8       ID
   9       ID   100-YEAR 24-HOUR MODEL
  10       ID   EXISTING CONDITIONS - WITH RECOMMENDED ALTERNATIVE ELEMENTS
  11       ID            MODELED AREA = 8.5 SQ. MILES
  12       ID
  13       ID   GREEN-AMPT LOSS METHOD
  14       ID
  15       ID   S-GRAPH UNIT HYDROGRAPHS
  16       ID     - MOUNTAIN
  17       ID     - DESERT/RANGELAND
  18       ID
  19       ID   NORMAL-DEPTH CHANNEL ROUTING
  20       ID
  21       ID   LAND USE DATA FROM EXAMINATION OF SLOPE FROM 10-FT DTM TO DISTINGUISH
  22       ID     - UNDEVELOPED DESERT RANGELAND (NDR) - SLOPES < 5 %
  23       ID     - HILLSLOPES, SONORAN DESERT (NHS) - SLOPES 5 - 10 %
  24       ID     - MOUNTAIN TERRAIN (NMT) - SLOPES > 10 %
  25       ID
  26       ID   SOILS DATA FROM FCDMC GIS DATABASE (RECEIVED FROM FCDMC JULY 2005)
  27       IT       5  1JAN99    1200    2000
  28       IN      15
  29       IO       3
          *DIAGRAM
           *
  30       JD   4.198  0.1000
  31       PC   0.000   0.002   0.005   0.008   0.011   0.014   0.017   0.020   0.023   0.026
  32       PC   0.029   0.032   0.035   0.038   0.041   0.044   0.048   0.052   0.056   0.060
  33       PC   0.064   0.068   0.072   0.076   0.080   0.085   0.090   0.095   0.100   0.105
  34       PC   0.110   0.115   0.120   0.126   0.133   0.140   0.147   0.155   0.163   0.172
  35       PC   0.181   0.191   0.203   0.218   0.236   0.257   0.283   0.387   0.663   0.707
  36       PC   0.735   0.758   0.776   0.791   0.804   0.815   0.825   0.834   0.842   0.849
  37       PC   0.856   0.863   0.869   0.875   0.881   0.887   0.893   0.898   0.903   0.908
  38       PC   0.913   0.918   0.922   0.926   0.930   0.934   0.938   0.942   0.946   0.950
  39       PC   0.953   0.956   0.959   0.962   0.965   0.968   0.971   0.974   0.977   0.980
  40       PC   0.983   0.986   0.989   0.992   0.995   0.998   1.000
  41       JD   3.990    10.0
           *

  42       KK      W1   BASIN
  43       KM        Compute runoff from subbasin W1
  44       BA   4.054
  45       LG    0.25    0.35    3.95    0.40       7
  46       UI     320     352    1022    1585    2126    2444    3094    3528    2240    1909
  47       UI    1727    1521    1333    1181     959     814     756     676     530     444
  48       UI     396     348     308     245     245     171     156     157     158      74
  49       UI      61      62      61      62      61      62      61      62      61       0
  50       UI       0       0       0       0       0       0       0       0       0       0
  51       ZW                C=FLOW
           *
1                                   HEC-1 INPUT                                         PAGE  2

 LINE      ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  52       KK    RRW1 STORAGE
  53       KM   PROPOSED DETENTION BASIN
  54       KM    ROUTE RUNOFF FROM SUBBASIN W1 THROUGH PROPOSED DETENTION BASIN
  55       KM    STRUCTURE ID:RRW1
  56       KM    OUTLET BASED ON ASSUMED 2 pipe(s), dia: 5 ft
  57       RS       1    STOR      -1
  58       SV     0.0    16.0    68.5    95.7   123.5   151.9   180.8   210.5   240.7   271.6
  59       SE     0.0     2.0     4.0     5.0     6.0     7.0     8.0     9.0    10.0    11.0
  60       SQ     0.0    56.6   167.7   210.8   255.6   312.7   361.3   403.3   440.2   476.9
  61       ZW                C=FLOW
           *

  62       KK   W1W2A   ROUTE
  63       KM   PROPOSED CHANNEL
  64       KM    ROUTE OUTFLOW FROM RRW1 TO CW2A
  65       KM    Slope=(1330.0 - 1301.0) / 1524.0
  66       RS       1    FLOW      -1
  67       RC   0.045   0.045   0.045  1524.0   0.019   104.5
  68       RX     0.0     0.0     0.0     0.0    40.0    40.0    40.0    40.0
  69       RY   104.5   100.0   100.0   100.0   100.0   100.0   100.0   104.5
  70       ZW                C=FLOW
           *

  71       KK     W2A   BASIN
  72       KM        Compute runoff from subbasin W2A
  73       BA   0.283
  74       LG    0.25    0.35    3.95    0.40       7
  75       UI      73     274     479     425     280     202     137     102      65      49
  76       UI      33      26      12      11      10      10       0       0       0       0
           *

  77       KK    CW2A COMBINE
  78       KM        Combine runoff from W2A w/ routed outflows from Skyline Fan detention ba
  79       HC       2
  80       ZW                C=FLOW
           *

  81       KK  W2AW2B   ROUTE
  82       KM   PROPOSED CHANNEL
  83       KM    ROUTE COMBINED FLOWS FROM CW2A TO CW2B
  84       KM    & SECOND DETENTION BASIN AT INSET FAN APEX
  85       KM    Slope=(1301.0 - 1236.0) / 3971.0
  86       RS       3    FLOW      -1
  87       RC   0.045   0.045   0.045  3971.0   0.016   104.5
  88       RX     0.0     0.0     0.0     0.0   180.0   180.0   180.0   180.0
  89       RY   104.5   100.0   100.0   100.0   100.0   100.0   100.0   104.5
  90       ZW                C=FLOW
           *
1                                   HEC-1 INPUT                                         PAGE  3

 LINE      ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  91       KK     W2B   BASIN
  92       KM        Compute runoff from subbasin W2B
  93       BA   0.858
  94       LG    0.32    0.35    3.78    0.45       3
  95       UI     291    1105    1793    1107     806     515     359     226     156      98
  96       UI      69      36      35      36       0       0       0       0       0       0
           *

  97       KK    CW2B COMBINE
  98       KM        Combine runoff from W2B routed flows from CW2A
  99       HC       2
 100       ZW                C=FLOW
           *

 101       KK   RRW2B STORAGE
 102       KM   PROPOSED DETENTION BASIN
 103       KM    ROUTE COMBINED FLOW THROUGH PROPOSED DETENTION BASIN AT INSET FAN ON EAST SI
 104       KM    STRUCTURE ID:RRW2B
 105       KM    OUTLET BASED ON ASSUMED 2 pipe(s), dia: 5 ft
 106       RS       1    STOR      -1
 107       SV     0.0     0.0     4.8    12.3    28.2    45.6    54.8    64.4    74.4    84.7
 108       SE     0.0     1.0     2.0     3.0     5.0     7.0     8.0     9.0    10.0    11.0
 109       SQ     0.0    28.3    56.6   111.3   210.8   312.7   361.3   403.3   440.2   476.9
 110       ZW                C=FLOW
           *

 111       KK  W2BW2C   ROUTE
 112       KM   PROPOSED CHANNEL
 113       KM    ROUTE OUTFLOW FROM RRW2B TO CONFLUENCE WITH OUTFLOW FROM RRX1A
 114       KM    Slope=(1222.0 - 1184.0) / 2321.0
 115       RS       1    FLOW      -1
 116       RC   0.045   0.045   0.045  2321.0   0.016   104.5
 117       RX     0.0     0.0     0.0     0.0    50.0    50.0    50.0    50.0
 118       RY   104.5   100.0   100.0   100.0   100.0   100.0   100.0   104.5
 119       ZW                C=FLOW
           *

 120       KK     W2C   BASIN
 121       KM        Compute runoff from subbasin W2C
 122       BA   0.124
 123       LG    0.35    0.35    3.81    0.44       0
 124       UI     162     437     232      85      29      11       0       0       0       0
           *

 125       KK   CW2CR COMBINE
 126       KM        Combine runoff from W2C with routed outflows from 2nd detention basin.
 127       HC       2
           *
```

```
1                                   HEC-1 INPUT                                          PAGE  4

          LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

           128          KK     X1A   BASIN
           129          KM        Compute runoff from subbasin X1A
           130          BA   0.696
           131          LG    0.25    0.35    3.95    0.40       7
           132          UI      77     178     386     545     733     756     483     413     347     286
           133          UI     223     183     157     119      95      84      60      56      38      38
           134          UI      30      15      15      15      15      15      15       0       0       0
           135          ZW                C=FLOW
                        *

           136          KK   RRX1A STORAGE
           137          KM   PROPOSED DETENTION BASIN
           138          KM    ROUTE RUNOFF FROM X1A THROUGH PROPOSED DETENTION BASIN
           139          KM    STRUCTURE ID:RRX1A
           140          KM    OUTLET BASED ON ASSUMED 1 pipe(s), dia: 3 ft
           141          RS       1    STOR      -1
           142          SV     0.0     5.7    17.5    23.8    30.5    37.5    44.9    52.5    60.5    68.9
           143          SE     0.0     2.0     4.0     5.0     6.0     7.0     8.0     9.0    10.0    11.0
           144          SQ     0.0    18.6    41.0    51.5    61.4    68.9    76.3    83.1    89.1    90.7
           145          ZW                C=FLOW
                        *

           146          KK  X1AW2C   ROUTE
           147          KM   PROPOSED CHANNEL
           148          KM    ROUTE OUTFLOW FROM RRX1A TO CONFLUENCE WITH PROPOSED NEW CHANNEL FROM RRW2B
           149          KM    Slope=(1205.0 - 1184.0) / 1208.0
           150          RS       1    FLOW      -1
           151          RC   0.045   0.045   0.045  1208.0   0.017   104.5
           152          RX     0.0     0.0     0.0     0.0    80.0    80.0    80.0    80.0
           153          RY   104.5   100.0   100.0   100.0   100.0   100.0   100.0   104.5
           154          ZW                C=FLOW
                        *

           155          KK    CW2C COMBINE
           156          KM        Combine routed outflow from SkyET detention basin with
           157          KM        combined flows at CW2CR.
           158          HC       2
           159          ZW                C=FLOW
                        *

           160          KK  W2CW2D   ROUTE
           161          KM   PROPOSED CHANNEL
           162          KM    ROUTE COMBINED FLOW TO FRS NO. 3 VIA PROPOSED NEW CHANNEL
           163          KM    Slope=(1184.0 - 1160.0) / 1456.0
           164          RS       1    FLOW      -1
           165          RC   0.045   0.045   0.045  1456.0   0.016   104.5
           166          RX     0.0     0.0     0.0     0.0    70.0    70.0    70.0    70.0
           167          RY   104.5   100.0   100.0   100.0   100.0   100.0   100.0   104.5
           168          ZW                C=FLOW
                        *
1                                   HEC-1 INPUT                                          PAGE  5

          LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

           169          KK     W2D   BASIN
           170          KM        Compute runoff from subbasin W2D
           171          BA   0.120
           172          LG    0.35    0.35    4.15    0.44       0
           173          UI     279     464     139      35       0       0       0       0       0       0
                        *

           174          KK    CW2D COMBINE
           175          KM        Combine runoff from W2D with routed flows from CW2C.
           176          HC       2
                        *

           177          KK    S800   BASIN
           178          KM        Compute runoff from subbasin 800
           179          BA   0.431
           180          LG    0.27    0.35    4.60    0.34       9
           181          UI      49     118     252     353     489     442     297     255     213     170
           182          UI     134     113      92      69      57      48      38      29      24      25
           183          UI      12       9      10       9      10       9      10       0       0       0
                        *

           184          KK    S810   BASIN
           185          KM        Compute runoff from subbasin 810
           186          BA   1.607
           187          LG    0.30    0.35    4.65    0.32       4
           188          UI     140     200     493     790     997    1196    1589    1066     843     750
           189          UI     668     569     489     397     336     309     256     202     176     155
           190          UI     130     106     102      68      68      69      46      27      27      27
           191          UI      26      27      27      27      27       0       0       0       0       0
                        *

           192          KK    S820   BASIN
           193          KM        Compute runoff from subbasin S820.  Runoff to Fan 20 apex.
           194          BA   0.362
           195          LG    0.25    0.35    4.35    0.40      18
           196          UI      45     123     260     348     490     307     248     208     166     125
           197          UI     105      83      61      51      39      33      23      22      15       8
           198          UI       9       8       9       9       0       0       0       0       0       0
           199          ZZ
1
```

```
                                   SCHEMATIC DIAGRAM OF STREAM NETWORK
INPUT
 LINE      (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

 NO.       (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

  42          W1
               V
               V
  52        RRW1
               V
               V
  62       W1W2A
               .
               .
  71           .         W2A
               .           .
               .           .
  77       CW2A...........
               V
               V
  81      W2AW2B
               .
               .
  91           .         W2B
               .           .
               .           .
  97       CW2B...........
               V
               V
 101       RRW2B
               V
               V
 111      W2BW2C
               .
               .
 120           .         W2C
               .           .
               .           .
 125       CW2CR...........
               .
               .
 128           .         X1A
               .           V
               .           V
 136           .       RRX1A
               .           V
               .           V
 146           .      X1AW2C
               .           .
               .           .
 155       CW2C............
               V
               V
 160      W2CW2D
               .
               .
 169           .         W2D
               .           .
               .           .
 174       CW2D............
               .
               .
 177           .        S800
               .           .
               .           .
 184           .           .        S810
               .           .          .
               .           .          .
 192           .           .          .        S820

 (***) RUNOFF ALSO COMPUTED AT THIS LOCATION
1****************************************                                    ************************************
 *                                      *                                    *                                  *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *                                    *   U.S. ARMY CORPS OF ENGINEERS   *
 *              JUN   1998              *                                    *  HYDROLOGIC ENGINEERING CENTER   *
 *            VERSION 4.1               *                                    *        609 SECOND STREET         *
 *                                      *                                    *      DAVIS, CALIFORNIA 95616     *
 *  RUN DATE   20DEC06  TIME  22:00:43  *                                    *         (916) 756-1104           *
 *                                      *                                    *                                  *
 ****************************************                                    ************************************
```

```
HYDROLOGY FOR STEP 3 RECOMMENDED ALTERNATIVE FOR SUN VALLEY ADMP
    - SKYLINE WASH FAN SYSTEM

SUN VALLEY AREA DRAINAGE MASTER PLAN (SVADMP) - FCD 2004C049
JE FULLER / HYDROLOGY & GEOMORPHOLOGY, INC.
MODELER: TED LEHMAN
FILENAME: SKY24.DAT

100-YEAR 24-HOUR MODEL
EXISTING CONDITIONS - WITH RECOMMENDED ALTERNATIVE ELEMENTS
        MODELED AREA = 8.5 SQ. MILES

GREEN-AMPT LOSS METHOD
```

```
                    S-GRAPH UNIT HYDROGRAPHS
                      - MOUNTAIN
                      - DESERT/RANGELAND

                    NORMAL-DEPTH CHANNEL ROUTING

                    LAND USE DATA FROM EXAMINATION OF SLOPE FROM 10-FT DTM TO DISTINGUISH
                      - UNDEVELOPED DESERT RANGELAND (NDR) - SLOPES < 5 %
                      - HILLSLOPES, SONORAN DESERT (NHS) - SLOPES 5 - 10 %
                      - MOUNTAIN TERRAIN (NMT) - SLOPES > 10 %

                    SOILS DATA FROM FCDMC GIS DATABASE (RECEIVED FROM FCDMC JULY 2005)

 29 IO          OUTPUT CONTROL VARIABLES
                      IPRNT          3  PRINT CONTROL
                      IPLOT          0  PLOT CONTROL
                      QSCAL         0.  HYDROGRAPH PLOT SCALE

 28 IN          TIME DATA FOR INPUT TIME SERIES
                      JXMIN         15  TIME INTERVAL IN MINUTES
                     JXDATE     1JAN99  STARTING DATE
                     JXTIME       1200  STARTING TIME

    IT          HYDROGRAPH TIME DATA
                       NMIN          5  MINUTES IN COMPUTATION INTERVAL
                      IDATE     1JAN99  STARTING DATE
                      ITIME       1200  STARTING TIME
                         NQ       2000  NUMBER OF HYDROGRAPH ORDINATES
                     NDDATE     8JAN99  ENDING DATE
                     NDTIME       1035  ENDING TIME
                      ICENT         19  CENTURY MARK

                 COMPUTATION INTERVAL     .08 HOURS
                      TOTAL TIME BASE  166.58 HOURS

          ENGLISH UNITS
               DRAINAGE AREA           SQUARE MILES
               PRECIPITATION DEPTH     INCHES
               LENGTH, ELEVATION       FEET
               FLOW                    CUBIC FEET PER SECOND
               STORAGE VOLUME          ACRE-FEET
               SURFACE AREA            ACRES
               TEMPERATURE             DEGREES FAHRENHEIT

 30 JD           INDEX STORM NO. 1
                      STRM        4.20  PRECIPITATION DEPTH
                      TRDA         .10  TRANSPOSITION DRAINAGE AREA

 31 PI             PRECIPITATION PATTERN
                     .00    .00    .00    .00    .00    .00    .00    .00    .00    .00
                     .00    .00    .00    .00    .00    .00    .00    .00    .00    .00
                     .00    .00    .00    .00    .00    .00    .00    .00    .00    .00
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                     .00    .00    .00    .00    .00    .00    .00    .01    .00    .01
                     .01    .01    .01    .01    .01    .01    .01    .01    .03    .03
                     .03    .09    .09    .09    .01    .01    .01    .01    .01    .01
                     .01    .01    .01    .01    .01    .01    .00    .00    .00    .00
                     .00    .00    .00    .00    .00    .00    .00    .00    .00    .00
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                     .00    .00    .00    .00    .00    .00    .00    .00

 41 JD           INDEX STORM NO. 2
                      STRM        3.99  PRECIPITATION DEPTH
                      TRDA       10.00  TRANSPOSITION DRAINAGE AREA

  0 PI             PRECIPITATION PATTERN
                     .00    .00    .00    .00    .00    .00    .00    .00    .00    .00
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                     .01    .01    .01    .01    .01    .01    .01    .01    .03    .03
                     .03    .09    .09    .09    .01    .01    .01    .01    .01    .01
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*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

              **************
              *            *
 42 KK        *      W1    *       BASIN
              *            *
              **************
                                 Compute runoff from subbasin W1

                SUBBASIN RUNOFF DATA

 44 BA            SUBBASIN CHARACTERISTICS
                       TAREA        4.05  SUBBASIN AREA

 45 LG            GREEN AND AMPT LOSS RATE
                       STRTL         .25  STARTING LOSS
                         DTH         .35  MOISTURE DEFICIT
                        PSIF        3.95  WETTING FRONT SUCTION
                       XKSAT         .40  HYDRAULIC CONDUCTIVITY
                       RTIMP        7.00  PERCENT IMPERVIOUS AREA

 43 UI            INPUT UNITGRAPH,  39 ORDINATES,  VOLUME = 1.00
                   320.0     352.0    1022.0    1585.0    2126.0    2444.0    3094.0    3528.0    2240.0    1909.0
                  1727.0    1521.0    1333.0    1181.0     959.0     814.0     756.0     676.0     530.0     444.0
                   396.0     348.0     308.0     245.0     245.0     171.0     156.0     157.0     158.0      74.0
                    61.0      62.0      61.0      62.0      61.0      62.0      61.0      62.0      61.0

                                                              ***

       ***           ***           ***           ***           ***

                             HYDROGRAPH AT STATION        W1
                            TRANSPOSITION AREA        .1 SQ MI

    TOTAL RAINFALL =     4.20, TOTAL LOSS =     2.83, TOTAL EXCESS =     1.37

  PEAK FLOW      TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR        24-HR        72-HR     166.58-HR
+   (CFS)        (HR)
                            (CFS)
+   3392.       12.42                559.         149.          50.          21.
                          (INCHES)  1.281        1.366        1.367        1.367
                           (AC-FT)   277.         295.         296.         296.

                           CUMULATIVE AREA =     4.05 SQ MI

       ***           ***           ***           ***           ***

                             HYDROGRAPH AT STATION        W1
                            TRANSPOSITION AREA      10.0 SQ MI

    TOTAL RAINFALL =     3.99, TOTAL LOSS =     2.72, TOTAL EXCESS =     1.27

  PEAK FLOW      TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR        24-HR        72-HR     166.58-HR
+   (CFS)        (HR)
                            (CFS)
+   3148.       12.42                517.         138.          46.          20.
                          (INCHES)  1.186        1.267        1.268        1.268
                           (AC-FT)   257.         274.         274.         274.

                           CUMULATIVE AREA =     4.05 SQ MI

     -----DSS---ZOPEN:  Existing File Opened,  File: SKY24.DSS
                        Unit:  71;  DSS Version: 6-JG
  -----DSS---ZWRITE Unit  71; Vers.   60:  //W1/FLOW/01JAN1999/5MIN//
  -----DSS---ZWRITE Unit  71; Vers.   60:  //W1/FLOW/02JAN1999/5MIN//
  -----DSS---ZWRITE Unit  71; Vers.   60:  //W1/FLOW/03JAN1999/5MIN//
  -----DSS---ZWRITE Unit  71; Vers.   60:  //W1/FLOW/04JAN1999/5MIN//
  -----DSS---ZWRITE Unit  71; Vers.   60:  //W1/FLOW/05JAN1999/5MIN//
  -----DSS---ZWRITE Unit  71; Vers.   60:  //W1/FLOW/06JAN1999/5MIN//
  -----DSS---ZWRITE Unit  71; Vers.   60:  //W1/FLOW/07JAN1999/5MIN//
  -----DSS---ZWRITE Unit  71; Vers.   60:  //W1/FLOW/08JAN1999/5MIN//
       ***           ***           ***           ***           ***

                           INTERPOLATED HYDROGRAPH AT        W1

  PEAK FLOW      TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR        24-HR        72-HR     166.58-HR
+   (CFS)        (HR)
```

```
                          (CFS)
+    3196.     12.42                525.        140.        47.         20.
                        (INCHES)    1.205       1.287       1.288       1.288
                         (AC-FT)    261.        278.        278.        278.

                        CUMULATIVE AREA =    4.05 SQ MI


 *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


            **************
            *            *
   52 KK    *     RRW1   *      STORAGE
            *            *
            **************
                          PROPOSED DETENTION BASIN
                           ROUTE RUNOFF FROM SUBBASIN W1 THROUGH PROPOSED DETENTION BASIN
                           STRUCTURE ID:RRW1
                           OUTLET BASED ON ASSUMED 2 pipe(s), dia: 5 ft

              HYDROGRAPH ROUTING DATA

   57 RS          STORAGE ROUTING
                     NSTPS           1  NUMBER OF SUBREACHES
                      ITYP        STOR  TYPE OF INITIAL CONDITION
                    RSVRIC       -1.00  INITIAL CONDITION
                         X         .00 WORKING R AND D COEFFICIENT

   58 SV           STORAGE          .0      16.0      68.5      95.7     123.5     151.9     180.8     210.5     240.7     271.6

   59 SE          ELEVATION        .00      2.00      4.00      5.00      6.00      7.00      8.00      9.00     10.00     11.00

   60 SQ          DISCHARGE         0.       57.      168.      211.      256.      313.      361.      403.      440.      477.

                                                                 ***

      ***            ***            ***            ***            ***

                        HYDROGRAPH AT STATION     RRW1
                      TRANSPOSITION AREA       .1 SQ MI

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+     406.     13.75                334.        145.         50.         21.
                        (INCHES)    .766       1.331       1.367       1.367
                         (AC-FT)    166.        288.        296.        296.

 PEAK STORAGE   TIME                          MAXIMUM AVERAGE STORAGE
                                     6-HR       24-HR       72-HR    166.58-HR
+  (AC-FT)      (HR)
     213.     13.75                167.         66.         22.         10.

  PEAK STAGE    TIME                          MAXIMUM AVERAGE STAGE
                                     6-HR       24-HR       72-HR    166.58-HR
+   (FEET)      (HR)
      9.08     13.75                7.52        3.55        1.23         .53

                        CUMULATIVE AREA =    4.05 SQ MI


      ***            ***            ***            ***            ***

                        HYDROGRAPH AT STATION     RRW1
                      TRANSPOSITION AREA     10.0 SQ MI

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+     383.     13.75                312.        135.         46.         20.
                        (INCHES)    .716       1.236       1.268       1.268
                         (AC-FT)    155.        267.        274.        274.

 PEAK STORAGE   TIME                          MAXIMUM AVERAGE STORAGE
                                     6-HR       24-HR       72-HR    166.58-HR
+  (AC-FT)      (HR)
     196.     13.75                154.         60.         20.          9.

  PEAK STAGE    TIME                          MAXIMUM AVERAGE STAGE
                                     6-HR       24-HR       72-HR    166.58-HR
+   (FEET)      (HR)
      8.53     13.75                7.06        3.32        1.15         .50

                        CUMULATIVE AREA =    4.05 SQ MI

 -----DSS---ZWRITE Unit  71; Vers.   60:  //RRW1/FLOW/01JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   60:  //RRW1/FLOW/02JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   60:  //RRW1/FLOW/03JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   60:  //RRW1/FLOW/04JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   60:  //RRW1/FLOW/05JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   60:  //RRW1/FLOW/06JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   60:  //RRW1/FLOW/07JAN1999/5MIN//
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 -----DSS---ZWRITE Unit  71; Vers.   60:  //RRW1/FLOW/08JAN1999/5MIN//
      ***            ***            ***            ***            ***


                        INTERPOLATED HYDROGRAPH AT     RRW1

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+     388.     13.75                317.        137.         47.         20.
                        (INCHES)    .726       1.254       1.288       1.288
                         (AC-FT)    157.        271.        278.        278.

                        CUMULATIVE AREA =    4.05 SQ MI


 *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


            **************
            *            *
   62 KK    *     W1W2A  *        ROUTE
            *            *
            **************
                          PROPOSED CHANNEL
                           ROUTE OUTFLOW FROM RRW1 TO CW2A
                           Slope=(1330.0 - 1301.0) / 1524.0

              HYDROGRAPH ROUTING DATA

   66 RS          STORAGE ROUTING
                     NSTPS           1  NUMBER OF SUBREACHES
                      ITYP        FLOW  TYPE OF INITIAL CONDITION
                    RSVRIC       -1.00  INITIAL CONDITION
                         X         .00 WORKING R AND D COEFFICIENT

   67 RC          NORMAL DEPTH CHANNEL
                       ANL        .045  LEFT OVERBANK N-VALUE
                      ANCH        .045  MAIN CHANNEL N-VALUE
                       ANR        .045  RIGHT OVERBANK N-VALUE
                     RLNTH       1524.  REACH LENGTH
                       SEL       .0190  ENERGY SLOPE
                     ELMAX       104.5  MAX. ELEV. FOR STORAGE/OUTFLOW CALCULATION

                                   CROSS-SECTION DATA
                          --- LEFT OVERBANK --- + ------ MAIN CHANNEL ------- + --- RIGHT OVERBANK ---
   69 RY        ELEVATION    104.50    100.00    100.00    100.00    100.00    100.00    100.00    104.50
   68 RX        DISTANCE        .00       .00       .00       .00     40.00     40.00     40.00     40.00

                                                                 ***

                                   COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

            STORAGE        .00       .33       .66       .99      1.33      1.66      1.99      2.32      2.65      2.98
            OUTFLOW        .00     16.49     52.14    102.08    164.24    237.32    320.36    412.64    513.55    622.60
          ELEVATION     100.00    100.24    100.47    100.71    100.95    101.18    101.42    101.66    101.89    102.13

            STORAGE       3.31      3.65      3.98      4.31      4.64      4.97      5.30      5.63      5.97      6.30
            OUTFLOW     739.34    863.41    994.48   1132.23   1276.41   1426.76   1583.05   1745.07   1912.64   2085.56
          ELEVATION     102.37    102.61    102.84    103.08    103.32    103.55    103.79    104.03    104.26    104.50

 *** WARNING *** MODIFIED PULS ROUTING MAY BE NUMERICALLY UNSTABLE FOR OUTFLOWS BETWEEN      413. TO     2086.
                 THE ROUTED HYDROGRAPH SHOULD BE EXAMINED FOR OSCILLATIONS OR OUTFLOWS GREATER THAN PEAK INFLOWS.
                 THIS CAN BE CORRECTED BY DECREASING THE TIME INTERVAL OR INCREASING STORAGE (USE A LONGER REACH.)

      ***            ***            ***            ***            ***

                        HYDROGRAPH AT STATION    W1W2A
                      TRANSPOSITION AREA       .1 SQ MI

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+     406.     13.75                334.        145.         50.         21.
                        (INCHES)    .766       1.331       1.367       1.367
                         (AC-FT)    166.        288.        296.        296.

 PEAK STORAGE   TIME                          MAXIMUM AVERAGE STORAGE
                                     6-HR       24-HR       72-HR    166.58-HR
+  (AC-FT)      (HR)
       2.     13.75                  2.          1.          0.          0.

  PEAK STAGE    TIME                          MAXIMUM AVERAGE STAGE
                                     6-HR       24-HR       72-HR    166.58-HR
+   (FEET)      (HR)
     101.64    13.75               101.45      100.79      100.28      100.12

                        CUMULATIVE AREA =    4.05 SQ MI


      ***            ***            ***            ***            ***

                        HYDROGRAPH AT STATION    W1W2A
                      TRANSPOSITION AREA     10.0 SQ MI
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  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                      6-HR        24-HR        72-HR     166.58-HR
+   (CFS)       (HR)
                          (CFS)
+     383.     13.75                  312.         135.         46.          20.
                        (INCHES)      .716        1.235       1.268        1.268
                         (AC-FT)      155.         267.        274.         274.

 PEAK STORAGE   TIME                        MAXIMUM AVERAGE STORAGE
                                      6-HR        24-HR        72-HR     166.58-HR
+  (AC-FT)      (HR)
        2.     13.75                    2.           1.          0.           0.

  PEAK STAGE    TIME                          MAXIMUM AVERAGE STAGE
                                      6-HR        24-HR        72-HR     166.58-HR
+   (FEET)      (HR)
    101.58     13.75                 101.39       100.75      100.27       100.12

                         CUMULATIVE AREA =    4.05 SQ MI

 -----DSS---ZWRITE Unit  71; Vers.   60:  //W1W2A/FLOW/01JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   60:  //W1W2A/FLOW/02JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   60:  //W1W2A/FLOW/03JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   60:  //W1W2A/FLOW/04JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   60:  //W1W2A/FLOW/05JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   60:  //W1W2A/FLOW/06JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   60:  //W1W2A/FLOW/07JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   60:  //W1W2A/FLOW/08JAN1999/5MIN//
      ***            ***            ***            ***            ***

                         INTERPOLATED HYDROGRAPH AT    W1W2A

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                      6-HR        24-HR        72-HR     166.58-HR
+   (CFS)       (HR)
                          (CFS)
+     388.     13.75                  316.         137.         47.          20.
                        (INCHES)      .726        1.254       1.288        1.288
                         (AC-FT)      157.         271.        278.         278.

                         CUMULATIVE AREA =    4.05 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


           **************
           *            *
  71 KK    *     W2A    *      BASIN
           *            *
           **************
                                Compute runoff from subbasin W2A

              SUBBASIN RUNOFF DATA

  73 BA          SUBBASIN CHARACTERISTICS
                       TAREA         .28  SUBBASIN AREA

  74 LG          GREEN AND AMPT LOSS RATE
                       STRTL         .25  STARTING LOSS
                         DTH         .35  MOISTURE DEFICIT
                        PSIF        3.95  WETTING FRONT SUCTION
                       XKSAT         .40  HYDRAULIC CONDUCTIVITY
                       RTIMP        7.00  PERCENT IMPERVIOUS AREA

  72 UI          INPUT UNITGRAPH,  16 ORDINATES,  VOLUME = 1.00
                      73.0     274.0     479.0     425.0     280.0     202.0     137.0     102.0      65.0      49.0
                      33.0      26.0      12.0      11.0      10.0      10.0
                                                                          ***

      ***            ***            ***            ***            ***

                         HYDROGRAPH AT STATION      W2A
                       TRANSPOSITION AREA       .1 SQ MI

    TOTAL RAINFALL =    4.20, TOTAL LOSS =    2.83, TOTAL EXCESS =    1.37

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                      6-HR        24-HR        72-HR     166.58-HR
+   (CFS)       (HR)
                          (CFS)
+     426.     12.08                   39.          10.          3.           1.
                        (INCHES)     1.281       1.366       1.366        1.366
                         (AC-FT)      19.          21.         21.          21.

                         CUMULATIVE AREA =     .28 SQ MI

      ***            ***            ***            ***            ***

                         HYDROGRAPH AT STATION      W2A
                       TRANSPOSITION AREA     10.0 SQ MI

    TOTAL RAINFALL =    3.99, TOTAL LOSS =    2.72, TOTAL EXCESS =    1.27

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                      6-HR        24-HR        72-HR     166.58-HR
+   (CFS)       (HR)
                          (CFS)
+     396.     12.08                   36.          10.          3.           1.
                        (INCHES)     1.186       1.267       1.267        1.267
                         (AC-FT)      18.          19.         19.          19.

                         CUMULATIVE AREA =     .28 SQ MI

      ***            ***            ***            ***            ***

                         INTERPOLATED HYDROGRAPH AT      W2A

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                      6-HR        24-HR        72-HR     166.58-HR
+   (CFS)       (HR)
                          (CFS)
+     419.     12.08                   38.          10.          3.           1.
                        (INCHES)     1.259       1.343       1.344        1.344
                         (AC-FT)      19.          20.         20.          20.

                         CUMULATIVE AREA =     .28 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

           **************
           *            *
  77 KK    *     CW2A   *      COMBINE
           *            *
           **************
                                Combine runoff from W2A w/ routed outflows from Skyline Fan detention ba

  79 HC          HYDROGRAPH COMBINATION
                      ICOMP           2  NUMBER OF HYDROGRAPHS TO COMBINE
                                                                   ***

      ***            ***            ***            ***            ***

                         HYDROGRAPH AT STATION     CW2A
                       TRANSPOSITION AREA       .1 SQ MI

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                      6-HR        24-HR        72-HR     166.58-HR
+   (CFS)       (HR)
                          (CFS)
+     497.     12.17                  355.         155.         53.          23.
                        (INCHES)      .761        1.331       1.367        1.367
                         (AC-FT)      176.         308.        316.         316.

                         CUMULATIVE AREA =    4.34 SQ MI

      ***            ***            ***            ***            ***

                         HYDROGRAPH AT STATION     CW2A
                       TRANSPOSITION AREA     10.0 SQ MI

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                      6-HR        24-HR        72-HR     166.58-HR
+   (CFS)       (HR)
                          (CFS)
+     463.     12.17                  331.         144.         49.          21.
                        (INCHES)      .711        1.235       1.268        1.268
                         (AC-FT)     164.         286.        293.         293.

                         CUMULATIVE AREA =    4.34 SQ MI

 -----DSS---ZWRITE Unit  71; Vers.   60:  //CW2A/FLOW/01JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   60:  //CW2A/FLOW/02JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   60:  //CW2A/FLOW/03JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   60:  //CW2A/FLOW/04JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   60:  //CW2A/FLOW/05JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   60:  //CW2A/FLOW/06JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   60:  //CW2A/FLOW/07JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   60:  //CW2A/FLOW/08JAN1999/5MIN//
      ***            ***            ***            ***            ***

                         INTERPOLATED HYDROGRAPH AT     CW2A

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                      6-HR        24-HR        72-HR     166.58-HR
+   (CFS)       (HR)
                          (CFS)
+     469.     12.17                  336.         146.         50.          22.
                        (INCHES)      .720        1.253       1.286        1.286
                         (AC-FT)     166.         290.        298.         298.

                         CUMULATIVE AREA =    4.34 SQ MI
```

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*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

          **************
          *            *
  81 KK   *   W2AW2B   *        ROUTE
          *            *
          **************
                        PROPOSED CHANNEL
                         ROUTE COMBINED FLOWS FROM CW2A TO CW2B
                         & SECOND DETENTION BASIN AT INSET FAN APEX
                         Slope=(1301.0 - 1236.0) / 3971.0

             HYDROGRAPH ROUTING DATA

  86 RS          STORAGE ROUTING
                      NSTPS           3  NUMBER OF SUBREACHES
                       ITYP        FLOW  TYPE OF INITIAL CONDITION
                     RSVRIC       -1.00  INITIAL CONDITION
                          X         .00  WORKING R AND D COEFFICIENT

  87 RC          NORMAL DEPTH CHANNEL
                        ANL        .045  LEFT OVERBANK N-VALUE
                       ANCH        .045  MAIN CHANNEL N-VALUE
                        ANR        .045  RIGHT OVERBANK N-VALUE
                      RLNTH       3971.  REACH LENGTH
                        SEL       .0160  ENERGY SLOPE
                      ELMAX       104.5  MAX. ELEV. FOR STORAGE/OUTFLOW CALCULATION

                                   CROSS-SECTION DATA
                        --- LEFT OVERBANK --- + ------ MAIN CHANNEL ------- + --- RIGHT OVERBANK ---
  89 RY        ELEVATION    104.50    100.00    100.00    100.00    100.00    100.00    100.00    104.50
  88 RX        DISTANCE        .00       .00       .00       .00    180.00    180.00    180.00    180.00

                                                   ***

                                   COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

          STORAGE        .00      3.89      7.77     11.66     15.55     19.43     23.32     27.20     31.09     34.98
          OUTFLOW        .00     68.29    216.61    425.39    686.50    994.90   1347.01   1740.09   2171.94   2640.74
        ELEVATION     100.00    100.24    100.47    100.71    100.95    101.18    101.42    101.66    101.89    102.13

          STORAGE      38.86     42.75     46.64     50.52     54.41     58.29     62.18     66.07     69.95     73.84
          OUTFLOW    3144.93   3683.18   4254.31   4857.26   5491.08   6154.92   6848.00   7569.59   8319.03   9095.70
        ELEVATION     102.37    102.61    102.84    103.08    103.32    103.55    103.79    104.03    104.26    104.50


*** WARNING *** MODIFIED PULS ROUTING MAY BE NUMERICALLY UNSTABLE FOR OUTFLOWS BETWEEN     1347. TO     9096.
                THE ROUTED HYDROGRAPH SHOULD BE EXAMINED FOR OSCILLATIONS OR OUTFLOWS GREATER THAN PEAK INFLOWS.
                THIS CAN BE CORRECTED BY DECREASING THE TIME INTERVAL OR INCREASING STORAGE (USE A LONGER REACH.)

      ***            ***            ***            ***            ***

                        HYDROGRAPH AT STATION   W2AW2B
                      TRANSPOSITION AREA       .1 SQ MI

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+     416.     12.42                352.        155.         53.         23.
                        (INCHES)    .754       1.331       1.367       1.367
                         (AC-FT)    174.        308.        316.        316.

 PEAK STORAGE   TIME                         MAXIMUM AVERAGE STORAGE
                                     6-HR       24-HR       72-HR    166.58-HR
+  (AC-FT)      (HR)
        4.     12.42                  3.          2.          1.          0.

  PEAK STAGE    TIME                          MAXIMUM AVERAGE STAGE
                                     6-HR       24-HR       72-HR    166.58-HR
+   (FEET)      (HR)
    100.70     12.42               100.63      100.33      100.12      100.05

                       CUMULATIVE AREA =    4.34 SQ MI

      ***            ***            ***            ***            ***

                        HYDROGRAPH AT STATION   W2AW2B
                      TRANSPOSITION AREA     10.0 SQ MI

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+     386.     12.42                328.        144.         49.         21.
                        (INCHES)    .703       1.235       1.268       1.268
                         (AC-FT)    163.        286.        293.        293.

 PEAK STORAGE   TIME                         MAXIMUM AVERAGE STORAGE
                                     6-HR       24-HR       72-HR    166.58-HR
+  (AC-FT)      (HR)
        4.     12.42                  3.          2.          1.          0.

  PEAK STAGE    TIME                          MAXIMUM AVERAGE STAGE
                                     6-HR       24-HR       72-HR    166.58-HR
+   (FEET)      (HR)
    100.67     12.42               100.60      100.32      100.11      100.05

                       CUMULATIVE AREA =    4.34 SQ MI

 -----DSS---ZWRITE Unit  71; Vers.   60:  //W2AW2B/FLOW/01JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   60:  //W2AW2B/FLOW/02JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   60:  //W2AW2B/FLOW/03JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   60:  //W2AW2B/FLOW/04JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   60:  //W2AW2B/FLOW/05JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   60:  //W2AW2B/FLOW/06JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   60:  //W2AW2B/FLOW/07JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   60:  //W2AW2B/FLOW/08JAN1999/5MIN//
       ***            ***            ***            ***            ***

                       INTERPOLATED HYDROGRAPH AT   W2AW2B

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+     391.     12.42                332.        146.         50.         22.
                        (INCHES)    .712       1.252       1.286       1.286
                         (AC-FT)    165.        290.        298.        298.

                       CUMULATIVE AREA =    4.34 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

          **************
          *            *
  91 KK   *     W2B    *        BASIN
          *            *
          **************
                                Compute runoff from subbasin W2B

             SUBBASIN RUNOFF DATA

  93 BA          SUBBASIN CHARACTERISTICS
                      TAREA         .86  SUBBASIN AREA

  94 LG          GREEN AND AMPT LOSS RATE
                      STRTL         .32  STARTING LOSS
                        DTH         .35  MOISTURE DEFICIT
                       PSIF        3.78  WETTING FRONT SUCTION
                      XKSAT         .45  HYDRAULIC CONDUCTIVITY
                      RTIMP        3.00  PERCENT IMPERVIOUS AREA

  92 UI          INPUT UNITGRAPH,  14 ORDINATES,  VOLUME = 1.00
                     291.0    1105.0    1793.0    1107.0     806.0     515.0     359.0     226.0     156.0      98.0
                      69.0      36.0      35.0      36.0

                                                   ***

      ***            ***            ***            ***            ***

                        HYDROGRAPH AT STATION      W2B
                      TRANSPOSITION AREA       .1 SQ MI

    TOTAL RAINFALL =    4.20, TOTAL LOSS =    3.00, TOTAL EXCESS =    1.19

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+    1352.     12.08                107.         27.          9.          4.
                        (INCHES)   1.155       1.192       1.192       1.192
                         (AC-FT)    53.         55.         55.         55.

                       CUMULATIVE AREA =     .86 SQ MI

      ***            ***            ***            ***            ***

                        HYDROGRAPH AT STATION      W2B
                      TRANSPOSITION AREA     10.0 SQ MI

    TOTAL RAINFALL =    3.99, TOTAL LOSS =    2.89, TOTAL EXCESS =    1.10

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+    1252.     12.08                 98.         25.          8.          4.
                        (INCHES)   1.061       1.096       1.096       1.096
                         (AC-FT)    49.         50.         50.         50.

                       CUMULATIVE AREA =     .86 SQ MI

      ***            ***            ***            ***            ***

                       INTERPOLATED HYDROGRAPH AT      W2B
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                                          MAXIMUM AVERAGE FLOW
  PEAK FLOW     TIME                  6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+    1305.     12.08                 103.        26.          9.          4.
                        (INCHES)    1.111       1.147       1.147       1.147
                         (AC-FT)      51.         52.         52.         52.

                        CUMULATIVE AREA =     .86 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

            **************
            *            *
  97 KK     *     CW2B   *      COMBINE
            *            *
            **************
                                Combine runoff from W2B routed flows from CW2A

  99 HC          HYDROGRAPH COMBINATION
                       ICOMP           2  NUMBER OF HYDROGRAPHS TO COMBINE

                                                                  ***

     ***            ***            ***            ***            ***

                        HYDROGRAPH AT STATION     CW2B
                      TRANSPOSITION AREA       .1 SQ MI

                                          MAXIMUM AVERAGE FLOW
  PEAK FLOW     TIME                  6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+    1450.     12.08                 441.       182.         62.         27.
                        (INCHES)     .789       1.305       1.338       1.338
                         (AC-FT)     219.        361.        371.        371.

                        CUMULATIVE AREA =    5.19 SQ MI

     ***            ***            ***            ***            ***

                        HYDROGRAPH AT STATION     CW2B
                      TRANSPOSITION AREA     10.0 SQ MI

                                          MAXIMUM AVERAGE FLOW
  PEAK FLOW     TIME                  6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+    1331.     12.08                 410.       169.         58.         25.
                        (INCHES)     .734       1.209       1.240       1.240
                         (AC-FT)     203.        335.        344.        344.

                        CUMULATIVE AREA =    5.19 SQ MI

 -----DSS---ZWRITE Unit  71; Vers.   60:  //CW2B/FLOW/01JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   60:  //CW2B/FLOW/02JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   60:  //CW2B/FLOW/03JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   60:  //CW2B/FLOW/04JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   60:  //CW2B/FLOW/05JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   60:  //CW2B/FLOW/06JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   60:  //CW2B/FLOW/07JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   60:  //CW2B/FLOW/08JAN1999/5MIN//
     ***            ***            ***            ***            ***


                        INTERPOLATED HYDROGRAPH AT     CW2B

                                          MAXIMUM AVERAGE FLOW
  PEAK FLOW     TIME                  6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+    1348.     12.08                 414.       171.         58.         25.
                        (INCHES)     .742       1.223       1.254       1.254
                         (AC-FT)     206.        339.        347.        347.

                        CUMULATIVE AREA =    5.19 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

            **************
            *            *
  101 KK    *     RRW2B  *      STORAGE
            *            *
            **************
                          PROPOSED DETENTION BASIN
                           ROUTE COMBINED FLOW THROUGH PROPOSED DETENTION BASIN AT INSET FAN ON EAST SI
                           STRUCTURE ID:RRW2B
                           OUTLET BASED ON ASSUMED 2 pipe(s), dia: 5 ft
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                    HYDROGRAPH ROUTING DATA

  106 RS          STORAGE ROUTING
                       NSTPS           1  NUMBER OF SUBREACHES
                        ITYP        STOR  TYPE OF INITIAL CONDITION
                       RSVRIC      -1.00  INITIAL CONDITION
                           X        .00  WORKING R AND D COEFFICIENT

  107 SV            STORAGE         .0        .0       4.8      12.3      28.2      45.6      54.8      64.4      74.4      84.7

  108 SE            ELEVATION      .00      1.00      2.00      3.00      5.00      7.00      8.00      9.00     10.00     11.00

  109 SQ            DISCHARGE       0.       28.       57.      111.      211.      313.      361.      403.      440.      477.

                                                                  ***

     ***            ***            ***            ***            ***

                        HYDROGRAPH AT STATION    RRW2B
                      TRANSPOSITION AREA       .1 SQ MI

                                          MAXIMUM AVERAGE FLOW
  PEAK FLOW     TIME                  6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+     379.     15.25                 360.       182.         62.         27.
                        (INCHES)     .644       1.305       1.338       1.338
                         (AC-FT)     178.        361.        371.        371.

                                          MAXIMUM AVERAGE STORAGE
  PEAK STORAGE  TIME                  6-HR       24-HR       72-HR    166.58-HR
+  (AC-FT)      (HR)
      59.      15.25                  55.         25.          8.          4.

                                          MAXIMUM AVERAGE STAGE
  PEAK STAGE    TIME                  6-HR       24-HR       72-HR    166.58-HR
+   (FEET)      (HR)
     8.41      15.25                 7.99       4.38        1.73         .96

                        CUMULATIVE AREA =    5.19 SQ MI

     ***            ***            ***            ***            ***

                        HYDROGRAPH AT STATION    RRW2B
                      TRANSPOSITION AREA     10.0 SQ MI

                                          MAXIMUM AVERAGE FLOW
  PEAK FLOW     TIME                  6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+     357.     15.17                 336.       169.         58.         25.
                        (INCHES)     .602       1.209       1.240       1.240
                         (AC-FT)     167.        335.        343.        343.

                                          MAXIMUM AVERAGE STORAGE
  PEAK STORAGE  TIME                  6-HR       24-HR       72-HR    166.58-HR
+  (AC-FT)      (HR)
      54.      15.17                  50.         23.          8.          3.

                                          MAXIMUM AVERAGE STAGE
  PEAK STAGE    TIME                  6-HR       24-HR       72-HR    166.58-HR
+   (FEET)      (HR)
     7.92      15.17                 7.49       4.10        1.69         .97

                        CUMULATIVE AREA =    5.19 SQ MI

 -----DSS---ZWRITE Unit  71; Vers.   59:  //RRW2B/FLOW/01JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   59:  //RRW2B/FLOW/02JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   59:  //RRW2B/FLOW/03JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   59:  //RRW2B/FLOW/04JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   59:  //RRW2B/FLOW/05JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   59:  //RRW2B/FLOW/06JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   59:  //RRW2B/FLOW/07JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   59:  //RRW2B/FLOW/08JAN1999/5MIN//
     ***            ***            ***            ***            ***


                        INTERPOLATED HYDROGRAPH AT     RRW2B

                                          MAXIMUM AVERAGE FLOW
  PEAK FLOW     TIME                  6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+     360.     15.17                 340.       171.         58.         25.
                        (INCHES)     .608       1.223       1.254       1.254
                         (AC-FT)     169.        339.        347.        347.

                        CUMULATIVE AREA =    5.19 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***
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              **************
              *            *
 111 KK       *    W2BW2C  *        ROUTE
              *            *
              **************
                             PROPOSED CHANNEL
                              ROUTE OUTFLOW FROM RRW2B TO CONFLUENCE WITH OUTFLOW FROM RRX1A
                              Slope=(1222.0 - 1184.0) / 2321.0

                HYDROGRAPH ROUTING DATA

 115 RS           STORAGE ROUTING
                       NSTPS           1  NUMBER OF SUBREACHES
                        ITYP        FLOW  TYPE OF INITIAL CONDITION
                      RSVRIC       -1.00  INITIAL CONDITION
                           X         .00  WORKING R AND D COEFFICIENT

 116 RC           NORMAL DEPTH CHANNEL
                         ANL        .045  LEFT OVERBANK N-VALUE
                        ANCH        .045  MAIN CHANNEL N-VALUE
                         ANR        .045  RIGHT OVERBANK N-VALUE
                       RLNTH       2321.  REACH LENGTH
                         SEL       .0160  ENERGY SLOPE
                       ELMAX       104.5  MAX. ELEV. FOR STORAGE/OUTFLOW CALCULATION

                                   CROSS-SECTION DATA
                          --- LEFT OVERBANK --- + ------ MAIN CHANNEL ------- + --- RIGHT OVERBANK ---
 118 RY        ELEVATION    104.50    100.00    100.00    100.00    100.00    100.00    100.00    104.50
 117 RX        DISTANCE        .00       .00       .00       .00     50.00     50.00     50.00     50.00

                                                  ***

                                   COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

          STORAGE        .00       .63      1.26      1.89      2.52      3.15      3.79      4.42      5.05      5.68
          OUTFLOW        .00     18.93     59.90    117.37    188.98    273.27    369.17    475.86    592.66    719.02
        ELEVATION     100.00    100.24    100.47    100.71    100.95    101.18    101.42    101.66    101.89    102.13

          STORAGE       6.31      6.94      7.57      8.20      8.83      9.46     10.10     10.73     11.36     11.99
          OUTFLOW     854.46    998.56   1150.95   1311.29   1479.28   1654.65   1837.14   2026.52   2222.58   2425.11
        ELEVATION     102.37    102.61    102.84    103.08    103.32    103.55    103.79    104.03    104.26    104.50


*** WARNING *** MODIFIED PULS ROUTING MAY BE NUMERICALLY UNSTABLE FOR OUTFLOWS BETWEEN     1837. TO     2425.
                THE ROUTED HYDROGRAPH SHOULD BE EXAMINED FOR OSCILLATIONS OR OUTFLOWS GREATER THAN PEAK INFLOWS.
                THIS CAN BE CORRECTED BY DECREASING THE TIME INTERVAL OR INCREASING STORAGE (USE A LONGER REACH.)

     ***            ***            ***            ***            ***

                      HYDROGRAPH AT STATION   W2BW2C
                    TRANSPOSITION AREA       .1 SQ MI

     ***            ***            ***            ***            ***

                      HYDROGRAPH AT STATION   W2BW2C
                    TRANSPOSITION AREA     10.0 SQ MI

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+     357.     15.25                 336.        169.         58.         25.
                        (INCHES)     .602       1.209       1.240       1.240
                         (AC-FT)     167.        335.        343.        343.

 PEAK STORAGE   TIME                          MAXIMUM AVERAGE STORAGE
                                     6-HR       24-HR       72-HR    166.58-HR
+  (AC-FT)      (HR)
       4.      15.17                   4.          2.          1.          0.

  PEAK STAGE    TIME                          MAXIMUM AVERAGE STAGE
                                     6-HR       24-HR       72-HR    166.58-HR
+   (FEET)      (HR)
    101.39     15.25                101.34      100.81      100.29      100.13

                      CUMULATIVE AREA =     5.19 SQ MI

 -----DSS---ZWRITE Unit  71; Vers.   59:  //W2BW2C/FLOW/01JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   59:  //W2BW2C/FLOW/02JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   59:  //W2BW2C/FLOW/03JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   59:  //W2BW2C/FLOW/04JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   59:  //W2BW2C/FLOW/05JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   59:  //W2BW2C/FLOW/06JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   59:  //W2BW2C/FLOW/07JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   59:  //W2BW2C/FLOW/08JAN1999/5MIN//
      ***            ***            ***            ***            ***

                      INTERPOLATED HYDROGRAPH AT   W2BW2C

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+     360.     15.25                 340.        171.         58.         25.
                        (INCHES)     .608       1.222       1.254       1.254
                         (AC-FT)     168.        339.        347.        347.

                      CUMULATIVE AREA =     5.19 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

              **************
              *            *
 120 KK       *       W2C  *        BASIN
              *            *
              **************
                                 Compute runoff from subbasin W2C

                SUBBASIN RUNOFF DATA

 122 BA           SUBBASIN CHARACTERISTICS
                       TAREA         .12  SUBBASIN AREA

 123 LG           GREEN AND AMPT LOSS RATE
                       STRTL         .35  STARTING LOSS
                         DTH         .35  MOISTURE DEFICIT
                        PSIF        3.81  WETTING FRONT SUCTION
                       XKSAT         .44  HYDRAULIC CONDUCTIVITY
                       RTIMP         .00  PERCENT IMPERVIOUS AREA

 121 UI           INPUT UNITGRAPH,   6 ORDINATES,  VOLUME = 1.00
                      162.0     437.0     232.0      85.0      29.0      11.0
                                                                          ***

     ***            ***            ***            ***            ***

                      HYDROGRAPH AT STATION      W2C
                    TRANSPOSITION AREA       .1 SQ MI

     TOTAL RAINFALL =    4.20, TOTAL LOSS =    3.10, TOTAL EXCESS =    1.10

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+     264.     12.00                  15.          4.          1.          1.
                        (INCHES)    1.098       1.098       1.098       1.098
                         (AC-FT)      7.          7.          7.          7.

                      CUMULATIVE AREA =      .12 SQ MI

     ***            ***            ***            ***            ***

                      HYDROGRAPH AT STATION      W2C
                    TRANSPOSITION AREA     10.0 SQ MI

     TOTAL RAINFALL =    3.99, TOTAL LOSS =    2.98, TOTAL EXCESS =    1.01

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+     246.     12.00                  13.          3.          1.          0.
                        (INCHES)    1.005       1.005       1.005       1.005
                         (AC-FT)      7.          7.          7.          7.

                      CUMULATIVE AREA =      .12 SQ MI

     ***            ***            ***            ***            ***


                      INTERPOLATED HYDROGRAPH AT      W2C

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+     264.     12.00                  15.          4.          1.          1.
                        (INCHES)    1.093       1.093       1.093       1.093
                         (AC-FT)      7.          7.          7.          7.
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                    CUMULATIVE AREA =     .12 SQ MI


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          **************
          *            *
125 KK    *    CW2CR   *     COMBINE
          *            *
          **************
                         Combine runoff from W2C with routed outflows from 2nd detention basin.

127 HC          HYDROGRAPH COMBINATION
                     ICOMP           2  NUMBER OF HYDROGRAPHS TO COMBINE
                                                                  ***

     ***             ***             ***             ***             ***

                       HYDROGRAPH AT STATION    CW2CR
                      TRANSPOSITION AREA       .1 SQ MI

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+     379.     15.33                360.        186.         64.          27.
                       (INCHES)     .629       1.299       1.332        1.332
                        (AC-FT)     178.        369.        378.         378.

                       CUMULATIVE AREA =    5.32 SQ MI

     ***             ***             ***             ***             ***

                       HYDROGRAPH AT STATION    CW2CR
                      TRANSPOSITION AREA     10.0 SQ MI

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+     357.     15.25                336.        172.         59.          25.
                       (INCHES)     .588       1.204       1.234        1.234
                        (AC-FT)     167.        342.        350.         350.

                       CUMULATIVE AREA =    5.32 SQ MI

     ***             ***             ***             ***             ***


                       INTERPOLATED HYDROGRAPH AT    CW2CR

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+     360.     15.25                340.        174.         60.          26.
                       (INCHES)     .594       1.218       1.248        1.248
                        (AC-FT)     168.        345.        354.         354.

                       CUMULATIVE AREA =    5.32 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

          **************
          *            *
128 KK    *     X1A    *       BASIN
          *            *
          **************
                         Compute runoff from subbasin X1A

            SUBBASIN RUNOFF DATA

130 BA          SUBBASIN CHARACTERISTICS
                      TAREA          .70  SUBBASIN AREA

131 LG          GREEN AND AMPT LOSS RATE
                      STRTL          .25  STARTING LOSS
                        DTH          .35  MOISTURE DEFICIT
                       PSIF         3.95  WETTING FRONT SUCTION
                      XKSAT          .40  HYDRAULIC CONDUCTIVITY
                      RTIMP         7.00  PERCENT IMPERVIOUS AREA

129 UI          INPUT UNITGRAPH,  27 ORDINATES,  VOLUME = 1.00
                     77.0     178.0     386.0     545.0     733.0     756.0     483.0     413.0     347.0     286.0
                    223.0     183.0     157.0     119.0      95.0      84.0      60.0      56.0      38.0      38.0
                     30.0      15.0      15.0      15.0      15.0      15.0      15.0
                                                                  ***
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     ***             ***             ***             ***             ***

                       HYDROGRAPH AT STATION      X1A
                      TRANSPOSITION AREA       .1 SQ MI

    TOTAL RAINFALL =    4.20, TOTAL LOSS =    2.83, TOTAL EXCESS =    1.37

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+     752.     12.25                 96.         26.          9.           4.
                       (INCHES)    1.279       1.364       1.365        1.365
                        (AC-FT)     47.         51.         51.          51.

                       CUMULATIVE AREA =     .70 SQ MI

     ***             ***             ***             ***             ***

                       HYDROGRAPH AT STATION      X1A
                      TRANSPOSITION AREA     10.0 SQ MI

    TOTAL RAINFALL =    3.99, TOTAL LOSS =    2.72, TOTAL EXCESS =    1.27

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+     698.     12.25                 89.         24.          8.           3.
                       (INCHES)    1.185       1.265       1.266        1.266
                        (AC-FT)     44.         47.         47.          47.

                       CUMULATIVE AREA =     .70 SQ MI

 -----DSS---ZWRITE Unit  71; Vers.   59:  //X1A/FLOW/01JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   59:  //X1A/FLOW/02JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   59:  //X1A/FLOW/03JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   59:  //X1A/FLOW/04JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   59:  //X1A/FLOW/05JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   59:  //X1A/FLOW/06JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   59:  //X1A/FLOW/07JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   59:  //X1A/FLOW/08JAN1999/5MIN//
     ***             ***             ***             ***             ***


                       INTERPOLATED HYDROGRAPH AT      X1A

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+     729.     12.25                 93.         25.          8.           4.
                       (INCHES)    1.240       1.323       1.323        1.323
                        (AC-FT)     46.         49.         49.          49.

                       CUMULATIVE AREA =     .70 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

          **************
          *            *
136 KK    *    RRX1A   *      STORAGE
          *            *
          **************
                         PROPOSED DETENTION BASIN
                          ROUTE RUNOFF FROM X1A THROUGH PROPOSED DETENTION BASIN
                          STRUCTURE ID:RRX1A
                          OUTLET BASED ON ASSUMED 1 pipe(s), dia: 3 ft

            HYDROGRAPH ROUTING DATA

141 RS          STORAGE ROUTING
                      NSTPS           1  NUMBER OF SUBREACHES
                       ITYP        STOR  TYPE OF INITIAL CONDITION
                      RSVRIC      -1.00  INITIAL CONDITION
                          X        .00  WORKING R AND D COEFFICIENT

142 SV            STORAGE          .0       5.7      17.5      23.8      30.5      37.5      44.9      52.5      60.5      68.9

143 SE          ELEVATION         .00      2.00      4.00      5.00      6.00      7.00      8.00      9.00     10.00     11.00

144 SQ          DISCHARGE          0.       19.       41.       52.       61.       69.       76.       83.       89.       91.

                                                                  ***

     ***             ***             ***             ***             ***

                       HYDROGRAPH AT STATION    RRX1A
                      TRANSPOSITION AREA       .1 SQ MI

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
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                                                 6-HR        24-HR        72-HR    166.58-HR
 +   (CFS)        (HR)
                                 (CFS)
 +        70.     13.33                           59.          25.           9.           4.
                              (INCHES)           .782        1.331        1.365        1.365
                               (AC-FT)            29.          49.          51.          51.

  PEAK STORAGE    TIME                                  MAXIMUM AVERAGE STORAGE
                                                 6-HR        24-HR        72-HR    166.58-HR
 +  (AC-FT)       (HR)
          38.     13.33                           29.          11.           4.           2.

   PEAK STAGE     TIME                                  MAXIMUM AVERAGE STAGE
                                                 6-HR        24-HR        72-HR    166.58-HR
 +   (FEET)       (HR)
         7.13     13.33                          5.79         2.51          .86          .37

                                   CUMULATIVE AREA =       .70 SQ MI


       ***            ***            ***            ***            ***

                                     HYDROGRAPH AT STATION     RRX1A
                                   TRANSPOSITION AREA     10.0 SQ MI

   PEAK FLOW      TIME                                  MAXIMUM AVERAGE FLOW
                                                 6-HR        24-HR        72-HR    166.58-HR
 +   (CFS)        (HR)
                                 (CFS)
 +        67.     13.33                           55.          23.           8.           3.
                              (INCHES)           .737        1.235        1.266        1.266
                               (AC-FT)            27.          46.          47.          47.

  PEAK STORAGE    TIME                                  MAXIMUM AVERAGE STORAGE
                                                 6-HR        24-HR        72-HR    166.58-HR
 +  (AC-FT)       (HR)
          35.     13.33                           27.          10.           3.           1.

   PEAK STAGE     TIME                                  MAXIMUM AVERAGE STAGE
                                                 6-HR        24-HR        72-HR    166.58-HR
 +   (FEET)       (HR)
         6.70     13.33                          5.42         2.32          .79          .34

                                   CUMULATIVE AREA =       .70 SQ MI

  -----DSS---ZWRITE Unit  71; Vers.   59:  //RRX1A/FLOW/01JAN1999/5MIN//
  -----DSS---ZWRITE Unit  71; Vers.   59:  //RRX1A/FLOW/02JAN1999/5MIN//
  -----DSS---ZWRITE Unit  71; Vers.   59:  //RRX1A/FLOW/03JAN1999/5MIN//
  -----DSS---ZWRITE Unit  71; Vers.   59:  //RRX1A/FLOW/04JAN1999/5MIN//
  -----DSS---ZWRITE Unit  71; Vers.   59:  //RRX1A/FLOW/05JAN1999/5MIN//
  -----DSS---ZWRITE Unit  71; Vers.   59:  //RRX1A/FLOW/06JAN1999/5MIN//
  -----DSS---ZWRITE Unit  71; Vers.   59:  //RRX1A/FLOW/07JAN1999/5MIN//
  -----DSS---ZWRITE Unit  71; Vers.   59:  //RRX1A/FLOW/08JAN1999/5MIN//
       ***            ***            ***            ***            ***


                                   INTERPOLATED HYDROGRAPH AT     RRX1A

   PEAK FLOW      TIME                                  MAXIMUM AVERAGE FLOW
                                                 6-HR        24-HR        72-HR    166.58-HR
 +   (CFS)        (HR)
                                 (CFS)
 +        69.     13.33                           57.          24.           8.           4.
                              (INCHES)           .763        1.291        1.323        1.323
                               (AC-FT)            28.          48.          49.          49.

                                   CUMULATIVE AREA =       .70 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


              **************
              *            *
  146 KK      *   X1AW2C   *        ROUTE
              *            *
              **************
                               PROPOSED CHANNEL
                                ROUTE OUTFLOW FROM RRX1A TO CONFLUENCE WITH PROPOSED NEW CHANNEL FROM RRW2B
                                Slope=(1205.0 - 1184.0) / 1208.0

                        HYDROGRAPH ROUTING DATA

  150 RS          STORAGE ROUTING
                      NSTPS            1  NUMBER OF SUBREACHES
                       ITYP         FLOW  TYPE OF INITIAL CONDITION
                     RSVRIC        -1.00  INITIAL CONDITION
                          X          .00 WORKING R AND D COEFFICIENT

  151 RC          NORMAL DEPTH CHANNEL
                        ANL         .045  LEFT OVERBANK N-VALUE
                       ANCH         .045  MAIN CHANNEL N-VALUE
                        ANR         .045  RIGHT OVERBANK N-VALUE
                      RLNTH        1208.  REACH LENGTH
                        SEL        .0170  ENERGY SLOPE
                      ELMAX        104.5  MAX. ELEV. FOR STORAGE/OUTFLOW CALCULATION
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                                                       CROSS-SECTION DATA
                                      --- LEFT OVERBANK --- + ------ MAIN CHANNEL ------- + --- RIGHT OVERBANK ---
  153 RY          ELEVATION    104.50     100.00     100.00     100.00     100.00     100.00     100.00     104.50
  152 RX           DISTANCE       .00        .00        .00        .00      80.00      80.00      80.00      80.00

                                                                ***

                                                    COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

                    STORAGE        .00        .53       1.05       1.58       2.10       2.63       3.15       3.68       4.20       4.73
                    OUTFLOW        .00      31.25      99.02     194.25     313.14     453.32     613.10     791.17     986.47    1198.12
                  ELEVATION     100.00     100.24     100.47     100.71     100.95     101.18     101.42     101.66     101.89     102.13

                    STORAGE       5.25       5.78       6.31       6.83       7.36       7.88       8.41       8.93       9.46       9.98
                    OUTFLOW    1425.38    1667.58    1924.15    2194.57    2478.37    2775.13    3084.45    3405.98    3739.39    4084.35
                  ELEVATION     102.37     102.61     102.84     103.08     103.32     103.55     103.79     104.03     104.26     104.50

*** WARNING *** MODIFIED PULS ROUTING MAY BE NUMERICALLY UNSTABLE FOR OUTFLOWS BETWEEN       453. TO      4084.
                THE ROUTED HYDROGRAPH SHOULD BE EXAMINED FOR OSCILLATIONS OR OUTFLOWS GREATER THAN PEAK INFLOWS.
                THIS CAN BE CORRECTED BY DECREASING THE TIME INTERVAL OR INCREASING STORAGE (USE A LONGER REACH.)

       ***            ***            ***            ***            ***

                                     HYDROGRAPH AT STATION    X1AW2C
                                   TRANSPOSITION AREA       .1 SQ MI

   PEAK FLOW      TIME                                  MAXIMUM AVERAGE FLOW
                                                 6-HR        24-HR        72-HR    166.58-HR
 +   (CFS)        (HR)
                                 (CFS)
 +        70.     13.42                           58.          25.           9.           4.
                              (INCHES)           .780        1.331        1.365        1.365
                               (AC-FT)            29.          49.          51.          51.

  PEAK STORAGE    TIME                                  MAXIMUM AVERAGE STORAGE
                                                 6-HR        24-HR        72-HR    166.58-HR
 +  (AC-FT)       (HR)
           1.     13.33                            1.           0.           0.           0.

   PEAK STAGE     TIME                                  MAXIMUM AVERAGE STAGE
                                                 6-HR        24-HR        72-HR    166.58-HR
 +   (FEET)       (HR)
       100.37     13.42                        100.33       100.16       100.05       100.02

                                   CUMULATIVE AREA =       .70 SQ MI


       ***            ***            ***            ***            ***

                                     HYDROGRAPH AT STATION    X1AW2C
                                   TRANSPOSITION AREA     10.0 SQ MI

   PEAK FLOW      TIME                                  MAXIMUM AVERAGE FLOW
                                                 6-HR        24-HR        72-HR    166.58-HR
 +   (CFS)        (HR)
                                 (CFS)
 +        67.     13.42                           55.          23.           8.           3.
                              (INCHES)           .735        1.235        1.266        1.266
                               (AC-FT)            27.          46.          47.          47.

  PEAK STORAGE    TIME                                  MAXIMUM AVERAGE STORAGE
                                                 6-HR        24-HR        72-HR    166.58-HR
 +  (AC-FT)       (HR)
           1.     13.33                            1.           0.           0.           0.

   PEAK STAGE     TIME                                  MAXIMUM AVERAGE STAGE
                                                 6-HR        24-HR        72-HR    166.58-HR
 +   (FEET)       (HR)
       100.36     13.42                        100.32       100.15       100.05       100.02

                                   CUMULATIVE AREA =       .70 SQ MI

  -----DSS---ZWRITE Unit  71; Vers.   59:  //X1AW2C/FLOW/01JAN1999/5MIN//
  -----DSS---ZWRITE Unit  71; Vers.   59:  //X1AW2C/FLOW/02JAN1999/5MIN//
  -----DSS---ZWRITE Unit  71; Vers.   59:  //X1AW2C/FLOW/03JAN1999/5MIN//
  -----DSS---ZWRITE Unit  71; Vers.   59:  //X1AW2C/FLOW/04JAN1999/5MIN//
  -----DSS---ZWRITE Unit  71; Vers.   59:  //X1AW2C/FLOW/05JAN1999/5MIN//
  -----DSS---ZWRITE Unit  71; Vers.   59:  //X1AW2C/FLOW/06JAN1999/5MIN//
  -----DSS---ZWRITE Unit  71; Vers.   59:  //X1AW2C/FLOW/07JAN1999/5MIN//
  -----DSS---ZWRITE Unit  71; Vers.   59:  //X1AW2C/FLOW/08JAN1999/5MIN//
       ***            ***            ***            ***            ***


                                   INTERPOLATED HYDROGRAPH AT    X1AW2C

   PEAK FLOW      TIME                                  MAXIMUM AVERAGE FLOW
                                                 6-HR        24-HR        72-HR    166.58-HR
 +   (CFS)        (HR)
                                 (CFS)
 +        68.     13.42                           57.          24.           8.           4.
                              (INCHES)           .761        1.291        1.323        1.323
                               (AC-FT)            28.          48.          49.          49.

                                   CUMULATIVE AREA =       .70 SQ MI
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*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

              **************
              *            *
 155 KK       *    CW2C    *      COMBINE
              *            *
              **************
                                 Combine routed outflow from SkyET detention basin with
                                 combined flows at CW2CR.

 158 HC          HYDROGRAPH COMBINATION
                       ICOMP           2  NUMBER OF HYDROGRAPHS TO COMBINE

                                                                  ***

      ***             ***             ***             ***             ***

                        HYDROGRAPH AT STATION     CW2C
                      TRANSPOSITION AREA       .1 SQ MI

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+     441.     14.92                418.        211.         72.          31.
                       (INCHES)      .646       1.303       1.336        1.336
                        (AC-FT)      207.        418.        429.         429.

                       CUMULATIVE AREA =    6.01 SQ MI


      ***             ***             ***             ***             ***

                        HYDROGRAPH AT STATION     CW2C
                      TRANSPOSITION AREA     10.0 SQ MI

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+     417.     14.92                391.        195.         67.          29.
                       (INCHES)      .605       1.208       1.238        1.238
                        (AC-FT)      194.        387.        397.         397.

                       CUMULATIVE AREA =    6.01 SQ MI

 -----DSS---ZWRITE Unit  71; Vers.   59:  //CW2C/FLOW/01JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   59:  //CW2C/FLOW/02JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   59:  //CW2C/FLOW/03JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   59:  //CW2C/FLOW/04JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   59:  //CW2C/FLOW/05JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   59:  //CW2C/FLOW/06JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   59:  //CW2C/FLOW/07JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   59:  //CW2C/FLOW/08JAN1999/5MIN//
      ***             ***             ***             ***             ***


                       INTERPOLATED HYDROGRAPH AT     CW2C

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+     420.     14.92                394.        197.         67.          29.
                       (INCHES)      .609       1.218       1.249        1.249
                        (AC-FT)      195.        391.        401.         401.

                       CUMULATIVE AREA =    6.01 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

              **************
              *            *
 160 KK       *   W2CW2D   *        ROUTE
              *            *
              **************
                                 PROPOSED CHANNEL
                                  ROUTE COMBINED FLOW TO FRS NO. 3 VIA PROPOSED NEW CHANNEL
                                  Slope=(1184.0 - 1160.0) / 1456.0

                     HYDROGRAPH ROUTING DATA

 164 RS          STORAGE ROUTING
                      NSTPS           1  NUMBER OF SUBREACHES
                       ITYP        FLOW  TYPE OF INITIAL CONDITION
                     RSVRIC       -1.00  INITIAL CONDITION
                          X         .00  WORKING R AND D COEFFICIENT

 165 RC          NORMAL DEPTH CHANNEL
                        ANL        .045  LEFT OVERBANK N-VALUE
                       ANCH        .045  MAIN CHANNEL N-VALUE
                        ANR        .045  RIGHT OVERBANK N-VALUE
                      RLNTH       1456.  REACH LENGTH
                        SEL       .0160  ENERGY SLOPE

                       ELMAX       104.5  MAX. ELEV. FOR STORAGE/OUTFLOW CALCULATION

                                   CROSS-SECTION DATA
                          --- LEFT OVERBANK --- + ------ MAIN CHANNEL ------- + --- RIGHT OVERBANK ---
 167 RY       ELEVATION    104.50    100.00    100.00    100.00    100.00    100.00    100.00    104.50
 166 RX       DISTANCE        .00       .00       .00       .00     70.00     70.00     70.00     70.00

                                                                  ***

                                   COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

              STORAGE        .00       .55      1.11      1.66      2.22      2.77      3.32      3.88      4.43      4.99
              OUTFLOW        .00     26.52     84.01    164.75    265.52    384.28    519.58    670.31    835.55   1014.55
            ELEVATION     100.00    100.24    100.47    100.71    100.95    101.18    101.42    101.66    101.89    102.13

              STORAGE       5.54      6.10      6.65      7.20      7.76      8.31      8.87      9.42      9.97     10.53
              OUTFLOW    1206.67   1411.33   1628.05   1856.37   2095.89   2346.25   2607.10   2878.13   3159.07   3449.63
            ELEVATION     102.37    102.61    102.84    103.08    103.32    103.55    103.79    104.03    104.26    104.50


 *** WARNING *** MODIFIED PULS ROUTING MAY BE NUMERICALLY UNSTABLE FOR OUTFLOWS BETWEEN      670. TO     3450.
                 THE ROUTED HYDROGRAPH SHOULD BE EXAMINED FOR OSCILLATIONS OR OUTFLOWS GREATER THAN PEAK INFLOWS.
                 THIS CAN BE CORRECTED BY DECREASING THE TIME INTERVAL OR INCREASING STORAGE (USE A LONGER REACH.)

      ***             ***             ***             ***             ***

                        HYDROGRAPH AT STATION   W2CW2D
                      TRANSPOSITION AREA       .1 SQ MI

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+     441.     15.00                418.        211.         72.          31.
                       (INCHES)      .646       1.303       1.336        1.336
                        (AC-FT)      207.        418.        429.         429.

 PEAK STORAGE   TIME                          MAXIMUM AVERAGE STORAGE
                                     6-HR       24-HR       72-HR    166.58-HR
+  (AC-FT)      (HR)
       3.      14.92                  3.          2.          1.           0.

  PEAK STAGE    TIME                          MAXIMUM AVERAGE STAGE
                                     6-HR       24-HR       72-HR    166.58-HR
+   (FEET)      (HR)
    101.28     15.00               101.24      100.76      100.27       100.12

                       CUMULATIVE AREA =    6.01 SQ MI


      ***             ***             ***             ***             ***

                        HYDROGRAPH AT STATION   W2CW2D
                      TRANSPOSITION AREA     10.0 SQ MI

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+     417.     14.92                391.        195.         67.          29.
                       (INCHES)      .605       1.207       1.238        1.238
                        (AC-FT)      194.        387.        397.         397.

 PEAK STORAGE   TIME                          MAXIMUM AVERAGE STORAGE
                                     6-HR       24-HR       72-HR    166.58-HR
+  (AC-FT)      (HR)
       3.      14.83                  3.          2.          1.           0.

  PEAK STAGE    TIME                          MAXIMUM AVERAGE STAGE
                                     6-HR       24-HR       72-HR    166.58-HR
+   (FEET)      (HR)
    101.24     14.92               101.19      100.72      100.26       100.11

                       CUMULATIVE AREA =    6.01 SQ MI

 -----DSS---ZWRITE Unit  71; Vers.   59:  //W2CW2D/FLOW/01JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   59:  //W2CW2D/FLOW/02JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   59:  //W2CW2D/FLOW/03JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   59:  //W2CW2D/FLOW/04JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   59:  //W2CW2D/FLOW/05JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   59:  //W2CW2D/FLOW/06JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   59:  //W2CW2D/FLOW/07JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.   59:  //W2CW2D/FLOW/08JAN1999/5MIN//
      ***             ***             ***             ***             ***


                       INTERPOLATED HYDROGRAPH AT   W2CW2D

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+     420.     14.92                394.        197.         67.          29.
                       (INCHES)      .609       1.218       1.249        1.249
                        (AC-FT)      195.        391.        401.         401.

                       CUMULATIVE AREA =    6.01 SQ MI
```

```
*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

            **************
            *            *
 169 KK     *     W2D    *        BASIN
            *            *
            **************
                                Compute runoff from subbasin W2D

               SUBBASIN RUNOFF DATA

 171 BA          SUBBASIN CHARACTERISTICS
                      TAREA         .12  SUBBASIN AREA

 172 LG          GREEN AND AMPT LOSS RATE
                      STRTL         .35  STARTING LOSS
                        DTH         .35  MOISTURE DEFICIT
                       PSIF        4.15  WETTING FRONT SUCTION
                      XKSAT         .44  HYDRAULIC CONDUCTIVITY
                      RTIMP         .00  PERCENT IMPERVIOUS AREA

 170 UI          INPUT UNITGRAPH,   4 ORDINATES,  VOLUME =  .99
                     279.0     464.0     139.0      35.0

                                                          ***

      ***             ***             ***             ***             ***

                        HYDROGRAPH AT STATION      W2D
                      TRANSPOSITION AREA       .1 SQ MI

    TOTAL RAINFALL =    4.20, TOTAL LOSS =    3.12, TOTAL EXCESS =    1.08

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                      6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+     273.     12.00                  14.          3.          1.           0.
                        (INCHES)     1.067       1.067       1.067        1.067
                         (AC-FT)       7.          7.          7.           7.

                        CUMULATIVE AREA =     .12 SQ MI

      ***             ***             ***             ***             ***

                        HYDROGRAPH AT STATION      W2D
                      TRANSPOSITION AREA     10.0 SQ MI

    TOTAL RAINFALL =    3.99, TOTAL LOSS =    3.00, TOTAL EXCESS =     .99

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                      6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+     254.     12.00                  13.          3.          1.           0.
                        (INCHES)      .974        .974        .974         .974
                         (AC-FT)       6.          6.          6.           6.

                        CUMULATIVE AREA =     .12 SQ MI

      ***             ***             ***             ***             ***


                        INTERPOLATED HYDROGRAPH AT      W2D

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                      6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+     272.     12.00                  14.          3.          1.           0.
                        (INCHES)     1.063       1.063       1.063        1.063
                         (AC-FT)       7.          7.          7.           7.

                        CUMULATIVE AREA =     .12 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

            **************
            *            *
 174 KK     *     CW2D   *      COMBINE
            *            *
            **************
                                Combine runoff from W2D with routed flows from CW2C.

 176 HC          HYDROGRAPH COMBINATION
                      ICOMP           2  NUMBER OF HYDROGRAPHS TO COMBINE

                                                          ***

      ***             ***             ***             ***             ***
```

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                        HYDROGRAPH AT STATION     CW2D
                      TRANSPOSITION AREA       .1 SQ MI

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                      6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+     533.     12.00                 418.        214.         73.          32.
                        (INCHES)      .634       1.298       1.331        1.331
                         (AC-FT)     207.        425.        435.         435.

                        CUMULATIVE AREA =    6.13 SQ MI

      ***             ***             ***             ***             ***

                        HYDROGRAPH AT STATION     CW2D
                      TRANSPOSITION AREA     10.0 SQ MI

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                      6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+     491.     12.00                 391.        198.         68.          29.
                        (INCHES)      .593       1.203       1.233        1.233
                         (AC-FT)     194.        394.        403.         403.

                        CUMULATIVE AREA =    6.13 SQ MI

      ***             ***             ***             ***             ***


                        INTERPOLATED HYDROGRAPH AT     CW2D

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                      6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+     496.     12.00                 394.        200.         68.          30.
                        (INCHES)      .597       1.213       1.243        1.243
                         (AC-FT)     195.        397.        407.         407.

                        CUMULATIVE AREA =    6.13 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

            **************
            *            *
 177 KK     *     S800   *        BASIN
            *            *
            **************
                                Compute runoff from subbasin 800

               SUBBASIN RUNOFF DATA

 179 BA          SUBBASIN CHARACTERISTICS
                      TAREA         .43  SUBBASIN AREA

 180 LG          GREEN AND AMPT LOSS RATE
                      STRTL         .27  STARTING LOSS
                        DTH         .35  MOISTURE DEFICIT
                       PSIF        4.60  WETTING FRONT SUCTION
                      XKSAT         .34  HYDRAULIC CONDUCTIVITY
                      RTIMP        9.00  PERCENT IMPERVIOUS AREA

 178 UI          INPUT UNITGRAPH,  27 ORDINATES,  VOLUME = 1.00
                      49.0      118.0      252.0      353.0      489.0      442.0      297.0      255.0      213.0      170.0
                     134.0      113.0       92.0       69.0       57.0       48.0       38.0       29.0       24.0       25.0
                      12.0        9.0       10.0        9.0       10.0        9.0       10.0
                                                                                          ***

      ***             ***             ***             ***             ***

                        HYDROGRAPH AT STATION     S800
                      TRANSPOSITION AREA       .1 SQ MI

    TOTAL RAINFALL =    4.20, TOTAL LOSS =    2.74, TOTAL EXCESS =    1.46

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                      6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+     485.     12.25                  62.         17.          6.           2.
                        (INCHES)     1.345       1.454       1.455        1.455
                         (AC-FT)      31.         33.         33.          33.

                        CUMULATIVE AREA =     .43 SQ MI

      ***             ***             ***             ***             ***

                        HYDROGRAPH AT STATION     S800
                      TRANSPOSITION AREA     10.0 SQ MI
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      TOTAL RAINFALL =    3.99, TOTAL LOSS =    2.64, TOTAL EXCESS =    1.35

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+     451.     12.25                 58.         16.          5.           2.
                        (INCHES)    1.245       1.349       1.350        1.350
                         (AC-FT)     29.         31.         31.          31.

                        CUMULATIVE AREA =     .43 SQ MI

       ***            ***            ***            ***            ***


                        INTERPOLATED HYDROGRAPH AT     S800

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+     474.     12.25                 61.         16.          5.           2.
                        (INCHES)    1.313       1.421       1.422        1.422
                         (AC-FT)     30.         33.         33.          33.

                        CUMULATIVE AREA =     .43 SQ MI


 *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


            **************
            *            *
  184 KK    *     S810   *        BASIN
            *            *
            **************
                                Compute runoff from subbasin 810

              SUBBASIN RUNOFF DATA

  186 BA          SUBBASIN CHARACTERISTICS
                        TAREA        1.61  SUBBASIN AREA

  187 LG          GREEN AND AMPT LOSS RATE
                        STRTL         .30  STARTING LOSS
                          DTH         .35  MOISTURE DEFICIT
                         PSIF        4.65  WETTING FRONT SUCTION
                        XKSAT         .32  HYDRAULIC CONDUCTIVITY
                        RTIMP        4.00  PERCENT IMPERVIOUS AREA

  185 UI          INPUT UNITGRAPH,  35 ORDINATES,  VOLUME = 1.00
                      140.0     200.0     493.0     790.0     997.0    1196.0    1589.0    1066.0     843.0     750.0
                      668.0     569.0     489.0     397.0     336.0     309.0     256.0     202.0     176.0     155.0
                      130.0     106.0     102.0      68.0      68.0      69.0      46.0      27.0      27.0      27.0
                       26.0      27.0      27.0      27.0      27.0
                                                                                                   ***

       ***            ***            ***            ***            ***

                        HYDROGRAPH AT STATION     S810
                       TRANSPOSITION AREA       .1 SQ MI

      TOTAL RAINFALL =    4.20, TOTAL LOSS =    2.87, TOTAL EXCESS =    1.32

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+    1452.     12.33                220.         57.         19.           8.
                        (INCHES)    1.273       1.322       1.323        1.323
                         (AC-FT)    109.        113.        113.         113.

                        CUMULATIVE AREA =    1.61 SQ MI

       ***            ***            ***            ***            ***

                        HYDROGRAPH AT STATION     S810
                       TRANSPOSITION AREA     10.0 SQ MI

      TOTAL RAINFALL =    3.99, TOTAL LOSS =    2.77, TOTAL EXCESS =    1.22

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+    1344.     12.33                202.         53.         18.           8.
                        (INCHES)    1.171       1.217       1.218        1.218
                         (AC-FT)    100.        104.        104.         104.

                        CUMULATIVE AREA =    1.61 SQ MI

       ***            ***            ***            ***            ***
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                        INTERPOLATED HYDROGRAPH AT     S810

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+    1387.     12.33                209.         54.         18.           8.
                        (INCHES)    1.212       1.259       1.259        1.259
                         (AC-FT)    104.        108.        108.         108.

                        CUMULATIVE AREA =    1.61 SQ MI


 *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


            **************
            *            *
  192 KK    *     S820   *        BASIN
            *            *
            **************
                                Compute runoff from subbasin S820.  Runoff to Fan 20 apex.

              SUBBASIN RUNOFF DATA

  194 BA          SUBBASIN CHARACTERISTICS
                        TAREA         .36  SUBBASIN AREA

  195 LG          GREEN AND AMPT LOSS RATE
                        STRTL         .25  STARTING LOSS
                          DTH         .35  MOISTURE DEFICIT
                         PSIF        4.35  WETTING FRONT SUCTION
                        XKSAT         .40  HYDRAULIC CONDUCTIVITY
                        RTIMP       18.00  PERCENT IMPERVIOUS AREA

  193 UI          INPUT UNITGRAPH,  24 ORDINATES,  VOLUME = 1.00
                       45.0     123.0     260.0     348.0     490.0     307.0     248.0     208.0     166.0     125.0
                      105.0      83.0      61.0      51.0      39.0      33.0      23.0      22.0      15.0       8.0
                        9.0       8.0       9.0       9.0
                                                                                                   ***

       ***            ***            ***            ***            ***

                        HYDROGRAPH AT STATION     S820
                       TRANSPOSITION AREA       .1 SQ MI

      TOTAL RAINFALL =    4.20, TOTAL LOSS =    2.51, TOTAL EXCESS =    1.68

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+     432.     12.25                 57.         16.          5.           2.
                        (INCHES)    1.460       1.678       1.680        1.680
                         (AC-FT)     28.         32.         32.          32.

                        CUMULATIVE AREA =     .36 SQ MI

       ***            ***            ***            ***            ***

                        HYDROGRAPH AT STATION     S820
                       TRANSPOSITION AREA     10.0 SQ MI

      TOTAL RAINFALL =    3.99, TOTAL LOSS =    2.42, TOTAL EXCESS =    1.57

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+     402.     12.25                 53.         15.          5.           2.
                        (INCHES)    1.359       1.566       1.568        1.568
                         (AC-FT)     26.         30.         30.          30.

                        CUMULATIVE AREA =     .36 SQ MI

       ***            ***            ***            ***            ***


                        INTERPOLATED HYDROGRAPH AT     S820

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+     423.     12.25                 56.         16.          5.           2.
                        (INCHES)    1.432       1.647       1.649        1.649
                         (AC-FT)     28.         32.         32.          32.

                        CUMULATIVE AREA =     .36 SQ MI

1
                                                  RUNOFF SUMMARY
                                        FLOW IN CUBIC FEET PER SECOND
                                     TIME IN HOURS,  AREA IN SQUARE MILES
```

	OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
+	HYDROGRAPH AT	W1	3196.	12.42	525.	140.	47.	4.05		
+	ROUTED TO	RRW1	388.	13.75	317.	137.	47.	4.05		
+	ROUTED TO	W1W2A	388.	13.75	316.	137.	47.	4.05		
+	HYDROGRAPH AT	W2A	419.	12.08	38.	10.	3.	.28		
+	2 COMBINED AT	CW2A	469.	12.17	336.	146.	50.	4.34		
+	ROUTED TO	W2AW2B	391.	12.42	332.	146.	50.	4.34		
+	HYDROGRAPH AT	W2B	1305.	12.08	103.	26.	9.	.86		
+	2 COMBINED AT	CW2B	1348.	12.08	414.	171.	58.	5.19		
+	ROUTED TO	RRW2B	360.	15.17	340.	171.	58.	5.19		
+	ROUTED TO	W2BW2C	360.	15.25	340.	171.	58.	5.19		
+	HYDROGRAPH AT	W2C	264.	12.00	15.	4.	1.	.12		
+	2 COMBINED AT	CW2CR	360.	15.25	340.	174.	60.	5.32		
+	HYDROGRAPH AT	X1A	729.	12.25	93.	25.	8.	.70		
+	ROUTED TO	RRX1A	69.	13.33	57.	24.	8.	.70		
+	ROUTED TO	X1AW2C	68.	13.42	57.	24.	8.	.70		
+	2 COMBINED AT	CW2C	420.	14.92	394.	197.	67.	6.01		
+	ROUTED TO	W2CW2D	420.	14.92	394.	197.	67.	6.01		
+	HYDROGRAPH AT	W2D	272.	12.00	14.	3.	1.	.12		
+	2 COMBINED AT	CW2D	496.	12.00	394.	200.	68.	6.13		
+	HYDROGRAPH AT	S800	474.	12.25	61.	16.	5.	.43		
+	HYDROGRAPH AT	S810	1387.	12.33	209.	54.	18.	1.61		
+	HYDROGRAPH AT	S820	423.	12.25	56.	16.	5.	.36		

*** NORMAL END OF HEC-1 ***

```
-----DSS---ZCLOSE Unit:  71,   File: SKY24.DSS
           Pointer Utilization:   .31
           Number of Records:    104
           File Size:    191.5  Kbytes
           Percent Inactive:    .0
```

CURRENT DATE: 09-29-2006 FILE DATE: 09-29-2006
CURRENT TIME: 12:50:58 FILE NAME: RRX1A

FHWA CULVERT ANALYSIS
HY-8, VERSION 6.0

CULV NO.	SITE DATA: INLET ELEV. (ft)	OUTLET ELEV. (ft)	CULVERT LENGTH (ft)	CULVERT SHAPE, MATERIAL, INLET: BARRELS SHAPE MATERIAL	SPAN (ft)	RISE (ft)	MANNING n	INLET TYPE
1	100.00	98.00	400.01	1 RCP	3.00	3.00	.012	IMPR SDT CIR
2								
3								
4								
5								
6								

SUMMARY OF CULVERT FLOWS (cfs) FILE: RRX1A DATE: 09-29-2006

ELEV (ft)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
100.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	1
102.15	20.0	20.0	0.0	0.0	0.0	0.0	0.0	0.00	1
103.90	40.0	40.0	0.0	0.0	0.0	0.0	0.0	0.00	1
105.81	60.0	60.0	0.0	0.0	0.0	0.0	0.0	0.00	1
108.49	80.0	80.0	0.0	0.0	0.0	0.0	0.0	0.00	1
109.81	90.0	88.1	0.0	0.0	0.0	0.0	0.0	0.00	30
110.15	120.0	89.8	0.0	0.0	0.0	0.0	0.0	29.69	10
110.21	140.0	90.1	0.0	0.0	0.0	0.0	0.0	48.71	5
110.26	160.0	90.3	0.0	0.0	0.0	0.0	0.0	68.80	5
110.30	180.0	90.5	0.0	0.0	0.0	0.0	0.0	87.85	4
110.35	200.0	90.7	0.0	0.0	0.0	0.0	0.0	107.81	4
110.00	89.1	89.1	0.0	0.0	0.0	0.0	0.0	OVERTOPPING	

SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: RRX1A DATE: 09-29-2006

HEAD ELEV (ft)	HEAD ERROR (ft)	TOTAL FLOW (cfs)	FLOW ERROR (cfs)	% FLOW ERROR
100.00	0.000	0.00	0.00	0.00
102.15	0.000	20.00	0.00	0.00
103.90	0.000	40.00	0.00	0.00
105.81	0.000	60.00	0.00	0.00
108.49	0.000	80.00	0.00	0.00
109.81	-0.007	90.00	1.89	2.10
110.15	-0.002	120.00	0.56	0.47
110.21	-0.004	140.00	1.23	0.88
110.26	-0.003	160.00	0.92	0.57
110.30	-0.005	180.00	1.62	0.90
110.35	-0.005	200.00	1.45	0.73

<1> TOLERANCE (ft) = 0.010 <2> TOLERANCE (%) = 1.000

CURRENT DATE: 09-29-2006 FILE DATE: 09-29-2006
CURRENT TIME: 12:50:58 FILE NAME: RRX1A

PERFORMANCE CURVE FOR CULVERT 1 - 1(3.00 (ft) BY 3.00 (ft)) RCP

DIS-CHARGE FLOW (cfs)	HEAD-WATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRIT. DEPTH (ft)	OUTLET DEPTH (ft)	TW DEPTH (ft)	OUTLET VEL. (fps)	TW VEL. (fps)
0.00	100.00	0.00	-2.00	0-NF	0.00	0.00	0.00	0.00	0.00	0.00
20.00	102.15	2.15	0.67	1-S2n	1.30	1.43	1.23	0.28	7.34	1.77
40.00	103.90	3.90	2.34	1-S2n	2.00	2.06	2.00	0.43	8.02	2.33
60.00	105.81	5.81	4.15	2-M2c	3.00	2.49	2.49	0.54	9.61	2.73
80.00	108.49	8.49	8.21	2-M2c	3.00	2.81	2.81	0.64	11.71	3.06
88.11	109.81	9.80	9.81	2-M2c	3.00	2.94	2.94	0.69	12.60	3.20
89.75	110.14	10.08	10.14	2-M2c	3.00	2.96	2.96	0.82	12.78	3.58
90.06	110.20	10.13	10.20	2-M2c	3.00	2.97	2.97	0.90	12.81	3.80
90.28	110.25	10.17	10.25	2-M2c	3.00	2.97	2.97	0.98	12.84	4.00
90.53	110.30	10.21	10.30	2-M2c	3.00	2.98	2.98	1.05	12.86	4.18
90.74	110.34	10.25	10.34	2-M2c	3.00	2.98	2.98	1.12	12.88	4.35

El. inlet face invert 100.00 ft El. outlet invert 98.00 ft
El. inlet throat invert 100.00 ft El. inlet crest 0.00 ft

```
***** SITE DATA ***** CULVERT INVERT **************
      INLET STATION                          0.00 ft
      INLET ELEVATION                      100.00 ft
      OUTLET STATION                       400.00 ft
      OUTLET ELEVATION                      98.00 ft
      NUMBER OF BARRELS                      1
      SLOPE (V/H)                            0.0050
      CULVERT LENGTH ALONG SLOPE           400.01 ft

***** CULVERT DATA SUMMARY ************************
      BARREL SHAPE          CIRCULAR
      BARREL DIAMETER         3.00 ft
      BARREL MATERIAL       CONCRETE
      BARREL MANNING'S n    0.012
      INLET TYPE            IMPR SDT CIRC
      INLET EDGE AND WALL   SQUARE EDGE TOP (26-90 DEG WINGWALL)
      INLET DEPRESSION      NONE

***** SIDE-TAPERED CIRCULAR IMPROVED INLET *******
      FACE WIDTH                           3.00 ft
      SIDE TAPER (4:1 TO 6:1) (X:1)        4.00
      FACE HEIGHT                          3.00 ft
```

CURRENT DATE: 09-29-2006
CURRENT TIME: 12:50:58

FILE DATE: 09-29-2006
FILE NAME: RRX1A

TAILWATER

******* REGULAR CHANNEL CROSS SECTION ****************

BOTTOM WIDTH	40.00 ft
SIDE SLOPE H/V (X:1)	1.0
CHANNEL SLOPE V/H (ft/ft)	0.016
MANNING'S n (.01-0.1)	0.045
CHANNEL INVERT ELEVATION	98.00 ft
CULVERT NO.1 OUTLET INVERT ELEVATION	98.00 ft

******* UNIFORM FLOW RATING CURVE FOR DOWNSTREAM CHANNEL

FLOW (cfs)	W.S.E. (ft)	FROUDE NUMBER	DEPTH (ft)	VEL. (f/s)	SHEAR (psf)
0.00	98.00	0.000	0.00	0.00	0.00
20.00	98.28	0.590	0.28	1.77	0.28
40.00	98.43	0.630	0.43	2.33	0.42
60.00	98.54	0.654	0.54	2.73	0.54
80.00	98.64	0.671	0.64	3.06	0.64
90.00	98.69	0.678	0.69	3.20	0.69
120.00	98.82	0.695	0.82	3.58	0.82
140.00	98.90	0.705	0.90	3.80	0.90
160.00	98.98	0.713	0.98	4.00	0.98
180.00	99.05	0.720	1.05	4.18	1.05
200.00	99.12	0.726	1.12	4.35	1.12

ROADWAY OVERTOPPING DATA

ROADWAY SURFACE	GRAVEL
EMBANKMENT TOP WIDTH	50.00 ft
CREST LENGTH	200.00 ft
OVERTOPPING CREST ELEVATION	110.00 ft

CURRENT DATE: 09-28-2006
CURRENT TIME: 14:14:03

FILE DATE: 09-28-2006
FILE NAME: RRW1

FHWA CULVERT ANALYSIS
HY-8, VERSION 6.0

CULV NO.	SITE DATA: INLET ELEV. (ft)	OUTLET ELEV. (ft)	CULVERT LENGTH (ft)	CULVERT SHAPE, MATERIAL, INLET: BARRELS SHAPE MATERIAL	SPAN (ft)	RISE (ft)	MANNING n	INLET TYPE
1	100.00	97.10	585.01	2 RCP	5.00	5.00	.012	IMPR SDT CIR
2								
3								
4								
5								
6								

SUMMARY OF CULVERT FLOWS (cfs) FILE: RRW1 DATE: 09-28-2006

ELEV (ft)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
100.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	1
102.12	60.0	60.0	0.0	0.0	0.0	0.0	0.0	0.00	1
103.15	120.0	120.0	0.0	0.0	0.0	0.0	0.0	0.00	1
104.22	180.0	180.0	0.0	0.0	0.0	0.0	0.0	0.00	1
105.74	240.0	240.0	0.0	0.0	0.0	0.0	0.0	0.00	1
106.74	300.0	300.0	0.0	0.0	0.0	0.0	0.0	0.00	1
107.97	360.0	360.0	0.0	0.0	0.0	0.0	0.0	0.00	1
108.91	400.0	400.0	0.0	0.0	0.0	0.0	0.0	0.00	1
110.95	480.0	475.3	0.0	0.0	0.0	0.0	0.0	0.00	7
111.21	540.0	483.8	0.0	0.0	0.0	0.0	0.0	50.94	5
111.35	600.0	488.5	0.0	0.0	0.0	0.0	0.0	107.67	4
111.00	476.6	476.6	0.0	0.0	0.0	0.0	0.0	OVERTOPPING	

SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: RRW1 DATE: 09-28-2006

HEAD ELEV (ft)	HEAD ERROR (ft)	TOTAL FLOW (cfs)	FLOW ERROR (cfs)	% FLOW ERROR
100.00	0.000	0.00	0.00	0.00
102.12	0.000	60.00	0.00	0.00
103.15	0.000	120.00	0.00	0.00
104.22	0.000	180.00	0.00	0.00
105.74	0.000	240.00	0.00	0.00
106.74	0.000	300.00	0.00	0.00
107.97	0.000	360.00	0.00	0.00
108.91	0.000	400.00	0.00	0.00
110.95	-0.009	480.00	4.72	0.98
111.21	-0.008	540.00	5.24	0.97
111.35	-0.005	600.00	3.87	0.64

<1> TOLERANCE (ft) = 0.010 <2> TOLERANCE (%) = 1.000

CURRENT DATE: 09-28-2006 FILE DATE: 09-28-2006
CURRENT TIME: 14:14:03 FILE NAME: RRW1

PERFORMANCE CURVE FOR CULVERT 1 - 2(5.00 (ft) BY 5.00 (ft)) RCP

DIS-CHARGE FLOW (cfs)	HEAD-WATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRIT. DEPTH (ft)	OUTLET DEPTH (ft)	TW DEPTH (ft)	OUTLET VEL. (fps)	TW VEL. (fps)
0.00	100.00	0.00	-2.90	0-NF	0.00	0.00	0.00	-0.60	0.00	0.00
60.00	102.12	2.12	0.47	1-S2n	1.29	1.52	1.22	-0.01	8.03	2.50
120.00	103.15	3.15	1.12	1-S2n	1.87	2.17	1.77	0.30	9.64	3.28
180.00	104.22	4.22	1.93	1-S2n	2.35	2.68	2.28	0.54	10.30	3.83
240.00	105.74	5.74	2.91	1-S2n	2.79	3.12	2.72	0.76	10.99	4.27
300.00	106.74	6.74	4.09	1-S2n	3.24	3.51	3.21	0.95	11.28	4.64
360.00	107.97	7.97	5.45	5-S2n	3.73	3.83	3.63	1.13	11.81	4.97
400.00	108.91	8.91	6.62	2-M2c	4.13	4.03	4.03	1.25	11.79	5.17
475.28	110.95	10.95	8.07	2-M2c	5.00	4.31	4.31	1.46	13.25	5.53
483.82	111.21	11.21	8.40	2-M2c	5.00	4.34	4.34	1.61	13.40	5.78
488.45	111.35	11.35	8.58	2-M2c	5.00	4.36	4.36	1.76	13.48	6.01

El. inlet face invert 100.00 ft El. outlet invert 97.10 ft
El. inlet throat invert 100.00 ft El. inlet crest 0.00 ft

***** SITE DATA ***** CULVERT INVERT **********

INLET STATION	0.00 ft
INLET ELEVATION	100.00 ft
OUTLET STATION	585.00 ft
OUTLET ELEVATION	97.10 ft
NUMBER OF BARRELS	2
SLOPE (V/H)	0.0050
CULVERT LENGTH ALONG SLOPE	585.01 ft

***** CULVERT DATA SUMMARY **********

BARREL SHAPE	CIRCULAR
BARREL DIAMETER	5.00 ft
BARREL MATERIAL	CONCRETE
BARREL MANNING'S n	0.012
INLET TYPE	IMPR SDT CIRC
INLET EDGE AND WALL	SQUARE EDGE TOP (26-90 DEG WINGWALL)
INLET DEPRESSION	NONE

***** SIDE-TAPERED CIRCULAR IMPROVED INLET *******

FACE WIDTH	5.00 ft
SIDE TAPER (4:1 TO 6:1) (X:1)	4.00
FACE HEIGHT	5.00 ft

CURRENT DATE: 09-28-2006 FILE DATE: 09-28-2006
CURRENT TIME: 14:14:03 FILE NAME: RRW1

TAILWATER

******* REGULAR CHANNEL CROSS SECTION **********

BOTTOM WIDTH	40.00 ft
SIDE SLOPE H/V (X:1)	1.0
CHANNEL SLOPE V/H (ft/ft)	0.012
MANNING'S n (.01-0.1)	0.045
CHANNEL INVERT ELEVATION	96.50 ft
CULVERT NO.1 OUTLET INVERT ELEVATION	97.10 ft

******* UNIFORM FLOW RATING CURVE FOR DOWNSTREAM CHANNEL

FLOW (cfs)	W.S.E. (ft)	FROUDE NUMBER	DEPTH (ft)	VEL. (f/s)	SHEAR (psf)
0.00	96.50	0.000	0.00	0.00	0.00
60.00	97.09	0.574	0.59	2.50	0.44
120.00	97.40	0.610	0.90	3.28	0.67
180.00	97.64	0.631	1.14	3.83	0.86
240.00	97.86	0.645	1.36	4.27	1.02
300.00	98.05	0.657	1.55	4.64	1.16
360.00	98.23	0.666	1.73	4.97	1.30
400.00	98.35	0.671	1.85	5.17	1.38
480.00	98.56	0.679	2.06	5.53	1.54
540.00	98.71	0.685	2.21	5.78	1.66
600.00	98.86	0.690	2.36	6.01	1.76

ROADWAY OVERTOPPING DATA

ROADWAY SURFACE	GRAVEL
EMBANKMENT TOP WIDTH	50.00 ft
CREST LENGTH	200.00 ft
OVERTOPPING CREST ELEVATION	111.00 ft

1

CURRENT DATE: 09-28-2006 FILE DATE: 09-28-2006
CURRENT TIME: 14:13:21 FILE NAME: RRW2B

FHWA CULVERT ANALYSIS
HY-8, VERSION 6.0

CULV NO.	SITE DATA: INLET ELEV. (ft)	OUTLET ELEV. (ft)	CULVERT LENGTH (ft)	CULVERT SHAPE, MATERIAL, INLET: BARRELS SHAPE MATERIAL	SPAN (ft)	RISE (ft)	MANNING n	INLET TYPE
1	100.00	97.10	585.01	2 RCP	5.00	5.00	.012	IMPR SDT CIR
2								
3								
4								
5								
6								

SUMMARY OF CULVERT FLOWS (cfs) FILE: RRW2B DATE: 09-28-2006

ELEV (ft)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
100.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	1
102.12	60.0	60.0	0.0	0.0	0.0	0.0	0.0	0.00	1
103.15	120.0	120.0	0.0	0.0	0.0	0.0	0.0	0.00	1
104.22	180.0	180.0	0.0	0.0	0.0	0.0	0.0	0.00	1
105.74	240.0	240.0	0.0	0.0	0.0	0.0	0.0	0.00	1
106.74	300.0	300.0	0.0	0.0	0.0	0.0	0.0	0.00	1
107.97	360.0	360.0	0.0	0.0	0.0	0.0	0.0	0.00	1
108.91	400.0	400.0	0.0	0.0	0.0	0.0	0.0	0.00	1
110.95	480.0	475.3	0.0	0.0	0.0	0.0	0.0	0.00	7
111.21	540.0	483.8	0.0	0.0	0.0	0.0	0.0	50.94	5
111.35	600.0	488.5	0.0	0.0	0.0	0.0	0.0	107.67	4
111.00	476.6	476.6	0.0	0.0	0.0	0.0	0.0	OVERTOPPING	

SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: RRW2B DATE: 09-28-2006

HEAD ELEV (ft)	HEAD ERROR (ft)	TOTAL FLOW (cfs)	FLOW ERROR (cfs)	% FLOW ERROR
100.00	0.000	0.00	0.00	0.00
102.12	0.000	60.00	0.00	0.00
103.15	0.000	120.00	0.00	0.00
104.22	0.000	180.00	0.00	0.00
105.74	0.000	240.00	0.00	0.00
106.74	0.000	300.00	0.00	0.00
107.97	0.000	360.00	0.00	0.00
108.91	0.000	400.00	0.00	0.00
110.95	-0.009	480.00	4.72	0.98
111.21	-0.008	540.00	5.24	0.97
111.35	-0.005	600.00	3.87	0.64

<1> TOLERANCE (ft) = 0.010 <2> TOLERANCE (%) = 1.000

2

CURRENT DATE: 09-28-2006 FILE DATE: 09-28-2006
CURRENT TIME: 14:13:21 FILE NAME: RRW2B

PERFORMANCE CURVE FOR CULVERT 1 - 2(5.00 (ft) BY 5.00 (ft)) RCP

DIS-CHARGE FLOW (cfs)	HEAD-WATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRIT. DEPTH (ft)	OUTLET DEPTH (ft)	TW DEPTH (ft)	OUTLET VEL. (fps)	TW VEL. (fps)
0.00	100.00	0.00	-2.90	0-NF	0.00	0.00	0.00	-0.60	0.00	0.00
60.00	102.12	2.12	0.47	1-S2n	1.29	1.52	1.22	-0.01	8.03	2.50
120.00	103.15	3.15	1.12	1-S2n	1.87	2.17	1.77	0.30	9.64	3.28
180.00	104.22	4.22	1.93	1-S2n	2.35	2.68	2.28	0.54	10.30	3.83
240.00	105.74	5.74	2.91	1-S2n	2.79	3.12	2.72	0.76	10.99	4.27
300.00	106.74	6.74	4.09	1-S2n	3.24	3.51	3.21	0.95	11.28	4.64
360.00	107.97	7.97	5.45	5-S2n	3.73	3.83	3.63	1.13	11.81	4.97
400.00	108.91	8.91	6.62	2-M2c	4.13	4.03	4.03	1.25	11.79	5.17
475.28	110.95	10.95	8.07	2-M2c	5.00	4.31	4.31	1.46	13.25	5.53
483.82	111.21	11.21	8.40	2-M2c	5.00	4.34	4.34	1.61	13.40	5.78
488.45	111.35	11.35	8.58	2-M2c	5.00	4.36	4.36	1.76	13.48	6.01

El. inlet face invert 100.00 ft El. outlet invert 97.10 ft
El. inlet throat invert 100.00 ft El. inlet crest 0.00 ft

```
***** SITE DATA ***** CULVERT INVERT **************
      INLET STATION                          0.00 ft
      INLET ELEVATION                      100.00 ft
      OUTLET STATION                       585.00 ft
      OUTLET ELEVATION                      97.10 ft
      NUMBER OF BARRELS                      2
      SLOPE (V/H)                            0.0050
      CULVERT LENGTH ALONG SLOPE           585.01 ft

***** CULVERT DATA SUMMARY ************************
      BARREL SHAPE          CIRCULAR
      BARREL DIAMETER         5.00 ft
      BARREL MATERIAL       CONCRETE
      BARREL MANNING'S n    0.012
      INLET TYPE            IMPR SDT CIRC
      INLET EDGE AND WALL   SQUARE EDGE TOP (26-90 DEG WINGWALL)
      INLET DEPRESSION      NONE

***** SIDE-TAPERED CIRCULAR IMPROVED INLET *******
      FACE WIDTH                           5.00 ft
      SIDE TAPER (4:1 TO 6:1) (X:1)        4.00
      FACE HEIGHT                          5.00 ft
```

CURRENT DATE: 09-28-2006 FILE DATE: 09-28-2006
CURRENT TIME: 14:13:21 FILE NAME: RRW2B

TAILWATER

******* REGULAR CHANNEL CROSS SECTION ****************

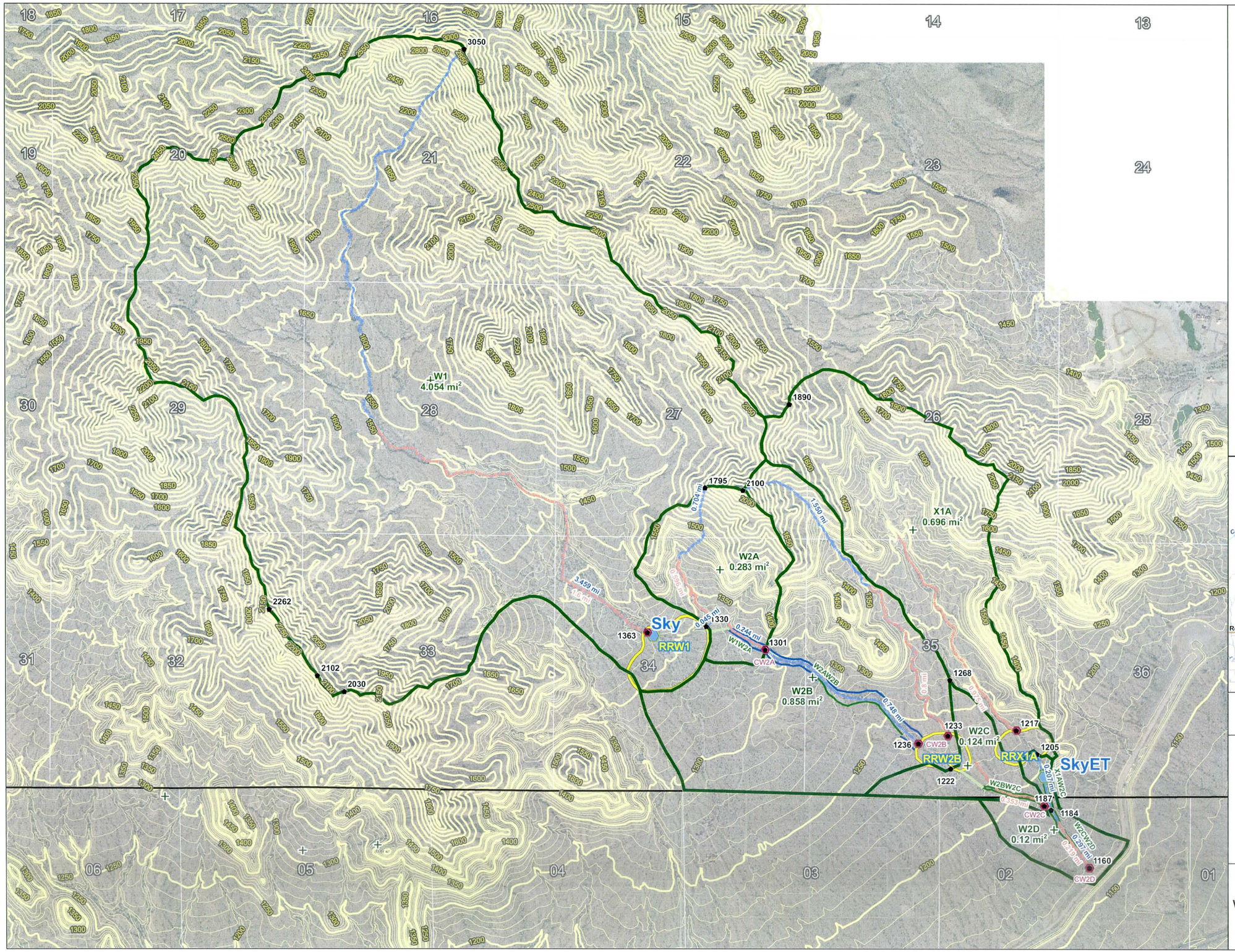
BOTTOM WIDTH	40.00 ft
SIDE SLOPE H/V (X:1)	1.0
CHANNEL SLOPE V/H (ft/ft)	0.012
MANNING'S n (.01-0.1)	0.045
CHANNEL INVERT ELEVATION	96.50 ft
CULVERT NO.1 OUTLET INVERT ELEVATION	97.10 ft

******* UNIFORM FLOW RATING CURVE FOR DOWNSTREAM CHANNEL

FLOW (cfs)	W.S.E. (ft)	FROUDE NUMBER	DEPTH (ft)	VEL. (f/s)	SHEAR (psf)
0.00	96.50	0.000	0.00	0.00	0.00
60.00	97.09	0.574	0.59	2.50	0.44
120.00	97.40	0.610	0.90	3.28	0.67
180.00	97.64	0.631	1.14	3.83	0.86
240.00	97.86	0.645	1.36	4.27	1.02
300.00	98.05	0.657	1.55	4.64	1.16
360.00	98.23	0.666	1.73	4.97	1.30
400.00	98.35	0.671	1.85	5.17	1.38
480.00	98.56	0.679	2.06	5.53	1.54
540.00	98.71	0.685	2.21	5.78	1.66
600.00	98.86	0.690	2.36	6.01	1.76

ROADWAY OVERTOPPING DATA

ROADWAY SURFACE	GRAVEL
EMBANKMENT TOP WIDTH	50.00 ft
CREST LENGTH	200.00 ft
OVERTOPPING CREST ELEVATION	111.00 ft



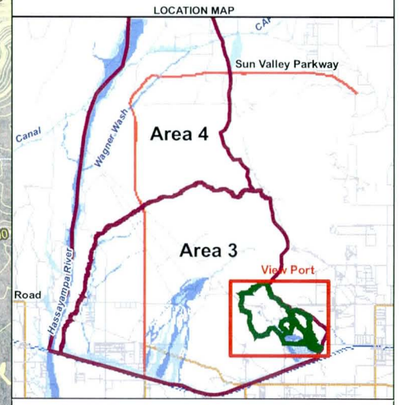
LEGEND

- Subbasin Boundaries
- Subbasin Centroids
- Lca Paths
- Lag & Routing Paths
- Elevation Points
- Concentration Points
- Step 3 Basins

Step 3 Corridors

- Floodwall
- No Floodwall
- Basin Outlet Pipe
- Countywide 10-ft Topo
- White Tank Mtn Park
- Fan Apices

LOCATION MAP



FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY

SUN VALLEY
AREA DRAINAGE MASTER PLAN
STEP 3 - HYDROLOGY
FRS 2 & 3 SUB-AREA
SKYLINE FAN SYSTEM
SUBBASIN MAP

FCD 2004C049
DECEMBER 2006

N
W E
S

Feet
0 900 1,800 2,700

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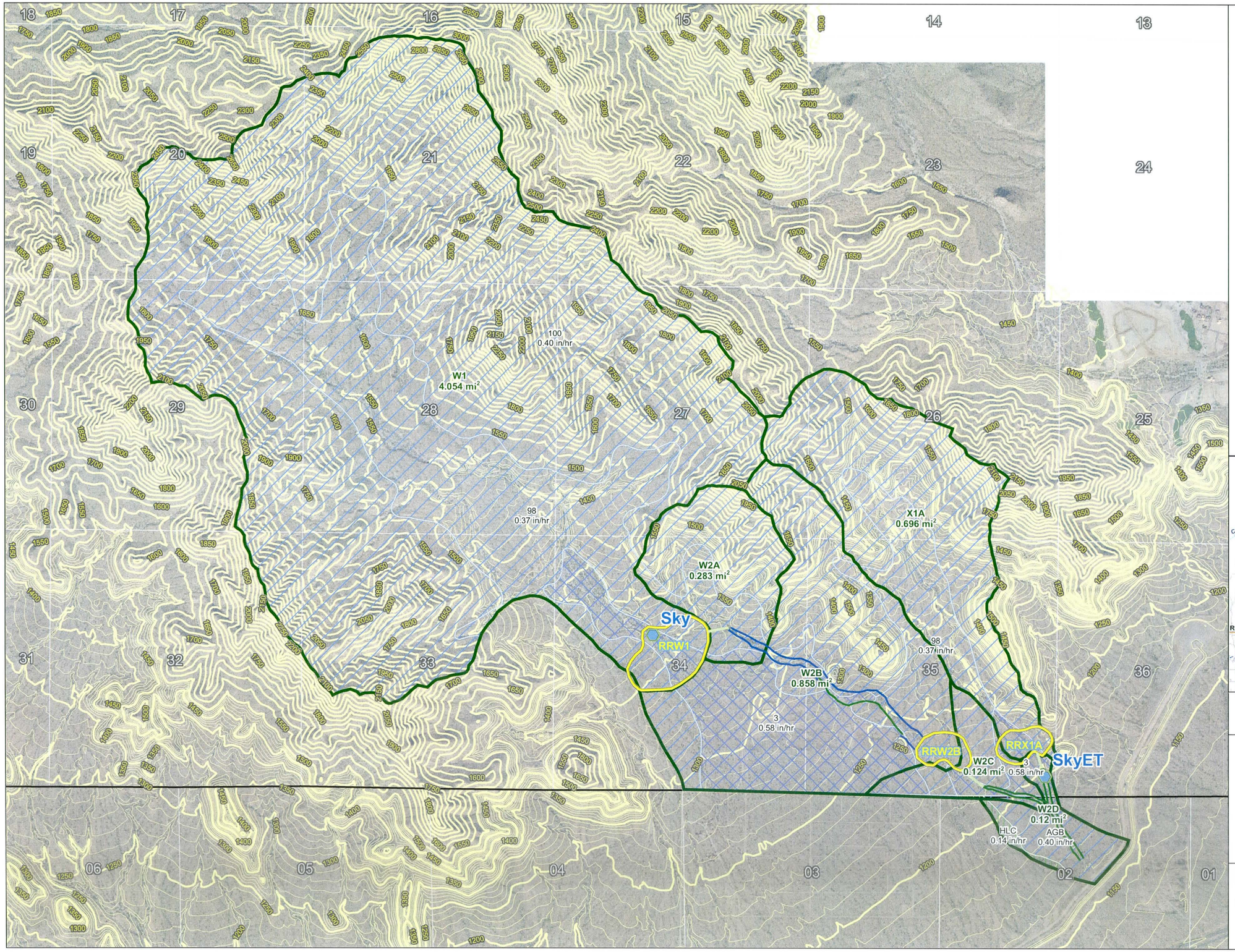


LEGEND

NRCS Soil Data

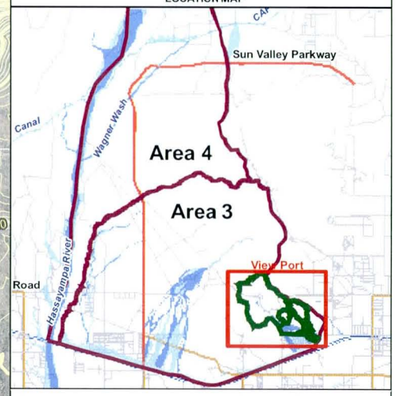
XKSAT (in/hr)

- 0.00 - 0.01
- 0.01 - 0.02
- 0.02 - 0.04
- 0.04 - 0.06
- 0.06 - 0.10
- 0.10 - 0.15
- 0.15 - 0.25
- 0.25 - 0.40
- 0.40 - 1.20
- Subbasin Boundaries

Step 3 Corridors

- Floodwall
- No Floodwall
- Basin Outlet Pipe
- Step 3 Basins
- Countywide 10-ft Topo
- White Tank Mtn Park
- Fan Apices

LOCATION MAP



FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY

SUN VALLEY
AREA DRAINAGE MASTER PLAN

STEP 3 - HYDROLOGY
FRS 2 & 3 SUB-AREA
SKYLINE FAN SYSTEM
SOIL MAP

FCD 2004C049

DECEMBER 2006

N
W E
S

Feet
0 900 1,800 2,700

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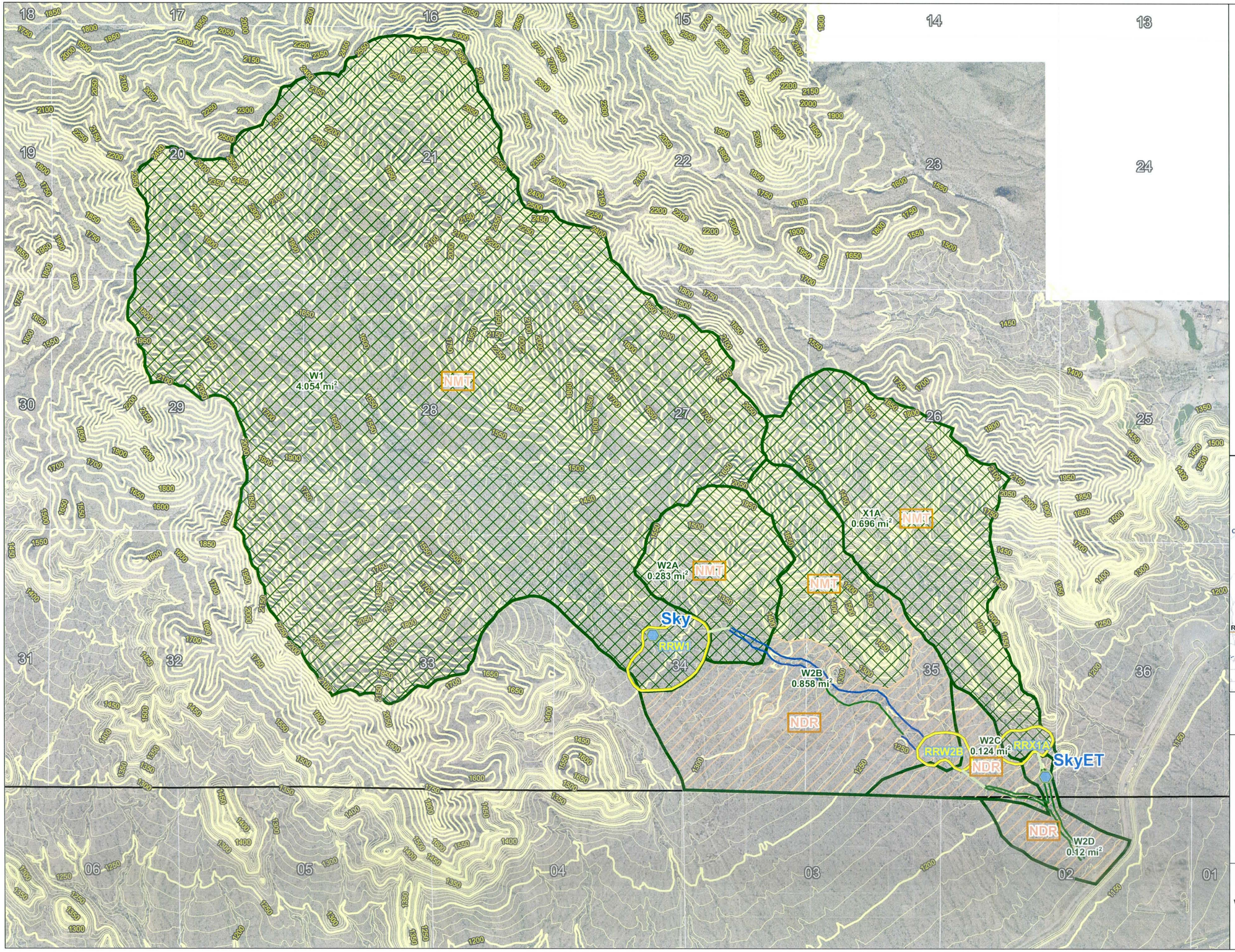


LEGEND

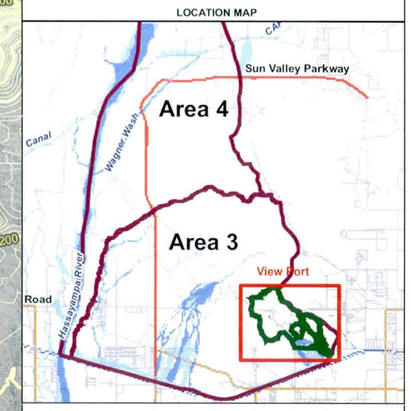
Existing Land Use

- Desert Rangeland (NDR), <5% Slopes
- Hillslopes (NHS), 5-10% slopes
- Mountain Terrain (NMT), >10% Slopes
- Subbasin Boundaries

Step 3 Corridors

- Floodwall
- No Floodwall
- Basin Outlet Pipe
- Step 3 Basins
- White Tank Mtn Park
- Countywide 10-ft Topo
- Fan Apices

LOCATION MAP



FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY

SUN VALLEY
AREA DRAINAGE MASTER PLAN
STEP 3 - HYDROLOGY
FRS 2 & 3 SUB-AREA
SKYLINE FAN SYSTEM
LAND USE MAP

FCD 2004C049
DECEMBER 2006

N
W E
S

Feet
0 900 1,800 2,700

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Appendix B

Design Analyses

Fan System 10, 11, & 20

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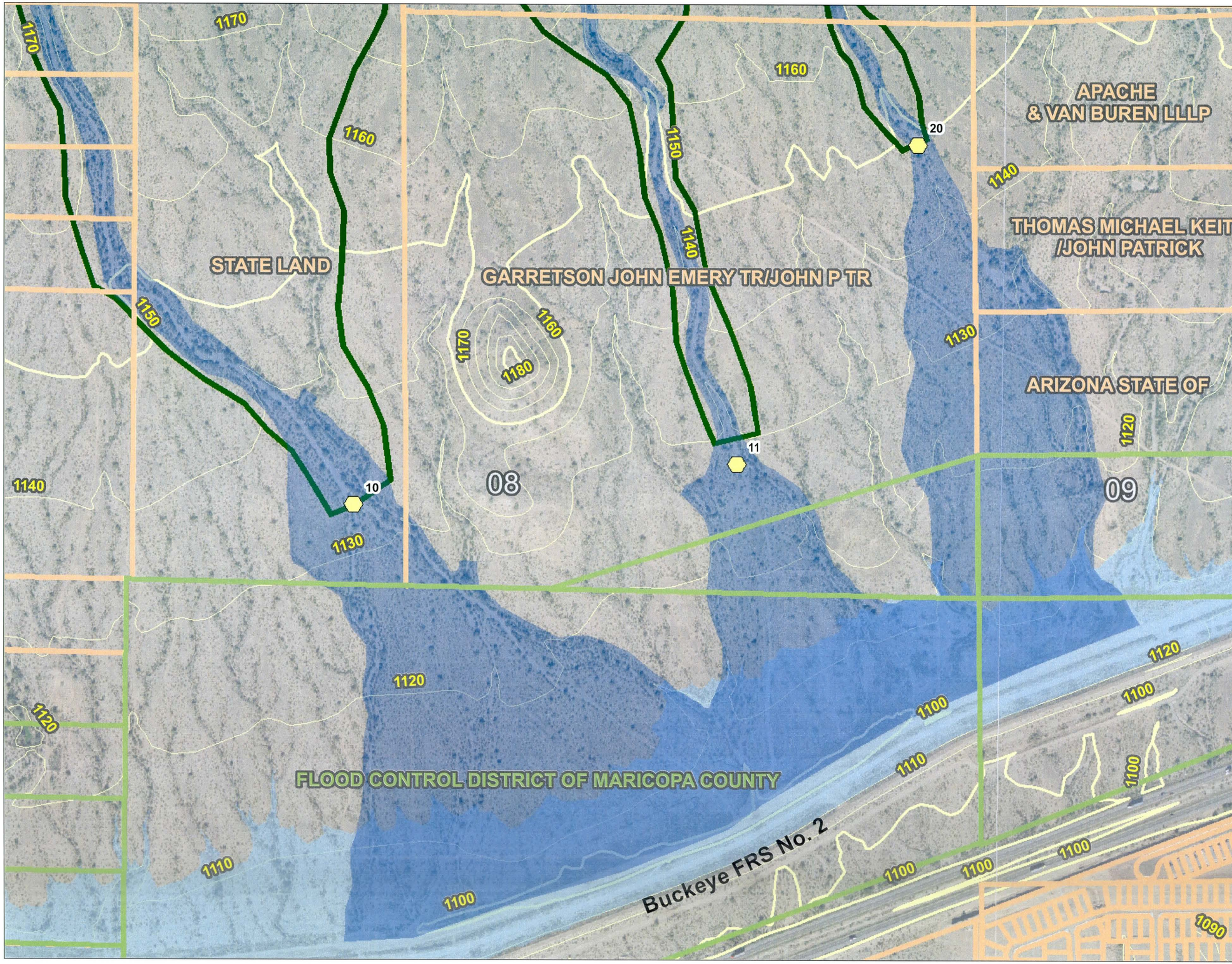
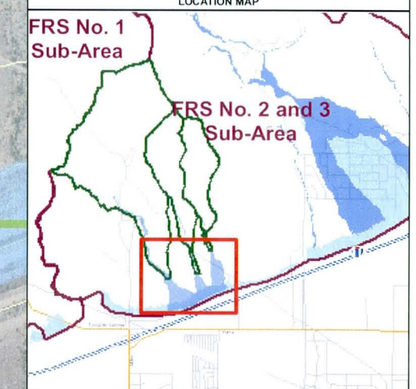


LEGEND

- Subbasin Boundaries
- Fan Apices
- Other Parcels
- FCDMC Parcels
- Floodplain
- Floodway

FAN ID	STAGE III Zone	Acres	Owner	% of Land
10	AFUFD	7.6	FCDMC	12.8
10	AFUFD	5.2	FCDMC	8.7
10	AFHH	36.3	FCDMC	61.2
Subtotal		49.1		82.7
10	AFHH	9.0	ASLD	15.1
10	AFHH	1.3	Private	2.2
Fan 10 Total		59.4		100.0
11	AFHH	24.1	FCDMC	85.4
11	AFHH	4.1	Private	14.6
Fan 11 Total		28.2		100.0
20	AFUFD	4.8	FCDMC	13.6
20	AFHH	10.7	FCDMC	30.0
Subtotal		15.5		43.6
20	AFHH	7.4	State of AZ	20.7
20	AFHH	2.1	Private	6.0
20	AFHH	10.5	Private	29.6
Fan 20 Total		35.5		100.0
Total FCDMC		88.6		**72.0**
Total Private		18.1		14.7
Total State		16.3		13.3
Grand Total		123.0		100.0

LOCATION MAP



FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY

SUN VALLEY
AREA DRAINAGE MASTER PLAN
STEP 3 - FRS 2 & 3 SUB-AREA
FAN SYSTEM 10, 11, & 20
RECOMMENDED ALTERNATIVE

SHEET 1 of 1
FCD 2004C049
DECEMBER 2006

N
W E
S

Feet
0 200 400 600

JE FULLER
HYDROLOGY & GEOMORPHOLOGY, INC.

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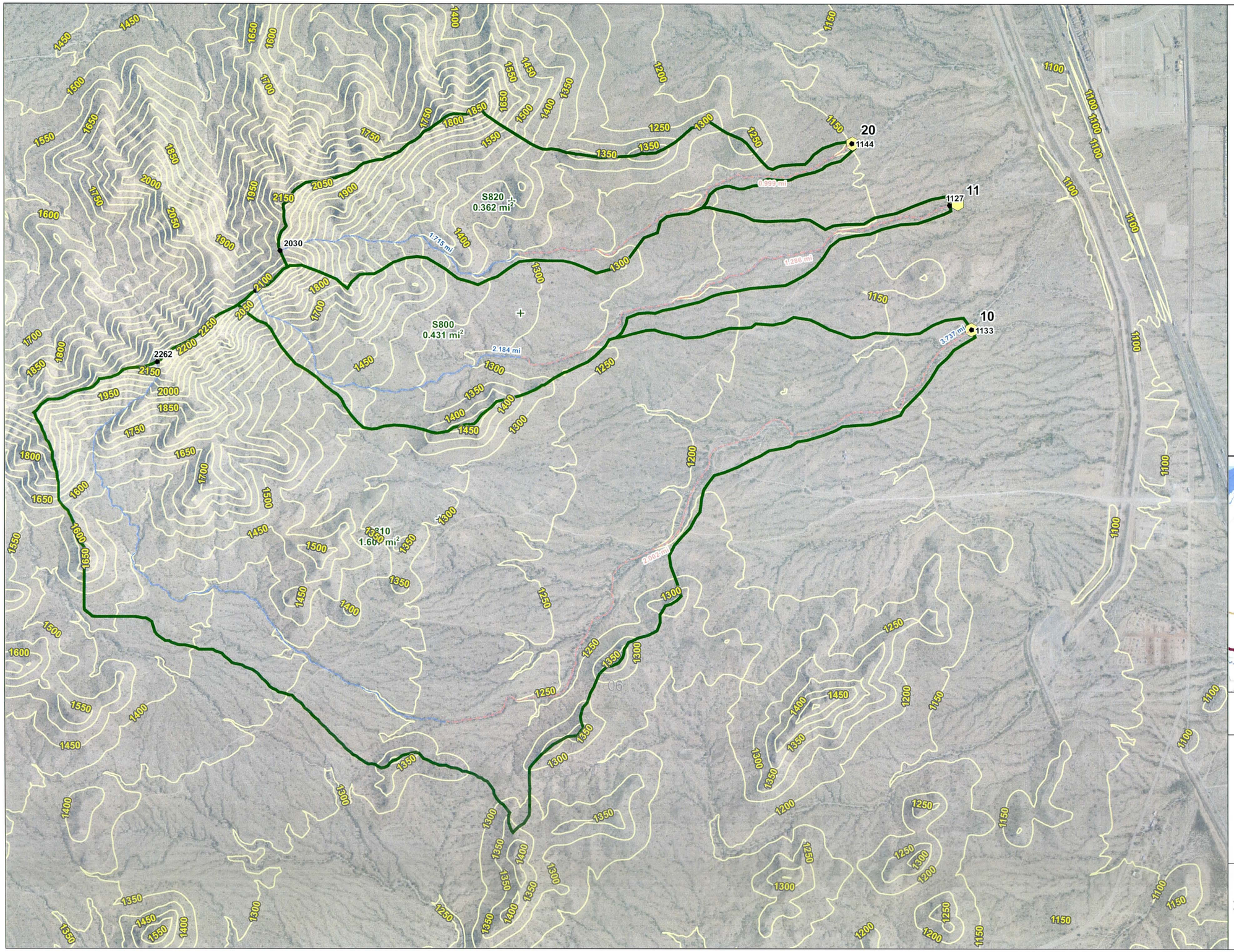
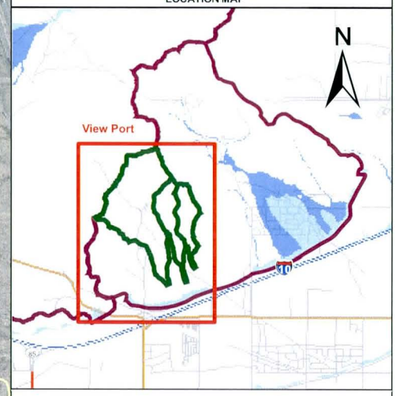


LEGEND

- Subbasin Boundaries
- Fan Apices
- Lag & Routing Paths
- Lca Paths
- Elevation Points
- Subbasin Centroids
- 50-ft Contours

LOCATION MAP



FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY

SUN VALLEY
AREA DRAINAGE MASTER PLAN
STEP 3 - HYDROLOGY
FRS 2 & 3 SUB-AREA
FAN SYSTEM 10, 11, & 20
SUBBASIN MAP

FCD 2004C049
DECEMBER 2006

Feet
0 600 1,200 1,800

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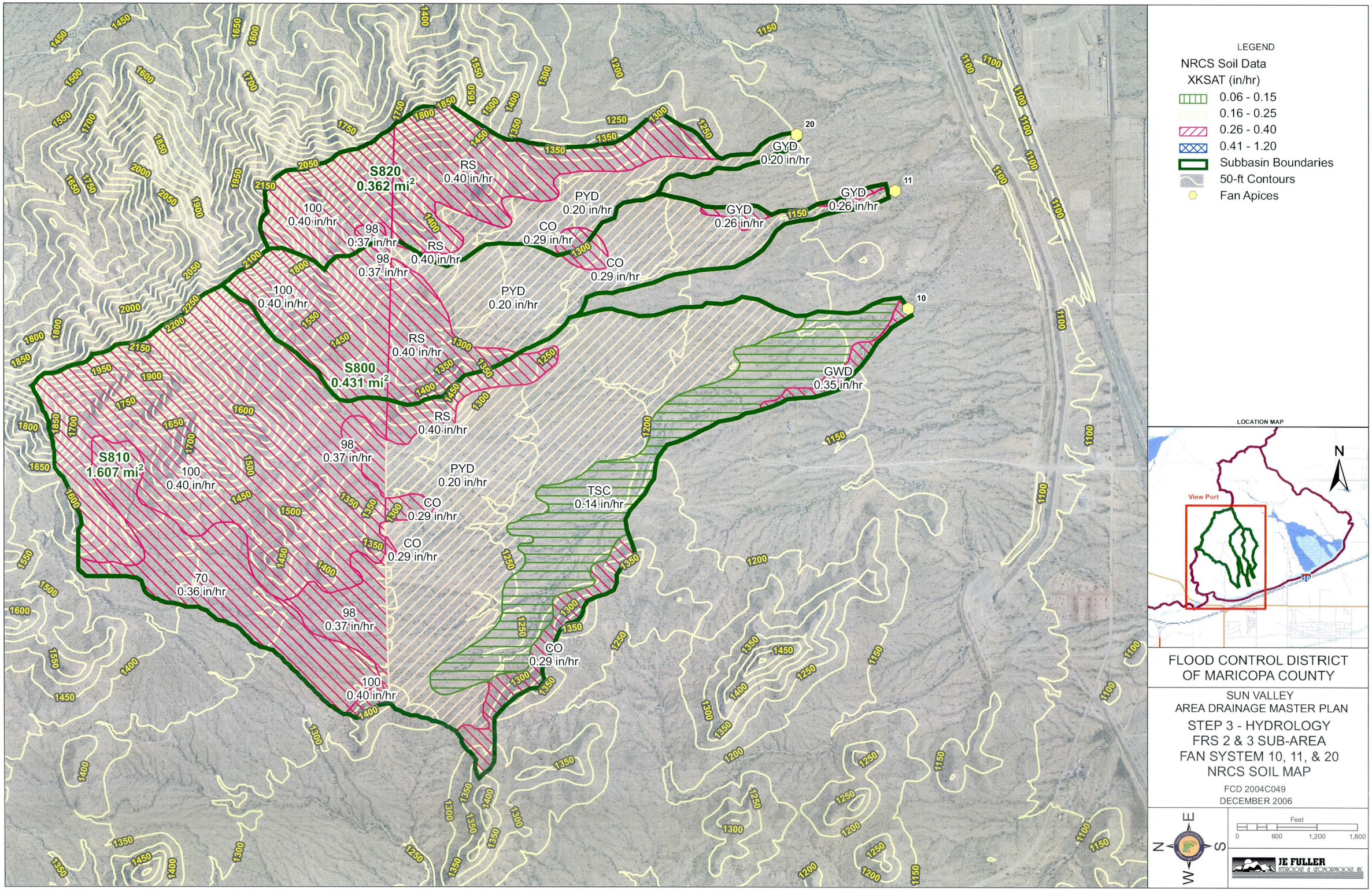
LEGEND
NRCS Soil Data
XKSAT (in/hr)
0.06 - 0.15
0.16 - 0.25
0.26 - 0.40
0.41 - 1.20
Subbasin Boundaries
50-ft Contours
Fan Apices
LOCATION MAP
View Port
N
S820
0.362 mi²
S800
0.431 mi²
S810
1.607 mi²
RS
0.40 in/hr
PYD
0.20 in/hr
CO
0.29 in/hr
GYD
0.20 in/hr
GYD
0.26 in/hr
GWD
0.35 in/hr
TSC
0.14 in/hr
100
0.40 in/hr
98
0.37 in/hr
70
0.36 in/hr
20
11
10
FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY
SUN VALLEY
AREA DRAINAGE MASTER PLAN
STEP 3 - HYDROLOGY
FRS 2 & 3 SUB-AREA
FAN SYSTEM 10, 11, & 20
NRCS SOIL MAP
FCD 2004C049
DECEMBER 2006
Feet
0
600
1,200
1,800
JE FULLER

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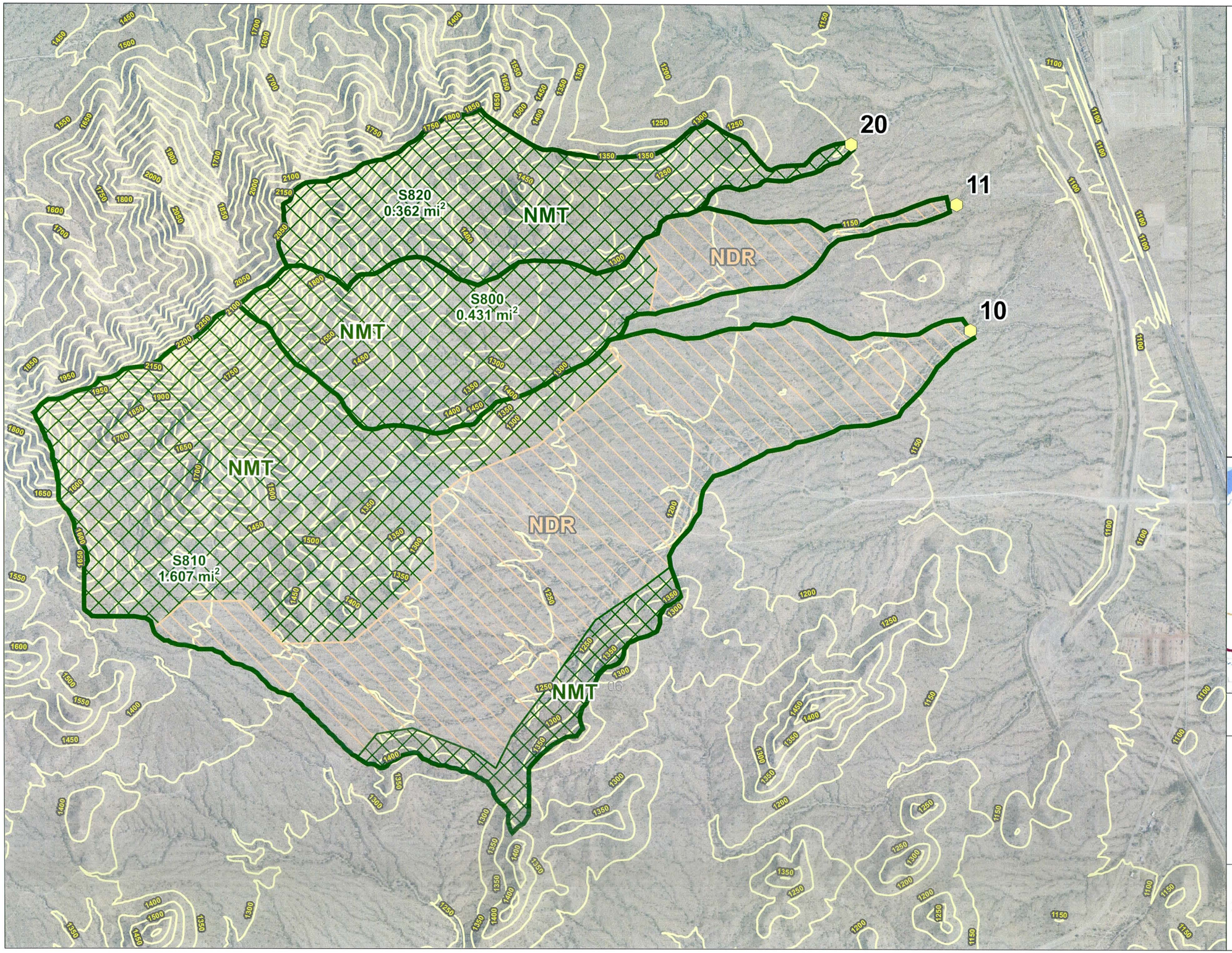
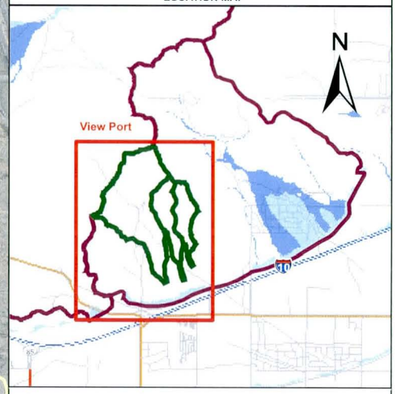


LEGEND

Existing Land Use

- Desert Rangeland (NDR), < 5 % Slopes
- Hillslopes (NHS), 5 - 10 % slopes
- Mountain Terrain (NMT), > 10 % Slopes
- Subbasin Boundaries
- 50-ft Contours
- Fan Apices

LOCATION MAP



FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY

SUN VALLEY
AREA DRAINAGE MASTER PLAN

STEP 3 - HYDROLOGY
FRS 2 & 3 SUB-AREA
FAN SYSTEM 10, 11, & 20
LAND USE MAP

FCD 2004C049
DECEMBER 2006

Feet
0 600 1,200 1,800

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Appendix C

Miscellaneous Additional Materials

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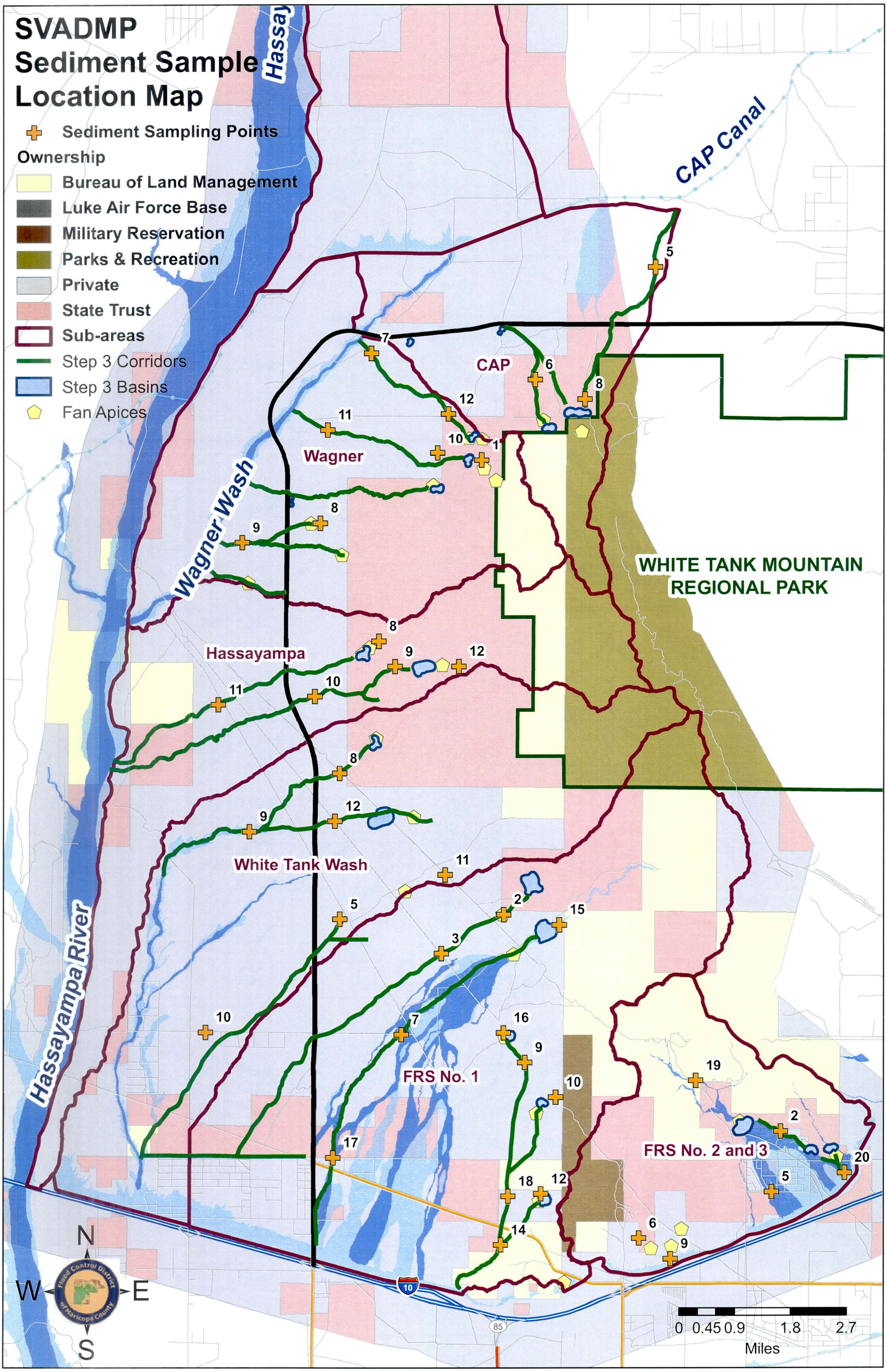
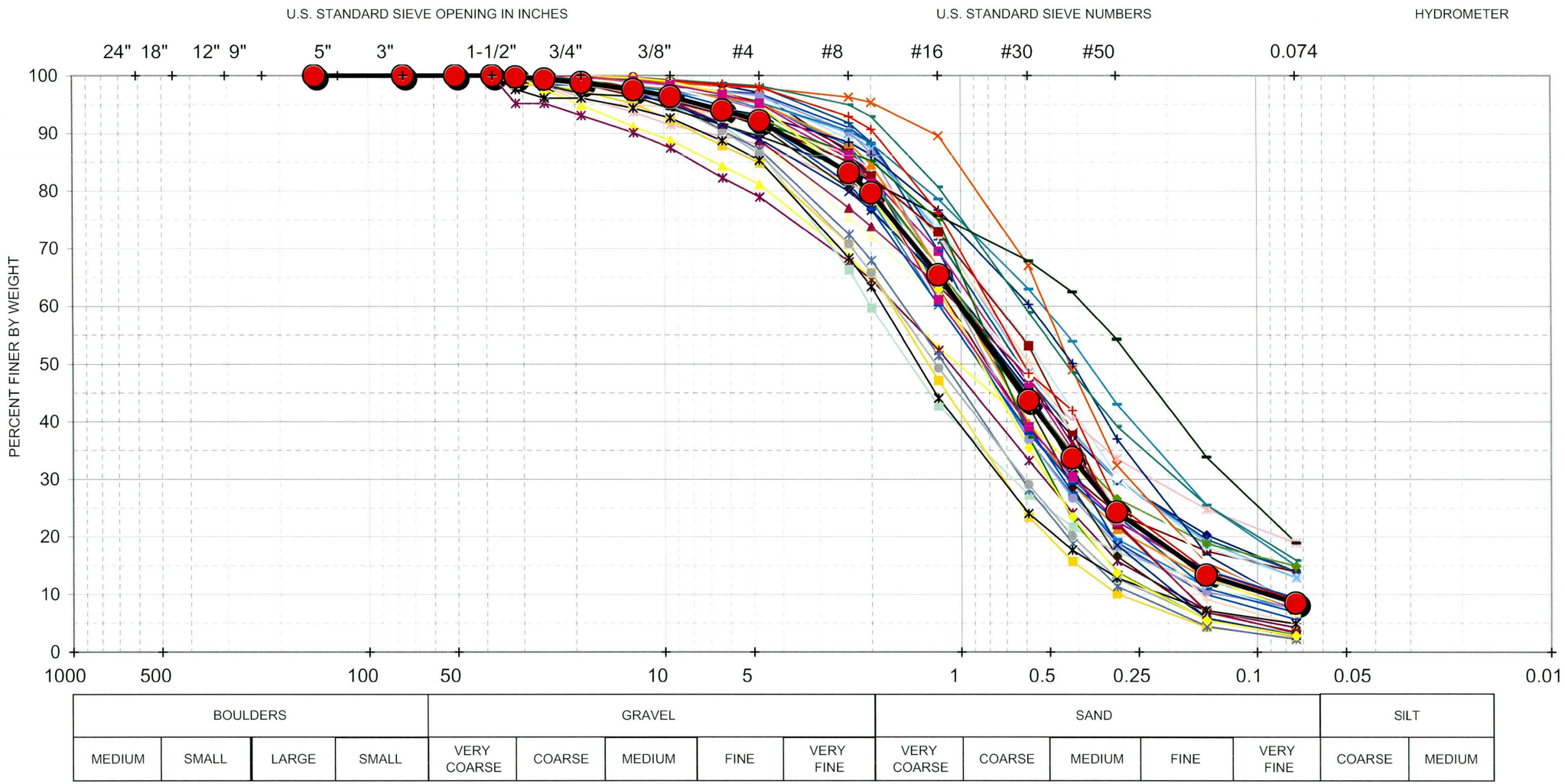

SVADMP
Sediment Sample
Location Map
Sediment Sampling Points
Ownership
Bureau of Land Management
Luke Air Force Base
Military Reservation
Parks & Recreation
Private
State Trust
Sub-areas
Step 3 Corridors
Step 3 Basins
Fan Apices
Hassay
CAP Canal
CAP
Wagner
Wagner Wash
Hassayampa
White Tank Wash
Hassayampa River
FRS No. 1
FRS No. 2 and 3
WHITE TANK MOUNTAIN
REGIONAL PARK
N
W
E
S
0 0.45 0.9 1.8 2.7
Miles



Hassayampa 8 — Hassayampa 9 — Hassayampa 10 — Hassayampa 11 — Hassayampa 12 — CAP 5 — CAP 6
CAP 8 — Wagner 1 — Wagner 7 — Wagner 8 — Wagner 9 — Wagner 10 — Wagner 11
Wagner 12 — FRS 1 - 2 — FRS 1 - 3 — FRS 1 - 7 — FRS 1 - 9 — FRS 1 - 10 — FRS 1 - 12
FRS 1 - 14 — FRS 1 - 15 — FRS 1 - 16 — FRS 1 - 17 — FRS 1 - 18 — White Tank 5 — White Tank 8
White Tank 9 — White Tank 10 — White Tank 11 — White Tank 12 — FRS 2 & 3 - 2 — FRS 2 & 3 - 5 — FRS 2 & 3 - 6
FRS 2 & 3 - 9 — FRS 2 & 3 - 19 — FRS 2 & 3 - 20 — Average — + Log Scale — + Sizes Labels

Sun Valley ADMP

JE Fuller Hydrology and Geomorphology Inc.
Tempe Arizona