ADOBE DAM/DESERT HILLS

AREA DRAINAGE MASTER PLAN

Part 8

Alternatives Formulation Report Appendices

Volume 4

Flood Control District of Maricopa County

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ADOBE DAM/DESERT HILLS AREA DRAINAGE MASTER PLAN

PHASE II ALTERNATIVES FORMULATION REPORT
PART 8, VOLUME 4

Flood Control District of Maricopa County

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ALTERNATIVES FORMULATION REPORT

PART 8, Volume 4

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SECTION 1: INTRODUCTION

As part of the *Phase II Alternatives Formulation, Part 8, Volume 3 and Recommended Alternatives, Part 10, Volume 1* alternatives have been formulated. This report only deals with structural alternatives. Refer to Part 8, Volume 3 for no action or nonstructural alternative analysis. For the purposes of this report, these alternatives have been evaluated for fatal flaws as well as for common sense solutions to existing problems within the Adobe Dam/ Desert Hills Area Drainage Master Plan (ADMP).

The technical backup necessary to assess each of the alternatives formulated in the *Phase I Alternatives Formulation & Preliminary Analysis, Part 8, Volume 1 and 2* reports are included in this report. This report is meant to work hand in hand with the *Phase II Alternatives Formulation Report Part 8, Volume 3 and Recommended Alternatives, Part 10, Volume 1.* This report actually functions as a technical appendix to the Part 8, Volume 3 and Part 10, Volume 1 reports.

SECTION 2: DATA SOURCES

A number of data sources were needed to perform the technical backup for the preliminary alternatives and then to further adjust the recommended alternatives. Before presenting the technical backup methodology for each site, data sources are listed and some context on their origin is provided. The data sources for the analyses were as follows, but may not be limited to:

- Existing studies used in analysis
  - *Phase 1, Design Option Report Pinnacle Peak Road Bridge Over Skunk Creek, BR-922765,* Performed by Wood/ Patel Associates in June, 1993. This report was used to establish an alternative that had already been mutually agreed upon by the City of Phoenix (Phoenix) and the Flood Control District of Maricopa County (FCDMC) for site number 1. The alternatives discussed in this report were carried forward for further analysis and cost estimation.

- *Split Flow Analysis Over Pinnacle Peak Road, CVL #98-0013,* Performed by Coe & Van Loo in October, 2002. This report shows the flow split in Skunk Creek north of Pinnacle Peak Road that was used as a basis for alternative design for site number 1.
- *Letter of Map Revision Request for Skunk Creek, City of Phoenix Contract No. SA-930222, Technical Data Notebook,* Performed by Tetra Tech, Inc., Submitted to EMCON/OWT, and prepared for the City of Phoenix in November, 2002. This report is a LOMR reflecting water surface elevation changes within Skunk Creek from Interstate 17 to the flood pool area of Adobe Dam. This report was necessary to reflect the construction of the Skunk Creek Landfill and associated levees; the Pinnacle Peak Road bridge, drop structure, and associated channelization; the Adobe Highlands residential development; and Paseo Highlands Park, located on the southeast corner of Pinnacle Peak Road and 35th Avenue. This LOMR impacts all of site number 1.
- *Skunk Creek Watercourse Master Plan, Attachment 3, Hydrology Report, FCD 99-23,* Performed by Tetra Tech, Inc. in August, 2001. This report was used as a foundation for all of the hydrology along the Skunk Creek Corridor. This impacts site numbers 2, 3, 8, 9, 10, and 11.
- *Skunk Creek Watercourse Master Plan, Attachment 7, Two Dimensional Hydraulic Model of the Confluence of Skunk Creek & Sonoran Wash at the CAP Canal, FCD 99-23,* Performed by Tetra Tech, Inc. in July, 2001. This report was used to look at the breakout at site number 2 out of Skunk Creek onto Interstate 17 north of the CAP Canal.
- *Floodplain Delineation Study for Skunk Creek Between the Central Arizona Project and Happy Valley Road, Two-Dimensional Hydraulic Model,* Performed by Tetra Tech, Inc. in June, 2002. This report was the basis for the alternatives at site number 2. The two-dimensional modeling that was performed in this report analyzed each of the alternatives looked at in the ADMP at site number 2.
- *Conceptual Plan for Desert Hills,* Performed by RBF Consulting in July, 2004 for the Arizona State Land Department. This report is a data collection and processing effort, suitability analysis, and an analysis of future land use needs for the State Trust parcels located in the Desert Hills area. This report was useful to determine the proposed land uses for site numbers 4 and 5.

- *Maricopa County Department of Transportation Construction Plans for: Carefree Highway – 7th Street to Cave Creek Road, Project No. 69003,* Performed by Dibble & Associates Consulting Engineers and issued for public bidding in August, 1997. These plans were used to determine the capacity of drainage facilities located in the Carefree Highway. This information was used to analyze the alternatives at site numbers 6 and 7.
- *Apache Wash Hydrology Report for Apache Wash Flood Insurance Study, FCDMC Contract No. 89-66,* Performed by Jerry R. Jones & Associates, Inc. in November, 1991. This report established the hydrology that was used for the Apache Wash Flood Insurance Study and site number 7.
- *Apache Wash Flood Insurance Study, FCDMC Contract No. 89-66,* Performed by Jerry R. Jones & Associates, Inc. in August, 1992. This report establishes the existing floodway/floodplain for Apache wash. This information was useful in the analysis of the alternatives at site number 7.
- *Hydrology Report, Rodger Creek Floodplain Delineation Study,* Performed by Michael Baker Jr., Inc. in 1989. This report established the hydrology that was used for the Rodger Creek Flood Insurance Study and site number 9.
- *Rodger Creek Flood Delineation Study,* Performed by Michael Baker Jr., Inc. in 1990. This report establishes the existing floodway/floodplain for Rodger Creek. This information was useful in the analysis of the alternatives at site number 9.
- *Skunk Creek Floodplain Delineation Study, Technical Data Notebook,* Performed by Montgomery Watson in 1997. This report establishes the existing floodway/floodplain for Skunk Creek north of the CAP. This information was useful in the analysis of the alternatives at site numbers 2, 3, 8, and 11.

o Stakeholder and Municipality information that was provided to JEF and used for analyses

- Ralph Goodall with the City of Phoenix provided updated cost estimates for the alternatives at site number 1.
- Randy Randolph with the Central Arizona Project provided excerpts from an internal hydrology report regarding reach 10 of the Granite Reef Aqueduct. These excerpts included hydrologic information about the design of the CAP Canal at site number 2.

- Chris Plumb with MCDOT provided updated cost information for roadways in Maricopa County. These were very useful for the cost estimates provided for each of the analysis sites.
- Andy Wojakiewicz with MCDOT provided typical roadway sections and typical bridge sections for use in analyzing site numbers 3, 4, 5, 6, 7, 8, 9, and 10.
- Tom Loomis with the FCDMC provided GIS mapping related to his two-dimensional modeling north of the New River Road Bridge on Skunk Creek. This information was used to establish the extent of flooding that is not represented in the effective floodplain delineation study for site number 11. It is important to note that this FLO-2D modeling should also be used to determine final design of site number 11.

o Additional information used for analyses

- The FCDMC provided GIS information at the beginning of this project. Aerial photography, contour information, existing floodway/floodplain information, assessor parcel information, and landuse information. This information was used in many diverse ways at each of the sites analyzed and will be documented further within.
- The ADMP has generated many deliverables such as new hydrology within selected areas, new floodplain delineations, a flood response plan, etc... This information was used in the analysis of each of the sites and will be documented further within.

SECTION 3: SITE ANALYSIS

3.1 General

This section is designed to discuss each individual site that was analyzed. It is organized by site. Each site is discussed in terms of problem description, methodology, design, plan and profile sheets, and cost estimates. Refer to Appendix B for supporting calculations by site number and alternatives schematics for alternatives that did not become the recommended alternative.

3.2 Individual Site Analysis

3.2.1 Site Number 1

Problem Description – In June of 1993 Wood/ Patel contracted with the City of Phoenix to perform an analysis of alternatives for design options of a bridge over Skunk Creek at Pinnacle Peak Road. This report, *Phase 1, Design Option Report Pinnacle Peak Road Bridge Over Skunk Creek, BR-922765,* Performed by Wood/ Patel Associates in June, 1993, looked at several options for bridges. From this report, the recommended alternative was Option C-1 which provides a 100-year crossing at Pinnacle Peak Road and allows for future extension of the 35th Avenue to the north (Appendix B). In addition, its channel geometry provides a sediment transport rate comparable to the existing channelization to the north.

Even though this alternative was recommended, what was actually built in 1995 was a four-span concrete box-girder bridge, a roller-compacted concrete drop structure located approximately 350 feet upstream of the bridge, and an excavated channel with soil-cement bank protection between the drop structure and the bridge. The excavated channel has a bottom width of 250 feet and continues, unlined, downstream of the bridge to the Adobe Dam reservoir area. After conversations with the City and Wood/ Patel, it appears that the reason for downgrading the construction from the recommended alternative was because of budgetary reasons. It was felt that it was better to build something that protected most of the time and improve it later when funds or cost sharing partners were available.

In 2002 Tetra Tech, Inc. completed the *Letter of Map Revision Request for Skunk Creek, City of Phoenix Contract No. SA-930222, Technical Data Notebook.* They submitted this report to FEMA, but as of this report it was unclear if it had been approved. This report identified a breakout from Skunk Creek downstream of the landfills and upstream of the drop structure across Pinnacle Peak Road. Also in 2002, Coe & Van Loo Consultants performed the *Split Flow Analysis Over Pinnacle Peak Road, CVL #98-0013.* This report took this breakout from Skunk Creek and carried it downstream through the park and back into the Adobe Dam reservoir impoundment area. This split flow analysis assumed that the entire 15,500 cfs breakout crossed Pinnacle Peak Road and entered the park site. Because of this breakout, the ADMP looked at this site and what could be done to eliminate this breakout and deliver the flows to the Adobe Dam reservoir area.

Methodology and Design – While researching this site, JEF found that considerable analysis has already been performed. The *Phase 1, Design Option Report Pinnacle Peak Road Bridge Over Skunk Creek, BR-922765,* performed by Wood/ Patel Associates in June, 1993 looked at several options at this particular location. After reviewing this report, JEF agrees with Wood/ Patel that Option C-1 is the best alternative for this site. The methodology that Wood/ Patel used follows generally accepted design methodology and makes the most economic sense.

This option consists of a 320-foot span of Pinnacle Peak Road bridge crossing, a concrete stepped drop structure immediately downstream of the southern boundary of the Skunk Creek Landfill, a levee between the drop structure and landfill, and an incised channel downstream of the drop structure. The cross-sectional geometry of the channel is a trapezoid with 2:1 side slopes. Refer to Figure 3.1 for a plan view of this option.

The drop structure is a stepped concrete structure with eight 2-foot high steps to dissipate energy. The levees will be keyed into the existing levee system for the landfill. All channel embankment lining consists of soil cement. The freeboard allowance for he 100-year flow condition is 1.5 feet.

Comparisons of the 100-year water surface elevations of this option with those of the revised CVL model shows that the water surface does not increase at any cross sections.

Based on the fact that this alternative has been recommended previously in other reports as well as further analysis by JEF and the ADMP team, this alternative has become part of the recommended alternative.

Plan and Profiles – The plan and profile sheet was put together incorporating Wood/ Patel's Option C-1 with updated aerial photography and topography. Existing utilities are shown in the plan view, but actual depths of these utilities are unknown. The profile shows the proposed condition in conjunction with the existing condition profile. The effective FIS design flow (100-year) of 39,000 cfs is also provided. Refer to Figure 3.2 for the Plan and Profile of Site Number 1 and Appendix B for all supporting data.

Cost Estimates –Since this alternative has already been recommended to the City, JEF talked with Ralph Goodall at the City and found that preparations had already been made to include this project into the City's Capital Improvement Program (CIP). Cost estimates for this alternative were provided by the City of Phoenix, so any further cost estimate preparation would be unnecessary. Refer to Table 3.1 for cost estimates for Site 1.

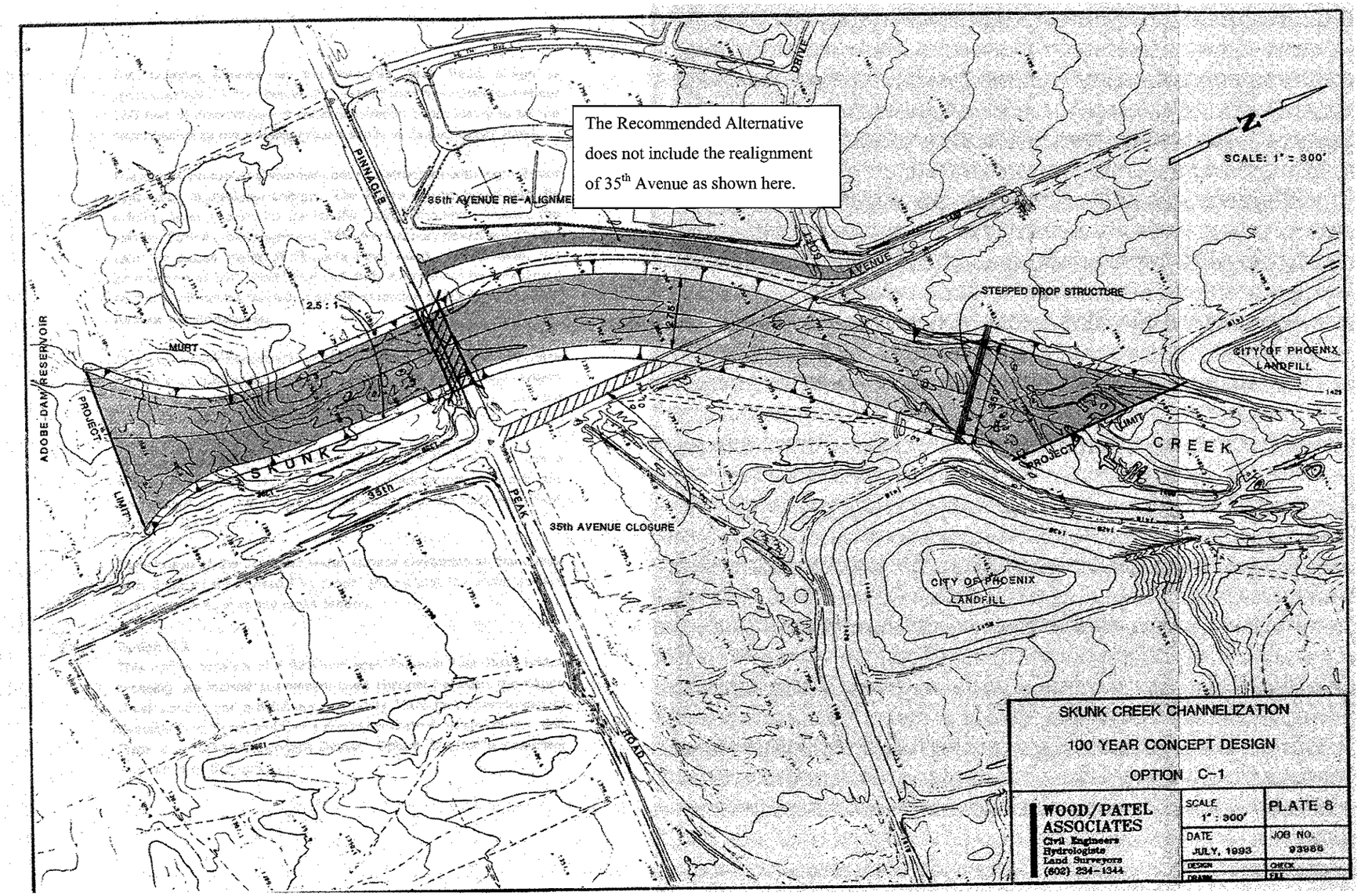

Figure 3.1

Plan View of Site Number 1

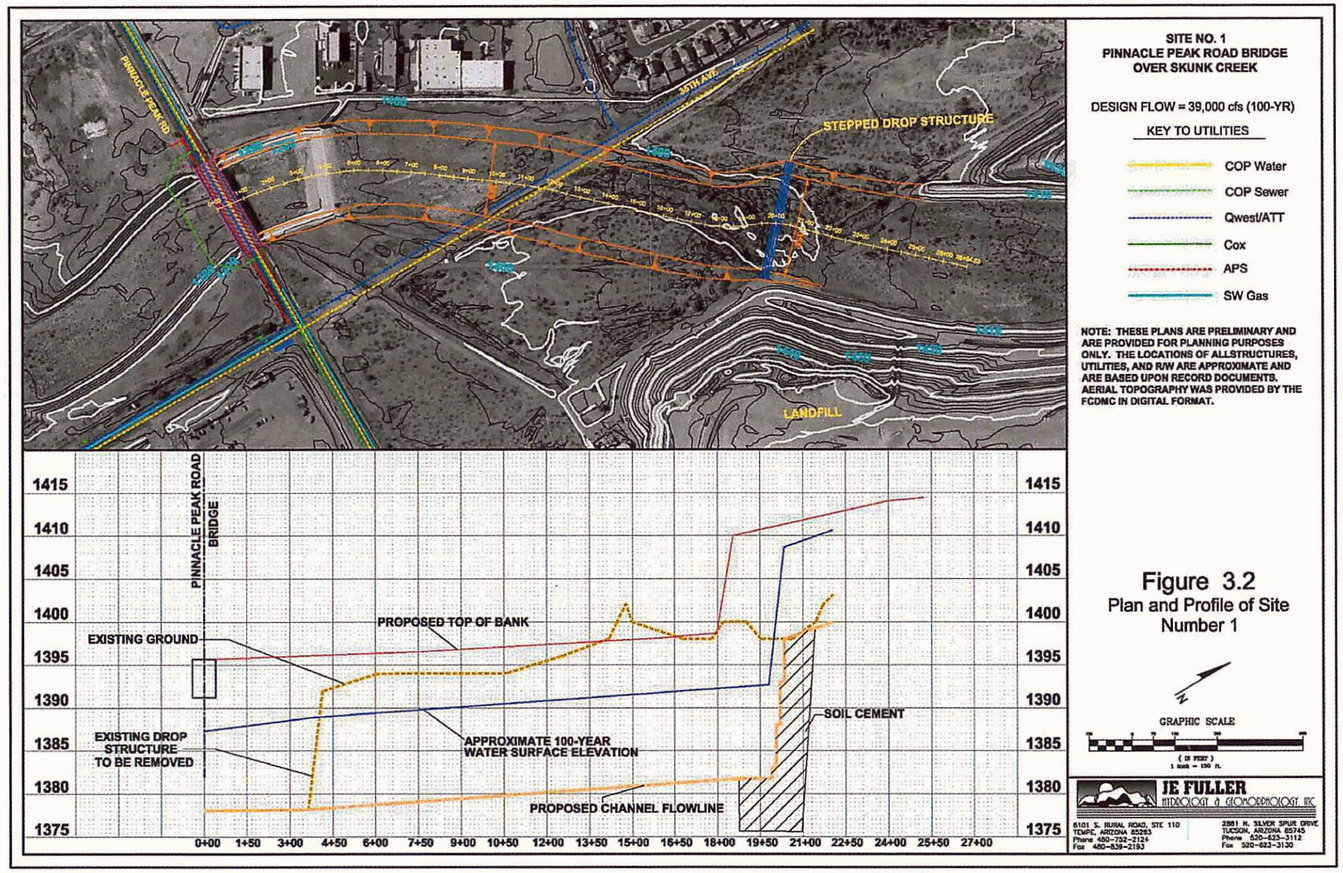

Figure 3.2

Plan and Profile of Site Number 1

Table 3.1

Cost Estimates for Site Number 1

Item	Unit	Quantity	Unit Cost	Total
Subgrade Prep.	Sq. Yd.	43413.00	$3.50	$151,945.50
Pavement (surface)	Tons	3662.97	$40.00	$146,518.88
Pavement (base)	Tons	14651.89	$38.00	$556,771.73
Tack Coat	Tons	36.47	$380.00	$13,857.43
Vert. Curb & Gutter	Lin. Ft.	11000.00	$9.00	$99,000.00
Single Curb	Lin. Ft.		$11.00	$0.00
Sidewalk	Sq. Ft.	55000.00	$2.00	$110,000.00
Ribbon Curb	Lin. Ft.		$8.00	$0.00
Landscaping	Sq. Ft.	105000.00	$2.50	$262,500.00
Deco Pavement	Sq. Ft.	1000.00	$6.00	$6,000.00
Street Lights	Lin. Ft.	11000.00	$8.00	$88,000.00
Storm Drain	Lin. Ft.	5280.00	$200.00	$1,056,000.00
Catch Basins	Each	20.00	$2,500.00	$50,000.00
Bridge	Sq. Ft.	37600.00	$66.00	$2,481,600.00
Channelization	C.Y.	385000.00	$3.00	$1,155,000.00
Soil Cement Bank Protection	C.Y.	71000.00	$50.00	$3,550,000.00
Remove RCC Drop Structure	L.S.	1.00	$200,000.00	$200,000.00
New RCC Drop Structure	C.Y.	6000.00	$75.00	$450,000.00
Adjustments	Each	40.00	$300.00	$12,000.00
Remove V.C.&G.	Lin. Ft.		$1.00	$0.00
Remove Concrete D/W,S/W,etc.	Sq. Ft.		$1.50	$0.00
Remove Structures	L.S.			$0.00
Misc.Removal and Other Work	L.S.	1.00	$15,000.00	$15,000.00
Waterline Relocation	Each			$0.00
Traffic Signals (Per Intersection)	Each	1.00	$50,000.00	$50,000.00
Contingent (20%)	L.S.			$2,090,838.71
TOTAL				**$12,545,032.24**

Table 3.1

Cost Estimates for Site Number 1

Item	Unit	Quantity	Unit Cost	Total
Design Cost				
Consultant				$752,701.93
DCM Staff				$1,003,602.58
Construction Adm.				$1,756,304.51
TOTAL Design/Const.				**$3,512,609.03**
Right-of-Way				$250,000.00
GRAND TOTAL				**$16,307,641.26**

Note: Costs provided by the City of Phoenix. This job has already been sent out for design bid.

No edits were made to the cost estimates at this time.

3.2.2 Site Number 2

Problem Description – In 1990, Coe & Van Loo used HEC-2 to estimate the 100-year floodplain limits for Skunk Creek upstream of the Central Arizona Project Canal (CAP) (Appendix B) and to estimate the amount of discharge that breaks away from Skunk Creek in the effective Flood Insurance Study. Their findings were as follows:

- Approximately 3,000 cfs breaks out to the west across I-17.
- Approximately 5,000 cfs breaks out to the south into the CAP Canal on the west side of the Skunk Creek Overchute.
- Approximately 1,000 cfs break out to the south into the CAP Canal on the east side of the Skunk Creek Overchute.
- Approximately 1,000 cfs breaks out to the south into the CAP Canal on the west side of the Sonoran Wash Overchute.

- Approximately 200 cfs breaks out south into the CAP Canal on the east side of the Sonoran Wash Overchute.
- And approximately 16,600 cfs continues down the Skunk Creek channel corridor.

In 1997 Montgomery –Watson accepted the Coe & Van Loo study for the *Skunk Creek Floodplain Delineation Study.*

In 2001 Tetra Tech, Inc. performed the Skunk Creek Watercourse Master plan (WCMP) and identified flooding across I-17 upstream of the CAP. This flooding is summarized in the *Skunk Creek Watercourse Master Plan, Attachment 7, Two Dimensional Hydraulic Model of the Confluence of Skunk Creek & Sonoran Wash at the CAP Canal, FCD 99-23.* This attachment was added to the Watercourse Master Plan because of the very complex problem of a very broad floodplain in the confluence area in combination with the structures associated with the CAP. The FCDMC was interested in better defining the following:

- The 100-year water surface elevations, limits of flooding, and flow patterns upstream and downstream of the CAP.
- The location and magnitude of flow that would break out of the Skunk Creek/Sonoran Wash corridors during the 100-year flood event.
- The associated hydraulic parameters associated with the 100-year event such as depths, velocities, etc...
- The location and type of hydraulic controls.
- The modifications needed to contain the 100-year event within the Skunk Creek/Sonoran Wash corridors.
- The ability of the CAP overchute structures to accommodate the 100-year event.
- The impact of the two dimensional analysis results on the starting water surface elevations specified in the existing FIS studies on Skunk Creek and the initial FIS study for Sonoran Wash.
- The recurrence interval of the initial breakout flow across I-17.

The following is summary of the results found in this initial two dimensional modeling:

- The 100-year starting water surface elevation for Skunk Creek was estimated at 1533.7 by two dimensional modeling which compares to a starting water surface elevation of 1532.5 that was used for both the effective FEMA study and the Tramonto CLOMR.
- The 100-year starting water surface elevation for Sonoran Wash was established as 1532.1.
- The breakout flow across I-17 is 6,400 cfs, has an average depth of 2.5 feet, and a total volume of 76,800 acre feet.
- The overchute structures are capable of passing the combined 100-year event from Skunk Creek and Sonoran Wash assuming that flow is directed to them by raising the upstream embankment so that the design flow is actually 100-year instead of 50-year. However, the extent of local scour upstream and downstream of the structures was not evaluated. These results assumed that ponding behind the proposed levee improvements upstream of the CAP are allowed to occur.
- The earliest breakout flow was noted to be 14.20 hours at I-17. This corresponds to a total discharge of approximately 17,600 cfs on the Skunk Creek Hydrograph which also corresponds to approximately a 26-year recurrence interval on the discharge frequency curve.
- Table 3.2 shows the comparison of this study with the Coe & Van Loo study with respect to breakout locations and magnitude.
- Table 3.3 is a summarization of levees that were modeled in this report to contain the flows.

Table 3.2

WCMP Comparison of Breakout Flows for Site Number 2

Location	100-Year Breakout Discharge (cfs)	Coe & Van Loo 100-Year Breakout Discharge (cfs)
West of the Skunk Creek Overchute	1,100	5,000
Across I-17	6,400	3,000
East of the Skunk Creek Overchute	500	1,000
West of the Sonoran Wash Overchute	2,500	1,000
East of the Sonoran Wash Overchute	1,200	200
Flow to the Southeast along the CAP.	100	Not Reported
Overchutes		
Skunk Creek	18,500	*16,600
Sonoran Wash	6,100	*16,600
Total	36,400	26,800
Reported total in Report	36,400	35,000

*It is unclear if these are for both overchutes together or individually. It was assumed that they are combined since they are different size hydraulic structures.

Table 3.3 WCMP Levee Design for Site Number 2			
Location Description	**Length of Levee (feet)**	**Estimated Height (feet)**	**Quantity of Fill (20' Average Width) (cu yd)**
From Skunk Creek Overchute, 1800' west	1,800	5	8,000
From the end of previous levee, 500' north	500	4	2,000
East side of Skunk Creek Overchute	500	5	2,300
West side of Sonoran Wash Overchute	200	4	1,000
East side of Sonoran Wash Overchute	300	4.5	1,500
East side of study area, upstream of the CAP	300	7	1,600
East side of Study area upstream of the CAP	300	4	900

One of the outcomes of the WCMP, was the recommendation that the two dimensional modeling be extended to include Buchanan Wash to the west and extend downstream to Happy Valley Road. In 2002, The FCDMC contracted with Tetra Tech, Inc. to perform this modeling. As a result of this, the *Floodplain Delineation Study for Skunk Creek Between the Central Arizona Project and Happy Valley Road, Two-Dimensional Hydraulic Model*, was performed. This two-dimensional study expanded on the previous studies and includes the following analyses for both the 100-year and Standard Project Flood (SPF) events:

- An expanded two dimensional analysis of existing conditions. The Skunk Creek study limits are from Happy Valley Road (downstream limit) to the

CAP. Buchanan Wash, from the CAP to its confluence with Skunk Creek, is also included in the study area.

- A floodplain analysis for the area west of I-17.
- Two pre-development condition models; one without the CAP and another without I-17 or the CAP.
- An analysis of widening the CAP overchutes as a possible remedial alternative.
- An analysis of extending the existing levee system to contain breakout flows.

The results from this study are as follows:

- The existing condition model confirmed breakouts north of the CAP over I-17 in both the 100-year and SPF flood events. The 100-year breakout goes over the canal and ponds on the north side of the CAP and in the medians.
- The existing condition model showed that significant ponding occurs north of the CAP on Buchanan Wash. This ponding causes significant attenuation in the model that is not accounted for in the effective FIS hydrologic model. The land in the ponding area is presently owned by the State of Arizona.
- The predevelopment models show that the flows were fairly well contained only after I-17 was built. The addition of the CAP only helped to contain the flows within the system.
- Widening the overchutes does not help to alleviate the flooding problems within the system. Flow still breaks out over I-17 north of the CAP.
- Extending the levees upstream from current location to the CAP, and north of the canal, on both the east and west sides effectively confines the flows in the channel corridor during the 100-year event. During the SPF event, there is some backwater leaving the channel through the opening between the Corp of Engineers (Corp) levees and the City of Phoenix landfill levees. The costs of these levees are summarized in tables 3.4 and 3.5.

Table 3.4

2D Report Levee Cost Estimates for Site Number 2 (Soil Alluvium Toe-Down)

Location	Height (feet)			Length (Feet)	Avg. End Area (sq ft)		Volume (cu yd)		Construction Cost		
	High	Low	Avg.		Levee	Toe-Down	Levee	Toe-Down	Levee	Toe-Down	Total
East bank from existing levee to CAP	6	2	3.3	4,600	78	135	13,289	23,000	$830,600	$1,437,500	$2,268,100
East bank from CAP to end	12	3	6.6	1,200	251	135	11,156	6,100	$697,300	$375,000	$1,072,300
West bank from existing levee to CAP	6	1	3.1	3,000	85	135	9,444	15,000	$590,300	$937,500	$1,527,800
West bank from CAP to end	7	1	3.8	2,000	89	135	6,593	10,000	$412,100	$625,000	$1,037,100
Total									$2,530,300	$3,375,000	$5,906,000

*Construction cost = $62.50 per cubic yard, per FCDMC.

Table 3.5

2D Report Levee Cost Estimates for Site Number 2 (Concrete Toe-Down)

Location	*Construction Cost		
	Levee	Toe-Down	Total
East bank from existing levee to CAP	$830,600	$480,700	$1,311,300
East bank from CAP to end	$697,300	$125,400	$822,700
West bank from existing levee to CAP	$590,300	$313,500	$903,800
West bank from CAP to end	$412,100	$209,000	$621,100
Total	$2,530,300	$1,128,600	$3,659,000

*Construction cost = $62.50 per cubic yard for Cement Soil Alluvium (levee), per FCDMC. $94 per cubic yard for concrete (toe-down), per CalTrans Construction Cost Index.

The ADMP was tasked with formulating alternatives that would solve the flooding across I-17 as well as the flooding that would occur upstream of the Corp of Engineers levees. The Corp of Engineers levees are upstream of the crossing of Skunk Creek and I-17. These levees, however, do not extend all of the way to the CAP. The aforementioned modeling shows that the 100-year flow backs up in the levee area and "end runs" the levees to both the east and west. New development currently exists to the east and established businesses and residences exist to the west between I-17 and the back side of the Corp. of Engineer's levees.

Methodology and Design –Because of the extensive modeling that has already been done in this area, JEF used this information along with basin analysis information performed by JEF above the CAP to formulate alternatives. The previous studies looked at widening the overchutes, and extending the levees, but did not look at the idea of creating a retention/detention area upstream of the CAP to attenuate the flow downstream. Refer to the WCMP and the two dimensional modeling report for modeling details regarding levee extension and overchute widening that was discussed in the Problem Description section of this report.

For attenuation modeling (retention, detention, etc.) north the CAP, JEF looked at the volume that would need to be captured, how much land area it would take, and at what rate the flow would need to be released. However, this alternative was discarded in phase 1 based on the following reasons:

- At a cost of 5.3 million dollars it would be very expensive and would not address the inundation of homes between the Corp levees and I-17 downstream of the CAP.
- Maintenance would be very expensive and difficult. The sediment yield to assure performance would be based on 63 square miles times 0.3 acre-feet per square mile per year, which is equal to 19 acre-feet per year. This would mean that the basin would fill in with sediment within 58 years without maintenance. Also it may need an additional 330 acre-feet for the 100-year event of inflow sediment.
- Additional topo would be required to analyze further.
- This alternative does not address the SPF event at all.

Along with the recommendations from both the WCMP and the additional two dimensional modeling report, JEF is recommending that the Corp levees be extended north until they tie into the CAP (4,600 from the east bank to the CAP and 3,000 feet from the west bank to the CAP). Additionally, a levee north of the CAP along I-17 is recommended (Approximately 2,000 feet of levee) to stop overtopping of the I-17. Refer to Table 3.4 for approximate lengths of levee extensions.

Based on the fact that this alternative has been recommended previously in other reports as well as further analysis by JEF, such as the upstream basin analysis, and the ADMP team discussions, this alternative has become part of the recommended alternative.

Plan and Profiles – The plan and profile sheet was put together with updated aerial photography and topography. Existing utilities are shown in the plan view, but actual depths of these utilities are unknown. The profile shows the proposed condition in conjunction with the existing condition profile. The design flow (100-year) for Skunk Creek, taken from the WCMP, of 26,513 cfs and Sonoran Wash of 9,825 cfs is provided. Refer to Figure 3.3 for the

Plan and Profile of Site Number 2. Figure 3.4 shows typical levee cross sections for Site Number 2 and Appendix B for all supporting data.

Cost Estimates – Cost estimates for this alternative were performed by JEF. Two different types of levees were looked at in this cost estimate. First JEF looked at levees with concrete toe-downs. Second costs were prepared for cement soil alluvium toe-downs.

Once these costs were established, it was necessary to provide a range of costs based on the land needed to construct the levees. The lower range cost was based on the amount of land needed if only the footprint of the levees was purchased. This is obviously going to be a cost that is too low based on the fact that it would be very difficult if not impossible to purchase just the land under the footprint of the levees. Because of this, an upper range was established based on the purchase of every parcel that the levees crossed in any way. The actual cost is going to fall somewhere between these two. At the time of the analysis (July, 2004), the land costs are assumed to equal $1.50 per square foot of raw ground or $65,340.26 per acre as provided by the FCDMC. Refer to Table 3.6 for cost estimates for Site Number 2.

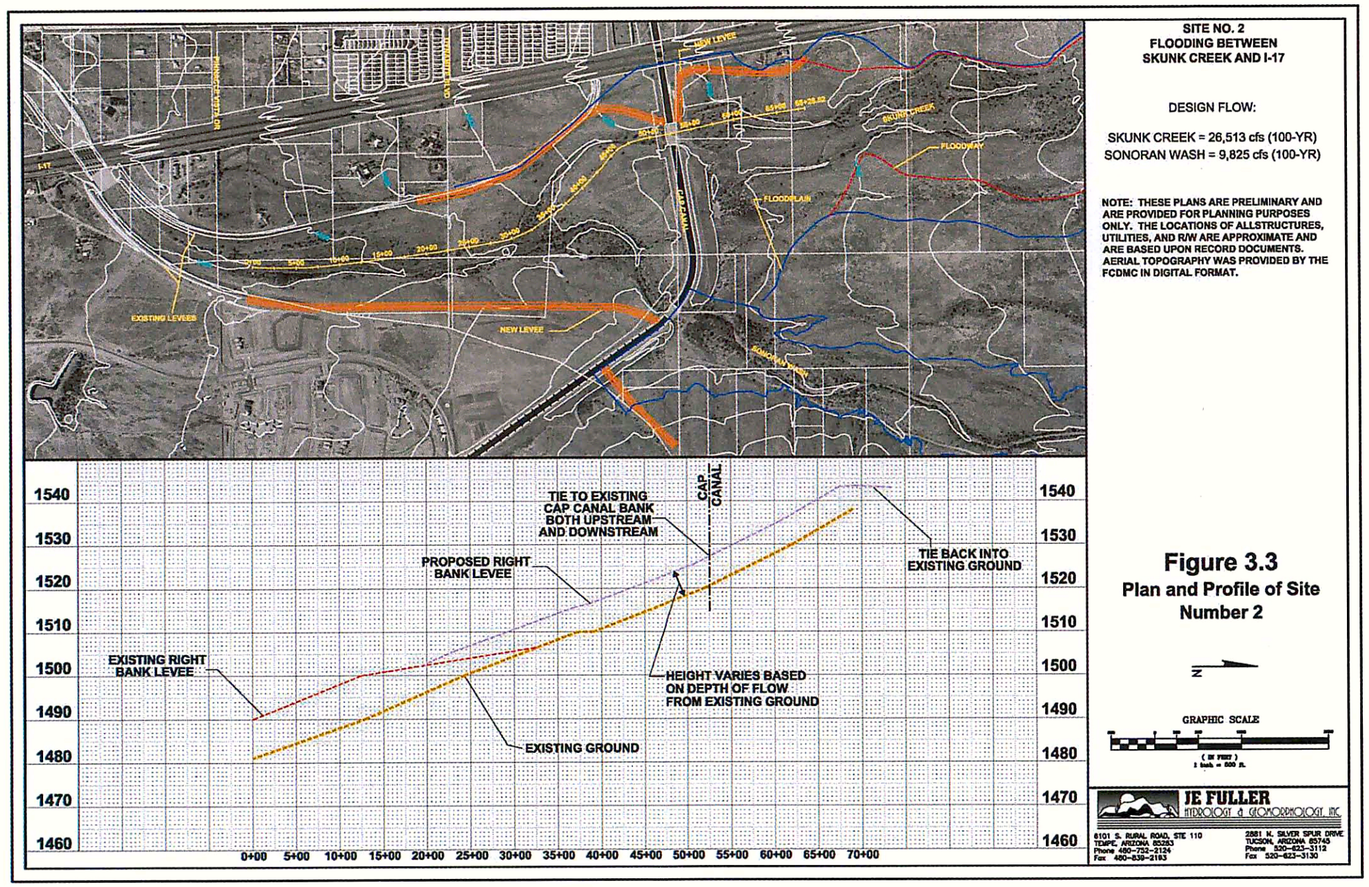

Figure 3.3

Plan and Profile of Site Number 2

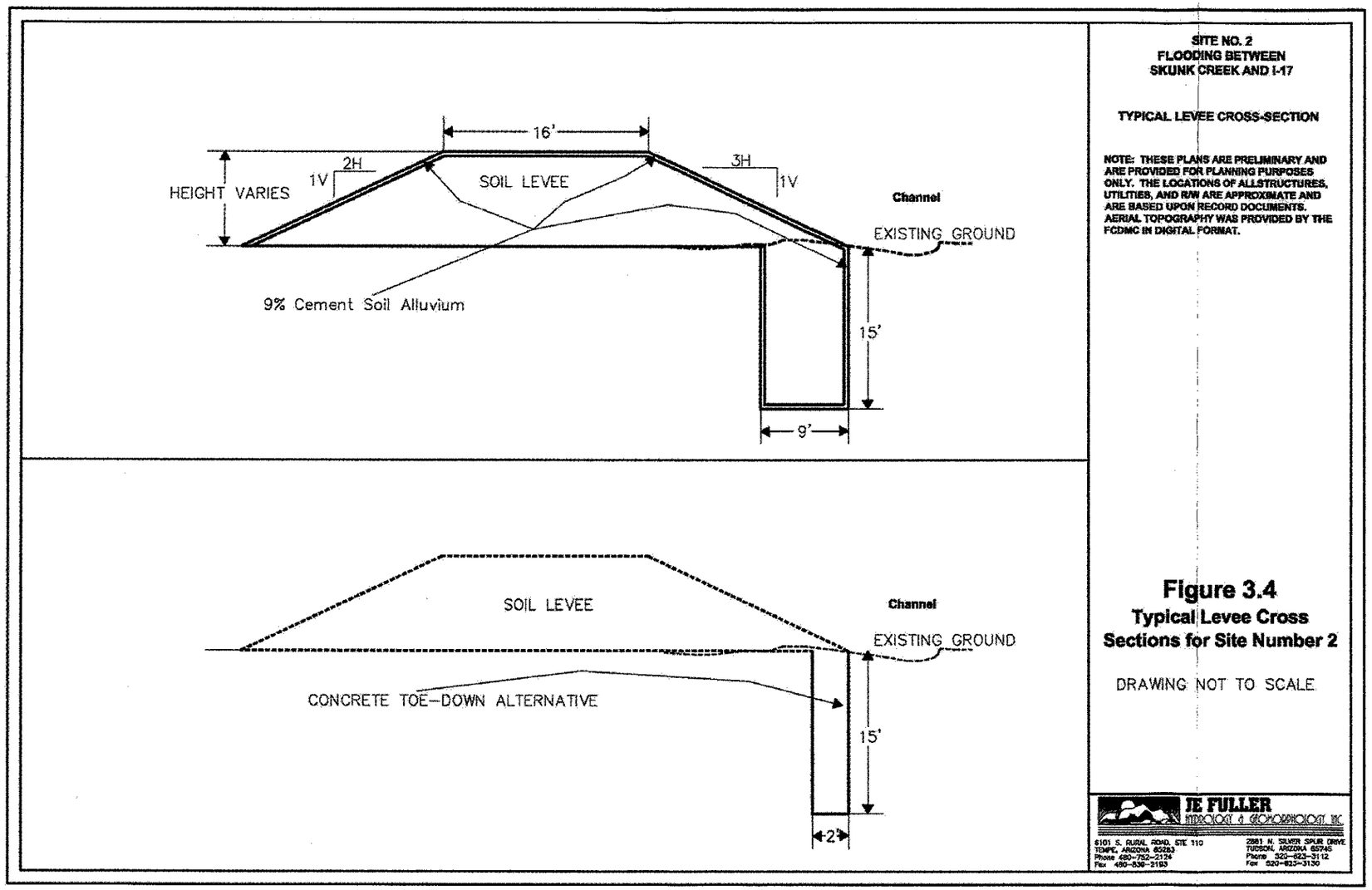

Figure 3.4

Typical Levee Cross Sections for Site Number 2

Table 3.6

Cost Estimates for Site Number 2

COSTS WITH CONCRETE TOE-DOWN

Item	Construction				Land				Contingency	Engineering	Total
	Units	Unit Cost	Quantity	Construction Cost	Units	Unit Cost	Quantity	Land Cost			
Dike Embankment	Cu. Yd.	$ 7	112217	$ 785,519	SF	$ 1.50	832373	$ 1,248,560	$ 196,380	$ 117,828	$ 2,348,286
Soil-Cement Bank Protection	Cu. Yd.	$ 71	10688	$ 758,848	SF	$ 1.50	0	$ -	$ 189,712	$ 113,827	$ 1,062,387
Clearing and Grubbing	LS	$ 4,000	1	$ 4,000	SF	$ 1.50	0	$ -	$ 1,000	$ 600	$ 5,600
Concrete Toe-Down (for Soil Cement Lining)	Cu. Yd.	$ 155	12332	$ 1,911,460	SF	$ 1.50	0	$ -	$ 477,865	$ 286,719	$ 2,676,044
			Totals	$ 3,459,827				$ 1,248,560	$ 864,957	$ 518,974	**$ 6,092,317**

Note: Land costs are assumed to equal $1.50 per square foot raw ground and is only the footprint of the structural alternative. This is equal to $65,340.26 per acre. (July, 2004)

COST WITH CEMENT SOIL ALLUVIUM TOE-DOWN

Item	Construction				Land				Contingency	Engineering	Total
	Units	Unit Cost	Quantity	Construction Cost	Units	Unit Cost	Quantity	Land Cost			
Dike Embankment	Cu. Yd.	$ 7	112217	$ 785,519	SF	$ 1.50	832373	$ 1,248,560	$ 196,380	$ 117,828	$ 2,348,286
Soil-Cement Bank Protection	Cu. Yd.	$ 71	66180	$ 4,698,780	SF	$ 1.50	0	$ -	$ 1,174,695	$ 704,817	$ 6,578,292
Clearing and Grubbing	LS	$ 4,000	1	$ 4,000	SF	$ 1.50	0	$ -	$ 1,000	$ 600	$ 5,600
			Totals	$ 5,488,299				$ 1,248,560	$ 1,372,075	$ 823,245	**$ 8,932,178**

Note: Land costs are assumed to equal $1.50 per square foot raw ground and is only the footprint of the structural alternative. This is equal to $65,340.26 per acre. (July, 2004)

LAND COSTS ASSUMING FULL TAKE ON AFFECTED PROPERTIES

Number of Parcels	Land				Number of Dev. Parcels	Unit Cost	Developed Costs	Total
	Units	Unit Cost	Quantity	Land Cost				
12 - Undeveloped Parcels	SF	$ 1.50	12938481	$ 19,407,722	0	$ -	$ -	$ 19,407,722
1 - Developed Parcel	SF	$ 1.50	0	$ -	1	$ 185,000	$ 185,000	$ 185,000
	Totals			$ 19,407,722			$ 185,000	**$ 19,592,722**

SUMMARY

	Minimum Costs	Maximum Costs
Range of Costs	**$ 6,092,317**	**$ 27,276,341**
Number of Parcels negatively impacted	**13**	
Number of Parcels positively impacted	**25**	

Note: All parcel and structure data based on 2002 parcel and aerial data.

3.2.3 Site Number 3

Problem Description – During the process of identifying problem areas within the ADMP study area, the ADMP team noticed that where Cloud Road bends north and transitions into 27th avenue (Appendix B), the existing alignment is located within the 100-year floodway of Skunk Creek. The ADMP team identified this site because of two major reasons. One, the high hazard potential of the roadway "washing out" would create a major public safety hazard and two; access north could be completely cut off due to the fact that the only other access to this area, at Skunk Creek and Desert Hills Drive, is a low water crossing.

Methodology and Design –Four structural alternatives were considered for site number 3. Each alternative was analyzed using the FIS models established by Montgomery Watson in 1997. The 100-year FIS flow that was used for design at Site Number 3 is 27,700 cfs.

The first alternative was to realign the existing roadway so that it was outside of the floodway. This alternative would be an all weather access that has a raised roadway embankment that is above the 100-year base flood elevation. The embankment would be protected.

This alternative would remove approximately 12 acres from the floodplain, but would require the "taking" of private property for right-of-way. The roadway would not be built to accommodate FEMA freeboard requirements and could cause potentially higher noise levels to existing homeowners due to the roadway being closer to the residences. This alternative also included the removal of the existing roadway so that the floodway could be opened up.

The second alternative was exactly the same as the first one with the exception being that the roadway is raised to accommodate the FEMA freeboard requirements. This would allow for redelineation of the floodplain so that structures currently considered in the floodplain could officially be removed altogether.

The third alternative was to build a bridge structure the entire length of the floodplain along the existing roadway alignment. This alternative would not require the acquisition of more right-of-way, but would require much higher construction costs. This alternative would not remove any existing structures from the floodplain.

The final alternative at Site Number 3 was construct floodwalls and erosion protection to protect the existing roadway alignment. This alternative would also not require any right-of-way costs, but because of the high velocities in the area, would require high construction costs. No existing structures are removed from the floodplain with this option and reconstruction of the floodwalls and erosion protection is very likely due to the high probability of "washouts".

The ADMP team looked at these alternatives and decided that the preferred alternative for this site was the first one. This decision was based on the fact that it addresses the public safety issue as well as providing access to the northern area with the lowest current and future costs associated with it.

As the team moved into the recommended alternative phase of the project, this site was dropped. Access to the north became the driving factor by the team. Site Number 8, a new bridge structure spanning the floodplain of Skunk Creek at Desert Hills Drive, also provides access to this same area. Since the bridge would be located on a major arterial road it became much more desirable to the team than Site Number 3. The fact that Site Number 3 is not included in the recommended alternative means that the possibility exists for roadway "washouts".

Plan and Profiles – The plan and profile sheet for the preferred alternative at this site was put together with updated aerial photography and topography. Existing utilities are shown in the plan view, but actual depths of these utilities are unknown. The profile shows the proposed condition of the new roadway. The design flow (100-year) for Skunk Creek of 27,700 cfs is provided. Refer to Figure 3.5 for the Plan and Profile of Site Number 3. Figure 3.6 shows typical roadway sections for Site Number 3 and Appendix B for all supporting data.

Cost Estimates – Cost estimates for this alternative were performed by JEF. As was discussed for Site Number 2 a range of costs based on the land needed to construct the roadway was necessary. The lower range cost was based on the amount of land needed if only the right-of-way of the roadway was purchased. This is obviously going to be a cost that

is too low based on the fact that it would be very difficult if not impossible to purchase just the land needed for right-of-way. Because of this, an upper range was established based on the purchase of every parcel that the right-of-way came in contact. The actual cost is going to fall somewhere between these two. At the time of the analysis (July, 2004), the land costs are assumed to equal $1.50 per square foot of raw ground or $65,340.26 per acre as provided by the FCDMC. Refer to Table 3.7 for cost estimates for Site Number 3.

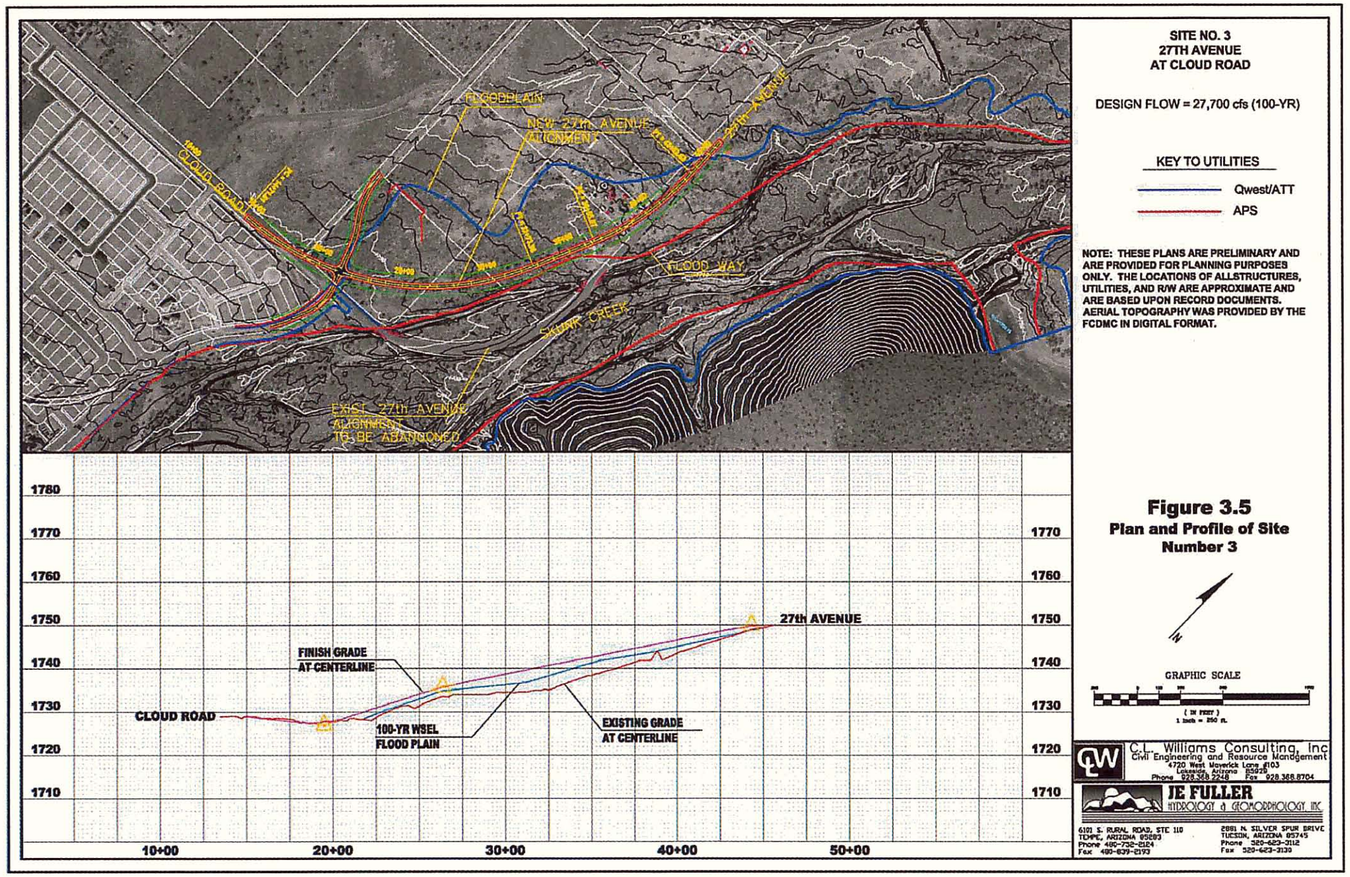

Figure 3.5

Plan and Profile of Site Number 3

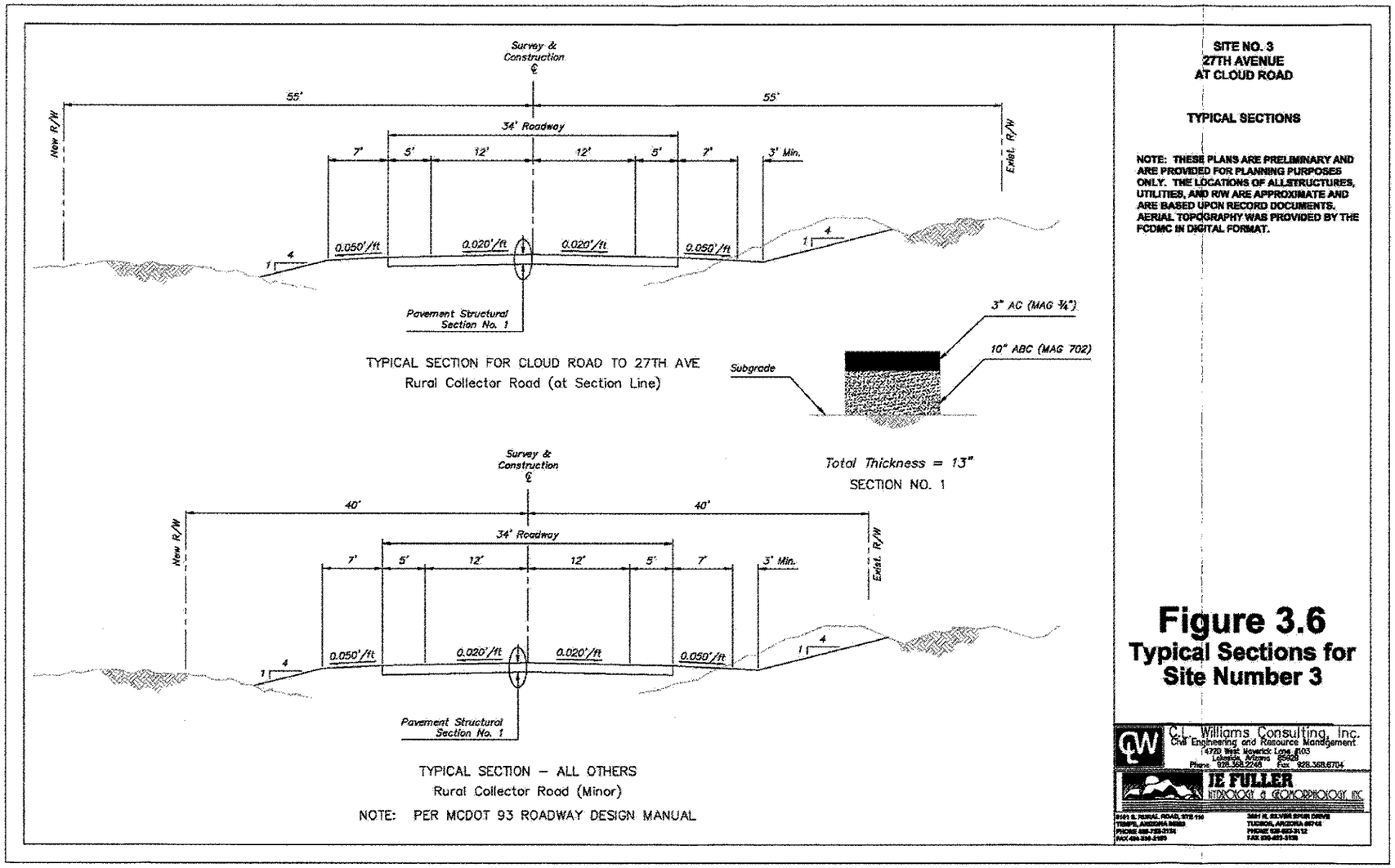

Figure 3.6

Typical Roadway Sections for Site Number 3

Table 3.7

Cost Estimates for Site Number 3

DESIGN CRITERIA

60 mph Design Speed, Rural Major Collector, 4% MSE – R = 1,600 ft, MCDOT 1993/AASHTO 2001 Standards, 300' Minimum Vertical Curves, and a potential fatal flaw of not meeting the design criteria and potential profile conflicts that may exist at Cloud Road.

ACTUAL RESULTS

40 mph Design Speed

Minimum Radius = 400 ft

ESTIMATE OF COSTS

Item	Construction				Land				Contigency	Engineering	Total
	Units	Unit Cost	Quantity	Construction Cost	Units	Unit Cost	Quantity	Land Cost			
Roadway Fill	Cu. Yd.	$ 10	13850	$ 138,500	SF	$ 1.50	0	$ -	$ 34,625	$ 20,775	$ 193,900
Pavement	Sq. Yd.	$ 25	9900	$ 247,500	SF	$ 1.50	0	$ -	$ 61,875	$ 37,125	$ 346,500
Misc. Roadway Items	LS	$ 250,000	1	$ 250,000	SF	$ 1.50	0	$ -	$ 62,500	$ 37,500	$ 350,000
Right-of-Way Acquisition	Acres	$ 50,000	4.7	$ 235,000	SF	$ 1.50	204733	$ 307,100	$ 58,750	$ 35,250	$ 636,100
Demolition	Sq. Yd.	$ 6	8100	$ 48,600	SF	$ 1.50	0	$ -	$ 12,150	$ 7,290	$ 68,040
Rehabilitation	Acres	$ 2,900	4.2	$ 12,180	SF	$ 150.00	0	$ -	$ 3,045	$ 1,827	$ 17,052
Environmental Assessment	LS	$ 100,000	1	$ 100,000	SF	$ 1.50	0	$ -	$ 25,000	$ 15,000	$ 140,000
Right-of-Way Abandonment	LS	$ 20,000	1	$ 20,000	SF	$ 1.50	0	$ -	$ 5,000	$ 3,000	$ 28,000
			Totals	$ 1,051,780				$ 307,100	$ 262,945	$ 157,767	**$ 1,779,592**

Note: Land costs are assumed to equal $1.50 per square foot raw ground and is only the footprint of the structural alternative. This is equal to $65,340.26 per acre. (July,2004)

Land Costs Assuming Full Take on Affected Properties

Number of Parcels		Land				Number of Dev. Parcels		Developed Costs	Total
		Units	Unit Cost	Quantity	Land Cost		Unit Cost		
3 - Undeveloped Parcels		SF	$ 1.50	1114540	$ 1,671,810	0	$ -	$ -	$ 1,671,810
2 - Developed Parcel		SF	$ 1.50	197032	$ 295,548	3	$ 185,000	$ 555,000	$ 850,548
	Totals				$ 1,967,358			$ 555,000	**$ 2,522,358**

Summary

	Minimum Costs	Maximum Costs
Range of Costs	**$ 1,779,592**	**$ 3,994,850**

Number of Parcels negatively impacted	**5**
Number of Parcels positively impacted	**56** (Approximately)

Note: All parcel and structure data based on 2002 parcel and aerial data.

3.2.4 Site Number 4

Problem Description – Site Number 4 (the area between 7th Avenue and 15th Avenue and between Joy Ranch Road and Cloud Road) (Appendix B) was identified by the ADMP team during the process of problem identification. The hydrology in this area showed that there is a flow breakout that occurs from Desert Lake Wash that was not accounted for in the Skunk Tank Wash Hydrology. JEF performed a FLO-2D analysis that encompassed the area between 12th Street and 15th Avenue east and west and between Saddle Mountain Road and the Carefree Highway north and south. This FLO-2D analysis showed where this flow breakout occurred and defined how much of the flow went in each direction. Refer to Part 3, Volume 2 for the results of the FLO-2D analysis. Flow for Site Number 4 floods existing structures and inundates the roadway system. More specifically, the flow that crosses Joy Ranch Road from the north and flows across the State Land Parcel currently intersects 7th Avenue between Joy Ranch Road and Cloud Road. It then continues west into Skunk Tank Wash, flooding several structures along the way. At the Skunk Tank Wash Confluence the flow combines with the Skunk Tank Wash flows coming from the north. The combined flow then continues west until it dumps into Skunk Creek.

The main issues with this site is to lower the peak discharge to a level that would protect the residences in danger and to manage the flow in such a way that it can be conveyed through the system so that it does not inundate the roadway system or spread into inhabited properties.

Methodology and Design –Design flows for this site came from a HEC-1 model performed by JEF that was built in the following manner (Refer to Figure 3.8):

- The flows crossing Joy Ranch Road east of 7th Avenue were derived from the previously stated Flo-2D analysis performed in Part 3, Volume 2 with modifications to add cross sections for determining flows along the northern edge of Joy Ranch Road just east of 7th Avenue and along the eastern edge of 7th Avenue between Joy Ranch Road and Lavitt Lane. These two cross sections are numbers 20 and 21 and are shown on Figure 3.7. The

combined hydrograph of FLO-2D section numbers 20 and 21 were entered into HEC-1 using QI records.

- Skunk Tank Wash Subbasins S17 and S18 were modeled as one subbasin using the Green and Ampt parameters reported in the Cave Creek WCMP and new S-Graph parameters. Also, subbasin S18 was modified to reflect the portion of watershed intercepted by Channel CH4A (Refer to Figure 3.12).
- Subbasins S19 and S20A were not modeled. Instead, a unit discharge of 1,000 cfs per square mile was used to estimate a peak discharge from these areas. That peak estimate was added directly to the HEC-1 results to get the design discharge.

Refer to Figure 3.8 for a map of subbasin layout. Refer to Appendix B for details regarding the FLO-2D modifications, hydrograph manipulation spreadsheets, and the HEC-1 model.

Once the hydrology was finalized, the ADMP team looked at an alternative that would intercept the overland flow prior to the overtopping of 7th Avenue between Joy Ranch Road and Lavitt Lane (CH4A) and convey it under three driveway accesses (CLV4A, CLV4B, and CLV4C) and eventually under Joy Ranch Road (CLV4D). The design discharge for CH4A, CLV4A, CLV4B, CLV4C, and CLV4D is 200 cfs. The interceptor channel (CH4B) would then continue from Joy Ranch Road parallel to 7th Avenue for approximately 3,400 feet where the natural channel bends 90 degrees to the west and convey the flow under 7th Avenue into a culvert crossing (CLV4E). The design discharge for CH4B and CLV4E is 1,350 cfs. At this location the flow will need to be reduced so that it is a manageable level continuing through the rest of the channel system. This is accomplished by diverting the flow through an offline detention basin (4B). Basin 4B will require 60 acre-feet of volume to function correctly. The basin depicted within the context of this report was designed to be 10 feet deep. The control/spillway structure will require a design that allows all but 420 cfs of inflow hydrograph to enter into the basin. Refer to Appendix B under the heading for Site Number 4 for an overall layout of this entire system.

Channel CH4C will convey the reduced peak discharge from 7th Avenue to 11th Avenue where it will convey through another culvert crossing (CLV4F). The design discharge for CH4C and CLV4F is 420 cfs. Channel CH4D will then continue from 11th Avenue to 15th

Avenue where it will convey under the roadway (CLV4G). The design discharge for CH4D and CLV4G is 800 cfs. Channel CH4E will then continue west until it converges with flow that is coming from the north. The design discharge for CH4E is 1,500 cfs.

Flow coming from the north in what is designated as Skunk Tank Wash enters an online detention basin (4C). Basin 4C will require 71 acre-feet of volume to function correctly. The basin depicted within the context of this report was designed to be 10 feet below the natural grade of Maddock Road which serves as the outlet. The outlet at Maddock Road (CLV4H) is designed for 2,150 cfs and establishes a rating curve for Basin 4C. Basin 4C does not, however, reduce the peak enough as to make it manageable downstream. Therefore, an offline basin (4B) is necessary to reduce the peak to a manageable level. Basin 4B will require 65 acre-feet of volume to function correctly. The basin depicted within the context of this report was designed at 15 feet deep. The control/spillway structure will require a design that allows all but 1,100 cfs of inflow hydrograph to enter into the basin.

Channel CH4H will take the flow not entering the detention basin and convey it from Maddock Road to the confluence with Channel CH4E. The design discharge for CH4H is 1,100 cfs. Channel CH4I will then convey the flow from the confluence to just west of 19th Avenue. Crossings at both 17th Avenue and 19th Avenue (CLV4I and CLV4J) are proposed to be ford crossings on grade. The design discharge for CH4I, CLV4I, and CLV4J is 2,810 cfs. Channel CH4I is also proposed to be a regrade of the existing wash so that the intent of the design is to provide bank-full capacity for something less than the 100-year flow, with the full 100-year flow being conveyed in a "floodway" (encroached) section that surcharges the channel by less than 1 foot.

The channels for Site Number 4 were designed using normal depth calculations and using the FlowMaster program distributed by Haestad Methods. The roadway crossings were designed using the HY8 computer program as distributed by the University of Florida, McTrans Center for Microcomputers in Transportation. FlowMaster output, HY8 printouts, and basin design calculations can also be found in Appendix B under the Site Number 4 Heading.

This alternative remedies many of the flooding issues happening along 7th Avenue, and the east branch of Skunk Tank Wash. It handles the breakout flows and the flooding onto 7th Avenue by providing an all weather access crossing. However, it does not help two floodway residences upstream of the confluence in Skunk Tank Wash and may not completely remove

the flood hazard downstream of the confluence. This is because the floodway residences are located very low in comparative elevation to the bottom of the flood hazard area or wash bottom. This is an expensive alternative that will require extensive maintenance within the flood structures themselves.

As the team moved into the recommended alternative phase of the project, this site was dropped. It was decided that the cost of this alternative and the fact that public acceptance of the large basins and channels would be low did not justify moving it into recommended alternative. It was recommended that the residences located within the floodway be included in the Floodprone Property Acquisition Program (FPAP). Since Site Number 4 is not included in the recommended alternative, flooding will continue to occur in the manner in which it currently does.

Plan and Profiles – The plan and profile sheets were put together with updated aerial photography and topography. Existing utilities are shown in the plan view, but actual depths of these utilities are unknown. The profile shows the proposed condition of the new channel along with the existing grade profile. The design flow (100-year) for the design is depicted on each of the individual sheets. Refer to Figures 3.9, 3.10, 3.11, 3.12, and 3.13 for the Plan and Profiles of Site Number 4 and Appendix B for all supporting data.

Cost Estimates – Cost estimates for this alternative were performed by JEF. As was discussed for Site Number 2 a range of costs based on the land needed to construct the channels and basins was necessary. The lower range cost was based on the amount of land needed if only the right-of-way of the channels and basins was purchased. This is obviously going to be a cost that is too low based on the fact that it would be very difficult if not impossible to purchase just the land needed for right-of-way. Because of this, an upper range was established based on the purchase of every parcel that the right-of-way came in contact. The actual cost is going to fall somewhere between these two. At the time of the analysis (July, 2004), the land costs are assumed to equal $1.50 per square foot of raw ground or $65,340.26 per acre as provided by the FCDMC. Refer to Table 3.8 for cost estimates for Site Number 4.

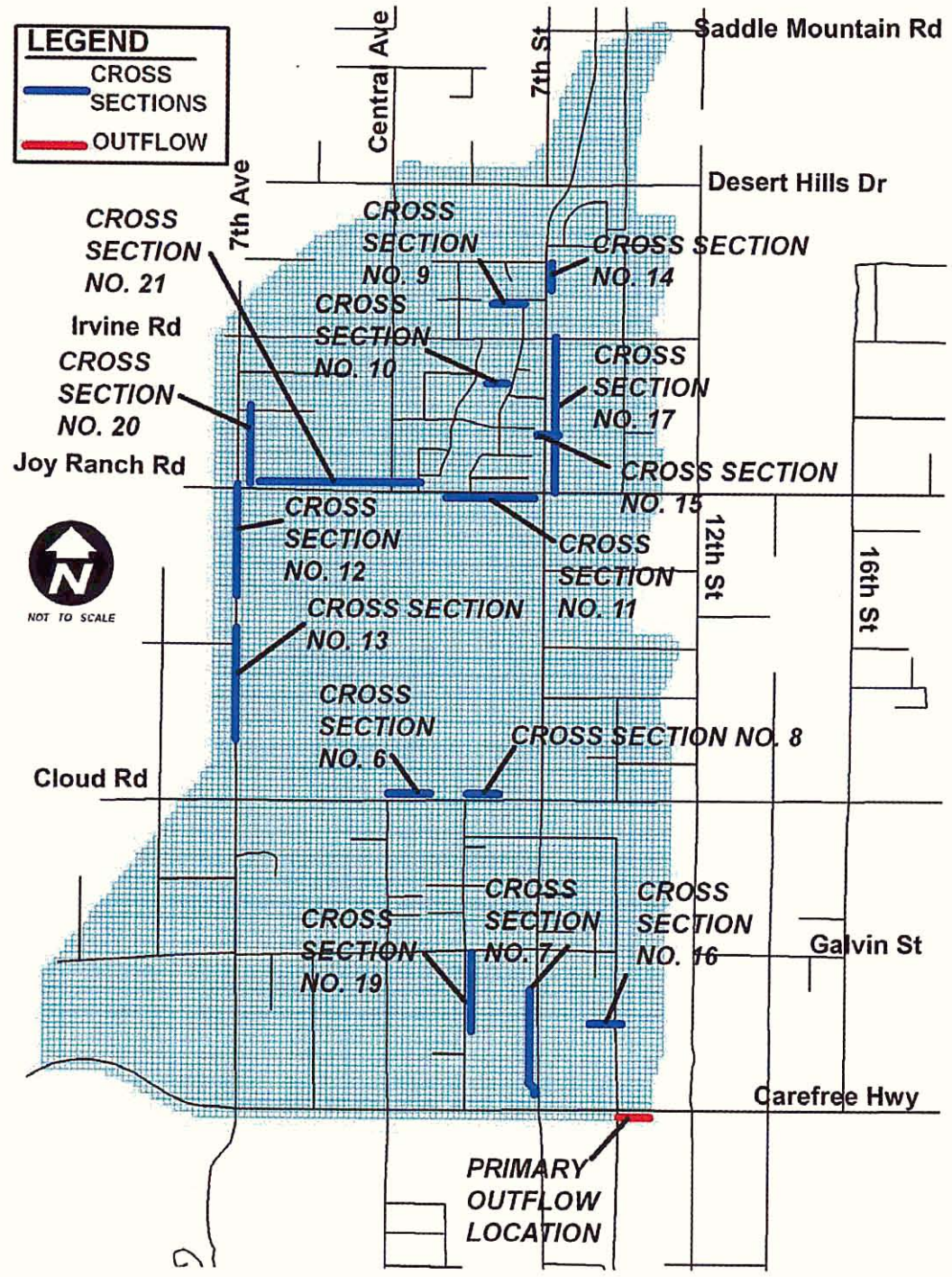

Figure 3.7

FLO-2D Cross Section Layout for Site Numbers 4 and 5

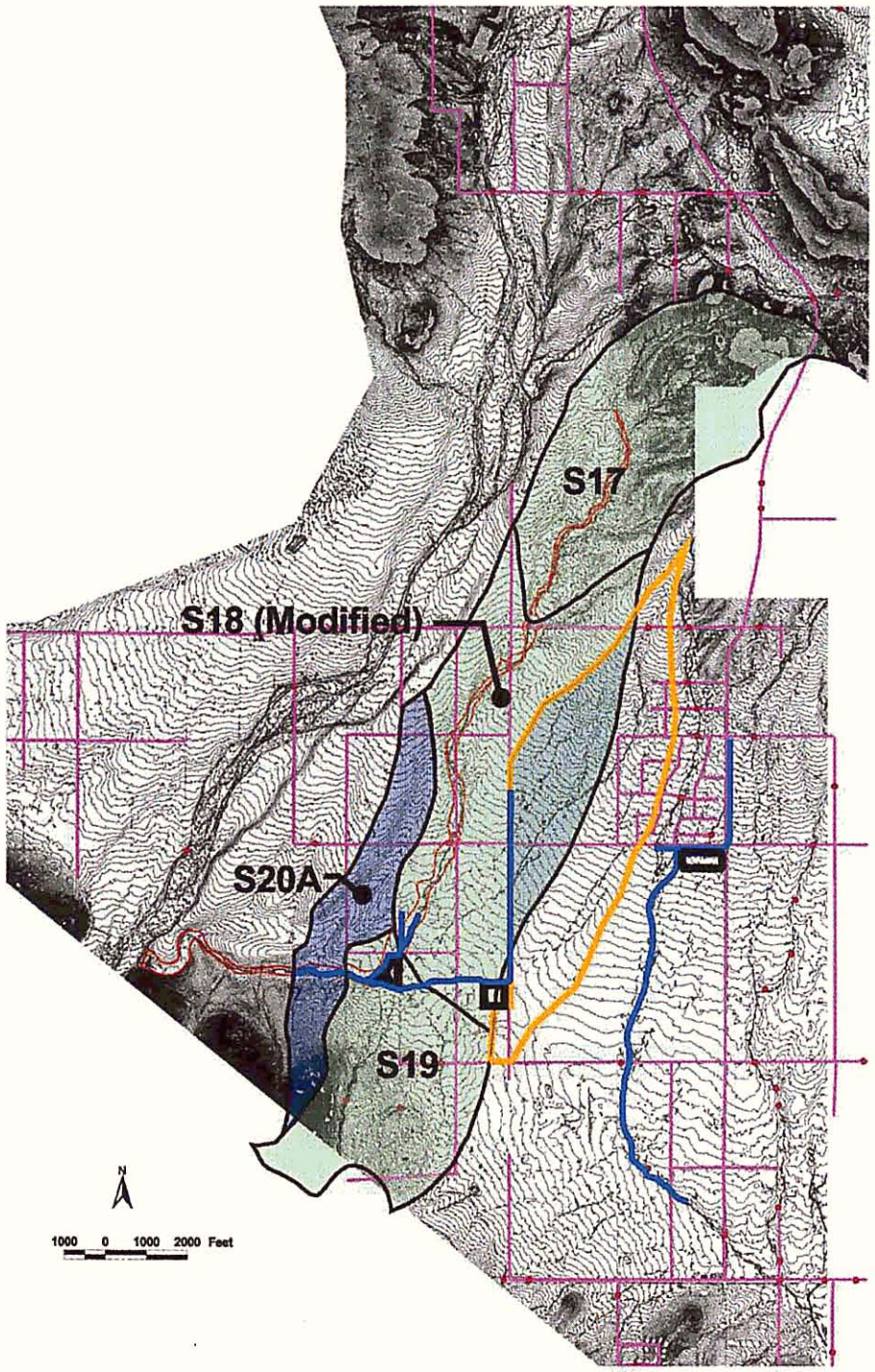

Figure 3.8

Subbasin Layout for Site Numbers 4 and 5

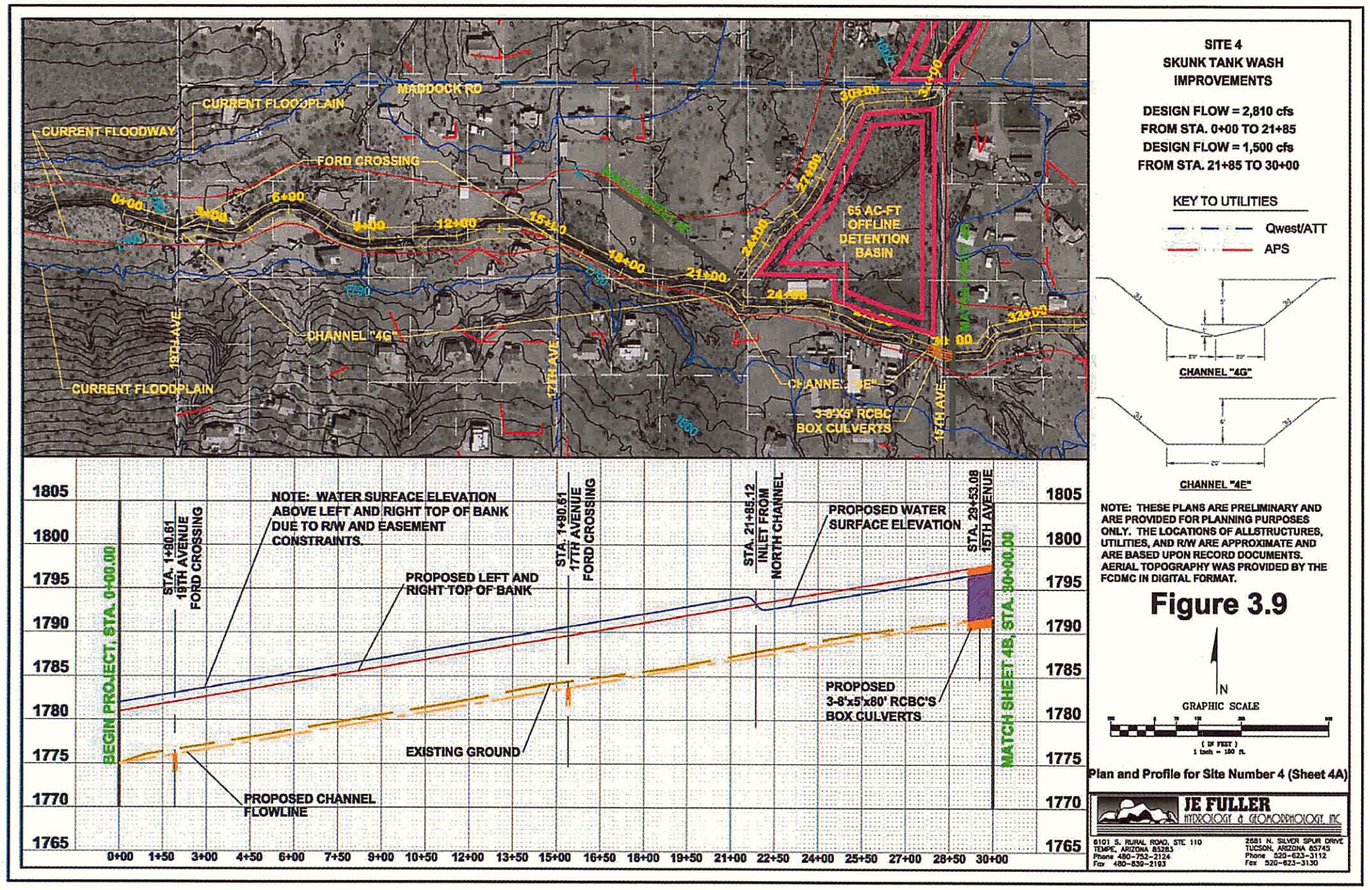

Figure 3.9

Plan and Profile for Site Number 4 (Sheet 4A)

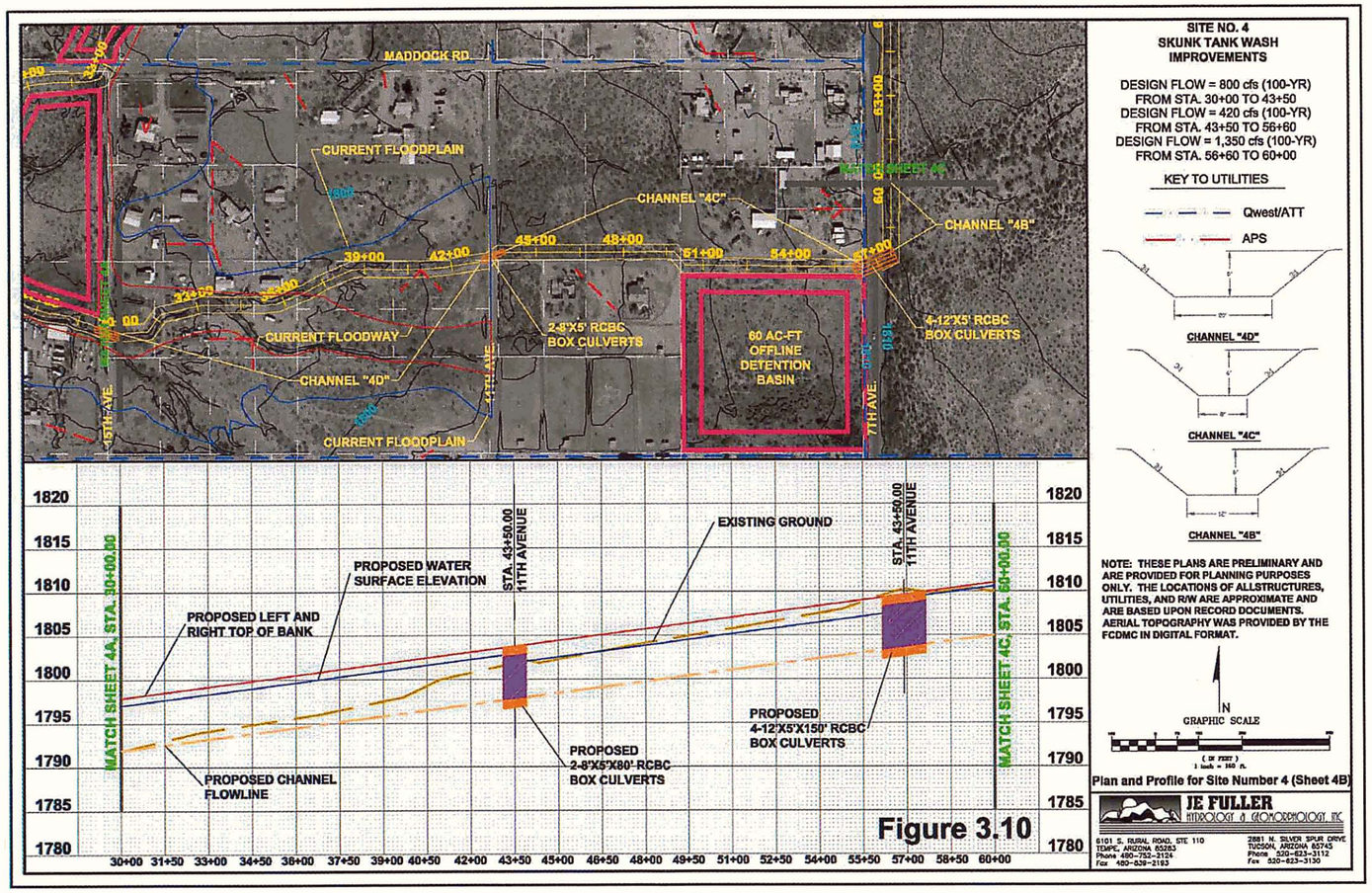

Figure 3.10

Plan and Profile for Site Number 4 (Sheet 4B)

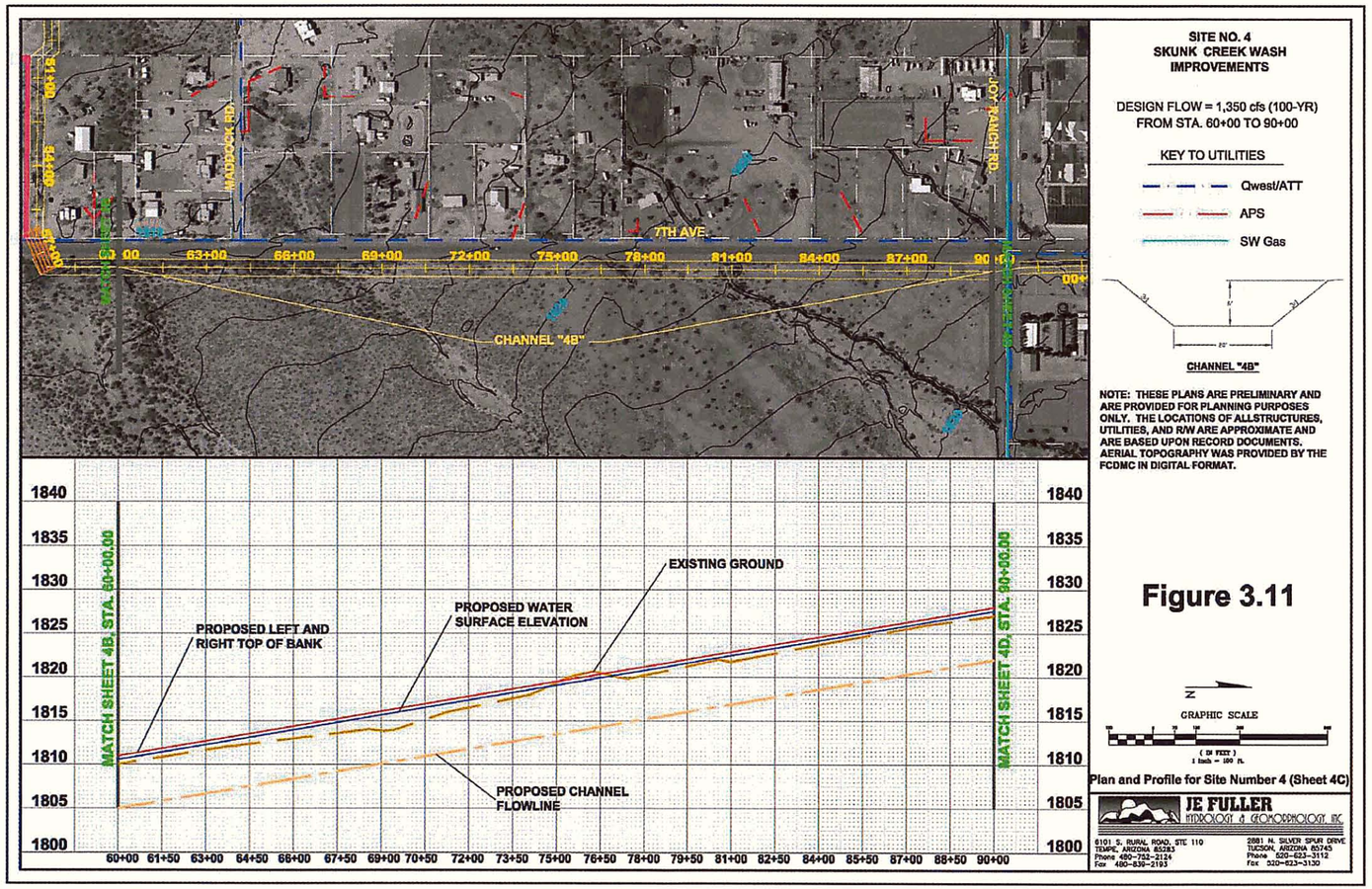

Figure 3.11

Plan and Profile for Site Number 4 (Sheet 4C)

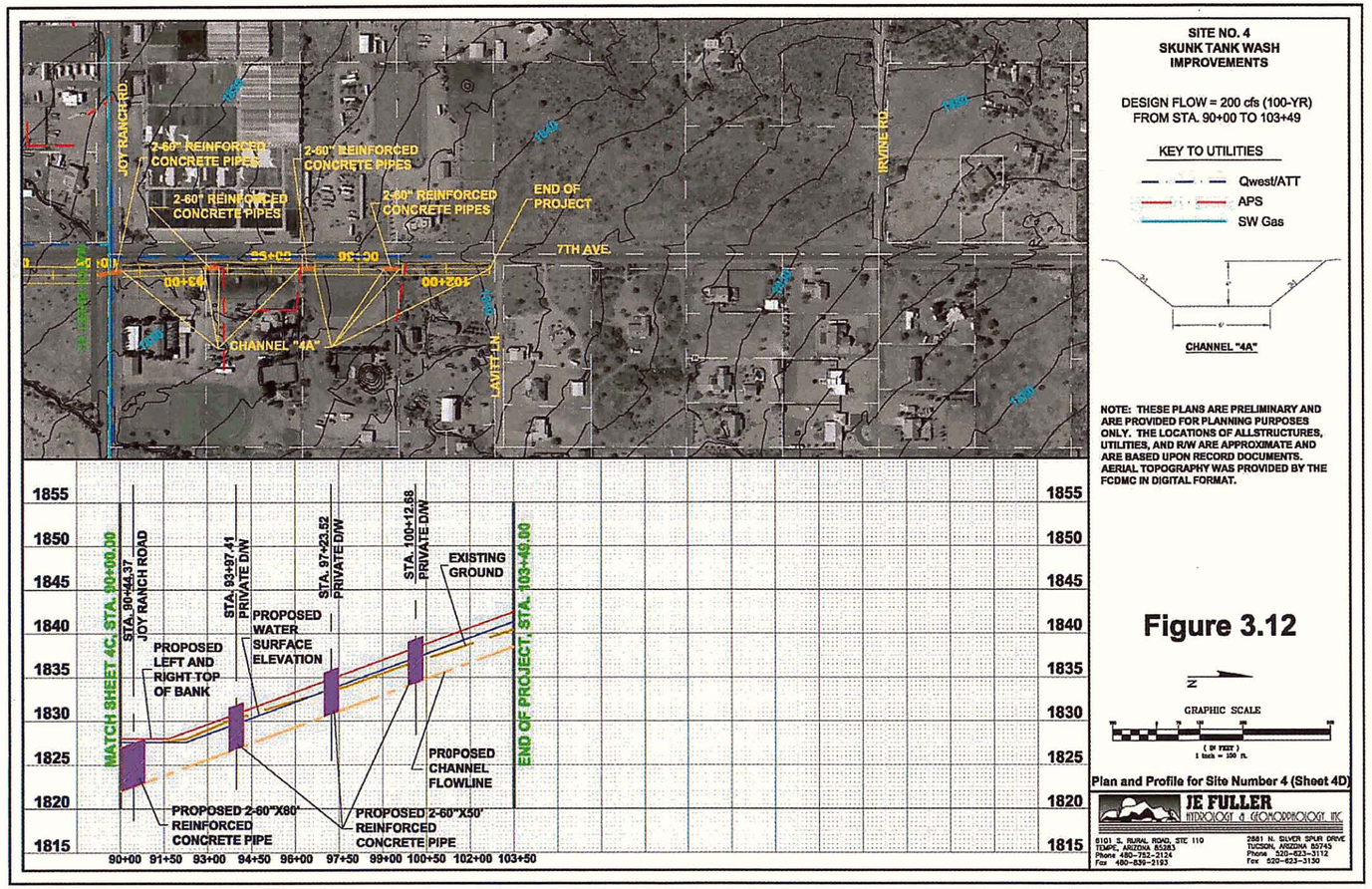

Figure 3.12

Plan and Profile for Site Number 4 (Sheet 4D)

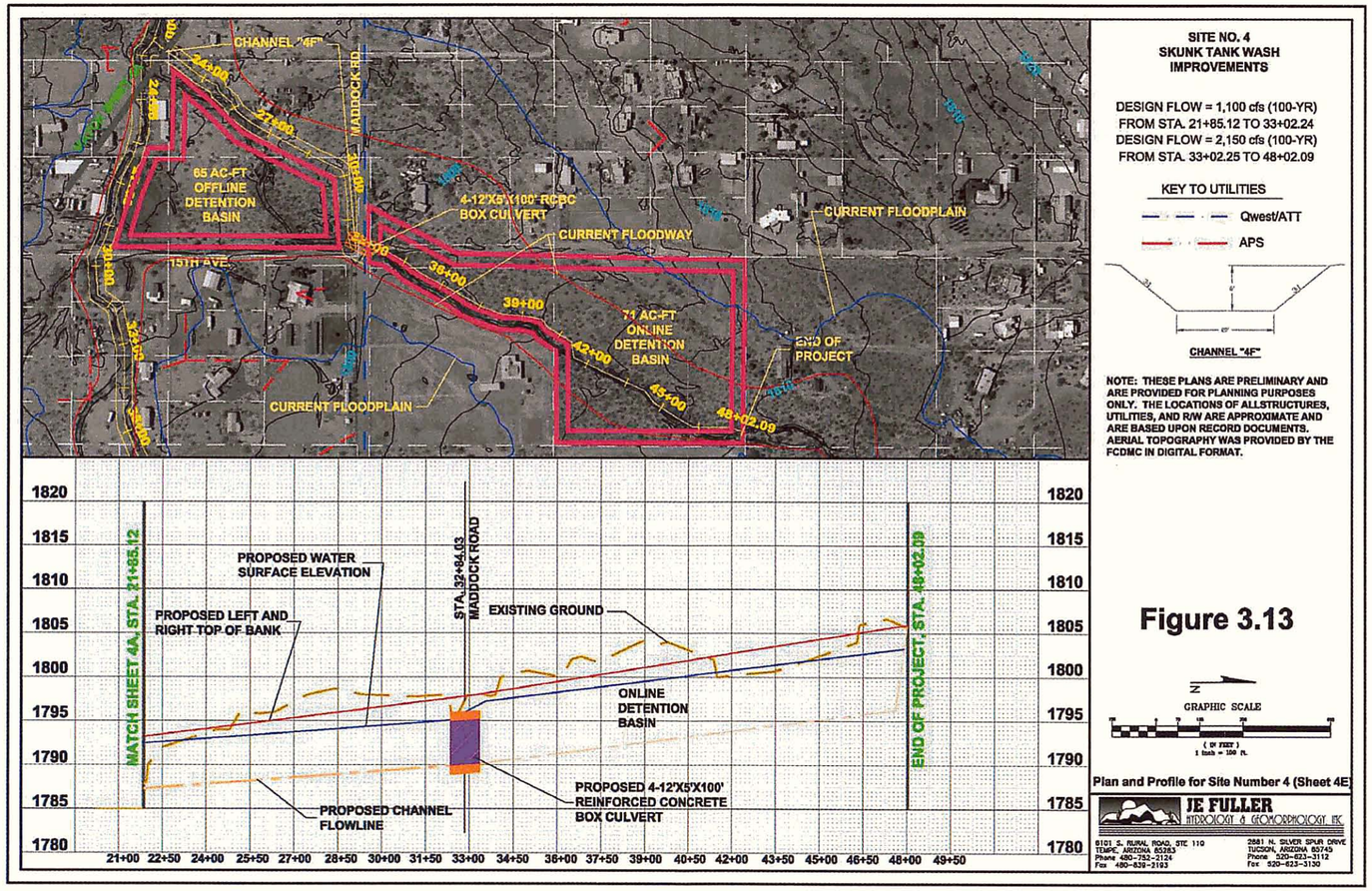

Figure 3.13

Plan and Profile for Site Number 4 (Sheet 4E)

Table 3.8

Cost Estimates for Site Number 4

Item	Description	Cost Estimates										
		Construction				Land				Contingency	Engineering	Total
		Units	Unit Cost	Quantity	Construction Cost	Units	Unit Cost	Quantity	Land Cost			
CLV4A	2 barrels of 60-inch concrete pipe with inlet and outlet headwalls.	LF	$140	100	$ 14,000	SF	$1.50	2000	$ 3,000	$ 3,500	$ 2,100	$ 22,600
CLV4B	2 barrels of 60-inch concrete pipe with inlet and outlet headwalls.	LF	$140	100	$ 14,000	SF	$1.50	2000	$ 3,000	$ 3,500	$ 2,100	$ 22,600
CLV4C	2 barrels of 60-inch concrete pipe with inlet and outlet headwalls.	LF	$140	100	$ 14,000	SF	$1.50	2000	$ 3,000	$ 3,500	$ 2,100	$ 22,600
CLV4D	2 barrels of 60-inch concrete pipe with inlet and outlet headwalls.	LF	$140	100	$ 14,000	SF	$1.50	2000	$ 3,000	$ 3,500	$ 2,100	$ 22,600
CH4A	1600' of 30' Channel	LF	$50	1600	$ 80,000	SF	$1.50	32000	$ 48,000	$ 20,000	$ 12,000	$160,000
CH4B	4800' of 56' Channel	LF	$135	4800	$ 648,000	SF	$1.50	192000	$ 288,000	$ 162,000	$ 97,200	$1,195,200
CLV4E	4 barrels of 12'x5' RCBC with inlet and outlet headwalls.	LF	$600	600	$ 360,000	SF	$1.50	28800	$ 43,200	$ 90,000	$ 54,000	$ 547,200
BASIN 4A	60 Ac-Ft Offline Detention Basin	LS	$484,000	1	$ 484,000	SF	$1.50	261361	$ 392,042	$ 121,000	$ 72,600	$1,069,642
CH4C	1600' of 44' Channel	LF	$135	1600	$ 216,000	SF	$1.50	80000	$ 120,000	$ 54,000	$ 32,400	$ 422,400
CLV4F	2 barrels of 8'x5' RCBC with inlet and outlet headwalls.	LF	$490	160	$ 78,400	SF	$1.50	5120	$ 7,680	$ 19,600	$ 11,760	$ 117,440
CH4D	1600' of 48' Channel	LF	$135	1600	$ 216,000	SF	$1.50	80000	$ 120,000	$ 54,000	$ 32,400	$ 422,400
CLV4G	3 barrels of 8'x5' RCBC with inlet and outlet headwalls.	LF	$500	240	$ 120,000	SF	$1.50	7680	$ 11,520	$ 30,000	$ 18,000	$ 179,520
CH4E	800' of 56' Channel	LF	$135	800	$ 108,000	SF	$1.50	48000	$ 72,000	$ 27,000	$ 16,200	$ 223,200
BASIN 4B	65 Ac-Ft Offline Detention Basin	LS	$565,000	1	$ 565,000	SF	$1.50	188761	$ 283,142	$ 141,250	$ 84,750	$1,074,142
BASIN 4C	71 Ac-Ft Online Detention Basin	LS	$573,000	1	$ 573,000	SF	$1.50	309278	$ 463,917	$ 143,250	$ 85,950	$1,266,117
CLV4H	4 barrels of 12'x5' RCBC with inlet and outlet headwalls.	LF	$600	400	$ 240,000	SF	$1.50	19200	$ 28,800	$ 60,000	$ 36,000	$ 364,800
CH4F	900' of 56' Channel	LF	$135	900	$ 121,500	SF	$1.50	54000	$ 81,000	$ 30,375	$ 18,225	$ 251,100
CH4G	2400' of 70' Channel	LF	$140	2400	$ 336,000	SF	$1.50	168000	$ 252,000	$ 84,000	$ 50,400	$ 722,400
CLV4I	Ford Crossing	LS	$10,000	1	$ 10,000	SF	$1.50	9600	$ 14,400	$ 2,500	$ 1,500	$ 28,400
CLV4J	Ford Crossing	LS	$10,000	1	$ 10,000	SF	$1.50	9600	$ 14,400	$ 2,500	$ 1,500	$ 28,400
				Totals	$ 4,221,900				$2,252,100	$ 1,055,475	$ 633,285	**$8,162,760**

Note: Land costs are assumed to equal $1.50 per square foot raw ground and is only the footprint of the structural alternative. This is equal to $65,340.26 per acre. (July, 2004)

Land Costs Assuming Full Take on Affected Properties

Number of Parcels		Land				Number of Dev. Parcels	Developed		
		Units	Unit Cost	Quantity	Land Cost		Unit Cost	Costs	Total
14 - Undeveloped Parcels		SF	$ 1.50	2607718	$3,911,577	0	$ -	$ -	$ 3,911,577
18 - Developed Parcel		SF	$ 1.50	1987584	$2,981,376	18	$ 185,000	$ 3,330,000	$ 6,311,376
	Totals				$6,892,953			$ 3,330,000	**$10,222,953**

Table 3.8

Cost Estimates for Site Number 4

Summary

	Minimum Costs	Maximum Costs
Range of Costs	$ 8,162,760	$ 16,133,613

Number of Parcels negatively impacted	**32**
Number of Parcels positively impacted	**48** (Approximately)

Note: All parcel and structure data based on 2002 parcel and aerial data.

3.2.5 Site Number 5

Problem Description – Site Number 5 (located between 7th Street and Central Avenue east and west and between Irvine Road and the Carefree Highway north and south) (Appendix B) was identified by the ADMP team during the process of problem identification. Overland flow coming from the northern area of Desert Hills, between the New River Road and 12Th Street, either uses 7th Street from Saddle Mountain Road to Cloud Road as a flow corridor or it crosses 7th street around Desert Hills Drive and flows south through a developed area until it intersects Joy Ranch Road where it crosses and continues across the Arizona State Land Department (ASLD) parcel to Cloud Road. Flooding of structures and the roadway system do occur north of Joy Ranch Road, but becomes a real concern once it reaches Cloud Road. The flow that comes down the right-of-way of 7th Street turns at Cloud Road in a southwesterly direction and sheet flows across a developed area before it enters Desert Lake Wash again west of 3rd Street. The flow from Desert Lake Wash continues south of Cloud Road combining with flow from 7th Street and continuing southeast back to 7th Street and eventually past the Carefree Highway toward Cave Creek.

The main issues with this site are to confine the flows from the north in such a manner as to convey them through the area without flooding the roads or any of the existing structures. Removal of structures from the floodway is also an important aspect of this site.

Methodology and Design –Design flows for this site came from the same FLO-2D model discussed for Site Number 4. The development of design discharges will be discussed along with the description of alternatives. Refer to Figure 3.7 for a map of cross section layout within the FLO-2D modeling area. Refer to Appendix B under the Site Number 4 heading for modifications of the FLO-2D model. A full submittal of the modified FLO-2D model is included on the data CD provided within this report. For details regarding the hydrograph manipulation spreadsheets refer to Appendix B under the heading Site Number 5.

Site Number 5 started out as several individual sites that were tied into the same system. The preliminary alternatives looked at Site Number 5 in the following manner (Refer to Figures 3.14 through 3.17 as well as Appendix B under the heading Site Number 5):

- For the area of Cloud Road downstream to 7th, Street, collector channels constructed on the north side of Cloud Road were analyzed to funnel the water to the south side of the road into an offline detention basin. This system would incorporate a pilot channel from the detention basin that would continue to 7th Street.
- For the same location, an alternative with the same scheme as stated above was analyzed with the difference of having the developer of the ASLD parcel pay for the collection channels north of Cloud Road.
- For the same area again, an alternative with the same scheme as stated above was analyzed with the difference of having the detention basin moved onto the ASLD parcel with some type of developer/State funding to pay for the improvements.
- Finally, for the same location, an alternative with the same scheme as stated above was analyzed with the difference of moving the detention basin to the north end of the ASLD parcel so that a smaller channel across the ASLD parcel could be constructed instead of the larger channel that would need to be provided by the developer of the ASLD parcel.
- For the area north of the ASLD parcel, an alternative was analyzed that would provide an interceptor channel located on the east side of 7th Street that would parallel 7th Street from Irvine Road to Joy Ranch Road. At the intersection of 7th Street and Joy Ranch Road, culverts would be constructed that would convey the flow to the ASLD parcel. The outlet channel to the culverts would parallel Joy Ranch Road for approximately 1,300 feet, serving as a collector channel for flows exiting the developed area to the north. All of this flow would then be released south in the alignment of Desert Lake Wash.

All of these potential alternatives were then combined and refined into the preferred alternative which is described in more detail in the following paragraphs.

Flow coming from the north is intercepted in a channel (CH5A) that parallels 7th Street from Irvine Street to Joy Ranch Road. One Culvert (CLV5A) would need to be constructed for

access within this stretch of channel. Once the flow gets to Joy Ranch Road, it is necessary to convey the flow from the northeast corner of the intersection to the southwest corner of the intersection. This would be done in a culvert (CLV5B) that would outlet onto the ASLD parcel. The design discharge for CHA, CLV5A, and CLV5B is 1,050 cfs which is taken from cross section number 17 of the FLO-2D.

Once the flow crosses the intersection of 7th Street and Joy Ranch Road, it continues parallel to Joy Ranch Road for approximately 1,300 feet. This Channel (CH5B) has three functions; first, to convey flow to the channel 5C which flows south to below Cloud Road,. second, to intercept flows crossing Joy Ranch Road from the north out of the Desert Hills Estates Subdivision, and third, to function as an inlet weir section to the offline detention basin (5A) located in the northeastern corner of the ASLD parcel. The design discharge for CH5B is 250 cfs based on the 4 resultant hydrograph bypassing basin 5A. The ultimate channel design will be a function of the amount of flow spilled to the basin which JEF estimates at 250 cfs.

The basin (5A) is designed with a required volume of 40 acre-feet to make it function correctly. For the graphical context of this report, JEF designed the basin at 5 feet deep. This basin will require a control/spillway structure to allow all but 250 cfs of inflow hydrograph into the basin.

After the peak has been reduced by the detention basin, a channel (CH5C) will be constructed that will flow south to Cloud Road where it will be conveyed under the Roadway by a culvert (CLV5C). Flow will then continue down to Leisure Lane where it will flow under the roadway in another culvert (CLV5D). The design discharge for CH5C, CLV5C, and CLV5D is 250 cfs which is the outlet resultant hydrograph bypassing basin 5A.

South of Leisure Lane, the flow will be conveyed in a channel (CH5D) until approximately 250 feet south of 3rd Street. The flow will also cross Galvin Street and 3rd Street in Culverts (CLV5E and CLV5F). The design discharge for CH5D, CLV5E and CLV5F is 1,350 cfs which is derived from taking the 250 cfs of flow from the north and adding flow generated by the area generally south of Cloud Road and West of 3rd Street (approximately 1,100 cfs at the peak time of the bypass hydrograph). The intervening tributary flow hydrograph was calculated from the future condition FLO-2D results by subtracting the resultant hydrograph at Cloud Road, between 3rd Avenue and 7th Street (cross sections 6 added to cross section 8), from the hydrograph at 3rd Street, between Cloud Road and a quarter of a mile south of

Galvin Street (cross section 19). Channel CH5D is to be a regrade of the existing wash to a section shown in the FlowMaster output located in Appendix B under the heading Site Number 5. The intent of the design is to provide bank-full capacity for something less than the 100-year flow (approximately 1,100 cfs), with the full 100-year flow being conveyed in a floodway (encroached section) that surcharges the channel by one foot.

The channels for Site Number 5 were designed using normal depth calculations and using the FlowMaster program distributed by Haestad Methods. The roadway crossings were designed using the HY8 computer program as distributed by the University of Florida, McTrans Center for Microcomputers in Transportation. FlowMaster output, HY8 printouts, and basin design calculations can also be found in Appendix B under the Site Number 5 Heading.

This alternative remedies many of the flooding issues happening along 7th Street and south of Cloud Road. It removes most of the floodplain inundated residences and all of the floodway residences. However, the cost is very high and has a low benefit/cost ratio. Maintenance of the designed system is also very expensive.

It is important to note that before the team actually performed the alternative formulation, this site was further altered. It was decided that the system north of Cloud Road was not only effective in reducing the peak discharge, but also addressed the problems along 7th Street. However, the area below Cloud Road was very expensive and could be accomplished by recommending the floodway residences to the FPAP program. Therefore, the area north of Cloud was carried forward to alternative formulation and eventually to recommended alternative and the area south of Cloud road was deleted from the alternative formulation other than in the ways already discussed. Once the floodway residences are removed, the channel will have more capacity and can be improved to better convey flow through the southern area of the system. Until the floodway residences are removed, the flooding will continue to occur in the manner in which it currently does due to the fact that a large amount of the contributing flow comes from the south and not all from the north.

Plan and Profiles – The plan and profile sheets were put together with updated aerial photography and topography. Existing utilities are shown in the plan view, but actual depths of these utilities are unknown. The profile shows the proposed condition of the new channel along with the existing grade profile. The design flow (100-year) for the design is depicted

on each of the individual sheets. Refer to Figures 3.14, 3.15, 3.16, and 3.17 for the Plan and Profiles of Site Number 5. Note that the figures shown in the body of the text start with sheet 5B. This is because only the recommended alternative is depicted within the body of the report. Refer to Appendix B under the heading Site Number 5 for a copy of the full alternative prior to the removal of the area south of Cloud Road.

Cost Estimates – Cost estimates for this alternative were performed by JEF. As was discussed previously a range of costs based on the land needed to construct the channels and basins was necessary. The lower range cost was based on the amount of land needed if only the right-of-way of the channels and basins was purchased. This is obviously going to be a cost that is too low based on the fact that it would be very difficult if not impossible to purchase just the land needed for right-of-way. Because of this, an upper range was established based on the purchase of every parcel that the right-of-way came in contact. The actual cost is going to fall somewhere between these two. At the time of the analysis (July, 2004), the land costs are assumed to equal $1.50 per square foot of raw ground or $65,340.26 per acre as provided by the FCDMC. Refer to Table 3.9 for cost estimates for Site Number 5. As was stated for the plan and profile figures, the cost estimate provided in the body of the text is for the recommended alternative only. Refer to Appendix B under the heading Site Number 5 for a copy of the cost estimates prior to the removal of area south of Cloud Road.

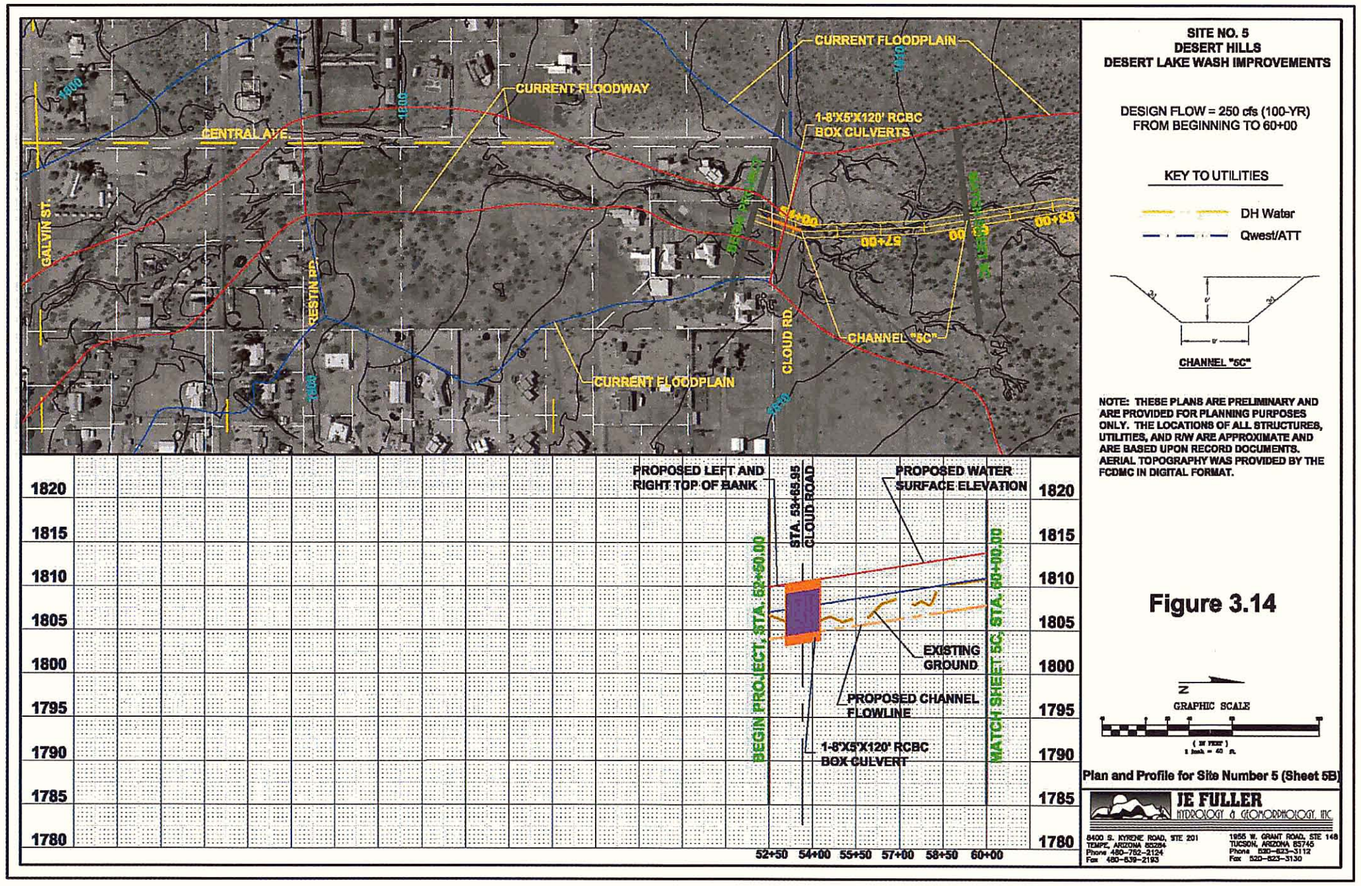

Figure 3.14

Plan and Profile for Site Number 5 (Sheet 5B)

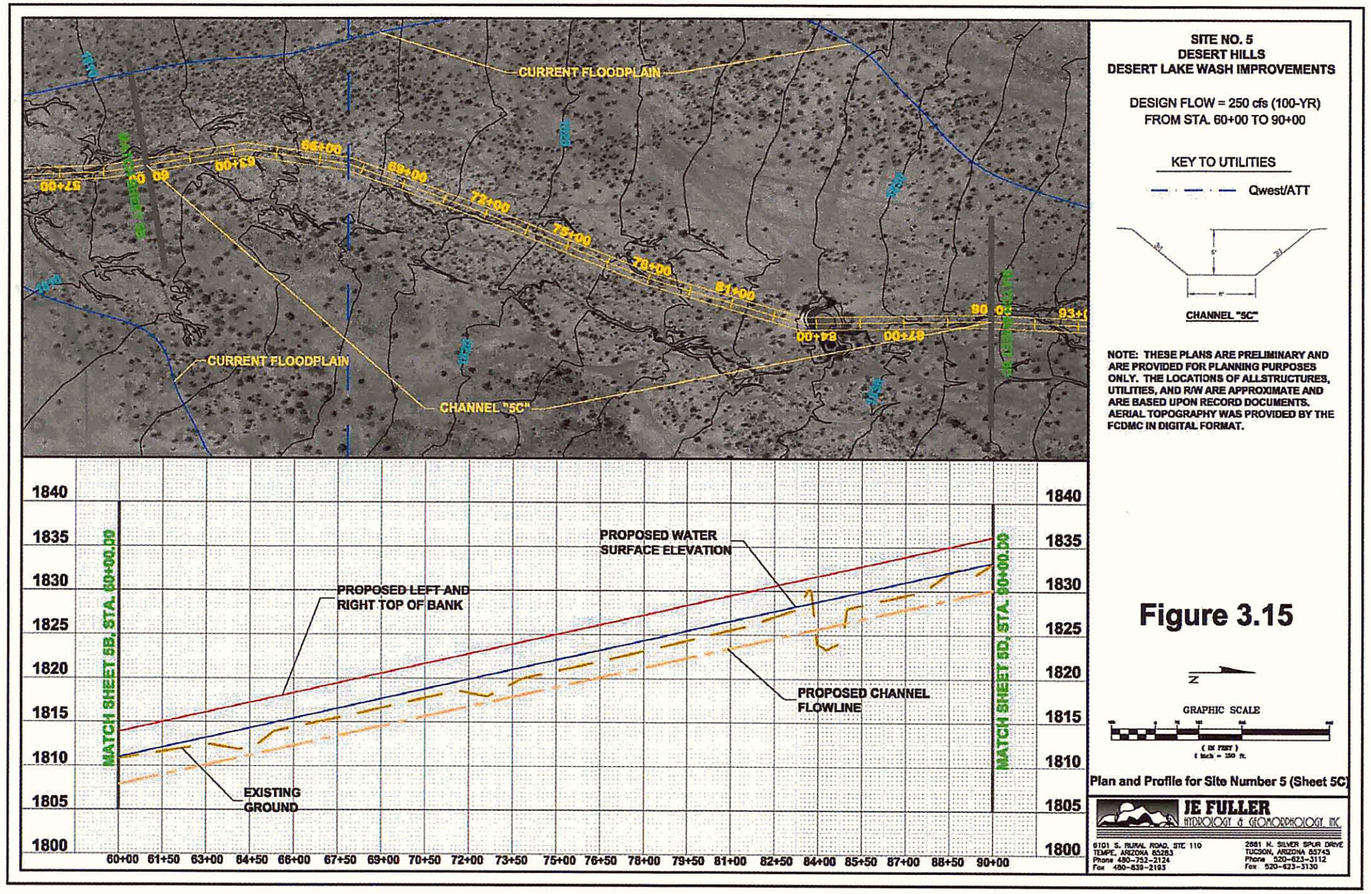

Figure 3.15

Plan and Profile for Site Number 5 (Sheet 5C)

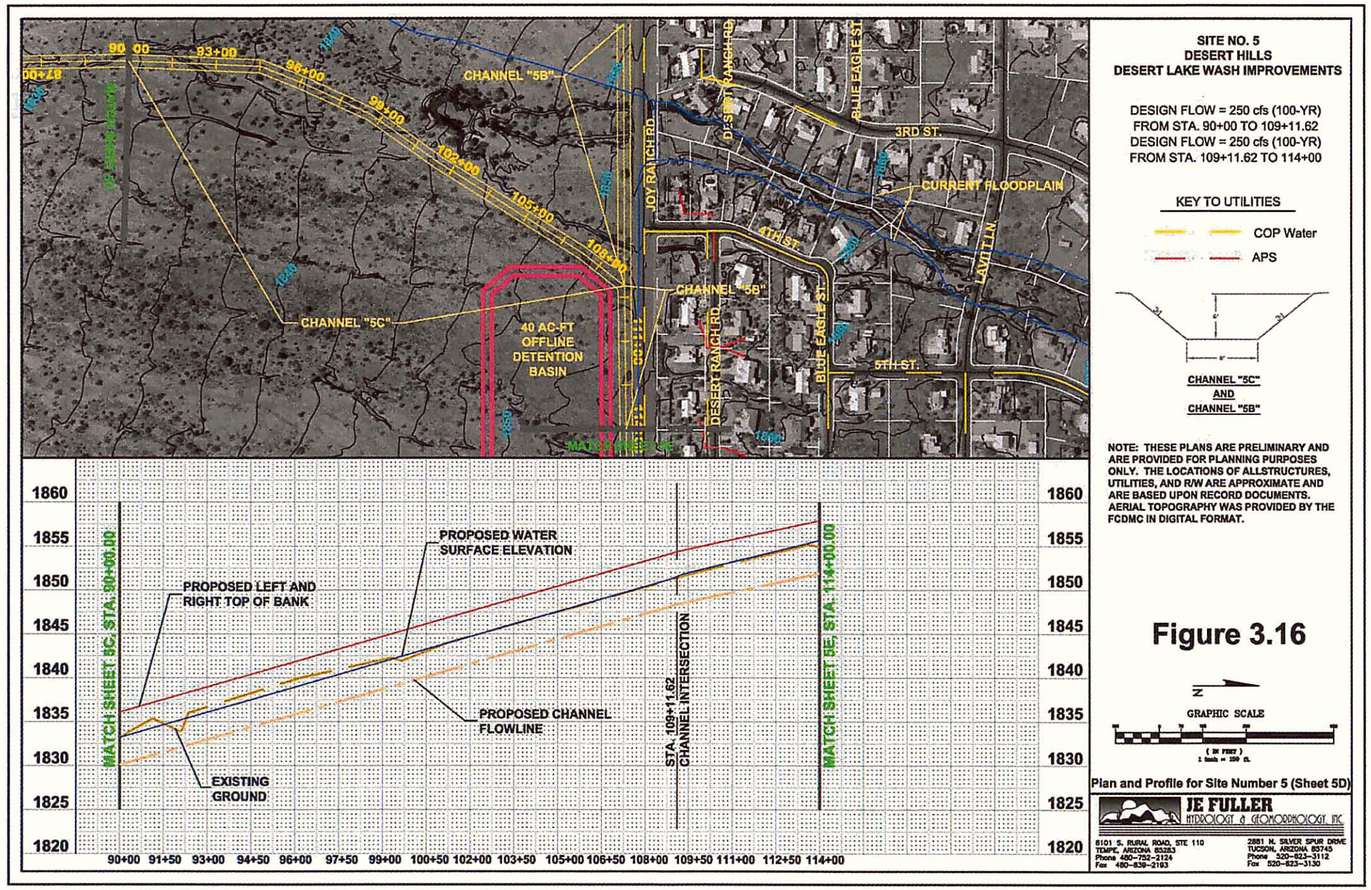

Figure 3.16

Plan and Profile for Site Number 5 (Sheet 5D)

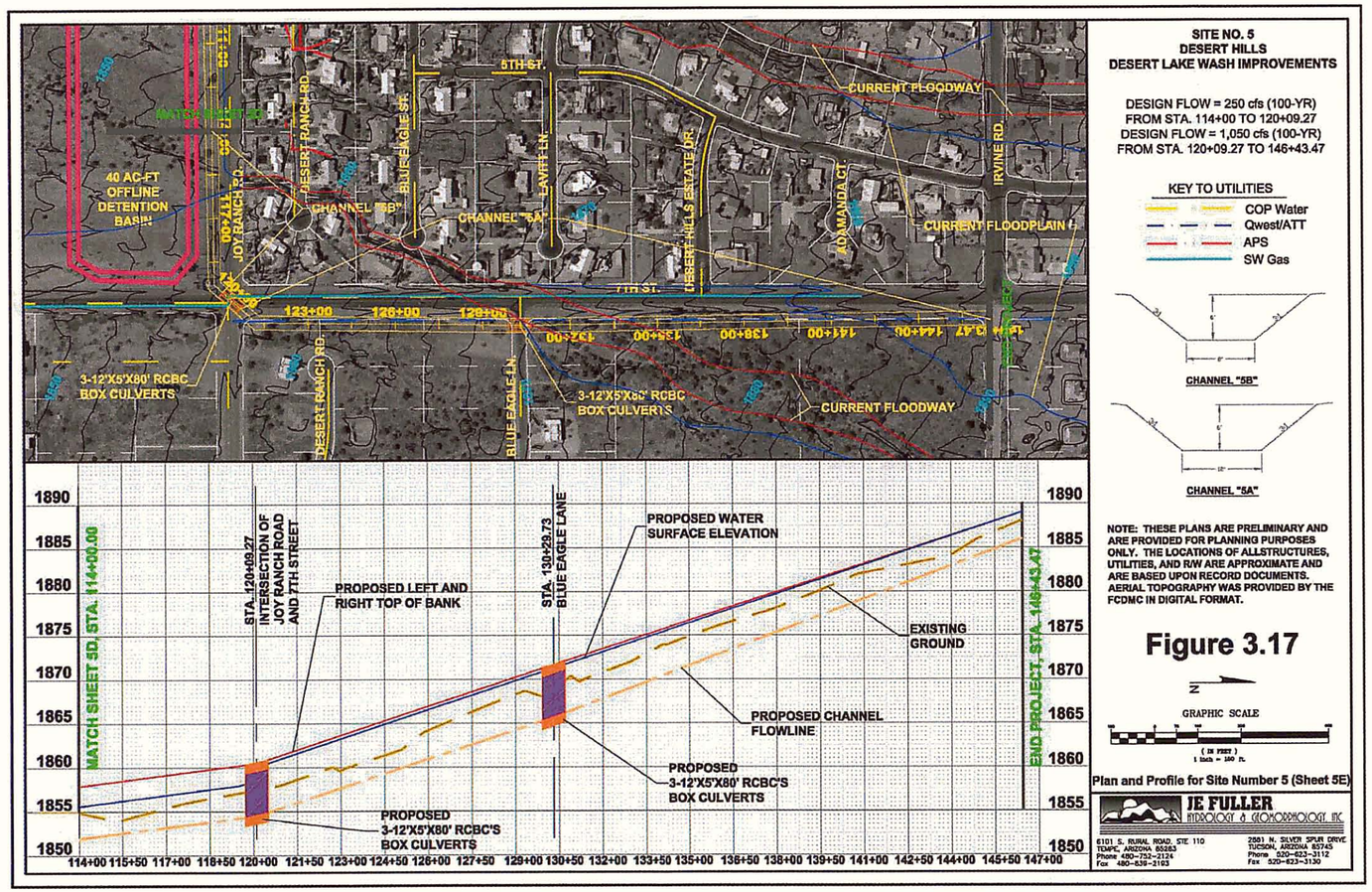
SITE NO. 5
DESERT HILLS
DESERT LAKE WASH IMPROVEMENTS
DESIGN FLOW = 250 cfs (100-YR)
FROM STA. 114+00 TO 120+09.27
DESIGN FLOW = 1,050 cfs (100-YR)
FROM STA. 120+09.27 TO 146+43.47
KEY TO UTILITIES
COP Water
Qwest/ATT
APS
SW Gas
CHANNEL "5B"
CHANNEL "5A"
NOTE: THESE PLANS ARE PRELIMINARY AND ARE PROVIDED FOR PLANNING PURPOSES ONLY. THE LOCATIONS OF ALLSTRUCTURES, UTILITIES, AND R/W ARE APPROXIMATE AND ARE BASED UPON RECORD DOCUMENTS. AERIAL TOPOGRAPHY WAS PROVIDED BY THE FCDMC IN DIGITAL FORMAT.
Figure 3.17
GRAPHIC SCALE
Plan and Profile for Site Number 5 (Sheet 5E)
JE FULLER
HYDROLOGY & GEOMORPHOLOGY, INC.
40 AC-FT OFFLINE DETENTION BASIN
WATER WAY
JOY RANCH RD.
DESERT RANCH RD.
BLUE EAGLE DR.
5TH ST.
LAVITT LN.
CHANNEL "5B"
CHANNEL "5A"
7TH ST.
DESERT HILLS ESTATE DR.
KOMANDA CT.
IRVINE RD.
CURRENT FLOODWAY
CURRENT FLOODPLAIN
3-12'X5'X80' RCBC BOX CULVERTS
BLUE EAGLE LN.
MATCH SHEET 5D, STA. 114+00.00
STA. 120+09.27 INTERSECTION OF JOY RANCH ROAD AND 7TH STREET
PROPOSED LEFT AND RIGHT TOP OF BANK
STA. 130+29.73 BLUE EAGLE LANE
PROPOSED WATER SURFACE ELEVATION
EXISTING GROUND
PROPOSED CHANNEL FLOWLINE
PROPOSED 3-12'X5'X80' RCBC'S BOX CULVERTS
END PROJECT, STA. 146+43.47

Figure 3.17

Plan and Profile for Site Number 5 (Sheet 5E)Table 3.9

Cost Estimates for Site Number 5

Item	Description	Construction				Land				Contingency	Engineering	Total
		Units	Unit Cost	Quantity	Construction Cost	Units	Unit Cost	Quantity	Land Cost			
CH5A	3200' of 48' Channel	LF	$135	3200	$ 432,000	SF	$1.50	160000	$ 240,000	$ 108,000	$ 64,800	$ 844,800
CLV5A	3 barrels of 12'x5' RCBC with inlet and outlet headwalls.	LF	$600	240	$ 144,000	SF	$1.50	11520	$ 17,280	$ 36,000	$ 21,600	$ 218,880
CLV5B	3 barrels of 12'x5' RCBC with inlet and outlet headwalls.	LF	$600	240	$ 144,000	SF	$1.50	11520	$ 17,280	$ 36,000	$ 21,600	$ 218,880
CH5B	2400' of 44" Channel	LF	$75	2400	$ 180,000	SF	$1.50	2000	$ 3,000	$ 45,000	$ 27,000	$ 255,000
BASIN 5A	40 Ac-Ft Offline Detention Basin	LS	$363,000	1	$ 363,000	SF	$1.50	348482	$ 522,723	$ 90,750	$ 54,450	$1,030,923
CH5C	8,300' of 44' Channel	LF	$75	8300	$ 622,500	SF	$1.50	365200	$ 547,800	$ 155,625	$ 93,375	$1,419,300
CLV5C	1- 8'x5' RCBC with inlet and outlet headwalls.	LF	$480	120	$ 57,600	SF	$1.50	3840	$ 5,760	$ 14,400	$ 8,640	$ 86,400
CLV5D	N/A	LF	$480	0	$ -	SF	$1.50	0	$ -	$ -	$ -	$ -
CH5D	N/A	LF	$135	0	$ -	SF	$1.50	0	$ -	$ -	$ -	$ -
CLV5E	N/A	LF	$600	0	$ -	SF	$1.50	0	$ -	$ -	$ -	$ -
CLV5F	N/A	LF	$600	0	$ -	SF	$1.50	0	$ -	$ -	$ -	$ -
				Totals	$ 1,943,100				$ 1,353,843	$ 485,775	$ 291,465	**$4,074,183**

Note: Land costs are assumed to equal $1.50 per square foot raw ground and is only the footprint of the structural alternative. This is equal to $65,340.26 per acre. (July, 2004)

LAND COSTS ASSUMING FULL TAKE ON AFFECTED PROPERTIES

Number of Parcels	Land				Number of Dev. Parcels	Developed		
	Units	Unit Cost	Quantity	Land Cost		Unit Cost	Costs	Total
16 - Undeveloped Parcels	SF	$ 1.50	381150	$ 571,725	0	$ -	$ -	$ 571,725
1 - Developed Parcels	SF	$ 1.50	21780	$ 32,670	1	$ 185,000	$ 185,000	$ 217,670
Totals				$ 604,395			$ 185,000	**$ 789,395**

SUMMARY

	Minimum Costs		Maximum Costs
Range of Costs	**$ 4,074,183**		**$ 4,583,258**

Number of Parcels negatively impacted	**29**
Number of Parcels positively impacted	**47** (Approximately)

Note: All parcel and structure data based on 2002 parcel and aerial data.

3.2.6 Site Number 6

Problem Description – While analyzing the alternatives in the Desert Hills area, it was observed that many of the roadway crossings associated with the Carefree Highway were undersized when analyzed with the 100-year recurrence interval storm (Appendix B). Therefore Site Number 6 was identified by the ADMP team as an area of concern. The probable impassable crossings along the Carefree Highway are at Desert Lake Wash, Desert Hills Wash, Apache Wash, the West Branch of Paradise Wash and Paradise Wash itself.

In addition to impassable crossings in the 100-year event, it was also identified in the FLO-2D analysis, referred to earlier for Site Numbers 4 and 5 (Figure 3.7), that flow running along the south side of the Carefree Highway between 3rd Avenue and the crossing of Desert Lake Wash is confined into a channel that does not contain the 100-year event. The channel and driveway access crossings are under-sized.

The main issues with this site are to confine the flows in the existing washes by upgrading the roadway crossings and upgrade the channel between 3rd Avenue and the Desert Lake Wash Crossing so that it is confined within the channel.

Methodology and Design –Design flows for this site came from two sources that are actually combined into one source. The flow from the south for sizing the channel came from the FLO-2D analysis discussed earlier. The culvert crossing discharges came from the Desert Hills Area Hydrology completed by JEF as part of the ADMP or more specifically combined together in the Part 3, Volumes 1 and 2.

The concrete channel was designed based on FlowMaster calculations and the two-dimensional analysis performed by FLO-2D. The hydraulic specifics were done as a part of Part 8, Volume 2, Section 4 of the ADMP entitled *Roadway Drainage Crossings Passability*. The hydraulic details and the FlowMaster details are located in Appendix B under the heading Site Number 6.

This alternative reduces the flooding associated with roadway crossings and allows for 100-year flows to pass under the Carefree Highway. However, it was discovered while talking with the Maricopa County Department of Transportation (MCDOT) that a recent upgrade had already been done to the Carefree highway and because of the cost of upgrading at this point

was not a very viable option for them. The Carefree Highway is also considered a scenic roadway, so a higher standard of design would also make this alternative very expensive. Because of these reasons, the ADMP team did not see this as an alternative that should be carried forward into recommended alternative. It is necessary to state that because it was not recommended as an alternative, flooding around these structures is probable. Possible "washouts" could occur and access to many residents and business would be lost if this occurred.

Plan and Profiles – The plan and profile sheets were put together with updated aerial photography and topography. Existing utilities are shown in the plan view, but actual depths of these utilities are unknown. The profile shows the proposed condition of the new roadway along with the existing grade profile. The design flow (100-year) for the design is depicted on each of the individual sheets. Refer to Figures 3.18, 3.19, 3.20, 3.21, 3.22, 3.23, and 3.24 for the Plan and Profiles and typical sections of Site Number 6 and Appendix B for all supporting data.

Cost Estimates – Cost estimates for this alternative were performed by JEF. Unlike the other sites, this site is much easier to cost based on the fact that right-of-way already exists for construction. At the time of the analysis (July, 2004), the land costs are assumed to equal $1.50 per square foot of raw ground or $65,340.26 per acre as provided by the FCDMC. Refer to Table 3.10 for cost estimates for Site Number 6.

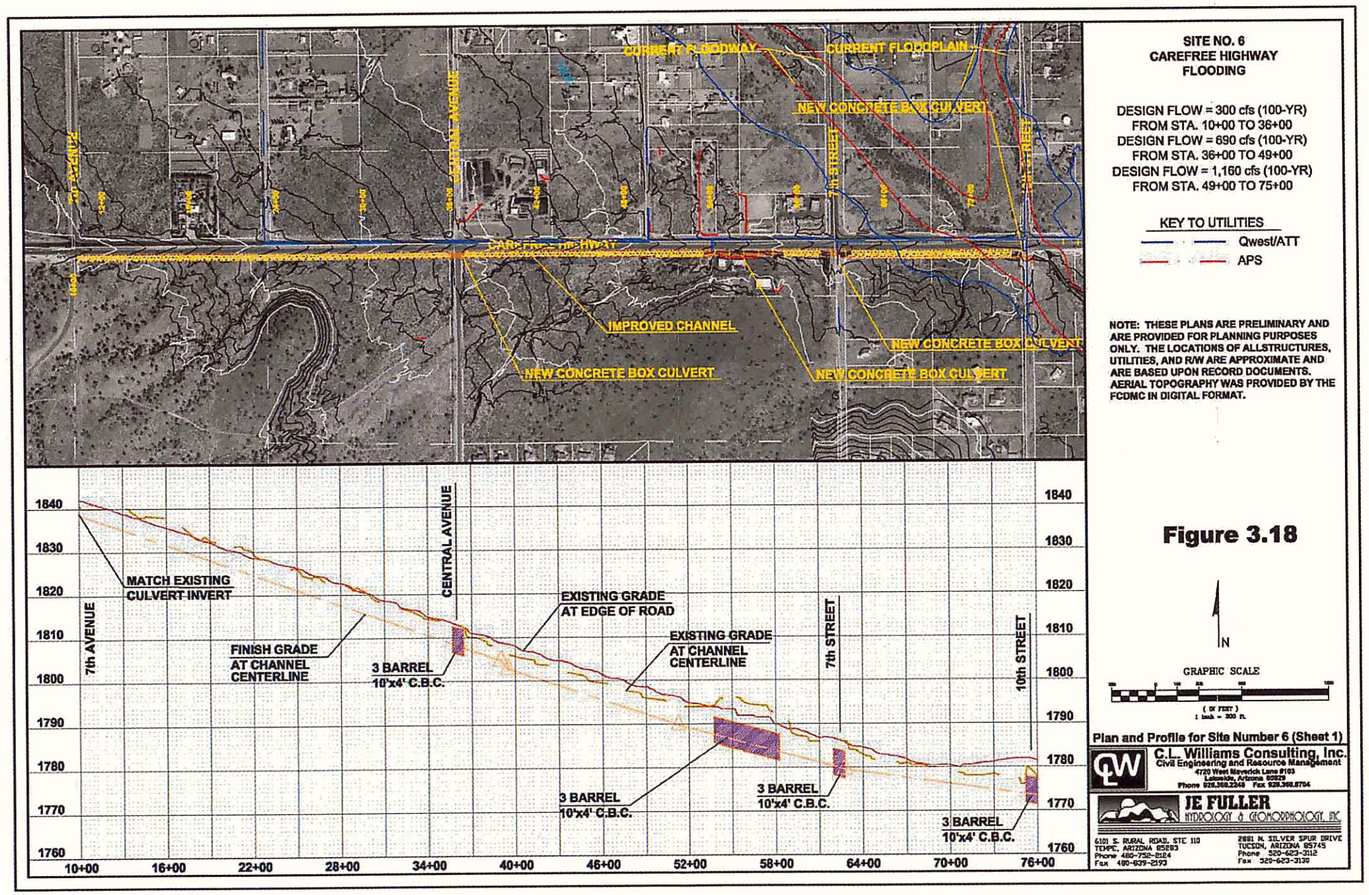

Figure 3.18

Plan and Profile for Site Number 6 (Sheet 1)

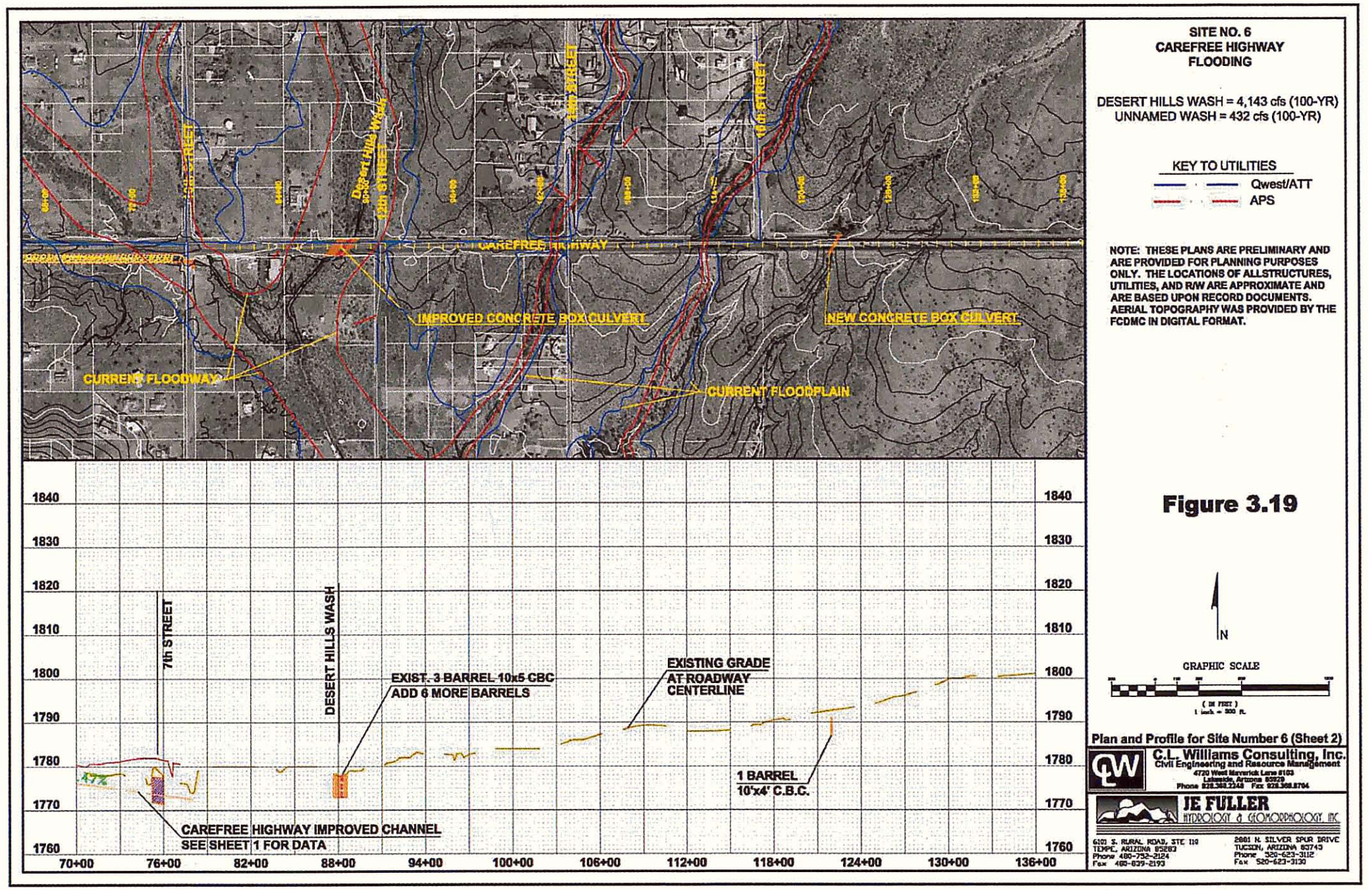

Figure 3.19

Plan and Profile for Site Number 6 (Sheet 2)

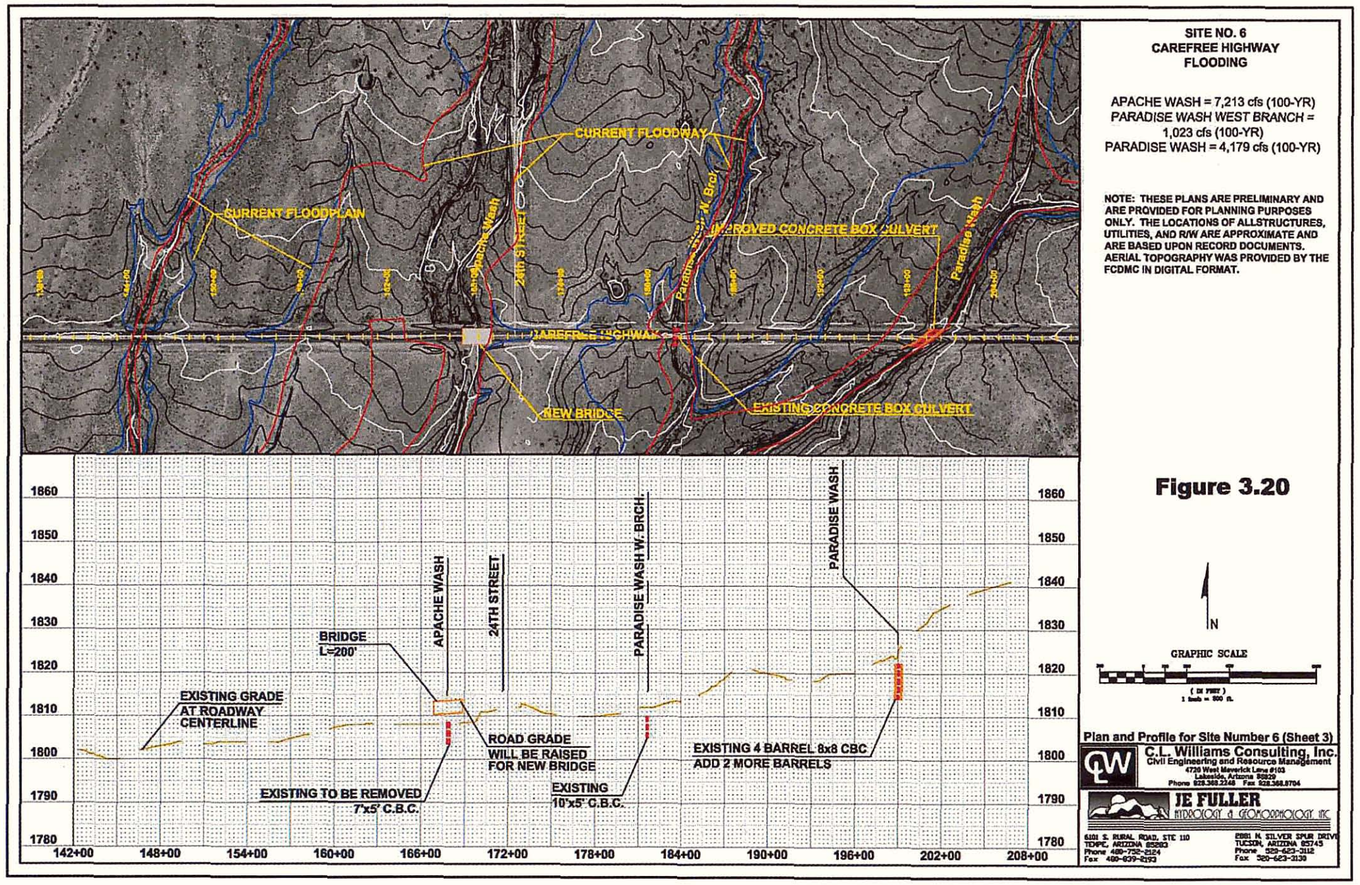

Figure 3.20

Plan and Profile for Site Number 6 (Sheet 3)

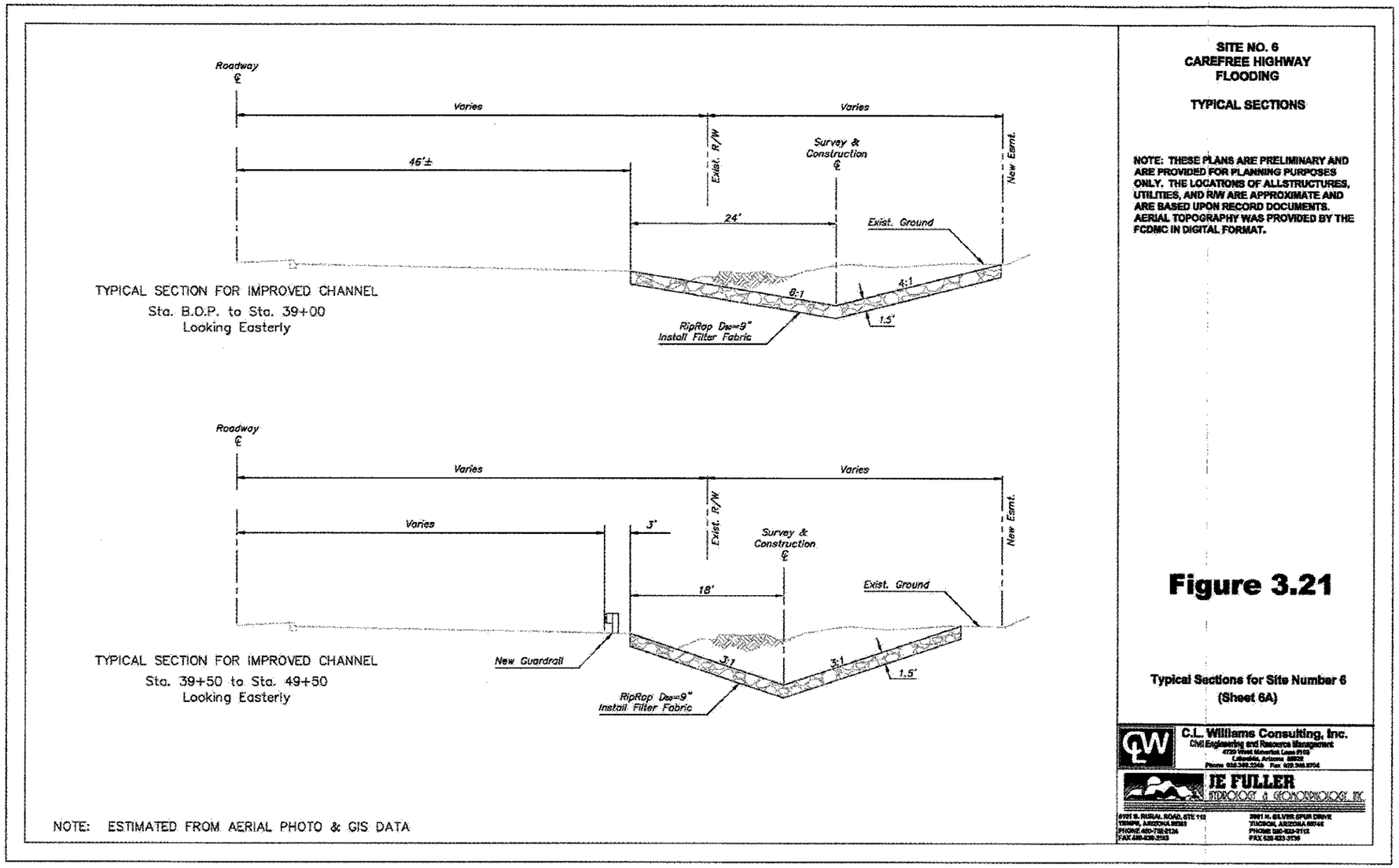

Figure 3.21

Typical Sections for Site Number 6 (Sheet 6A)

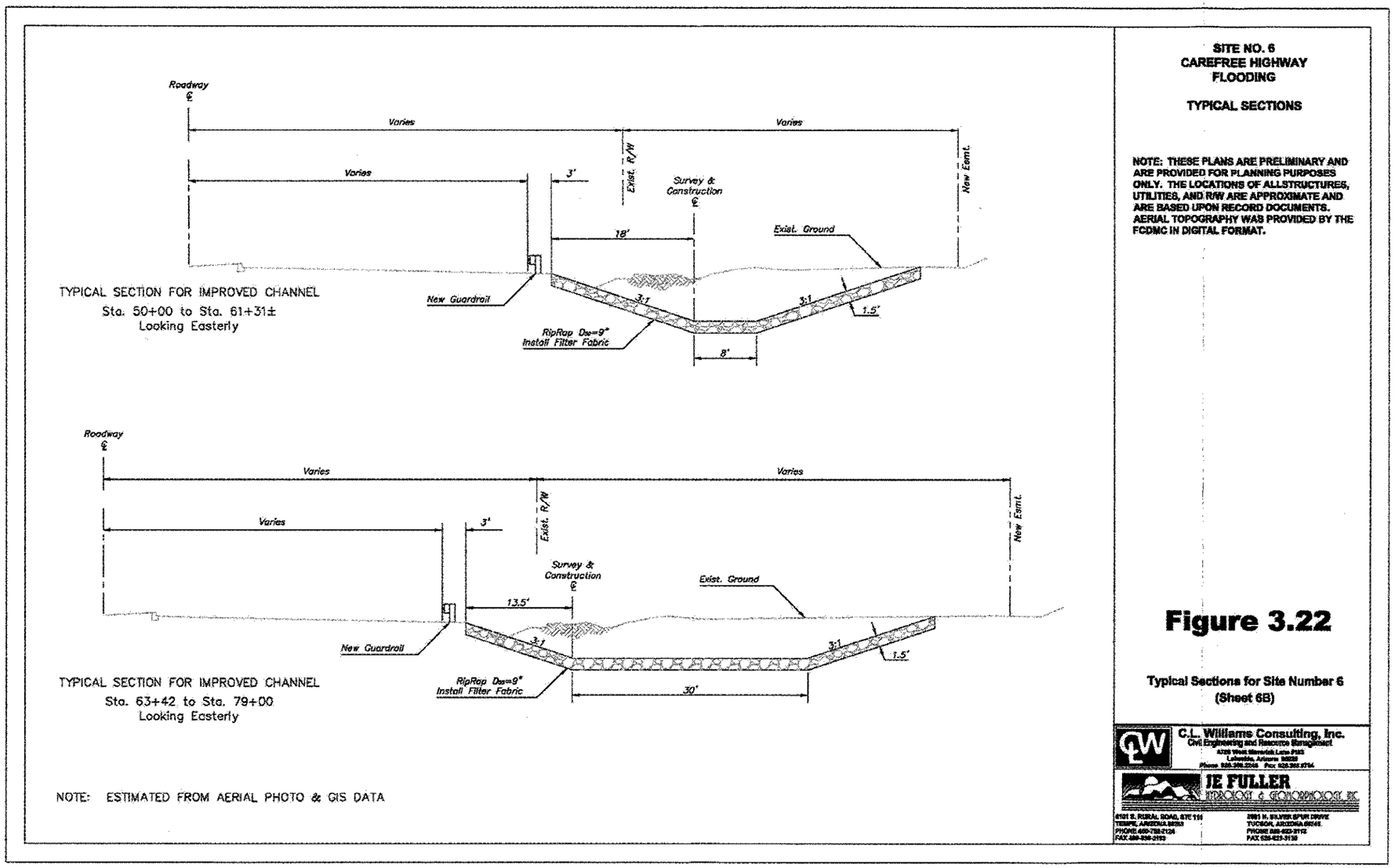

Figure 3.22

Typical Sections for Site Number 6 (Sheet 6B)

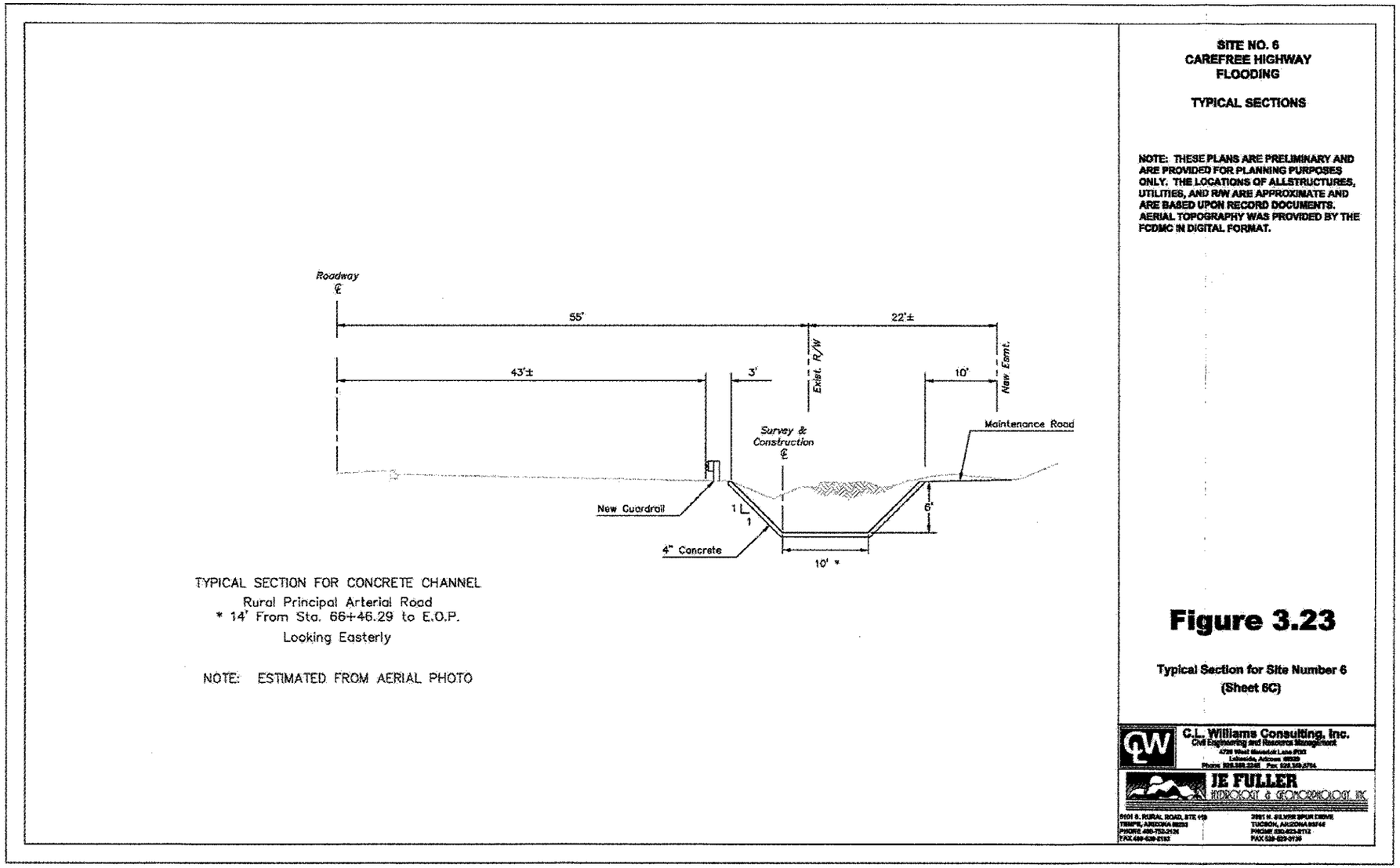

Figure 3.23

Typical Sections for Site Number 6 (Sheet 6C)

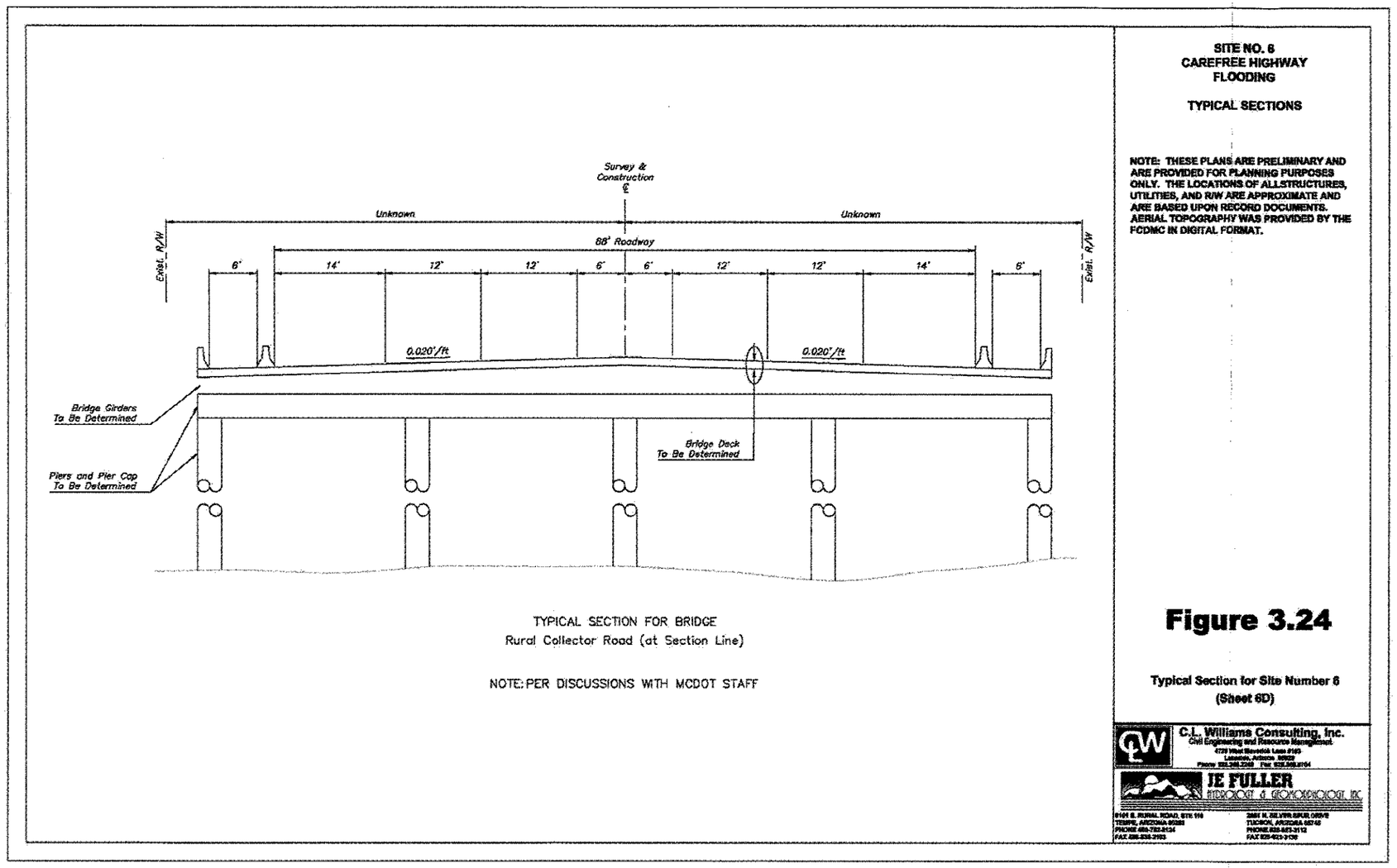

Figure 3.24

Typical Sections for Site Number 6 (Sheet 6D)

Table 3.10

Cost Estimates for Site Number 6

Description	Construction				Contingency	Engineering	Total
	Units	Unit Cost	Quantity	Construction Cost			
Channel Excavation	Cu.Yd.	$6	27250	$ 163,500	$ 40,875	$ 24,525	$ 228,900
Rip Rap	Cu.Yd.	$65	15000	$ 975,000	$ 243,750	$ 146,250	$ 1,365,000
Guardrail	LF	$20	6300	$ 126,000	$ 31,500	$ 18,900	$ 176,400
Misc. Roadway Items	LS	$210,000	5	$ 1,050,000	$ 262,500	$ 157,500	$ 1,470,000
Right-of-Way Acquisition	Acre	$50,000	2.6	$ 130,000	$ 32,500	$ 19,500	$ 182,000
Concrete Box Culvert (10'x4')	LF	$550	1963	$ 1,079,650	$ 269,913	$ 161,948	$ 1,511,510
Relocations & Adjustments	LS	$120,000	5	$ 600,000	$ 150,000	$ 90,000	$ 840,000
Concrete Box Culvert (10'x5')	LF	$766	2,380	$ 1,823,080	$ 455,770	$ 273,462	$ 2,552,312
New Bridge	Sq. Ft.	$85	21420	$ 1,820,700	$ 455,175	$ 273,105	$ 2,548,980
Concrete Box Culvert (8'x8')	LF	$600	375	$ 225,000	$ 56,250	$ 33,750	$ 315,000
			Totals	$ 7,992,930	$ 1,998,233	$ 1,198,940	**$ 11,190,102**

SUMMARY

	Minimum Costs		Maximum Costs
Range of Costs	**$ 11,190,102**		**$ 11,190,102**

Number of Parcels negatively impacted	**8**
Number of Parcels positively impacted	**31** (Approximately)

Note: All parcel and structure data based on 2002 parcel and aerial data.

3.2.7 Site Number 7

Problem Description – The Cave Creek Watercourse Master Plan identified this site as a problem area. Site 7 has been a problem since the 24th Street alignment north of the Carefree Highway is basically in the bottom of Apache Wash (Appendix B). The roadway and Apache Wash coexist for nearly 700 feet at one location and about 250 feet at another.

In the 100-year event of 7,210 cfs 24th Street is impassable. 24th Street is a primary artery for the residents to the area north. This situation will only increase in severity as the area to the north continues to develop.

Methodology and Design –Design flows for this site came from Part 3, Volume 1 of the ADMP report. The design 100-year peak flow of 7,210 cfs for Apache Wash comes from the north and flows directly south encompassing 24th Street for most of its length from Cloud Road to the Carefree Highway.

Two distinct alternatives were analyzed for Site Number 7; one alternative was to realign 24th Street so that it moves to the west up out of Apache Wash and the other alternative was to provide channelization and engineered roadway crossings that contain the flows within the existing right-of-way.

During the alternative selection process, the second alternative very quickly became not only cost prohibitive, but not practical in the sense that most of the roadway would need to be elevated to a level such that overtopping would not occur. Even if the road was elevated, the embankment along almost of the entire length of the roadway would have to be armored so that flows running parallel to it would not endanger the integrity of the roadway system. Additionally, it would be necessary to turn the large flows ninety degrees at the roadway crossings to convey it to the other side of the road. Since the Carefree Highway is considered a scenic roadway, it would be very expensive and difficult to make the channel and armoring system conform to the guidelines set forth for this type of scenic roadway.

Alternative one, although somewhat challenging, was determined by the ADMP team to be the most desirable. For this alternative, 24th Street would be realigned to the west side of Apache Wash, generally along the natural ridge that exists. At the Carefree Highway, the intersection would also need to be shifted west of Apache Wash so that there is no need for

crossing of the wash at all. At Cloud Road, the current intersection could be left alone since the roadway can be swung back into its original location at this point. The Road can be built in the floodplain fringe and elevated to preserve land. In fact, a breakout area just north of the Carefree Highway could be eliminated and kept within the Apache Wash corridor. No new culvert would be required to cross Apache Wash. A relief culvert may be required at the Carefree Highway depending on how the breakout flow is actually handled.

The realignment alternative removes the roadway out of the flood hazard and becomes an all weather access. No Apache Wash crossings are needed for this alternative. This alternative has the opportunity of stopping breakout flow from Apache Wash if that is considered desirable. All of the adjacent land is ASLD trust land. Because of this, the possibility exists for cost share either with the State Land Department or with a potential buyer of this property.

Because of the reasons stated, the realignment of 24th Street has been carried forward as part of the recommended alternative. This alternative completely removes the flooding problem associated with Apache Wash and provides and all weather access to the development to the north.

Plan and Profiles – The plan and profile sheets were put together with updated aerial photography and topography. Existing utilities are shown in the plan view, but actual depths of these utilities are unknown. The profile shows the proposed condition of the new roadway along with the existing grade profile. The design flow (100-year) for Apache Wash is 7,210 cfs and is depicted on the plan and profile sheet. Refer to Figures 3.25 and, 3.26 for the Plan and Profiles and typical sections of Site Number 7 and Appendix B for all supporting data.

Cost Estimates – Cost estimates for this alternative were performed by JEF. Similar to Site Number 6, this site is much easier to cost based on the fact that right-of-way impacts only one owner, the ASLD. At the time of the analysis (July, 2004), the land costs are assumed to equal $1.50 per square foot of raw ground or $65,340.26 per acre as provided by the FCDMC. Refer to Table 3.11 for cost estimates for Site Number 7.

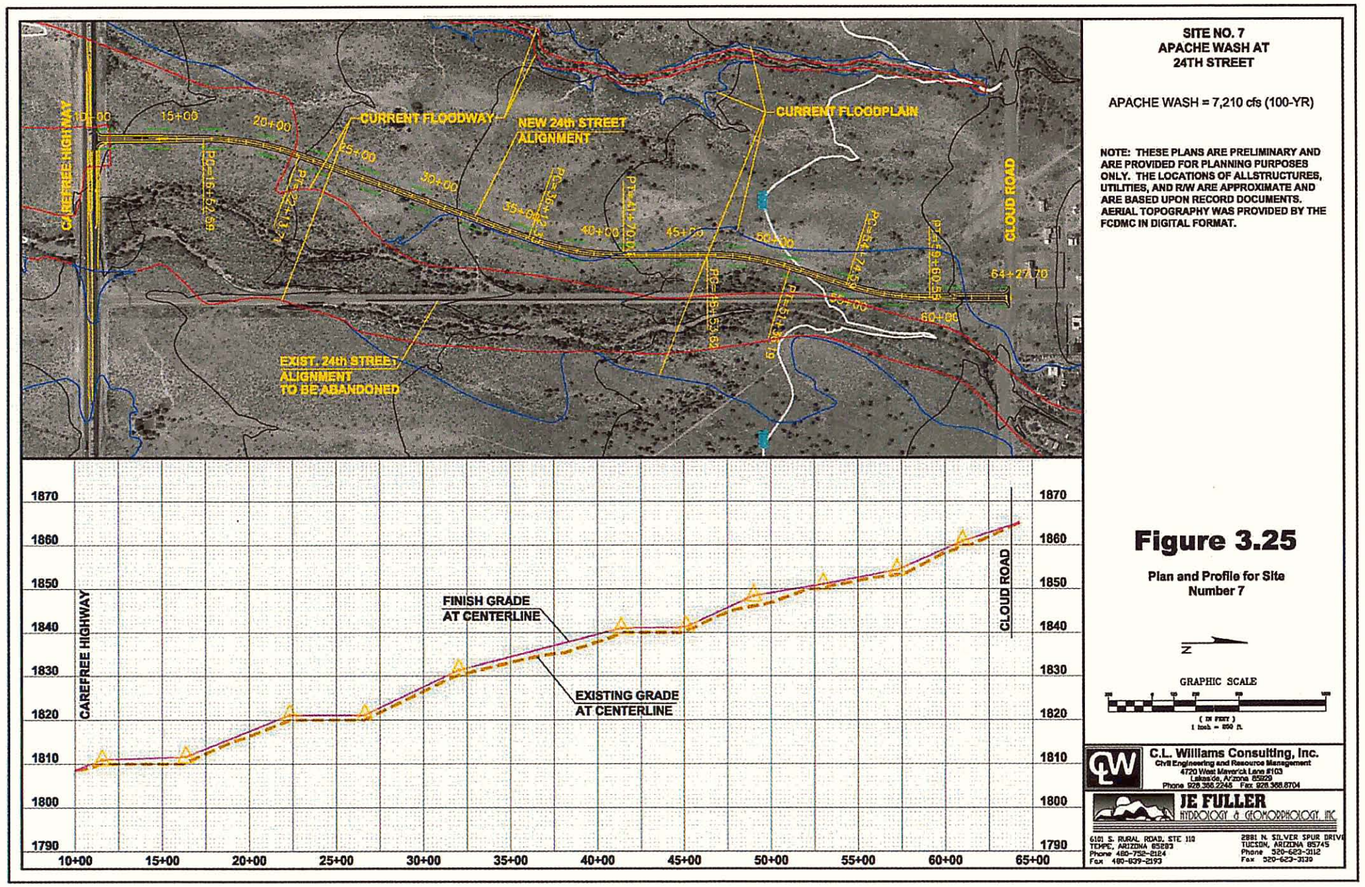

Figure 3.25

Plan and Profile for Site Number 7

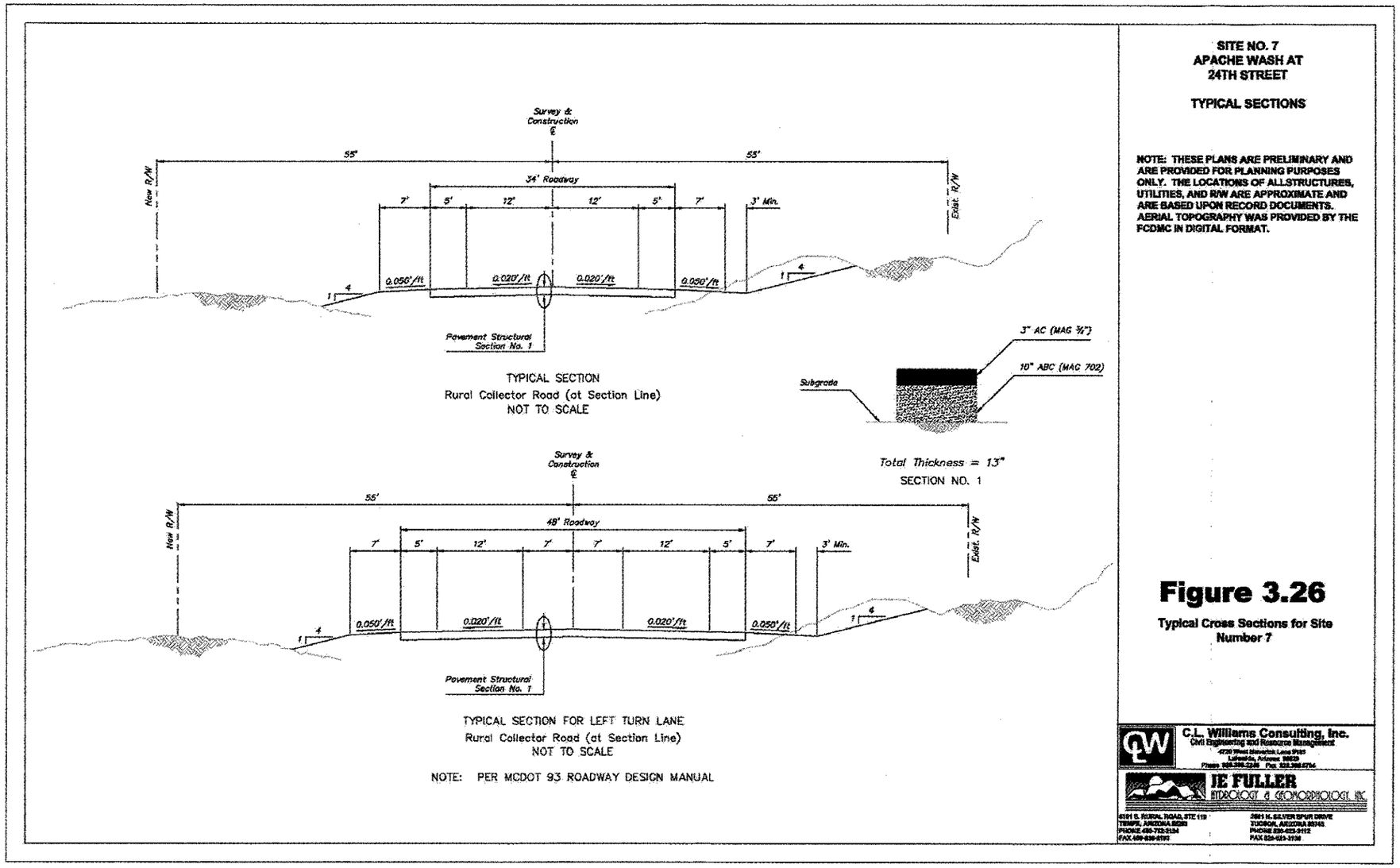

Figure 3.26

Typical Cross Sections for Site Number 7

Table 3.11

Cost Estimates for Site Number 7

Description	Construction				Contingency	Engineering	Total
	Units	Unit Cost	Quantity	Construction Cost			
Roadway Excavation	Cu.Yd.	$10	3,000	$ 30,000	$ 7,500	$ 4,500	$ 42,000
Pavement	Sq. Yd.	$25	22,000	$ 550,000	$ 137,500	$ 82,500	$ 770,000
Misc. Roadway Items	LS	$250,000	1	$ 250,000	$ 62,500	$ 37,500	$ 350,000
Right-of-Way Acquisition	Acre	$50,000	13.6	$ 680,000	$ 170,000	$ 102,000	$ 952,000
Improvements (Carefree Highway)	LS	$65,000	1	$ 65,000	$ 16,250	$ 9,750	$ 91,000
Demolition	Sq. Yd.	$5	22,100	$ 110,500	$ 27,625	$ 16,575	$ 154,700
Rehabilitation	Acre	$2,845	8.8	$ 25,036	$ 6,259	$ 3,755	$ 35,050
Environmental Assessment	LS	$100,000	1	$ 100,000	$ 25,000	$ 15,000	$ 140,000
Right-of-Way Abandonment	LS	$20,000	1	$ 20,000	$ 5,000	$ 3,000	$ 28,000
			Totals	$ 1,830,536	$ 457,634	$ 274,580	**$ 2,562,750**

SUMMARY

	Minimum Costs		Maximum Costs	
Range of Costs	**$ 2,562,750**		**$ 2,562,750**	

Number of Parcels negatively impacted	**2**
Number of Parcels positively impacted	**50** (Approximately)

Note: All parcel and structure data based on 2002 parcel and aerial data.

3.2.8 Site Number 8

Problem Description – Included in the sites recommended for upgrade in the Skunk Creek Watercourse Master Plan was Site Number 8. Site Number 8 is the confluence of Desert Hills Drive and Skunk Creek (Appendix B).

At this location, the flow coming down Skunk Creek intersects Desert Hills Drive, which is a low water crossing. All flow, including minor nuisance flow crosses over the roadway surface creating frequent road closures at this location. This crossing is continually barricaded during storm events.

From the discussion in Section 3.2.3, this location is one of two access points to the area west of Skunk Creek. Currently, if the roadway at Cloud Road and 27th Avenue were washed out and Site Number 8 was inundated with active flow, access to the west side of Skunk Creek would be cut off and residents would be stranded. Additionally, this would not allow for emergency services to cross Skunk Creek. The new Daisy Mountain fire station is located just east of Skunk Creek on Desert Hills Drive and 11th Avenue.

Methodology and Design –Design flows for this site came from the Skunk Creek WCMP. The design 100-year peak flow of 27,300 cfs comes from the north and flows directly south across Desert Hills Drive. The water surface elevation taken from the FIS model is 1856.69 at the crossing.

Only one structural alternative makes sense at this site and that is to bridge the crossing. The flows in this location are too large to warrant box culverts and would not allow for wildlife to cross under the roadway. The actual bridge looked at for this alternative is one that would span the floodplain. This is necessary so that the current flows are not disturbed in any way. Increasing water surface elevations at this location would mean increased flooding to current structures.

Although this alternative is an expensive one, it was carried forward by the ADMP team to recommended alternative. This was done because of two reasons; first, because this is a larger arterial roadway than 27th Avenue and has the potential for higher traffic usage, and second, because the access for emergency services from the Daisy Mountain fire district makes more sense due to the proximity to the new fire station.

One additional problem had to be solved for Site Number 8 because of the placement of the bridge itself. In order for the bridge to be able to span the floodplain, it cuts off access from Desert Hills Drive onto 15th Avenue, which is located just east of Skunk Creek in the floodway. For this alternative, 15th Avenue access would be accomplished by upgrading Tanya road to a paved section from its intersection with 15th Avenue east to 11th Avenue. 11th Avenue would also be upgraded to a paved section from Tanya Road north to the intersection of Desert Hills Drive.

Plan and Profiles – The plan and profile sheets were put together with updated aerial photography and topography. Existing utilities are shown in the plan view, but actual depths of these utilities are unknown. The profile shows the proposed condition of the new roadway and bridge section along with the existing grade profile. The design flow (100-year) for Skunk Creek is 27,300 cfs and is depicted on the plan and profile sheet. Refer to Figures 3.27, 3.28, and 3.29 for the Plan and Profiles and typical sections of Site Number 8 and Appendix B for all supporting data.

Cost Estimates – Cost estimates for this alternative were performed by JEF. Similar to Site Number 6, this site is much easier to cost based on the fact that right-of-way already exists for construction. At the time of the analysis (July, 2004), the land costs are assumed to equal $1.50 per square foot of raw ground or $65,340.26 per acre as provided by the FCDMC. Refer to Table 3.12 for cost estimates for Site Number 8.

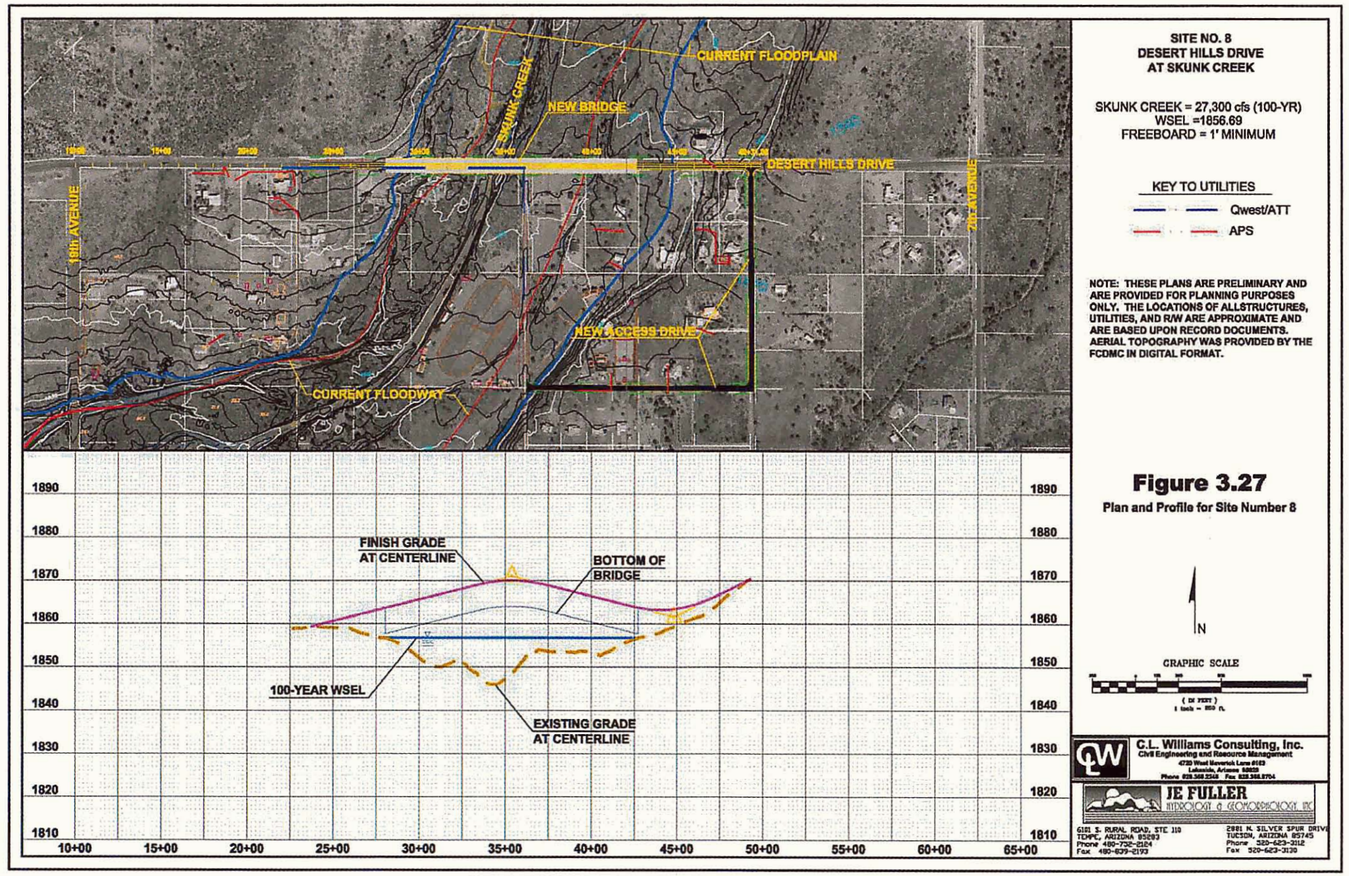

Figure 3.27

Plan and Profile for Site Number 8

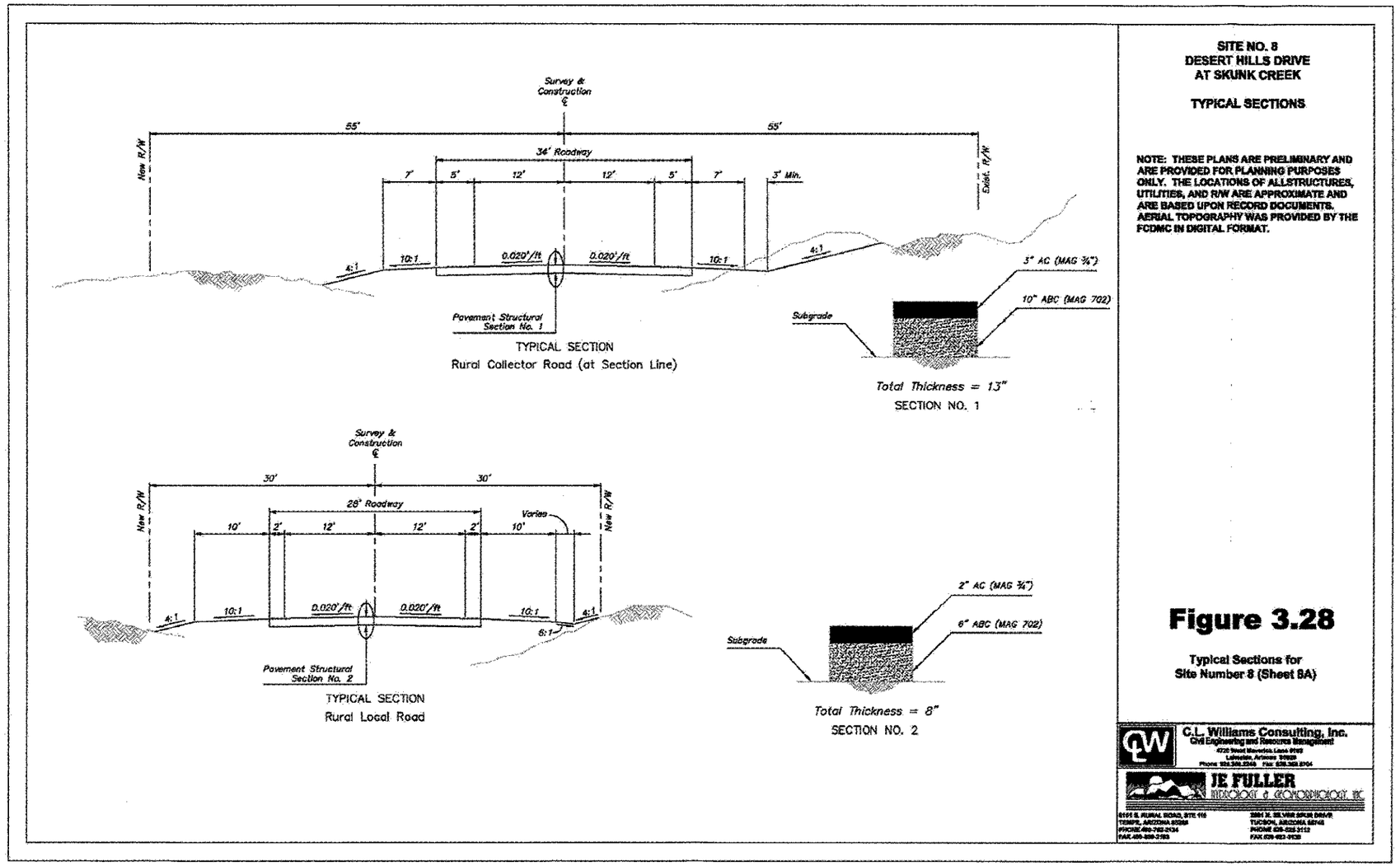

Figure 3.28

Typical Cross Sections for Site Number 8 (Sheet 8A)

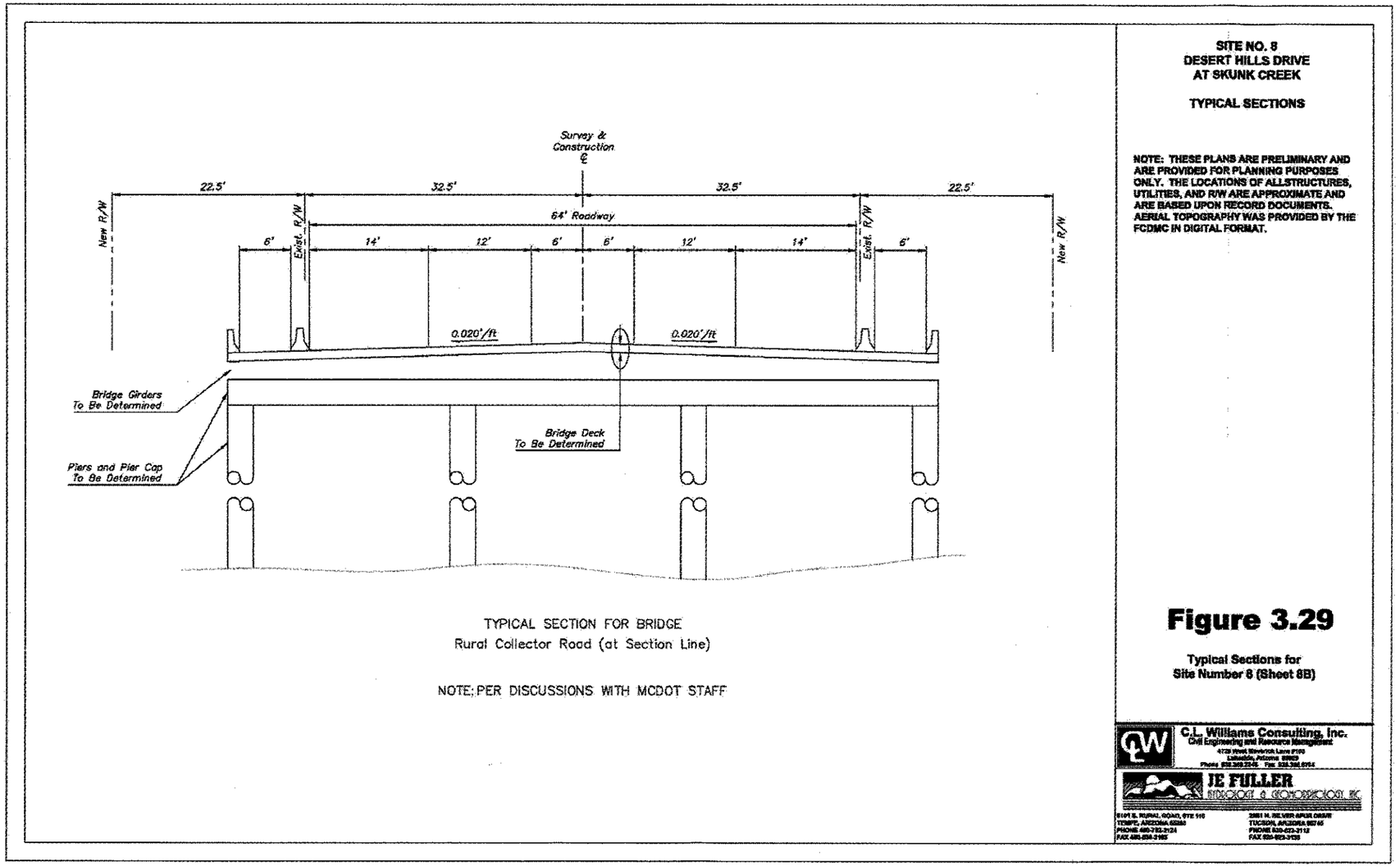

Figure 3.29

Typical Cross Sections for Site Number 8 (Sheet 8B)

Table 3.12

Cost Estimates for Site Number 8

COST ESTIMATE

Description	Construction				Contingency	Engineering	Total
	Units	Unit Cost	Quantity	Construction Cost			
Roadway Excavation	Cu.Yd.	$10	1,800	$ 18,000	$ 4,500	$ 2,700	$ 25,200
Pavement	Sq. Yd.	$25	12,550	$ 313,750	$ 78,438	$ 47,063	$ 439,250
Misc. Roadway Items	LS	$250,000	1	$ 250,000	$ 62,500	$ 37,500	$ 350,000
Right-of-Way Acquisition	Acre	$50,000	6.2	$ 310,000	$ 77,500	$ 46,500	$ 434,000
Bridge	Sq. Ft.	$85	121,200	$ 10,302,000	$ 2,575,500	$ 1,545,300	$ 14,422,800
Guardrail	LF	$15	200	$ 3,000	$ 750	$ 450	$ 4,200
Guardrail Terminals	Each	$2,500	4.0	$ 10,000	$ 2,500	$ 1,500	$ 14,000
			Totals	$ 11,206,750	$ 2,801,688	$ 1,681,013	**$ 15,689,450**

SUMMARY

	Minimum Costs	Maximum Costs
Range of Costs	**$ 15,689,450**	**$ 15,689,450**

Number of Parcels negatively impacted	**12**
Number of Parcels positively impacted	**65** (Approximately)

Note: All parcel and structure data based on 2002 parcel and aerial data.

3.2.9 Site Number 9

Problem Description – While looking at the issue of access throughout the Desert Hills/New River area for the Flood Response Plan, the Skunk Creek WCMP identified this location as a problem area for access north into the New River community. The ADMP team analyzed the issues associated with the area and agreed that the culvert crossing at Rodger Creek and the New River Road was old and could fail during any significant storm event (Appendix B). If this were to occur, the only access into the New River area is from the I-17 exit east into the New River community. Emergency services would be greatly hampered because of the distance that would have to be taken to get north into the area.

Flow in Rodger Creek coming from the northeast out of the area between Pyramid Peak and Apache Peak crosses the New River Road in two 8 foot diameter culverts. The headwalls of these culverts are hand placed rock and are very old and damaged. The 100-year peak discharge overtops the roadway making it impassable. Once flow exits these structures, serious erosion problems are evident along the southern bank. This erosion protection needs to be replaced or modified so that it functions more efficiently. The flow in Rodger Creek also inundates a floodway residence downstream of the crossing before it eventually enters Skunk Creek.

Methodology and Design –Design flows for Rodger Creek came from the Skunk Creek WCMP. The design 100-year peak flow of 6,170 cfs comes from the northeast and flows west across the New River Road. The water surface elevation taken from the FIS model is 2035.10 at the crossing.

Two structural alternatives were analyzed for the purposes of this study. The first was a 400 foot long span bridge over Rodger Creek that would span the floodplain. The roadway profile would need to be raised to accommodate the flow from Rodger Creek, but containment of the flow would be the driving force for the expense needed to achieve a bridge. A bridge would provide a 100-year all weather access, reduce the floodplain elevation and limits upstream of the culverts, and would potentially reduce scour of the left bank downstream due to existing culvert outflows. The cost is high, but MCDOT is a

potential partner. A bridge would also improve moderate habitat in the area to high and would provide a corridor for the Maricopa County trail system.

The second alternative is to improve the current crossing with several reinforced box culverts. To pass the 100-year flow it would require many different sizes of culverts. JEF looked at a stepped system were four 10 foot by 8 foot RCBs are placed in the main channel, four 6 foot by 8 foot RCBs are then stepped up into the right overbank, and then six 4 foot by 8 foot RCBs are stepped even higher into the right overbank. The costs of this type of crossing, or one similar, is less expensive than a bridge structure, but the tailwater control greatly reduces the effectiveness of the culverts, causing more tailwater effects and not making the situation better, and is tied to a rigid boundary. The culvert option does not help the trail system or improve the erosion problem on the downstream side. The differing heights of the culverts create an effect that is not very pleasing to the residents within the area.

These two options were compared to each other using the selection criteria and alternative one was accepted to continue to recommended alternative. This was done because of three reasons; first, because the agencies involved preferred a bridge section based on the fact that it is a critical major arterial serving the New River area and will only become more important as development continues north of the crossing, second, because the access for emergency services from the Daisy Mountain fire district makes more sense due to the location of the fire station located south of the crossing, and lastly, a bridge section provides an access for the Maricopa County trail system which has been identified as an important consideration in the environmental analysis.

Even though a bridge is recommended, the residence downstream of the crossing is still located within the floodway. This residence is also recommended to the FPAP program as part of the recommended alternative.

Plan and Profiles – The plan and profile sheet was put together with updated aerial photography and topography. Existing utilities are shown in the plan view, but actual depths of these utilities are unknown. The profile shows the proposed condition of the new bridge section along with the existing grade profile. The design flow (100-year) for Rodger Creek is 6,170 cfs and is depicted on the plan and profile sheet. Refer to Figures 3.30 and 3.31 for the

Plan and Profiles and typical sections of Site Number 9 and Appendix B for all supporting data.

Cost Estimates – Cost estimates for this alternative were performed by JEF. As was discussed previously a range of costs based on the land needed to construct the bridge, ingress/egress channels, and associated erosion protection was necessary. The lower range cost was based on the amount of land needed if only the right-of-way of the construction was purchased. This is obviously going to be a cost that is too low based on the fact that it would be very difficult if not impossible to purchase just the land needed for right-of-way. Because of this, an upper range was established based on the purchase of every parcel that the right-of-way came in contact. The actual cost is going to fall somewhere between these two. At the time of the analysis (July, 2004), the land costs are assumed to equal $1.50 per square foot of raw ground or $65,340.26 per acre as provided by the FCDMC. Refer to Table 3.13 for cost estimates for Site Number 9.

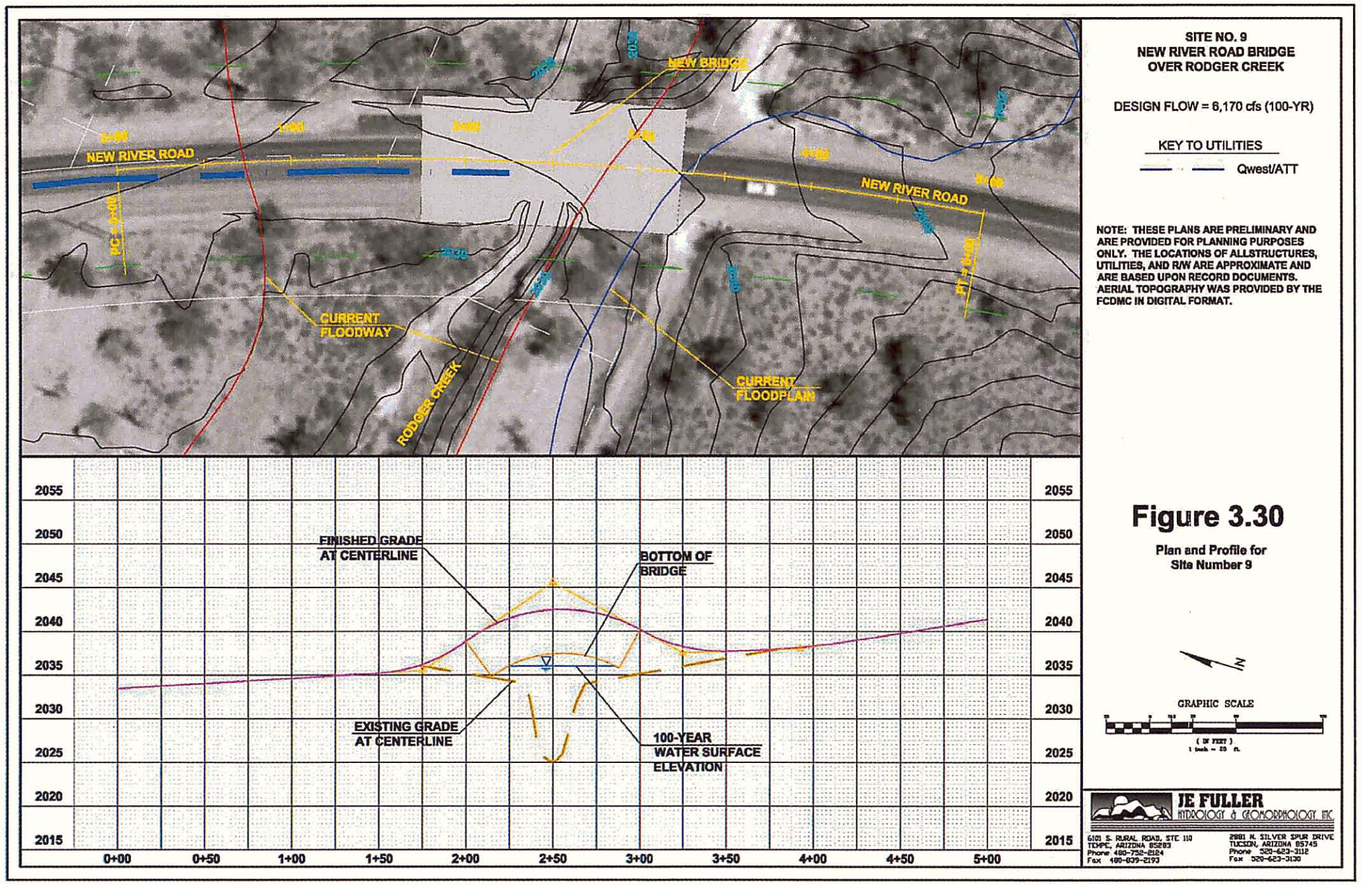

Figure 3.30

Plan and Profile for Site Number 9

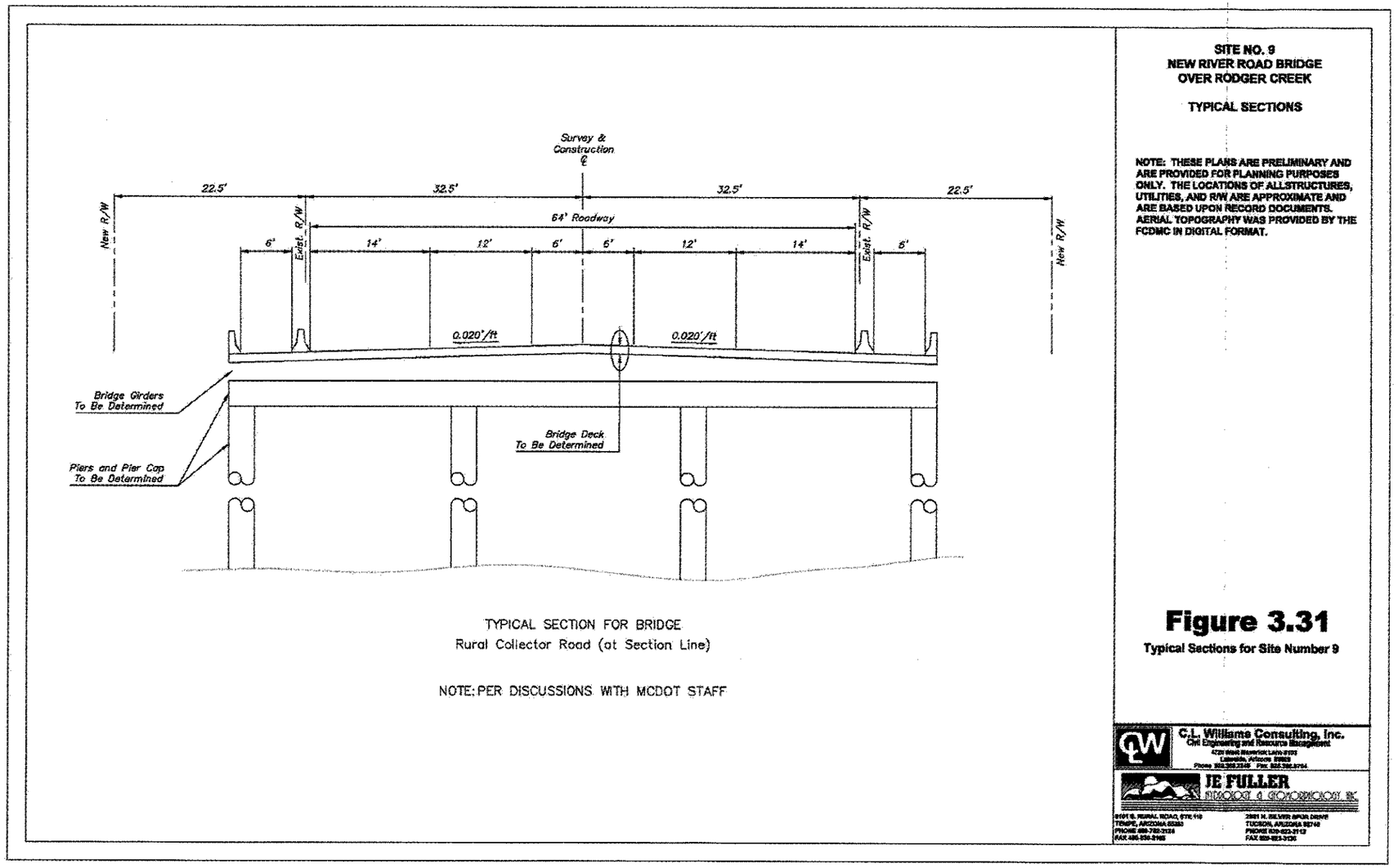

Figure 3.31

Typical Cross Sections for Site Number 9

Table 3.13
Cost Estimates for Site Number 9

COST ESTIMATE

Description	Construction				Land				Contingency	Engineering	Tota
	Units	Unit Cost	Quantity	Construction Cost	Units	Unit Cost	Quantity	Land Cost			
Roadway Excavation	Cu.Yd.	$10	500	$ 5,000	SF	$1.50	0	$ -	$ 1,250	$ 750	$ 7,000
Pavement	Sq. Yd.	$25	1450	$ 36,250	SF	$1.50	0	$ -	$ 9,063	$ 5,438	$ 50,750
Misc. Roadway Items	LS	$250,000	1	$ 250,000	SF	$1.50	0	$ -	$ 62,500	$ 37,500	$ 350,000
Right-of-Way Acquisition	Acre	$50,000	1	$ 50,000	SF	$1.50	43560	$ 65,340	$ 12,500	$ 7,500	$ 135,340
Bridge	Sq. Ft.	$85	10800	$ 918,000	SF	$1.50	0	$ -	$ 229,500	$ 137,700	$ 1,285,200
Guardrail	LF	$15	1200	$ 18,000	SF	$1.50	0	$ -	$ 4,500	$ 2,700	$ 25,200
Guardrail Terminals	Each	$2,500	4	$ 10,000	SF	$1.50	0	$ -	$ 2,500	$ 1,500	$ 14,000
			Totals	$ 1,287,250				$ 65,340	$ 321,813	$ 193,088	**$ 1,867,490**

Note: Land costs are assumed to equal $1.50 per square foot raw ground and is only the footprint of the structural alternative. This is equal to $65,340.26 per acre. (July, 2004)

LAND COSTS ASSUMING FULL TAKE ON AFFECTED PROPERTIES

Number of Parcels	Land				Number of Dev. Parcels	Developed		
	Units	Unit Cost	Quantity	Land Cost		Unit Cost	Costs	Total
1 - Undeveloped Parcels	SF	$ 1.50	95947	$ 143,921	0	$ -	$ -	$ 143,921
1 - Developed Parcel	SF	$ 1.50	206257	$ 309,386	1	$ 185,000	$ 185,000	$ 494,386
Totals				$ 453,306			$ 185,000	**$ 638,306**

SUMMARY

	Minimum Costs		Maximum Costs
Range of Costs	**$ 1,867,490**		**$ 2,440,456**

Number of Parcels negatively impacted	**2**
Number of Parcels positively impacted	**5** (5 Directly, All of the Cline Creek and New River area)

Note: All parcel and structure data based on 2002 parcel and aerial data.

3.2.10 Site Number 10

Problem Description – Site Number 10 evolved from discussions and field visits of the ADMP team. It was observed that flow in the Cline Creek tributary to Skunk Creek coming southwest out of the Tonto National Forest made a large sweeping bend at the base of Circle Mountain Road before it continued under the New River Road Bridge (Appendix B). Circle Mountain Road is elevated approximately 10 feet above the bottom of the wash bottom. The sideslope embankment of the roadway is currently unprotected from erosion in any way.

The reason that this particular location is critical is due to the fact that this is the sole access for residents in the Cline Creek Area. If the roadway embankment were to fail due to erosion, access would be cut off for approximately four square miles of developed land. Emergency access would only be available through the air.

Methodology and Design –Design flows for this site came from the Skunk Creek WCMP. The design 100-year peak flow of 13,747 cfs comes from the northeast and flows south into a large sweeping bend to the west before it crosses New River Road. The channel velocity in this location is 15 feet per second and the channel bank shear stress is 8 pounds per square foot. C. L. Williams Consulting, Inc. (CLW) analyzed this location. Design assumptions are listed on Figure 3.32.

This site is highly visible to the surrounding area, so aesthetics is an important factor in the solution chosen for this site. Four structural alternatives were analyzed for the purposes of this study. The first was the placement of dumped riprap along the entire face of the slope. Some of the problems associated with dumped rock riprap are the availability of suitable material for construction, permitting, public visual acceptance, and the location of a cultural site located in the northwest corner of the site. There are also issues that may arise with regards to the velocities. Dumped rock riprap would need to be sized large enough that movement does not occur.

Placement of gabion baskets or mattresses is another option that has been discussed. The issues associated with gabion baskets or mattresses are very similar to dumped rock riprap with the exception that they tend to be more stable and can withstand greater shear stress with smaller material. Once again some of the problems can be suitable material available for

construction, permitting, public visual acceptance, and the cultural site in the northwest corner.

Shotcrete is another method that could be implemented on this site. This alternative is very efficient in protecting the embankment, but has the lowest chance for public visual acceptance.

Finally, the ADMP team looked at a series of terraced walls that would be supplemented with a more naturalized treatment such as native plants and grasses. This alternative is much more visually pleasing as opposed to the more hard engineered solutions. This treatment would actually incorporate terraced gabion baskets that would be placed into the embankment. Dumped rock riprap would be placed below the gabions to protect the toe of the slope to the scour depth. Backfill would then be placed over the gabion baskets and riprap. The embankment would then be planted with natural vegetation of a type that would hold the slope in higher recurrence interval storms such as the 2-year event. Maintenance of the site would be necessary if a larger (100-year) event occurred that removed the top layer of the treatment. The integrity of the roadway embankment would not be compromised in anything less than a 100-year event.

All of these alternatives were compared to each other, discussed and presented to the public in the area. The terraced option was the most widely accepted alternative based on the visual aspects of the alternative. Because of these reasons, the terraced alternative was carried forward into the recommended alternative.

Plan and Profiles – The plan and profile sheet was put together with updated aerial photography and topography. Existing utilities are shown in the plan view, but actual depths of these utilities are unknown. The profile shows the existing grade of Circle Mountain Road, the 100-year water surface elevation profile, and the existing grade at the Cline Creek thalweg. The design flow (100-year) for Cline Creek is 13,747 cfs and is depicted on the plan and profile sheet. Refer to Figures 3.32 and 3.33 for the Plan and Profiles and typical sections of Site Number 10 and Appendix B for all supporting data.

Cost Estimates – Cost estimates for this alternative were performed by JEF. As was discussed previously a range of costs based on the land needed to construct the erosion protection was necessary. The lower range cost was based on the amount of land needed if only the right-of-way of the construction was purchased. This is obviously going to be a cost that is too low based on the fact that it would be very difficult if not impossible to purchase just the land needed for right-of-way. Because of this, an upper range was established based on the purchase of every parcel that the right-of-way came in contact. The actual cost is going to fall somewhere between these two. At the time of the analysis (July, 2004), the land costs are assumed to equal $1.50 per square foot of raw ground or $65,340.26 per acre as provided by the FCDMC. Refer to Table 3.14 for cost estimates for Site Number 10.

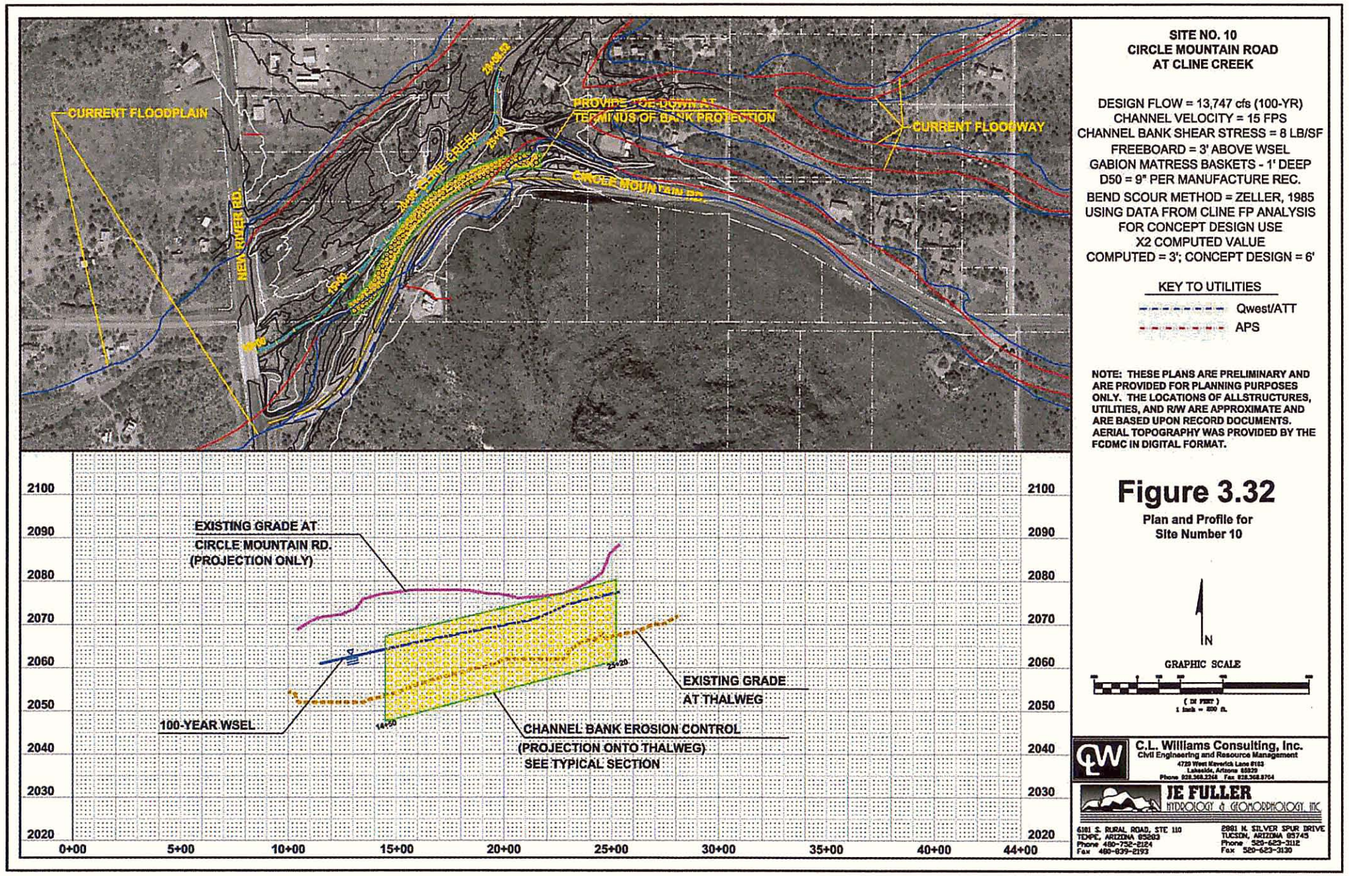

Figure 3.32

Plan and Profile for Site Number 10

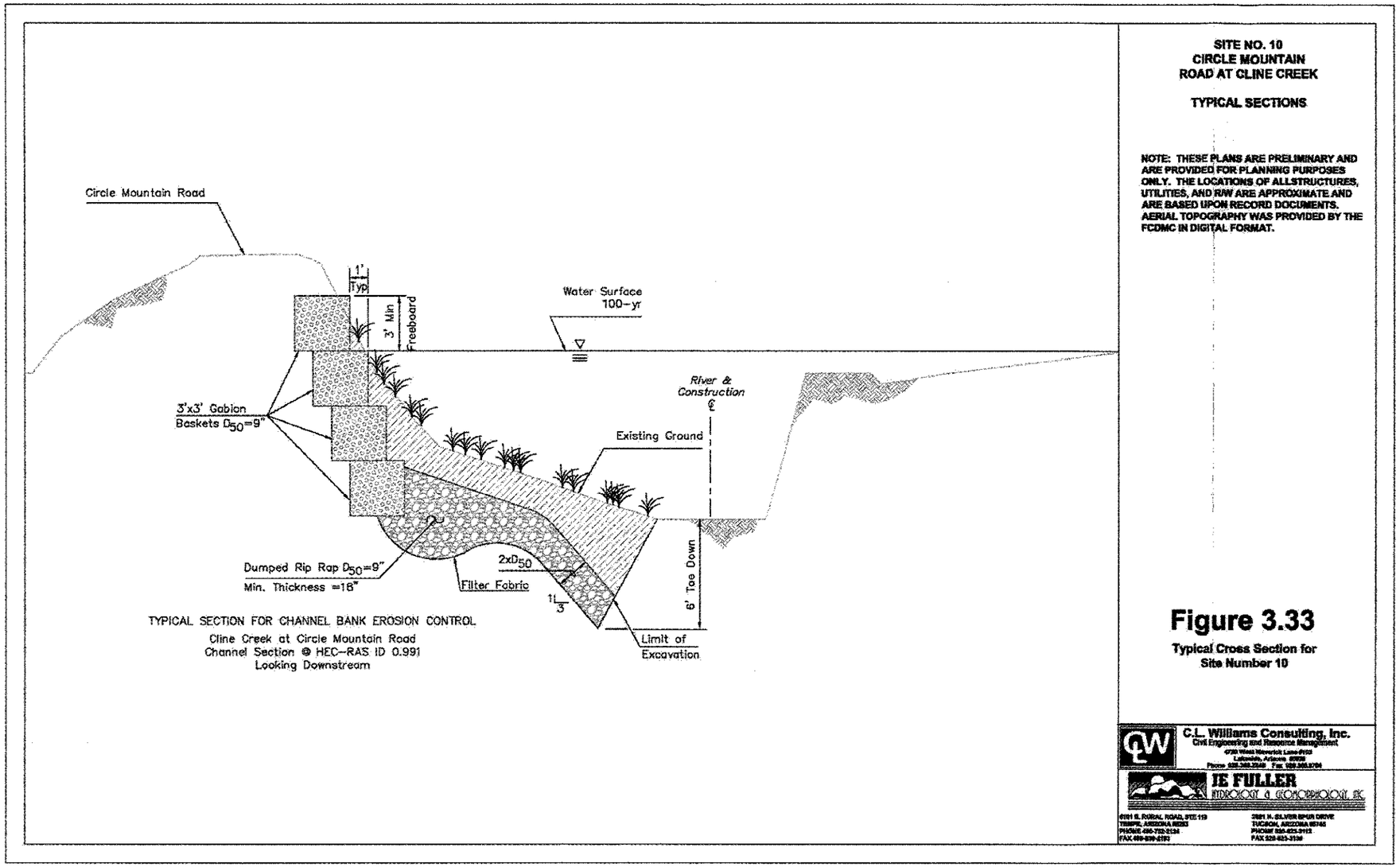

Figure 3.33

Typical Cross Sections for Site Number 10

Table 3.14
Cost Estimates for Site Number 10

COST ESTIMATE

Description	Construction				Land				Contingency	Engineering	Total
	Units	Unit Cost	Quantity	Construction Cost	Units	Unit Cost	Quantity	Land Cost			
Excavation	Cu.Yd.	$10	25400	$ 254,000	SF	$1.50	83468.55	$ 125,203	$ 63,500	$ 38,100	$ 480,803
Gabions	Cu.Yd.	$85	1560	$ 132,600	SF	$1.50	0	$ -	$ 33,150	$ 19,890	$ 185,640
Dumped Rip Rap	Cu.Yd.	$65	8000	$ 520,000	SF	$1.50	0	$ -	$ 130,000	$ 78,000	$ 728,000
Landscaping	Sq. Yd.	$6	9200	$ 55,200	SF	$1.50	0	$ -	$ 13,800	$ 8,280	$ 77,280
Misc. Erosion Items	LS	$100,000	1	$ 100,000	SF	$1.50	0	$ -	$ 25,000	$ 15,000	$ 140,000
			Totals	$ 1,061,800				$ 125,203	$ 265,450	$ 159,270	**$ 1,611,723**

Note: Land costs are assumed to equal $1.50 per square foot raw ground and is only the footprint of the structural alternative. This is equal to $65,340.26 per acre. (July, 2004)

LAND COSTS ASSUMING FULL TAKE ON AFFECTED PROPERTIES

Number of Parcels	Land				Number of Dev. Parcels	Developed		
	Units	Unit Cost	Quantity	Land Cost		Unit Cost	Costs	Total
2 - Undeveloped Parcels	SF	$ 1.50	776281	$ 1,164,422	0	$ -	$ -	$ 1,164,422
0 - Developed Parcel	SF	$ 1.50	0	$ -	0	$ -	$ -	$ -
Totals				$ 1,164,422			$ -	**$ 1,164,422**

SUMMARY

	Minimum Costs		Maximum Costs
Range of Costs	**$ 1,611,723**		**$ 2,650,942**

Number of Parcels negatively impacted	**2**
Number of Parcels positively impacted	**4 Square Miles** (All of the Cline Creek Area)

Note: All parcel and structure data based on 2002 parcel and aerial data.

3.2.11 Site Number 11

Problem Description – During the course of the WCMP, the WCMP team identified the Site Number 11 (located upstream and downstream of the New River Road Bridge at Skunk Creek) (Appendix B) as a significant problem area. Residences in the floodway, flow breakouts occurring in many locations as well as a bridge that has a very severe skew with regards to the flow of Skunk Creek.

Flows come down from the north in Skunk Creek. When they get to Wolf Trap Road, they begin to break out to the west and southwest. The flow continues to breakout from this location until approximately 600 feet north of the New River Road Bridge. The flow that breaks out continues west/southwest until it reaches the New River Road. At this point the flow inundates the roadway, crosses to the south, floods several residences, then turns southeast until it intersects back into Skunk Creek.

This occurs because of the following reasons; the channels in the area are braided with low banks that tend to allow flow to jump between flowpaths from flow event to flow event, the flows, as they approach the bridge, are backed up due to the skew of the bridge combined with Steeper slopes approaching the bridge flattening out causing the stream to drop its sediment and agrade through the bridge section increasing the water surface elevations and therefore pushing water out of the system.

Breakout that reaches New River Road just west of the bridge occurs in less than the 10-year recurrence interval, at a rate of between 700 and 1,000 cfs. The velocities impacting the road at this location are on the magnitude of 5 to 8 feet per second. Approximately 20 homes are impacted by this breakout either by erosion problems, access issues, or complete inundation.

Methodology and Design – Modeling of this area has taken on many forms. The FCDMC commenced FLO-2D modeling of this area prior to the beginning of this project and continues to the current date. The current FIS study, performed by Montgomery Watson in 1997, is the current regulated floodplain/floodway for Skunk Creek. Part 4, Volumes 1 and 2 of the ADMP are a mix of detailed and approximate zone A delineation of Skunk Creek to just below the confluence of tributary 6B and Skunk Creek in the south to the County boundaries in the north. This study also included a portion of tributary 6B and tributary

28.839. Part 4, Volumes 7 and 8 of the ADMP are floodplain delineations that include portions of Cline Creek Tributary C6, Skunk Creek Tributary 10A, Upper Skunk Tank Wash, East Fork Desert Lake Wash and West Fork Apache Wash. Of these the Skunk Creek Tributary 10A enters Skunk Creek just south of Wolf Trap Road. All of these studies provided backup to the analysis of Site Number 11.

Design flows for this site came from the Skunk Creek WCMP as well as revised flows input into FLO-2D. These revised flow inputs were done by the FCDMC and JEF used the FLO-2D GIS output for this analysis. For actual changes to any hydrology, those files can be found at the FCDMC. The design 100-year peak flow of 7,840 cfs taken from the WCMP was the design discharge JEF used for the hydraulic calculations.

Three structural alternatives were analyzed. One was to construct levees upstream and downstream of the New River Road Bridge. These levees would stretch approximately 6,200 lineal feet and would be constructed along both banks confining the flows within Skunk Creek upstream and downstream of the bridge. This alternative would remove all of the homes from the floodway and will make New River Road an all weather access during 100 year recurrence intervals. Sediment could be better controlled once ingress/egress to the bridge was made more efficient. However, this alternative is costly. The levees could create a negative visual impact to the surrounding area. Also, the tributary flow that currently flows into Skunk Creek naturally would be difficult to bring into the levee system.

The second alternative is to construct a 4,500 foot secondary diversion west of the bridge that would convey the flows along the route of the current breakout, pass it under the road, and deliver it back into Skunk Creek. This alternative would also remove the structures from the floodway, allow for the tributary side drainage, and keep New River Road an all weather access in the 100-year recurrence interval. This alternative would even be more expensive than alternative one and would not solve the sediment problem at the bridge.

The final structural alternative would be to allow the flows to breakout to a degree. More specifically, the inlet and outlet of the bridge would be improved so that it would more efficiently convey flow through the system. In theory, this would reduce the amount of breakout due to backwater effects. This does not however, address breakouts that are located far enough upstream of the bridge as to not be caused by the backwater of the bridge area. This alternative would be much less expensive, but does not address the problems of homes

in the floodway, breakouts upstream, and sediment accumulating at the bridge. This alternative does not provide an all weather access in the 100-year recurrence interval event.

The merits of each of the alternatives were compared by the ADMP team and alternative one was chosen based on several factors. First, this alternative stops the breakouts from occurring and conveys all of the flow to the bridge. Second, it solves the problem of access on New River Road Bridge making the it an all weather access in the 100-year recurrence interval. Finally, it is a less expensive alternative as compared with alternative two, based on the fact that it would follow the current flowpath of Skunk Creek and additional crossings would not be required. This alternative has some challenges associated with it. The acquisition of right-of-way for the levee system may be difficult, the permitting required for construction could be expensive and difficult, visual design of the levees will be expensive and challenging, and the habitat value around the bridge is moderate to high and would be impacted. With all of these factors taken into account, alternative one has been carried forward into recommended alternative. Refer to Appendix B under the heading Site Number 11 for FLO-2D Exhibits.

After the decision was made to carry alternative one forward to recommended alternative, discussions ensued regarding the actual design and aesthetics of the levees in this area. In response to this question, JEF performed an analysis using the FlowMaster computer program to determine the range of channel bottom widths that would be acceptable based on depth and velocity. The results of this analysis were that at 24 foot bottom width and 3 to 1 sideslopes resulted in a velocity of 16.74 feet per second. At a channel bottom width of 40 feet, the resulting velocity was 16.21 feet per second. Even though the depths reduce, the velocity remains somewhat constant creating the need for grade control structures, energy dissipaters, and possible erosion protection to reduce erosion within the final design. Refer to Appendix B under the heading Site Number 11 for FlowMaster output.

Plan and Profiles – The plan and profile sheet was put together with updated aerial photography and topography. Existing utilities are shown in the plan view, but actual depths of these utilities are unknown. The profile shows the existing flowpath of Skunk Creek and the proposed levee bank. The design flow (100-year) for Skunk Creek, taken from the WCMP, is 7,840 cfs and is depicted on the plan and profile sheet. Refer to Figures 3.34 and

3.35 for the Plan and Profiles and typical sections of Site Number 11 and Appendix B for all supporting data.

Cost Estimates – Cost estimates for this alternative were performed by JEF. As was discussed previously a range of costs based on the land needed to construct the levees was necessary. The lower range cost was based on the amount of land needed if only the right-of-way of the levees was purchased. This is obviously going to be a cost that is too low based on the fact that it would be very difficult if not impossible to purchase just the land needed for right-of-way. Because of this, an upper range was established based on the purchase of every parcel that the right-of-way came in contact. The actual cost is going to fall somewhere between these two. At the time of the analysis (July, 2004), the land costs are assumed to equal $1.50 per square foot of raw ground or $65,340.26 per acre as provided by the FCDMC. Refer to Table 3.15 for cost estimates for Site Number 11.

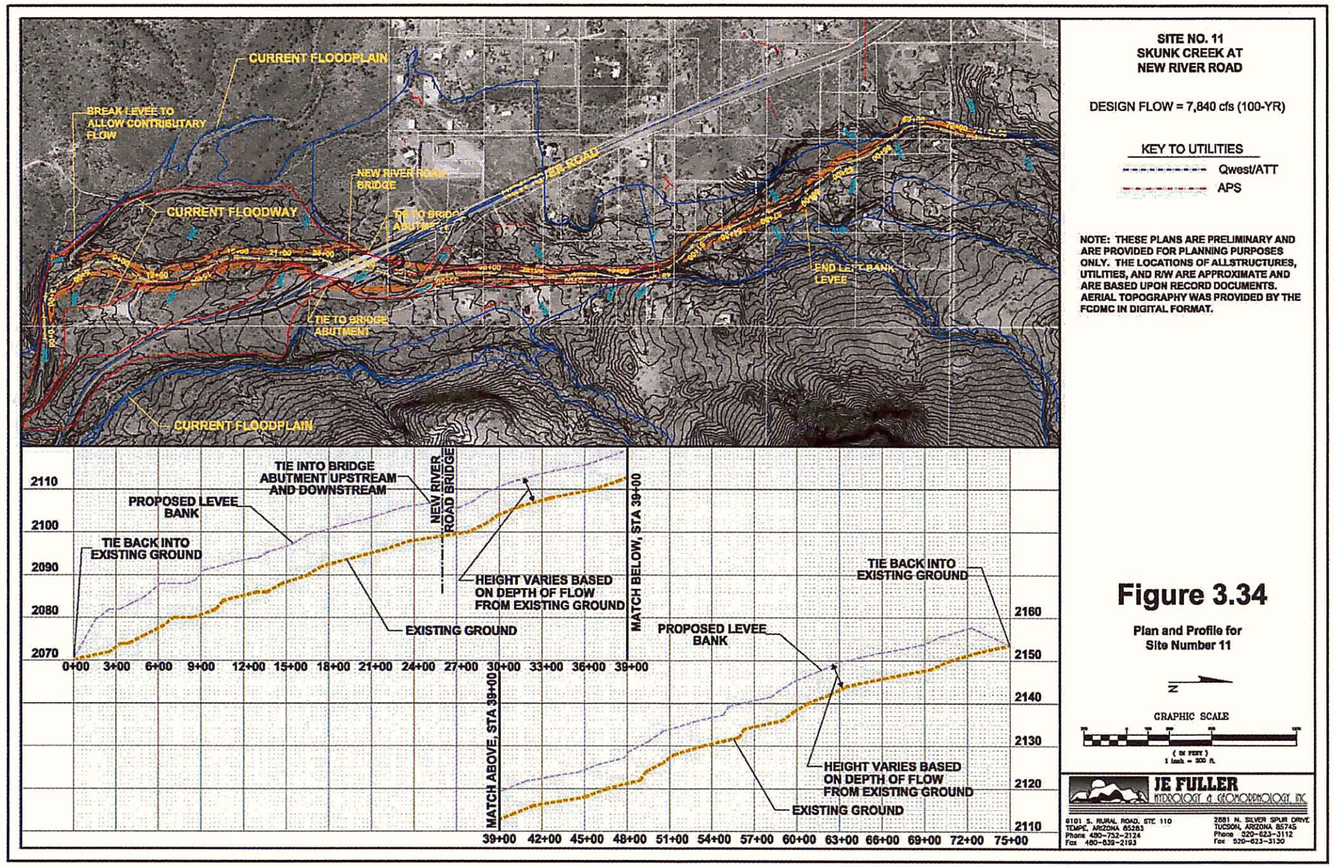

Figure 3.34

Plan and Profile for Site Number 11

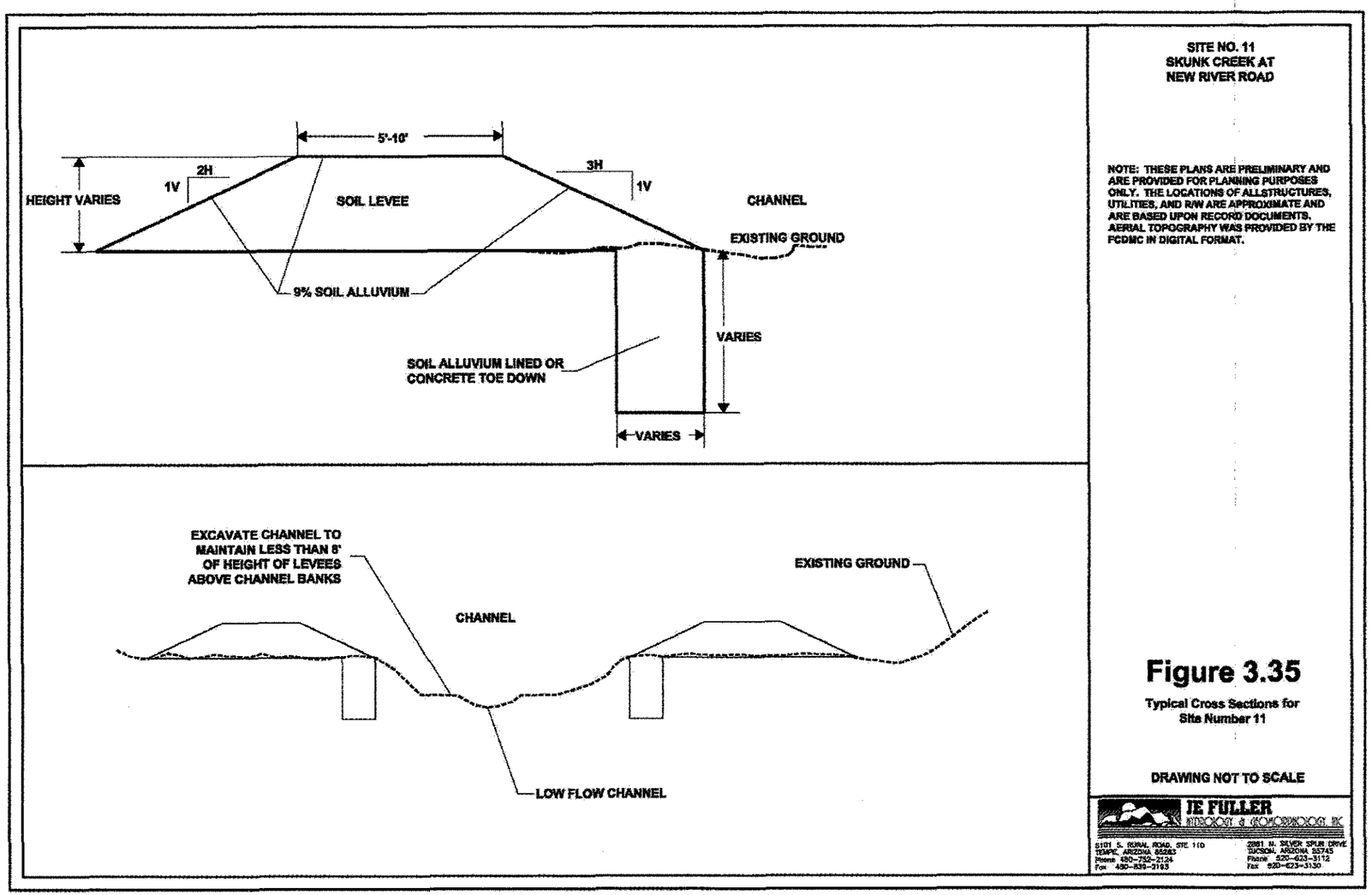

Figure 3.35

Typical Cross Sections for Site Number 11

Table 3.15
Cost Estimates for Site Number 11

COSTS WITH CONCRETE TOE-DOWN

Item	Construction				Land				Contingency	Engineering	Total
	Units	Unit Cost	Quantity	Construction Cost	Units	Unit Cost	Quantity	Land Cost			
Dike Embankment	Cu. Yd.	$ 7	48000	$ 336,000	SF	$ 1.50	283500	$ 425,250	$ 84,000	$ 50,400	$ 895,650
Channel Excavation	Cu. Yd.	$ 10	10000	$ 100,000	SF	$ 1.50	0	$ -	$ 25,000	$ 15,000	$ 140,000
Soil-Cement Bank Protection	Cu. Yd.	$ 71	8100	$ 575,100	SF	$ 1.50	0	$ -	$ 143,775	$ 86,265	$ 805,140
Clearing and Grubbing	LS	$ 8,000	1	$ 8,000	SF	$ 1.50	0	$ -	$ 2,000	$ 1,200	$ 11,200
Concrete Toe-Down (for Soil Cement Lining)	Cu. Yd.	$ 155	4050	$ 627,750	SF	$ 1.50	0	$ -	$ 156,938	$ 94,163	$ 878,850
			Totals	$ 1,646,850				$ 425,250	$ 411,713	$ 247,028	**$ 2,730,840**

Note: Land costs are assumed to equal $1.50 per square foot raw ground and is only the footprint of the structural alternative. This is equal to $65,340.26 per acre. (July, 2004)

COST WITH CEMENT SOIL ALLUVIUM TOE-DOWN

Item	Construction				Land				Contingency	Engineering	Total
	Units	Unit Cost	Quantity	Construction Cost	Units	Unit Cost	Quantity	Land Cost			
Dike Embankment	Cu. Yd.	$ 7	48000	$ 336,000	SF	$ 1.50	283500	$ 425,250	$ 84,000	$ 50,400	$ 895,650
Channel Excavation	Cu. Yd.	$ 10	10000	$ 100,000	SF	$ 1.50	0	$ -	$ 25,000	$ 15,000	$ 140,000
Soil-Cement Bank Protection	Cu. Yd.	$ 71	12600	$ 894,600	SF	$ 1.50	0	$ -	$ 223,650	$ 134,190	$ 1,252,440
Clearing and Grubbing	LS	$ 8,000	1	$ 8,000	SF	$ 1.50	0	$ -	$ 2,000	$ 1,200	$ 11,200
			Totals	$ 1,338,600				$ 425,250	$ 334,650	$ 200,790	**$ 2,299,290**

Note: Land costs are assumed to equal $1.50 per square foot raw ground and is only the footprint of the structural alternative. This is equal to $65,340.26 per acre. (July, 2004)

LAND COSTS ASSUMING FULL TAKE ON AFFECTED PROPERTIES

Number of Parcels	Land				Number of Dev. Parcels	Developed		
	Units	Unit Cost	Quantity	Land Cost		Unit Cost	Costs	Total
5 - Undeveloped Parcels	SF	$ 1.50	307969	$ 461,954	0	$ -	$ -	$ 461,954
13 - Developed Parcel	SF	$ 1.50	3041562	$ 4,562,343	13	$ 185,000	$ 2,405,000	$ 6,967,343
Totals				$ 5,024,297			$ 2,405,000	**$ 7,429,297**

Table 3.15 Cont.
Cost Estimates for Site Number 11

Summary			
	Minimum Costs		Maximum Costs
Range of Costs	$ 2,299,290		$ 9,734,887

Number of Parcels negatively impacted	**18**
Number of Parcels positively impacted	**72** (Approximately)
8100 Total feet of Levee Used for Calculations	

Note: All parcel and structure data based on 2002 parcel and aerial data.

3.2.12 Site Number 12

Problem Description – Site Number 12 was identified during the ADMP team's look at the Desert Hills area. At this location Desert Hills Wash flows from the north until it intersects Cloud Road (Appendix B). Flow then exceeds the limits of the banks and begins to inundate residences below Cloud Road.

Reduction of the peak discharge somewhere in the vicinity of Cloud Road and 12th Street would be necessary to remove the downstream residents from the floodway.

Methodology and Design – Design flows for this site came from Part 3, Volume 1 of the ADMP report. The design 100-year peak flow of 3,296 cfs was taken from the ADMP report. The volume associated with the 100-year design flow is 339 acre feet.

In order to reduce this design flow to a level that would be needed to protect the downstream floodway residents, it would need to be reduced to 1,200 cfs which is somewhat closer to the 10-year peak discharge. The volume required for detention would need to be closer to 120 Acre feet.

Three structural alternatives were analyzed. Each of the alternatives includes a detention basin that would scalp the peak down, attempting to reduce it to a level acceptable for outlet design. The only difference between the three alternatives is the location and size of the detention basin. However, when CLW attempted to take the three alternatives and put an actual design onto them, it was discovered that all three alternatives were not feasible based on one of two reasons. Either the basin could not be made large enough so that enough volume was captured based on the land available, or too many residences would need to be acquired in order to obtain enough land for the basin construction. Because of these reasons, this site was not analyzed further. Refer to Figure 3.36 for a plan view showing the three alternatives and the details associated with attempted design. Also, refer to Appendix B under the heading Site Number 12 for a copy of the letter sent to JEF by CLW regarding the design of these alternatives.

Residences located within the floodway will be recommended to the FPAP program. This will remove them from the floodway and allow for the FCDMC to reclaim those portions of the floodway for purposes suitable for floodway use.

Plan and Profiles – A plan view was prepared combining all three alternatives and design information. No profiles were prepared for this site.

Cost Estimates – No cost estimates were prepared for Site Number 12.

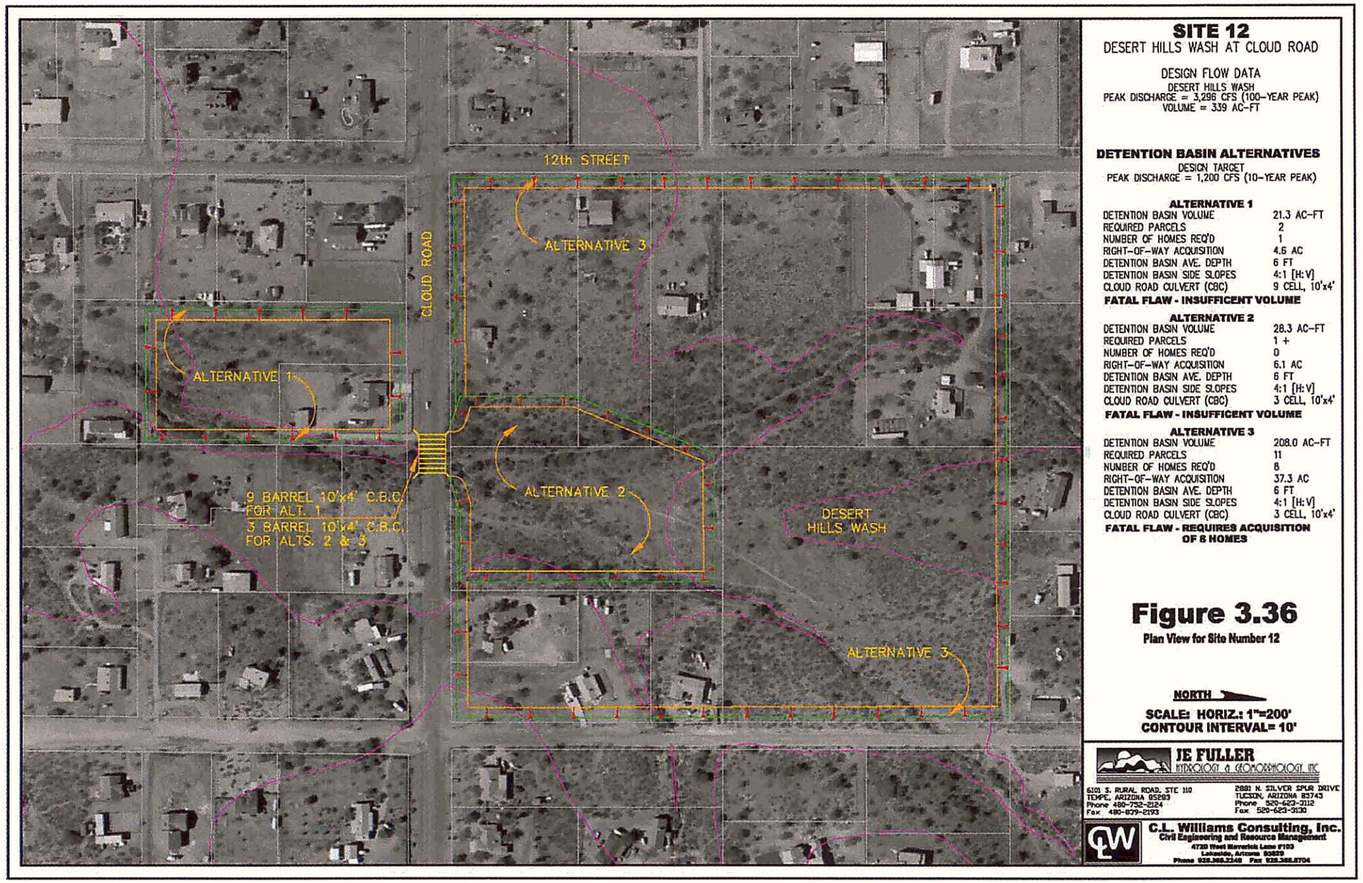

Figure 3.36

Plan View for Site Number 12

SECTION 4: CONCLUSIONS

During the analysis of the preliminary alternatives, the ADMP team looked at twelve separate sites and evaluated them qualitatively as well as quantitatively for reasonableness as well as trying to identify any fatal flaws. Many of these alternatives and sites were discarded for various reasons discussed within the body of this report. The intent was to come to an agreement on a recommended alternative that was feasible, made sense, removed as many residences from the floodway as possible, and provide a comprehensive drainage fix that would address the major flooding problems within the ADMP study area.

The sites carried forward to recommended alternative that include a structural element are Site Numbers 1, 2, 5, 7, 8,9,10, and 11. The form of each of those structural elements discussed within the body of this report vary, but when combined with the non-structural recommended alternatives provide a recommended alternative that meets the goals of the ADMP for reducing the flood hazard and risk throughout the entire ADMP study area.

Appendix A

Bibliography

1. Wood/Patel Associates, *Phase 1, Design Option Report Pinnacle Peak Road Bridge Over Skunk Creek, BR-922765,* June, 1993.

2. *Coe & Van Loo, Split Flow Analysis Over Pinnacle Peak Road, CVL #98-0013,* October, 2002.

3. Tetra Tech, Inc., Submitted to EMCON/OWT, and prepared for the City of Phoenix, *Letter of Map Revision Request for Skunk Creek, City of Phoenix Contract No. SA-930222, Technical Data Notebook,* November, 2002.

4. Tetra Tech, Inc., *Skunk Creek Watercourse Master Plan, Attachment 3, Hydrology Report, FCD 99-23,* August, 2001.

5. Tetra Tech, Inc.,*Skunk Creek Watercourse Master Plan, Attachment 7, Two Dimensional Hydraulic Model of the Confluence of Skunk Creek & Sonoran Wash at the CAP Canal, FCD 99-23,* July, 2001.

6. Tetra Tech, Inc., *Floodplain Delineation Study for Skunk Creek Between the Central Arizona Project and Happy Valley Road, Two-Dimensional Hydraulic Model,* June, 2002.

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8. Dibble & Associates Consulting Engineers, *Maricopa County Department of Transportation Construction Plans for: Carefree Highway – 7th Street to Cave Creek Road, Project No. 69003,* issued for public bidding in August, 1997.

9. Jerry R. Jones & Associates, Inc., *Apache Wash Hydrology Report for Apache Wash Flood Insurance Study, FCDMC Contract No. 89-66,* November, 1991.

10. Jerry R. Jones & Associates, Inc., *Apache Wash Flood Insurance Study, FCDMC Contract No. 89-66,* August, 1992.

11. Michael Baker Jr., Inc., *Hydrology Report, Rodger Creek Floodplain Delineation Study,* 1989.

12. Michael Baker Jr., Inc., *Rodger Creek Flood Delineation Study,* 1990.

13. Montgomery Watson, Skunk Creek Floodplain Delineation Study, Technical Data Notebook, 1997.

14. University of Florida, McTrans Center for Microcomputers in Transportation, *HY-8 Computer Program,* Version 4.0.

15. U.S. Army Corps of Engineers, *HEC-1 Computer Program,* April 1991.

16. Haested Methods, Inc., *FlowMaster Computer Program, Version 7.0*, 2005.

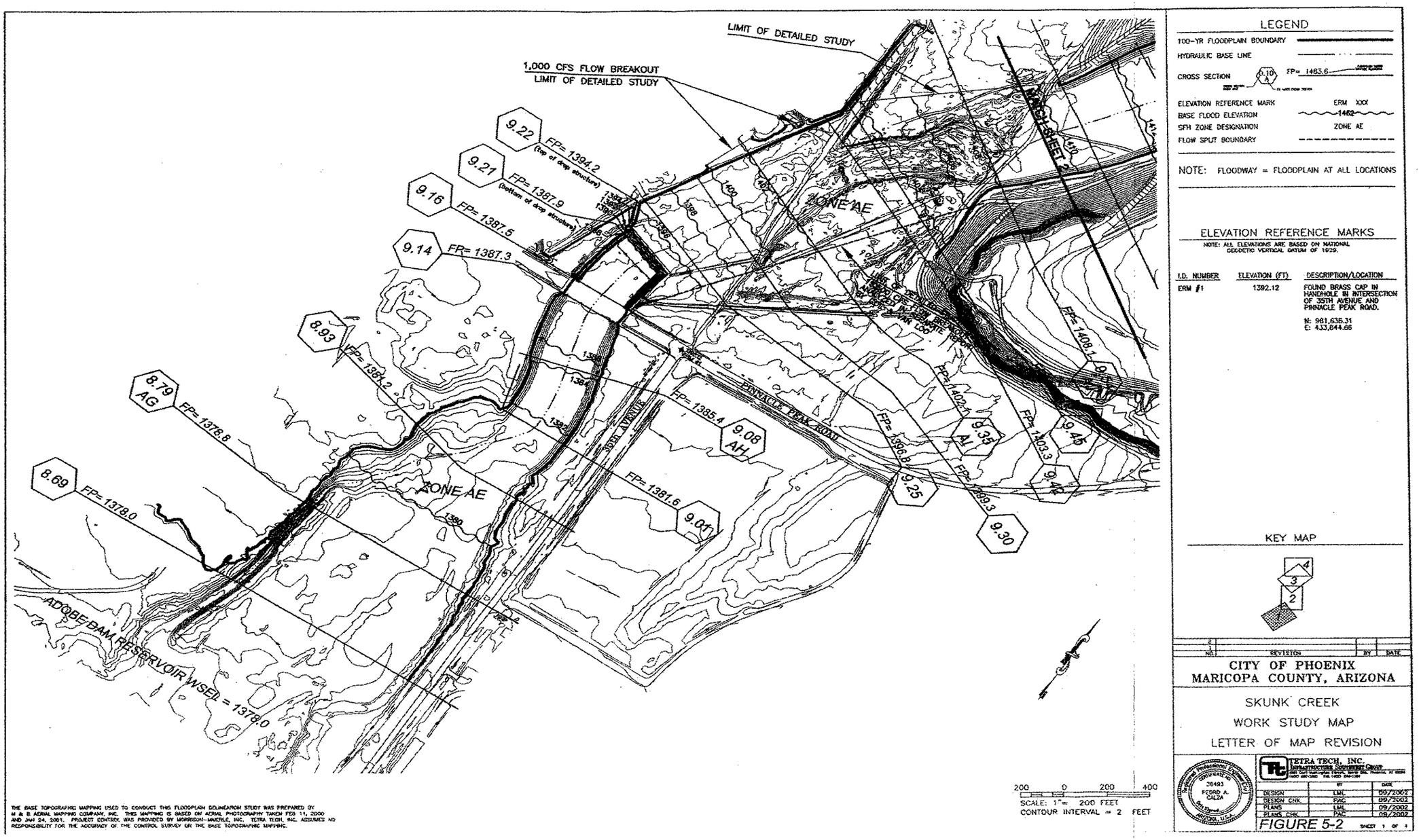
Appendix B

Supporting Calculations and

Alternative Schematic information

Site Number 1

Work Study Map from the Letter of Map Revision for Site Number 1



THE BASE TOPOGRAPHIC MAPPING USED TO CONDUCT THIS FLOODPLAIN DELINEATION STUDY WAS PREPARED BY M & B AERIAL MAPPING COMPANY, INC. THIS MAPPING IS BASED ON AERIAL PHOTOGRAPHY TAKEN FEB 11, 2000 AND JAN 24, 2001. PROJECT CONTROL WAS PROVIDED BY MORRISON-MAIERLE, INC. TETRA TECH, INC. ASSUMES NO RESPONSIBILITY FOR THE ACCURACY OF THE CONTROL SURVEY OR THE BASE TOPOGRAPHIC MAPPING.

P:\Emcn-002\Buchanan-Skunk\Workmaps.dwg, 09/17/2002 02:13:58 PM, LMI.

LEGEND

100-YR FLOODPLAIN BOUNDARY	
HYDRAULIC BASE LINE	
CROSS SECTION	9.10 A FP= 1483.6
ELEVATION REFERENCE MARK	ERM XXX
BASE FLOOD ELEVATION	1462
SFH ZONE DESIGNATION	ZONE AE
FLOW SPLIT BOUNDARY	

NOTE: FLOODWAY = FLOODPLAIN AT ALL LOCATIONS

ELEVATION REFERENCE MARKS

NOTE: ALL ELEVATIONS ARE BASED ON NATIONAL GEODETIC VERTICAL DATUM OF 1929.

I.D. NUMBER	ELEVATION (FT)	DESCRIPTION/LOCATION
ERM #1	1392.12	FOUND BRASS CAP IN HANDHOLE IN INTERSECTION OF 35TH AVENUE AND PINNACLE PEAK ROAD. N: 981,636.31 E: 433,844.66

KEY MAP

NO.	REVISION	BY	DATE

CITY OF PHOENIX
MARICOPA COUNTY, ARIZONA

SKUNK CREEK
WORK STUDY MAP
LETTER OF MAP REVISION

TETRA TECH, INC.
INFRASTRUCTURE SOLUTIONS GROUP

	BY	DATE
DESIGN	LMI	09/2002
DESIGN CHK.	PAC	09/2002
PLANS	LMI	09/2002
PLANS CHK.	PAC	09/2002

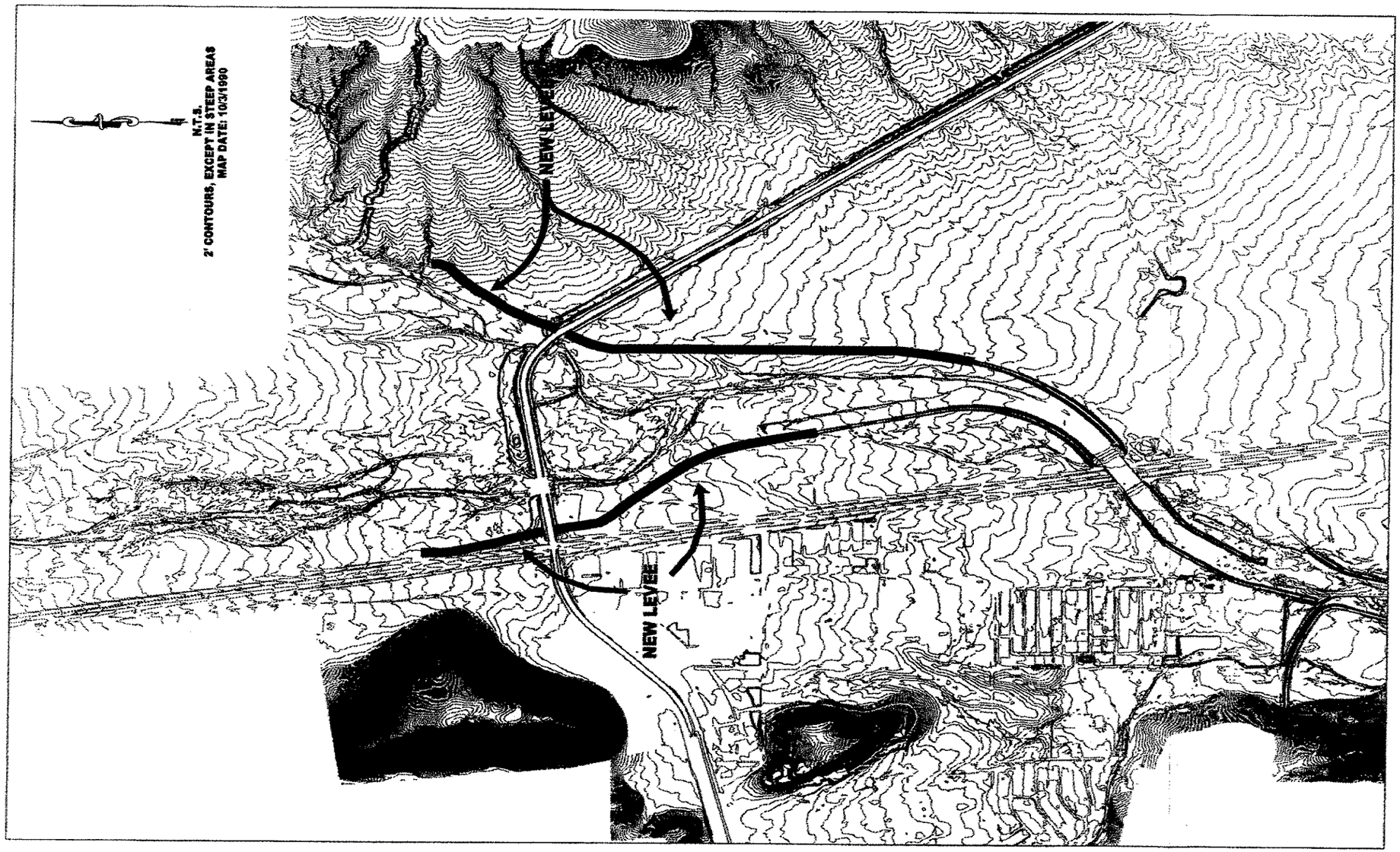
FIGURE 5-2 SHEET 1 OF 1

JE FULLER
HYDROLOGY & GEOMORPHOLOGY, INC.

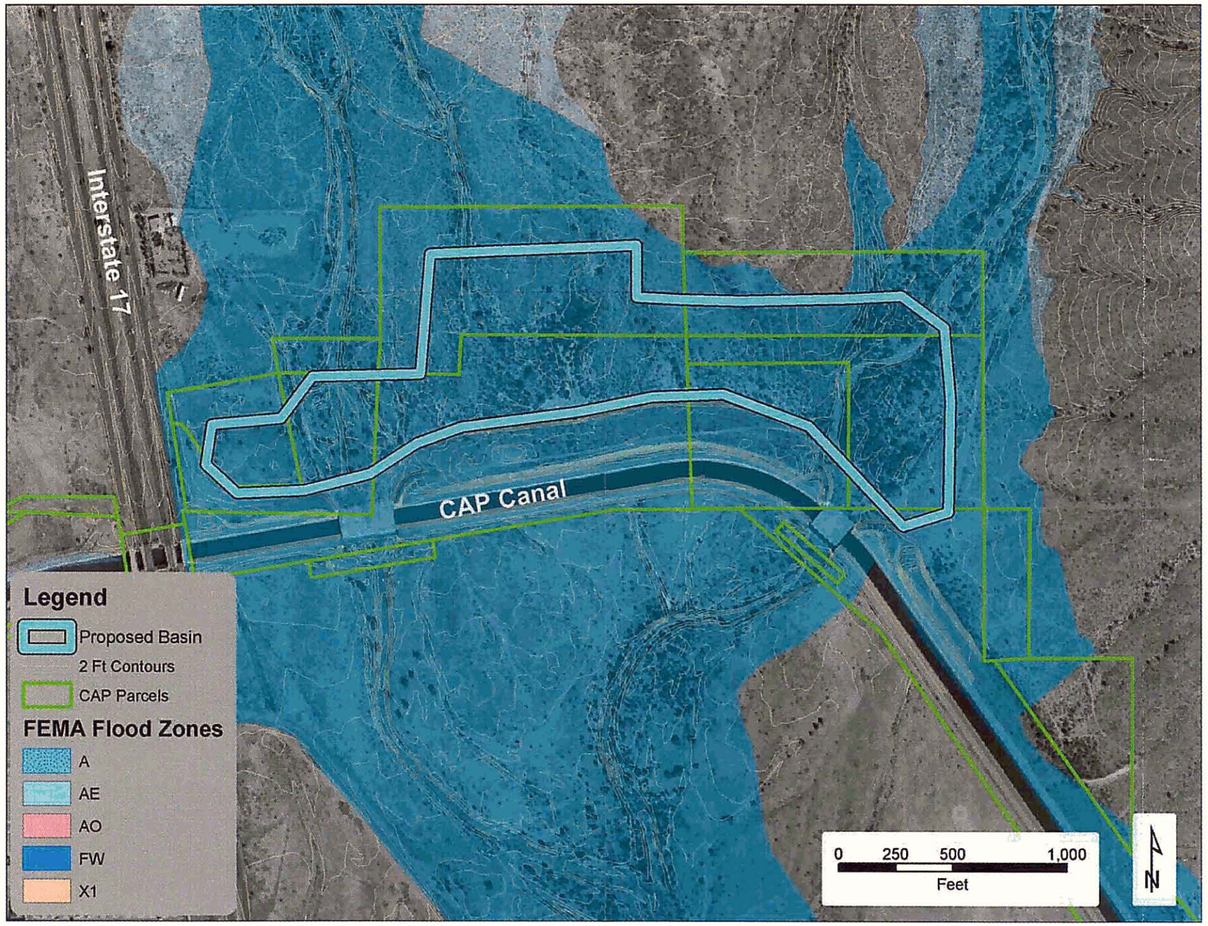
Site Number 2

Conceptual Plan Layout for Site Number 2

FIGURE 5-1: Conceptual Levee Design



Site Number 2 original conceptual design levee from the WCMP.

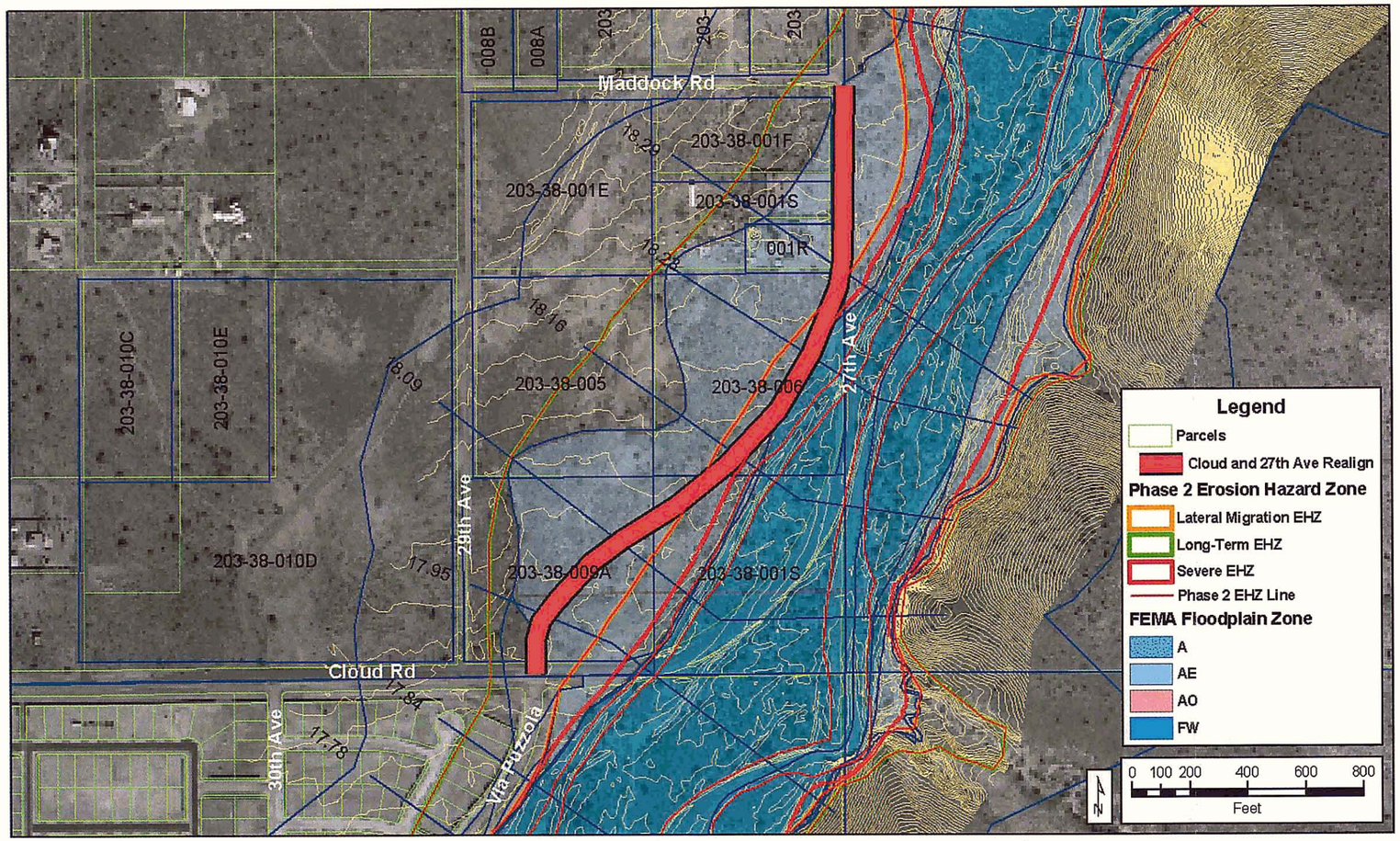


Site Number 2 Basin Alternative Schematic

"Meter Option" – Detention basin is 855 ac-ft at Skunk Creek (10 ac basin 9 feet deep or a 20 ac basin 5 feet deep) and 250 ac-ft at Sonoran Wash (10 ac basin 3 feet deep or a 20 ac basin 2 feet deep). This option would require additional storage for sediment, a maintenance plan, and a grade control structure to prevent upstream degradation.

Site Number 3

Conceptual Plan Layout for Site Number 3

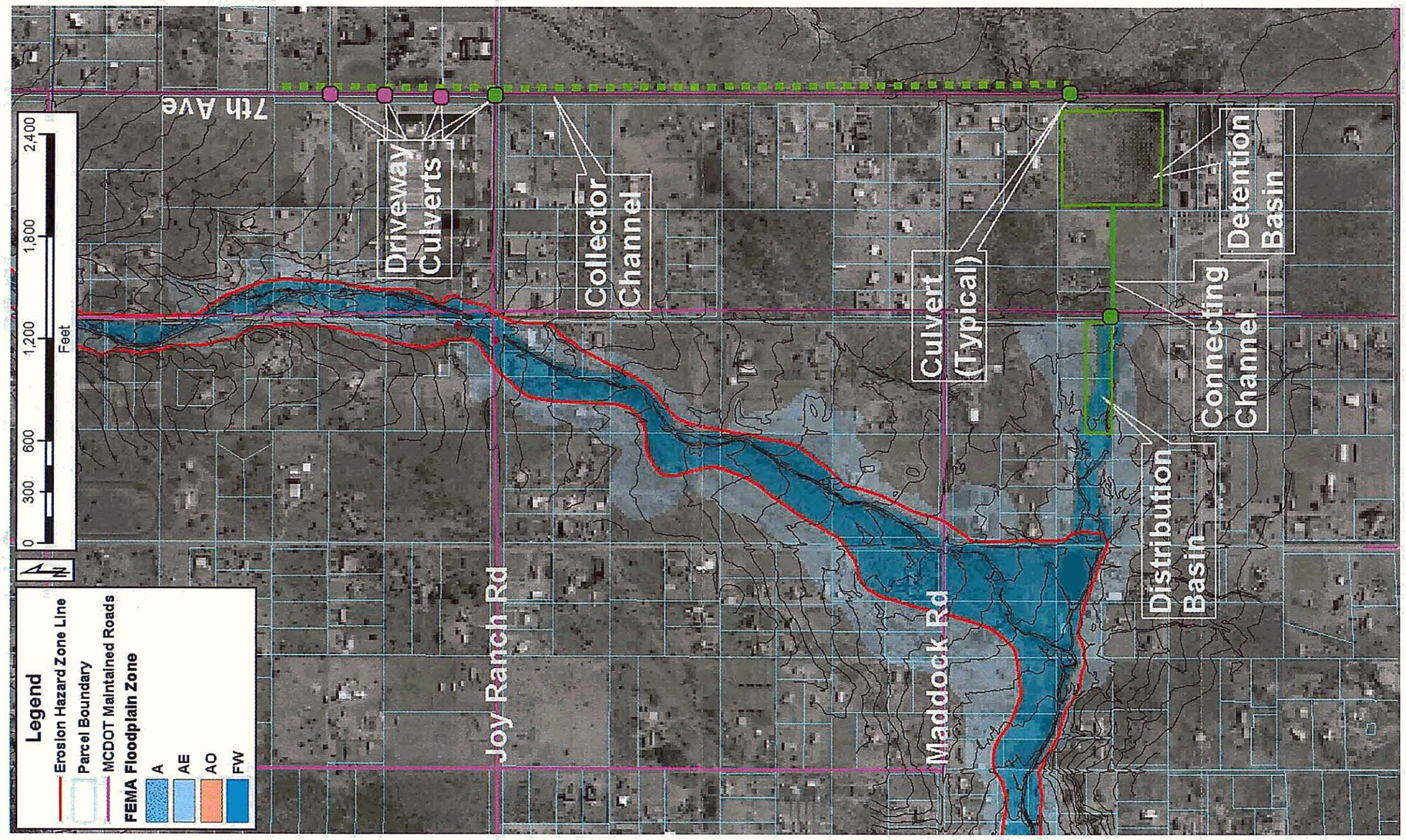


Original Plan View Schematic for Site Number 3

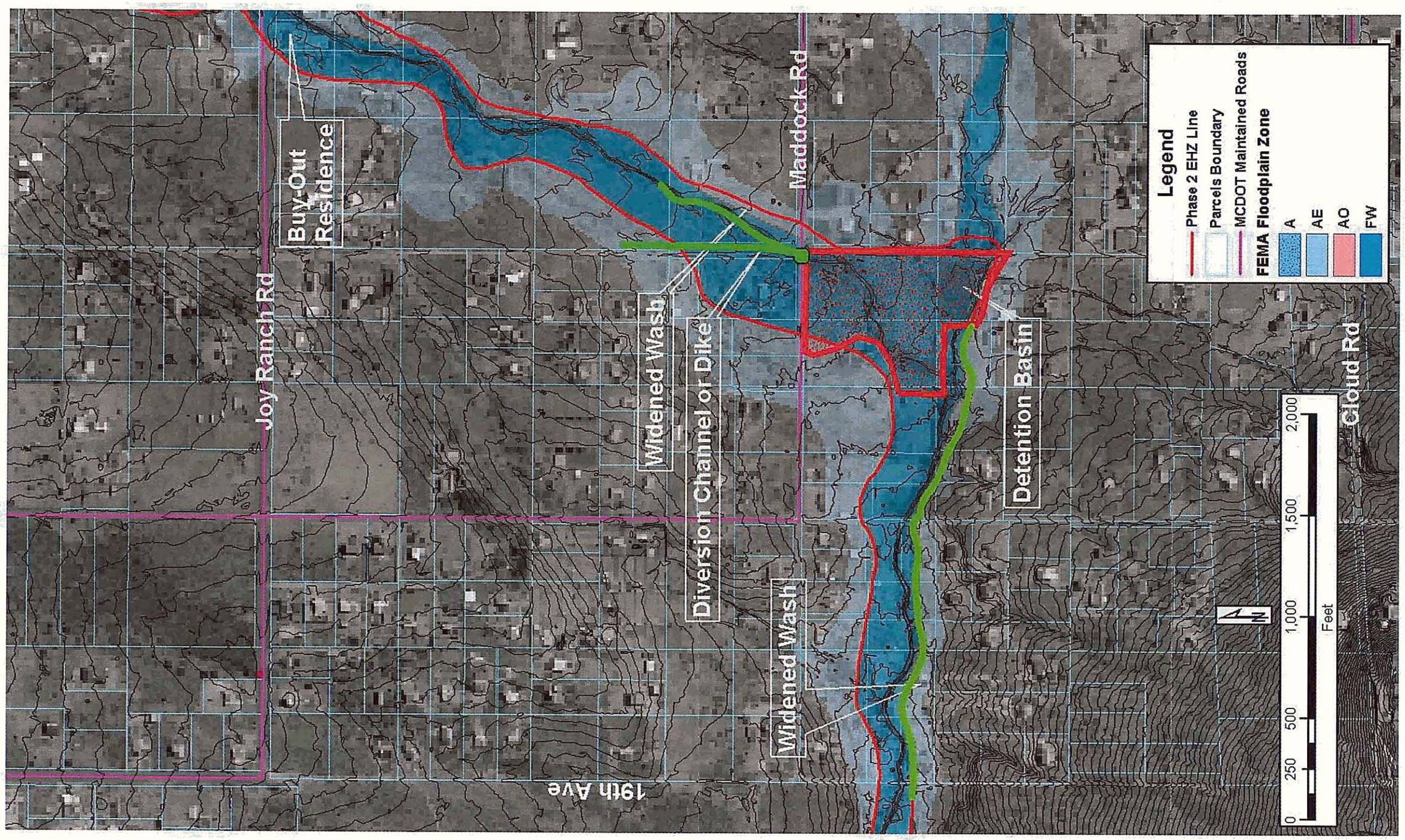
Site Number 4

(Portions of this section apply to Site Number 5)

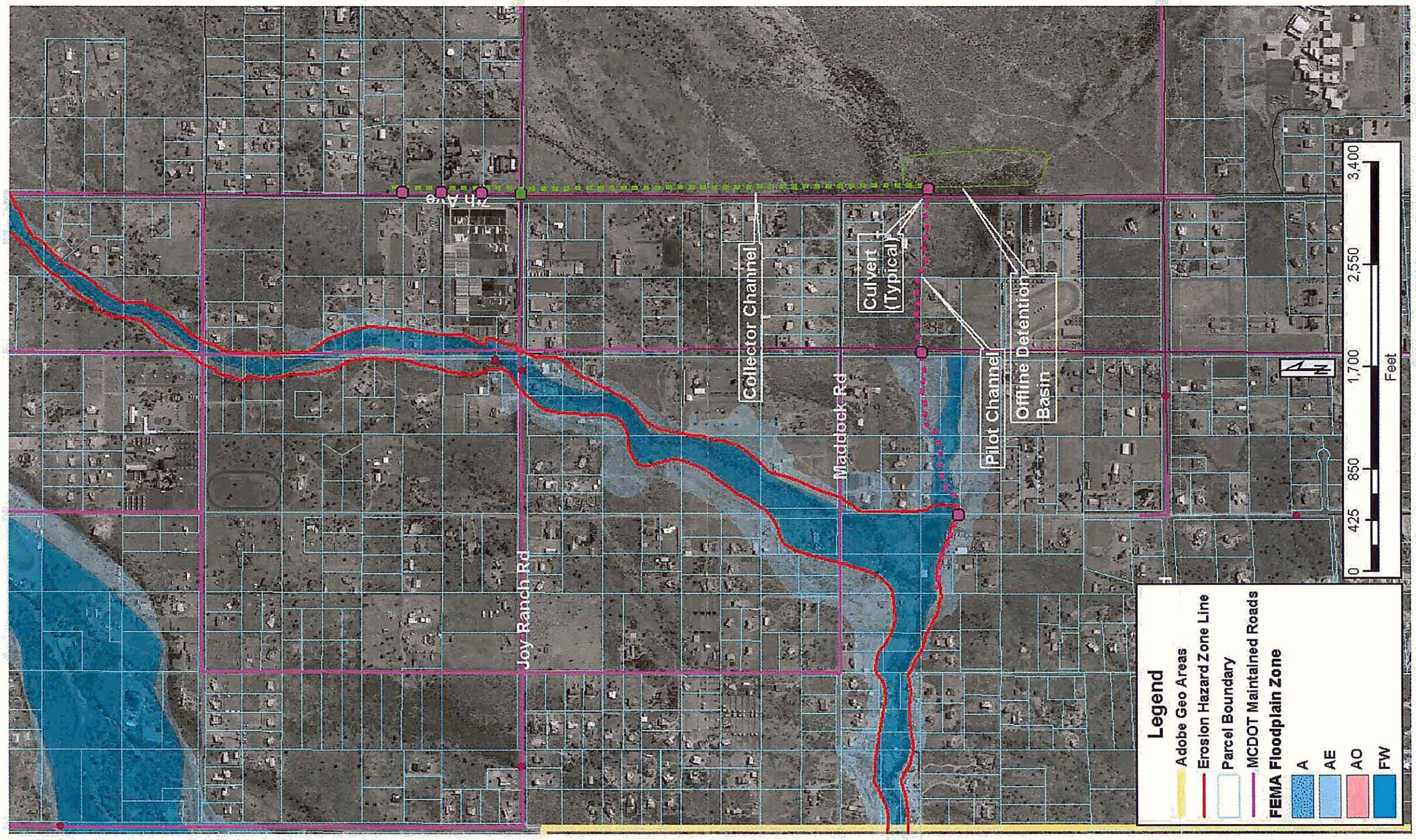
Conceptual Plan Layouts for Site Number 4



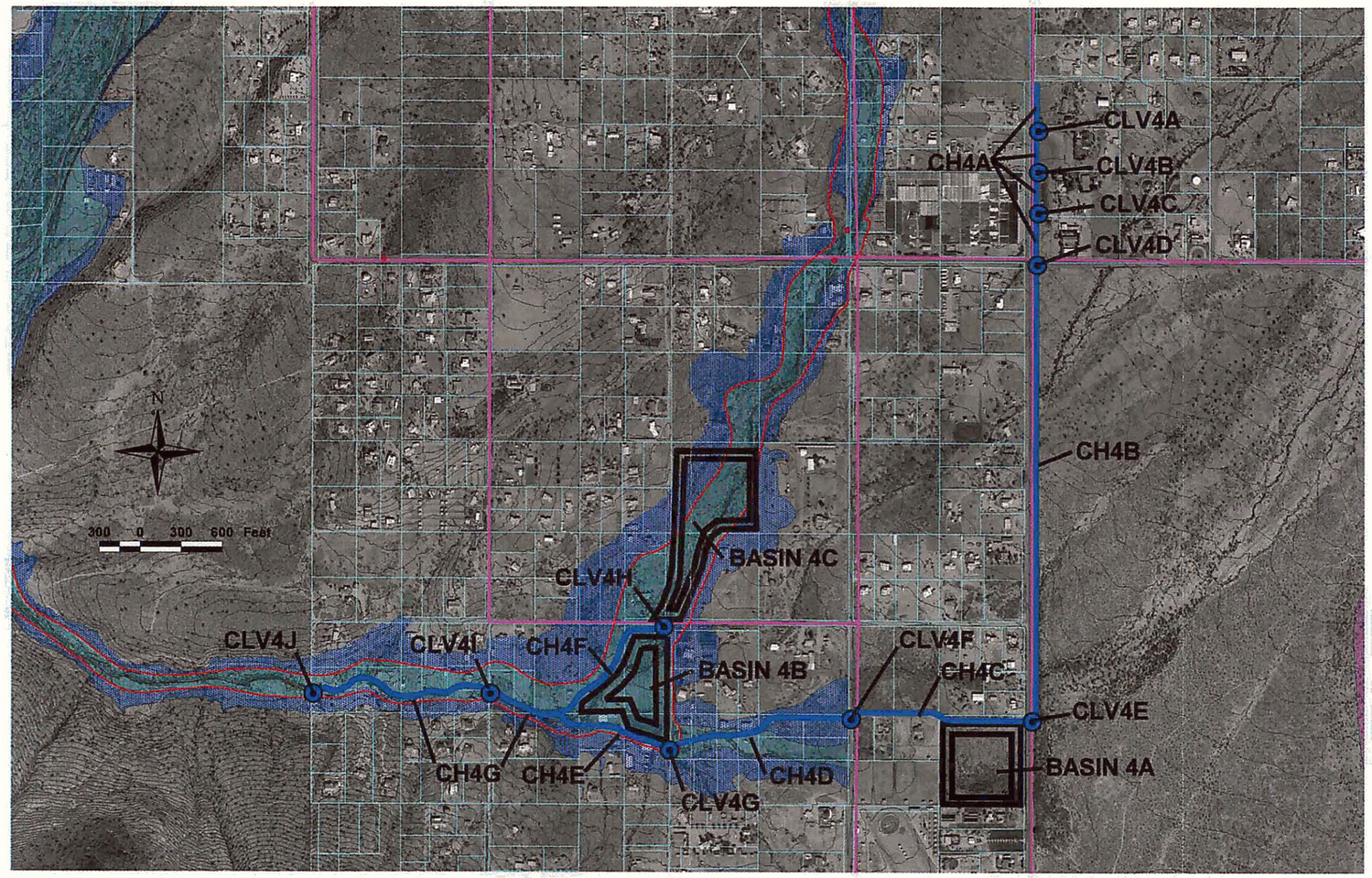
This was the original concept (DH5B) for Site Number 4. More specifically 7th Avenue between Cloud Road and the Carefree Highway.



This was the original concept (DH5C) for Site Number 4. More specifically Skunk Tank Wash Regrade.



This was the original concept (DH6A) for Site Number 4. More specifically Desert Lake Wash Breakout – 7th Avenue Interceptor Channel and Basin.



Once all of the alternatives were analyzed, they were combined into this concept which is the one that is discussed in the report body.

Design Memorandum for Site Number 4

Summary of SITE 4 Design H&H

GENERAL NOTES:

- FLO2D model and results are based on the future conditions model reported on in the TDN, with modifications to add cross sections for determining flows at certain locations.

- A spreadsheet was created to do some hydrograph manipulation using the output from FLO2D. The spreadsheet is named *Sites 4 and 5_DesignHydrographs.xls*.

- Normal depth channel calculations were performed using FlowMaster (FM). The project file is named *Sites 4 and 5.fm2.*

- An HEC-1 file was generated to fill in the gaps downstream of the FLO2D modeling limits. The combined hydrograph of FLO2D Section Nos. 20 and 21 was entered into HEC-1 using QI records. Skunk Tank Wash Subbasins S17 and S18 were modeled as one subbasin using the G&A parameters reported in the Cave Creek WCMP and new S-Graph parameters. Also, Subbasin S18 was modified to reflect the portion of watershed intercepted by Channel CH4A. Subbasins S19 and S20A were not modeled. Instead, a unit discharge of 1,000 csm was used to estimate a peak from these areas. That peak estimate was added directly to the HEC-1 results to get the design discharge (see additional comments in channel segments CH4D, CH4E, and CH4I). The HEC-1 model is named *STWSITE4.**.

- Culverts were calculated using HY8. The project files are named by culvert ID.

Channel CH4A and Culverts CLV4A-CLV4D:

- Design discharge = 200 cfs
- Source: FLO2D Cross Section No. 20
- Channel – see FM output
- Culverts are all 2-60" RCP's. See HY8 output for CLV4A

Channel CH4B and Culvert CLV4E:

- Design discharge = 1,350 cfs
- Source: FLO2D Cross Section Nos. 20 and 21 (see spreadsheet tab labeled *SITE 4 Detention Basin 4A*)
- Channel – see FM output
- Culvert is a 4 barrel, 12' x 5' RCBC. See HY8 output for CLVE

Basin 4A

- Basin is offline design
- Total volume required is 60 ac-feet
- Basin depth is approximately 10 feet
- Will require a control/spillway structure to allow all but 420 cfs of inflow hydrograph to enter into basin. This should be included graphically in some form with a cost of $20K associated with it.

Channel CH4C and Culvert CLV4F:

- Design discharge = 420 cfs
- Source: Resultant hydrograph bypassing Basin 4A (see spreadsheet tab labeled *SITE 4 Detention Basin 4A*)
- Channel – see FM output
- Culvert is a 2 barrel, 8'x 5' RCBC. See HY8 output for CLV4F

Channel CH4D and Culvert CLV4G:

- Design discharge = 800 cfs
- Source: 420 cfs bypassing basin plus about a third of Subbasin S19 (Total subbasin area = 0.77 square miles @ 1400 csm = 1080 cfs; third of that = 360 cfs; therefore Q = 420+360 approximately = 800 cfs).
- Channel – see FM output
- Culvert is a 3 barrel, 8'x 5' RCBC. See HY8 output for CLV4G

Channel CH4E:

- Design discharge = 1,500 cfs
- Source: HEC-1 model, operation S19CL
- Channel – see FM output

Basin 4C

- Basin is online design and is modeled in the HEC-1 file
- Total volume required is about 71 ac-feet
- Basin depth is approximately 10 below natural grade at Maddock Road
- CLV4H will be the outlet control for the basin.

Culvert CLV4H:

- Design discharge = 2,150 cfs
- Source: HEC-1 output for operation S18C
- Establishes rating curve for Basin 4C
- Culvert will be a 4 barrel, 12'x 5' RCBC. See HY8 output for CLV4H

Channel CH4H:

- Design discharge = 1,100 cfs
- Source: Assumes that all but 1,100 cfs of the hydrograph leaving Basin 4C is diverted and stored in Basin 4B.
- Channel – see FM output

Basin 4B

- Basin is offline design
- Total volume required is 65 ac-feet
- Basin depth is approximately 15 feet
- Will require a control/spillway structure to allow all but 1,100 cfs of Basin 4C outflow hydrograph to enter into basin.

Channel CH4I and Culverts CLV4I and CLV4J:

- Design discharge = 2,810 cfs (See third bullet)
- Source: FLO2D Cross Section No. 20
- Channel is to be a regrade of existing wash to section shown on FM output. The intent of the design is to provide bankfull capacity for something less than the 100-year flow, with the full 100-year flow being conveyed in a "floodway" (encroached) section that surcharges the channel by less than 1.0 foot. See FM output for cross section
- Ford crossings are proposed for the crossing locations CLV4I and CLV4J instead of culverts.

FLO-2D model information

(All files related to the FLO-2D models is found in Part 3, Volume 2. This appendix only contains a hard copy of those files that were changed for cross section modification. (FPINOUT.DAT and CROSSMAX.OUT))

FPINOUT.DAT

```
         8  0
 336       32
   0.00       0
   3.00       1
   3.08       2
   3.25       3
   3.33       4
   3.42       6
   3.50      11
   3.58      15
   3.67      21
   3.75      30
   3.83      37
   3.92      53
   4.00      79
   4.08     102
   4.17     106
   4.25      88
   4.33      68
   4.42      52
   4.50      38
   4.58      27
   4.67      20
   4.75      15
   4.83      12
   4.92       9
   5.00       7
   5.08       6
   5.17       5
   5.25       4
   5.67       3
   6.17       2
   6.42       1
   6.50       0
5948       56
   0.00       0
   0.75       1
   2.33       2
   3.25       3
   3.33       4
   3.42       9
   3.50      21
   3.58      40
   3.67      65
   3.75     104
   3.83     156
   3.92     219
   4.00     308
   4.08     417
   4.17     515
   4.25     584
   4.33     630
   4.42     672
   4.50     690
   4.58     675
   4.67     635
   4.75     575
   4.83     507
   4.92     441
   5.00     378
   5.08     323
   5.17     276
   5.25     236
   5.33     202
   5.42     170
   5.50     135
   5.58      97
   5.67      73
   5.75      60
   5.83      51
   5.92      44
   6.00      39
   6.08      34
   6.17      30
   6.25      27
   6.33      24
   6.42      21
   6.50      18
   6.58      16
   6.67      14
   6.75      12
   6.83      10
   6.92       9
   7.00       7
   7.08       6
   7.25       5
   7.33       4
   7.50       3
   7.92       2
   8.50       1
   8.58       0
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12841      18
   0.00     0
   3.42     1
   3.50     3
   3.58     4
   3.67     7
   3.75    10
   3.83    12
   3.92    20
   4.00    32
   4.08    38
   4.17    31
   4.25    18
   4.33    11
   4.42     7
   4.50     3
   4.58     2
   4.92     1
   5.00     0
13022      19
   0.00     0
   3.42     1
   3.58     3
   3.67     6
   3.75    11
   3.83    14
   3.92    23
   4.00    38
   4.08    49
   4.17    47
   4.25    33
   4.33    22
   4.42    15
   4.50     9
   4.58     5
   4.67     3
   4.75     2
   4.92     1
   5.00     0
13281      20
   0.00     0
   3.08     1
   3.58     3
   3.67     9
   3.75    28
   3.83    33
   3.92    37
   4.00    49
   4.08    58
   4.17    59
   4.25    57
   4.33    43
   4.42    36
   4.50    30
   4.58    21
   4.67    11
   4.75     5
   4.83     3
   5.08     1
   5.17     0
13372      22
   0.00     0
   3.42     1
   3.50     2
   3.58     4
   3.67     6
   3.75    10
   3.83    25
   3.92    54
   4.00   108
   4.08   189
   4.17   232
   4.25   191
   4.33   112
   4.42    61
   4.50    32
   4.58    13
   4.67     6
   4.75     4
   4.83     3
   4.92     2
   5.08     1
   5.17     0
13519      32
   0.00     0
   0.33     1
   0.58     2
   2.75     3
   3.17     4
   3.42     5
   3.50    11
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   3.58      23
   3.67      36
   3.75      60
   3.83      93
   3.92     124
   4.00     197
   4.08     299
   4.17     366
   4.25     342
   4.33     256
   4.42     186
   4.50     133
   4.58      88
   4.67      57
   4.75      38
   4.83      25
   4.92      17
   5.00      12
   5.08       8
   5.17       5
   5.25       4
   5.42       3
   6.25       2
   6.42       1
   6.50       0
13531      40
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   0.25       1
   0.42       2
   0.75       3
   2.58       4
   2.92       5
   3.17       6
   3.33       7
   3.42      10
   3.50      19
   3.58      31
   3.67      50
   3.75      82
   3.83     122
   3.92     187
   4.00     296
   4.08     427
   4.17     518
   4.25     508
   4.33     423
   4.42     318
   4.50     228
   4.58     159
   4.67     111
   4.75      77
   4.83      55
   4.92      40
   5.00      31
   5.08      23
   5.17      18
   5.25      13
   5.33      10
   5.42       7
   5.58       6
   5.75       5
   6.08       4
   6.25       3
   6.42       2
   6.75       1
   6.83       0
   372
     8     15     16     25     35     36     49     61     62     75
    88    101    102    115    128    129    142    156    170    184
   198    213    227    228    242    257    273    290    307    328
   369    410    451    493    535    577    620    664    717    772
   830    890    952   1014   1015   1078   1142   1208   1274   1275
  1342   1410   1479   1548   1549   1619   1690   1761   1762   1834
  1907   1980   2054   2055   2056   2131   2132   2207   2208   2283
  2284   2359   2360   2435   2436   2511   2512   2587   2588   2663
  2664   2739   2740   2815   2816   2891   2892   2967   2968   3043
  3044   3119   3120   3195   3196   3271   3272   3347   3348   3423
  3424   3499   3500   3575   3576   3577   3653   3654   3730   3731
  3807   3808   3884   3885   3961   3962   4038   4039   4115   4116
  4191   4192   4193   4268   4269   4343   4344   4345   4419   4420
  4494   4495   4568   4569   4570   4643   4644   4717   4718   4790
  4791   4792   4864   4865   4937   4938   5009   5010   5011   5082
  5083   5154   5155   5226   5227   5298   5299   5370   5371   5442
  5443   5514   5515   5586   5587   5658   5659   5730   5731   5802
  5803   5874   5875   5954   6033   6034   6113   6114   6192   6193
  6194   6272   6273   6351   6352   6429   6430   6431   6508   6509
  6585   6586   6587   6663   6664   6740   6741   6817   6818   6894
  6895   6971   6972   7048   7049   7125   7126   7127   7204   7205
  7282   7283   7284   7362   7363   7441   7442   7520   7521   7599
  7600   7678   7679   7680   7758   7759   7760   7839   7840   7920
  7921   7922   8002   8003   8004   8085   8086   8087   8169   8170
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   8171   8254   8255   8339   8340   8341   8425   8426   8427   8512
   8513   8514   8600   8601   8688   8689   8690   8777   8778   8779
   8867   8868   8869   8958   8959   8960   9050   9051   9142   9143
   9144   9235   9236   9237   9329   9330   9331   9424   9425   9426
   9520   9521   9616   9617   9618   9712   9713   9714   9715   9810
   9811   9812   9908   9909   9910  10007  10008  10106  10107  10108
  10206  10207  10208  10307  10308  10309  10409  10410  10411  10512
  10513  10615  10616  10617  10719  10720  10721  10824  10825  10826
  10930  10931  10932  11037  11038  11144  11145  11251  11252  11358
  11359  11465  11466  11572  11573  11679  11680  11786  11787  11893
  11894  12000  12001  12107  12108  12214  12215  12321  12322  12427
  12428  12429  12534  12535  12640  12641  12745  12746  12840  12931
  13020  13108  13194  13278  13360  13559  13560  13561  13562  13563
  13564  13565
   21    0
2     14  12088  12195  12302  12409  12516  12622  12728  12823  12914  13003  13091  13177  13261  13343
4     15   1111   1177   1244   1313   1381   1450   1521   1592   1664   1736   1808   1881   1955   2029   2104
4     14   2179   2255   2331   2406   2482   2558   2633   2709   2785   2861   2936   3012   3087   3162
4     12   3239   3315   3391   3466   3452   3618   3695   3771   3847   3924   4001   4077
4     47   4154   4231   4307   4382   4458   4531   4605   4678   4752   4825   4897   4970   5042   5113   5184   5255   5327   5398   5469
5540   5611   5682   5754   5826   5898   5976   6056   6135   6214   6292   6370   6449   6526   6603   6679   6755   6831   6907   6984   7060
7137   7215   7293   7372   7450   7528   7606
3     39   8095   8096   8097   8098   8099   8100   8101   8102   8103   8104   8105   8106   8107   8108   8109   8110   8111   8112   8113
8114   8115   8116   8117   8118   8119   8120   8121   8122   8123   8124   8125   8126   8127   8128   8129   8130   8131   8132   8133
2     19  11442  11549  11655  11763  11870  11977  12084  12191  12298  12405  12512  12618  12724  12819  12910  12999  13087  13174  13258
3     14   8134   8135   8136   8137   8138   8139   8140   8141   8142   8143   8144   8145   8146   8147
3      6   1591   1592   1593   1594   1595   1596
3      4   2634   2635   2636   2637
3     16   4155   4156   4157   4158   4159   4160   4161   4162   4163   4164   4165   4166   4167   4168   4169   4170
4     20   3964   4041   4118   4195   4271   4347   4422   4497   4572   4646   4720   4794   4867   4940   5013   5085   5157   5229   5301
5373
4     20   5805   5877   5956   6036   6116   6196   6275   6354   6433   6511   6589   6666   6743   6820   6897   6974   7051   7129   7207
7286
4      5   1122   1188   1255   1323   1391
3      4   3327   3328   3329   3330
3      6  12095  12096  12097  12098  12099  12100
4     27   2113   2189   2265   2341   2417   2493   2569   2645   2721   2797   2873   2949   3025   3101   3177   3253   3329   3405   3481
3557   3634   3711   3788   3865   3942   4019   4096
3     10   2036   2037   2038   2039   2040   2041   2042   2043   2044   2045
2     25  10173  10274  10376  10479  10582  10686  10791  10897  11004  11111  11218  11325  11432  11539  11646  11753  11860  11967  12074
12181  12288  12395  12502  12608  12714
4     12   3124   3200   3276   3352   3428   3504   3581   3658   3735   3812   3889   3966
3     35   3966   3967   3968   3969   3970   3971   3972   3973   3974   3975   3976   3977   3978   3979   3980   3981   3982   3983   3984
3985   3986   3987   3988   3989   3990   3991   3992   3993   3994   3995   3996   3997   3998   3999   4000
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CROSSMAX.OUT

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 THE MAXIMUM DISCHARGE FROM CROSS SECTION    1 IS    :   2053.61 CFS
THE MAXIMUM DISCHARGE FROM NODE   12088 IS:       3.01 CFS AT TIME  4.25 HOURS WITH A MAXIMUM DEPTH OF:    0.17 FEET
THE MAXIMUM DISCHARGE FROM NODE   12195 IS:       0.84 CFS AT TIME  4.83 HOURS WITH A MAXIMUM DEPTH OF:    0.11 FEET
THE MAXIMUM DISCHARGE FROM NODE   12302 IS:      61.05 CFS AT TIME  4.92 HOURS WITH A MAXIMUM DEPTH OF:    0.70 FEET
THE MAXIMUM DISCHARGE FROM NODE   12409 IS:     259.33 CFS AT TIME  4.91 HOURS WITH A MAXIMUM DEPTH OF:    1.72 FEET
THE MAXIMUM DISCHARGE FROM NODE   12516 IS:     380.02 CFS AT TIME  4.91 HOURS WITH A MAXIMUM DEPTH OF:    2.35 FEET
THE MAXIMUM DISCHARGE FROM NODE   12622 IS:     571.78 CFS AT TIME  4.93 HOURS WITH A MAXIMUM DEPTH OF:    3.89 FEET
THE MAXIMUM DISCHARGE FROM NODE   12728 IS:     264.35 CFS AT TIME  4.93 HOURS WITH A MAXIMUM DEPTH OF:    2.25 FEET
THE MAXIMUM DISCHARGE FROM NODE   12823 IS:     194.15 CFS AT TIME  5.12 HOURS WITH A MAXIMUM DEPTH OF:    1.71 FEET
THE MAXIMUM DISCHARGE FROM NODE   12914 IS:     102.89 CFS AT TIME  4.94 HOURS WITH A MAXIMUM DEPTH OF:    1.09 FEET
THE MAXIMUM DISCHARGE FROM NODE   13003 IS:      88.96 CFS AT TIME  4.90 HOURS WITH A MAXIMUM DEPTH OF:    0.74 FEET
THE MAXIMUM DISCHARGE FROM NODE   13091 IS:      81.46 CFS AT TIME  4.32 HOURS WITH A MAXIMUM DEPTH OF:    0.59 FEET
THE MAXIMUM DISCHARGE FROM NODE   13177 IS:      95.78 CFS AT TIME  4.26 HOURS WITH A MAXIMUM DEPTH OF:    0.61 FEET
THE MAXIMUM DISCHARGE FROM NODE   13261 IS:     137.68 CFS AT TIME  4.36 HOURS WITH A MAXIMUM DEPTH OF:    0.89 FEET
THE MAXIMUM DISCHARGE FROM NODE   13343 IS:      52.52 CFS AT TIME  4.41 HOURS WITH A MAXIMUM DEPTH OF:    0.51 FEET

 THE MAXIMUM DISCHARGE FROM CROSS SECTION    2 IS    :    416.89 CFS
THE MAXIMUM DISCHARGE FROM NODE    1111 IS:       0.62 CFS AT TIME  4.00 HOURS WITH A MAXIMUM DEPTH OF:    0.20 FEET
THE MAXIMUM DISCHARGE FROM NODE    1177 IS:       0.53 CFS AT TIME  4.00 HOURS WITH A MAXIMUM DEPTH OF:    0.20 FEET
THE MAXIMUM DISCHARGE FROM NODE    1244 IS:       8.79 CFS AT TIME  4.48 HOURS WITH A MAXIMUM DEPTH OF:    1.11 FEET
THE MAXIMUM DISCHARGE FROM NODE    1313 IS:      34.46 CFS AT TIME  4.42 HOURS WITH A MAXIMUM DEPTH OF:    1.79 FEET
THE MAXIMUM DISCHARGE FROM NODE    1381 IS:       4.38 CFS AT TIME  4.58 HOURS WITH A MAXIMUM DEPTH OF:    1.57 FEET
THE MAXIMUM DISCHARGE FROM NODE    1450 IS:     126.51 CFS AT TIME  4.56 HOURS WITH A MAXIMUM DEPTH OF:    1.60 FEET
THE MAXIMUM DISCHARGE FROM NODE    1521 IS:      44.78 CFS AT TIME  4.49 HOURS WITH A MAXIMUM DEPTH OF:    0.95 FEET
THE MAXIMUM DISCHARGE FROM NODE    1592 IS:      60.15 CFS AT TIME  4.49 HOURS WITH A MAXIMUM DEPTH OF:    1.25 FEET
THE MAXIMUM DISCHARGE FROM NODE    1664 IS:      32.30 CFS AT TIME  4.63 HOURS WITH A MAXIMUM DEPTH OF:    1.92 FEET
THE MAXIMUM DISCHARGE FROM NODE    1736 IS:      11.79 CFS AT TIME  4.57 HOURS WITH A MAXIMUM DEPTH OF:    0.44 FEET
THE MAXIMUM DISCHARGE FROM NODE    1808 IS:      40.18 CFS AT TIME  4.58 HOURS WITH A MAXIMUM DEPTH OF:    0.49 FEET
THE MAXIMUM DISCHARGE FROM NODE    1881 IS:      45.49 CFS AT TIME  4.61 HOURS WITH A MAXIMUM DEPTH OF:    0.92 FEET
THE MAXIMUM DISCHARGE FROM NODE    1955 IS:      18.92 CFS AT TIME  4.52 HOURS WITH A MAXIMUM DEPTH OF:    0.65 FEET
THE MAXIMUM DISCHARGE FROM NODE    2029 IS:       4.65 CFS AT TIME  4.95 HOURS WITH A MAXIMUM DEPTH OF:    0.32 FEET
THE MAXIMUM DISCHARGE FROM NODE    2104 IS:      40.77 CFS AT TIME  4.56 HOURS WITH A MAXIMUM DEPTH OF:    0.49 FEET

 THE MAXIMUM DISCHARGE FROM CROSS SECTION    3 IS    :    494.72 CFS
THE MAXIMUM DISCHARGE FROM NODE    2179 IS:      28.31 CFS AT TIME  4.68 HOURS WITH A MAXIMUM DEPTH OF:    0.56 FEET
THE MAXIMUM DISCHARGE FROM NODE    2255 IS:       3.76 CFS AT TIME  4.69 HOURS WITH A MAXIMUM DEPTH OF:    0.70 FEET
THE MAXIMUM DISCHARGE FROM NODE    2331 IS:      22.20 CFS AT TIME  4.62 HOURS WITH A MAXIMUM DEPTH OF:    0.81 FEET
THE MAXIMUM DISCHARGE FROM NODE    2406 IS:      28.60 CFS AT TIME  4.67 HOURS WITH A MAXIMUM DEPTH OF:    0.36 FEET
THE MAXIMUM DISCHARGE FROM NODE    2482 IS:      53.94 CFS AT TIME  4.74 HOURS WITH A MAXIMUM DEPTH OF:    0.63 FEET
THE MAXIMUM DISCHARGE FROM NODE    2558 IS:      55.64 CFS AT TIME  4.78 HOURS WITH A MAXIMUM DEPTH OF:    0.75 FEET
THE MAXIMUM DISCHARGE FROM NODE    2633 IS:      19.22 CFS AT TIME  4.69 HOURS WITH A MAXIMUM DEPTH OF:    0.30 FEET
THE MAXIMUM DISCHARGE FROM NODE    2709 IS:      29.11 CFS AT TIME  4.65 HOURS WITH A MAXIMUM DEPTH OF:    0.48 FEET
THE MAXIMUM DISCHARGE FROM NODE    2785 IS:      36.77 CFS AT TIME  4.63 HOURS WITH A MAXIMUM DEPTH OF:    0.45 FEET
THE MAXIMUM DISCHARGE FROM NODE    2861 IS:      83.22 CFS AT TIME  4.57 HOURS WITH A MAXIMUM DEPTH OF:    0.82 FEET
THE MAXIMUM DISCHARGE FROM NODE    2936 IS:      59.66 CFS AT TIME  4.55 HOURS WITH A MAXIMUM DEPTH OF:    0.82 FEET
THE MAXIMUM DISCHARGE FROM NODE    3012 IS:      70.75 CFS AT TIME  4.63 HOURS WITH A MAXIMUM DEPTH OF:    0.88 FEET
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THE MAXIMUM DISCHARGE FROM NODE    3087 IS:      57.70 CFS AT TIME  4.70 HOURS WITH A MAXIMUM DEPTH OF:    0.62 FEET
THE MAXIMUM DISCHARGE FROM NODE    3162 IS:      45.84 CFS AT TIME  4.70 HOURS WITH A MAXIMUM DEPTH OF:    0.42 FEET

 THE MAXIMUM DISCHARGE FROM CROSS SECTION    4 IS    :    557.98 CFS
THE MAXIMUM DISCHARGE FROM NODE    3239 IS:      89.61 CFS AT TIME  4.66 HOURS WITH A MAXIMUM DEPTH OF:    0.87 FEET
THE MAXIMUM DISCHARGE FROM NODE    3315 IS:      79.58 CFS AT TIME  4.64 HOURS WITH A MAXIMUM DEPTH OF:    0.90 FEET
THE MAXIMUM DISCHARGE FROM NODE    3391 IS:      63.72 CFS AT TIME  4.68 HOURS WITH A MAXIMUM DEPTH OF:    1.10 FEET
THE MAXIMUM DISCHARGE FROM NODE    3466 IS:      66.77 CFS AT TIME  4.66 HOURS WITH A MAXIMUM DEPTH OF:    0.73 FEET
THE MAXIMUM DISCHARGE FROM NODE    3452 IS:       2.84 CFS AT TIME  4.92 HOURS WITH A MAXIMUM DEPTH OF:    0.12 FEET
THE MAXIMUM DISCHARGE FROM NODE    3618 IS:      49.37 CFS AT TIME  4.65 HOURS WITH A MAXIMUM DEPTH OF:    0.42 FEET
THE MAXIMUM DISCHARGE FROM NODE    3695 IS:      70.36 CFS AT TIME  4.73 HOURS WITH A MAXIMUM DEPTH OF:    0.87 FEET
THE MAXIMUM DISCHARGE FROM NODE    3771 IS:      84.92 CFS AT TIME  4.78 HOURS WITH A MAXIMUM DEPTH OF:    0.87 FEET
THE MAXIMUM DISCHARGE FROM NODE    3847 IS:      76.52 CFS AT TIME  4.76 HOURS WITH A MAXIMUM DEPTH OF:    0.53 FEET
THE MAXIMUM DISCHARGE FROM NODE    3924 IS:      39.28 CFS AT TIME  4.95 HOURS WITH A MAXIMUM DEPTH OF:    0.39 FEET
THE MAXIMUM DISCHARGE FROM NODE    4001 IS:      17.23 CFS AT TIME  4.75 HOURS WITH A MAXIMUM DEPTH OF:    0.42 FEET
THE MAXIMUM DISCHARGE FROM NODE    4077 IS:       9.74 CFS AT TIME  4.79 HOURS WITH A MAXIMUM DEPTH OF:    0.20 FEET

 THE MAXIMUM DISCHARGE FROM CROSS SECTION    5 IS    :    157.94 CFS
THE MAXIMUM DISCHARGE FROM NODE    4154 IS:      24.34 CFS AT TIME  4.78 HOURS WITH A MAXIMUM DEPTH OF:    0.33 FEET
THE MAXIMUM DISCHARGE FROM NODE    4231 IS:      23.85 CFS AT TIME  4.92 HOURS WITH A MAXIMUM DEPTH OF:    0.35 FEET
THE MAXIMUM DISCHARGE FROM NODE    4307 IS:      22.93 CFS AT TIME  4.76 HOURS WITH A MAXIMUM DEPTH OF:    0.38 FEET
THE MAXIMUM DISCHARGE FROM NODE    4382 IS:      20.99 CFS AT TIME  4.76 HOURS WITH A MAXIMUM DEPTH OF:    0.30 FEET
THE MAXIMUM DISCHARGE FROM NODE    4458 IS:      14.20 CFS AT TIME  4.80 HOURS WITH A MAXIMUM DEPTH OF:    0.28 FEET
THE MAXIMUM DISCHARGE FROM NODE    4531 IS:      14.04 CFS AT TIME  4.85 HOURS WITH A MAXIMUM DEPTH OF:    0.26 FEET
THE MAXIMUM DISCHARGE FROM NODE    4605 IS:      13.36 CFS AT TIME  4.93 HOURS WITH A MAXIMUM DEPTH OF:    0.29 FEET
THE MAXIMUM DISCHARGE FROM NODE    4678 IS:      12.38 CFS AT TIME  4.96 HOURS WITH A MAXIMUM DEPTH OF:    0.26 FEET
THE MAXIMUM DISCHARGE FROM NODE    4752 IS:      12.31 CFS AT TIME  4.92 HOURS WITH A MAXIMUM DEPTH OF:    0.28 FEET
THE MAXIMUM DISCHARGE FROM NODE    4825 IS:       2.23 CFS AT TIME  5.12 HOURS WITH A MAXIMUM DEPTH OF:    0.20 FEET
THE MAXIMUM DISCHARGE FROM NODE    4897 IS:       1.35 CFS AT TIME  5.12 HOURS WITH A MAXIMUM DEPTH OF:    0.08 FEET
THE MAXIMUM DISCHARGE FROM NODE    4970 IS:       5.50 CFS AT TIME  4.98 HOURS WITH A MAXIMUM DEPTH OF:    0.23 FEET
THE MAXIMUM DISCHARGE FROM NODE    5042 IS:       2.13 CFS AT TIME  5.07 HOURS WITH A MAXIMUM DEPTH OF:    0.21 FEET
THE MAXIMUM DISCHARGE FROM NODE    5113 IS:       1.49 CFS AT TIME  5.15 HOURS WITH A MAXIMUM DEPTH OF:    0.12 FEET
THE MAXIMUM DISCHARGE FROM NODE    5184 IS:       0.96 CFS AT TIME  4.00 HOURS WITH A MAXIMUM DEPTH OF:    0.07 FEET
THE MAXIMUM DISCHARGE FROM NODE    5255 IS:       0.98 CFS AT TIME  4.00 HOURS WITH A MAXIMUM DEPTH OF:    0.06 FEET
THE MAXIMUM DISCHARGE FROM NODE    5327 IS:       1.61 CFS AT TIME  5.27 HOURS WITH A MAXIMUM DEPTH OF:    0.10 FEET
THE MAXIMUM DISCHARGE FROM NODE    5398 IS:       2.14 CFS AT TIME  5.27 HOURS WITH A MAXIMUM DEPTH OF:    0.14 FEET
THE MAXIMUM DISCHARGE FROM NODE    5469 IS:       1.53 CFS AT TIME  4.01 HOURS WITH A MAXIMUM DEPTH OF:    0.11 FEET
THE MAXIMUM DISCHARGE FROM NODE    5540 IS:       1.20 CFS AT TIME  4.02 HOURS WITH A MAXIMUM DEPTH OF:    0.10 FEET
THE MAXIMUM DISCHARGE FROM NODE    5611 IS:       1.36 CFS AT TIME  4.14 HOURS WITH A MAXIMUM DEPTH OF:    0.08 FEET
THE MAXIMUM DISCHARGE FROM NODE    5682 IS:       1.49 CFS AT TIME  4.00 HOURS WITH A MAXIMUM DEPTH OF:    0.08 FEET
THE MAXIMUM DISCHARGE FROM NODE    5754 IS:       1.87 CFS AT TIME  3.96 HOURS WITH A MAXIMUM DEPTH OF:    0.11 FEET
THE MAXIMUM DISCHARGE FROM NODE    5826 IS:       1.67 CFS AT TIME  4.15 HOURS WITH A MAXIMUM DEPTH OF:    0.10 FEET
THE MAXIMUM DISCHARGE FROM NODE    5898 IS:       1.24 CFS AT TIME  3.99 HOURS WITH A MAXIMUM DEPTH OF:    0.09 FEET
THE MAXIMUM DISCHARGE FROM NODE    5976 IS:       1.60 CFS AT TIME  4.07 HOURS WITH A MAXIMUM DEPTH OF:    0.12 FEET
THE MAXIMUM DISCHARGE FROM NODE    6056 IS:       1.75 CFS AT TIME  4.15 HOURS WITH A MAXIMUM DEPTH OF:    0.12 FEET
THE MAXIMUM DISCHARGE FROM NODE    6135 IS:       1.65 CFS AT TIME  3.98 HOURS WITH A MAXIMUM DEPTH OF:    0.10 FEET
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THE MAXIMUM DISCHARGE FROM NODE    6214 IS:      2.04 CFS AT TIME  4.05 HOURS WITH A MAXIMUM DEPTH OF:    0.16 FEET
THE MAXIMUM DISCHARGE FROM NODE    6292 IS:      2.46 CFS AT TIME  4.25 HOURS WITH A MAXIMUM DEPTH OF:    0.13 FEET
THE MAXIMUM DISCHARGE FROM NODE    6370 IS:      2.56 CFS AT TIME  4.17 HOURS WITH A MAXIMUM DEPTH OF:    0.14 FEET
THE MAXIMUM DISCHARGE FROM NODE    6449 IS:      1.70 CFS AT TIME  4.15 HOURS WITH A MAXIMUM DEPTH OF:    0.11 FEET
THE MAXIMUM DISCHARGE FROM NODE    6526 IS:      1.38 CFS AT TIME  4.15 HOURS WITH A MAXIMUM DEPTH OF:    0.12 FEET
THE MAXIMUM DISCHARGE FROM NODE    6603 IS:      1.70 CFS AT TIME  4.15 HOURS WITH A MAXIMUM DEPTH OF:    0.14 FEET
THE MAXIMUM DISCHARGE FROM NODE    6679 IS:      2.02 CFS AT TIME  4.25 HOURS WITH A MAXIMUM DEPTH OF:    0.15 FEET
THE MAXIMUM DISCHARGE FROM NODE    6755 IS:      2.52 CFS AT TIME  4.24 HOURS WITH A MAXIMUM DEPTH OF:    0.13 FEET
THE MAXIMUM DISCHARGE FROM NODE    6831 IS:      1.86 CFS AT TIME  4.25 HOURS WITH A MAXIMUM DEPTH OF:    0.14 FEET
THE MAXIMUM DISCHARGE FROM NODE    6907 IS:      2.69 CFS AT TIME  4.25 HOURS WITH A MAXIMUM DEPTH OF:    0.20 FEET
THE MAXIMUM DISCHARGE FROM NODE    6984 IS:      3.11 CFS AT TIME  4.25 HOURS WITH A MAXIMUM DEPTH OF:    0.16 FEET
THE MAXIMUM DISCHARGE FROM NODE    7060 IS:      2.08 CFS AT TIME  4.24 HOURS WITH A MAXIMUM DEPTH OF:    0.13 FEET
THE MAXIMUM DISCHARGE FROM NODE    7137 IS:      1.93 CFS AT TIME  4.21 HOURS WITH A MAXIMUM DEPTH OF:    0.12 FEET
THE MAXIMUM DISCHARGE FROM NODE    7215 IS:      2.00 CFS AT TIME  4.22 HOURS WITH A MAXIMUM DEPTH OF:    0.13 FEET
THE MAXIMUM DISCHARGE FROM NODE    7293 IS:      4.00 CFS AT TIME  5.45 HOURS WITH A MAXIMUM DEPTH OF:    0.29 FEET
THE MAXIMUM DISCHARGE FROM NODE    7372 IS:      6.93 CFS AT TIME  5.50 HOURS WITH A MAXIMUM DEPTH OF:    0.35 FEET
THE MAXIMUM DISCHARGE FROM NODE    7450 IS:      2.05 CFS AT TIME  5.52 HOURS WITH A MAXIMUM DEPTH OF:    0.24 FEET
THE MAXIMUM DISCHARGE FROM NODE    7528 IS:      1.76 CFS AT TIME  4.00 HOURS WITH A MAXIMUM DEPTH OF:    0.14 FEET
THE MAXIMUM DISCHARGE FROM NODE    7606 IS:      2.16 CFS AT TIME  4.00 HOURS WITH A MAXIMUM DEPTH OF:    0.14 FEET

 THE MAXIMUM DISCHARGE FROM CROSS SECTION    6 IS    :   1051.31 CFS
THE MAXIMUM DISCHARGE FROM NODE    8095 IS:      0.63 CFS AT TIME  4.23 HOURS WITH A MAXIMUM DEPTH OF:    0.14 FEET
THE MAXIMUM DISCHARGE FROM NODE    8096 IS:      1.07 CFS AT TIME  4.22 HOURS WITH A MAXIMUM DEPTH OF:    0.16 FEET
THE MAXIMUM DISCHARGE FROM NODE    8097 IS:      1.38 CFS AT TIME  4.15 HOURS WITH A MAXIMUM DEPTH OF:    0.18 FEET
THE MAXIMUM DISCHARGE FROM NODE    8098 IS:      1.97 CFS AT TIME  4.19 HOURS WITH A MAXIMUM DEPTH OF:    0.20 FEET
THE MAXIMUM DISCHARGE FROM NODE    8099 IS:      2.16 CFS AT TIME  4.19 HOURS WITH A MAXIMUM DEPTH OF:    0.20 FEET
THE MAXIMUM DISCHARGE FROM NODE    8100 IS:      2.03 CFS AT TIME  4.23 HOURS WITH A MAXIMUM DEPTH OF:    0.21 FEET
THE MAXIMUM DISCHARGE FROM NODE    8101 IS:      1.09 CFS AT TIME  4.25 HOURS WITH A MAXIMUM DEPTH OF:    0.22 FEET
THE MAXIMUM DISCHARGE FROM NODE    8102 IS:      0.99 CFS AT TIME  4.31 HOURS WITH A MAXIMUM DEPTH OF:    0.20 FEET
THE MAXIMUM DISCHARGE FROM NODE    8103 IS:      1.39 CFS AT TIME  4.33 HOURS WITH A MAXIMUM DEPTH OF:    0.19 FEET
THE MAXIMUM DISCHARGE FROM NODE    8104 IS:      4.34 CFS AT TIME  4.29 HOURS WITH A MAXIMUM DEPTH OF:    0.20 FEET
THE MAXIMUM DISCHARGE FROM NODE    8105 IS:      3.85 CFS AT TIME  4.12 HOURS WITH A MAXIMUM DEPTH OF:    0.22 FEET
THE MAXIMUM DISCHARGE FROM NODE    8106 IS:      5.24 CFS AT TIME  4.26 HOURS WITH A MAXIMUM DEPTH OF:    0.23 FEET
THE MAXIMUM DISCHARGE FROM NODE    8107 IS:     29.29 CFS AT TIME  4.31 HOURS WITH A MAXIMUM DEPTH OF:    0.61 FEET
THE MAXIMUM DISCHARGE FROM NODE    8108 IS:     36.38 CFS AT TIME  4.31 HOURS WITH A MAXIMUM DEPTH OF:    0.53 FEET
THE MAXIMUM DISCHARGE FROM NODE    8109 IS:     29.73 CFS AT TIME  4.32 HOURS WITH A MAXIMUM DEPTH OF:    0.46 FEET
THE MAXIMUM DISCHARGE FROM NODE    8110 IS:     27.33 CFS AT TIME  4.32 HOURS WITH A MAXIMUM DEPTH OF:    0.42 FEET
THE MAXIMUM DISCHARGE FROM NODE    8111 IS:     31.47 CFS AT TIME  5.61 HOURS WITH A MAXIMUM DEPTH OF:    0.44 FEET
THE MAXIMUM DISCHARGE FROM NODE    8112 IS:     25.76 CFS AT TIME  5.61 HOURS WITH A MAXIMUM DEPTH OF:    0.37 FEET
THE MAXIMUM DISCHARGE FROM NODE    8113 IS:     19.96 CFS AT TIME  5.53 HOURS WITH A MAXIMUM DEPTH OF:    0.31 FEET
THE MAXIMUM DISCHARGE FROM NODE    8114 IS:     16.43 CFS AT TIME  5.51 HOURS WITH A MAXIMUM DEPTH OF:    0.27 FEET
THE MAXIMUM DISCHARGE FROM NODE    8115 IS:     13.19 CFS AT TIME  5.49 HOURS WITH A MAXIMUM DEPTH OF:    0.23 FEET
THE MAXIMUM DISCHARGE FROM NODE    8116 IS:     12.31 CFS AT TIME  5.34 HOURS WITH A MAXIMUM DEPTH OF:    0.24 FEET
THE MAXIMUM DISCHARGE FROM NODE    8117 IS:     11.76 CFS AT TIME  5.34 HOURS WITH A MAXIMUM DEPTH OF:    0.23 FEET
THE MAXIMUM DISCHARGE FROM NODE    8118 IS:     11.48 CFS AT TIME  5.38 HOURS WITH A MAXIMUM DEPTH OF:    0.21 FEET
THE MAXIMUM DISCHARGE FROM NODE    8119 IS:     17.52 CFS AT TIME  5.29 HOURS WITH A MAXIMUM DEPTH OF:    0.28 FEET
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THE MAXIMUM DISCHARGE FROM NODE    8120 IS:     35.22 CFS AT TIME  5.35 HOURS WITH A MAXIMUM DEPTH OF:    0.43 FEET
THE MAXIMUM DISCHARGE FROM NODE    8121 IS:     59.60 CFS AT TIME  5.32 HOURS WITH A MAXIMUM DEPTH OF:    0.56 FEET
THE MAXIMUM DISCHARGE FROM NODE    8122 IS:    141.46 CFS AT TIME  5.37 HOURS WITH A MAXIMUM DEPTH OF:    1.34 FEET
THE MAXIMUM DISCHARGE FROM NODE    8123 IS:    206.60 CFS AT TIME  5.31 HOURS WITH A MAXIMUM DEPTH OF:    1.89 FEET
THE MAXIMUM DISCHARGE FROM NODE    8124 IS:    202.41 CFS AT TIME  5.34 HOURS WITH A MAXIMUM DEPTH OF:    2.17 FEET
THE MAXIMUM DISCHARGE FROM NODE    8125 IS:    169.21 CFS AT TIME  5.30 HOURS WITH A MAXIMUM DEPTH OF:    2.04 FEET
THE MAXIMUM DISCHARGE FROM NODE    8126 IS:     72.07 CFS AT TIME  5.34 HOURS WITH A MAXIMUM DEPTH OF:    1.16 FEET
THE MAXIMUM DISCHARGE FROM NODE    8127 IS:     18.13 CFS AT TIME  5.37 HOURS WITH A MAXIMUM DEPTH OF:    0.39 FEET
THE MAXIMUM DISCHARGE FROM NODE    8128 IS:      1.41 CFS AT TIME  3.99 HOURS WITH A MAXIMUM DEPTH OF:    0.11 FEET
THE MAXIMUM DISCHARGE FROM NODE    8129 IS:      1.70 CFS AT TIME  4.01 HOURS WITH A MAXIMUM DEPTH OF:    0.14 FEET
THE MAXIMUM DISCHARGE FROM NODE    8130 IS:      1.56 CFS AT TIME  3.99 HOURS WITH A MAXIMUM DEPTH OF:    0.10 FEET
THE MAXIMUM DISCHARGE FROM NODE    8131 IS:      2.44 CFS AT TIME  4.02 HOURS WITH A MAXIMUM DEPTH OF:    0.14 FEET
THE MAXIMUM DISCHARGE FROM NODE    8132 IS:      2.16 CFS AT TIME  4.03 HOURS WITH A MAXIMUM DEPTH OF:    0.13 FEET
THE MAXIMUM DISCHARGE FROM NODE    8133 IS:      1.60 CFS AT TIME  4.00 HOURS WITH A MAXIMUM DEPTH OF:    0.12 FEET

 THE MAXIMUM DISCHARGE FROM CROSS SECTION    7 IS    :   2134.78 CFS
THE MAXIMUM DISCHARGE FROM NODE   11442 IS:      0.75 CFS AT TIME  4.00 HOURS WITH A MAXIMUM DEPTH OF:    0.10 FEET
THE MAXIMUM DISCHARGE FROM NODE   11549 IS:      9.97 CFS AT TIME  4.30 HOURS WITH A MAXIMUM DEPTH OF:    0.21 FEET
THE MAXIMUM DISCHARGE FROM NODE   11655 IS:      0.22 CFS AT TIME  3.78 HOURS WITH A MAXIMUM DEPTH OF:    0.08 FEET
THE MAXIMUM DISCHARGE FROM NODE   11763 IS:     57.66 CFS AT TIME  4.28 HOURS WITH A MAXIMUM DEPTH OF:    1.03 FEET
THE MAXIMUM DISCHARGE FROM NODE   11870 IS:     37.68 CFS AT TIME  4.90 HOURS WITH A MAXIMUM DEPTH OF:    1.28 FEET
THE MAXIMUM DISCHARGE FROM NODE   11977 IS:    125.44 CFS AT TIME  4.85 HOURS WITH A MAXIMUM DEPTH OF:    3.19 FEET
THE MAXIMUM DISCHARGE FROM NODE   12084 IS:    347.82 CFS AT TIME  4.84 HOURS WITH A MAXIMUM DEPTH OF:    3.30 FEET
THE MAXIMUM DISCHARGE FROM NODE   12191 IS:    508.62 CFS AT TIME  4.93 HOURS WITH A MAXIMUM DEPTH OF:    2.79 FEET
THE MAXIMUM DISCHARGE FROM NODE   12298 IS:    473.35 CFS AT TIME  4.83 HOURS WITH A MAXIMUM DEPTH OF:    2.26 FEET
THE MAXIMUM DISCHARGE FROM NODE   12405 IS:    388.88 CFS AT TIME  4.93 HOURS WITH A MAXIMUM DEPTH OF:    2.27 FEET
THE MAXIMUM DISCHARGE FROM NODE   12512 IS:    162.52 CFS AT TIME  4.77 HOURS WITH A MAXIMUM DEPTH OF:    2.20 FEET
THE MAXIMUM DISCHARGE FROM NODE   12618 IS:    118.89 CFS AT TIME  4.49 HOURS WITH A MAXIMUM DEPTH OF:    2.30 FEET
THE MAXIMUM DISCHARGE FROM NODE   12724 IS:     94.65 CFS AT TIME  4.63 HOURS WITH A MAXIMUM DEPTH OF:    1.59 FEET
THE MAXIMUM DISCHARGE FROM NODE   12819 IS:     71.42 CFS AT TIME  4.39 HOURS WITH A MAXIMUM DEPTH OF:    1.03 FEET
THE MAXIMUM DISCHARGE FROM NODE   12910 IS:     44.36 CFS AT TIME  4.46 HOURS WITH A MAXIMUM DEPTH OF:    0.57 FEET
THE MAXIMUM DISCHARGE FROM NODE   12999 IS:     11.45 CFS AT TIME  4.36 HOURS WITH A MAXIMUM DEPTH OF:    0.27 FEET
THE MAXIMUM DISCHARGE FROM NODE   13087 IS:      0.37 CFS AT TIME  4.00 HOURS WITH A MAXIMUM DEPTH OF:    0.03 FEET
THE MAXIMUM DISCHARGE FROM NODE   13174 IS:    102.31 CFS AT TIME  4.33 HOURS WITH A MAXIMUM DEPTH OF:    1.56 FEET
THE MAXIMUM DISCHARGE FROM NODE   13258 IS:    173.88 CFS AT TIME  4.32 HOURS WITH A MAXIMUM DEPTH OF:    1.32 FEET

 THE MAXIMUM DISCHARGE FROM CROSS SECTION    8 IS    :    173.91 CFS
THE MAXIMUM DISCHARGE FROM NODE    8134 IS:      0.46 CFS AT TIME  4.00 HOURS WITH A MAXIMUM DEPTH OF:    0.05 FEET
THE MAXIMUM DISCHARGE FROM NODE    8135 IS:      2.05 CFS AT TIME  4.28 HOURS WITH A MAXIMUM DEPTH OF:    0.14 FEET
THE MAXIMUM DISCHARGE FROM NODE    8136 IS:     63.14 CFS AT TIME  4.28 HOURS WITH A MAXIMUM DEPTH OF:    0.82 FEET
THE MAXIMUM DISCHARGE FROM NODE    8137 IS:     38.87 CFS AT TIME  4.29 HOURS WITH A MAXIMUM DEPTH OF:    0.53 FEET
THE MAXIMUM DISCHARGE FROM NODE    8138 IS:     20.01 CFS AT TIME  4.29 HOURS WITH A MAXIMUM DEPTH OF:    0.33 FEET
THE MAXIMUM DISCHARGE FROM NODE    8139 IS:     14.29 CFS AT TIME  5.12 HOURS WITH A MAXIMUM DEPTH OF:    0.30 FEET
THE MAXIMUM DISCHARGE FROM NODE    8140 IS:      6.26 CFS AT TIME  5.14 HOURS WITH A MAXIMUM DEPTH OF:    0.20 FEET
THE MAXIMUM DISCHARGE FROM NODE    8141 IS:      5.22 CFS AT TIME  5.03 HOURS WITH A MAXIMUM DEPTH OF:    0.22 FEET
THE MAXIMUM DISCHARGE FROM NODE    8142 IS:      8.21 CFS AT TIME  5.05 HOURS WITH A MAXIMUM DEPTH OF:    0.23 FEET
THE MAXIMUM DISCHARGE FROM NODE    8143 IS:      8.34 CFS AT TIME  5.01 HOURS WITH A MAXIMUM DEPTH OF:    0.22 FEET
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THE MAXIMUM DISCHARGE FROM NODE    8144 IS:      6.77 CFS AT TIME  4.74 HOURS WITH A MAXIMUM DEPTH OF:    0.22 FEET
THE MAXIMUM DISCHARGE FROM NODE    8145 IS:      5.87 CFS AT TIME  4.92 HOURS WITH A MAXIMUM DEPTH OF:    0.21 FEET
THE MAXIMUM DISCHARGE FROM NODE    8146 IS:      5.37 CFS AT TIME  4.93 HOURS WITH A MAXIMUM DEPTH OF:    0.22 FEET
THE MAXIMUM DISCHARGE FROM NODE    8147 IS:      1.11 CFS AT TIME  4.25 HOURS WITH A MAXIMUM DEPTH OF:    0.11 FEET

 THE MAXIMUM DISCHARGE FROM CROSS SECTION    9 IS    :   1053.49 CFS
THE MAXIMUM DISCHARGE FROM NODE    1591 IS:    148.37 CFS AT TIME  4.49 HOURS WITH A MAXIMUM DEPTH OF:    1.01 FEET
THE MAXIMUM DISCHARGE FROM NODE    1592 IS:    170.07 CFS AT TIME  4.50 HOURS WITH A MAXIMUM DEPTH OF:    1.25 FEET
THE MAXIMUM DISCHARGE FROM NODE    1593 IS:    424.88 CFS AT TIME  4.50 HOURS WITH A MAXIMUM DEPTH OF:    3.53 FEET
THE MAXIMUM DISCHARGE FROM NODE    1594 IS:    245.44 CFS AT TIME  4.52 HOURS WITH A MAXIMUM DEPTH OF:    1.77 FEET
THE MAXIMUM DISCHARGE FROM NODE    1595 IS:     61.83 CFS AT TIME  4.49 HOURS WITH A MAXIMUM DEPTH OF:    0.96 FEET
THE MAXIMUM DISCHARGE FROM NODE    1596 IS:      5.66 CFS AT TIME  4.36 HOURS WITH A MAXIMUM DEPTH OF:    0.20 FEET

 THE MAXIMUM DISCHARGE FROM CROSS SECTION   10 IS    :    663.18 CFS
THE MAXIMUM DISCHARGE FROM NODE    2634 IS:     56.70 CFS AT TIME  4.62 HOURS WITH A MAXIMUM DEPTH OF:    0.43 FEET
THE MAXIMUM DISCHARGE FROM NODE    2635 IS:    261.68 CFS AT TIME  4.59 HOURS WITH A MAXIMUM DEPTH OF:    1.30 FEET
THE MAXIMUM DISCHARGE FROM NODE    2636 IS:    265.79 CFS AT TIME  4.60 HOURS WITH A MAXIMUM DEPTH OF:    1.62 FEET
THE MAXIMUM DISCHARGE FROM NODE    2637 IS:     81.50 CFS AT TIME  4.60 HOURS WITH A MAXIMUM DEPTH OF:    0.82 FEET

 THE MAXIMUM DISCHARGE FROM CROSS SECTION   11 IS    :   1035.19 CFS
THE MAXIMUM DISCHARGE FROM NODE    4155 IS:     64.57 CFS AT TIME  4.78 HOURS WITH A MAXIMUM DEPTH OF:    0.51 FEET
THE MAXIMUM DISCHARGE FROM NODE    4156 IS:    141.70 CFS AT TIME  4.78 HOURS WITH A MAXIMUM DEPTH OF:    0.79 FEET
THE MAXIMUM DISCHARGE FROM NODE    4157 IS:    133.53 CFS AT TIME  4.79 HOURS WITH A MAXIMUM DEPTH OF:    0.76 FEET
THE MAXIMUM DISCHARGE FROM NODE    4158 IS:     88.83 CFS AT TIME  4.75 HOURS WITH A MAXIMUM DEPTH OF:    0.61 FEET
THE MAXIMUM DISCHARGE FROM NODE    4159 IS:     70.36 CFS AT TIME  4.81 HOURS WITH A MAXIMUM DEPTH OF:    0.51 FEET
THE MAXIMUM DISCHARGE FROM NODE    4160 IS:     95.96 CFS AT TIME  4.74 HOURS WITH A MAXIMUM DEPTH OF:    0.68 FEET
THE MAXIMUM DISCHARGE FROM NODE    4161 IS:     74.43 CFS AT TIME  4.73 HOURS WITH A MAXIMUM DEPTH OF:    0.51 FEET
THE MAXIMUM DISCHARGE FROM NODE    4162 IS:     61.24 CFS AT TIME  4.72 HOURS WITH A MAXIMUM DEPTH OF:    0.50 FEET
THE MAXIMUM DISCHARGE FROM NODE    4163 IS:     38.83 CFS AT TIME  4.73 HOURS WITH A MAXIMUM DEPTH OF:    0.36 FEET
THE MAXIMUM DISCHARGE FROM NODE    4164 IS:     36.43 CFS AT TIME  4.68 HOURS WITH A MAXIMUM DEPTH OF:    0.47 FEET
THE MAXIMUM DISCHARGE FROM NODE    4165 IS:     26.20 CFS AT TIME  4.67 HOURS WITH A MAXIMUM DEPTH OF:    0.31 FEET
THE MAXIMUM DISCHARGE FROM NODE    4166 IS:     42.01 CFS AT TIME  4.63 HOURS WITH A MAXIMUM DEPTH OF:    0.41 FEET
THE MAXIMUM DISCHARGE FROM NODE    4167 IS:     80.18 CFS AT TIME  4.62 HOURS WITH A MAXIMUM DEPTH OF:    0.55 FEET
THE MAXIMUM DISCHARGE FROM NODE    4168 IS:     47.86 CFS AT TIME  4.62 HOURS WITH A MAXIMUM DEPTH OF:    0.37 FEET
THE MAXIMUM DISCHARGE FROM NODE    4169 IS:     54.92 CFS AT TIME  4.61 HOURS WITH A MAXIMUM DEPTH OF:    0.47 FEET
THE MAXIMUM DISCHARGE FROM NODE    4170 IS:     19.32 CFS AT TIME  4.60 HOURS WITH A MAXIMUM DEPTH OF:    0.21 FEET

 THE MAXIMUM DISCHARGE FROM CROSS SECTION   12 IS    :    538.19 CFS
THE MAXIMUM DISCHARGE FROM NODE    3964 IS:     22.03 CFS AT TIME  4.49 HOURS WITH A MAXIMUM DEPTH OF:    0.47 FEET
THE MAXIMUM DISCHARGE FROM NODE    4041 IS:     35.38 CFS AT TIME  4.50 HOURS WITH A MAXIMUM DEPTH OF:    0.55 FEET
THE MAXIMUM DISCHARGE FROM NODE    4118 IS:     50.53 CFS AT TIME  5.01 HOURS WITH A MAXIMUM DEPTH OF:    0.62 FEET
THE MAXIMUM DISCHARGE FROM NODE    4195 IS:     55.04 CFS AT TIME  5.08 HOURS WITH A MAXIMUM DEPTH OF:    0.65 FEET
THE MAXIMUM DISCHARGE FROM NODE    4271 IS:     48.43 CFS AT TIME  5.01 HOURS WITH A MAXIMUM DEPTH OF:    0.62 FEET
THE MAXIMUM DISCHARGE FROM NODE    4347 IS:     37.95 CFS AT TIME  5.05 HOURS WITH A MAXIMUM DEPTH OF:    0.53 FEET
THE MAXIMUM DISCHARGE FROM NODE    4422 IS:     33.55 CFS AT TIME  5.06 HOURS WITH A MAXIMUM DEPTH OF:    0.53 FEET
THE MAXIMUM DISCHARGE FROM NODE    4497 IS:     25.25 CFS AT TIME  5.07 HOURS WITH A MAXIMUM DEPTH OF:    0.47 FEET
THE MAXIMUM DISCHARGE FROM NODE    4572 IS:     21.79 CFS AT TIME  5.13 HOURS WITH A MAXIMUM DEPTH OF:    0.41 FEET
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THE MAXIMUM DISCHARGE FROM NODE    4646 IS:      24.49 CFS AT TIME  5.15 HOURS WITH A MAXIMUM DEPTH OF:    0.41 FEET
THE MAXIMUM DISCHARGE FROM NODE    4720 IS:      36.71 CFS AT TIME  5.19 HOURS WITH A MAXIMUM DEPTH OF:    0.44 FEET
THE MAXIMUM DISCHARGE FROM NODE    4794 IS:      37.34 CFS AT TIME  5.16 HOURS WITH A MAXIMUM DEPTH OF:    0.40 FEET
THE MAXIMUM DISCHARGE FROM NODE    4867 IS:      29.40 CFS AT TIME  5.23 HOURS WITH A MAXIMUM DEPTH OF:    0.33 FEET
THE MAXIMUM DISCHARGE FROM NODE    4940 IS:      30.52 CFS AT TIME  5.23 HOURS WITH A MAXIMUM DEPTH OF:    0.34 FEET
THE MAXIMUM DISCHARGE FROM NODE    5013 IS:      30.29 CFS AT TIME  5.27 HOURS WITH A MAXIMUM DEPTH OF:    0.36 FEET
THE MAXIMUM DISCHARGE FROM NODE    5085 IS:      21.60 CFS AT TIME  5.28 HOURS WITH A MAXIMUM DEPTH OF:    0.35 FEET
THE MAXIMUM DISCHARGE FROM NODE    5157 IS:       9.96 CFS AT TIME  5.33 HOURS WITH A MAXIMUM DEPTH OF:    0.37 FEET
THE MAXIMUM DISCHARGE FROM NODE    5229 IS:       9.95 CFS AT TIME  5.56 HOURS WITH A MAXIMUM DEPTH OF:    0.38 FEET
THE MAXIMUM DISCHARGE FROM NODE    5301 IS:       8.34 CFS AT TIME  5.19 HOURS WITH A MAXIMUM DEPTH OF:    0.25 FEET
THE MAXIMUM DISCHARGE FROM NODE    5373 IS:       6.68 CFS AT TIME  5.45 HOURS WITH A MAXIMUM DEPTH OF:    0.20 FEET

 THE MAXIMUM DISCHARGE FROM CROSS SECTION   13 IS    :    663.26 CFS
THE MAXIMUM DISCHARGE FROM NODE    5805 IS:       4.24 CFS AT TIME  4.25 HOURS WITH A MAXIMUM DEPTH OF:    0.17 FEET
THE MAXIMUM DISCHARGE FROM NODE    5877 IS:      12.05 CFS AT TIME  4.24 HOURS WITH A MAXIMUM DEPTH OF:    0.20 FEET
THE MAXIMUM DISCHARGE FROM NODE    5956 IS:      12.39 CFS AT TIME  4.25 HOURS WITH A MAXIMUM DEPTH OF:    0.20 FEET
THE MAXIMUM DISCHARGE FROM NODE    6036 IS:      18.25 CFS AT TIME  4.25 HOURS WITH A MAXIMUM DEPTH OF:    0.27 FEET
THE MAXIMUM DISCHARGE FROM NODE    6116 IS:      22.05 CFS AT TIME  5.38 HOURS WITH A MAXIMUM DEPTH OF:    0.37 FEET
THE MAXIMUM DISCHARGE FROM NODE    6196 IS:      70.89 CFS AT TIME  5.33 HOURS WITH A MAXIMUM DEPTH OF:    0.97 FEET
THE MAXIMUM DISCHARGE FROM NODE    6275 IS:      70.78 CFS AT TIME  5.33 HOURS WITH A MAXIMUM DEPTH OF:    0.78 FEET
THE MAXIMUM DISCHARGE FROM NODE    6354 IS:     105.41 CFS AT TIME  5.32 HOURS WITH A MAXIMUM DEPTH OF:    1.18 FEET
THE MAXIMUM DISCHARGE FROM NODE    6433 IS:      66.87 CFS AT TIME  5.39 HOURS WITH A MAXIMUM DEPTH OF:    0.56 FEET
THE MAXIMUM DISCHARGE FROM NODE    6511 IS:      80.14 CFS AT TIME  5.33 HOURS WITH A MAXIMUM DEPTH OF:    0.76 FEET
THE MAXIMUM DISCHARGE FROM NODE    6589 IS:      65.76 CFS AT TIME  5.34 HOURS WITH A MAXIMUM DEPTH OF:    0.76 FEET
THE MAXIMUM DISCHARGE FROM NODE    6666 IS:      35.45 CFS AT TIME  5.35 HOURS WITH A MAXIMUM DEPTH OF:    0.51 FEET
THE MAXIMUM DISCHARGE FROM NODE    6743 IS:      38.30 CFS AT TIME  5.35 HOURS WITH A MAXIMUM DEPTH OF:    0.55 FEET
THE MAXIMUM DISCHARGE FROM NODE    6820 IS:      37.46 CFS AT TIME  5.52 HOURS WITH A MAXIMUM DEPTH OF:    0.53 FEET
THE MAXIMUM DISCHARGE FROM NODE    6897 IS:      31.06 CFS AT TIME  5.50 HOURS WITH A MAXIMUM DEPTH OF:    0.56 FEET
THE MAXIMUM DISCHARGE FROM NODE    6974 IS:      23.92 CFS AT TIME  5.70 HOURS WITH A MAXIMUM DEPTH OF:    0.62 FEET
THE MAXIMUM DISCHARGE FROM NODE    7051 IS:      14.63 CFS AT TIME  5.55 HOURS WITH A MAXIMUM DEPTH OF:    0.59 FEET
THE MAXIMUM DISCHARGE FROM NODE    7129 IS:       5.54 CFS AT TIME  5.55 HOURS WITH A MAXIMUM DEPTH OF:    0.84 FEET
THE MAXIMUM DISCHARGE FROM NODE    7207 IS:       0.35 CFS AT TIME  4.00 HOURS WITH A MAXIMUM DEPTH OF:    0.05 FEET
THE MAXIMUM DISCHARGE FROM NODE    7286 IS:       0.29 CFS AT TIME  3.96 HOURS WITH A MAXIMUM DEPTH OF:    0.10 FEET

 THE MAXIMUM DISCHARGE FROM CROSS SECTION   14 IS    :    137.42 CFS
THE MAXIMUM DISCHARGE FROM NODE    1122 IS:       1.55 CFS AT TIME  3.98 HOURS WITH A MAXIMUM DEPTH OF:    0.06 FEET
THE MAXIMUM DISCHARGE FROM NODE    1188 IS:      19.80 CFS AT TIME  4.20 HOURS WITH A MAXIMUM DEPTH OF:    0.26 FEET
THE MAXIMUM DISCHARGE FROM NODE    1255 IS:      66.73 CFS AT TIME  4.24 HOURS WITH A MAXIMUM DEPTH OF:    0.51 FEET
THE MAXIMUM DISCHARGE FROM NODE    1323 IS:      58.40 CFS AT TIME  4.20 HOURS WITH A MAXIMUM DEPTH OF:    0.46 FEET
THE MAXIMUM DISCHARGE FROM NODE    1391 IS:       2.00 CFS AT TIME  4.10 HOURS WITH A MAXIMUM DEPTH OF:    0.08 FEET

 THE MAXIMUM DISCHARGE FROM CROSS SECTION   15 IS    :    277.02 CFS
THE MAXIMUM DISCHARGE FROM NODE    3327 IS:      16.05 CFS AT TIME  4.50 HOURS WITH A MAXIMUM DEPTH OF:    0.20 FEET
THE MAXIMUM DISCHARGE FROM NODE    3328 IS:     138.73 CFS AT TIME  4.50 HOURS WITH A MAXIMUM DEPTH OF:    1.24 FEET
THE MAXIMUM DISCHARGE FROM NODE    3329 IS:      90.55 CFS AT TIME  4.51 HOURS WITH A MAXIMUM DEPTH OF:    0.90 FEET
THE MAXIMUM DISCHARGE FROM NODE    3330 IS:      32.99 CFS AT TIME  4.51 HOURS WITH A MAXIMUM DEPTH OF:    0.38 FEET

 THE MAXIMUM DISCHARGE FROM CROSS SECTION   16 IS    :    890.18 CFS
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THE MAXIMUM DISCHARGE FROM NODE   12095 IS:      1.13 CFS AT TIME  4.00 HOURS WITH A MAXIMUM DEPTH OF:   0.06 FEET
THE MAXIMUM DISCHARGE FROM NODE   12096 IS:     12.18 CFS AT TIME  5.10 HOURS WITH A MAXIMUM DEPTH OF:   0.20 FEET
THE MAXIMUM DISCHARGE FROM NODE   12097 IS:    690.64 CFS AT TIME  5.09 HOURS WITH A MAXIMUM DEPTH OF:   2.83 FEET
THE MAXIMUM DISCHARGE FROM NODE   12098 IS:    187.40 CFS AT TIME  5.09 HOURS WITH A MAXIMUM DEPTH OF:   1.01 FEET
THE MAXIMUM DISCHARGE FROM NODE   12099 IS:      0.64 CFS AT TIME  4.00 HOURS WITH A MAXIMUM DEPTH OF:   0.04 FEET
THE MAXIMUM DISCHARGE FROM NODE   12100 IS:      1.98 CFS AT TIME  4.00 HOURS WITH A MAXIMUM DEPTH OF:   0.10 FEET

 THE MAXIMUM DISCHARGE FROM CROSS SECTION   17 IS    :   1043.12 CFS
THE MAXIMUM DISCHARGE FROM NODE    2113 IS:     29.89 CFS AT TIME  4.44 HOURS WITH A MAXIMUM DEPTH OF:   0.37 FEET
THE MAXIMUM DISCHARGE FROM NODE    2189 IS:     64.25 CFS AT TIME  4.37 HOURS WITH A MAXIMUM DEPTH OF:   0.50 FEET
THE MAXIMUM DISCHARGE FROM NODE    2265 IS:    139.19 CFS AT TIME  4.46 HOURS WITH A MAXIMUM DEPTH OF:   0.74 FEET
THE MAXIMUM DISCHARGE FROM NODE    2341 IS:    151.53 CFS AT TIME  4.43 HOURS WITH A MAXIMUM DEPTH OF:   0.75 FEET
THE MAXIMUM DISCHARGE FROM NODE    2417 IS:     75.17 CFS AT TIME  4.39 HOURS WITH A MAXIMUM DEPTH OF:   0.46 FEET
THE MAXIMUM DISCHARGE FROM NODE    2493 IS:     60.99 CFS AT TIME  4.43 HOURS WITH A MAXIMUM DEPTH OF:   0.41 FEET
THE MAXIMUM DISCHARGE FROM NODE    2569 IS:     84.91 CFS AT TIME  4.45 HOURS WITH A MAXIMUM DEPTH OF:   0.66 FEET
THE MAXIMUM DISCHARGE FROM NODE    2645 IS:     57.71 CFS AT TIME  4.60 HOURS WITH A MAXIMUM DEPTH OF:   0.55 FEET
THE MAXIMUM DISCHARGE FROM NODE    2721 IS:     89.60 CFS AT TIME  4.47 HOURS WITH A MAXIMUM DEPTH OF:   0.73 FEET
THE MAXIMUM DISCHARGE FROM NODE    2797 IS:     65.43 CFS AT TIME  4.51 HOURS WITH A MAXIMUM DEPTH OF:   0.58 FEET
THE MAXIMUM DISCHARGE FROM NODE    2873 IS:     39.77 CFS AT TIME  4.48 HOURS WITH A MAXIMUM DEPTH OF:   0.50 FEET
THE MAXIMUM DISCHARGE FROM NODE    2949 IS:     45.64 CFS AT TIME  4.47 HOURS WITH A MAXIMUM DEPTH OF:   0.68 FEET
THE MAXIMUM DISCHARGE FROM NODE    3025 IS:     38.81 CFS AT TIME  4.52 HOURS WITH A MAXIMUM DEPTH OF:   0.53 FEET
THE MAXIMUM DISCHARGE FROM NODE    3101 IS:     43.42 CFS AT TIME  4.53 HOURS WITH A MAXIMUM DEPTH OF:   0.65 FEET
THE MAXIMUM DISCHARGE FROM NODE    3177 IS:     55.55 CFS AT TIME  4.51 HOURS WITH A MAXIMUM DEPTH OF:   0.76 FEET
THE MAXIMUM DISCHARGE FROM NODE    3253 IS:     51.98 CFS AT TIME  4.51 HOURS WITH A MAXIMUM DEPTH OF:   0.73 FEET
THE MAXIMUM DISCHARGE FROM NODE    3329 IS:     58.96 CFS AT TIME  4.55 HOURS WITH A MAXIMUM DEPTH OF:   0.90 FEET
THE MAXIMUM DISCHARGE FROM NODE    3405 IS:     27.44 CFS AT TIME  4.62 HOURS WITH A MAXIMUM DEPTH OF:   0.43 FEET
THE MAXIMUM DISCHARGE FROM NODE    3481 IS:     16.28 CFS AT TIME  4.60 HOURS WITH A MAXIMUM DEPTH OF:   0.43 FEET
THE MAXIMUM DISCHARGE FROM NODE    3557 IS:     13.34 CFS AT TIME  4.53 HOURS WITH A MAXIMUM DEPTH OF:   0.41 FEET
THE MAXIMUM DISCHARGE FROM NODE    3634 IS:     15.71 CFS AT TIME  4.63 HOURS WITH A MAXIMUM DEPTH OF:   0.39 FEET
THE MAXIMUM DISCHARGE FROM NODE    3711 IS:      9.32 CFS AT TIME  4.45 HOURS WITH A MAXIMUM DEPTH OF:   0.32 FEET
THE MAXIMUM DISCHARGE FROM NODE    3788 IS:     22.15 CFS AT TIME  4.56 HOURS WITH A MAXIMUM DEPTH OF:   0.43 FEET
THE MAXIMUM DISCHARGE FROM NODE    3865 IS:     23.68 CFS AT TIME  4.58 HOURS WITH A MAXIMUM DEPTH OF:   0.44 FEET
THE MAXIMUM DISCHARGE FROM NODE    3942 IS:     12.99 CFS AT TIME  4.75 HOURS WITH A MAXIMUM DEPTH OF:   0.39 FEET
THE MAXIMUM DISCHARGE FROM NODE    4019 IS:     17.38 CFS AT TIME  4.70 HOURS WITH A MAXIMUM DEPTH OF:   0.50 FEET
THE MAXIMUM DISCHARGE FROM NODE    4096 IS:     11.95 CFS AT TIME  4.53 HOURS WITH A MAXIMUM DEPTH OF:   0.51 FEET

 THE MAXIMUM DISCHARGE FROM CROSS SECTION   18 IS    :   1151.94 CFS
THE MAXIMUM DISCHARGE FROM NODE    2036 IS:      6.70 CFS AT TIME  4.53 HOURS WITH A MAXIMUM DEPTH OF:   0.20 FEET
THE MAXIMUM DISCHARGE FROM NODE    2037 IS:     23.31 CFS AT TIME  4.46 HOURS WITH A MAXIMUM DEPTH OF:   0.26 FEET
THE MAXIMUM DISCHARGE FROM NODE    2038 IS:     47.74 CFS AT TIME  4.45 HOURS WITH A MAXIMUM DEPTH OF:   0.39 FEET
THE MAXIMUM DISCHARGE FROM NODE    2039 IS:     76.45 CFS AT TIME  4.43 HOURS WITH A MAXIMUM DEPTH OF:   0.52 FEET
THE MAXIMUM DISCHARGE FROM NODE    2040 IS:    201.81 CFS AT TIME  4.41 HOURS WITH A MAXIMUM DEPTH OF:   1.43 FEET
THE MAXIMUM DISCHARGE FROM NODE    2041 IS:    181.66 CFS AT TIME  4.39 HOURS WITH A MAXIMUM DEPTH OF:   1.04 FEET
THE MAXIMUM DISCHARGE FROM NODE    2042 IS:    279.59 CFS AT TIME  4.39 HOURS WITH A MAXIMUM DEPTH OF:   1.22 FEET
THE MAXIMUM DISCHARGE FROM NODE    2043 IS:    334.97 CFS AT TIME  4.39 HOURS WITH A MAXIMUM DEPTH OF:   1.34 FEET
THE MAXIMUM DISCHARGE FROM NODE    2044 IS:      8.53 CFS AT TIME  4.44 HOURS WITH A MAXIMUM DEPTH OF:   0.20 FEET
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THE MAXIMUM DISCHARGE FROM NODE    2045 IS:       1.25 CFS AT TIME  4.55 HOURS WITH A MAXIMUM DEPTH OF:    0.06 FEET

 THE MAXIMUM DISCHARGE FROM CROSS SECTION   19 IS    :   1818.89 CFS
THE MAXIMUM DISCHARGE FROM NODE   10173 IS:      22.41 CFS AT TIME  4.21 HOURS WITH A MAXIMUM DEPTH OF:    0.37 FEET
THE MAXIMUM DISCHARGE FROM NODE   10274 IS:      16.24 CFS AT TIME  4.26 HOURS WITH A MAXIMUM DEPTH OF:    0.35 FEET
THE MAXIMUM DISCHARGE FROM NODE   10376 IS:      11.41 CFS AT TIME  4.19 HOURS WITH A MAXIMUM DEPTH OF:    0.30 FEET
THE MAXIMUM DISCHARGE FROM NODE   10479 IS:       5.20 CFS AT TIME  4.25 HOURS WITH A MAXIMUM DEPTH OF:    0.26 FEET
THE MAXIMUM DISCHARGE FROM NODE   10582 IS:       1.70 CFS AT TIME  4.00 HOURS WITH A MAXIMUM DEPTH OF:    0.20 FEET
THE MAXIMUM DISCHARGE FROM NODE   10686 IS:       1.40 CFS AT TIME  4.00 HOURS WITH A MAXIMUM DEPTH OF:    0.11 FEET
THE MAXIMUM DISCHARGE FROM NODE   10791 IS:       0.37 CFS AT TIME  4.00 HOURS WITH A MAXIMUM DEPTH OF:    0.05 FEET
THE MAXIMUM DISCHARGE FROM NODE   10897 IS:       0.33 CFS AT TIME  4.00 HOURS WITH A MAXIMUM DEPTH OF:    0.05 FEET
THE MAXIMUM DISCHARGE FROM NODE   11004 IS:      25.95 CFS AT TIME  4.75 HOURS WITH A MAXIMUM DEPTH OF:    0.61 FEET
THE MAXIMUM DISCHARGE FROM NODE   11111 IS:     262.45 CFS AT TIME  4.77 HOURS WITH A MAXIMUM DEPTH OF:    1.99 FEET
THE MAXIMUM DISCHARGE FROM NODE   11218 IS:     484.37 CFS AT TIME  4.75 HOURS WITH A MAXIMUM DEPTH OF:    2.36 FEET
THE MAXIMUM DISCHARGE FROM NODE   11325 IS:     524.45 CFS AT TIME  4.76 HOURS WITH A MAXIMUM DEPTH OF:    2.87 FEET
THE MAXIMUM DISCHARGE FROM NODE   11432 IS:     293.05 CFS AT TIME  4.75 HOURS WITH A MAXIMUM DEPTH OF:    1.69 FEET
THE MAXIMUM DISCHARGE FROM NODE   11539 IS:     163.75 CFS AT TIME  4.79 HOURS WITH A MAXIMUM DEPTH OF:    1.11 FEET
THE MAXIMUM DISCHARGE FROM NODE   11646 IS:      75.32 CFS AT TIME  4.85 HOURS WITH A MAXIMUM DEPTH OF:    0.60 FEET
THE MAXIMUM DISCHARGE FROM NODE   11753 IS:       8.11 CFS AT TIME  4.77 HOURS WITH A MAXIMUM DEPTH OF:    0.20 FEET
THE MAXIMUM DISCHARGE FROM NODE   11860 IS:       3.64 CFS AT TIME  3.99 HOURS WITH A MAXIMUM DEPTH OF:    0.17 FEET
THE MAXIMUM DISCHARGE FROM NODE   11967 IS:       2.15 CFS AT TIME  4.00 HOURS WITH A MAXIMUM DEPTH OF:    0.11 FEET
THE MAXIMUM DISCHARGE FROM NODE   12074 IS:       6.91 CFS AT TIME  4.01 HOURS WITH A MAXIMUM DEPTH OF:    0.23 FEET
THE MAXIMUM DISCHARGE FROM NODE   12181 IS:      12.50 CFS AT TIME  4.25 HOURS WITH A MAXIMUM DEPTH OF:    0.20 FEET
THE MAXIMUM DISCHARGE FROM NODE   12288 IS:      14.57 CFS AT TIME  4.76 HOURS WITH A MAXIMUM DEPTH OF:    0.24 FEET
THE MAXIMUM DISCHARGE FROM NODE   12395 IS:      14.73 CFS AT TIME  4.76 HOURS WITH A MAXIMUM DEPTH OF:    0.22 FEET
THE MAXIMUM DISCHARGE FROM NODE   12502 IS:      19.86 CFS AT TIME  4.67 HOURS WITH A MAXIMUM DEPTH OF:    0.25 FEET
THE MAXIMUM DISCHARGE FROM NODE   12608 IS:      21.48 CFS AT TIME  4.59 HOURS WITH A MAXIMUM DEPTH OF:    0.27 FEET
THE MAXIMUM DISCHARGE FROM NODE   12714 IS:      14.86 CFS AT TIME  4.54 HOURS WITH A MAXIMUM DEPTH OF:    0.22 FEET

 THE MAXIMUM DISCHARGE FROM CROSS SECTION   20 IS    :    202.59 CFS
THE MAXIMUM DISCHARGE FROM NODE    3124 IS:       8.53 CFS AT TIME  4.23 HOURS WITH A MAXIMUM DEPTH OF:    0.21 FEET
THE MAXIMUM DISCHARGE FROM NODE    3200 IS:       6.33 CFS AT TIME  4.24 HOURS WITH A MAXIMUM DEPTH OF:    0.22 FEET
THE MAXIMUM DISCHARGE FROM NODE    3276 IS:       3.44 CFS AT TIME  4.47 HOURS WITH A MAXIMUM DEPTH OF:    0.23 FEET
THE MAXIMUM DISCHARGE FROM NODE    3352 IS:      11.17 CFS AT TIME  4.29 HOURS WITH A MAXIMUM DEPTH OF:    0.28 FEET
THE MAXIMUM DISCHARGE FROM NODE    3428 IS:      11.67 CFS AT TIME  4.25 HOURS WITH A MAXIMUM DEPTH OF:    0.37 FEET
THE MAXIMUM DISCHARGE FROM NODE    3504 IS:      13.32 CFS AT TIME  4.36 HOURS WITH A MAXIMUM DEPTH OF:    0.44 FEET
THE MAXIMUM DISCHARGE FROM NODE    3581 IS:      21.54 CFS AT TIME  4.32 HOURS WITH A MAXIMUM DEPTH OF:    0.48 FEET
THE MAXIMUM DISCHARGE FROM NODE    3658 IS:      33.69 CFS AT TIME  4.42 HOURS WITH A MAXIMUM DEPTH OF:    0.50 FEET
THE MAXIMUM DISCHARGE FROM NODE    3735 IS:      31.15 CFS AT TIME  4.32 HOURS WITH A MAXIMUM DEPTH OF:    0.48 FEET
THE MAXIMUM DISCHARGE FROM NODE    3812 IS:      34.60 CFS AT TIME  4.32 HOURS WITH A MAXIMUM DEPTH OF:    0.50 FEET
THE MAXIMUM DISCHARGE FROM NODE    3889 IS:      46.86 CFS AT TIME  4.47 HOURS WITH A MAXIMUM DEPTH OF:    0.59 FEET
THE MAXIMUM DISCHARGE FROM NODE    3966 IS:      52.80 CFS AT TIME  4.61 HOURS WITH A MAXIMUM DEPTH OF:    0.63 FEET

 THE MAXIMUM DISCHARGE FROM CROSS SECTION   21 IS    :   1161.77 CFS
THE MAXIMUM DISCHARGE FROM NODE    3966 IS:      56.31 CFS AT TIME  4.44 HOURS WITH A MAXIMUM DEPTH OF:    0.63 FEET
THE MAXIMUM DISCHARGE FROM NODE    3967 IS:      19.43 CFS AT TIME  4.62 HOURS WITH A MAXIMUM DEPTH OF:    0.35 FEET
THE MAXIMUM DISCHARGE FROM NODE    3968 IS:      12.16 CFS AT TIME  4.99 HOURS WITH A MAXIMUM DEPTH OF:    0.25 FEET
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THE MAXIMUM DISCHARGE FROM NODE    3969 IS:     14.09 CFS AT TIME  5.02 HOURS WITH A MAXIMUM DEPTH OF:    0.25 FEET
THE MAXIMUM DISCHARGE FROM NODE    3970 IS:     14.44 CFS AT TIME  5.01 HOURS WITH A MAXIMUM DEPTH OF:    0.21 FEET
THE MAXIMUM DISCHARGE FROM NODE    3971 IS:     18.62 CFS AT TIME  4.93 HOURS WITH A MAXIMUM DEPTH OF:    0.22 FEET
THE MAXIMUM DISCHARGE FROM NODE    3972 IS:     36.35 CFS AT TIME  4.96 HOURS WITH A MAXIMUM DEPTH OF:    0.33 FEET
THE MAXIMUM DISCHARGE FROM NODE    3973 IS:     44.04 CFS AT TIME  4.97 HOURS WITH A MAXIMUM DEPTH OF:    0.40 FEET
THE MAXIMUM DISCHARGE FROM NODE    3974 IS:     34.07 CFS AT TIME  4.96 HOURS WITH A MAXIMUM DEPTH OF:    0.40 FEET
THE MAXIMUM DISCHARGE FROM NODE    3975 IS:     22.63 CFS AT TIME  4.98 HOURS WITH A MAXIMUM DEPTH OF:    0.33 FEET
THE MAXIMUM DISCHARGE FROM NODE    3976 IS:     15.18 CFS AT TIME  4.98 HOURS WITH A MAXIMUM DEPTH OF:    0.22 FEET
THE MAXIMUM DISCHARGE FROM NODE    3977 IS:     29.54 CFS AT TIME  4.97 HOURS WITH A MAXIMUM DEPTH OF:    0.31 FEET
THE MAXIMUM DISCHARGE FROM NODE    3978 IS:     39.58 CFS AT TIME  5.00 HOURS WITH A MAXIMUM DEPTH OF:    0.38 FEET
THE MAXIMUM DISCHARGE FROM NODE    3979 IS:     14.59 CFS AT TIME  4.98 HOURS WITH A MAXIMUM DEPTH OF:    0.20 FEET
THE MAXIMUM DISCHARGE FROM NODE    3980 IS:      0.67 CFS AT TIME  4.00 HOURS WITH A MAXIMUM DEPTH OF:    0.04 FEET
THE MAXIMUM DISCHARGE FROM NODE    3981 IS:     13.35 CFS AT TIME  5.13 HOURS WITH A MAXIMUM DEPTH OF:    0.30 FEET
THE MAXIMUM DISCHARGE FROM NODE    3982 IS:      5.62 CFS AT TIME  5.13 HOURS WITH A MAXIMUM DEPTH OF:    0.32 FEET
THE MAXIMUM DISCHARGE FROM NODE    3983 IS:      1.68 CFS AT TIME  5.19 HOURS WITH A MAXIMUM DEPTH OF:    0.20 FEET
THE MAXIMUM DISCHARGE FROM NODE    3984 IS:      4.62 CFS AT TIME  5.01 HOURS WITH A MAXIMUM DEPTH OF:    0.26 FEET
THE MAXIMUM DISCHARGE FROM NODE    3985 IS:      4.71 CFS AT TIME  5.03 HOURS WITH A MAXIMUM DEPTH OF:    0.20 FEET
THE MAXIMUM DISCHARGE FROM NODE    3986 IS:      8.32 CFS AT TIME  4.97 HOURS WITH A MAXIMUM DEPTH OF:    0.20 FEET
THE MAXIMUM DISCHARGE FROM NODE    3987 IS:     15.78 CFS AT TIME  4.95 HOURS WITH A MAXIMUM DEPTH OF:    0.24 FEET
THE MAXIMUM DISCHARGE FROM NODE    3988 IS:     35.43 CFS AT TIME  4.92 HOURS WITH A MAXIMUM DEPTH OF:    0.42 FEET
THE MAXIMUM DISCHARGE FROM NODE    3989 IS:     44.76 CFS AT TIME  4.89 HOURS WITH A MAXIMUM DEPTH OF:    0.52 FEET
THE MAXIMUM DISCHARGE FROM NODE    3990 IS:     51.38 CFS AT TIME  4.90 HOURS WITH A MAXIMUM DEPTH OF:    0.57 FEET
THE MAXIMUM DISCHARGE FROM NODE    3991 IS:     62.42 CFS AT TIME  4.89 HOURS WITH A MAXIMUM DEPTH OF:    0.54 FEET
THE MAXIMUM DISCHARGE FROM NODE    3992 IS:     54.80 CFS AT TIME  4.88 HOURS WITH A MAXIMUM DEPTH OF:    0.39 FEET
THE MAXIMUM DISCHARGE FROM NODE    3993 IS:     79.69 CFS AT TIME  4.86 HOURS WITH A MAXIMUM DEPTH OF:    0.47 FEET
THE MAXIMUM DISCHARGE FROM NODE    3994 IS:     99.24 CFS AT TIME  4.84 HOURS WITH A MAXIMUM DEPTH OF:    0.55 FEET
THE MAXIMUM DISCHARGE FROM NODE    3995 IS:     74.25 CFS AT TIME  4.86 HOURS WITH A MAXIMUM DEPTH OF:    0.50 FEET
THE MAXIMUM DISCHARGE FROM NODE    3996 IS:     32.62 CFS AT TIME  4.84 HOURS WITH A MAXIMUM DEPTH OF:    0.28 FEET
THE MAXIMUM DISCHARGE FROM NODE    3997 IS:     90.62 CFS AT TIME  4.86 HOURS WITH A MAXIMUM DEPTH OF:    0.66 FEET
THE MAXIMUM DISCHARGE FROM NODE    3998 IS:     88.35 CFS AT TIME  4.81 HOURS WITH A MAXIMUM DEPTH OF:    0.81 FEET
THE MAXIMUM DISCHARGE FROM NODE    3999 IS:     56.05 CFS AT TIME  4.80 HOURS WITH A MAXIMUM DEPTH OF:    0.75 FEET
THE MAXIMUM DISCHARGE FROM NODE    4000 IS:     25.13 CFS AT TIME  4.80 HOURS WITH A MAXIMUM DEPTH OF:    0.29 FEET
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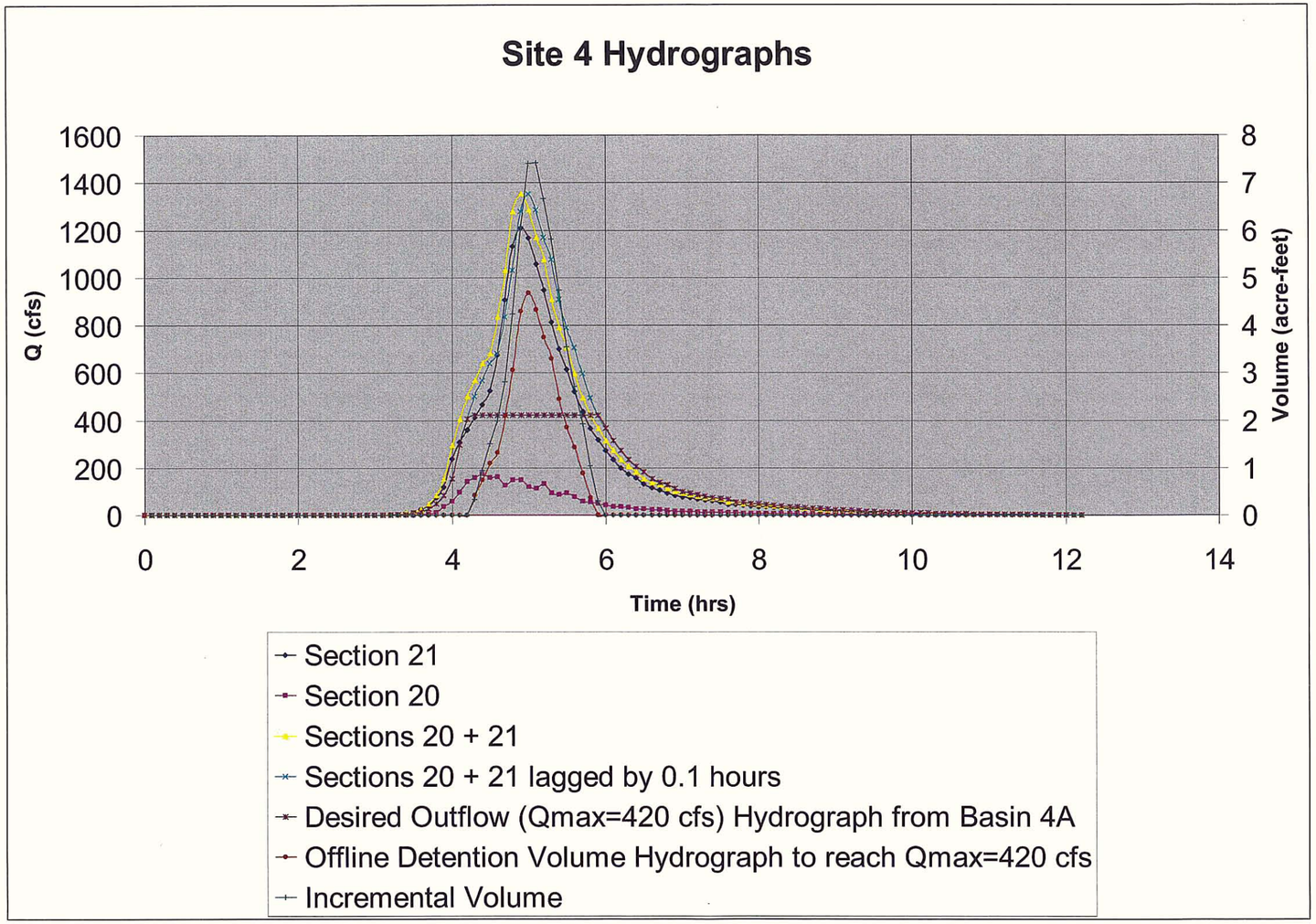
Hydrograph Information


Site 4 Hydrographs
Q (cfs)
1600
1400
1200
1000
800
600
400
200
0
Volume (acre-feet)
8
7
6
5
4
3
2
1
0
0
2
4
6
8
10
12
14
Time (hrs)
Section 21
Section 20
Sections 20 + 21
Sections 20 + 21 lagged by 0.1 hours
Desired Outflow (Qmax=420 cfs) Hydrograph from Basin 4A
Offline Detention Volume Hydrograph to reach Qmax=420 cfs
Incremental Volume

HEC-1 Information

HEC-1 Input File

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ID  PROJECT: ADOBE DAM/DESERT HILLS ADMP                    FILE: STWSITE4.IH1
ID       BY: JE FULLER/HYDROLOGY & GEOMORPHOLOGY, INC.
ID      FOR: FCDMC                                         DATE: 03/08/04
ID
ID
ID   100-YEAR, 6-HOUR MODEL FOR SITE 4 ALTERNATIVE ON SKUNK TANK WASH
ID
ID   ESTIMATE OF PEAK DISCHARGE WITHIN SKUNK
ID    TANK WASH AT MADDOCK ROAD.  THE FOLLOWING SUMMARIZE THE ESTIMATION OF
ID    MODELING PARAMETERS:
ID
ID      - RAINFALL PER DESERT HILLS MODELING
ID      - G&A PARAMETERS FROM SKUNK CREEK FDS MODEL DATED MARCH 1996 WITH
ID         MODIFICATIONS PER SCWCMP FOR FUTURE LAND USE CONDITIONS
ID      - S-GRAPH UH PARAMETERS ESTIMATED USING NEW 2'CI MAPPING AND DDMSW V2.0
ID      - DESERT/RANGELAND S-GRAPH USED
ID      - SUBBASIN DELINEATION REFLECTS 7TH STREET CHANNEL IN PLACE (AREA
ID         OF SUBBASINS S17 AND S18 IS REDUCED BY 0.37 SM).
ID      - INFLOW HYDROGRAPH AT 7TH AVE & MADDOCK FROM FLO-2D MODEL
ID      - BASIN 4A IS LOCATED ALONG 7TH AVE, SOUTH OF MADDOCK
ID              - MODELED USING A DIVERT OPERATION
ID              - APPROX 9.5 ACRE PARCEL
ID              - OFFLINE VOLUME = 60 AC-FT
ID              - DEPTH = 10 FT
ID      - BASIN 4B IS LOCATED ALONG 15TH AVE & MADDOCK
ID              - MODELED USING A DIVERT OPERATION
ID              - APPROX 8 ACRE PARCEL
ID              - OFFLINE VOLUME = 65 AC-FT
ID              - DEPTH = 15 FT
*
*DIAGRAM
IT     5                    300
IO     3
*
KKFLO2DI
KM  INFLOW FROM FLO2D SECTIONS 20 AND 21 LAGGED BY 6 MINUTES
BA 2.0
IN     6
QI     0       0       0       0       0       0       0       0       0       0
QI     0       0       0       0       0       0       0       0       0       0
QI     0       0       0       0       0       0       0       0       0       0
QI     0     0.1     2.1     4.2     8.1    12.4    27.0    47.9    83.0   153.1
QI 296.8   403.3   502.5   568.0   639.3   682.2   836.2  1030.8  1277.6  1354.1
QI1283.7  1168.4  1077.6   908.0   789.5   707.4   597.9   495.3   419.9   365.8
QI 316.1   271.8   234.6   204.8   183.4   155.8   139.4   127.1   112.9    98.3
QI  93.0    87.5    80.4    74.9    71.8    66.9    55.9    54.2    49.5    46.8
QI  44.4    42.2    38.2    36.8    34.3    32.1    29.3    28.1    24.2    24.0
QI  21.1    21.0    18.9    17.0    16.7    13.8    13.5    12.3    11.0    10.3
QI   9.5     8.5     7.8     7.1     6.4     5.8     4.8     4.3     3.8     3.7
QI   3.0     2.8     2.4     2.1     1.9     1.7     1.6     1.3     1.1     1.0
QI   0.8       0       0       0       0       0       0       0       0       0
*
KKBSN_4A
KM  OFFLINE BASIN 4A LOCATED AT 7TH AVE, S. OF MADDOCK DR. (MODELED AS DIVERT)
DT 4A_IN
DI     0     420    5000
DQ     0       0    4580
*
KK   S19   BASIN
KM  SUBBASIN PARAMETERS TAKEN FROM SCWCMP FUTURE CONDITION MODELS
BA 0.772
LG  0.17    0.29    8.40    0.07      11
IN    15
PB 3.275
PC 0.000   0.009   0.016   0.025   0.034   0.042   0.051   0.059   0.067   0.076
PC 0.087   0.100   0.120   0.160   0.248   0.443   0.708   0.845   0.903   0.939
PC 0.951   0.964   0.976   0.988   1.000
UI    90     222     476     687     837     843     731     554     405     302
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UI   222     163     122      92      61      55      22      22      21      22
UI    22       0       0       0       0       0       0       0       0       0
UI     0       0       0       0       0       0       0       0       0       0
*
KK S19CL
KM  COMBINE HYDROGRAPH BYPASSING BASIN 4A WITH RUNOFF FROM S19
HC     2
*
KK  S18C   BASIN
KM  STW SUBBASINS S17 AND S18 COMBINED INTO SINGLE SUBBASIN
BA 2.402
LG  0.15    0.27    8.80    0.06      12
UI   122     124     122     342     483     627     764     884    1022    1090
UI  1157    1171    1158    1125    1051     911     822     701     613     554
UI   472     414     369     323     271     241     221     187     175     129
UI   130     113      84      84      84      84      33      30      30      29
UI    30      30      30      30      29      30      30      30       0       0
UI     0       0       0       0       0       0       0       0       0       0
*
KK RR18C
KM  ROUTE S18C THROUGH DETENTION BASIN 4C
RS     1    STOR       0
SA   4.0     6.0    11.0
SE     0       4      10
SQ     0     215     430     645     860    1075    1290    1450    1720    2200
SE     4     5.5     6.3     7.0     7.6     8.2     8.8     9.6    10.3    11.2
*
KKS18C_C
KM  PORTION OF S18C TO CONTINUE AROUND OFFLINE BASIN (S18C_B GOES TO BASIN)
DTS18C_B
DI     0    1100    5000
DQ     0       0    3900
*
KK  S20A   BASIN
BA 0.415
LG  0.17    0.27    8.80    0.06      11
UI    53     161     326     453     515     474     353     256     182     128
UI    93      65      46      37      17      14      13      13      13       0
UI     0       0       0       0       0       0       0       0       0       0
UI     0       0       0       0       0       0       0       0       0       0
*
KK S20AC
KM  COMBINE S18C_C WITH S20A AND S19CL
HC     3
*
KK 4B_IN
DRS18C_B
*
KKBSN_4B
KM  OFFLINE BASIN 4B LOCATED AT 15TH AVE AND MADDOCK DR.
RS     1    STOR       0
SA   2.3     6.3
SE     0      15
SQ     0     0.1
SE     0      15
*
ZZ
```

HEC-1 Output File

```
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   16MAR04  TIME  15:46:02  *                                    *          (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    PROJECT: ADOBE DAM/DESERT HILLS ADMP                FILE: STWSITE4.IH1
    2           ID         BY: JE FULLER/HYDROLOGY & GEOMORPHOLOGY, INC.
    3           ID        FOR: FCDMC                                              DATE: 03/08/04
    4           ID
    5           ID
    6           ID     100-YEAR, 6-HOUR MODEL FOR SITE 4 ALTERNATIVE ON SKUNK TANK WASH
    7           ID
    8           ID     ESTIMATE OF PEAK DISCHARGE WITHIN SKUNK
    9           ID      TANK WASH AT MADDOCK ROAD.  THE FOLLOWING SUMMARIZE THE ESTIMATION OF
   10           ID      MODELING PARAMETERS:
   11           ID
   12           ID            - RAINFALL PER DESERT HILLS MODELING
   13           ID            - G&A PARAMETERS FROM SKUNK CREEK FDS MODEL DATED MARCH 1996 WITH
   14           ID           MODIFICATIONS PER SCWCMP FOR FUTURE LAND USE CONDITIONS
   15           ID            - S-GRAPH UH PARAMETERS ESTIMATED USING NEW 2'CI MAPPING AND DDMSW V2.0
   16           ID            - DESERT/RANGELAND S-GRAPH USED
   17           ID            - SUBBASIN DELINEATION REFLECTS 7TH STREET CHANNEL IN PLACE (AREA
   18           ID           OF SUBBASINS S17 AND S18 IS REDUCED BY 0.37 SM).
   19           ID            - INFLOW HYDROGRAPH AT 7TH AVE & MADDOCK FROM FLO-2D MODEL
   20           ID            - BASIN 4A IS LOCATED ALONG 7TH AVE, SOUTH OF MADDOCK
   21           ID                      - MODELED USING A DIVERT OPERATION
   22           ID                      - APPROX 9.5 ACRE PARCEL
   23           ID                      - OFFLINE VOLUME = 60 AC-FT
   24           ID                      - DEPTH = 10 FT
   25           ID            - BASIN 4B IS LOCATED ALONG 15TH AVE & MADDOCK
   26           ID                      - MODELED USING A DIVERT OPERATION
   27           ID                      - APPROX 8 ACRE PARCEL
   28           ID                      - OFFLINE VOLUME = 65 AC-FT
   29           ID                      - DEPTH = 15 FT
                *
                *DIAGRAM
   30           IT       5                     300
   31           IO       3
                *

   32           KK  FLO2DI
   33           KM    INFLOW FROM FLO2D SECTIONS 20 AND 21 LAGGED BY 6 MINUTES
   34           BA   2.0
   35           IN       6
   36           QI       0       0       0       0       0       0       0       0       0       0
   37           QI       0       0       0       0       0       0       0       0       0       0
   38           QI       0       0       0       0       0       0       0       0       0       0
   39           QI       0     0.1     2.1     4.2     8.1    12.4    27.0    47.9    83.0   153.1
   40           QI   296.8   403.3   502.5   568.0   639.3   682.2   836.2  1030.8  1277.6  1354.1
   41           QI  1283.7  1168.4  1077.6   908.0   789.5   707.4   597.9   495.3   419.9   365.8
   42           QI   316.1   271.8   234.6   204.8   183.4   155.8   139.4   127.1   112.9    98.3
   43           QI    93.0    87.5    80.4    74.9    71.8    66.9    55.9    54.2    49.5    46.8
   44           QI    44.4    42.2    38.2    36.8    34.3    32.1    29.3    28.1    24.2    24.0
   45           QI    21.1    21.0    18.9    17.0    16.7    13.8    13.5    12.3    11.0    10.3
   46           QI     9.5     8.5     7.8     7.1     6.4     5.8     4.8     4.3     3.8     3.7
   47           QI     3.0     2.8     2.4     2.1     1.9     1.7     1.6     1.3     1.1     1.0
   48           QI     0.8       0       0       0       0       0       0       0       0       0
                *
1                                                HEC-1 INPUT                                                          PAGE  2

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

   49           KK  BSN_4A
   50           KM    OFFLINE BASIN 4A LOCATED AT 7TH AVE, S. OF MADDOCK DR. (MODELED AS DIVERT)
   51           DT   4A_IN
   52           DI       0     420    5000
   53           DQ       0       0    4580
                *
```

```
 54          KK     S19   BASIN
 55          KM    SUBBASIN PARAMETERS TAKEN FROM SCWCMP FUTURE CONDITION MODELS
 56          BA   0.772
 57          LG    0.17    0.29    8.40    0.07      11
 58          IN      15
 59          PB   3.275
 60          PC   0.000   0.009   0.016   0.025   0.034   0.042   0.051   0.059   0.067   0.076
 61          PC   0.087   0.100   0.120   0.160   0.248   0.443   0.708   0.845   0.903   0.939
 62          PC   0.951   0.964   0.976   0.988   1.000
 63          UI      90     222     476     687     837     843     731     554     405     302
 64          UI     222     163     122      92      61      55      22      22      21      22
 65          UI      22       0       0       0       0       0       0       0       0       0
 66          UI       0       0       0       0       0       0       0       0       0       0
             *

 67          KK   S19CL
 68          KM    COMBINE HYDROGRAPH BYPASSING BASIN 4A WITH RUNOFF FROM S19
 69          HC       2
             *

 70          KK    S18C   BASIN
 71          KM    STW SUBBASINS S17 AND S18 COMBINED INTO SINGLE SUBBASIN
 72          BA   2.402
 73          LG    0.15    0.27    8.80    0.06      12
 74          UI     122     124     122     342     483     627     764     884    1022    1090
 75          UI    1157    1171    1158    1125    1051     911     822     701     613     554
 76          UI     472     414     369     323     271     241     221     187     175     129
 77          UI     130     113      84      84      84      84      33      30      30      29
 78          UI      30      30      30      30      29      30      30      30       0       0
 79          UI       0       0       0       0       0       0       0       0       0       0
             *

 80          KK   RR18C
 81          KM    ROUTE S18C THROUGH DETENTION BASIN 4C
 82          RS       1    STOR       0
 83          SA     4.0     6.0    11.0
 84          SE       0       4      10
 85          SQ       0     215     430     645     860    1075    1290    1450    1720    2200
 86          SE       4     5.5     6.3     7.0     7.6     8.2     8.8     9.6    10.3    11.2
             *

 87          KK  S18C_C
 88          KM    PORTION OF S18C TO CONTINUE AROUND OFFLINE BASIN (S18C_B GOES TO BASIN)
 89          DT  S18C_B
 90          DI       0    1100    5000
 91          DQ       0       0    3900
             *
1                                          HEC-1 INPUT                                          PAGE  3
        LINE         ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

 92          KK    S20A   BASIN
 93          BA   0.415
 94          LG    0.17    0.27    8.80    0.06      11
 95          UI      53     161     326     453     515     474     353     256     182     128
 96          UI      93      65      46      37      17      14      13      13      13       0
 97          UI       0       0       0       0       0       0       0       0       0       0
 98          UI       0       0       0       0       0       0       0       0       0       0
             *

 99          KK   S20AC
100          KM    COMBINE S18C_C WITH S20A AND S19CL
101          HC       3
             *

102          KK   4B_IN
103          DR  S18C_B
             *

104          KK  BSN_4B
105          KM    OFFLINE BASIN 4B LOCATED AT 15TH AVE AND MADDOCK DR.
106          RS       1    STOR       0
107          SA     2.3     6.3
108          SE       0      15
109          SQ       0     0.1
110          SE       0      15
             *
111          ZZ
1
             SCHEMATIC DIAGRAM OF STREAM NETWORK
 INPUT
  LINE     (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

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

   32      FLO2DI
                .
                .
   51           .------->   4A_IN
   49      BSN_4A
                .
                .
   54           .         S19
                .           .
                .           .
   67       S19CL............
                .
                .
   70           .        S18C
                .          V
                .          V
   80           .       RR18C
```

```
                .           .
                .           .
   89           .           .-------> S18C_B
   87           .      S18C_C
                .           .
                .           .
   92           .           .       S20A
                .           .          .
                .           .          .
   99       S20AC.......................
                .
                .
  103           .           .<-------- S18C_B
  102           .       4B_IN
                .          V
                .          V
  104           .      BSN_4B

 (***) 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   16MAR04  TIME  15:46:02  *                    *          (916) 756-1104              *
 *                                      *                    *                                      *
 ****************************************                    ****************************************
```

PROJECT: ADOBE DAM/DESERT HILLS ADMP FILE: STWSITE4.IH1
BY: JE FULLER/HYDROLOGY & GEOMORPHOLOGY, INC.
FOR: FCDMC DATE: 03/08/04

100-YEAR, 6-HOUR MODEL FOR SITE 4 ALTERNATIVE ON SKUNK TANK WASH

ESTIMATE OF PEAK DISCHARGE WITHIN SKUNK
TANK WASH AT MADDOCK ROAD. THE FOLLOWING SUMMARIZE THE ESTIMATION OF
MODELING PARAMETERS:

- RAINFALL PER DESERT HILLS MODELING
- G&A PARAMETERS FROM SKUNK CREEK FDS MODEL DATED MARCH 1996 WITH
  MODIFICATIONS PER SCWCMP FOR FUTURE LAND USE CONDITIONS
- S-GRAPH UH PARAMETERS ESTIMATED USING NEW 2'CI MAPPING AND DDMSW V2.0
- DESERT/RANGELAND S-GRAPH USED
- SUBBASIN DELINEATION REFLECTS 7TH STREET CHANNEL IN PLACE (AREA
  OF SUBBASINS S17 AND S18 IS REDUCED BY 0.37 SM).
- INFLOW HYDROGRAPH AT 7TH AVE & MADDOCK FROM FLO-2D MODEL
- BASIN 4A IS LOCATED ALONG 7TH AVE, SOUTH OF MADDOCK
  - MODELED USING A DIVERT OPERATION
  - APPROX 9.5 ACRE PARCEL
  - OFFLINE VOLUME = 60 AC-FT
  - DEPTH = 10 FT
- BASIN 4B IS LOCATED ALONG 15TH AVE & MADDOCK
  - MODELED USING A DIVERT OPERATION
  - APPROX 8 ACRE PARCEL
  - OFFLINE VOLUME = 65 AC-FT
  - DEPTH = 15 FT

```
*** ERROR *** SPECIFIED START AND END DATES RESULT IN TOO MANY TIME PERIODS

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

     IT          HYDROGRAPH TIME DATA
                        NMIN          5  MINUTES IN COMPUTATION INTERVAL
                       IDATE      1    0  STARTING DATE
                       ITIME       0000  STARTING TIME
                          NQ       2000  NUMBER OF HYDROGRAPH ORDINATES
                      NDDATE      7    0  ENDING DATE
                      NDTIME       2235  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


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


            **************
            *            *
  32 KK     *    FLO2DI  *
            *            *
            **************
```

INFLOW FROM FLO2D SECTIONS 20 AND 21 LAGGED BY 6 MINUTES

```
 35 IN          TIME DATA FOR INPUT TIME SERIES
                      JXMIN          6  TIME INTERVAL IN MINUTES
                     JXDATE      1   0  STARTING DATE
                     JXTIME          0  STARTING TIME

              SUBBASIN RUNOFF DATA

 34 BA          SUBBASIN CHARACTERISTICS
                      TAREA       2.00  SUBBASIN AREA

                                                                  ***

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

                     HYDROGRAPH AT STATION   FLO2DI

 PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+    1342.      4.92                311.         79.         27.          12.
                         (INCHES)   1.447       1.469       1.498        1.555
                          (AC-FT)    154.        157.        160.         166.

                        CUMULATIVE AREA =    2.00 SQ MI


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


            **************
            *            *
 49 KK      *   BSN_4A   *
            *            *
            **************
                        OFFLINE BASIN 4A LOCATED AT 7TH AVE, S. OF MADDOCK DR. (MODELED AS DIVERT)

    DT          DIVERSION
                      ISTAD      4A_IN  DIVERSION HYDROGRAPH IDENTIFICATION

    DI             INFLOW         .00    420.00   5000.00

    DQ      DIVERTED FLOW         .00       .00   4580.00

                                                                  ***

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

                     DIVERSION HYDROGRAPH    4A_IN

 PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+     922.     4.92                120.         30.         10.           4.
                         (INCHES)    .557        .557        .557         .557
                          (AC-FT)     59.         59.         59.          59.

                        CUMULATIVE AREA =    2.00 SQ MI

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

                     HYDROGRAPH AT STATION   BSN_4A

 PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+     420.     4.17                191.         49.         17.           8.
                         (INCHES)    .890        .912        .941         .998
                          (AC-FT)     95.         97.        100.         106.

                        CUMULATIVE AREA =    2.00 SQ MI


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


            **************
            *            *
 54 KK      *     S19    *        BASIN
            *            *
            **************
                        SUBBASIN PARAMETERS TAKEN FROM SCWCMP FUTURE CONDITION MODELS

 58 IN          TIME DATA FOR INPUT TIME SERIES
                      JXMIN         15  TIME INTERVAL IN MINUTES
                     JXDATE      1   0  STARTING DATE
                     JXTIME          0  STARTING TIME

              SUBBASIN RUNOFF DATA

 56 BA          SUBBASIN CHARACTERISTICS
                      TAREA        .77  SUBBASIN AREA

              PRECIPITATION DATA

 59 PB                STORM       3.28  BASIN TOTAL PRECIPITATION
```

```
 60 PI            INCREMENTAL 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       .06       .06       .06       .09       .09       .09       .05       .05
                     .05       .02       .02       .02       .01       .01       .01       .00       .00       .00
                     .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
                     .00       .00

 57 LG          GREEN AND AMPT LOSS RATE
                     STRTL        .17  STARTING LOSS
                       DTH        .29  MOISTURE DEFICIT
                      PSIF       8.40  WETTING FRONT SUCTION
                     XKSAT        .07  HYDRAULIC CONDUCTIVITY
                     RTIMP      11.00  PERCENT IMPERVIOUS AREA

 63 UI          INPUT UNITGRAPH,  21 ORDINATES,  VOLUME = 1.00
                    90.0     222.0     476.0     687.0     837.0     843.0     731.0     554.0     405.0     302.0
                   222.0     163.0     122.0      92.0      61.0      55.0      22.0      22.0      21.0      22.0
                    22.0

                                                                                  ***

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

                       HYDROGRAPH AT STATION      S19

   TOTAL RAINFALL =    3.27, TOTAL LOSS =    1.11, TOTAL EXCESS =    2.16

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+    1078.      4.33                179.         45.         15.          6.
                        (INCHES)    2.158       2.161       2.161        2.161
                         (AC-FT)     89.         89.         89.          89.

                        CUMULATIVE AREA =     .77 SQ MI


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


            **************
            *            *
 67 KK      *     S19CL  *
            *            *
            **************
                       COMBINE HYDROGRAPH BYPASSING BASIN 4A WITH RUNOFF FROM S19

 69 HC          HYDROGRAPH COMBINATION
                     ICOMP           2  NUMBER OF HYDROGRAPHS TO COMBINE

                                                                                  ***

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

                       HYDROGRAPH AT STATION    S19CL

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+    1498.      4.33                367.         94.         32.         14.
                        (INCHES)    1.233       1.258       1.280       1.322
                         (AC-FT)    182.        186.        189.        195.

                        CUMULATIVE AREA =    2.77 SQ MI


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


            **************
            *            *
 70 KK      *     S18C   *        BASIN
            *            *
            **************
                       STW SUBBASINS S17 AND S18 COMBINED INTO SINGLE SUBBASIN

               SUBBASIN RUNOFF DATA

 72 BA          SUBBASIN CHARACTERISTICS
                     TAREA        2.40  SUBBASIN AREA

                PRECIPITATION DATA

 59 PB               STORM        3.28  BASIN TOTAL PRECIPITATION

 60 PI            INCREMENTAL 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       .06       .06       .06       .09       .09       .09       .05       .05
                     .05       .02       .02       .02       .01       .01       .01       .00       .00       .00
                     .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
```

```
                    .00       .00

73 LG          GREEN AND AMPT LOSS RATE
                    STRTL          .15  STARTING LOSS
                      DTH          .27  MOISTURE DEFICIT
                     PSIF         8.80  WETTING FRONT SUCTION
                    XKSAT          .06  HYDRAULIC CONDUCTIVITY
                    RTIMP        12.00  PERCENT IMPERVIOUS AREA

71 UI          INPUT UNITGRAPH,  48 ORDINATES,  VOLUME = 1.00
                 122.0     124.0     122.0     342.0     483.0     627.0     764.0     884.0    1022.0    1090.0
                1157.0    1171.0    1158.0    1125.0    1051.0     911.0     822.0     701.0     613.0     554.0
                 472.0     414.0     369.0     323.0     271.0     241.0     221.0     187.0     175.0     129.0
                 130.0     113.0      84.0      84.0      84.0      84.0      33.0      30.0      30.0      29.0
                  30.0      30.0      30.0      30.0      29.0      30.0      30.0      30.0
                                                                  ***

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

                     HYDROGRAPH AT STATION     S18C

   TOTAL RAINFALL =    3.27, TOTAL LOSS =    1.03, TOTAL EXCESS =    2.24

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+    2154.      4.83                575.        145.         48.          21.
                        (INCHES)    2.227       2.242       2.242        2.242
                         (AC-FT)    285.        287.        287.         287.

                       CUMULATIVE AREA =    2.40 SQ MI


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


            **************
            *            *
80 KK       *     RR18C  *
            *            *
            **************
                      ROUTE S18C THROUGH DETENTION BASIN 4C

              HYDROGRAPH ROUTING DATA

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

83 SA               AREA         4.0       6.0      11.0

84 SE          ELEVATION         .00      4.00     10.00

85 SQ          DISCHARGE          0.       215.      430.      645.      860.     1075.     1290.     1450.     1720.     2200.

86 SE          ELEVATION        4.00      5.50      6.30      7.00      7.60      8.20      8.80      9.60     10.30     11.20

                                                                  ***

                                          COMPUTED STORAGE-ELEVATION DATA

            STORAGE        .00     19.87     70.11
          ELEVATION        .00      4.00     10.00

                                         COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

            STORAGE        .00     19.87     29.69     35.62     41.24     46.38     51.83     57.59     65.79     70.11
             OUTFLOW       .00       .00    215.00    430.00    645.00    860.00   1075.00   1290.00   1450.00   1604.29
          ELEVATION        .00      4.00      5.50      6.30      7.00      7.60      8.20      8.80      9.60     10.00

            STORAGE      73.46     84.02
             OUTFLOW   1720.00   2200.00
          ELEVATION      10.30     11.20

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

                     HYDROGRAPH AT STATION    RR18C

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+    1869.      5.17                539.        135.         45.          19.
                        (INCHES)    2.086       2.087       2.087        2.087
                         (AC-FT)    267.        267.        267.         267.

 PEAK STORAGE   TIME                          MAXIMUM AVERAGE STORAGE
                                     6-HR       24-HR       72-HR    166.58-HR
+  (AC-FT)      (HR)
      77.       5.17                 37.         24.         21.          20.

  PEAK STAGE    TIME                          MAXIMUM AVERAGE STAGE
                                     6-HR       24-HR       72-HR    166.58-HR
+   (FEET)      (HR)
     10.58      5.17                6.24        4.56        4.19         4.00
```

```
                    CUMULATIVE AREA =    2.40 SQ MI

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

          **************
          *            *
  87 KK   *   S18C_C   *
          *            *
          **************
                    PORTION OF S18C TO CONTINUE AROUND OFFLINE BASIN (S18C_B GOES TO BASIN)

    DT          DIVERSION
                     ISTAD      S18C_B  DIVERSION HYDROGRAPH IDENTIFICATION

    DI             INFLOW        .00   1100.00   5000.00

    DQ      DIVERTED FLOW        .00       .00   3900.00
                                                          ***

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

                    DIVERSION HYDROGRAPH   S18C_B

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                    6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+    769.       5.17       109.        27.         9.          4.
                       (INCHES)      .420        .420        .420        .420
                        (AC-FT)       54.         54.         54.         54.

                    CUMULATIVE AREA =    2.40 SQ MI

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

                    HYDROGRAPH AT STATION   S18C_C

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                    6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+   1100.       4.58       430.       108.        36.         16.
                       (INCHES)     1.666       1.667       1.667       1.667
                        (AC-FT)      213.        214.        214.        214.

                    CUMULATIVE AREA =    2.40 SQ MI

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

          **************
          *            *
  92 KK   *    S20A    *        BASIN
          *            *
          **************

             SUBBASIN RUNOFF DATA

  93 BA        SUBBASIN CHARACTERISTICS
                    TAREA          .41  SUBBASIN AREA

               PRECIPITATION DATA

  59 PB             STORM        3.28  BASIN TOTAL PRECIPITATION

  60 PI          INCREMENTAL 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        .01        .01        .01        .01        .01        .03
                    .03        .03        .06        .06        .06        .09        .09        .09        .05        .05
                    .05        .02        .02        .02        .01        .01        .01        .00        .00        .00
                    .00        .00        .00        .00        .00        .00        .00        .00        .00        .00
                    .00        .00

  94 LG        GREEN AND AMPT LOSS RATE
                    STRTL         .17  STARTING LOSS
                      DTH         .27  MOISTURE DEFICIT
                     PSIF        8.80  WETTING FRONT SUCTION
                    XKSAT         .06  HYDRAULIC CONDUCTIVITY
                    RTIMP       11.00  PERCENT IMPERVIOUS AREA

  93 UI        INPUT UNITGRAPH,  19 ORDINATES,  VOLUME = 1.00
                   53.0      161.0      326.0      453.0      515.0      474.0      353.0      256.0      182.0      128.0
                   93.0       65.0       46.0       37.0       17.0       14.0       13.0       13.0       13.0
                                                                          ***

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

                    HYDROGRAPH AT STATION     S20A

   TOTAL RAINFALL =    3.27, TOTAL LOSS =    1.05, TOTAL EXCESS =    2.22
```

```
  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR        24-HR        72-HR     166.58-HR
+   (CFS)       (HR)
                                   (CFS)
+     622.      4.25                 99.          25.           8.           4.
                                (INCHES)       2.219        2.222        2.222        2.222
                                 (AC-FT)        49.          49.          49.          49.

                                CUMULATIVE AREA =      .41 SQ MI


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


            **************
            *            *
  99 KK     *     S20AC  *
            *            *
            **************
                                COMBINE S18C_C WITH S20A AND S19CL

 101 HC          HYDROGRAPH COMBINATION
                       ICOMP            3  NUMBER OF HYDROGRAPHS TO COMBINE
                                                                   ***

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

                          HYDROGRAPH AT STATION    S20AC

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR        24-HR        72-HR     166.58-HR
+   (CFS)       (HR)
                                   (CFS)
+    2807.      4.50                895.         226.          76.          33.
                                (INCHES)       1.488        1.505        1.516        1.537
                                 (AC-FT)       444.         449.         452.         458.

                                CUMULATIVE AREA =     5.59 SQ MI


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


            **************
            *            *
 102 KK     *     4B_IN  *
            *            *
            **************

 103 DR          RETRIEVE DIVERSION HYDROGRAPH
                       ISTAD      S18C_B  DIVERSION HYDROGRAPH IDENTIFICATION
                                                                   ***

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

                          HYDROGRAPH AT STATION    4B_IN

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR        24-HR        72-HR     166.58-HR
+   (CFS)       (HR)
                                   (CFS)
+     769.      5.17                109.          27.           9.           4.
                                (INCHES)        .181         .181         .181         .181
                                 (AC-FT)        54.          54.          54.          54.

                                CUMULATIVE AREA =      .00 SQ MI


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


            **************
            *            *
 104 KK     *    BSN_4B  *
            *            *
            **************
                                OFFLINE BASIN 4B LOCATED AT 15TH AVE AND MADDOCK DR.

                HYDROGRAPH ROUTING DATA

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

 107 SA                AREA         2.3       6.3

 108 SE          ELEVATION          .00     15.00

 109 SQ          DISCHARGE           0.        0.

 110 SE          ELEVATION          .00     15.00
```

```
                                                  ***
                                        COMPUTED STORAGE-ELEVATION DATA

            STORAGE        .00     62.03
          ELEVATION        .00     15.00

                                   COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

            STORAGE        .00     62.03
            OUTFLOW        .00       .10
          ELEVATION        .00     15.00

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

                     HYDROGRAPH AT STATION   BSN_4B

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                      6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                                    (CFS)
+      0.       5.92                  0.          0.          0.          0.
                                 (INCHES)       .000        .000        .000        .000
                                  (AC-FT)        0.          0.          1.          1.

 PEAK STORAGE   TIME                          MAXIMUM AVERAGE STORAGE
                                      6-HR       24-HR       72-HR    166.58-HR
+  (AC-FT)      (HR)
     54.        6.00                 54.         54.         54.         52.

  PEAK STAGE    TIME                          MAXIMUM AVERAGE STAGE
                                      6-HR       24-HR       72-HR    166.58-HR
+   (FEET)      (HR)
    13.02       6.00                13.01       13.00       12.95       12.48

                     CUMULATIVE AREA =     .00 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	FLO2DI	1342.	4.92	311.	79.	27.	2.00		
+	DIVERSION TO	4A_IN	922.	4.17	120.	30.	10.	2.00		
+	HYDROGRAPH AT	BSN_4A	420.	4.17	191.	49.	17.	2.00		
+	HYDROGRAPH AT	S19	1078.	4.33	179.	45.	15.	.77		
+	2 COMBINED AT	S19CL	1498.	4.33	367.	94.	32.	2.77		
+	HYDROGRAPH AT	S18C	2154.	4.83	575.	145.	48.	2.40		
+	ROUTED TO	RR18C	1869.	5.17	539.	135.	45.	2.40		
+									10.58	5.17
+	DIVERSION TO	S18C_B	769.	4.58	109.	27.	9.	2.40		
+	HYDROGRAPH AT	S18C_C	1100.	4.58	430.	108.	36.	2.40		
+	HYDROGRAPH AT	S20A	622.	4.25	99.	25.	8.	.41		
+	3 COMBINED AT	S20AC	2807.	4.50	895.	226.	76.	5.59		
+	HYDROGRAPH AT	4B_IN	769.	5.17	109.	27.	9.	.00		
+	ROUTED TO	BSN_4B	0.	5.92	0.	0.	0.	.00		
+									13.02	6.00

*** NORMAL END OF HEC-1 ***

FlowMaster Information

Channel CH4A
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Site 4 - Channel CH4A
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

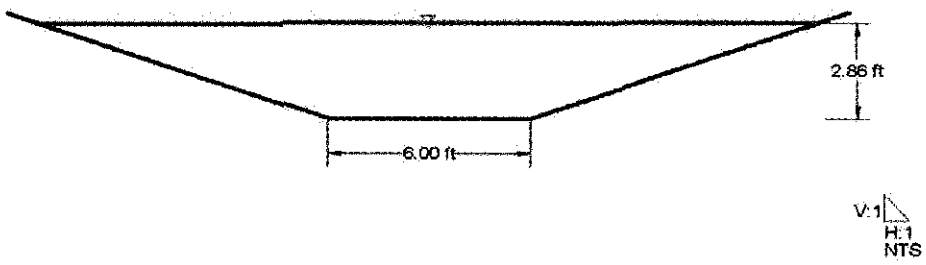
Input Data		
Mannings Coefficient	0.040	
Channel Slope	0.008000	ft/ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	6.00	ft
Discharge	200.00	cfs

Results		
Depth	2.86	ft
Flow Area	41.7	ft²
Wetted Perimeter	24.10	ft
Top Width	23.17	ft
Critical Depth	2.27	ft
Critical Slope	0.021492	ft/ft
Velocity	4.79	ft/s
Velocity Head	0.36	ft
Specific Energy	3.22	ft
Froude Number	0.63	
Flow Type	Subcritical	

Cross Section
Cross Section for Trapezoidal Channel

Project Description	
Worksheet	Site 4 - Channel CH4A
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data		
Mannings Coefficient	0.040	
Channel Slope	0.008000	ft/ft
Depth	2.86	ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	6.00	ft
Discharge	200.00	cfs



Channel CH4B
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Site 4 - Channel CH4B
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

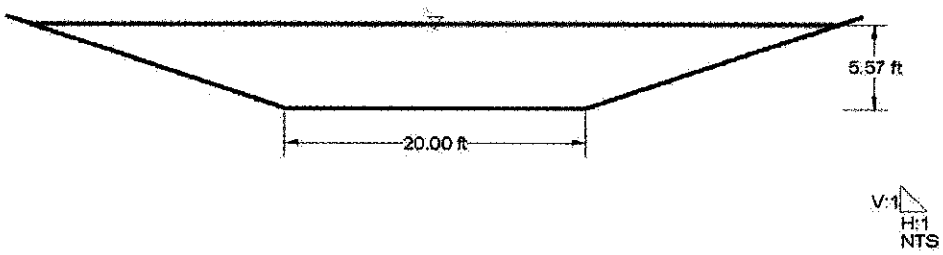
Input Data		
Mannings Coefficient	0.040	
Channel Slope	0.005500	ft/ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	20.00	ft
Discharge	1,350.00	cfs

Results		
Depth	5.57	ft
Flow Area	204.7	ft²
Wetted Perimeter	58.25	ft
Top Width	53.44	ft
Critical Depth	4.20	ft
Critical Slope	0.016768	ft/ft
Velocity	6.60	ft/s
Velocity Head	0.68	ft
Specific Energy	6.25	ft
Froude Number	0.59	
Flow Type	Subcritical	

Cross Section
Cross Section for Trapezoidal Channel

Project Description	
Worksheet	Site 4 - Channel CH4B
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data		
Mannings Coefficient	0.040	
Channel Slope	0.005500	ft/ft
Depth	5.57	ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	20.00	ft
Discharge	1,350.00	cfs



Channel CH4C
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Site 4 - Channel CH4C
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

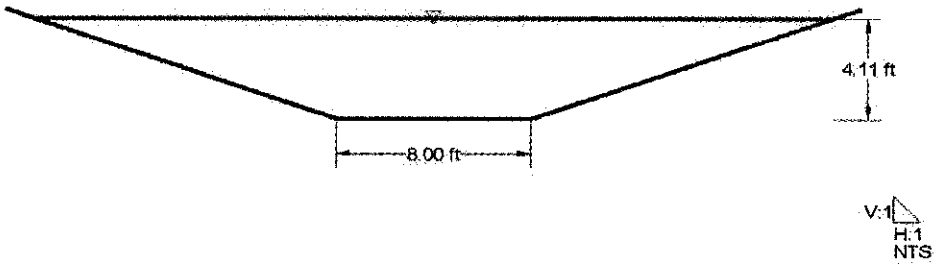
Input Data		
Mannings Coefficient	0.040	
Channel Slope	0.005500	ft/ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	8.00	ft
Discharge	420.00	cfs

Results		
Depth	4.11	ft
Flow Area	83.7	ft²
Wetted Perimeter	34.01	ft
Top Width	32.68	ft
Critical Depth	3.06	ft
Critical Slope	0.019467	ft/ft
Velocity	5.02	ft/s
Velocity Head	0.39	ft
Specific Energy	4.50	ft
Froude Number	0.55	
Flow Type	Subcritical	

Cross Section
Cross Section for Trapezoidal Channel

Project Description	
Worksheet	Site 4 - Channel CH4C
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data		
Mannings Coefficient	0.040	
Channel Slope	0.005500	ft/ft
Depth	4.11	ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	8.00	ft
Discharge	420.00	cfs



Channel CH4D
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Site 4 - Channel CH4D
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

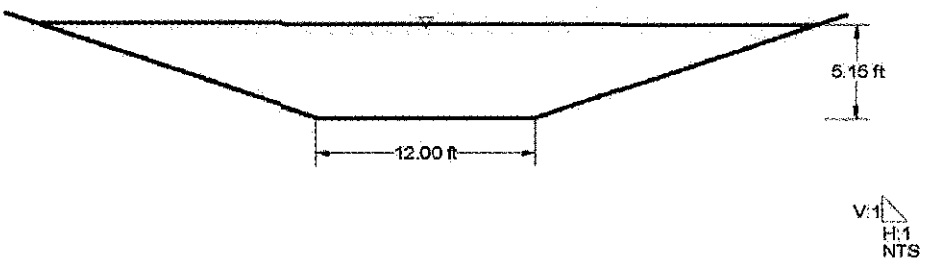
Input Data		
Mannings Coefficient	0.040	
Channel Slope	0.006000	ft/ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	12.00	ft
Discharge	800.00	cfs

Results		
Depth	5.15	ft
Flow Area	141.2	ft²
Wetted Perimeter	44.54	ft
Top Width	42.87	ft
Critical Depth	3.78	ft
Critical Slope	0.017885	ft/ft
Velocity	5.67	ft/s
Velocity Head	0.50	ft
Specific Energy	5.64	ft
Froude Number	0.55	
Flow Type	Subcritical	

Cross Section
Cross Section for Trapezoidal Channel

Project Description	
Worksheet	Site 4 - Channel CH4D
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data		
Mannings Coefficient	0.040	
Channel Slope	0.005000	ft/ft
Depth	5.15	ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	12.00	ft
Discharge	800.00	cfs



Channel CH4E
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Site 4 - Channel CH4E
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

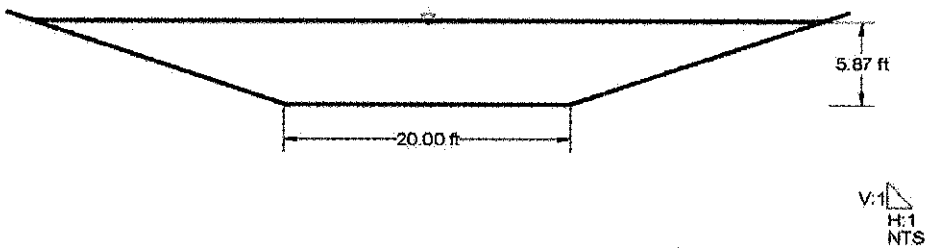
Input Data		
Mannings Coefficient	0.040	
Channel Slope	0.005500	ft/ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	20.00	ft
Discharge	1,500.00	cfs

Results		
Depth	5.87	ft
Flow Area	221.0	ft²
Wetted Perimeter	57.15	ft
Top Width	55.24	ft
Critical Depth	4.46	ft
Critical Slope	0.016517	ft/ft
Velocity	6.79	ft/s
Velocity Head	0.72	ft
Specific Energy	6.59	ft
Froude Number	0.60	
Flow Type	Subcritical	

Cross Section
Cross Section for Trapezoidal Channel

Project Description	
Worksheet	Site 4 - Channel CH4E
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data		
Mannings Coefficient	0.040	
Channel Slope	0.005500	ft/ft
Depth	6.87	ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	20.00	ft
Discharge	1,500.00	cfs



Channel CH4F
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Site 4 - Channel CH4F
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

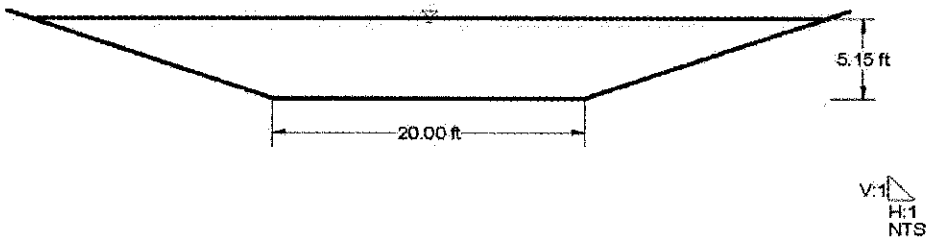
Input Data		
Mannings Coefficient	0.040	
Channel Slope	0.005000	ft/ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	20.00	ft
Discharge	1,100.00	cfs

Results		
Depth	5.15	ft
Flow Area	182.6	ft²
Wetted Perimeter	52.58	ft
Top Width	50.90	ft
Critical Depth	3.74	ft
Critical Slope	0.017276	ft/ft
Velocity	6.02	ft/s
Velocity Head	0.56	ft
Specific Energy	5.71	ft
Froude Number	0.56	
Flow Type	Subcritical	

Cross Section
Cross Section for Trapezoidal Channel

Project Description	
Worksheet	Site 4 - Channel CH4F
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data		
Mannings Coefficient	0.040	
Channel Slope	0.005000	ft/ft
Depth	5.15	ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	20.00	ft
Discharge	1,100.00	cfs



Channel CH4I
Worksheet for Irregular Channel

Project Description	
Worksheet	Site 4 - Channel CH4I
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Channel Slope	0.005500	ft/ft
Discharge	2,810.00	cfs

Options	
Current Roughness Method	Improved Lotter's Method
Open Channel Weighting Method	Improved Lotter's Method
Closed Channel Weighting Metho	Horton's Method

Results		
Mannings Coefficient	0.040	
Water Surface Elevation	10.87	ft
Elevation Range	4.00 to 10.00	
Flow Area	356.0	ft²
Wetted Perimeter	73.42	ft
Top Width	70.00	ft
Actual Depth	6.87	ft
Critical Elevation	9.39	ft
Critical Slope	0.015359	ft/ft
Velocity	7.89	ft/s
Velocity Head	0.97	ft
Specific Energy	11.84	ft
Froude Number	0.62	
Flow Type	Subcritical	

Calculation Messages:
Water elevation exceeds lowest end station by 0.87166719 ft.

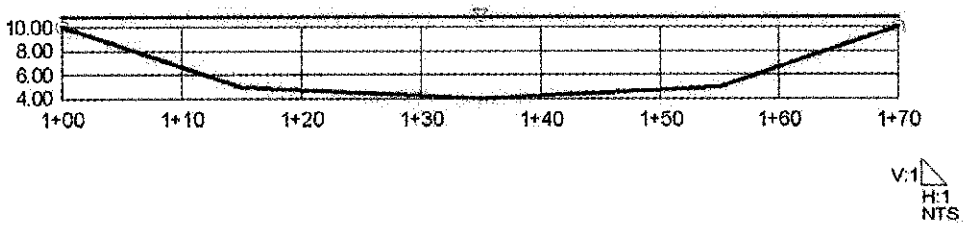
Roughness Segments		
Start Station	End Station	Mannings Coefficient
1+00	1+70	0.040

Natural Channel Points	
Station (ft)	Elevation (ft)
1+00	10.00
1+15	5.00
1+35	4.00
1+55	5.00
1+70	10.00

Cross Section
Cross Section for Irregular Channel

Project Description	
Worksheet	Site 4 - Channel CH4I
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data	
Mannings Coefficient	0.040
Channel Slope	0.005500 ft/ft
Water Surface Elevation	10.87 ft
Elevation Range	4.00 to 10.00
Discharge	2,810.00 cfs



HY8 Information

CURRENT DATE: 03-15-2004 FILE DATE: 03-15-2004
CURRENT TIME: 16:45:40 FILE NAME: CLV4A

****
********** FHWA CULVERT ANALYSIS **********
********** HY-8, VERSION 6.1 **********
****

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	10.00	9.70	50.00	2 RCP	5.00	5.00	.012	CONVENTIONAL
2								
3								
4								
5								
6								

****

SUMMARY OF CULVERT FLOWS (cfs) FILE: CLV4A DATE: 03-15-2004

ELEV (ft)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
10.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	1
11.02	20.0	20.0	0.0	0.0	0.0	0.0	0.0	0.00	1
11.54	40.0	40.0	0.0	0.0	0.0	0.0	0.0	0.00	1
12.00	60.0	60.0	0.0	0.0	0.0	0.0	0.0	0.00	1
12.42	80.0	80.0	0.0	0.0	0.0	0.0	0.0	0.00	1
12.79	100.0	100.0	0.0	0.0	0.0	0.0	0.0	0.00	1
13.13	120.0	120.0	0.0	0.0	0.0	0.0	0.0	0.00	1
13.44	140.0	140.0	0.0	0.0	0.0	0.0	0.0	0.00	1
13.59	150.0	150.0	0.0	0.0	0.0	0.0	0.0	0.00	1
14.01	180.0	180.0	0.0	0.0	0.0	0.0	0.0	0.00	1
14.28	200.0	200.0	0.0	0.0	0.0	0.0	0.0	0.00	1
16.00	320.0	320.0	0.0	0.0	0.0	0.0	0.0	OVERTOPPING	

****

SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: CLV4A DATE: 03-15-2004

HEAD ELEV (ft)	HEAD ERROR (ft)	TOTAL FLOW (cfs)	FLOW ERROR (cfs)	% FLOW ERROR
10.00	0.000	0.00	0.00	0.00
11.02	0.000	20.00	0.00	0.00
11.54	0.000	40.00	0.00	0.00
12.00	0.000	60.00	0.00	0.00
12.42	0.000	80.00	0.00	0.00
12.79	0.000	100.00	0.00	0.00
13.13	0.000	120.00	0.00	0.00
13.44	0.000	140.00	0.00	0.00
13.59	0.000	150.00	0.00	0.00
14.01	0.000	180.00	0.00	0.00
14.28	0.000	200.00	0.00	0.00

****

<1> TOLERANCE (ft) = 0.010 <2> TOLERANCE (%) = 1.000

****

CURRENT DATE: 03-15-2004 FILE DATE: 03-15-2004
CURRENT TIME: 16:45:40 FILE NAME: CLV4A

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	10.00	0.00	0.00	0-NF	0.00	0.00	0.00	0.00	0.00	0.00
20.00	11.02	1.02	1.02	1-S2n	0.69	0.83	0.63	0.90	6.67	2.55
40.00	11.54	1.54	1.54	1-S2n	1.02	1.21	1.05	1.30	6.63	3.11
60.00	12.00	2.00	2.00	1-S2n	1.23	1.52	1.29	1.60	7.43	3.48
80.00	12.42	2.42	2.42	1-S2n	1.44	1.75	1.52	1.85	7.95	3.76
100.00	12.79	2.79	2.79	1-S2n	1.62	1.98	1.71	2.06	8.41	3.99
120.00	13.13	3.13	3.13	1-S2n	1.78	2.17	1.90	2.25	8.78	4.19
140.00	13.44	3.44	3.44	1-S2n	1.94	2.35	2.07	2.42	9.12	4.37
150.00	13.59	3.59	3.59	1-S2n	2.02	2.44	2.14	2.50	9.32	4.45
180.00	14.01	4.01	4.01	1-S2n	2.23	2.68	2.37	2.72	9.79	4.66
200.00	14.28	4.28	4.28	1-S2n	2.37	2.84	2.53	2.86	10.05	4.79

El. inlet face invert 10.00 ft El. outlet invert 9.70 ft
El. inlet throat invert 0.00 ft El. inlet crest 0.00 ft

***** SITE DATA ***** CULVERT INVERT **********

INLET STATION	100.00 ft
INLET ELEVATION	10.00 ft
OUTLET STATION	150.00 ft
OUTLET ELEVATION	9.70 ft
NUMBER OF BARRELS	2
SLOPE (V/H)	0.0060
CULVERT LENGTH ALONG SLOPE	50.00 ft

***** CULVERT DATA SUMMARY **********

BARREL SHAPE	CIRCULAR
BARREL DIAMETER	5.00 ft
BARREL MATERIAL	CONCRETE
BARREL MANNING'S n	0.012
INLET TYPE	CONVENTIONAL
INLET EDGE AND WALL	SQUARE EDGE WITH HEADWALL
INLET DEPRESSION	NONE

CURRENT DATE: 03-15-2004 FILE DATE: 03-15-2004
CURRENT TIME: 16:45:40 FILE NAME: CLV4A

****
********** TAILWATER **********
****

******* REGULAR CHANNEL CROSS SECTION **********

BOTTOM WIDTH	6.00 ft
SIDE SLOPE H/V (X:1)	3.0
CHANNEL SLOPE V/H (ft/ft)	0.008
MANNING'S n (.01-0.1)	0.040
CHANNEL INVERT ELEVATION	9.70 ft
CULVERT NO.1 OUTLET INVERT ELEVATION	9.70 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	9.70	0.000	0.00	0.00	0.00
20.00	10.60	0.472	0.90	2.55	0.45
40.00	11.00	0.480	1.30	3.11	0.65
60.00	11.30	0.485	1.60	3.48	0.80
80.00	11.55	0.488	1.85	3.76	0.92
100.00	11.76	0.491	2.06	3.99	1.03
120.00	11.95	0.493	2.25	4.19	1.12
140.00	12.12	0.495	2.42	4.37	1.21
150.00	12.20	0.496	2.50	4.45	1.25
180.00	12.42	0.498	2.72	4.66	1.36
200.00	12.56	0.499	2.86	4.79	1.43

****
********** ROADWAY OVERTOPPING DATA **********
****

ROADWAY SURFACE	GRAVEL
EMBANKMENT TOP WIDTH	40.00 ft
CREST LENGTH	100.00 ft
OVERTOPPING CREST ELEVATION	16.00 ft

****

CURRENT DATE: 03-15-2004 FILE DATE: 03-15-2004
CURRENT TIME: 16:50:22 FILE NAME: CLV4E

****
********** FHWA CULVERT ANALYSIS **********
********** HY-8, VERSION 6.1 **********
****

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	10.00	9.40	150.00	4 RCB	12.00	5.00	.012	CONVENTIONAL
2								
3								
4								
5								
6								

****

SUMMARY OF CULVERT FLOWS (cfs) FILE: CLV4E DATE: 03-15-2004

ELEV (ft)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
10.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	1
11.08	135.0	135.0	0.0	0.0	0.0	0.0	0.0	0.00	1
12.15	270.0	270.0	0.0	0.0	0.0	0.0	0.0	0.00	1
12.81	405.0	405.0	0.0	0.0	0.0	0.0	0.0	0.00	1
13.38	540.0	540.0	0.0	0.0	0.0	0.0	0.0	0.00	1
13.88	675.0	675.0	0.0	0.0	0.0	0.0	0.0	0.00	1
14.34	810.0	810.0	0.0	0.0	0.0	0.0	0.0	0.00	1
14.76	945.0	945.0	0.0	0.0	0.0	0.0	0.0	0.00	1
14.85	1000.0	1000.0	0.0	0.0	0.0	0.0	0.0	0.00	1
15.53	1215.0	1215.0	0.0	0.0	0.0	0.0	0.0	0.00	1
15.99	1350.0	1350.0	0.0	0.0	0.0	0.0	0.0	0.00	1
16.00	1352.8	1352.8	0.0	0.0	0.0	0.0	0.0	OVERTOPPING	

****

SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: CLV4E DATE: 03-15-2004

HEAD ELEV (ft)	HEAD ERROR (ft)	TOTAL FLOW (cfs)	FLOW ERROR (cfs)	% FLOW ERROR
10.00	0.000	0.00	0.00	0.00
11.08	0.000	135.00	0.00	0.00
12.15	0.000	270.00	0.00	0.00
12.81	0.000	405.00	0.00	0.00
13.38	0.000	540.00	0.00	0.00
13.88	0.000	675.00	0.00	0.00
14.34	0.000	810.00	0.00	0.00
14.76	0.000	945.00	0.00	0.00
14.85	0.000	1000.00	0.00	0.00
15.53	0.000	1215.00	0.00	0.00
15.99	0.000	1350.00	0.00	0.00

****

<1> TOLERANCE (ft) = 0.010 <2> TOLERANCE (%) = 1.000

****

CURRENT DATE: 03-15-2004 FILE DATE: 03-15-2004
CURRENT TIME: 16:50:22 FILE NAME: CLV4E

PERFORMANCE CURVE FOR CULVERT 1 - 4(12.00 (ft) BY 5.00 (ft)) RCB

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	10.00	0.00	0.00	0-NF	0.00	0.00	0.00	0.00	0.00	0.00
135.00	11.08	1.08	1.08	1-S2n	0.55	0.63	0.43	1.67	6.58	3.23
270.00	12.15	1.70	2.15	3-M1t	0.85	1.00	2.45	2.45	2.29	4.02
405.00	12.81	2.23	2.81	3-M1t	1.11	1.31	3.06	3.06	2.76	4.54
540.00	13.38	2.69	3.38	3-M1t	1.34	1.58	3.57	3.57	3.15	4.93
675.00	13.88	3.11	3.88	3-M1t	1.55	1.84	4.01	4.01	3.51	5.26
810.00	14.34	3.50	4.34	3-M1t	1.75	2.07	4.41	4.41	3.83	5.53
945.00	14.76	3.87	4.76	3-M1t	1.94	2.30	4.77	4.77	4.13	5.78
1000.00	14.85	4.02	4.85	3-M1t	2.02	2.38	4.91	4.91	4.25	5.87
1215.00	15.53	4.58	5.53	4-FFt	2.29	2.72	5.00	5.41	5.06	6.19
1350.00	15.99	4.92	5.99	4-FFt	2.47	2.91	5.00	5.71	5.63	6.37

El. inlet face invert 10.00 ft El. outlet invert 9.40 ft
El. inlet throat invert 0.00 ft El. inlet crest 0.00 ft

***** SITE DATA ***** CULVERT INVERT **********

INLET STATION	100.00 ft
INLET ELEVATION	10.00 ft
OUTLET STATION	250.00 ft
OUTLET ELEVATION	9.40 ft
NUMBER OF BARRELS	4
SLOPE (V/H)	0.0040
CULVERT LENGTH ALONG SLOPE	150.00 ft

***** CULVERT DATA SUMMARY **********

BARREL SHAPE	BOX
BARREL SPAN	12.00 ft
BARREL RISE	5.00 ft
BARREL MATERIAL	CONCRETE
BARREL MANNING'S n	0.012
INLET TYPE	CONVENTIONAL
INLET EDGE AND WALL	SQUARE EDGE (90-45 DEG.)
INLET DEPRESSION	NONE

CURRENT DATE: 03-15-2004 FILE DATE: 03-15-2004
CURRENT TIME: 16:50:22 FILE NAME: CLV4E

****
********** TAILWATER **********
****

******* REGULAR CHANNEL CROSS SECTION **********

BOTTOM WIDTH	20.00 ft
SIDE SLOPE H/V (X:1)	3.0
CHANNEL SLOPE V/H (ft/ft)	0.005
MANNING'S n (.01-0.1)	0.040
CHANNEL INVERT ELEVATION	9.40 ft
CULVERT NO.1 OUTLET INVERT ELEVATION	9.40 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	9.40	0.000	0.00	0.00	0.00
135.00	11.07	0.441	1.67	3.23	0.52
270.00	11.85	0.452	2.45	4.02	0.77
405.00	12.46	0.457	3.06	4.54	0.95
540.00	12.97	0.460	3.57	4.93	1.11
675.00	13.41	0.463	4.01	5.26	1.25
810.00	13.81	0.465	4.41	5.53	1.38
945.00	14.17	0.466	4.77	5.78	1.49
1000.00	14.31	0.467	4.91	5.87	1.53
1215.00	14.81	0.469	5.41	6.19	1.69
1350.00	15.11	0.470	5.71	6.37	1.78

****
********** ROADWAY OVERTOPPING DATA **********
****

ROADWAY SURFACE	PAVED
EMBANKMENT TOP WIDTH	100.00 ft
CREST LENGTH	100.00 ft
OVERTOPPING CREST ELEVATION	16.00 ft

****

CURRENT DATE: 03-15-2004 FILE DATE: 03-15-2004
CURRENT TIME: 16:53:53 FILE NAME: CLV4F

****
********** FHWA CULVERT ANALYSIS **********
********** HY-8, VERSION 6.1 **********
****

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	10.00	9.50	80.00	2 RCB	8.00	5.00	.012	CONVENTIONAL
2								
3								
4								
5								
6								

****
SUMMARY OF CULVERT FLOWS (cfs) FILE: CLV4F DATE: 03-15-2004

ELEV (ft)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
10.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	1
11.03	42.0	42.0	0.0	0.0	0.0	0.0	0.0	0.00	1
11.62	84.0	84.0	0.0	0.0	0.0	0.0	0.0	0.00	1
12.13	126.0	126.0	0.0	0.0	0.0	0.0	0.0	0.00	1
12.57	168.0	168.0	0.0	0.0	0.0	0.0	0.0	0.00	1
12.97	210.0	210.0	0.0	0.0	0.0	0.0	0.0	0.00	1
13.34	252.0	252.0	0.0	0.0	0.0	0.0	0.0	0.00	1
13.70	294.0	294.0	0.0	0.0	0.0	0.0	0.0	0.00	1
14.03	336.0	336.0	0.0	0.0	0.0	0.0	0.0	0.00	1
14.14	350.0	350.0	0.0	0.0	0.0	0.0	0.0	0.00	1
14.69	420.0	420.0	0.0	0.0	0.0	0.0	0.0	0.00	1
16.00	587.9	587.9	0.0	0.0	0.0	0.0	0.0	OVERTOPPING	

****
SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: CLV4F DATE: 03-15-2004

HEAD ELEV (ft)	HEAD ERROR (ft)	TOTAL FLOW (cfs)	FLOW ERROR (cfs)	% FLOW ERROR
10.00	0.000	0.00	0.00	0.00
11.03	0.000	42.00	0.00	0.00
11.62	0.000	84.00	0.00	0.00
12.13	0.000	126.00	0.00	0.00
12.57	0.000	168.00	0.00	0.00
12.97	0.000	210.00	0.00	0.00
13.34	0.000	252.00	0.00	0.00
13.70	0.000	294.00	0.00	0.00
14.03	0.000	336.00	0.00	0.00
14.14	0.000	350.00	0.00	0.00
14.69	0.000	420.00	0.00	0.00

****
<1> TOLERANCE (ft) = 0.010 <2> TOLERANCE (%) = 1.000
****

CURRENT DATE: 03-15-2004 FILE DATE: 03-15-2004
CURRENT TIME: 16:53:53 FILE NAME: CLV4F

PERFORMANCE CURVE FOR CULVERT 1 - 2(8.00 (ft) BY 5.00 (ft)) RCB

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	10.00	0.00	0.00	0-NF	0.00	0.00	0.00	0.00	0.00	0.00
42.00	11.03	1.03	1.03	1-S2n	0.46	0.60	0.40	1.35	6.57	2.59
84.00	11.62	1.62	1.62	1-S2n	0.71	0.95	0.65	1.93	8.06	3.16
126.00	12.13	2.13	2.13	1-S2n	0.95	1.25	0.98	2.37	8.00	3.53
168.00	12.57	2.57	2.57	1-S2n	1.14	1.51	1.20	2.73	8.75	3.81
210.00	12.97	2.97	2.97	1-S2n	1.32	1.75	1.40	3.04	9.36	4.04
252.00	13.34	3.34	3.34	1-S2n	1.51	1.98	1.60	3.31	9.85	4.24
294.00	13.70	3.70	3.70	1-S2n	1.67	2.19	1.78	3.56	10.30	4.42
336.00	14.03	4.03	4.03	1-S2n	1.83	2.40	1.97	3.79	10.67	4.57
350.00	14.14	4.14	4.14	1-S2n	1.88	2.46	2.02	3.86	10.81	4.62
420.00	14.69	4.69	4.69	1-S2n	2.13	2.78	2.31	4.20	11.35	4.85

El. inlet face invert 10.00 ft El. outlet invert 9.50 ft
El. inlet throat invert 0.00 ft El. inlet crest 0.00 ft

***** SITE DATA ***** CULVERT INVERT **********

INLET STATION	100.00 ft
INLET ELEVATION	10.00 ft
OUTLET STATION	180.00 ft
OUTLET ELEVATION	9.50 ft
NUMBER OF BARRELS	2
SLOPE (V/H)	0.0063
CULVERT LENGTH ALONG SLOPE	80.00 ft

***** CULVERT DATA SUMMARY **********

BARREL SHAPE	BOX
BARREL SPAN	8.00 ft
BARREL RISE	5.00 ft
BARREL MATERIAL	CONCRETE
BARREL MANNING'S n	0.012
INLET TYPE	CONVENTIONAL
INLET EDGE AND WALL	SQUARE EDGE (90-45 DEG.)
INLET DEPRESSION	NONE

CURRENT DATE: 03-15-2004 FILE DATE: 03-15-2004
CURRENT TIME: 16:53:53 FILE NAME: CLV4F

****
********** TAILWATER **********
****

******* REGULAR CHANNEL CROSS SECTION **********

BOTTOM WIDTH	8.00 ft
SIDE SLOPE H/V (X:1)	3.0
CHANNEL SLOPE V/H (ft/ft)	0.005
MANNING'S n (.01-0.1)	0.040
CHANNEL INVERT ELEVATION	9.50 ft
CULVERT NO.1 OUTLET INVERT ELEVATION	9.50 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	9.50	0.000	0.00	0.00	0.00
42.00	10.85	0.394	1.35	2.59	0.42
84.00	11.43	0.400	1.93	3.16	0.60
126.00	11.87	0.404	2.37	3.53	0.74
168.00	12.23	0.407	2.73	3.81	0.85
210.00	12.54	0.409	3.04	4.04	0.95
252.00	12.81	0.411	3.31	4.24	1.03
294.00	13.06	0.413	3.56	4.42	1.11
336.00	13.29	0.414	3.79	4.57	1.18
350.00	13.36	0.414	3.86	4.62	1.21
420.00	13.70	0.417	4.20	4.85	1.31

****
********** ROADWAY OVERTOPPING DATA **********
****

ROADWAY SURFACE	PAVED
EMBANKMENT TOP WIDTH	100.00 ft
CREST LENGTH	100.00 ft
OVERTOPPING CREST ELEVATION	16.00 ft

****

CURRENT DATE: 03-16-2004 FILE DATE: 03-16-2004
CURRENT TIME: 16:16:06 FILE NAME: CLV4G

****
********** FHWA CULVERT ANALYSIS **********
********** HY-8, VERSION 6.1 **********
****

C U L V 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	10.00	9.50	80.00	3 RCB	8.00	5.00	.012	CONVENTIONAL
2								
3								
4								
5								
6								

****

SUMMARY OF CULVERT FLOWS (cfs) FILE: CLV4G DATE: 03-16-2004

ELEV (ft)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
10.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	1
11.21	80.0	80.0	0.0	0.0	0.0	0.0	0.0	0.00	1
11.90	160.0	160.0	0.0	0.0	0.0	0.0	0.0	0.00	1
12.49	240.0	240.0	0.0	0.0	0.0	0.0	0.0	0.00	1
13.00	320.0	320.0	0.0	0.0	0.0	0.0	0.0	0.00	1
13.47	400.0	400.0	0.0	0.0	0.0	0.0	0.0	0.00	1
13.91	480.0	480.0	0.0	0.0	0.0	0.0	0.0	0.00	1
14.33	560.0	560.0	0.0	0.0	0.0	0.0	0.0	0.00	1
14.53	600.0	600.0	0.0	0.0	0.0	0.0	0.0	0.00	1
15.14	720.0	720.0	0.0	0.0	0.0	0.0	0.0	0.00	1
15.56	800.0	800.0	0.0	0.0	0.0	0.0	0.0	0.00	1
16.00	882.1	882.1	0.0	0.0	0.0	0.0	0.0	OVERTOPPING	

****

SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: CLV4G DATE: 03-16-2004

HEAD ELEV (ft)	HEAD ERROR (ft)	TOTAL FLOW (cfs)	FLOW ERROR (cfs)	% FLOW ERROR
10.00	0.000	0.00	0.00	0.00
11.21	0.000	80.00	0.00	0.00
11.90	0.000	160.00	0.00	0.00
12.49	0.000	240.00	0.00	0.00
13.00	0.000	320.00	0.00	0.00
13.47	0.000	400.00	0.00	0.00
13.91	0.000	480.00	0.00	0.00
14.33	0.000	560.00	0.00	0.00
14.53	0.000	600.00	0.00	0.00
15.14	0.000	720.00	0.00	0.00
15.56	0.000	800.00	0.00	0.00

****

<1> TOLERANCE (ft) = 0.010 <2> TOLERANCE (%) = 1.000

****

CURRENT DATE: 03-16-2004 FILE DATE: 03-16-2004
CURRENT TIME: 16:16:06 FILE NAME: CLV4G

PERFORMANCE CURVE FOR CULVERT 1 - 3(8.00 (ft) BY 5.00 (ft)) RCB

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	10.00	0.00	0.00	0-NF	0.00	0.00	0.00	0.00	0.00	0.00
80.00	11.21	1.21	1.21	1-S2n	0.54	0.70	0.55	1.24	6.03	2.72
160.00	11.90	1.90	1.90	1-S2n	0.84	1.12	0.88	1.84	7.61	3.41
240.00	12.49	2.49	2.49	1-S2n	1.11	1.46	1.06	2.30	9.42	3.88
320.00	13.00	3.00	3.00	1-S2n	1.34	1.77	1.42	2.69	9.38	4.23
400.00	13.47	3.47	3.47	1-S2n	1.56	2.06	1.67	3.04	10.01	4.52
480.00	13.91	3.91	3.91	1-S2n	1.76	2.32	1.90	3.35	10.52	4.77
560.00	14.33	4.33	4.33	1-S2n	1.97	2.57	2.12	3.64	11.00	4.99
600.00	14.53	4.53	4.53	1-S2n	2.06	2.69	2.23	3.77	11.19	5.09
720.00	15.14	5.14	5.14	5-S2n	2.34	3.04	2.54	4.15	11.81	5.36
800.00	15.56	5.56	5.56	5-S2n	2.53	3.26	2.74	4.38	12.15	5.52

El. inlet face invert 10.00 ft El. outlet invert 9.50 ft
El. inlet throat invert 0.00 ft El. inlet crest 0.00 ft

***** SITE DATA ***** CULVERT INVERT **********

INLET STATION	100.00 ft
INLET ELEVATION	10.00 ft
OUTLET STATION	180.00 ft
OUTLET ELEVATION	9.50 ft
NUMBER OF BARRELS	3
SLOPE (V/H)	0.0063
CULVERT LENGTH ALONG SLOPE	80.00 ft

***** CULVERT DATA SUMMARY **********

BARREL SHAPE	BOX
BARREL SPAN	8.00 ft
BARREL RISE	5.00 ft
BARREL MATERIAL	CONCRETE
BARREL MANNING'S n	0.012
INLET TYPE	CONVENTIONAL
INLET EDGE AND WALL	SQUARE EDGE (90-45 DEG.)
INLET DEPRESSION	NONE

CURRENT DATE: 03-16-2004 FILE DATE: 03-16-2004
CURRENT TIME: 16:16:06 FILE NAME: CLV4G

****
********** TAILWATER **********
****

******* REGULAR CHANNEL CROSS SECTION **********

BOTTOM WIDTH	20.00 ft
SIDE SLOPE H/V (X:1)	3.0
CHANNEL SLOPE V/H (ft/ft)	0.005
MANNING'S n (.01-0.1)	0.040
CHANNEL INVERT ELEVATION	9.50 ft
CULVERT NO.1 OUTLET INVERT ELEVATION	9.50 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	9.50	0.000	0.00	0.00	0.00
80.00	10.74	0.431	1.24	2.72	0.39
160.00	11.34	0.444	1.84	3.41	0.57
240.00	11.80	0.450	2.30	3.88	0.72
320.00	12.19	0.454	2.69	4.23	0.84
400.00	12.54	0.457	3.04	4.52	0.95
480.00	12.85	0.459	3.35	4.77	1.04
560.00	13.14	0.461	3.64	4.99	1.13
600.00	13.27	0.462	3.77	5.09	1.18
720.00	13.65	0.463	4.15	5.36	1.29
800.00	13.88	0.465	4.38	5.52	1.37

****
********** ROADWAY OVERTOPPING DATA **********
****

ROADWAY SURFACE	PAVED
EMBANKMENT TOP WIDTH	100.00 ft
CREST LENGTH	100.00 ft
OVERTOPPING CREST ELEVATION	16.00 ft

****

CURRENT DATE: 03-15-2004 FILE DATE: 03-15-2004
CURRENT TIME: 17:00:24 FILE NAME: CLV4H

FHWA CULVERT ANALYSIS
HY-8, VERSION 6.1

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	10.00	9.50	100.00	4 RCB	12.00	5.00	.012	CONVENTIONAL
2								
3								
4								
5								
6								

SUMMARY OF CULVERT FLOWS (cfs) FILE: CLV4H DATE: 03-15-2004

ELEV (ft)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
10.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	1
11.47	215.0	215.0	0.0	0.0	0.0	0.0	0.0	0.00	1
12.32	430.0	430.0	0.0	0.0	0.0	0.0	0.0	0.00	1
13.02	645.0	645.0	0.0	0.0	0.0	0.0	0.0	0.00	1
13.64	860.0	860.0	0.0	0.0	0.0	0.0	0.0	0.00	1
14.21	1075.0	1075.0	0.0	0.0	0.0	0.0	0.0	0.00	1
14.77	1290.0	1290.0	0.0	0.0	0.0	0.0	0.0	0.00	1
15.55	1450.0	1450.0	0.0	0.0	0.0	0.0	0.0	0.00	1
16.33	1720.0	1658.4	0.0	0.0	0.0	0.0	0.0	57.88	3
16.79	1935.0	1726.1	0.0	0.0	0.0	0.0	0.0	211.85	3
17.18	2150.0	1761.7	0.0	0.0	0.0	0.0	0.0	389.16	3
16.00	1593.2	1593.2	0.0	0.0	0.0	0.0	0.0	OVERTOPPING	

SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: CLV4H DATE: 03-15-2004

HEAD ELEV (ft)	HEAD ERROR (ft)	TOTAL FLOW (cfs)	FLOW ERROR (cfs)	% FLOW ERROR
10.00	0.000	0.00	0.00	0.00
11.47	0.000	215.00	0.00	0.00
12.32	0.000	430.00	0.00	0.00
13.02	0.000	645.00	0.00	0.00
13.64	0.000	860.00	0.00	0.00
14.21	0.000	1075.00	0.00	0.00
14.77	0.000	1290.00	0.00	0.00
15.55	0.000	1450.00	0.00	0.00
16.33	-0.004	1720.00	3.74	0.22
16.79	0.003	1935.00	-2.96	-0.15
17.18	0.001	2150.00	-0.88	-0.04

<1> TOLERANCE (ft) = 0.010 <2> TOLERANCE (%) = 1.000

CURRENT DATE: 03-15-2004 FILE DATE: 03-15-2004
CURRENT TIME: 17:00:24 FILE NAME: CLV4H

PERFORMANCE CURVE FOR CULVERT 1 - 4(12.00 (ft) BY 5.00 (ft)) RCB

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	10.00	0.00	0.00	0-NF	0.00	0.00	0.00	0.00	0.00	0.00
215.00	11.47	1.47	1.47	1-S2n	0.68	0.86	0.70	1.76	6.38	3.46
430.00	12.32	2.32	2.32	1-S2n	1.07	1.36	1.11	2.61	8.09	4.34
645.00	13.02	3.02	3.02	1-S2n	1.40	1.78	1.46	3.28	9.21	4.94
860.00	13.64	3.64	3.64	1-S2n	1.69	2.16	1.78	3.84	10.08	5.39
1075.00	14.21	4.21	4.21	1-S2n	1.96	2.50	2.08	4.34	10.75	5.76
1290.00	14.77	4.77	4.77	1-S2n	2.21	2.83	2.37	4.78	11.36	6.08
1450.00	15.55	5.17	5.55	4-FFt	2.40	3.06	5.00	5.09	6.04	6.29
1658.39	16.33	5.72	6.33	4-FFt	2.63	3.34	5.00	5.57	6.91	6.61
1726.11	16.79	5.90	6.79	4-FFt	2.70	3.43	5.00	5.93	7.19	6.84
1761.71	17.18	5.99	7.18	4-FFt	2.74	3.48	5.00	6.26	7.34	7.04

El. inlet face invert 10.00 ft El. outlet invert 9.50 ft
El. inlet throat invert 0.00 ft El. inlet crest 0.00 ft

***** SITE DATA ***** CULVERT INVERT **********

INLET STATION	100.00 ft
INLET ELEVATION	10.00 ft
OUTLET STATION	200.00 ft
OUTLET ELEVATION	9.50 ft
NUMBER OF BARRELS	4
SLOPE (V/H)	0.0050
CULVERT LENGTH ALONG SLOPE	100.00 ft

***** CULVERT DATA SUMMARY **********

BARREL SHAPE	BOX
BARREL SPAN	12.00 ft
BARREL RISE	5.00 ft
BARREL MATERIAL	CONCRETE
BARREL MANNING'S n	0.012
INLET TYPE	CONVENTIONAL
INLET EDGE AND WALL	SQUARE EDGE (90-45 DEG.)
INLET DEPRESSION	NONE

CURRENT DATE: 03-15-2004 FILE DATE: 03-15-2004
CURRENT TIME: 17:00:24 FILE NAME: CLV4H

****
********** TAILWATER **********
****

******* REGULAR CHANNEL CROSS SECTION **********

BOTTOM WIDTH	30.00 ft
SIDE SLOPE H/V (X:1)	3.0
CHANNEL SLOPE V/H (ft/ft)	0.005
MANNING'S n (.01-0.1)	0.040
CHANNEL INVERT ELEVATION	9.50 ft
CULVERT NO.1 OUTLET INVERT ELEVATION	9.50 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	9.50	0.000	0.00	0.00	0.00
215.00	11.26	0.459	1.76	3.46	0.55
430.00	12.11	0.474	2.61	4.34	0.82
645.00	12.78	0.480	3.28	4.94	1.02
860.00	13.34	0.485	3.84	5.39	1.20
1075.00	13.84	0.488	4.34	5.76	1.35
1290.00	14.28	0.490	4.78	6.08	1.49
1450.00	14.59	0.491	5.09	6.29	1.59
1720.00	15.07	0.494	5.57	6.61	1.74
1935.00	15.43	0.495	5.93	6.84	1.85
2150.00	15.76	0.496	6.26	7.04	1.95

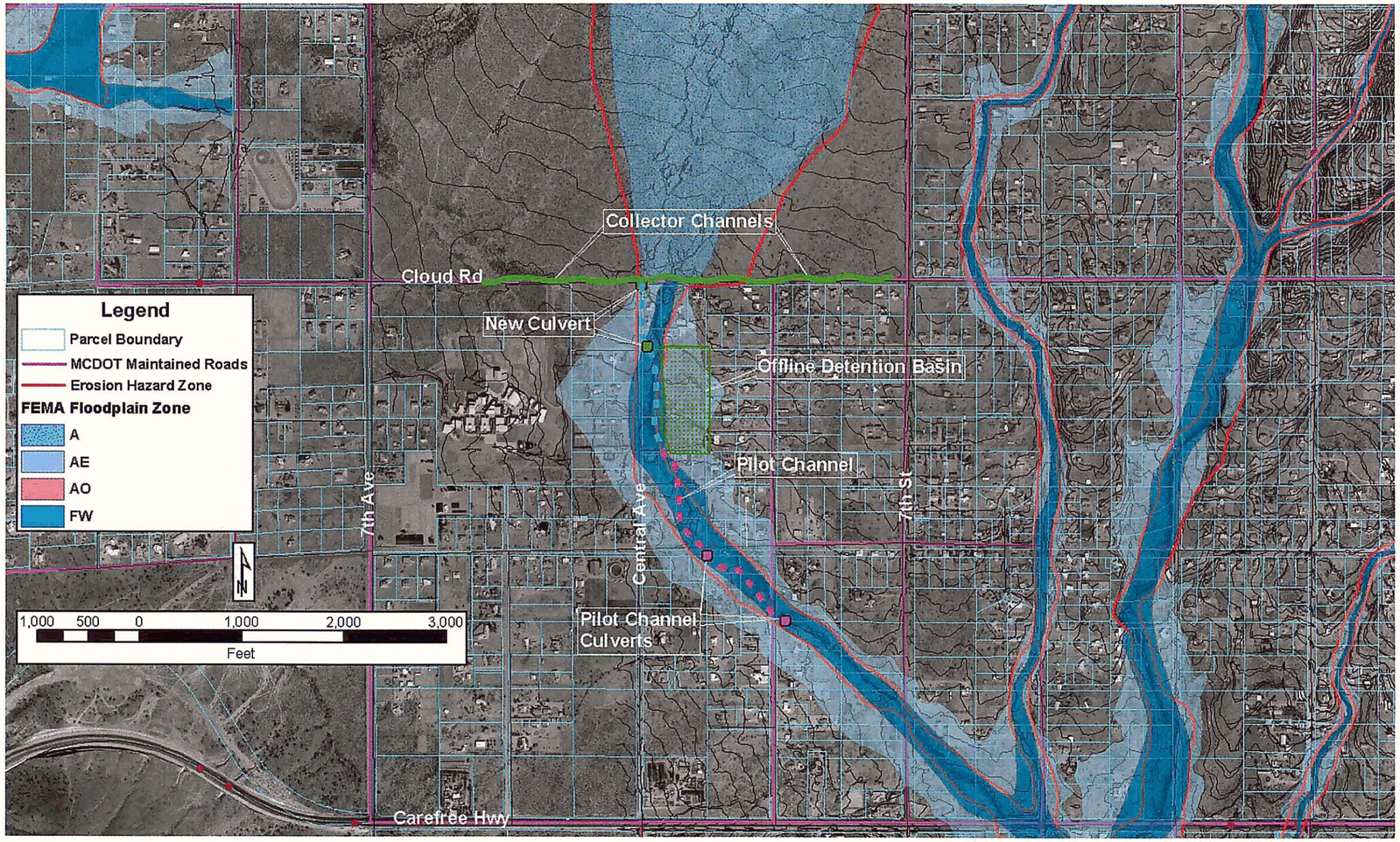
****
********** ROADWAY OVERTOPPING DATA **********
****

ROADWAY SURFACE	PAVED
EMBANKMENT TOP WIDTH	60.00 ft
CREST LENGTH	100.00 ft
OVERTOPPING CREST ELEVATION	16.00 ft

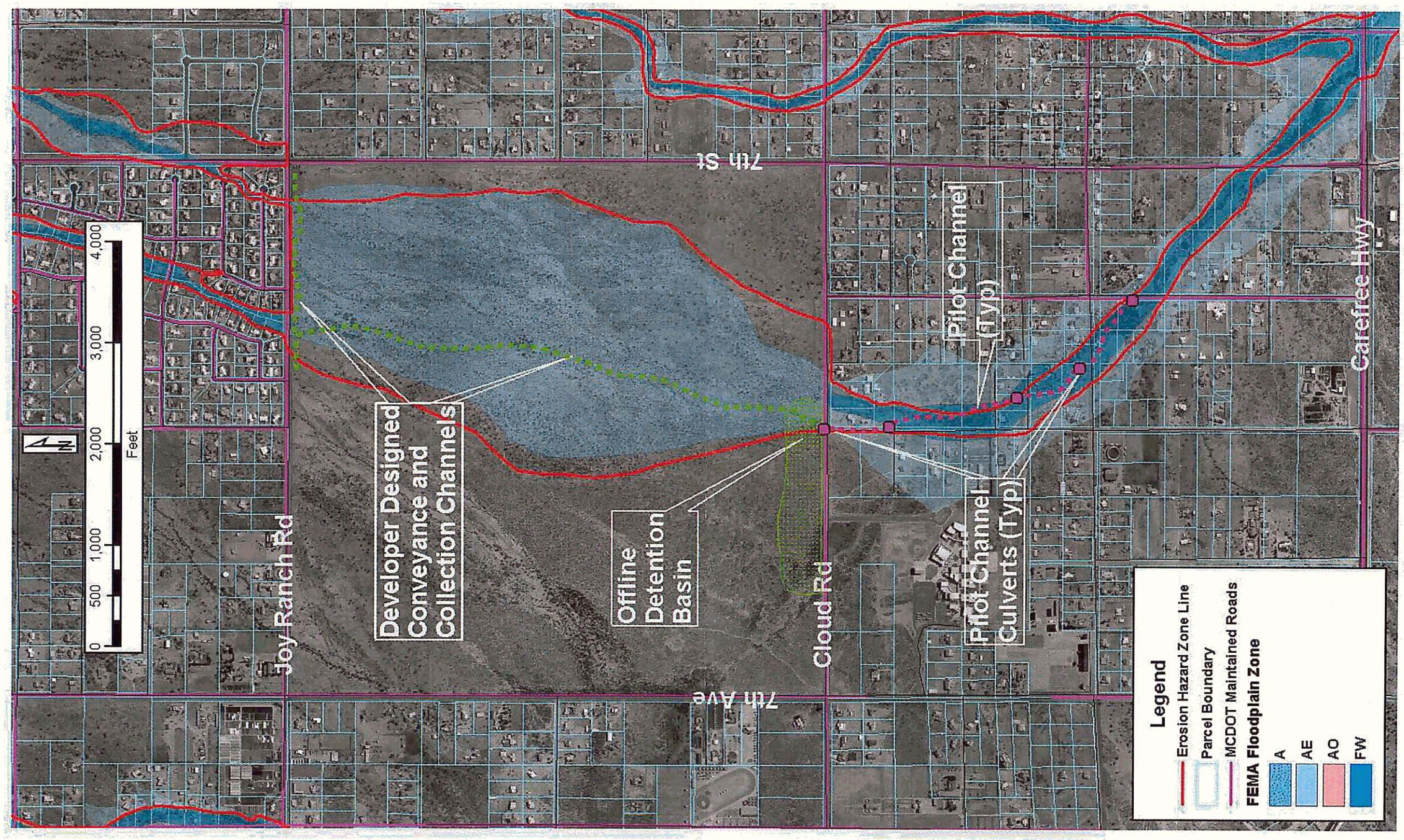
****

Site Number 5

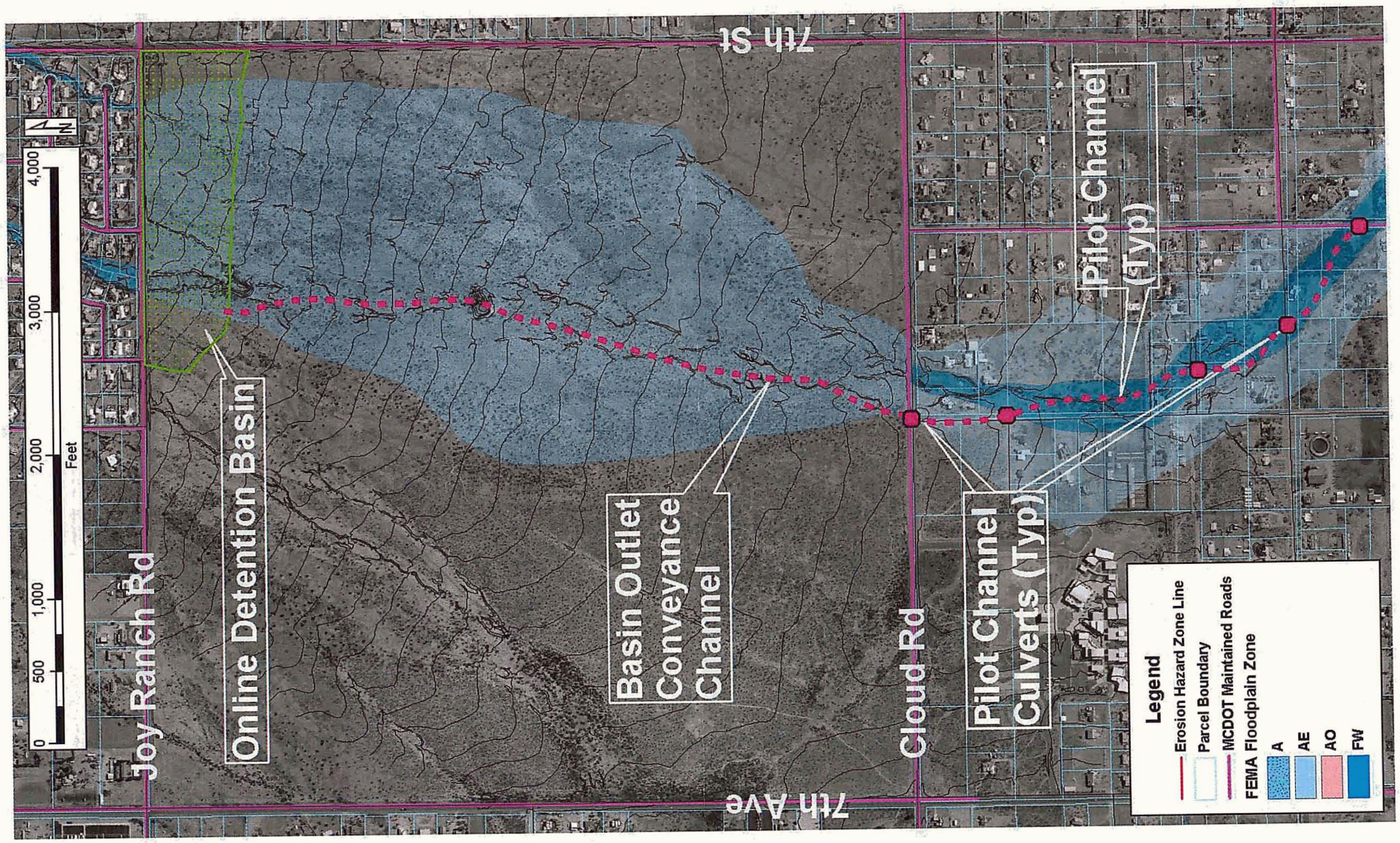
Conceptual Plan Layouts for Site Number 5



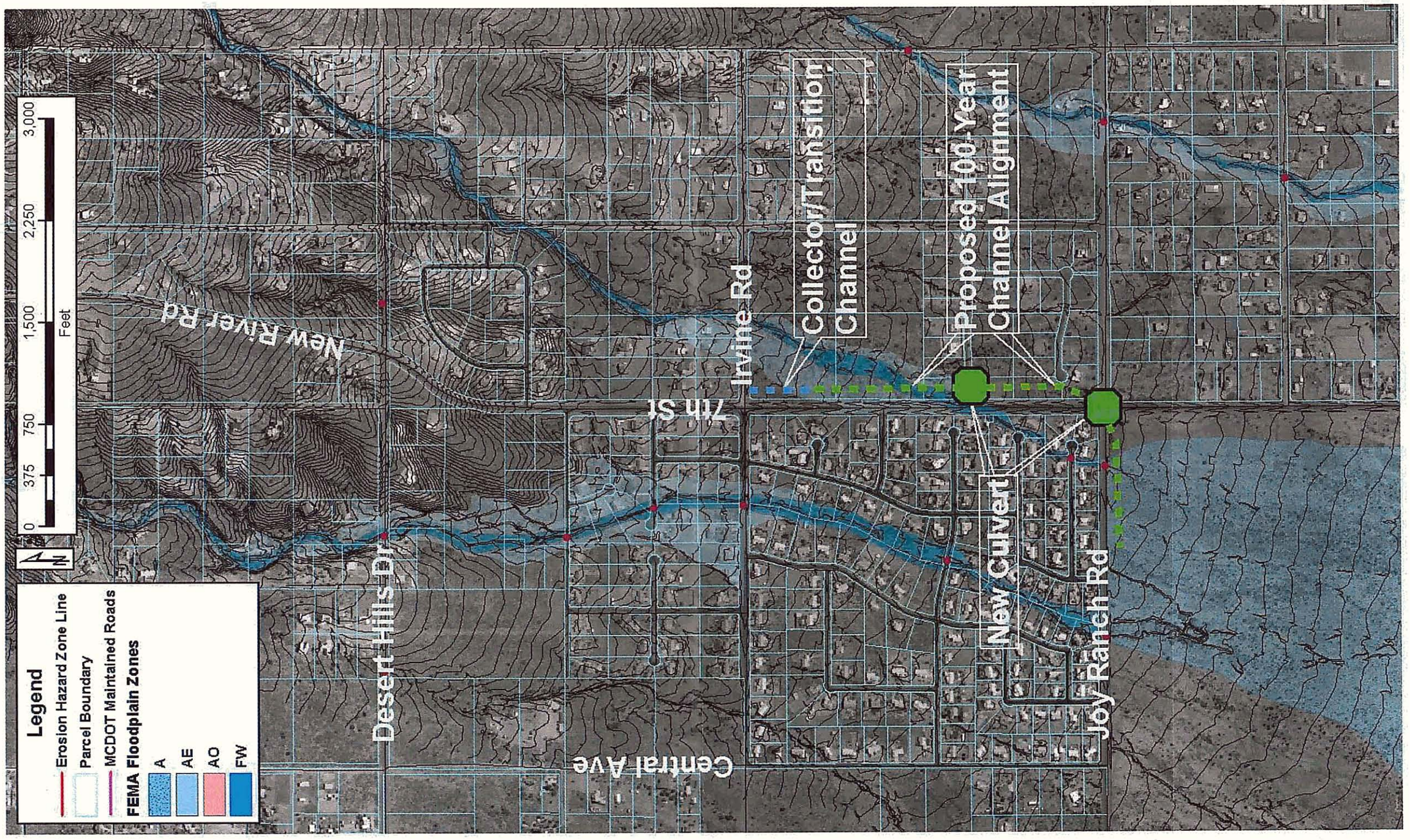
This was the original two concepts (DH7A and DH7B) for Site Number 5. More specifically Desert Lake Wash Downstream of Cloud Road.



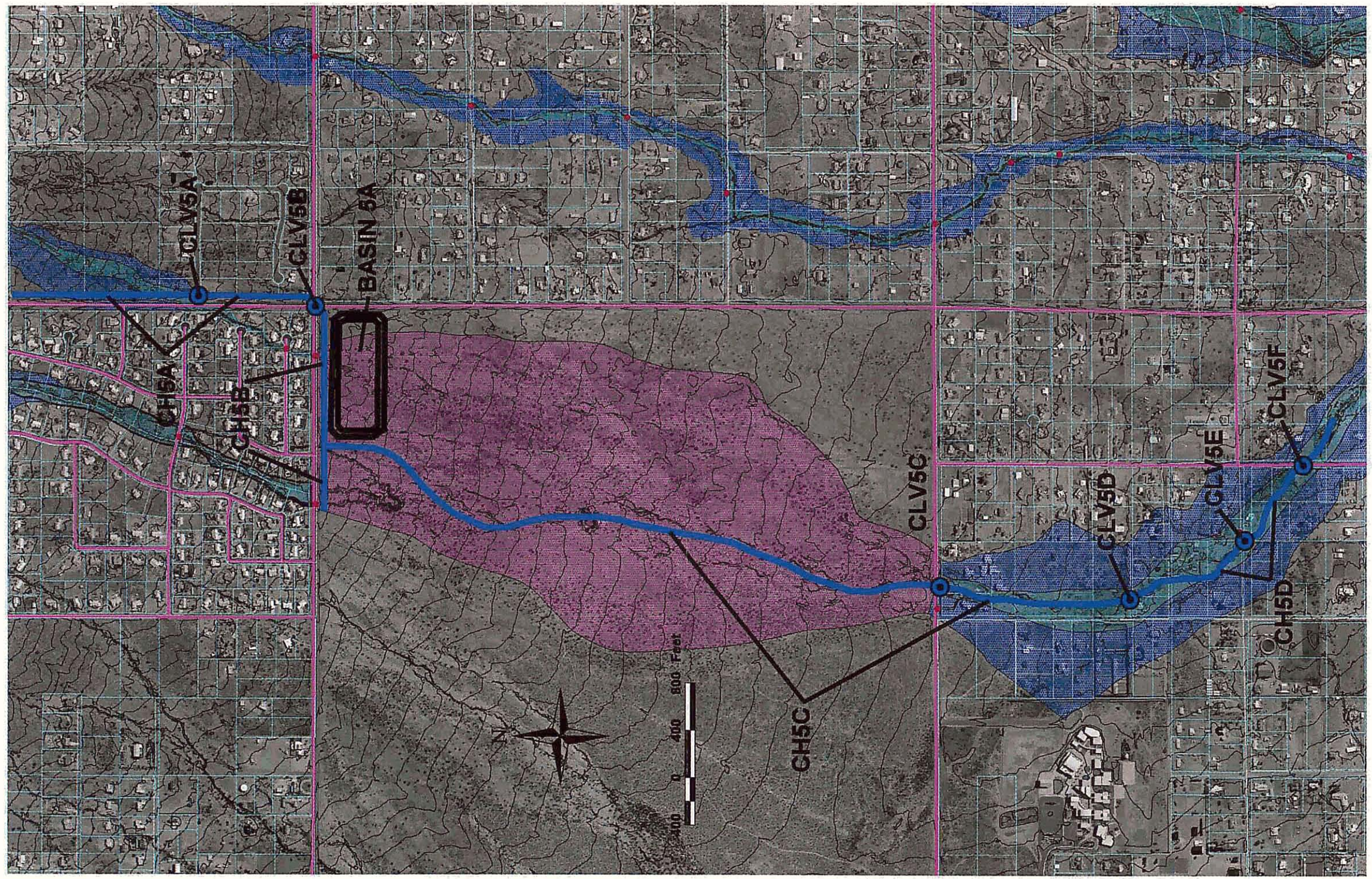
This was the original concept (DH7C) for Site Number 5. More specifically Desert Lake Wash Downstream of Cloud Road – Basin on ASLD Parcel.



This was the original concept (DH7D) for Site Number 5. More specifically Desert Lake Wash downstream of Joy Ranch Road – Online Detention Basin on ASLD Parcel.



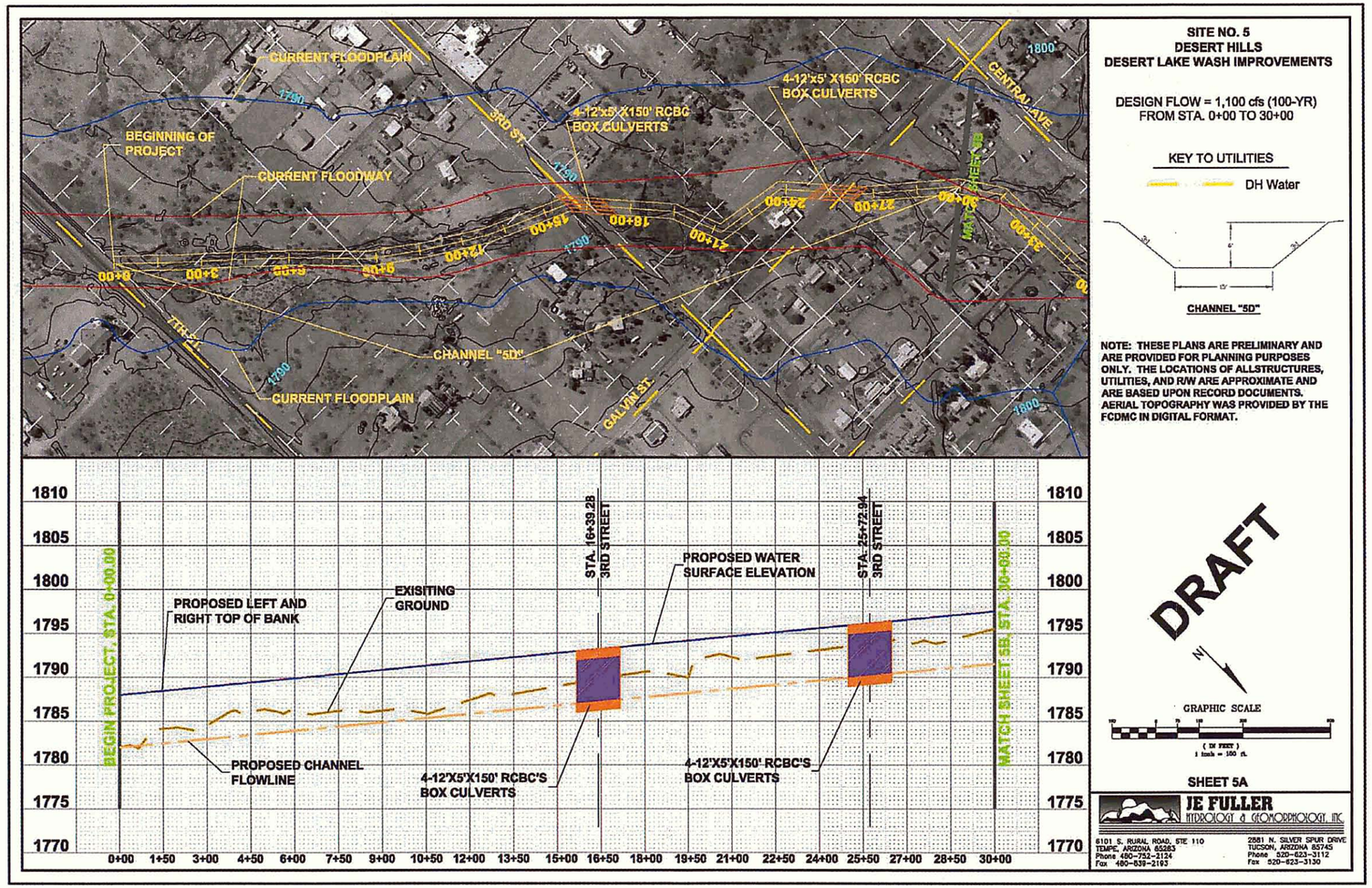
This was the original concept (DH8A) for Site Number 5. More specifically Desert Lake Wash Tributary 2 along 7th Street.



Once all of the alternatives were analyzed, they were combined into this concept which is the one that is discussed in the report body.

Plan and Profile Sheets for Site Number 5

Prior to Recommended Alternative


CURRENT FLOODPLAIN
BEGINNING OF PROJECT
CURRENT FLOODWAY
4-12'x5' X150' RCBC BOX CULVERTS
3RD ST
CENTRAL AVE
MATCH SHEET 5B
CHANNEL "5D"
GALVIN ST
1790
1800
0+00
3+00
6+00
9+50
12+00
15+00
18+00
21+00
24+00
27+00
30+00
33+00
SITE NO. 5
DESERT HILLS
DESERT LAKE WASH IMPROVEMENTS
DESIGN FLOW = 1,100 cfs (100-YR)
FROM STA. 0+00 TO 30+00
KEY TO UTILITIES
DH Water
CHANNEL "5D"
NOTE: THESE PLANS ARE PRELIMINARY AND ARE PROVIDED FOR PLANNING PURPOSES ONLY. THE LOCATIONS OF ALLSTRUCTURES, UTILITIES, AND R/W ARE APPROXIMATE AND ARE BASED UPON RECORD DOCUMENTS. AERIAL TOPOGRAPHY WAS PROVIDED BY THE FCDMC IN DIGITAL FORMAT.
DRAFT
N
GRAPHIC SCALE
SHEET 5A
JE FULLER
HYDROLOGY & GEOMORPHOLOGY, INC.
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Fax 480-639-2193
2881 N. SILVER SPUR DRIVE
TUCSON, ARIZONA 85745
Phone 520-623-3112
Fax 520-623-3130
1810
1805
1800
1795
1790
1785
1780
1775
1770
BEGIN PROJECT, STA. 0+00.00
STA. 16+39.28 3RD STREET
STA. 25+72.94 3RD STREET
MATCH SHEET 5B, STA. 30+93.00
PROPOSED LEFT AND RIGHT TOP OF BANK
EXISITING GROUND
PROPOSED WATER SURFACE ELEVATION
PROPOSED CHANNEL FLOWLINE
4-12'X5'X150' RCBC'S BOX CULVERTS
4-12'X5'X150' RCBC'S BOX CULVERTS
0+00
1+50
3+00
4+50
6+00
7+50
9+00
10+50
12+00
13+50
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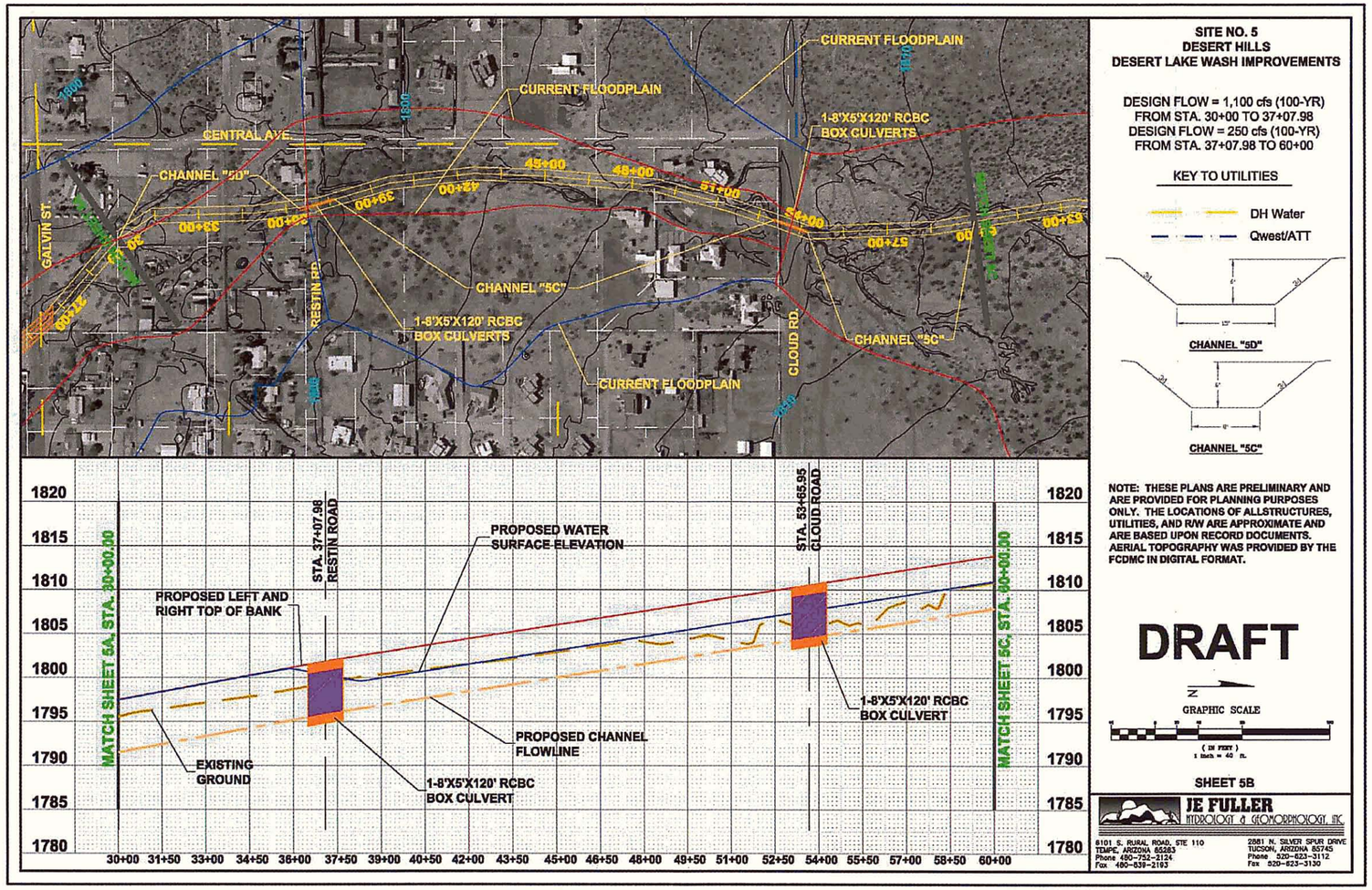
25+50
27+00
28+50
30+00



SITE NO. 5
DESERT HILLS
DESERT LAKE WASH IMPROVEMENTS

DESIGN FLOW = 1,100 cfs (100-YR)
FROM STA. 30+00 TO 37+07.98
DESIGN FLOW = 250 cfs (100-YR)
FROM STA. 37+07.98 TO 60+00

KEY TO UTILITIES

DH Water
Qwest/ATT

CHANNEL "5D"

CHANNEL "5C"

NOTE: THESE PLANS ARE PRELIMINARY AND ARE PROVIDED FOR PLANNING PURPOSES ONLY. THE LOCATIONS OF ALLSTRUCTURES, UTILITIES, AND R/W ARE APPROXIMATE AND ARE BASED UPON RECORD DOCUMENTS. AERIAL TOPOGRAPHY WAS PROVIDED BY THE FCDMC IN DIGITAL FORMAT.

DRAFT

N

GRAPHIC SCALE

(IN FEET)
1 inch = 40 ft.

SHEET 5B

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TUCSON, ARIZONA 85745
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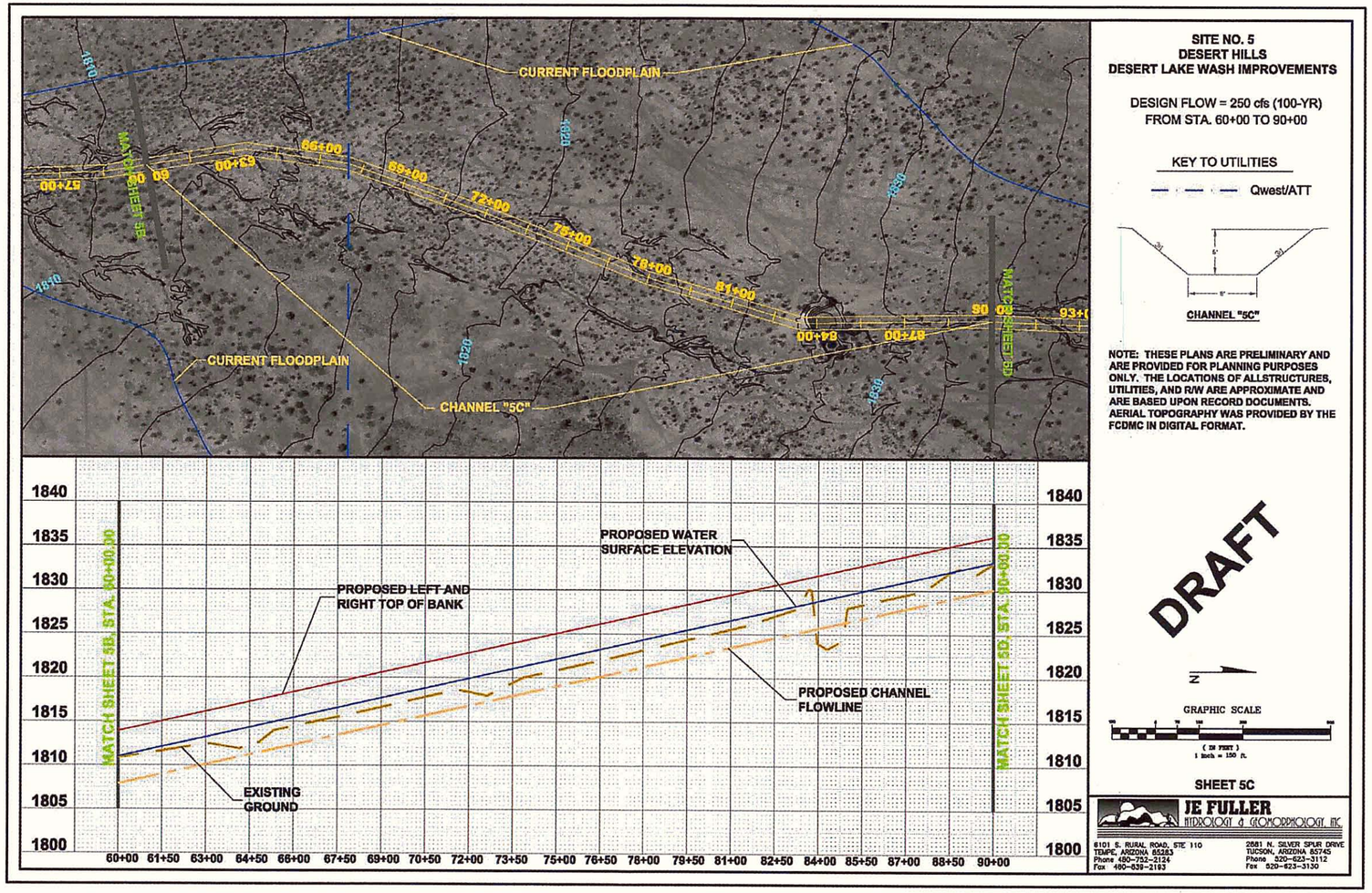
Fax 520-623-3130



SITE NO. 5
DESERT HILLS
DESERT LAKE WASH IMPROVEMENTS

DESIGN FLOW = 250 cfs (100-YR)
FROM STA. 60+00 TO 90+00

KEY TO UTILITIES

Qwest/ATT

CHANNEL "5C"

NOTE: THESE PLANS ARE PRELIMINARY AND ARE PROVIDED FOR PLANNING PURPOSES ONLY. THE LOCATIONS OF ALLSTRUCTURES, UTILITIES, AND R/W ARE APPROXIMATE AND ARE BASED UPON RECORD DOCUMENTS. AERIAL TOPOGRAPHY WAS PROVIDED BY THE FCDMC IN DIGITAL FORMAT.

DRAFT

N

GRAPHIC SCALE

(IN FEET)
1 inch = 150 ft.

SHEET 5C

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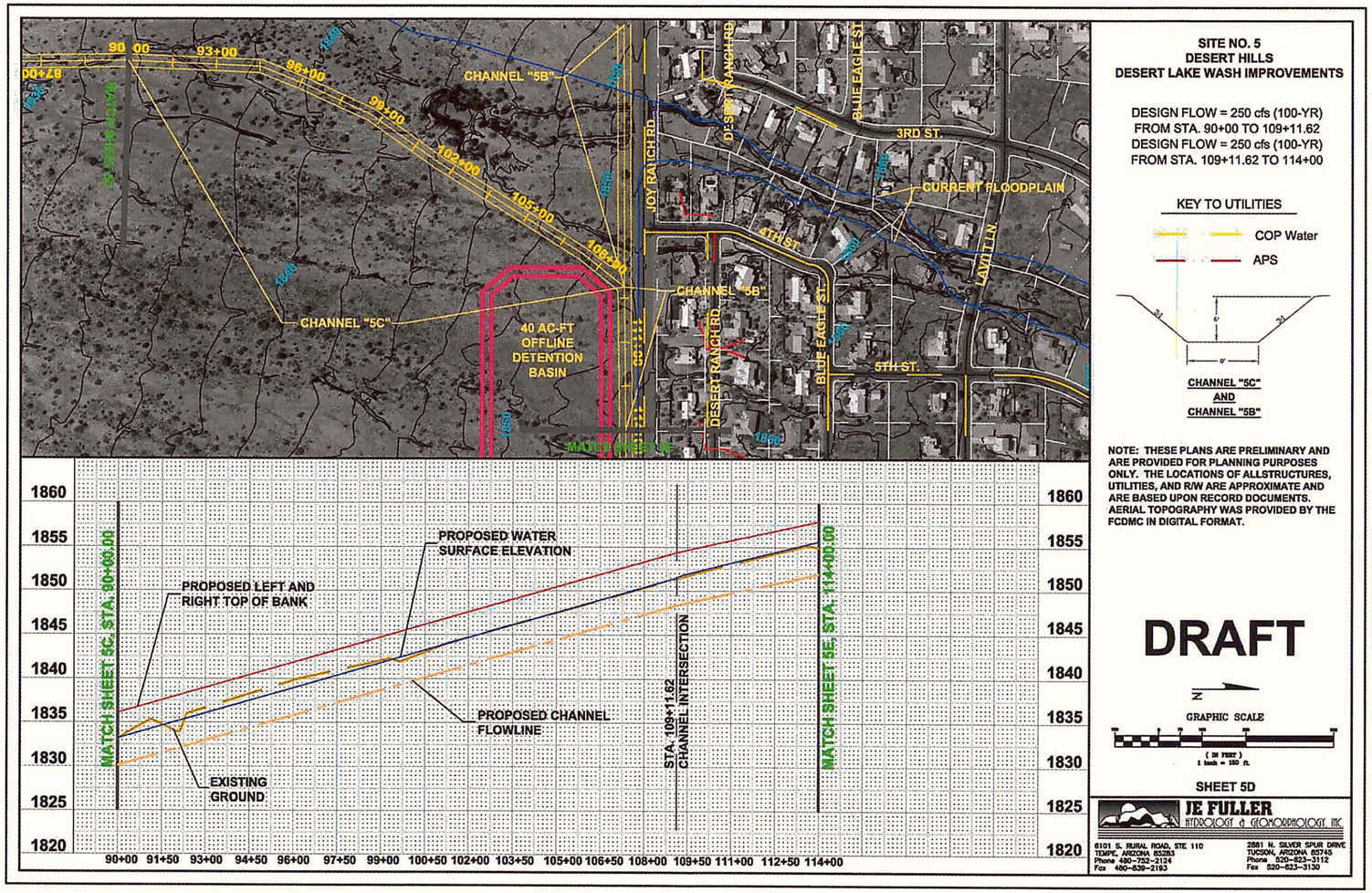
Phone 520-623-3112
Fax 520-623-3130



SITE NO. 5
DESERT HILLS
DESERT LAKE WASH IMPROVEMENTS

DESIGN FLOW = 250 cfs (100-YR)
FROM STA. 90+00 TO 109+11.62
DESIGN FLOW = 250 cfs (100-YR)
FROM STA. 109+11.62 TO 114+00

KEY TO UTILITIES

COP Water

APS

CHANNEL "5C"
AND
CHANNEL "5B"

NOTE: THESE PLANS ARE PRELIMINARY AND ARE PROVIDED FOR PLANNING PURPOSES ONLY. THE LOCATIONS OF ALLSTRUCTURES, UTILITIES, AND R/W ARE APPROXIMATE AND ARE BASED UPON RECORD DOCUMENTS. AERIAL TOPOGRAPHY WAS PROVIDED BY THE FCDMC IN DIGITAL FORMAT.

DRAFT

N

GRAPHIC SCALE

(IN FEET)
1 inch = 150 ft.

SHEET 5D

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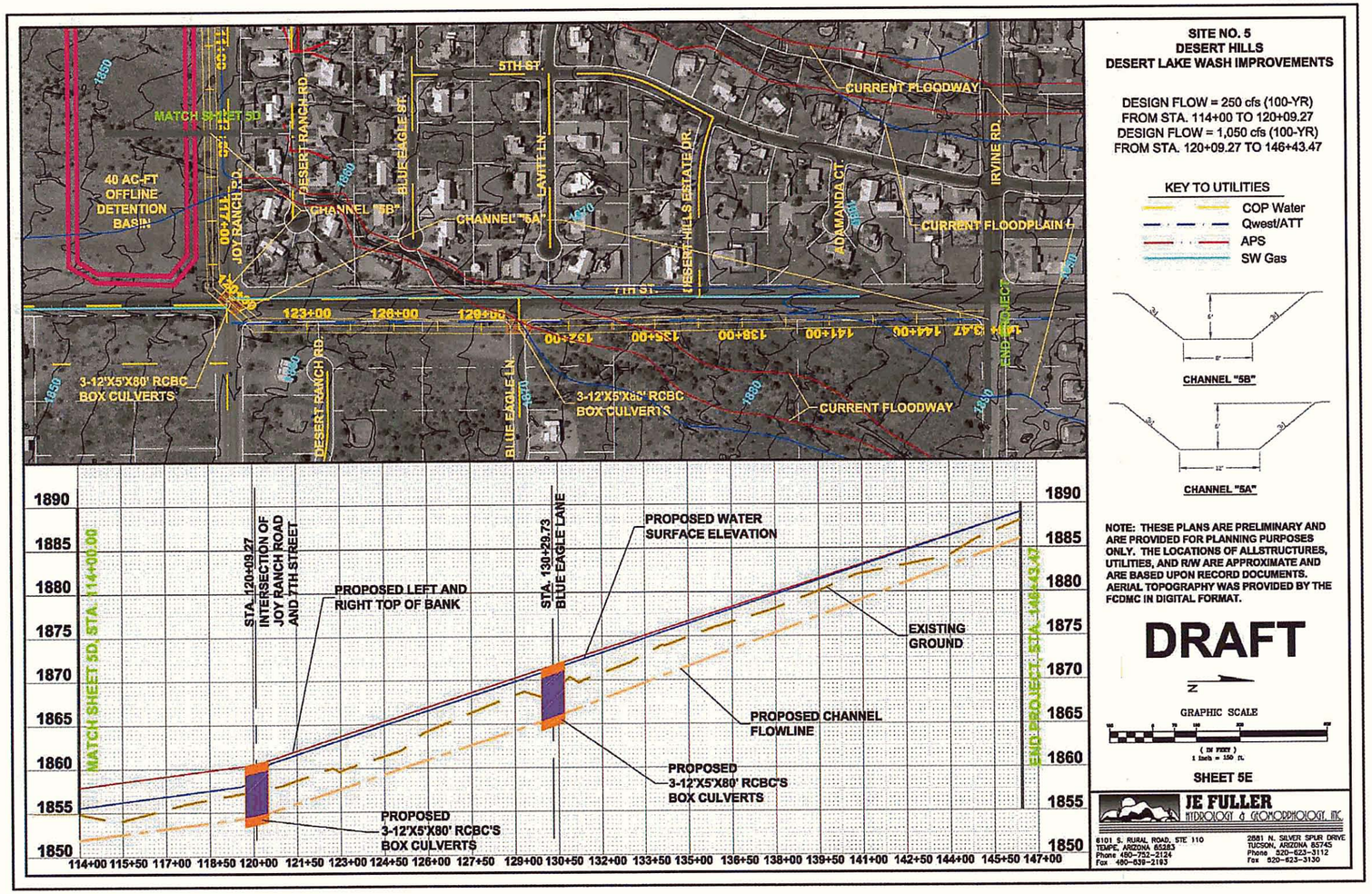
Phone 520-623-3112
Fax 520-623-3130


SITE NO. 5
DESERT HILLS
DESERT LAKE WASH IMPROVEMENTS
DESIGN FLOW = 250 cfs (100-YR)
FROM STA. 114+00 TO 120+09.27
DESIGN FLOW = 1,050 cfs (100-YR)
FROM STA. 120+09.27 TO 146+43.47
KEY TO UTILITIES
COP Water
Qwest/ATT
APS
SW Gas
CHANNEL "5B"
CHANNEL "5A"
NOTE: THESE PLANS ARE PRELIMINARY AND ARE PROVIDED FOR PLANNING PURPOSES ONLY. THE LOCATIONS OF ALLSTRUCTURES, UTILITIES, AND R/W ARE APPROXIMATE AND ARE BASED UPON RECORD DOCUMENTS. AERIAL TOPOGRAPHY WAS PROVIDED BY THE FCDMC IN DIGITAL FORMAT.
DRAFT
N
GRAPHIC SCALE
(IN FEET)
1 inch = 150 ft.
SHEET 5E
JE FULLER
HYDROLOGY & GEOMORPHOLOGY, INC.
6101 S. RURAL ROAD, STE 110
TEMPE, ARIZONA 85283
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Fax 480-839-2193
2681 N. SILVER SPUR DRIVE
TUCSON, ARIZONA 85745
Phone 520-623-3112
Fax 520-623-3130
MATCH SHEET 5D
40 AC-FT OFFLINE DETENTION BASIN
JOY RANCH RD.
DESERT RANCH RD.
BLUE EAGLE DR.
CHANNEL "5B"
CHANNEL "5A"
5TH ST.
7TH ST.
LAVITE LN.
DESERT HILLS ESTATE DR.
ADAMANDA CT.
IRVINE RD.
CURRENT FLOODWAY
CURRENT FLOODPLAIN
3-12'X5'X80' RCBC BOX CULVERTS
BLUE EAGLE LN.
END PROJECT
123+00
126+00
129+00
132+00
135+00
138+00
141+00
144+00
147+00
1890
1885
1880
1875
1870
1865
1860
1855
1850
MATCH SHEET 5D, STA. 114+00.00
STA. 120+09.27 INTERSECTION OF JOY RANCH ROAD AND 7TH STREET
STA. 130+29.73 BLUE EAGLE LANE
END PROJECT, STA. 146+43.47
PROPOSED WATER SURFACE ELEVATION
PROPOSED LEFT AND RIGHT TOP OF BANK
EXISTING GROUND
PROPOSED CHANNEL FLOWLINE
PROPOSED 3-12'X5'X80' RCBC'S BOX CULVERTS
PROPOSED 3-12'X5'X80' RCBC'S BOX CULVERTS
114+00 115+50 117+00 118+50 120+00 121+50 123+00 124+50 126+00 127+50 129+00 130+50 132+00 133+50 135+00 136+50 138+00 139+50 141+00 142+50 144+00 145+50 147+00

Cost Estimates for Site Number 5 Prior to Recommended Alternative

SITE NO. 5

DESERT HILLS, DESERT LAKE WASH IMPROVEMENTS

COST ESTIMATES

Item	Description	Construction				Land				Contingency	Engineering	Total
		Units	Unit Cost	Quantity	Construction Cost	Units	Unit Cost	Quantity	Land Cost			
CH5A	3200' of 48' Channel	LF	$135	3200	$ 432,000	SF	$1.50	160000	$ 240,000	$ 108,000	$ 64,800	$ 844,800
CLV5A	3 barrels of 12'x5' RCBC with inlet and outlet headwalls.	LF	$600	240	$ 144,000	SF	$1.50	11520	$ 17,280	$ 36,000	$ 21,600	$ 218,880
CLV5B	3 barrels of 12'x5' RCBC with inlet and outlet headwalls.	LF	$600	240	$ 144,000	SF	$1.50	11520	$ 17,280	$ 36,000	$ 21,600	$ 218,880
CH5B	2400' of 44" Channel	LF	$75	2400	$ 180,000	SF	$1.50	2000	$ 3,000	$ 45,000	$ 27,000	$ 255,000
BASIN 5A	40 Ac-Ft Offline Detention Basin	LS	$363,000	1	$ 363,000	SF	$1.50	348482	$ 522,723	$ 90,750	$ 54,450	$1,030,923
CH5C	9,800' of 44' Channel	LF	$75	9800	$ 735,000	SF	$1.50	490000	$ 735,000	$ 183,750	$ 110,250	$1,764,000
CLV5C	1- 8'x5' RCBC with inlet and outlet headwalls.	LF	$480	120	$ 57,600	SF	$1.50	3840	$ 5,760	$ 14,400	$ 8,640	$ 86,400
CLV5D	1- 8'x5' RCBC with inlet and outlet headwalls.	LF	$480	120	$ 57,600	SF	$1.50	3840	$ 5,760	$ 14,400	$ 8,640	$ 86,400
CH5D	3400' of 51" Channel	LF	$135	3400	$ 459,000	SF	$1.50	187000	$ 280,500	$ 114,750	$ 68,850	$ 923,100
CLV5E	4 barrels of 12'x5' RCBC with inlet and outlet headwalls.	LF	$600	600	$ 360,000	SF	$1.50	28800	$ 43,200	$ 90,000	$ 54,000	$ 547,200
CLV5F	4 barrels of 12'x5' RCBC with inlet and outlet headwalls.	LF	$600	600	$ 360,000	SF	$1.50	28800	$ 43,200	$ 90,000	$ 54,000	$ 547,200
				Totals	$ 3,292,200				$1,913,703	$ 823,050	$ 493,830	**$6,522,783**

Note: Land costs are assumed to equal $1.50 per square foot raw ground and is only the footprint of the structural alternative. This is equal to $65,340.26 per acre.

LAND COSTS ASSUMING FULL TAKE ON AFFECTED PROPERTIES

Number of Parcels	Land				Number of Dev. Parcels	Developed		
	Units	Unit Cost	Quantity	Land Cost		Unit Cost	Costs	Total
16 - Undeveloped Parcels	SF	$ 1.50	2663190	$ 3,994,785	0	$ -	$ -	$ 3,994,785
12 - Developed Parcel	SF	$ 1.50	1146140	$ 1,719,211	12	$ 185,000	$ 2,220,000	$ 3,939,211
Totals				$ 5,713,995			$ 2,220,000	**$ 7,933,995**

SUMMARY

	Minimum Costs	Maximum Costs
Range of Costs	**$ 6,522,783**	**$ 12,543,075**

Number of Parcels negatively impacted	**29**
Number of Parcels positively impacted	**47** (Approximately)

Note: All parcel and structure data based on 2002 parcel and aerial data.

Design Memorandum for Site Number 5

Summary of SITE 5 Design H&H

GENERAL NOTES:

- FLO2D model and results are based on the future conditions model reported on in the TDN, with modifications to add cross sections for determining flows at certain locations.
- A spreadsheet was created to do some hydrograph manipulation using the output from FLO2D. The spreadsheet is named *Sites 4 and 5_DesignHydrographs.xls*.
- Normal depth channel calculations were performed using FlowMaster (FM). The project file is named *Sites 4 and 5.fm2*.
- Culverts were calculated using HY8. The project files are named by culvert ID.

Channel CH5A and Culverts CLV5A and CLV5B:

- Design discharge = 1,050 cfs
- Source: FLO2D Cross Section No. 17
- Channel – see FM output
- Culverts – Use 3 barrel, 12 foot by 5 foot RCB (see HY8 output for CLV5A)

Channel CH5B:

- Design discharge = 250 cfs (see note on third bullet)
- Source: Resultant hydrograph bypassing Basin 5A (see spreadsheet tab labeled *SITE 5 Detention Basin*)
- Channel – ultimate channel design will be a function of the amount of flow spilled to the basin. Will probably be about 250 cfs (see FM output)

Basin 5A

- Basin is offline design
- Total volume required is 40 ac-feet
- Basin depth is approximately 5 feet
- Will require two control/spillway structures to allow all but 250 cfs of inflow hydrograph to enter into basin.

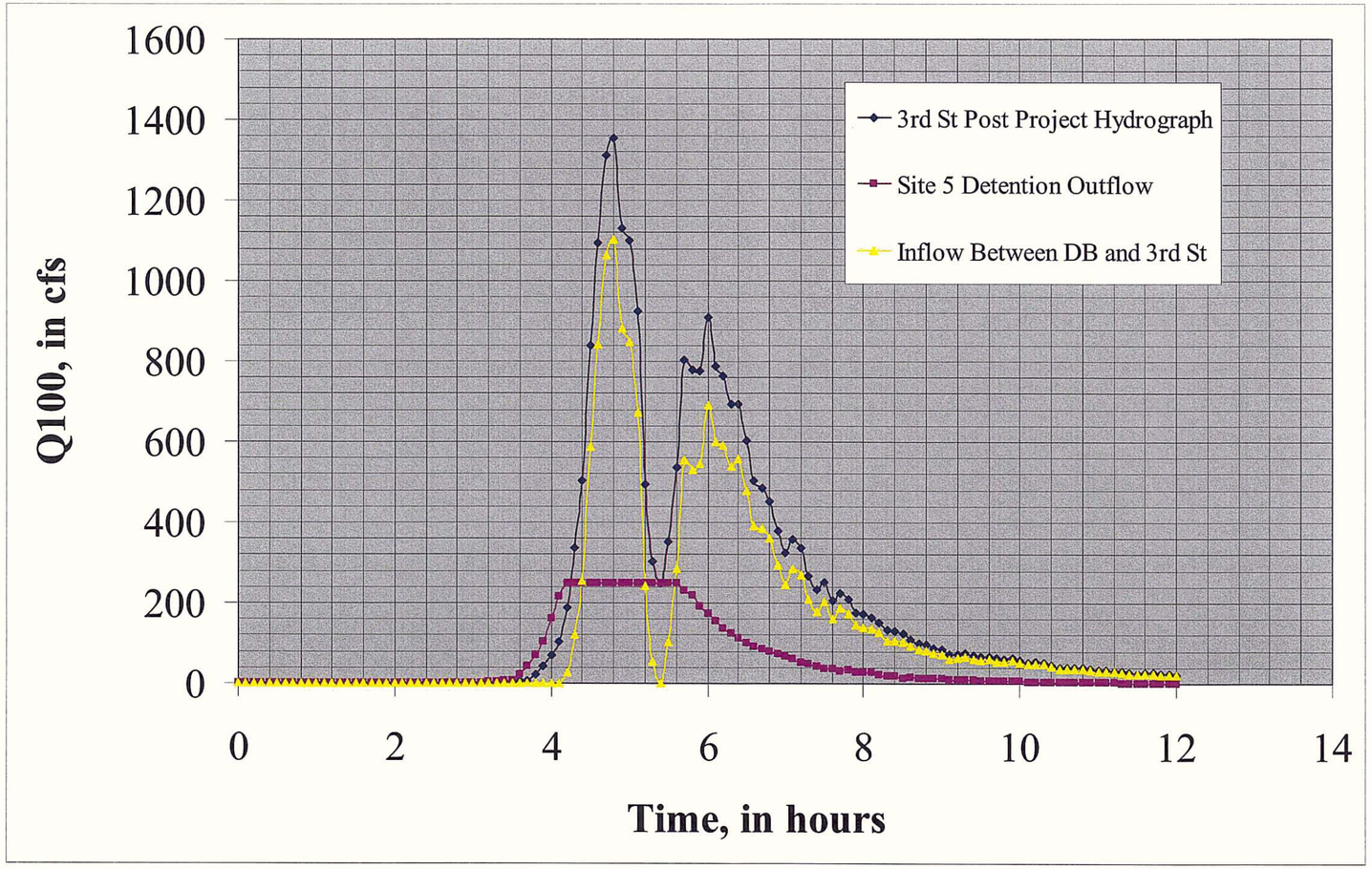
Channel CH5C and Culverts CLV5C and CLV5D:

- Design discharge = 250 cfs
- Source: Resultant hydrograph bypassing Basin 4A (see spreadsheet tab labeled *SITE 5 Detention Basin*)
- Channel – see FM output
- Culverts – Use 1 barrel, 8 foot by 5 foot RCB (see HY8 output for CLV5C)

Channel CH5D and Culverts CLV5E and CLV5F:

- Design discharge = 1,350 cfs (see third bullet)
- Source: 250 cfs bypassing Basin 5A plus the additional flow generated by the area generally south of Cloud Road and West of 3rd Street (approximately 1,100 cfs at the peak time of the bypass hydrograph). The intervening tributary flow hydrograph was calculated from the future condition FLO2D results by subtracting the resultant hydrograph at Cloud Road, between 3rd Avenue and 7th Street (Cross Sections 6 plus 8), from the hydrograph at 3rd Street, between Cloud Road and a quarter of a mile south of Galvin Street (Cross Section 19).
- Channel is to be a regrade of existing wash to section shown on FM output. The intent of the design is to provide bankfull capacity for something less than the 100-year flow (approximately 1,100 cfs), with the full 100-year flow being conveyed in a "floodway" (encroached section) that surcharges the channel by one foot. See FM output for cross section.
- Culverts – Use 4 barrel, 12 foot by 5 foot RCB (see HY8 output for CLV5E)

Hydrograph Information


1600
1400
1200
1000
800
600
400
200
0
Q100, in cfs
0
2
4
6
8
10
12
14
Time, in hours
3rd St Post Project Hydrograph
Site 5 Detention Outflow
Inflow Between DB and 3rd St

FlowMaster Information

Channel CH5A
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Site 5 - Channel CH5A
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

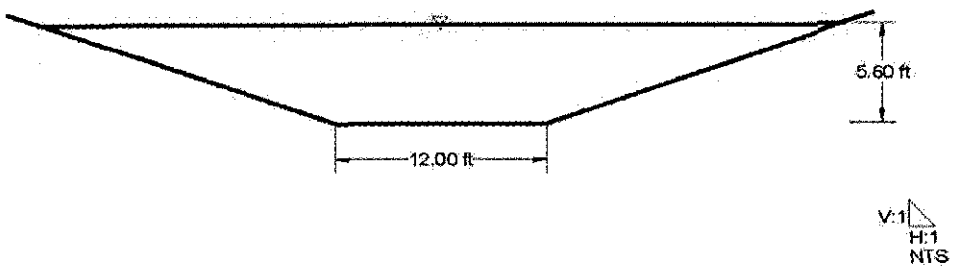
Input Data		
Mannings Coefficient	0.040	
Channel Slope	0.006000	ft/ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	12.00	ft
Discharge	1,050.00	cfs

Results		
Depth	5.60	ft
Flow Area	161.3	ft²
Wetted Perimeter	47.42	ft
Top Width	45.61	ft
Critical Depth	4.36	ft
Critical Slope	0.017231	ft/ft
Velocity	6.51	ft/s
Velocity Head	0.66	ft
Specific Energy	6.26	ft
Froude Number	0.61	
Flow Type	Subcritical	

Cross Section
Cross Section for Trapezoidal Channel

Project Description	
Worksheet	Site 5 - Channel CH5A
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data		
Mannings Coefficient	0.040	
Channel Slope	0.006000	ft/ft
Depth	5.60	ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	12.00	ft
Discharge	1,050.00	cfs



Channel CH5B
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Site 5 - Channel CH5B
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

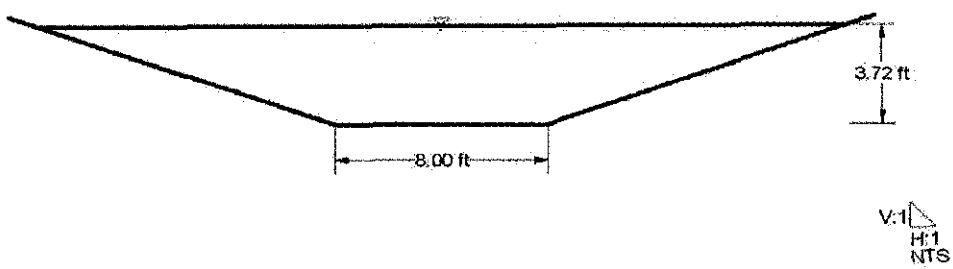
Input Data		
Mannings Coefficient	0.040	
Channel Slope	0.003000	ft/ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	8.00	ft
Discharge	250.00	cfs

Results		
Depth	3.72	ft
Flow Area	71.3	ft²
Wetted Perimeter	31.54	ft
Top Width	30.33	ft
Critical Depth	2.33	ft
Critical Slope	0.020893	ft/ft
Velocity	3.51	ft/s
Velocity Head	0.19	ft
Specific Energy	3.91	ft
Froude Number	0.40	
Flow Type	Subcritical	

Cross Section
Cross Section for Trapezoidal Channel

Project Description	
Worksheet	Site 5 - Channel CH5B
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data		
Mannings Coefficient	0.040	
Channel Slope	0.003000	ft/ft
Depth	3.72	ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	8.00	ft
Discharge	250.00	cfs



Channel CH5C
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Site 5 - Channel CH5C
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

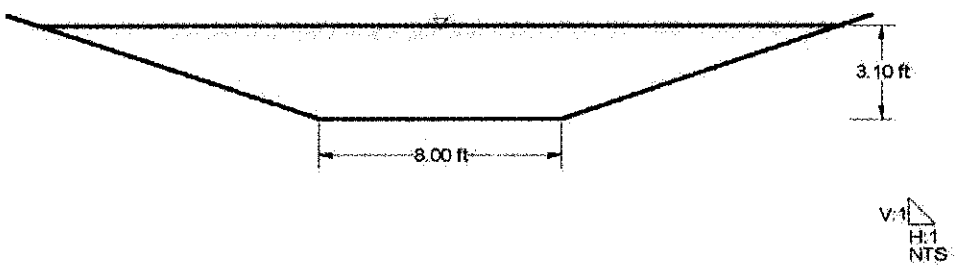
Input Data		
Mannings Coefficient	0.040	
Channel Slope	0.006500	ft/ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	8.00	ft
Discharge	250.00	cfs

Results		
Depth	3.10	ft
Flow Area	53.6	ft²
Wetted Perimeter	27.60	ft
Top Width	26.60	ft
Critical Depth	2.33	ft
Critical Slope	0.020899	ft/ft
Velocity	4.66	ft/s
Velocity Head	0.34	ft
Specific Energy	3.44	ft
Froude Number	0.56	
Flow Type	Subcritical	

Cross Section
Cross Section for Trapezoidal Channel

Project Description	
Worksheet	Site 5 - Channel CH5C
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data		
Mannings Coefficient	0.040	
Channel Slope	0.006500	ft/ft
Depth	3.10	ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	8.00	ft
Discharge	250.00	cfs



Channel CH5D
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Site 5 - Channel CH5D
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

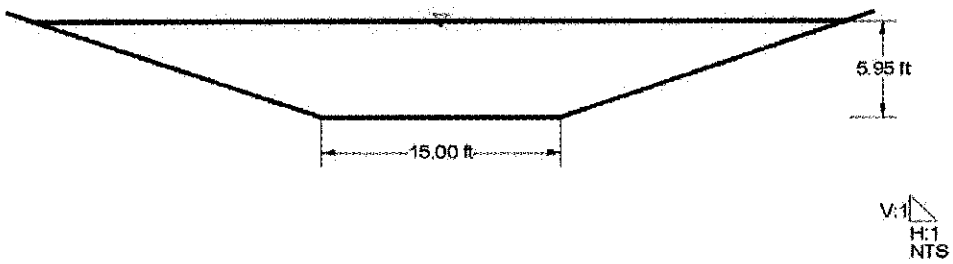
Input Data		
Mannings Coefficient	0.040	
Channel Slope	0.004000	ft/ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	15.00	ft
Discharge	1,100.00	cfs

Results		
Depth	5.95	ft
Flow Area	195.3	ft²
Wetted Perimeter	52.61	ft
Top Width	50.68	ft
Critical Depth	4.17	ft
Critical Slope	0.017161	ft/ft
Velocity	5.63	ft/s
Velocity Head	0.49	ft
Specific Energy	6.44	ft
Froude Number	0.51	
Flow Type	Subcritical	

Cross Section
Cross Section for Trapezoidal Channel

Project Description	
Worksheet	Site 5 - Channel CH5D
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data		
Mannings Coefficient	0.040	
Channel Slope	0.004000	ft/ft
Depth	5.95	ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	15.00	ft
Discharge	1,100.00	cfs



HY8 Information

CURRENT DATE: 03-15-2004 FILE DATE: 03-15-2004
CURRENT TIME: 15:44:55 FILE NAME: CLV5A

****
********** FHWA CULVERT ANALYSIS **********
********** HY-8, VERSION 6.1 **********
****

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	10.00	9.50	80.00	3 RCB	12.00	5.00	.012	CONVENTIONAL
2								
3								
4								
5								
6								

****

SUMMARY OF CULVERT FLOWS (cfs) FILE: CLV5A DATE: 03-15-2004

ELEV (ft)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
10.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	1
11.38	105.0	105.0	0.0	0.0	0.0	0.0	0.0	0.00	1
12.23	210.0	210.0	0.0	0.0	0.0	0.0	0.0	0.00	1
12.87	315.0	315.0	0.0	0.0	0.0	0.0	0.0	0.00	1
13.43	420.0	420.0	0.0	0.0	0.0	0.0	0.0	0.00	1
13.91	525.0	525.0	0.0	0.0	0.0	0.0	0.0	0.00	1
14.23	600.0	600.0	0.0	0.0	0.0	0.0	0.0	0.00	1
14.76	735.0	735.0	0.0	0.0	0.0	0.0	0.0	0.00	1
15.10	840.0	840.0	0.0	0.0	0.0	0.0	0.0	0.00	1
15.54	945.0	945.0	0.0	0.0	0.0	0.0	0.0	0.00	1
15.97	1050.0	1050.0	0.0	0.0	0.0	0.0	0.0	0.00	1
20.00	1953.8	1953.8	0.0	0.0	0.0	0.0	0.0	OVERTOPPING	

****

SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: CLV5A DATE: 03-15-2004

HEAD ELEV (ft)	HEAD ERROR (ft)	TOTAL FLOW (cfs)	FLOW ERROR (cfs)	% FLOW ERROR
10.00	0.000	0.00	0.00	0.00
11.38	0.000	105.00	0.00	0.00
12.23	0.000	210.00	0.00	0.00
12.87	0.000	315.00	0.00	0.00
13.43	0.000	420.00	0.00	0.00
13.91	0.000	525.00	0.00	0.00
14.23	0.000	600.00	0.00	0.00
14.76	0.000	735.00	0.00	0.00
15.10	0.000	840.00	0.00	0.00
15.54	0.000	945.00	0.00	0.00
15.97	0.000	1050.00	0.00	0.00

****

<1> TOLERANCE (ft) = 0.010 <2> TOLERANCE (%) = 1.000

****

CURRENT DATE: 03-15-2004 FILE DATE: 03-15-2004
CURRENT TIME: 15:44:55 FILE NAME: CLV5A

****

PERFORMANCE CURVE FOR CULVERT 1 - 3(12.00 (ft) BY 5.00 (ft)) RCB

****

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	10.00	0.00	0.00	0-NF	0.00	0.00	0.00	0.00	0.00	0.00
105.00	11.38	1.10	1.38	3-M1t	0.50	0.64	1.76	1.76	1.66	3.45
210.00	12.23	1.74	2.23	3-M1t	0.74	1.02	2.54	2.54	2.30	4.22
315.00	12.87	2.28	2.87	3-M1t	0.99	1.34	3.12	3.12	2.80	4.72
420.00	13.43	2.75	3.43	3-M1t	1.18	1.62	3.61	3.61	3.24	5.10
525.00	13.91	3.18	3.91	3-M1t	1.37	1.88	4.02	4.02	3.62	5.42
600.00	14.23	3.47	4.23	3-M1t	1.50	2.06	4.29	4.29	3.88	5.62
735.00	14.76	3.96	4.76	3-M1t	1.70	2.35	4.73	4.73	4.31	5.93
840.00	15.10	4.33	5.10	4-FFt	1.86	2.57	5.00	5.04	4.67	6.14
945.00	15.54	4.69	5.54	4-FFt	2.02	2.78	5.00	5.33	5.25	6.33
1050.00	15.97	5.04	5.97	4-FFt	2.17	2.98	5.00	5.60	5.83	6.51

****

El. inlet face invert 10.00 ft El. outlet invert 9.50 ft
El. inlet throat invert 0.00 ft El. inlet crest 0.00 ft

****

***** SITE DATA ***** CULVERT INVERT **********

INLET STATION	100.00 ft
INLET ELEVATION	10.00 ft
OUTLET STATION	180.00 ft
OUTLET ELEVATION	9.50 ft
NUMBER OF BARRELS	3
SLOPE (V/H)	0.0063
CULVERT LENGTH ALONG SLOPE	80.00 ft

***** CULVERT DATA SUMMARY **********

BARREL SHAPE	BOX
BARREL SPAN	12.00 ft
BARREL RISE	5.00 ft
BARREL MATERIAL	CONCRETE
BARREL MANNING'S n	0.012
INLET TYPE	CONVENTIONAL
INLET EDGE AND WALL	SQUARE EDGE (90-45 DEG.)
INLET DEPRESSION	NONE

****

CURRENT DATE: 03-15-2004 FILE DATE: 03-15-2004
CURRENT TIME: 15:44:55 FILE NAME: CLV5A

****
********** TAILWATER **********
****

******* REGULAR CHANNEL CROSS SECTION **********

BOTTOM WIDTH	12.00 ft
SIDE SLOPE H/V (X:1)	3.0
CHANNEL SLOPE V/H (ft/ft)	0.006
MANNING'S n (.01-0.1)	0.040
CHANNEL INVERT ELEVATION	9.50 ft
CULVERT NO.1 OUTLET INVERT ELEVATION	9.50 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	9.50	0.000	0.00	0.00	0.00
105.00	11.26	0.459	1.76	3.45	0.66
210.00	12.04	0.467	2.54	4.22	0.95
315.00	12.62	0.471	3.12	4.72	1.17
420.00	13.11	0.474	3.61	5.10	1.35
525.00	13.52	0.476	4.02	5.42	1.51
600.00	13.79	0.478	4.29	5.62	1.61
735.00	14.23	0.480	4.73	5.93	1.77
840.00	14.54	0.482	5.04	6.14	1.89
945.00	14.83	0.483	5.33	6.33	2.00
1050.00	15.10	0.485	5.60	6.51	2.10

****
********** ROADWAY OVERTOPPING DATA **********
****

ROADWAY SURFACE	PAVED
EMBANKMENT TOP WIDTH	60.00 ft
CREST LENGTH	100.00 ft
OVERTOPPING CREST ELEVATION	20.00 ft

****

CURRENT DATE: 03-15-2004 FILE DATE: 03-15-2004
CURRENT TIME: 15:57:42 FILE NAME: CLV5C

****
********** FHWA CULVERT ANALYSIS **********
********** HY-8, VERSION 6.1 **********
****

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	10.00	9.40	120.00	1 RCB	8.00	5.00	.012	CONVENTIONAL
2								
3								
4								
5								
6								

****

SUMMARY OF CULVERT FLOWS (cfs) FILE: CLV5C DATE: 03-15-2004

ELEV (ft)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
10.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	1
11.16	25.0	25.0	0.0	0.0	0.0	0.0	0.0	0.00	1
11.83	50.0	50.0	0.0	0.0	0.0	0.0	0.0	0.00	1
12.39	75.0	75.0	0.0	0.0	0.0	0.0	0.0	0.00	1
12.88	100.0	100.0	0.0	0.0	0.0	0.0	0.0	0.00	1
13.33	125.0	125.0	0.0	0.0	0.0	0.0	0.0	0.00	1
13.75	150.0	150.0	0.0	0.0	0.0	0.0	0.0	0.00	1
14.15	175.0	175.0	0.0	0.0	0.0	0.0	0.0	0.00	1
14.54	200.0	200.0	0.0	0.0	0.0	0.0	0.0	0.00	1
14.92	225.0	225.0	0.0	0.0	0.0	0.0	0.0	0.00	1
15.30	250.0	250.0	0.0	0.0	0.0	0.0	0.0	0.00	1
20.00	492.8	492.8	0.0	0.0	0.0	0.0	0.0	OVERTOPPING	

****

SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: CLV5C DATE: 03-15-2004

HEAD ELEV (ft)	HEAD ERROR (ft)	TOTAL FLOW (cfs)	FLOW ERROR (cfs)	% FLOW ERROR
10.00	0.000	0.00	0.00	0.00
11.16	0.000	25.00	0.00	0.00
11.83	0.000	50.00	0.00	0.00
12.39	0.000	75.00	0.00	0.00
12.88	0.000	100.00	0.00	0.00
13.33	0.000	125.00	0.00	0.00
13.75	0.000	150.00	0.00	0.00
14.15	0.000	175.00	0.00	0.00
14.54	0.000	200.00	0.00	0.00
14.92	0.000	225.00	0.00	0.00
15.30	0.000	250.00	0.00	0.00

****

<1> TOLERANCE (ft) = 0.010 <2> TOLERANCE (%) = 1.000

****

CURRENT DATE: 03-15-2004 FILE DATE: 03-15-2004
CURRENT TIME: 15:57:42 FILE NAME: CLV5C

PERFORMANCE CURVE FOR CULVERT 1 - 1(8.00 (ft) BY 5.00 (ft)) RCB

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	10.00	0.00	0.00	0-NF	0.00	0.00	0.00	0.00	0.00	0.00
25.00	11.16	1.16	1.16	1-S2n	0.56	0.67	0.47	0.97	6.60	2.37
50.00	11.83	1.83	1.83	1-S2n	0.87	1.07	0.77	1.41	8.13	2.91
75.00	12.39	2.39	2.39	1-S2n	1.14	1.40	1.16	1.74	8.05	3.27
100.00	12.88	2.88	2.88	1-S2n	1.39	1.70	1.42	2.01	8.82	3.54
125.00	13.33	3.33	3.33	1-S2n	1.61	1.97	1.57	2.25	9.96	3.76
150.00	13.75	3.75	3.75	1-S2n	1.83	2.22	1.88	2.47	9.97	3.95
175.00	14.15	4.15	4.15	1-S2n	2.04	2.46	2.09	2.66	10.45	4.12
200.00	14.54	4.54	4.54	1-S2n	2.23	2.69	2.30	2.84	10.85	4.27
225.00	14.92	4.92	4.92	1-S2n	2.43	2.91	2.50	3.00	11.24	4.40
250.00	15.30	5.30	5.30	5-S2n	2.62	3.13	2.71	3.16	11.55	4.53

El. inlet face invert 10.00 ft El. outlet invert 9.40 ft
El. inlet throat invert 0.00 ft El. inlet crest 0.00 ft

***** SITE DATA ***** CULVERT INVERT **********

INLET STATION	100.00 ft
INLET ELEVATION	10.00 ft
OUTLET STATION	220.00 ft
OUTLET ELEVATION	9.40 ft
NUMBER OF BARRELS	1
SLOPE (V/H)	0.0050
CULVERT LENGTH ALONG SLOPE	120.00 ft

***** CULVERT DATA SUMMARY **********

BARREL SHAPE	BOX
BARREL SPAN	8.00 ft
BARREL RISE	5.00 ft
BARREL MATERIAL	CONCRETE
BARREL MANNING'S n	0.012
INLET TYPE	CONVENTIONAL
INLET EDGE AND WALL	SQUARE EDGE (90-45 DEG.)
INLET DEPRESSION	NONE

CURRENT DATE: 03-15-2004 FILE DATE: 03-15-2004
CURRENT TIME: 15:57:42 FILE NAME: CLV5C

****
********** TAILWATER **********
****

******* REGULAR CHANNEL CROSS SECTION **********

BOTTOM WIDTH	8.00 ft
SIDE SLOPE H/V (X:1)	3.0
CHANNEL SLOPE V/H (ft/ft)	0.006
MANNING'S n (.01-0.1)	0.040
CHANNEL INVERT ELEVATION	9.40 ft
CULVERT NO.1 OUTLET INVERT ELEVATION	9.40 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	9.40	0.000	0.00	0.00	0.00
25.00	10.37	0.424	0.97	2.37	0.36
50.00	10.81	0.432	1.41	2.91	0.53
75.00	11.14	0.437	1.74	3.27	0.65
100.00	11.41	0.439	2.01	3.54	0.75
125.00	11.65	0.441	2.25	3.76	0.84
150.00	11.87	0.443	2.47	3.95	0.92
175.00	12.06	0.445	2.66	4.12	1.00
200.00	12.24	0.447	2.84	4.27	1.06
225.00	12.40	0.448	3.00	4.40	1.13
250.00	12.56	0.449	3.16	4.53	1.18

****
********** ROADWAY OVERTOPPING DATA **********
****

ROADWAY SURFACE	PAVED
EMBANKMENT TOP WIDTH	60.00 ft
CREST LENGTH	100.00 ft
OVERTOPPING CREST ELEVATION	20.00 ft

****

CURRENT DATE: 03-15-2004 FILE DATE: 03-15-2004
CURRENT TIME: 15:56:40 FILE NAME: CLV5E

****
********** FHWA CULVERT ANALYSIS **********
********** HY-8, VERSION 6.1 **********
****

C U L V 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	10.00	9.40	150.00	4 RCB	12.00	5.00	.012	CONVENTIONAL
2								
3								
4								
5								
6								

****

SUMMARY OF CULVERT FLOWS (cfs) FILE: CLV5E DATE: 03-15-2004

ELEV (ft)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
10.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	1
11.62	135.0	135.0	0.0	0.0	0.0	0.0	0.0	0.00	1
12.57	270.0	270.0	0.0	0.0	0.0	0.0	0.0	0.00	1
13.30	405.0	405.0	0.0	0.0	0.0	0.0	0.0	0.00	1
13.92	540.0	540.0	0.0	0.0	0.0	0.0	0.0	0.00	1
14.45	675.0	675.0	0.0	0.0	0.0	0.0	0.0	0.00	1
14.85	810.0	810.0	0.0	0.0	0.0	0.0	0.0	0.00	1
15.36	945.0	945.0	0.0	0.0	0.0	0.0	0.0	0.00	1
15.75	1050.0	1050.0	0.0	0.0	0.0	0.0	0.0	0.00	1
16.29	1215.0	1167.4	0.0	0.0	0.0	0.0	0.0	47.77	4
16.64	1350.0	1193.8	0.0	0.0	0.0	0.0	0.0	156.08	4
16.00	1099.0	1099.0	0.0	0.0	0.0	0.0	0.0	OVERTOPPING	

****

SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: CLV5E DATE: 03-15-2004

HEAD ELEV (ft)	HEAD ERROR (ft)	TOTAL FLOW (cfs)	FLOW ERROR (cfs)	% FLOW ERROR
10.00	0.000	0.00	0.00	0.00
11.62	0.000	135.00	0.00	0.00
12.57	0.000	270.00	0.00	0.00
13.30	0.000	405.00	0.00	0.00
13.92	0.000	540.00	0.00	0.00
14.45	0.000	675.00	0.00	0.00
14.85	0.000	810.00	0.00	0.00
15.36	0.000	945.00	0.00	0.00
15.75	0.000	1050.00	0.00	0.00
16.29	0.000	1215.00	-0.16	-0.01
16.64	0.000	1350.00	0.08	0.01

****

<1> TOLERANCE (ft) = 0.010 <2> TOLERANCE (%) = 1.000

****

CURRENT DATE: 03-15-2004 FILE DATE: 03-15-2004
CURRENT TIME: 15:56:40 FILE NAME: CLV5E

PERFORMANCE CURVE FOR CULVERT 1 - 4(12.00 (ft) BY 5.00 (ft)) RCB

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	10.00	0.00	0.00	0-NF	0.00	0.00	0.00	0.00	0.00	0.00
135.00	11.62	1.08	1.62	3-M1t	0.55	0.63	2.04	2.04	1.38	3.14
270.00	12.57	1.70	2.57	3-M1t	0.85	1.00	2.95	2.95	1.91	3.84
405.00	13.30	2.23	3.30	3-M1t	1.11	1.31	3.63	3.63	2.32	4.30
540.00	13.92	2.69	3.92	3-M1t	1.34	1.58	4.20	4.20	2.68	4.66
675.00	14.45	3.11	4.45	3-M1t	1.55	1.84	4.69	4.69	3.00	4.95
810.00	14.85	3.50	4.85	1-S1f	1.75	2.07	5.00	5.13	3.38	5.20
945.00	15.36	3.87	5.36	4-FFt	1.94	2.30	5.00	5.53	3.94	5.41
1050.00	15.75	4.15	5.75	4-FFt	2.08	2.46	5.00	5.82	4.38	5.57
1167.39	16.29	4.45	6.29	4-FFt	2.23	2.64	5.00	6.23	4.86	5.78
1193.83	16.64	4.52	6.64	4-FFt	2.27	2.68	5.00	6.55	4.97	5.95

El. inlet face invert 10.00 ft El. outlet invert 9.40 ft
El. inlet throat invert 0.00 ft El. inlet crest 0.00 ft

***** SITE DATA ***** CULVERT INVERT **********

INLET STATION	100.00 ft
INLET ELEVATION	10.00 ft
OUTLET STATION	250.00 ft
OUTLET ELEVATION	9.40 ft
NUMBER OF BARRELS	4
SLOPE (V/H)	0.0040
CULVERT LENGTH ALONG SLOPE	150.00 ft

***** CULVERT DATA SUMMARY **********

BARREL SHAPE	BOX
BARREL SPAN	12.00 ft
BARREL RISE	5.00 ft
BARREL MATERIAL	CONCRETE
BARREL MANNING'S n	0.012
INLET TYPE	CONVENTIONAL
INLET EDGE AND WALL	SQUARE EDGE (90-45 DEG.)
INLET DEPRESSION	NONE

CURRENT DATE: 03-15-2004 FILE DATE: 03-15-2004
CURRENT TIME: 15:56:40 FILE NAME: CLV5E

****
********** TAILWATER **********
****

******* REGULAR CHANNEL CROSS SECTION **********

BOTTOM WIDTH	15.00 ft
SIDE SLOPE H/V (X:1)	3.0
CHANNEL SLOPE V/H (ft/ft)	0.004
MANNING'S n (.01-0.1)	0.040
CHANNEL INVERT ELEVATION	9.40 ft
CULVERT NO.1 OUTLET INVERT ELEVATION	9.40 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	9.40	0.000	0.00	0.00	0.00
135.00	11.44	0.387	2.04	3.14	0.51
270.00	12.35	0.394	2.95	3.84	0.74
405.00	13.03	0.398	3.63	4.30	0.91
540.00	13.60	0.400	4.20	4.66	1.05
675.00	14.09	0.402	4.69	4.95	1.17
810.00	14.53	0.404	5.13	5.20	1.28
945.00	14.93	0.406	5.53	5.41	1.38
1050.00	15.22	0.407	5.82	5.57	1.45
1215.00	15.63	0.408	6.23	5.78	1.56
1350.00	15.95	0.409	6.55	5.95	1.63

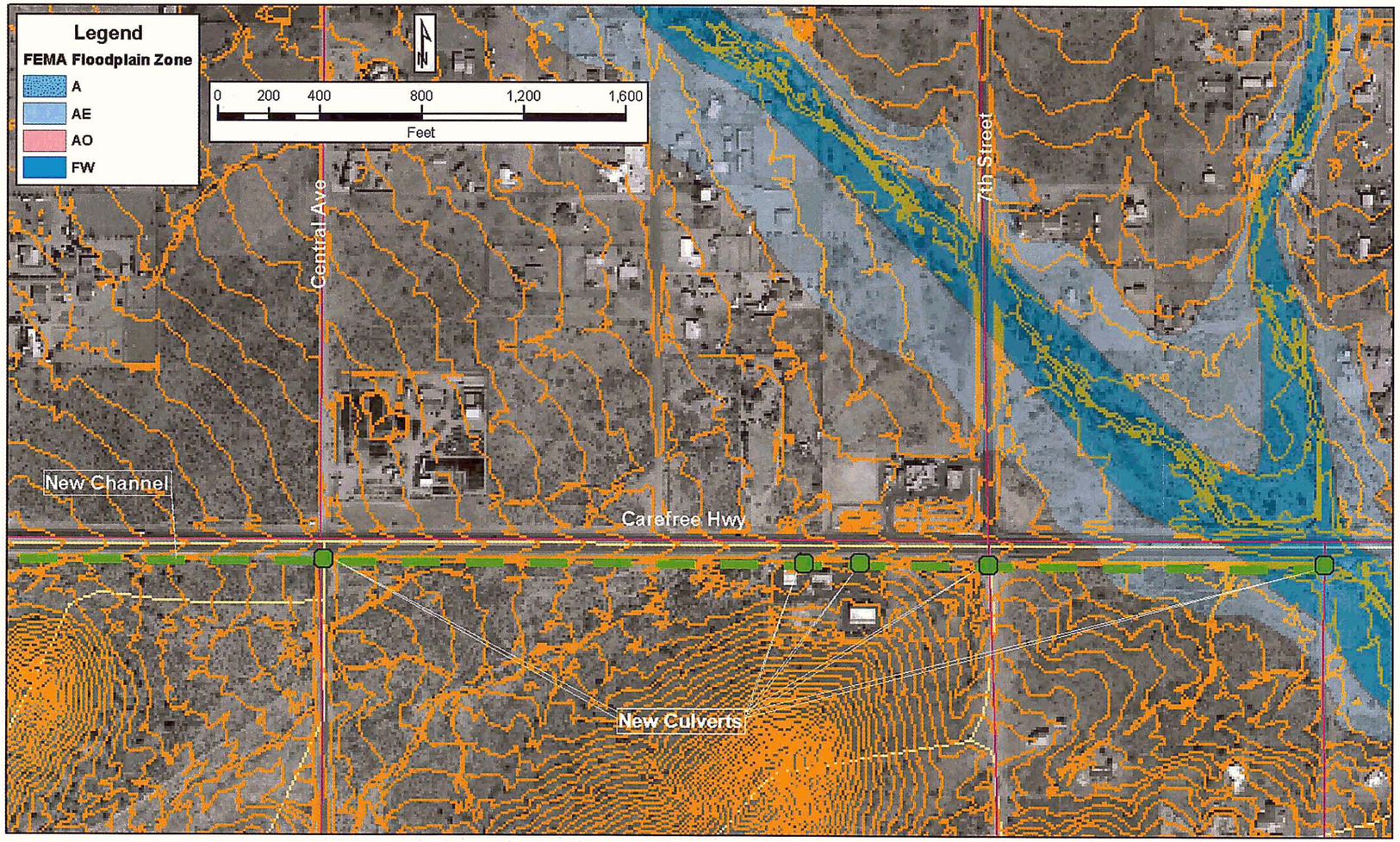
****
********** ROADWAY OVERTOPPING DATA **********
****

ROADWAY SURFACE	PAVED
EMBANKMENT TOP WIDTH	80.00 ft
CREST LENGTH	100.00 ft
OVERTOPPING CREST ELEVATION	16.00 ft

****

Site Number 6

Conceptual Plan Layout for Site Number 6



This was the original concept (DH10A) for Site Number 6. More specifically Carefree Highway Flooding.

Table from Part 8, Volume 2, Section 4

(Sources of Hydrologic and Hydraulic Data for Roadway Drainage Crossings Analysis and Results)

Sources of Hydrologic and Hydraulic Data for Roadway Drainage Crossings Analysis and Results

ct_ID	Stream Name	Street Name	# of Barrels	Structure Description	Structure Material	Source of Hydrologic Data	Q2	Q10	Q100	KK_ID	Source of Hydraulic Data	OT Depth	OT Velocity	Q100 in Pipe	Q at 0.5 ft OT	R.I. of 0.5 ft OT
jef0139	Cline Wash Tributary C8	16th Street	1	n/a	Ashpalt	FDS workmaps; FCD ratios	228	800	2280	C-8	RA RAS clinec8.prj (impassable below 2-yr)	5.0	11.3	N/A	100	1
jef0175	Desert Hills Wash	16th Street	1	n/a	Dirt	FDS; DH#6e.out	117	411	1787	C109C	J.J. dthl.out HEC-2 RM 4.48	6.9	2.0	N/A	50	1
jef0152	Desert Hills Wash Tributary 1	16th Street	2	24"	CMP	FDS; DH#6e.out	39	160	417	C138	Stanley dthl-t1.prj RM 0.66	0.7	1.6	164	300	49
jef0149	Desert Hills Wash Tributary 2	16th Street	2	48"	Spiral CMP	FDS; DH#6e.out	39	157	437	C132	Stanley dthl-t2.prj RM 1.12	1.3	2.3	162	145	9
jef0169	Desert Hills Wash Tributary 3	16th Street	2	48"	CMP	FDS; DH#6e.out	48	169	532	S119	Stanley dthl-t3.prj RM 0.46	1.0	1.1	210	275	24
brd0174	Desert Hills Wash Tributary 4	16th Street	1	3' x 2'	CMP	Stanley FDS; FCD ratios	33	116	330	N/A	HY8 brd0174.inp	0.5	2.0	30	330	100
jef0179	Desert Hills Wash Tributary 6	16th Street	1	48"	Spiral CMP	FDS; DH#6e.out	38	180	430	C115	Stanley dthl-t6.prj RM 0.06	1.2	3.0	124	160	11
brd0167	unnamed	16th Street	2	2'	CMP	DH#6e.out	4	12	35	22 ac. of S121	HY8 S121_1.inp	0.2	1.1	8	0	> 100
brd0166	unnamed	16th Street	2	2'	CMP	DH#6e.out	4	12	35	22 ac. of S121	HY8 S121_1.inp	0.2	1.1	8	0	> 100
brd0104	Skunk Creek	19th Avenue	1	dip	Asphalt	SCWMP - SCE100.OH1	4900	14000	26500	S16C	SCWMP RAS RM 20.08	7.0	9.0	N/A	400	1
brd0199	Apache Wash	24th Street	2	2.5'x5'	elliptical concrete pipe	FDS; DH#6e.out	515	1943	7213	C221	apache1.prj from CC CMP RM 4.96	2.0	7.0	200	2600	11
brd0130	West Fork Apache Wash	26th Street	2	5'	CMP	FDS; DH#6e.out	180	690	2191	C214	HY8 WBAWAT26.inp	1.8	3.8	360	555	5
brd0171	Paradise Wash Trib	32nd Street	1	3'	CMP	13.1 ac of S304 in DH#6e.out	3	11	30	S304	HY8 S304_1	0.0	0.0	> 40	0	> 100
brd0196	Ranieri Tank Wash	32nd Street	9	2.5' to 6' diameter	CMPs	DH#6e.out	207	726	2074	RR310	RR310 and HY8 for SE-SQ curve	0.2	1.0	2000	0	> 100
brd0193	Paradise Wash	32nd Street/Cloud Road	2	8' x 6'	Box	FDS; DH#6e.out	224	852	1701	C303	J.J. HEC-2 file PARADFCD.DAT (SC betw 3.149-3.177)	-5.5	0.0	1701	0	> 100
brd0165	Skunk Tank Wash	7th Ave	2	5'	CMP	MKE FDS; FCD Ratios	157	550	1570	N/A	STW_FW1Y.OH2	1.5	2.4	413	400	5
	unnamed	7th Ave	0	Paved dip	Paved dip	Estimated from DHA FLO-2D Grid 9638	15	28	70	FLO2D	FLO-2D Grid cell 9638	0.6	1.2	N/A	70	10
jef0118	Desert Lake Wash	7th Street	6	12' x 6.5'	RCBC	FDS; FCD Ratios	341	1192	3406	N/A	HY8 7th_st.inp	0.5	1.7	3200	3400	100
	Desert Lake Wash Trib 2	7th Street	1	N/A	N/A	FDS; DH#6e.out	112	430	1330	C104	FLO2D grid 3328	1.3	2.1	N/A	110	2
brd0198	Apache Wash	Carefree Highway	3	5' x 7'	Box	FDS; DH#6e.out	505	1748	7213	C222	J.J. apache.dat HEC-2 (Q100 = 5739; 1474 in w chl)	2.0	4.3	1486	2000	6
jef0154	Apache Wash tributary 1	Carefree Highway	2	4'x10'	RCBC	FDS; DH#6e.out	67	232	641	C226	Stanley apch-t1.prj; RM 0.73	-3.7	0.0	641	0	> 100
jef0141	Desert Hills Wash	Carefree Highway	3	10'x5' (approx. 60 dg skew)	RCBC	FDS; DH#6e.out	243	928	4143	C127L	J.J.dthl.out in HEC-2 RM 2.005	2.4	2.2	1420	2700	39
jef0144	Desert Hills Wash Tributary 1	Carefree Highway	2	10'x5'	RCBC	FDS; DH#6e.out	39	160	417	C138	Stanley dthl-t1.prj RM 0.53, under	-4.0	0.0	417	0	> 100
jef0143	Desert Hills Wash Tributary 2	Carefree Highway	5	4.5'x6.5'	CMPA	FDS; DH#6e.out	46	155	562	C133	Stanley dthl-t2.prj RM 0.4	-4.0	0.0	562	0	> 100
jef0117	Desert Lake Wash	Carefree Highway	4	12' x 6.5'	RCBC	FDS; DH#6e.out	137	674	4772	FLO2D	J.J. jona.out HEC2 RM 0.22	1.8	4.8	1872	2000	15
brd0197	Paradise Wash	Carefree Highway	4	8' x 8'	Box	FDS; DH#6e.out	256	1300	4179	C314	FDS work map plot shows about 1 ft over road	1.0	3.0	2200	2800	42
jef0156	Paradise Wash West Branch	Carefree Highway	3	5'x10'	RCBC	FDS; DH#6e.out	136	523	1023	C317	J.J. prdwst.out HEC-2 RM 0.345	1.0	2.1	455	600	31
tjn0116	Skunk Creek	Carefree Highway	1	4-Pier Bridge (9'3" high to bridge bottom)	Concrete	SC#e.OH1	4872	13837	27283	S22C	SC_FEMA.prj from SCWMP	-1.0	0.0	27300	0	> 100
brd0184	unnamed	Carefree Highway	1	2.5'	CMP	4 cfs/ac * 43 ac; FCD ratios	17	60	172	N/A	Undetermined	0.0	0.0		0	Undetermined
brd0183	unnamed	Carefree Highway	1	2'	CMP	4 cfs/ac * 6.3 ac; FCD ratios	3	9	25	N/A	Undetermined	0.0	0.0		0	Undetermined
brd0182	unnamed	Carefree Highway	1	2.5'	CMP	4 cfs/ac * 29.8 ac; FCD ratios	12	42	120	N/A	Undetermined	0.0	0.0		0	Undetermined
brd0181	unnamed	Carefree Highway	2	2.5'	CMP	4 cfs/ac * 19.0 ac; FCD ratios	8	27	76	N/A	Undetermined	0.0	0.0		0	Undetermined
brd0180	unnamed	Carefree Highway	1	2'	CMP	4 cfs/ac * 12.4 ac; FCD ratios	5	18	50	N/A	Undetermined	0.0	0.0		0	Undetermined
brd0179	unnamed	Carefree Highway	2	5'	CMP	4 cfs/ac * 18.3 ac; FCD ratios	7	26	73	N/A	Undetermined	0.0	0.0		0	Undetermined
brd0176	unnamed	Carefree Highway	2	3.5'	CMP	DH#6e.out	43	151	432	S140	HY8 S140	0.5	2.5	60	383	77
brd0175	unnamed	Carefree Highway	3	3' x 2'	CMP	26.1 ac of S140 in DH#6e.out	7	25	71	S140	HY8 S140_E	0.0	0.0	15	0	> 100
brd0200	unnamed	Carefree Highway	4	1'	CMP	DH#6e.out	5	63	233	C153	HY8 brd0200.inp	0.4	3.6	35	0	> 100
brd0201	unnamed	Carefree Highway	2	2'	CMP	DH#6e.out; HY8 D152.inp	26	91	260	D152	HY8 D152.inp; Q > pipe flows E along CFH not over	0.0	0.0	58	0	> 100
brd0202	unnamed	Carefree Highway	2	2'	CMP	DH#6e.OUT	5	17	49	S151	HY8 brd0202.inp	0.1	0.5	45	0	> 100

Sources of Hydrologic and Hydraulic Data for Roadway Drainage Crossings Analysis and Results

ct_ID	Stream Name	Street Name	# of Barrels	Structure Description	Structure Material	Source of Hydrologic Data	Q2	Q10	Q100	KK_ID	Source of Hydraulic Data	OT Depth	OT Velocity	Q100 in Pipe	Q at 0.5 ft OT	R.I. of 0.5 ft OT
brd0203	unnamed	Carefree Highway	2	5'	CMP	DH#6e.OUT	4	13	38	S150	HY8 brd0203.inp	0.0	0.0	> 40	0	> 100
brd0204	unnamed	Carefree Highway	1	3.5'	CMP	BF FDS	0	20	852	RR17	HY8 C170.INP	0.8	2.6	30	450	50
twl0100	unnamed trib of Desert Hills Wash	Carefree Highway	0			DH#6.OUT	9	31	89	S130	Undetermined possibly no culvert here	0.0	0.0		0	Undetermined
jef0138	Cline Wash Tributary C8	Circle Mountain Road	1	2 cell arch (est. 24' x 6')	Steel	FDS workmaps; FCD ratios	228	780	2280	C-8	HY8 tc8atcm.inp	0.3	1.4	2220	0	> 100
brd0189	Apache Wash	Cloud Road	0			FDS; DH#6e.out	515	1943	7213	C221	J.J. apache.out HEC-2 RM 5.64	5.2	5.2	N/A	100	1
brd0169	Apache Wash Trib 1	Cloud Road	2	5'	CMP	DH#6e.out	54	190	543	S225	HY8 file s225w	0.7	1.3	233	330	34
brd0170	Apache Wash Trib 1	Cloud Road	1	3'	CMP	DH#6e.out	54	190	543	S225	HY8 file s225e	0.7	1.3	54	120	4
jef0172	Desert Hills Wash	Cloud Road	1	n/a	Concrete	FDS; DH#6e.out	260	1006	3669	C116	J.J. dthl.out RM 3.13	4.8	7.0	N/A	50	1
brd0168	Desert Hills Wash Trib 2	Cloud Road	2	2'	CMP	DH#6e.out	20	72	205	S131	HY8 s131.inp	0.3	1.6	43	0	> 100
jef0148	Desert Hills Wash Tributary 1	Cloud Road	3	24"	Spiral CMP	DH#6e.out	17	60	171	S137	HY8 file s137.inp	0.2	1.3	69	0	> 100
jef0121	Desert Lake Wash	Cloud Road	1	n/a	Concrete	FDS; FCD Ratios	148	519	1484	N/A	Stanley dslk-so.prj RM 1.76	3.0	2.6	N/A	100	1
jef0157	East Fork Desert Lake Wash	Cloud Road	1	n/a	Concrete	FDS; FCD Ratios	93	327	933	N/A	Stanley dslk-ef.prj RM 1.1	4.8	1.7	N/A	50	1
jef0155	Paradise Wash West Branch	Cloud Road	1	6'	CMP	FDS; DH#6e.out	101	377	798	C316	Stanley Parads-WF.prj RM 1.48	1.5	2.6	188	295	11
brd0161	unnamed	Cloud Road	3	2.5' x 2'	CMP	Region 12 Reg. Eq.; FCD Ratios	59	187	585	N/A	HY8 brd0161.inp	0.8	2.0	60	227	13
brd0164	unnamed	Cloud Road	1	3' x 2'	ECMP	Reg. 12 Reg Eq; FCD ratios	33	114	325	N/A	HY8 brd0164.inp	0.5	2.2	42	325	100
brd0154	unnamed	Cloud Road	1	6' x 4'	Box	Tramanto MDP	92	153	327	Basin G	HY8 brd0154.inp	0.2	1.0	270	0	> 100
twl007	unnamed trib of Skunk Tank Wash	Cloud Road	0			Region 12 Reg. Eq.; FCD Ratios	27	93	266	N/A	Undetermined	0.0	0.0		0	Undetermined
brd0101	Skunk Creek	Cloud Road/27th Ave	3	6'	CMP	SC#E.OH1	4900	13800	27300	S21C2	SCWMP Att 11 (road in F/P)	2.8	3.5	N/A	10500	12
jef0130	Desert Lake Wash	Desert Hills Drive	6	3-4' x 3.2', 2-4.5'x3.3'	CMPA & CMP	FDS; DH#6e.out	110	410	992	C101	Stanley dslk.prj RM 3.985	0.9	2.8	339	640	38
brd0105	Skunk Creek	Desert Hills Drive	1	n/a	Asphalt	SCWMP - SCE100.OH1	4900	14000	26500	S16C	SCWMP RAS RM 20.77	10.0	12.0	N/A	100	1
brd0153	Skunk Tank Wash	Desert Hills Drive	2	5'	CMP	MKE FDS; FCD Ratios	142	497	1420	N/A	STW_FW1Y.OH2	1.5	1.5	410	420	7
brd0152	unnamed	Desert Hills Drive	1	2.5' x 2'	CMP	DH#6.OUT	11	37	105	S500	HY8 brd152.inp	0.3	1.2	35	0	> 100
tjn0100	Skunk Creek	I-17	1	8-barrel box	Concrete	SCWMP - SCE100.OH1	5400	14800	28700	S24C	Tetra Tech FLO-2D	0.0	0.0	28700	0	> 100
twl000	Skunk Creek	I-17	0	none	n/a	TetraTech FLO-2D	0	0	6000	N/A	TetraTech FLO-2D	2.5	0.0	N/A	0	50
brd0185	unnamed	I-17	2	10' x 5'	Box	BF#6e.out	46	160	720	B18C	Biscuit Flat FDS	0.0	0.0	720	0	> 100
jef0162	Desert Hills Wash Trib 5	Jor Ranch Road	2	48"	CMP	FDS; dh#6e.out	82	286	782	S109	Stanley dthl-t5.prj RM 0.21 (with brd0172)	0.6	2.6	250	600	56
jef0125	Desert Lake Wash	Joy Ranch	1	n/a	Concrete	FDS; FCD Ratios	92	320	915	N/A	FLO-2D grid 4079	1.0	2.0	N/A	50	1
jef0174	Desert Hills Wash	Joy Ranch Road	3	2-48", 1-5'	Spiral CMP	FDS; DH#6e.out	117	411	1787	C109C	J.J. dthl.out HEC-2 RM 4.4	1.7	3.2	445	530	7
jef0178	Desert Hills Wash Tributary 6	Joy Ranch Road	1	48"	Spiral CMP	FDS; DH#6e.out	38	180	430	C115	Stanley dthl-t6.prj RM 0.22	1.9	2.6	98	105	5
jef0142	Desert Lake Wash Tributary 2	Joy Ranch Road	4	n/a	Concrete	FDS; FCD Ratios	52	182	520		FLO-2D grid 4091	0.8	1.8	N/A	50	2
jef0164	East Fork Desert Lake Wash	Joy Ranch Road	2	48"	CMP	FDS; DH#6e.out	53	176	692	C106	Stanley dslk-ef.prj RM 2.26	0.5	2.5	209	640	84
brd0162	Skunk Tank Wash	Joy Ranch Road	3	5'	CMP	MKE FDS; FCD Ratios	211	740	2110	N/A	STW_FW1Y.OH2	2.2	1.8	285	420	3
brd0172	Trib to Desert Hills Wash Trib 5	Joy Ranch Road	1	3"	CMP	FDS; dh#6e.out	82	286	782	S109	Stanley dthl-t5.prj RM 0.21 (with jef0162)	0.6	2.6	37	600	56
jef0132	Desert Lake Wash	New River Road	1	6'	CMP	FDS; DH#6e.out	92	321	645	S100	Stanley dslk.prj RM 4.96	0.5	2.2	386	635	97
brd0118	Rodger Creek	New River Road	2	8'	CMP	FDS; SC#e.OH1	1699	3310	6500	CO-2	Rodger Creek FDS	3.2	1.9	1300	1250	1
	Skunk Creek	New River Road	0			SC#E.OH1	1463	4063	7840	S6C	SCWMP Att 11	2.2	5.1	3000	3000	12
jef0140	Skunk Creek Tributary 10A	New River Road	2	5' projecting inlet on skew	CMP	520 ac of S-10, SC#E.Oh1	187	529	1215	S-10	HY8 T10AatNR.inp	0.8	2.3	364	630	24
jef0145	Skunk Creek Tributary 12	New River Road	2	5'	CMP	SLA work maps; SC#E.OH1	499	1230	2255	S-12	HY8 T12ATNR.inp	2.5	4.3	302	470	4
brd0099	Skunk Creek Tributary10B	New River Road	2	5' projecting inlet on skew	CMP	SLA workmaps and ADMP ratios	182	640	1820		HY8 T10BATNR.inp; WEIR T10BatNR.OUT	2.7	4.7	388	475	5

Sources of Hydrologic and Hydraulic Data for Roadway Drainage Crossings Analysis and Results

ct_ID	Stream Name	Street Name	# of Barrels	Structure Description	Structure Material	Source of Hydrologic Data	Q2	Q10	Q100	KK_ID	Source of Hydraulic Data	OT Depth	OT Velocity	Q100 in Pipe	Q at 0.5 ft OT	R.I. of 0.5 ft OT
brd0149	unnamed	New River Road	1	4'	CMP	37.7 ac of S101, DH#6e.dat	13	45	129	S101	HY8 S101_1	0.1	1.2	92	0	> 100
brd0138	unnamed	New River Road	4	4'	Concrete	252 ac of S-7 in SC#E.OH1	179	365	622	S-7	HY8 TWOFSC.INP	0.2	0.4	592	0	> 100
brd0141	unnamed	New River Road	1	2'	CMP	SC#E.out	2150	6975	13750	CCO-5	new FDS shows all flow under NR Rd bridge	0.0	0.0	13750	0	> 100
twl005	unnamed	New River Road	0			Region 12 Reg. Eq.; FCD Ratios	48	167	478	N/A	Undetermined	0.0	0.0		0	Undetermined
twl006	unnamed	New River Road	0			Region 12 Reg. Eq.; FCD Ratios	12	41	117	N/A	Undetermined	0.0	0.0		0	Undetermined
mjk0100		New River Road	2	10' x 5'	RCB	Region 12 Reg. Eq.; FCD ratios	228	797	2277	N/A	HY8 MJK0100.inp	1.0	3.5	1300	1600	46
mjk0101		New River Road	3	12' x 5.5'	RCB	Region 12 Reg. Eq.; FCD ratios	407	1424	4070	N/A	HY8 MJK0101.inp	0.8	3.2	2550	3310	64
twl001		New River Road	0			Region 12 Reg. Eq.; FCD Ratios	430	1500	4310	N/A	Undetermined	0.0	0.0		0	Undetermined
twl004		New River Road	0			Region 12 Reg. Eq.; FCD Ratios	53	186	531	N/A	Undetermined	0.0	0.0		0	Undetermined
twl003		New River Road	0			Region 12 Reg. Eq.; FCD Ratios	9	33	93	N/A	Undetermined	0.0	0.0		0	Undetermined
twl002		New River Road	0			Region 12 Reg. Eq.; FCD Ratios	88	308	880	N/A	Undetermined	0.0	0.0		0	Undetermined

FlowMaster Information

B.O.P. to Sta. 39+00
Worksheet for Triangular Channel

Project Description	
Worksheet	BOP to Sta. 39+00
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

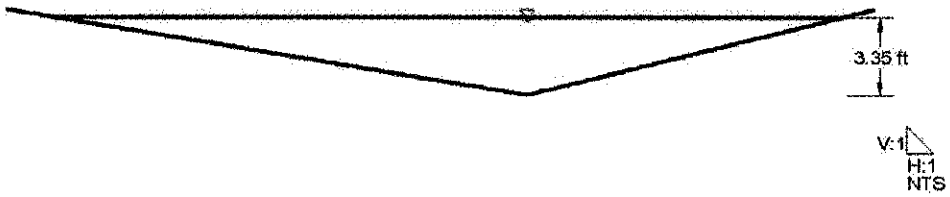
Input Data		
Mannings Coefficient	0.035	
Channel Slope	0.008205	ft/ft
Left Side Slope	6.00	H : V
Right Side Slope	4.00	H : V
Discharge	300.00	cfs

Results		
Depth	3.35	ft
Flow Area	56.1	ft^2
Wetted Perimeter	34.18	ft
Top Width	33.49	ft
Critical Depth	2.95	ft
Critical Slope	0.016113	ft/ft
Velocity	5.35	ft/s
Velocity Head	0.44	ft
Specific Energy	3.79	ft
Froude Number	0.73	
Flow Type	Subcritical	

Cross Section
Cross Section for Triangular Channel

Project Description	
Worksheet	BOP to Sta. 39+00
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data		
Mannings Coefficient	0.035	
Channel Slope	0.008205	ft/ft
Depth	3.35	ft
Left Side Slope	6.00	H : V
Right Side Slope	4.00	H : V
Discharge	300.00	cfs



Sta. 39+50 to 49+50
Worksheet for Triangular Channel

Project Description	
Worksheet	Sta 39+50 to 49+50
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.035	
Channel Slope	0.010000	ft/ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Discharge	690.00	cfs

Results		
Depth	5.38	ft
Flow Area	87.0	ft²
Wetted Perimeter	34.06	ft
Top Width	32.31	ft
Critical Depth	5.05	ft
Critical Slope	0.014062	ft/ft
Velocity	7.93	ft/s
Velocity Head	0.98	ft
Specific Energy	6.36	ft
Froude Number	0.85	
Flow Type	Subcritical	

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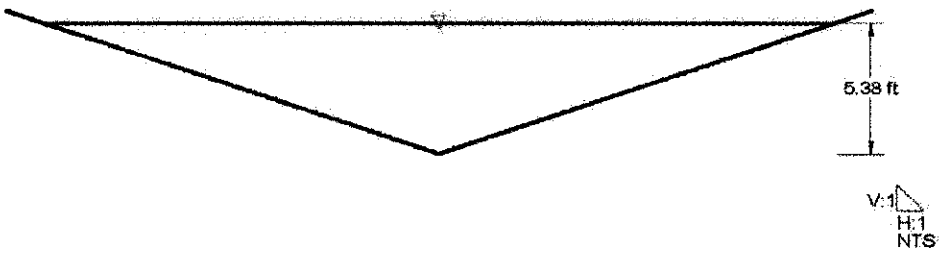
Cross Section
Cross Section for Triangular Channel

Project Description	
Worksheet	Sta 39+50 to 49+50
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data		
Mannings Coefficient	0.035	
Channel Slope	0.010000	ft/ft
Depth	5.38	ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Discharge	690.00	cfs



HYDROLOGY & GEOMORPHOLOGY, INC.

Sta. 50+00 to 61+31
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Sta. 50+00 to 61+31
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

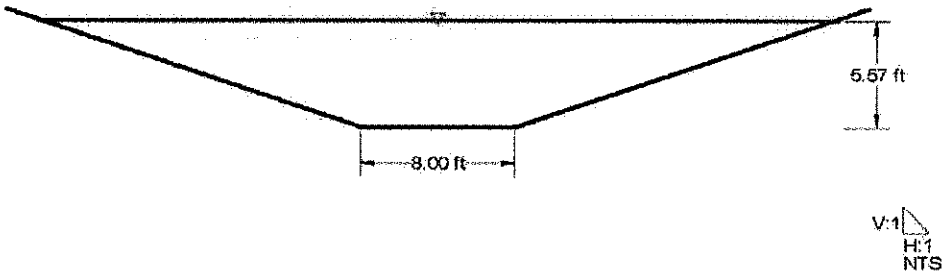
Input Data		
Mannings Coefficient	0.035	
Channel Slope	0.008417	ft/ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	8.00	ft
Discharge	1,160.00	cfs

Results		
Depth	5.57	ft
Flow Area	137.6	ft²
Wetted Perimeter	43.23	ft
Top Width	41.42	ft
Critical Depth	5.05	ft
Critical Slope	0.013010	ft/ft
Velocity	8.43	ft/s
Velocity Head	1.10	ft
Specific Energy	6.67	ft
Froude Number	0.82	
Flow Type	Subcritical	

Cross Section
Cross Section for Trapezoidal Channel

Project Description	
Worksheet	Sta. 50+00 to 81+31
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data		
Mannings Coefficient	0.035	
Channel Slope	0.008417	ft/ft
Depth	5.57	ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	8.00	ft
Discharge	1,160.00	cfs



Sta. 63+42 to 79+00
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Sta. 63+42 to 79+00
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

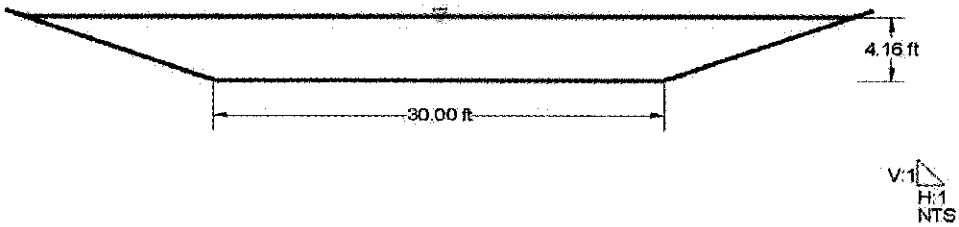
Input Data		
Mannings Coefficient	0.035	
Channel Slope	0.005181	ft/ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	30.00	ft
Discharge	1,160.00	cfs

Results		
Depth	4.16	ft
Flow Area	177.0	ft²
Wetted Perimeter	56.34	ft
Top Width	54.99	ft
Critical Depth	3.21	ft
Critical Slope	0.013376	ft/ft
Velocity	6.55	ft/s
Velocity Head	0.67	ft
Specific Energy	4.83	ft
Froude Number	0.64	
Flow Type	Subcritical	

Cross Section
Cross Section for Trapezoidal Channel

Project Description	
Worksheet	Sta. 63+42 to 79+00
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data		
Mannings Coefficient	0.035	
Channel Slope	0.005181	ft/ft
Depth	4.16	ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	30.00	ft
Discharge	1,160.00	cfs



Site 6 Conc. Channel
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Site 6 Conc. Channel
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

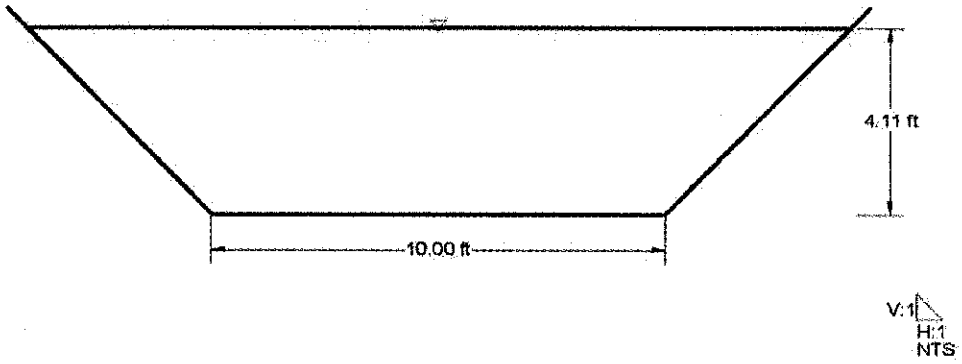
Input Data		
Mannings Coefficient	0.013	
Channel Slope	0.008205	ft/ft
Left Side Slope	1.00	H : V
Right Side Slope	1.00	H : V
Bottom Width	10.00	ft
Discharge	1,160.00	cfs

Results		
Depth	4.11	ft
Flow Area	58.0	ft²
Wetted Perimeter	21.63	ft
Top Width	18.22	ft
Critical Depth	6.07	ft
Critical Slope	0.001974	ft/ft
Velocity	19.99	ft/s
Velocity Head	6.21	ft
Specific Energy	10.32	ft
Froude Number	1.97	
Flow Type	Supercritical	

Cross Section
Cross Section for Trapezoidal Channel

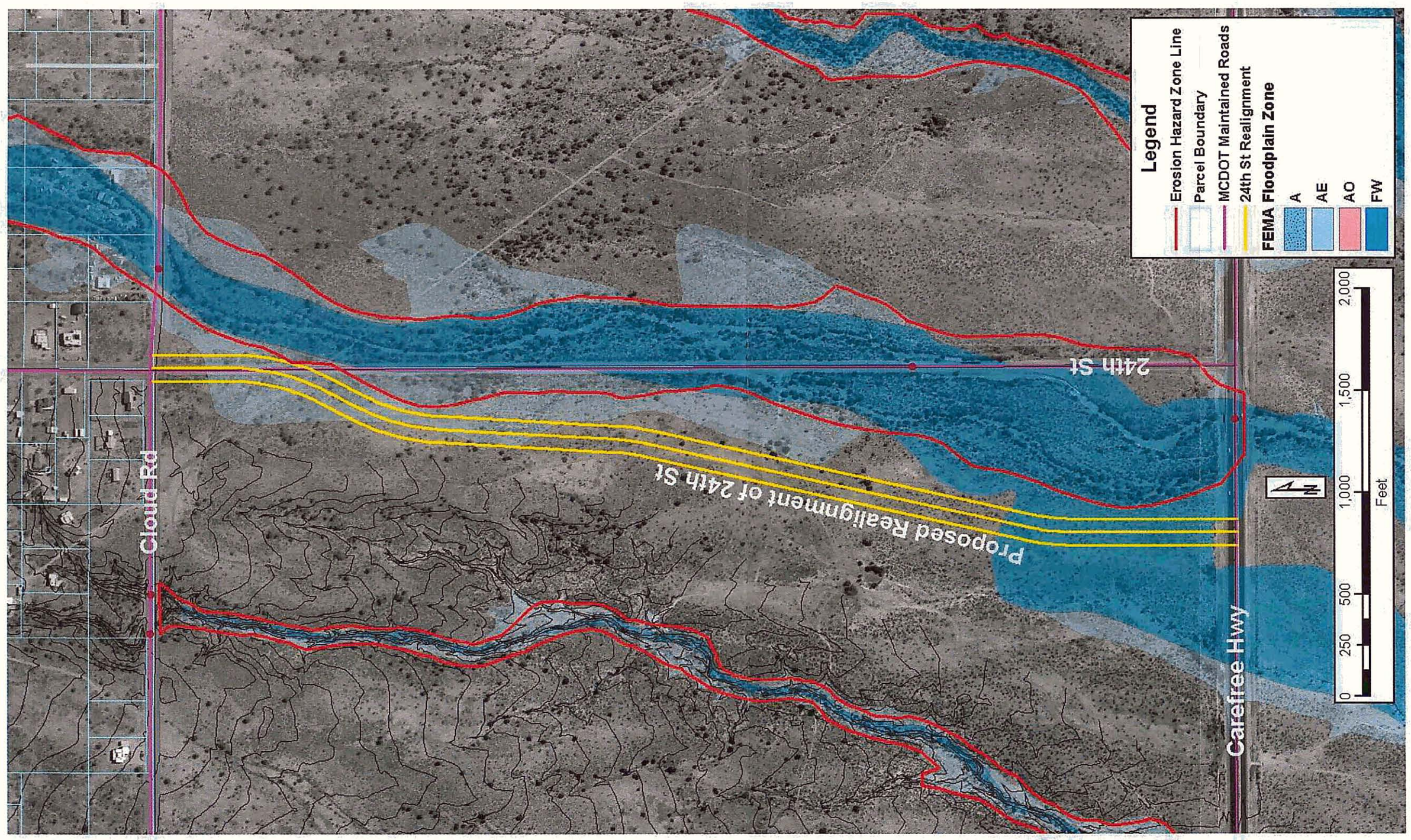
Project Description	
Worksheet	Site 6 Conc. Channel
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data		
Mannings Coefficient	0.013	
Channel Slope	0.008205	ft/ft
Depth	4.11	ft
Left Side Slope	1.00	H : V
Right Side Slope	1.00	H : V
Bottom Width	10.00	ft
Discharge	1,160.00	cfs



Site Number 7

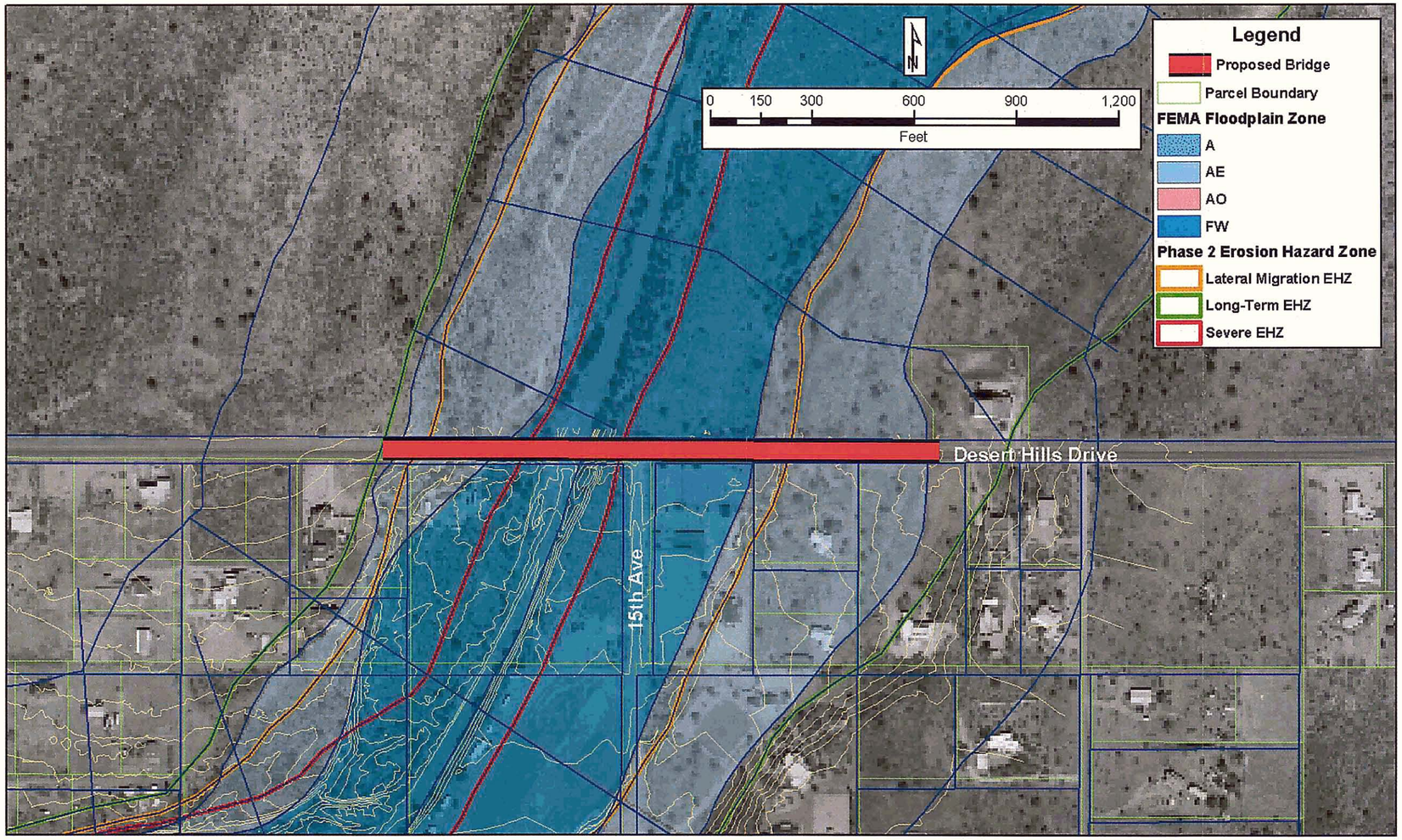
Conceptual Plan Layout for Site Number 7



This was the original concept (DH11A) for Site Number 7. More specifically 24th Street Alignment between Cloud Road and the Carefree Highway.

Site Number 8

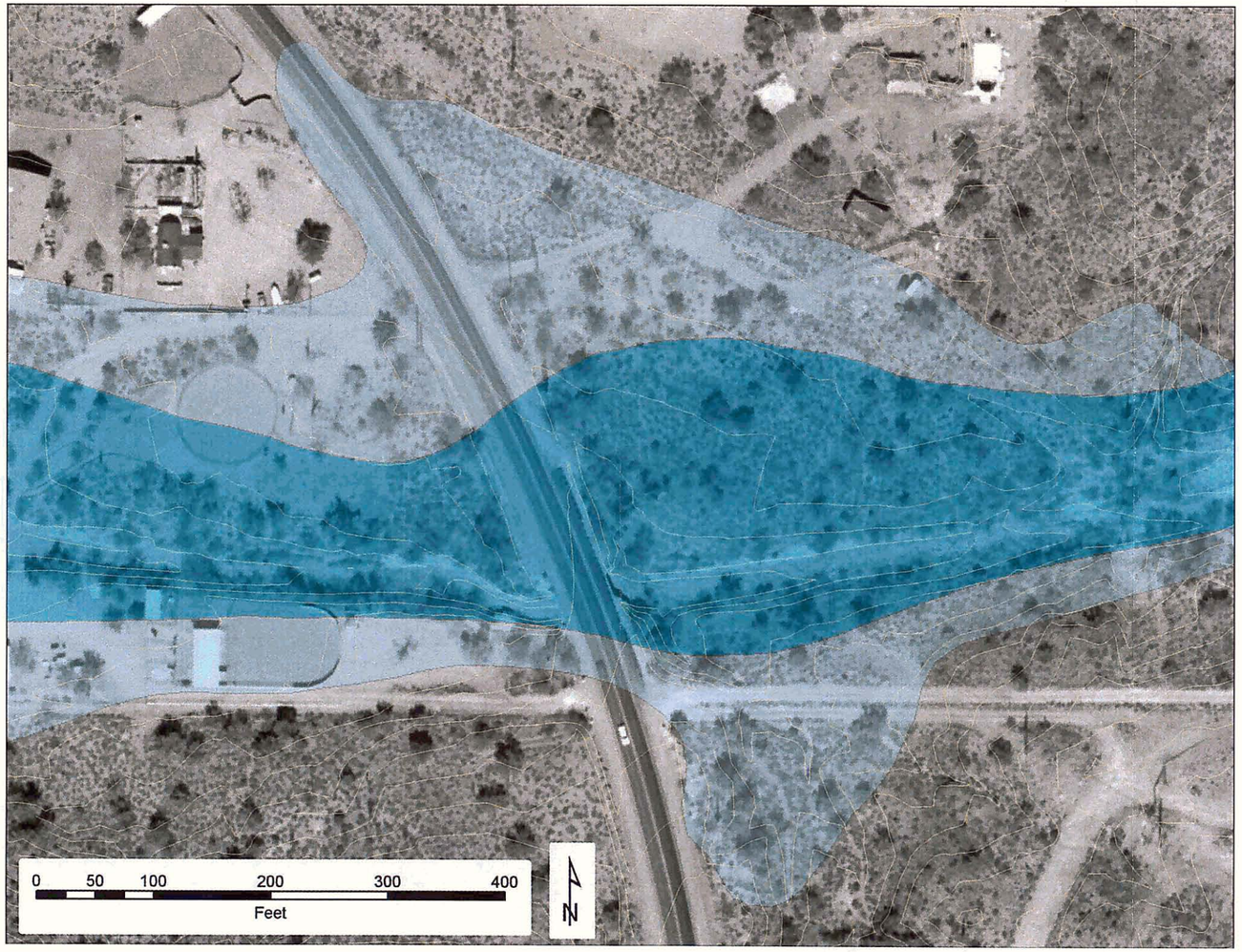
Conceptual Plan Layout for Site Number 8



This was the original concept (DH13A) for Site Number 8. More specifically Skunk Creek and Desert Hills Drive.

Site Number 9

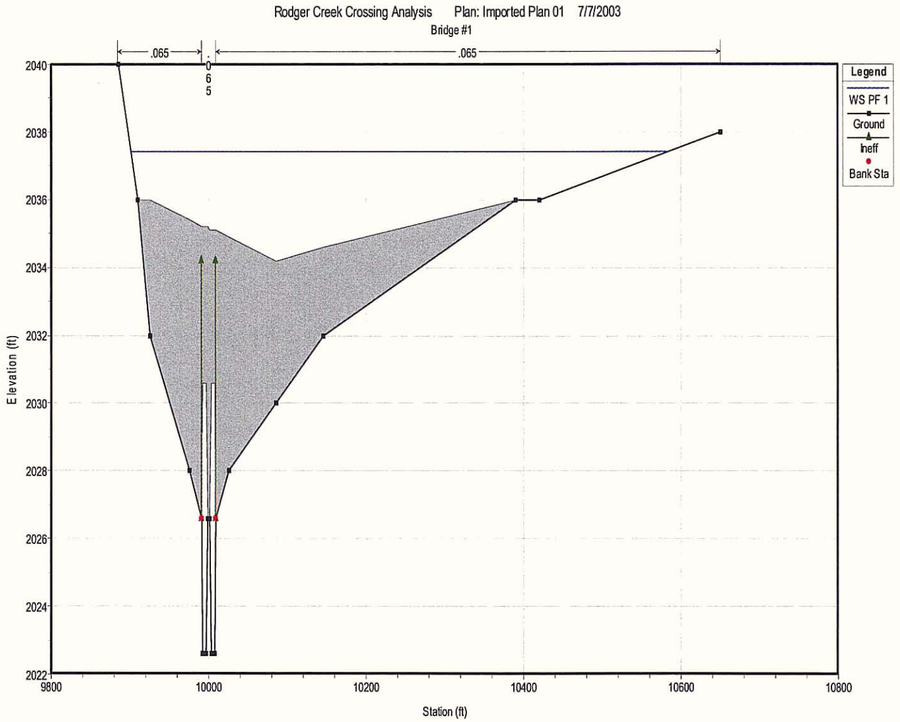
Conceptual Plan Layout for Site Number 9



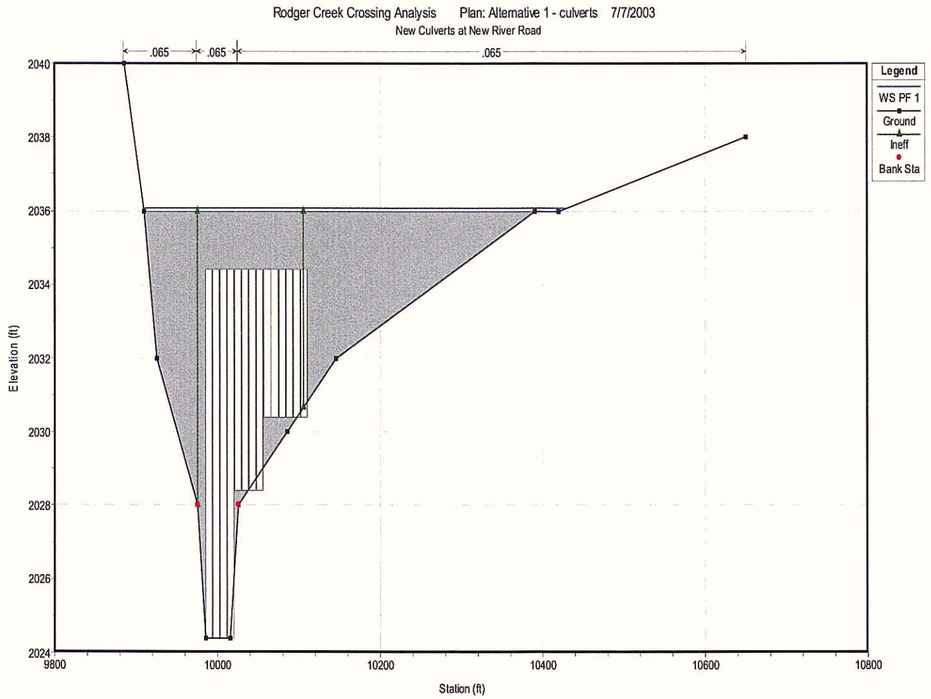
This was the original concept (NR14A) for Site Number 9. More specifically Rodger Creek and New River Road.

HECRAS Output Cross Section Associated With New Culvert Crossings

For Site Number 9



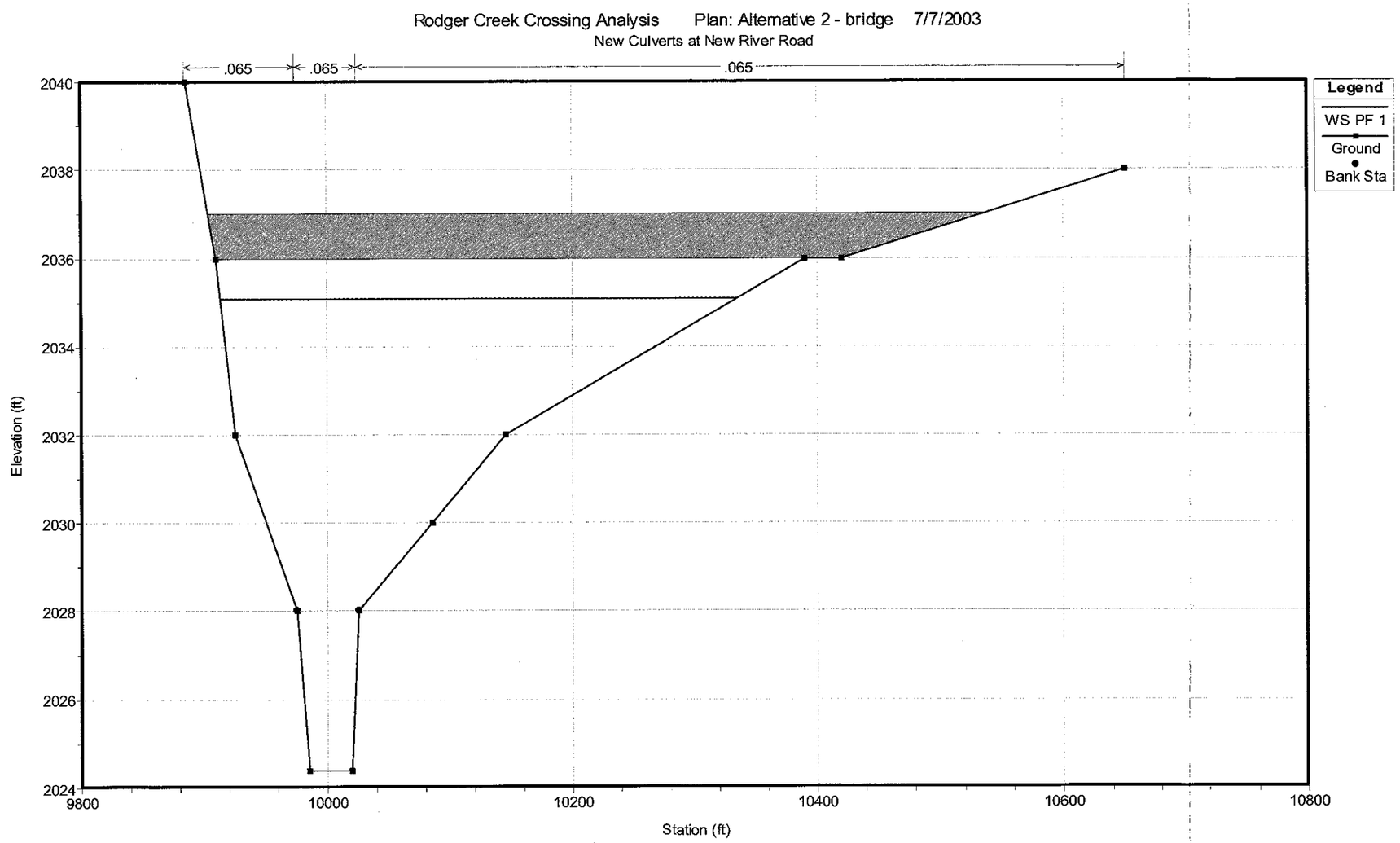
Existing Crossing at New River Road



Culvert Alternative

HECRAS Output Cross Section Associated With New Bridge Span

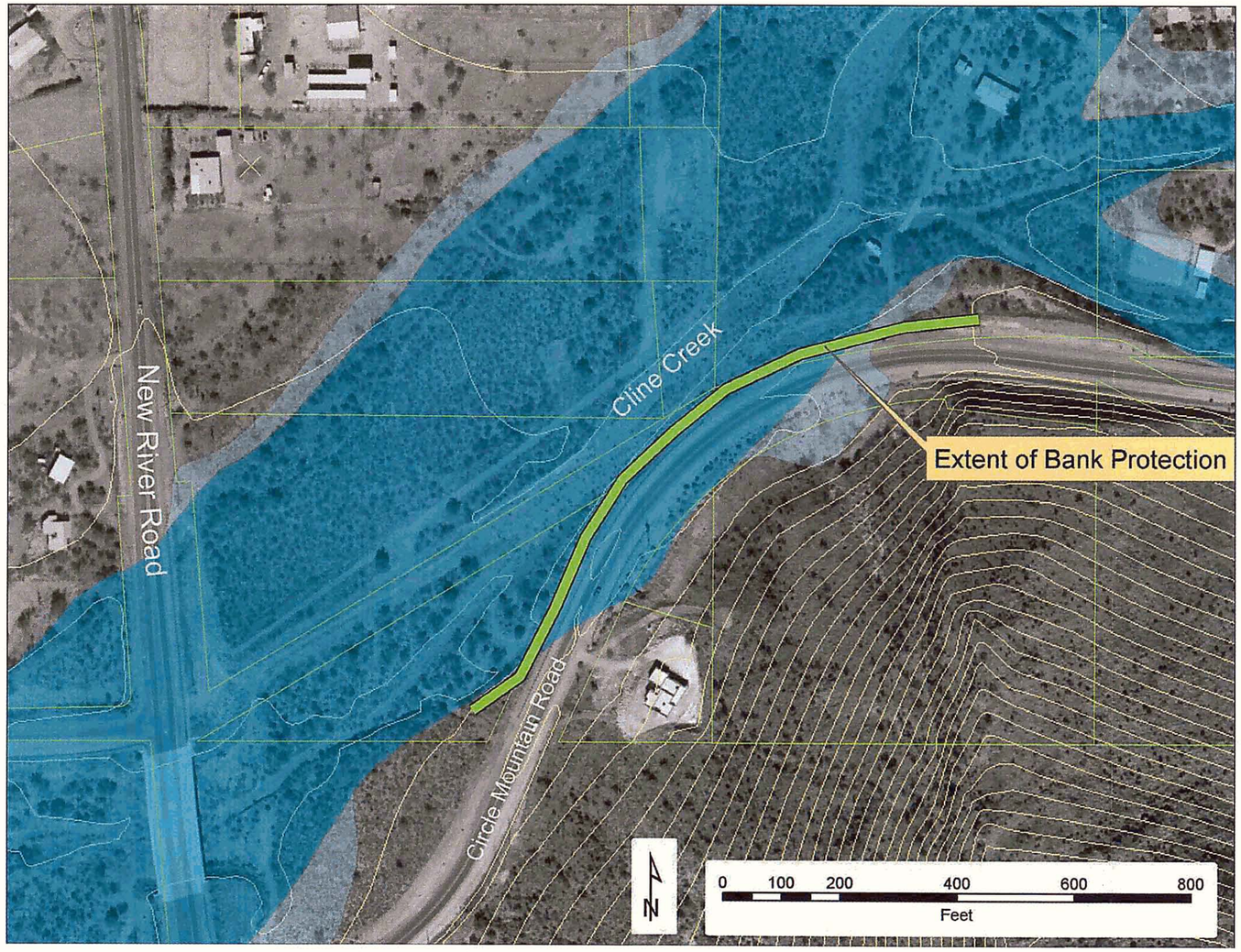
For Site Number 9



Spanning bridge

Conceptual Plan Layout for Site Number 10

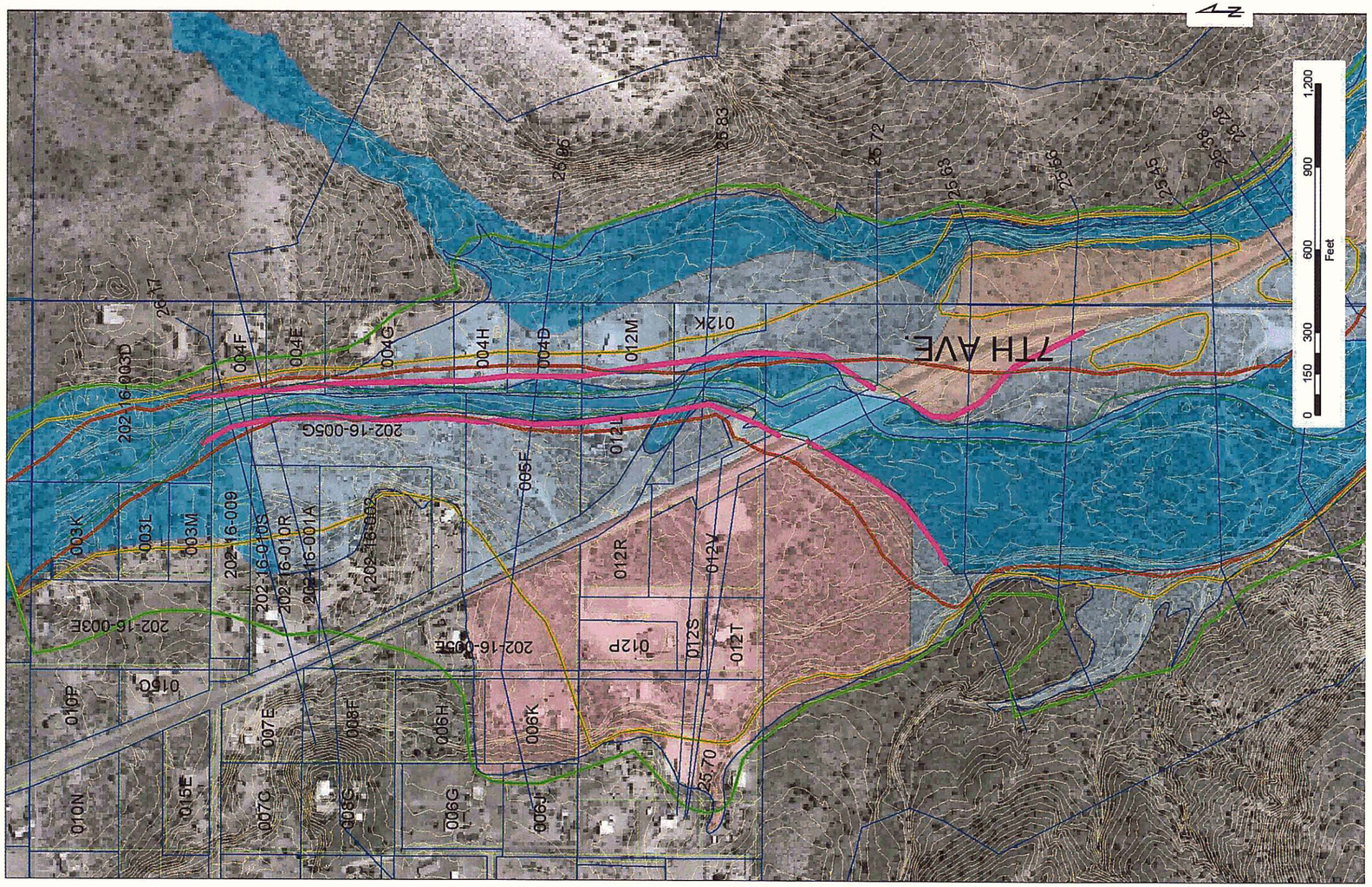
Site Number 10



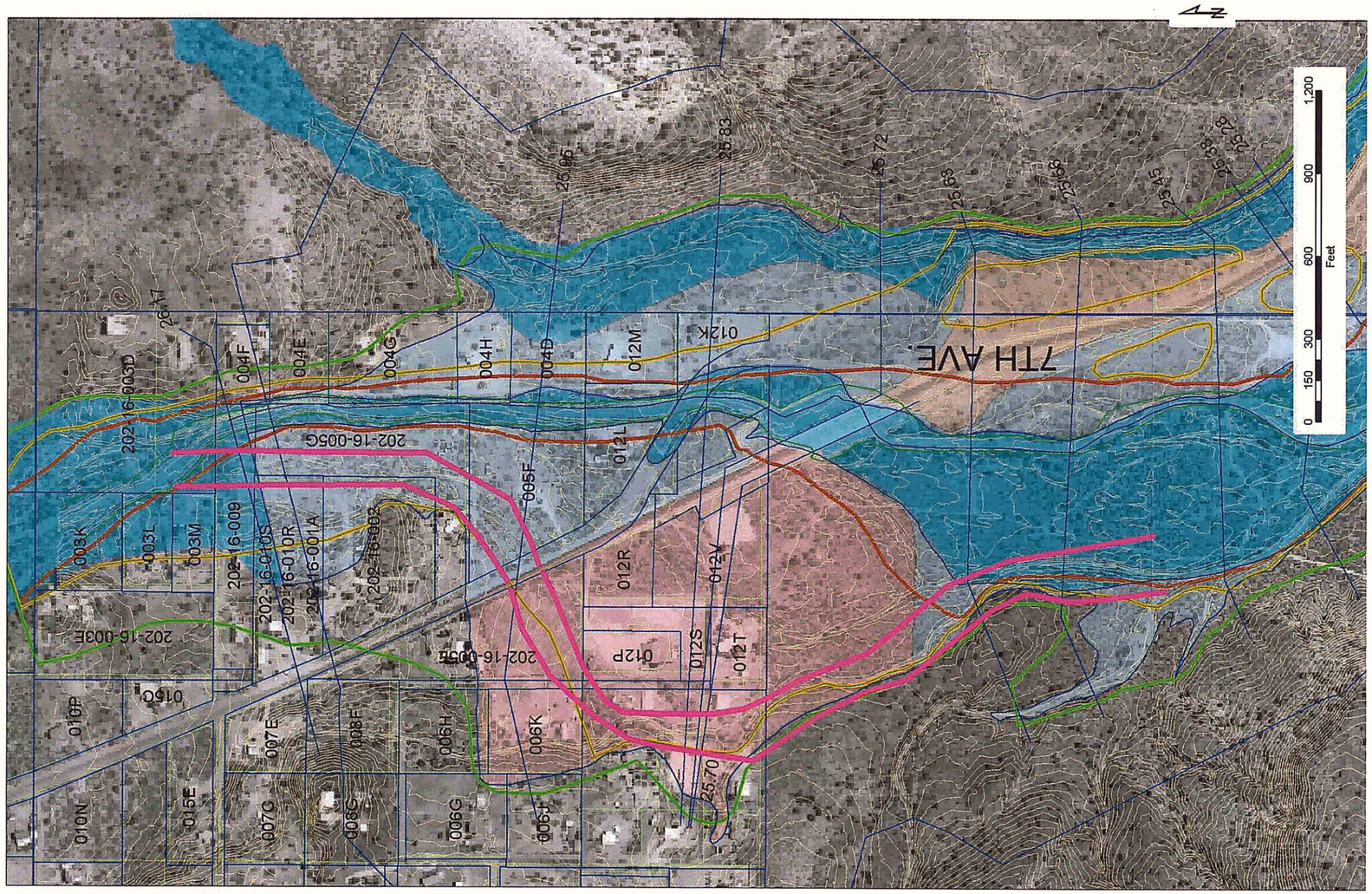
This was the original concept (NR15A, NR15B, & NR15C) for Site Number 10. More specifically Circle Mountain Road and Cline Creek.

Site Number 11

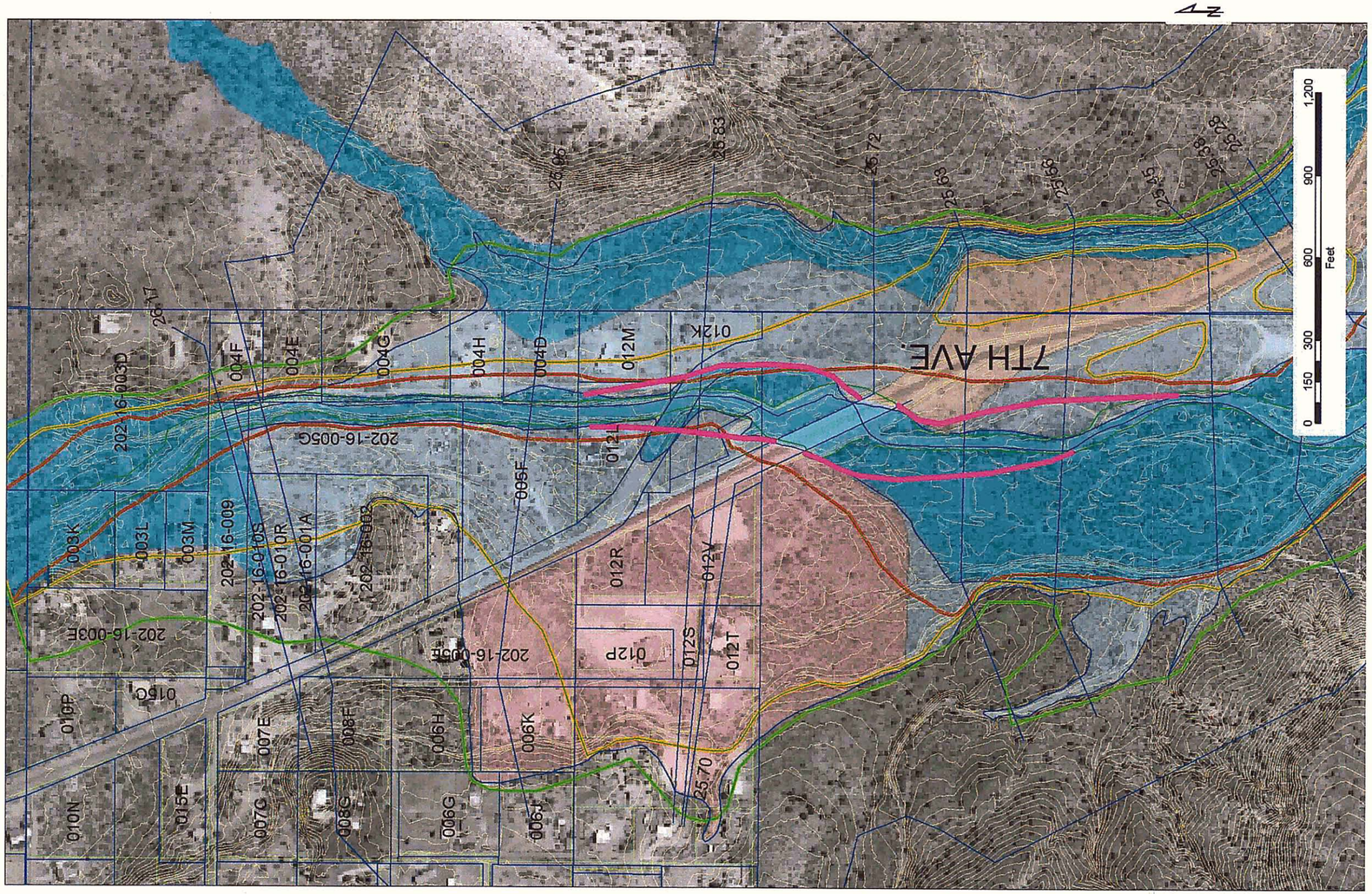
Conceptual Plan Layouts for Site Number 11



This was the original concept (NR16A) for Site Number 11. More specifically New River Road Bridge Levee Alternative One.



This was the original concept (NR16B) for Site Number 11. More specifically New River Road Bridge Levee Alternative Two.



This was the original concept (NR16C) for Site Number 11. More specifically New River Road Bridge Levee Alternative Three.

FlowMaster Output

Site 11 - 24'
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Site 11 Minimum Width
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

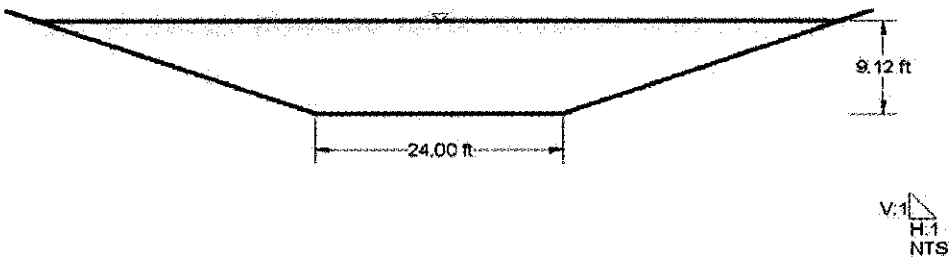
Input Data		
Mannings Coefficient	0.030	
Channel Slope	0.011133	ft/ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	24.00	ft
Discharge	7,840.00	cfs

Results		
Depth	9.12	ft
Flow Area	468.3	ft²
Wetted Perimeter	81.67	ft
Top Width	78.71	ft
Critical Depth	10.05	ft
Critical Slope	0.007410	ft/ft
Velocity	16.74	ft/s
Velocity Head	4.36	ft
Specific Energy	13.47	ft
Froude Number	1.21	
Flow Type	Supercritical	

Cross Section
Cross Section for Trapezoidal Channel

Project Description	
Worksheet	Site 11 Minimum Width
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data		
Mannings Coefficient	0.030	
Channel Slope	0.011133	ft/ft
Depth	9.12	ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	24.00	ft
Discharge	7,840.00	cfs



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Site 11 - 26'
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Site 11 - 26'
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

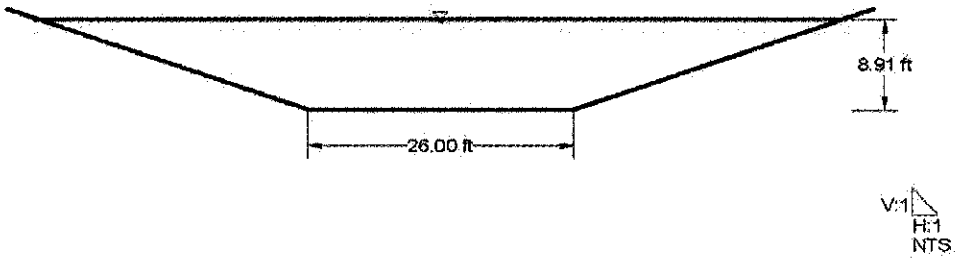
Input Data		
Mannings Coefficient	0.030	
Channel Slope	0.011133	ft/ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	26.00	ft
Discharge	7,840.00	cfs

Results		
Depth	8.91	ft
Flow Area	469.8	ft²
Wetted Perimeter	82.35	ft
Top Width	79.46	ft
Critical Depth	9.83	ft
Critical Slope	0.007412	ft/ft
Velocity	16.69	ft/s
Velocity Head	4.33	ft
Specific Energy	13.24	ft
Froude Number	1.21	
Flow Type	Supercritical	

Cross Section
Cross Section for Trapezoidal Channel

Project Description	
Worksheet	Site 11 - 26'
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data		
Mannings Coefficient	0.030	
Channel Slope	0.011133	ft/ft
Depth	8.91	ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	26.00	ft
Discharge	7,840.00	cfs



Site 11 - 28'
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Site 11 - 28'
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.030	
Channel Slope	0.011133	ft/ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	28.00	ft
Discharge	7,840.00	cfs

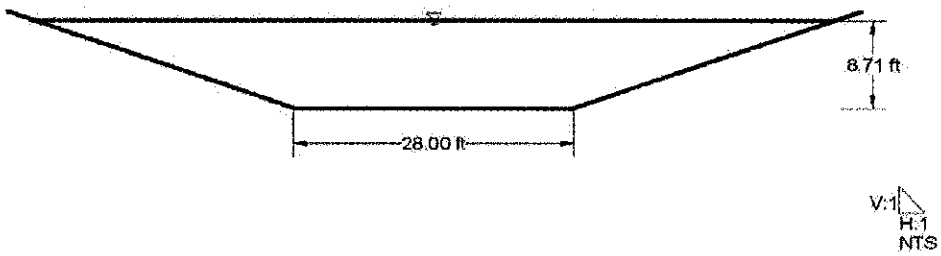
Results		
Depth	8.71	ft
Flow Area	471.5	ft²
Wetted Perimeter	83.09	ft
Top Width	80.26	ft
Critical Depth	9.62	ft
Critical Slope	0.007416	ft/ft
Velocity	16.63	ft/s
Velocity Head	4.30	ft
Specific Energy	13.01	ft
Froude Number	1.21	
Flow Type	Supercritical	

HYDROLOGY & GEOMORPHOLOGY, INC.

Cross Section
Cross Section for Trapezoidal Channel

Project Description	
Worksheet	Site 11 - 28'
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data		
Mannings Coefficient	0.030	
Channel Slope	0.011133	ft/ft
Depth	8.71	ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	28.00	ft
Discharge	7,840.00	cfs



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Site 11 - 30'
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Site 11 - 30'
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.030	
Channel Slope	0.011133	ft/ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	30.00	ft
Discharge	7,840.00	cfs

Results		
Depth	8.52	ft
Flow Area	473.3	ft²
Wetted Perimeter	83.88	ft
Top Width	81.12	ft
Critical Depth	9.42	ft
Critical Slope	0.007421	ft/ft
Velocity	16.56	ft/s
Velocity Head	4.26	ft
Specific Energy	12.78	ft
Froude Number	1.21	
Flow Type	Supercritical	

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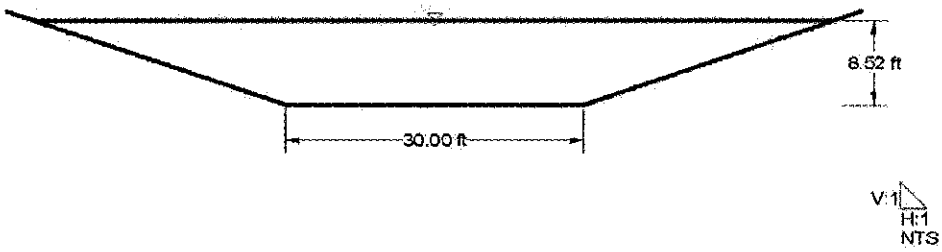
Cross Section
Cross Section for Trapezoidal Channel

Project Description	
Worksheet	Site 11 - 30'
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data		
Mannings Coefficient	0.030	
Channel Slope	0.011133	ft/ft
Depth	8.52	ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	30.00	ft
Discharge	7,840.00	cfs



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Site 11 - 32'
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Site 11 - 32'
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.030	
Channel Slope	0.011133	ft/ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	32.00	ft
Discharge	7,840.00	cfs

Results		
Depth	8.34	ft
Flow Area	475.2	ft²
Wetted Perimeter	84.72	ft
Top Width	82.01	ft
Critical Depth	9.23	ft
Critical Slope	0.007426	ft/ft
Velocity	16.50	ft/s
Velocity Head	4.23	ft
Specific Energy	12.57	ft
Froude Number	1.21	
Flow Type	Supercritical	

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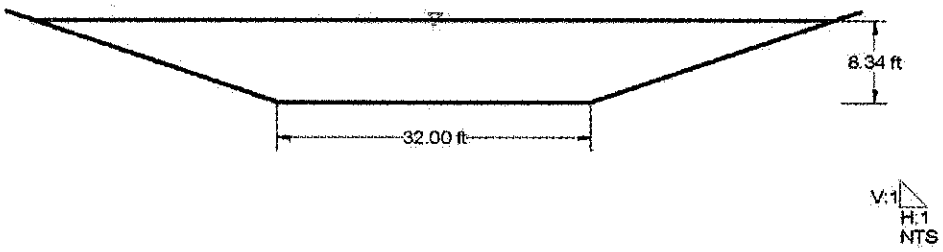
Cross Section
Cross Section for Trapezoidal Channel

Project Description	
Worksheet	Site 11 - 32'
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data		
Mannings Coefficient	0.030	
Channel Slope	0.011133	ft/ft
Depth	8.34	ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	32.00	ft
Discharge	7,840.00	cfs



JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC.

Site 11 - 34'
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Site 11 - 34'
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

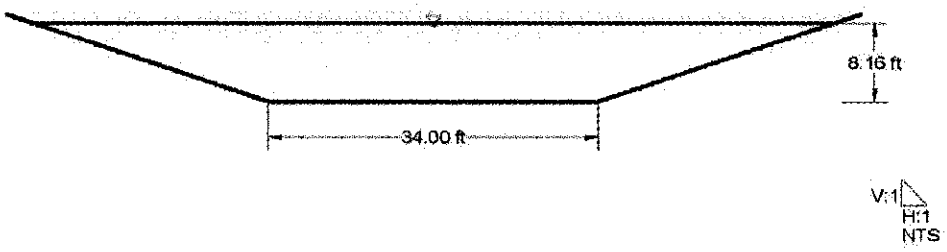
Input Data		
Mannings Coefficient	0.030	
Channel Slope	0.011133	ft/ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	34.00	ft
Discharge	7,840.00	cfs

Results		
Depth	8.16	ft
Flow Area	477.2	ft²
Wetted Perimeter	85.61	ft
Top Width	82.96	ft
Critical Depth	9.04	ft
Critical Slope	0.007433	ft/ft
Velocity	16.43	ft/s
Velocity Head	4.19	ft
Specific Energy	12.35	ft
Froude Number	1.21	
Flow Type	Supercritical	

Cross Section
Cross Section for Trapezoidal Channel

Project Description	
Worksheet	Site 11 - 34'
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data		
Mannings Coefficient	0.030	
Channel Slope	0.011133	ft/ft
Depth	8.16	ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	34.00	ft
Discharge	7,840.00	cfs



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Site 11 - 36'
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Site 11 - 36'
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.030	
Channel Slope	0.011133	ft/ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	36.00	ft
Discharge	7,840.00	cfs

Results		
Depth	7.99	ft
Flow Area	479.3	ft²
Wetted Perimeter	86.54	ft
Top Width	83.95	ft
Critical Depth	8.86	ft
Critical Slope	0.007440	ft/ft
Velocity	16.36	ft/s
Velocity Head	4.16	ft
Specific Energy	12.15	ft
Froude Number	1.21	
Flow Type	Supercritical	

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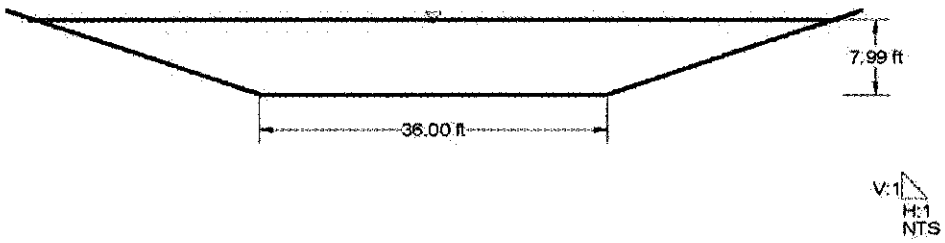
Cross Section
Cross Section for Trapezoidal Channel

Project Description	
Worksheet	Site 11 - 35'
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data		
Mannings Coefficient	0.030	
Channel Slope	0.011133	ft/ft
Depth	7.99	ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	36.00	ft
Discharge	7,840.00	cfs



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Site 11 - 38'
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Site 11 - 38'
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.030	
Channel Slope	0.011133	ft/ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	38.00	ft
Discharge	7,840.00	cfs

Results		
Depth	7.83	ft
Flow Area	461.4	ft²
Wetted Perimeter	87.52	ft
Top Width	84.98	ft
Critical Depth	8.68	ft
Critical Slope	0.007449	ft/ft
Velocity	16.29	ft/s
Velocity Head	4.12	ft
Specific Energy	11.95	ft
Froude Number	1.21	
Flow Type	Supercritical	

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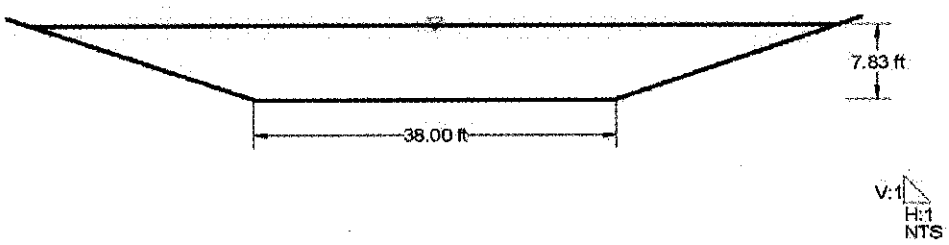
Cross Section
Cross Section for Trapezoidal Channel

Project Description	
Worksheet	Site 11 - 38'
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data		
Mannings Coefficient	0.030	
Channel Slope	0.011133	ft/ft
Depth	7.83	ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	38.00	ft
Discharge	7,840.00	cfs



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Site 11 - 40'
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Site 11 - 40'
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.030	
Channel Slope	0.011133	ft/ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	40.00	ft
Discharge	7,840.00	cfs

Results		
Depth	7.67	ft
Flow Area	463.7	ft²
Wetted Perimeter	88.54	ft
Top Width	86.05	ft
Critical Depth	8.52	ft
Critical Slope	0.007458	ft/ft
Velocity	16.21	ft/s
Velocity Head	4.08	ft
Specific Energy	11.76	ft
Froude Number	1.21	
Flow Type	Supercritical	

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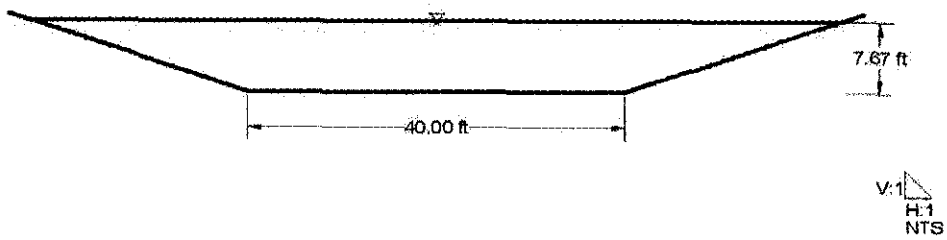
Cross Section
Cross Section for Trapezoidal Channel

Project Description	
Worksheet	Site 11 - 40'
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data		
Mannings Coefficient	0.030	
Channel Slope	0.011133	ft/ft
Depth	7.67	ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	40.00	ft
Discharge	7,840.00	cfs



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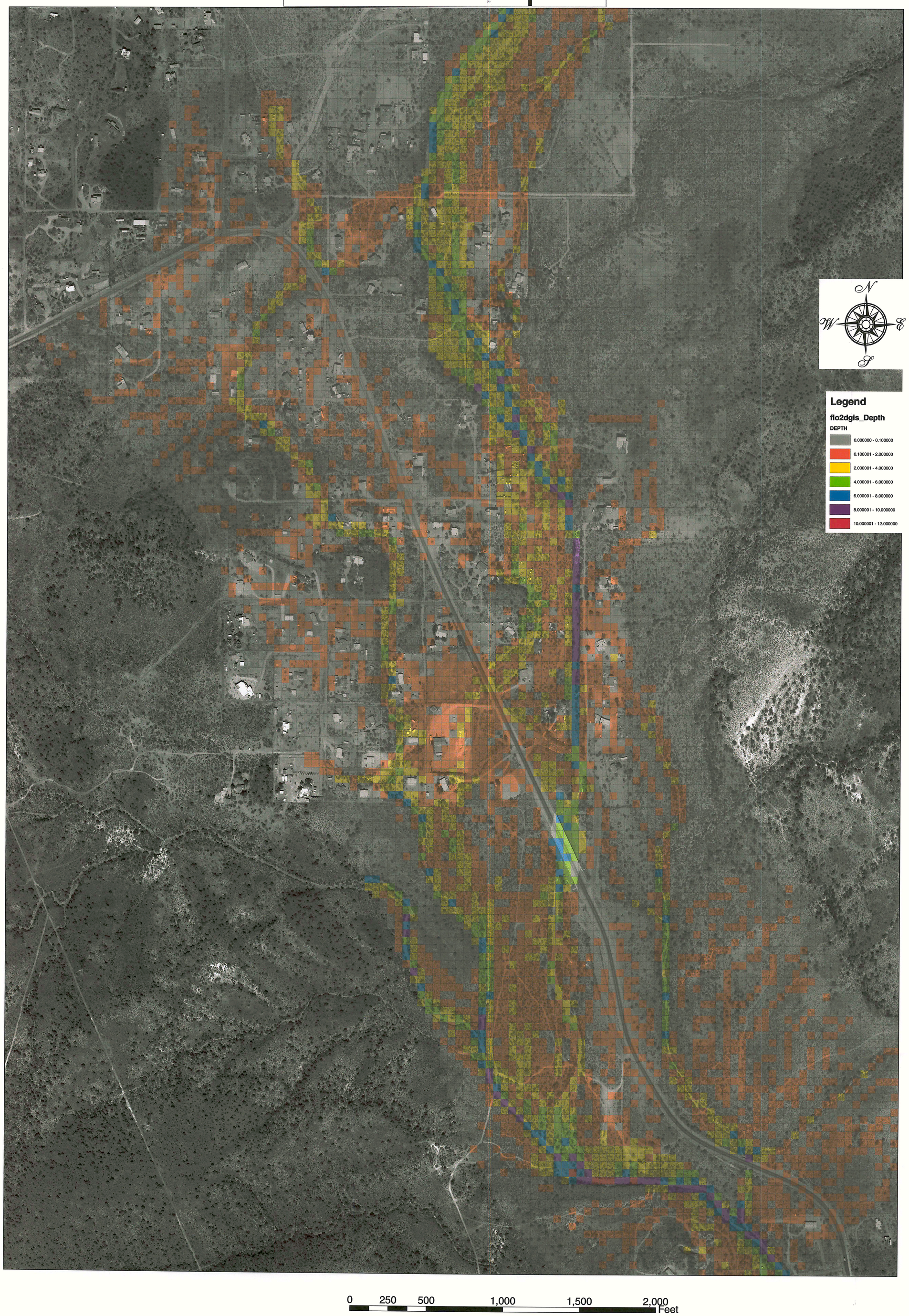
FLO-2D Exhibits for Site Number 11

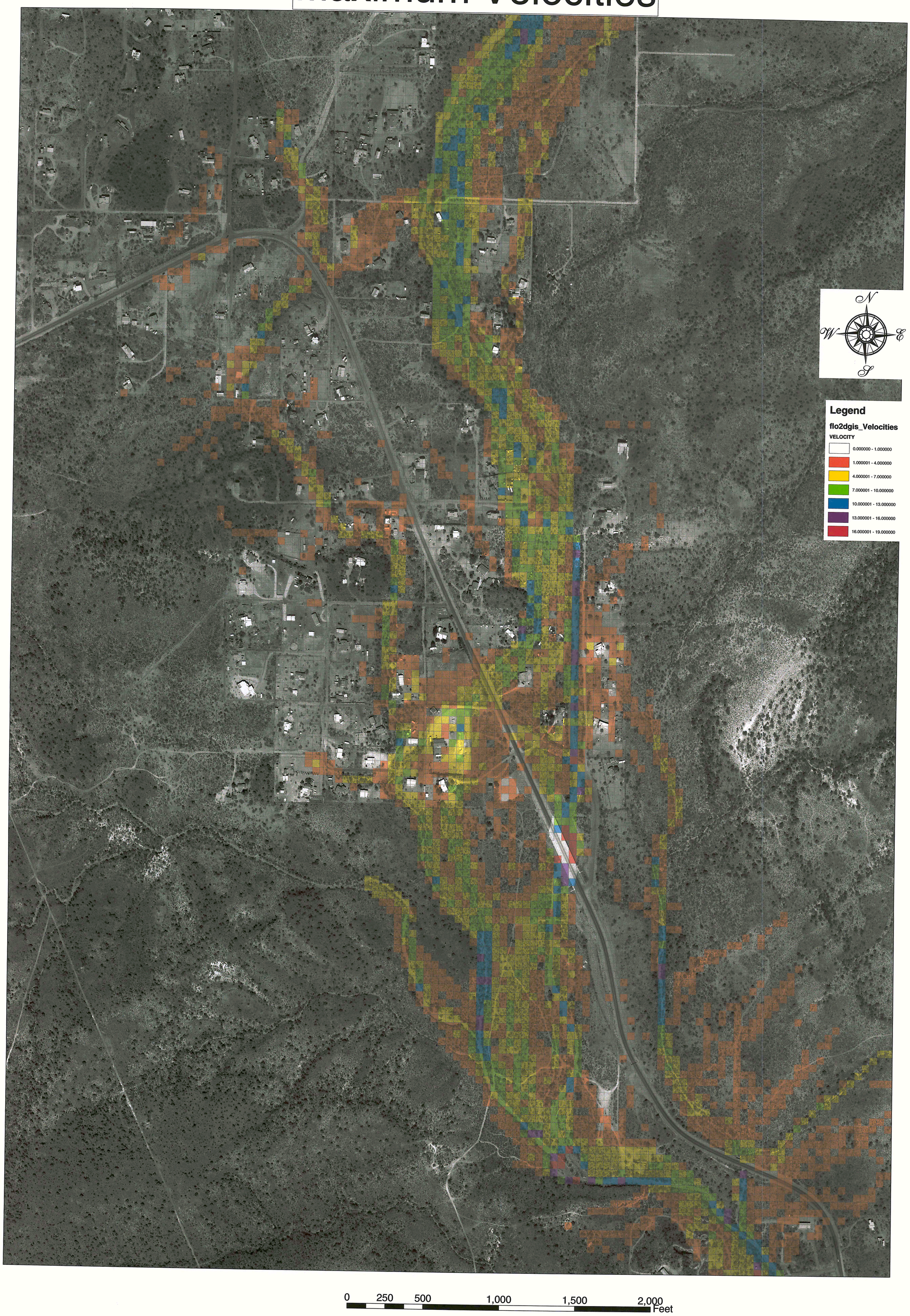
Maximum Depths

Maximum Depths



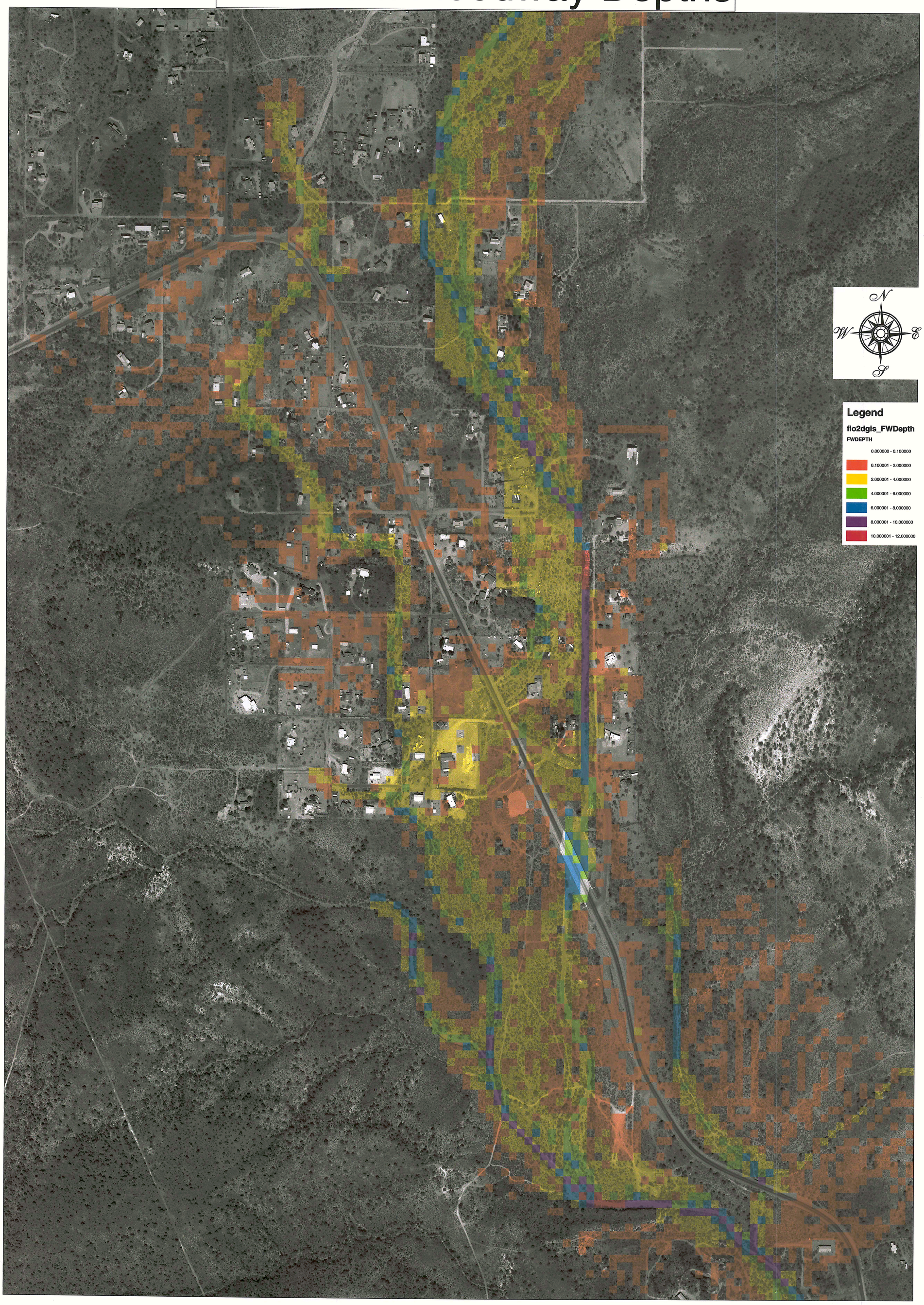
Maximum Velocities

Maximum Velocities



Maximum Floodway Depths

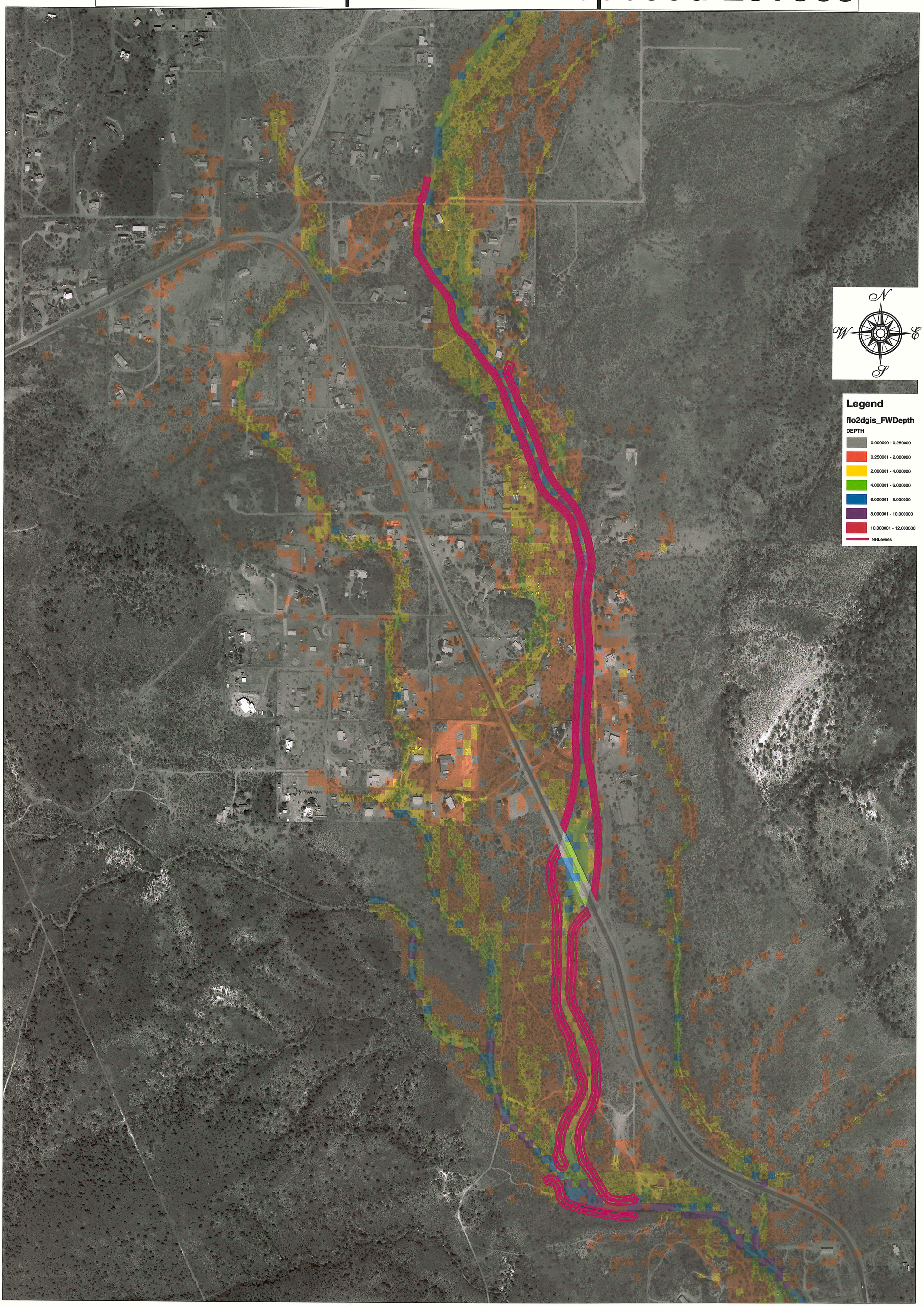
Maximum Floodway Depths



0 250 500 1,000 1,500 2,000 Feet

Maximum Depths With Proposed Levees

Maximum Depths With Proposed Levees



0 250 500 1,000 1,500 2,000 Feet

Site Number 12

CLW Letter to JEF Regarding Site Number 12

C.L. WILLIAMS CONSULTING, INC.
CIVIL ENGINEERING AND RESOURCE MANAGEMENT

March 30, 2004

Ms. Patricia Q. Deschamps, P.E.
JE Fuller Hydrology & Geomorphology, Inc.
6101 South Rural Rd.
Suite 110
Tempe, Arizona 85283

RE: Conceptual Design Comments
Site 12 – Desert Hills Wash at Cloud Road
Adobe Dam/Desert Hills Area Drainage Master Plan
Project 002-01-08

Dear Ms. Deschamps:

C.L. Williams Consulting has undertaken the conceptual design phase for the above site and found that the recommended design alternative, as outlined within Volume 1 of the *Alternatives Formulation and Preliminary Analysis*, is not feasible based on the following information and analyses results.

Primary Alternative

The primary alternative, as described within the summary of alternatives for Desert Hills section of the above report for Description Number DH9A, is an "off-line" detention basin located immediately south of Cloud Road at Desert Hills wash that results in an outlet peak discharge of approximately 1,200 cubic feet per second (cfs).

Given the incoming peak discharge of 3,296 cfs and an overall incoming volume of 339 acre-feet (ac-ft), a detention basin with an average depth of six (6) feet would require a surface area of approximately 36 acres and therefore appears not to be feasible given the project goal for this location. The incoming peak discharge and volume are described by HEC-1 ID C116 of the HEC-1 model dh1006f.ih1 given to CLW by JEF.

CLW has evaluated two other alternative detention systems immediately upstream of Cloud Road and again given the required surface area these alternatives do not appear to be feasible as well. Please see the enclosed exhibit for all alternatives and related information.

4720 WEST MAVERICK LANE
SUITE 103
LAKESIDE, ARIZONA 85929

TEL: 928-368-2248
FAX: 928-368-8704
www.clwilliams.net

Conceptual Design Comments
Site 12 – Desert Hills Wash at Cloud Road
Adobe Dam/Desert Hills Area Drainage Master Plan
Page 2 of 2

Please advise CLW if you wish us to prepare other alternatives for this site. If you have any questions or comments please feel free to call me at (928) 368-2248.

Sincerely,

Chuck Williams

Chuck Williams, P.E.
Principal

Draft

DEVELOPMENT GUIDELNES for INDIVIDUAL SINGLE-FAMILY LOTS

DEVELOPMENT GUIDELINES FOR INDIVIDUAL SINGLE-FAMILY LOTS
Part 8, Volume 4, Section 2

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Appendix B: Development Guidelines Checklist

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SECTION 1: INTRODUCTION

1.1 Applicability

Development guidelines are a work product of an Area Drainage Master Plan (ADMP). This plan is based on an Area Drainage Master Study (ADMS) which develops hydrology for a watershed, identifies potential flood prone areas and drainage problems, and identifies alternatives for solving these problems. There are 48 identified study areas within the jurisdiction of the Flood Control District of Maricopa County (FCDMC). To date, there have been 32 studies completed and the remainder are projected to be completed by 2010. See Figure 1.1.1 for the general boundaries of all 48 study areas.

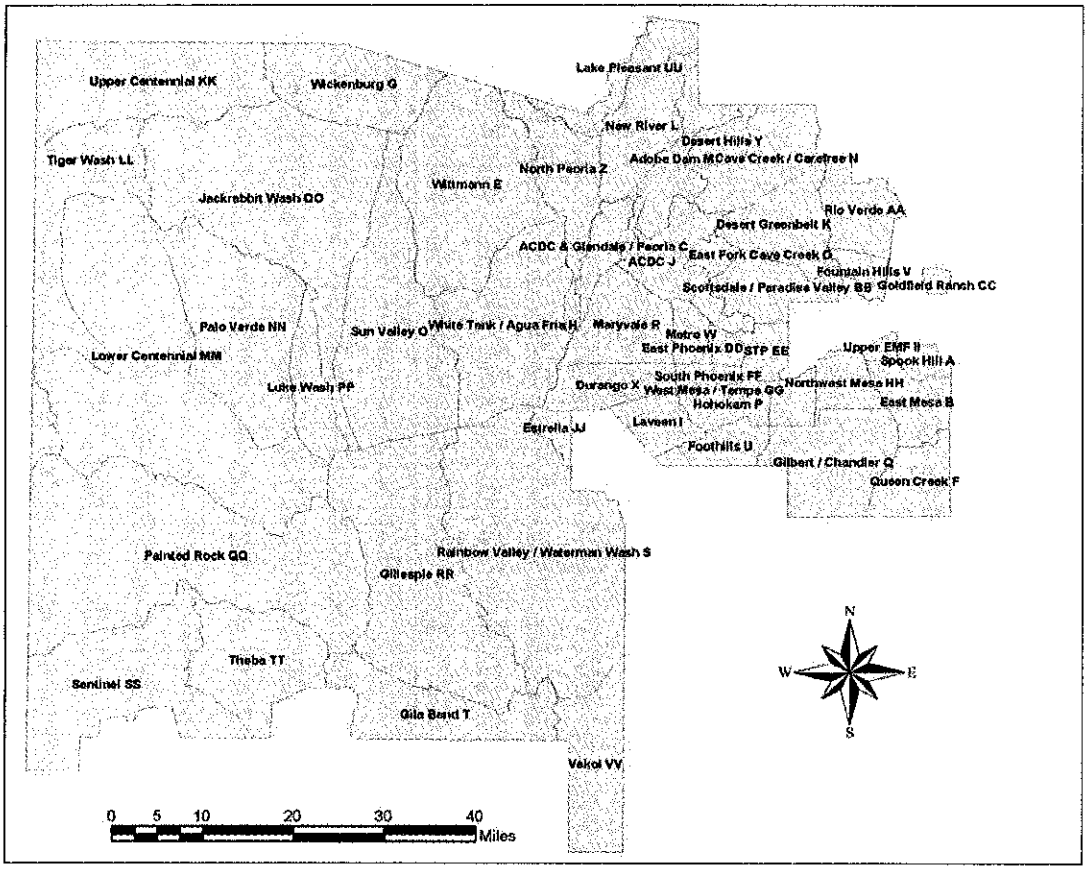


Figure 1.1.1 Maricopa County Drainage Study Areas

The ADMP takes the information from the ADMS and analyzes the alternatives to reach a preferred solution. The solutions proposed are both structural (such as levees, basins, culverts and channels) and non-structural (such as development guidelines, flood warning system, and property acquisition) in nature.

The Adobe Dam/Desert Hills study area is located in the north central portion of the Phoenix metropolitan area (see Figure 1.1.2). The southern half of the study area lies predominantly within the incorporated limits of the City of Phoenix. The Town of Cave Creek covers a small area in the northeastern portion of the study area. The majority of the northern portion of the study area is unincorporated Maricopa County.

Counties lack the regulatory authority to manage lot splits. As a result, these types of land division are exempt from subdivision and/or other improvement requirements. Although impacts from lot split development may appear relatively insignificant when viewed on the individual lot basis, frequently the cumulative impact of such external impacts is much more significant. Counties have greater ability to review residential subdivisions, multi-family, industrial and commercial projects to address potential impacts on adjacent properties. Cities have the authority to review and require compliance with development standards for the above projects, as well as individual lots.

In reviewing these issues, it became apparent that development guidelines would have the most positive affect on single-family development on individual lots within the unincorporated areas of Maricopa County. Therefore, the analysis of the types of potential regulations was done with a specific focus on the nature of single-family development on individual lots.

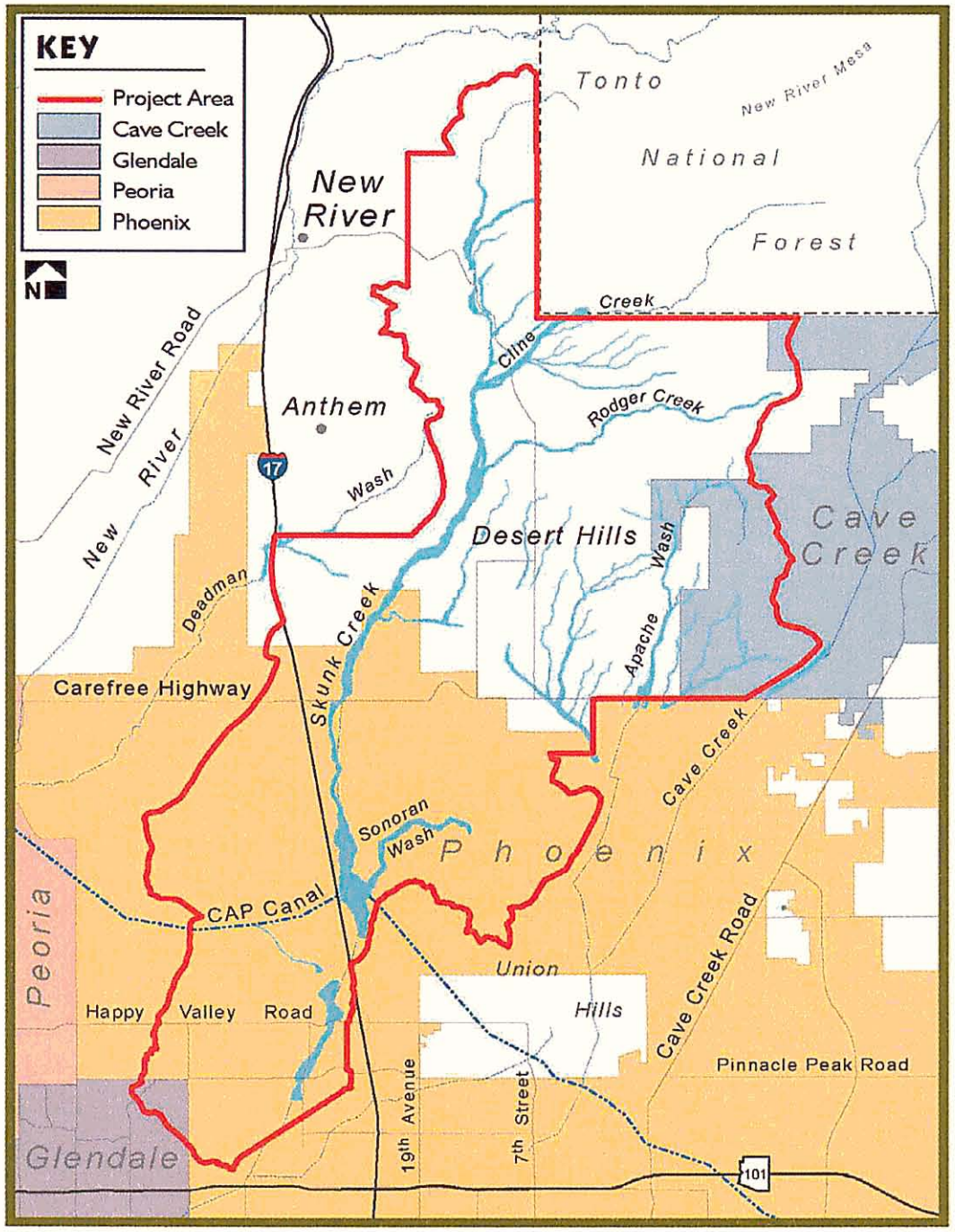


Figure 1.1.2 Adobe Dam/Desert Hills Study Area

1.2 Development Guidelines Objectives

The Adobe Dam/ Desert Hills ADMP identifies flooding and erosion hazards in the New River and Desert Hills areas and recommends measures to mitigate those hazards. Both structural and non-structural measures are component parts of the recommended alternative plan for addressing drainage and flooding problems. The development guidelines are one of the non-structural components of the alternative plan. The general objectives of the development guidelines include the following:

General Objectives

- Enhance public safety by guiding development in the watershed to protect current and future residents from the effects of flooding.
- Reduce adverse drainage impacts due to development in the watershed by guiding activities of new residents so that future runoff to Skunk Creek is maintained at current conditions and downstream neighbors are not negatively impacted.
- Guide future development in a manner consistent with the recommended alternative plan of the Adobe ADMP.

The following specific objectives were established to guide the development of the recommended criteria as presented herein and their means of implementation:

Specific Objectives

- Use existing aerial photography, topographic data, and parcel database resources to the maximum extent possible.
- Use available resources and the work products of the ADMP, including floodplain delineations, geomorphic evaluation, and identification of drainage problems, as input to the review required for each permit application.
- Develop guidelines that have been tested against the actual environmental and development conditions within the study area.
- Provide the consumer with a development guidelines checklist to minimize cost and time investments for all parties.

- Provide a means for flexibility in the review process so that drainage permit applicants may proceed with lot development incorporating drainage features that do not explicitly meet the development guidelines provided they are designed and sealed by a registered professional engineer, and reviewed and approved by the District.

- Develop guidelines consistent and compatible with existing statutes, ordinances, and regulations.

- Limit the guidelines to solely those necessary to address watershed-specific problems not adequately covered by existing Floodplain and/or Drainage Regulations.

The proposed development guidelines for the Adobe Dam/Desert Hills ADMP are consistent with the general and specific objectives set forth above.

1.3 Summary and Conclusions

A careful analysis of area development trends and regulatory options was conducted to identify specific issues that were not addressed by the existing drainage and floodplain regulations. It became apparent that single-family development on individual lots within unincorporated areas was the one category with insufficient standards to address the cumulative impacts of this type of development. See Appendix A for a discussion of the statutory basis of the development guidelines.

This analysis documented the existing practices and procedures and carefully integrated a unique toolkit to address individual single-family lot development in the study area. An option is also available for individuals to obtain approval for variations to the regulations if a higher degree of drainage analysis is provided by a registered professional engineer in order to justify the proposed change(s). By providing this degree of flexibility, both the public and FCDMC staff will benefit from these proposed Development Guidelines.

SECTION 2: DEVELOPMENT GUIDELINES

2.1 Overview

A number of tools or criteria were evaluated for application to single-lot development in the Adobe Dam/ Desert Hills ADMP study area. The tools were evaluated based on their hydrologic efficacy, long-term viability, and their potential for implementation. Seven types of tools, or development guidelines, relating to single-family, individual lot development were examined:

- Drainageways
- (Erosion Hazard) Setbacks
- Finished Floor Elevations
- Disturbance Envelopes
- Culverts, Driveways, & Roads
- Walls, Fences, & Berms
- Retention

Based on this investigation, development guidelines were created for each of the categories listed above. A development guidelines checklist is provided in Appendix B for use by developers and landowners as a guide to construction on their property. These guidelines are shown, in bold, below. The technical basis for these guidelines may be found in Appendix C.

2.2 Drainageways

Development Guideline – Drainageways
A detailed drainage analysis prepared by a licensed civil engineer shall be submitted for properties crossed by a drainageway or located within 150 feet on either side of a drainageway to verify that proposed improvements will not negatively alter pre-development drainage conditions.

The primary use of the drainageways will be as a tool to quickly determine which parcels may require more detailed engineering analysis prior to processing a permit for development.

Submittals for parcels outside of the drainageway influence area and which comply with all development guidelines and drainage regulations would be limited to a site plan and general drainage information. However, parcels within the influence area, or those seeking to deviate from a development guideline, would require a detailed drainage analysis prepared by a licensed civil engineer.

2.3 Erosion Hazard Setbacks

> ***Development Guideline – Erosion Hazard Setbacks***
> **Properties crossed by a delineated wash with a detailed erosion hazard zone shall comply with the erosion hazard setbacks set forth in the *Riverine Erosion Hazard Delineation and Development Guidelines* (FCDMC, 200X).**

An erosion hazard setback shall be identified for any parcel crossed by or adjacent to "a delineated floodplain and watercourses or contributing watersheds that have flows greater than 50 cfs during a 100-year flood event." All of the existing FEMA floodplain delineations and those being conducted as part of the ADMP have, or will have, a detailed erosion hazard zone identified for them. Any drainageway that carries more than 50 cfs in the 100-year flood event (i.e., subject to the Floodplain Regulation) will also need to have an erosion hazard setback assessment prior to development. The erosion setback shall be determined using the District's draft *Riverine Erosion Hazard Delineation and Development Guidelines*. These guidelines describe a three-level approach. Generally, additional information and analysis are required to reduce the required setback distance without erosion protection measures. A minimum setback of 15 ft or 2 times the bank height, whichever is greater, is required per the draft erosion hazard guidelines. Structural measures for erosion hazard mitigation are also presented in the guidelines.

2.4 Disturbance Envelope

Development Guidelines – Disturbance Envelope

- **No more than 50% of the site may be disturbed, and all improvements (including, but not limited to, roof-bearing structures, retention, cleared and grubbed areas such as horse corrals, landscaping with permanent irrigation, and areas with impervious ground cover and/or barriers that preclude infiltration) shall be located within this area.**
- **Boundaries of the disturbed area must be delineated on the property with permanent markers.**
- **Temporary disturbance in excess of the 50% is allowed for utility installation, temporary construction access, and temporary stockpiling of construction related materials. Revegetation of these areas is required and must be completed prior to final certificate of occupancy.**

A disturbance envelope is a contiguous spatial limit on a lot which may be altered from its natural state as part of the development of the lot. The rationale for the disturbance envelope is that the removal of vegetation and other disturbance of the natural ground results in an adverse impact on storm water runoff from the lot. Namely, rainfall is no longer intercepted by the native plants and consequently becomes runoff. In addition, plant roots and other biological activity associated with the plant increase the rate at which rainfall soaks into the soil. The combined result is an increase in both the magnitude and frequency of runoff from the disturbed area. Another consequence of the disturbance of the natural areas is a disruption and elimination of habitat for native desert species.

2.5 Culverts, Driveways, Roads

Development Guidelines – Culverts, Driveways, Roads

- **Dip crossings should be used for driveways and local streets unless it can be demonstrated that culverts are necessary due to the depth and/or velocity of flows.**
- **All culverts and bridged crossings should be designed to minimize the disruption of sediment transport continuity upstream and downstream of the crossing. Crossings that mimic the natural channel's depth and width within the reach being crossed will be most successful.**
- **Lowering of the local channel bottom elevation is discouraged.**
- **Roadways shall be designed so as not to divert flows.**

Dip crossings are preferred to culvert crossings for access on driveways and local streets. Arterial streets should be designed in accordance with existing County criteria. However in addition to the design levels prescribed in those criteria, all culverts or bridged crossings should be designed to minimize disruption of sediment transport continuity upstream and downstream of the crossing. Crossings that mimic the natural channel's depth and width within the reach being crossed will be most successful. Lowering of local channel bottom elevations is also discouraged. Roadways shall be designed so as not to divert flows.

2.6 Walls, Fences, Berms

Development Guidelines – Walls, Fences, Berms

- **Fences at the perimeter of a parcel shall be limited to open-type fencing (pipe rail, split rail, barbed wire, etc.) for lots crossed by or within 150-feet of a drainageway or within the inundation limits of the 100-year flood along a drainageway or floodplain.**
- **Chain link and chicken wire are not considered open-type fencing, as it must have openings at least 8-inches in diameter.**
- **A solid "courtyard" wall is permitted immediately downslope or upslope of the principle dwelling unit, and is defined a wall that surrounds an area immediately adjacent to the principle dwelling unit and is limited in lateral distance to no more than 15 feet if oriented perpendicular to the direction of flow and is not limited in lateral distance if oriented parallel to the direction of flow.**
- **Closed fences, walls or perimeter berms are not allowed unless it can be demonstrated to the satisfaction of the Drainage Administrator that there is no increase in peak discharge, flow depth or velocity, or flow diversion as a result of the proposed improvement.**

Perimeter fences shall be limited to open-type fencing (pipe rail, barb wire, etc.) for lots within drainageway influence areas or within the inundation limits of the 100-year flood along a drainageway or floodplain. Chain link or chicken wire does not constitute open-type fencing. In order to be considered "open-type" fencing, the openings must be a minimum of 8 inches in diameter. For lots not in a drainageway influence area or 100-year floodplain, solid perimeter fences that comply with current Maricopa County development standards are permitted.

"Courtyard" fences are considered acceptable immediately upslope or downslope of the residence. A "courtyard" fence is considered any fence (open-type or otherwise) or wall that

surrounds an area immediately adjacent to a residential structure and is limited laterally to no more than 15 feet from the building walls in the direction perpendicular to flow (i.e. parallel to the topographic contours). The "courtyard" fence or wall may extend as far as desired if it projects from an exterior wall of the residential structure in the upslope or downslope direction parallel to flow (i.e. perpendicular to the topographic contours). See Figure 2.6.1, below.

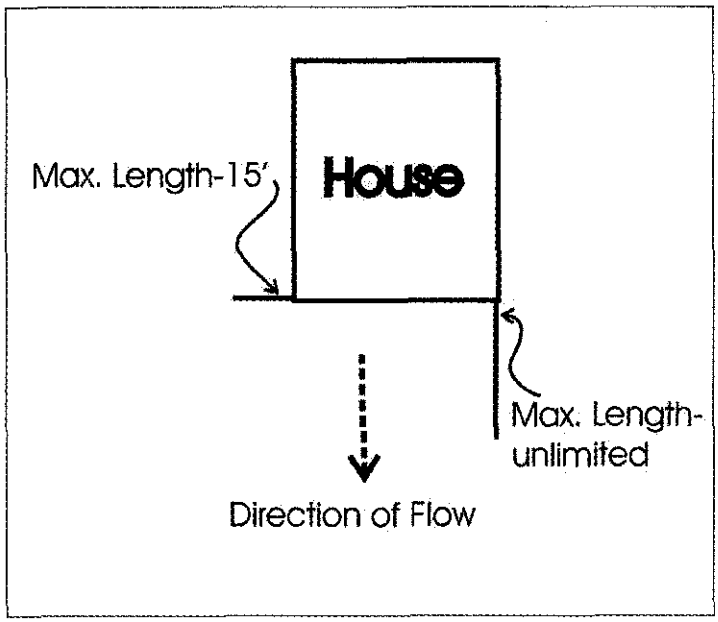


Figure 2.6.1 Courtyard Walls

Closed fences, walls, or perimeter berms are not allowed without a demonstration that no adverse impact on neighboring properties results from the construction of the proposed fence, wall, or berm. That is, it can be demonstrated to the satisfaction of the Drainage Administrator that there is no increase in peak discharge, flow depth, or velocity or flow diversion as the result of the proposed improvement(s).

2.7 Retention

Development Guidelines – Retention

- **On-lot retention shall be provided based on the following formula:**
  - **R-43 Zoning: 1500 ft^3/acre**
  - **R-70 Zoning: 1600 ft^3/acre**
  - **R-190 Zoning: 2200 ft^3/acre**
- **Retention areas shall be located within the 50% disturbable area limit and in such a fashion as to effectively capture runoff from the impervious surfaces of the lot.**
- **Retention may be provided in multiple basins.**
- **Retention areas shall not be placed within a regulatory floodplain or otherwise such that off-site runoff is intercepted. The regulatory floodplain included delineated floodplains and watercourses that have flows greater than 50 cfs during a 100-year flood.**
- **Septic system percolation rates shall determine the suitable of a retention area location.**
- **Retention areas may be landscaped with organic and/or inorganic ground cover.**

Although concern has been raised about the long-term assurance of single-lot retention facilities, retention may be the most effective tool available to mitigate adverse hydrologic impacts from development. Additionally, retention may have possible complementary benefits with respect to requirements of the Clean Water Act.

2.8 Summary and Recommendations

Table 2.9.1 summarizes the recommended tools and measures for the Development Guidelines for the Adobe ADMP.

Table 2.9.1 Summary of Development Guidelines Criteria for Adobe ADMP

Tool	Measure	Source/Basis
Erosion Hazard Setback	▪ Function of discharge ▪ Minimum 15 ft or 2 times bank height (whichever is greater)	▪ Riverine Erosion Hazard Delineation ▪ Development Guidelines
Minimum Floor Elevation	▪ 1 ft above highest adjacent natural ground ▪ 1 ft above regulatory base flood	▪ Drainage Regulations ▪ Floodplain Regulations
Disturbance Envelope	50% of lot	Consistent with current zoning regulatory environment
Culverts, driveways, roads	▪ Prefer dips ▪ Maintain sediment transport continuity ▪ Prevent base level lowering ▪ Do not divert flow	▪ Drainage Design Manual Vol. II ▪ Drainage Regulations
Walls, Fences, Berms	Open-type fencing and courtyard fencing allowed	Floodplain Regulations
Retention	R-43: 1500 ft^3/acre R-70: 1600 ft^3/acre R-190: 2200 ft^3/acre	▪ 100-yr 2-hr ▪ Drainage Design Manual Vol. II

Any variations from these minimum criteria will require engineering analyses that demonstrate to the satisfaction of the Drainage or Floodplain Administrator that no adverse impact to adjacent properties results from the requested variations, and that the proposed improvements will themselves be free of inundation from the 100-year flood event and protected against erosion.

SECTION 3: CONCLUSION

The development guidelines are intended to provide a mechanism to manage the potential cumulative impacts to drainage and flooding caused by single-family development on individual lots within incorporated Maricopa County in the study area. The guidelines are based upon customary regulations that have been successfully implemented in numerous jurisdictions within Maricopa County.

APPENDIX A

Statutory Basis for Development Guidelines

APPENDIX A

A.1 Statutory Basis for Development Guidelines

Governmental entities are limited in their powers to those the State has expressly granted them. The Arizona Revised Statutes describe these powers and duties. The Statutes are divided into Titles (or chapters) that address the various governmental entities in Arizona. Title 11 addresses county authority to regulate. Special Districts, such as the Flood Control District, are addressed in Title 48. Specific applicable citations from the Statutes are given below.

Figure A.1.1 depicts the approximate boundaries or areas of limitation for the respective statutory authorities. Title 48 authorities apply to 100-year flood areas regulated by the National Flood Insurance Program (NFIP) and Arizona Department of Water Resources. Title 11 authorities regulate drainage concerns in areas outside of the regulatory 100-year floodplain. In practice, Title 11 authorities sometimes overlap into the Title 48 area.

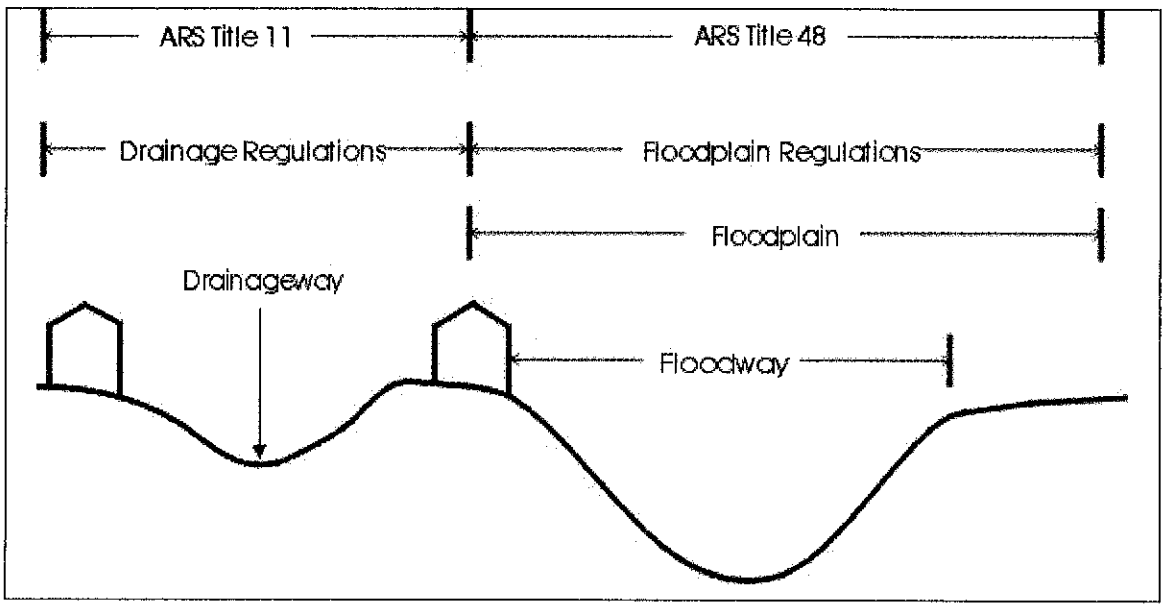


Figure A.1.1 Statute Applicability

Section A.2.1 summarizes State Statutes, while Section A.2.2 summarizes Maricopa County ordinance authorized under Title 11. Section A.2.3 summarizes Flood Control District of Maricopa County ordinance authorized under Title 48. The underlined sections within the statutes highlight

language that relates to development guidelines. These statutes and ordinances are provided as references to facilitate a better understanding of the opportunities and limitations associated with development guidelines.

A.2.1 Arizona Revised Statutes

State statutes specifically pertaining to "development guidelines" include the following:

ARS 11-251.36. Subject to the prohibitions, restrictions and limitations as set forth in section 11-830, adopt and enforce standards for excavation, landfill and grading to prevent unnecessary loss from erosion, flooding and landslides.

ARS 48-2664.D. The Board may adopt equitable by-laws, rules and regulations and perform all acts necessary to carry out the purposes of this chapter.

ARS 48-3609.B. Except as provided in section 48-3610, the board shall adopt and enforce regulations governing floodplains and floodplain management in its area of jurisdiction which shall include the following:

1. Regulations for all development of land, construction of residential, commercial or industrial structures or uses of any kind which may divert, retard or obstruct floodwater and threaten public health or safety or the general welfare.

ARS 48-3609.01.A. If a district organized pursuant to this chapter has completed a watercourse master plan which includes one or more watercourses, and if the plan has been adopted by the board or by any other jurisdiction in that river or drainage system, then the board and the governing body of each jurisdiction may adopt and shall enforce uniform rules for the river or drainage system within the jurisdiction using criteria that meet or exceed criteria adopted by the director of water resources pursuant to section 48-3605, subsection A.

A.2.2 Drainage Regulations

The Drainage Regulations for Maricopa County, dated 1994, provides specific guidance for "development guidelines" associated with Area Drainage Master Studies.

Article III. Definitions

3. Area Drainage Master Study – a study to develop stormwater hydrology for a watershed, to define drainage systems, identify potential flood hazard areas, drainage problems and recommend solutions and standards for sound floodplain and stormwater management. The ADMS identifies alternative solutions to a given flooding or drainage problem. An Area Drainage Master Plan (ADMP) identifies the preferred alternative. An ADMP, unique to the subject watershed provides minimum criteria and standards (for flood control and drainage) for land use and development.

Article XI. Area Drainage Master Study

Section 1101. Adoption

Whenever an Area Drainage Master Study authorized under this regulation has been completed, such plan including uniform rules for development may be submitted to the Board of Supervisors for adoption as an Area Drainage Master Plan. If adopted by the Board of Supervisors, the District shall enforce the Area Drainage Master Plan under this Regulation.

A.2.3 Floodplain Regulations

The Maricopa County Flood Control District Board of Directors has adopted floodplain regulations as required by State Statute. In the current regulations, dated 1993, further basis is found for "development guidelines" in the following sections:

Article III. Definitions

Section 301.

6. Area Drainage Master Study (ADMS): A study to develop hydrology for a watershed, to define watercourses, identify potential flood problem areas, drainage problems and recommend solutions and standards for sound

floodplain and stormwater management. The ADMS will identify alternative solutions to a given flooding or drainage problem. An Area Drainage Master Plan (ADMP) identifies the preferred alternative. An ADMP, unique to the subject watershed provides minimum criteria and standards (for flood control and drainage) for land use and development.

Article VIII. Flood Hazard Boundaries

Section 803. Other Flood Hazard Boundaries

Whenever the District determines through a flood hazard study, watercourse master plan or other flood related study authorized by the Board that a flood related hazard exists due to such factors as high-velocity flows, erosion, sediment transport, deposition, unstable soil conditions or land subsidence, the Floodplain Administrator shall designate such hazard areas on the Flood Control Management Maps for Maricopa County and shall establish technical criteria and enforce rules and regulations for subsequent development that meet or exceed criteria adopted by the Director, State Department of Water Resources and when appropriate such studies may be forwarded to the Federal Emergency Management Agency.

Article XIV. Other Flood Hazard Zones

Section 1402. Flood Hazard Development Standards

1. Standards adopted for development contained in a Watercourse Master Plan, Area Drainage Master Plan or other hydrologically oriented master plan shall be consistent with sound floodplain management practices and this Regulation.

6. The standards, provisions, criteria and requirements for development in flood hazard zones imposed by an authorized master plan shall meet or exceed the requirements of this Regulation.

APPENDIX B

Development Guidelines Checklist

APPENDIX B

DEVELOPMENT GUIDELINES CHECKLIST

Drainageways

- A detailed drainage analysis prepared by a licensed civil engineer shall be submitted for properties crossed by a drainageway or located within 150 feet on either side of a drainageway to verify that proposed improvements will not negatively alter pre-development drainage conditions.

Erosion Hazard Setbacks

- Properties crossed by a delineated wash with a detailed erosion hazard zone shall comply with the erosion hazard setbacks set forth in the *Riverine Erosion Hazard Delineation and Development Guidelines* (FCDMC, 200X).

Minimum Floor Elevation

- All properties shall meet the District standard per the current Drainage Regulations and Floodplain Regulations.

Disturbance Envelope

- No more than 50% of the site may be disturbed, and all improvements (including, but not limited to, roof-bearing structures, retention, cleared and grubbed areas such as horse corrals, landscaping with permanent irrigation, and areas with impervious ground cover and/or barriers that preclude infiltration) shall be located within this area.
- Boundaries of the disturbed area must be delineated on the property with permanent markers.
- Temporary disturbance in excess of the 50% is allowed for utility installation, temporary construction access, and temporary stockpiling of construction related materials. Revegetation of these areas is required and must be completed prior to final development approval.

Culverts, Driveways and Roads

- Dip crossings should be used for driveways and local streets unless it can be demonstrated that culverts are necessary due to the depth and/or velocity of flows.

- All culverts and bridged crossings should be designed to minimize the disruption of sediment transport continuity upstream and downstream of the crossing. Crossings that mimic the natural channel's depth and width within the reach being crossed will be most successful.
- Lowering of the local channel bottom elevation is discouraged.
- Roadways shall be designed so as not to divert flows.

Walls, Fences, Berms

- Fences at the perimeter of a parcel shall be limited to open-type fencing (pipe rail, split rail, barbed wire, etc.) for lots crossed by or within 150-feet of a drainageway or within the inundation limits of the 100-year flood along a drainageway or floodplain.
- Chain link and chicken wire are not considered open-type fencing, as it must have openings at least 8-inches in diameter.
- A solid "courtyard" wall is permitted immediately downslope or upslope of the principle dwelling unit, and is defined a wall that surrounds an area immediately adjacent to the principle dwelling unit and is limited in lateral distance to no more than 15 feet if oriented perpendicular to the direction of flow and is not limited in lateral distance if oriented parallel to the direction of flow.
- Closed fences, walls or perimeter berms are not allowed unless it can be demonstrated to the satisfaction of the Drainage Administrator that there is no increase in peak discharge, flow depth or velocity, or flow diversion as a result of the proposed improvement.

Retention

- On-lot retention shall be provided based on the following formula:
  2.75" x maximum lot coverage (see zoning ordinance) x lot size (in square feet) = retention volume required.
- Retention areas shall be located within the 50% disturbable area limit and in such a fashion as to effectively capture runoff from the impervious surfaces of the lot.
- Retention may be provided in multiple basins.
- Retention areas shall not be placed within a regulatory floodplain or otherwise such that off-site runoff is intercepted. The regulatory floodplain included delineated floodplains and watercourses that have flows greater than 50 cfs during a 100-year flood.
- Septic system percolation rates shall determine the suitable of a retention area location.
- Retention areas may be landscaped with organic and/or inorganic ground cover.

APPENDIX C

Toolkit Evaluation

APPENDIX C

TOOLKIT EVALUATION

C.1 Overview

A number of tools or criteria were evaluated for application to single-lot development in the Adobe Dam / Desert Hills ADMP study area. The tools were evaluated based on their hydrologic efficacy, long-term viability, and their potential for implementation. Seven types of tools or criteria relating to single-family, individual lot development were examined:

- Drainageways
- (Erosion Hazard) Setbacks
- Finished Floor Elevations
- Disturbance Envelopes
- Culverts, Driveways, & Roads
- Walls, Fences, & Berms
- Retention

Each criterion and their evaluation is discussed in the following sections. Recommendations are made for selection of specific measures or requirements for each tool or criteria for the ADMP.

C.2 Drainageways

The primary use of the drainageways will be as a routing tool to quickly assess parcels requesting a permit for development. This function is discussed further under the implementation discussion in Section 3. It should be recognized that many of these drainageways may potentially carry 50 cfs or more during the 100-year event. Article IV of the *Floodplain Regulations for Maricopa County* states that "The Regulation is applicable to all lands located within a delineated floodplain and watercourses or contributing watersheds that have flows greater than 50 cfs during a 100-year flood event which are within the area of jurisdiction of the Flood Control District of Maricopa County." As such, they would be subject to the Floodplain Regulations.

Drainageways were delineated based on examination of available topography and interpretation of 2002 orthographic aerial photographs. Drainageways include all observable washes, swales or other drainage features as indicated by their physical, biological (vegetation), or topographic characteristics. Drainageways were delineated for all areas outside of the City of Phoenix and the Cave Creek Recreation Area.

The delineated drainageways were used to identify existing parcels crossed by these drainageways. In addition, a second set of parcels were identified that lie within a 150-foot influence area of any delineated drainageway. The parcels crossed by drainageways, or within their influence area, were selected using ArcView GIS 8.2. A map and a summary table of the number and acreage of parcels affected by drainageways and the 150-foot influence area are provided in a memorandum to Afshin Ahouraiyan dated July 7, 2004 describing the development guidelines implementation strategy.

The 150-foot width of the influence area was determined based on a 160-acre drainage area (the limit of State Standard 2-96 for floodplain delineation (Title 48)). A discharge of 500 cfs (2000 cfs/ square mile * 0.25) (also State Standard) with an assumed depth of 1 foot, a width of 250 feet, and a velocity of 2 ft/s, gives 125 feet from center. Therefore, a 150-foot distance was selected as a "conservative" measurement for use in identifying parcels that might be influenced by or potentially have an effect on the drainageways, and therefore require additional drainage and/or floodplain review.

C.3 Erosion Hazard Setbacks

An erosion hazard setback shall be identified for any parcel crossed by or adjacent to "a delineated floodplain and watercourses or contributing watersheds that have flows greater than 50 cfs during a 100-year flood event." All of the existing FEMA floodplain delineations and those being conducted as part of the ADMP have or will have a detailed erosion hazard zone identified for them. Any drainageway that carries more than 50 cfs in the 100-year flood event (i.e. subject to the Floodplain Regulation) will also need to have an erosion hazard setback assessment prior to development. The erosion setback shall be determined using the District's draft *Riverine Erosion Hazard Delineation and Development Guidelines*. These guidelines describe a three level approach. Generally, additional information and analysis are required to reduce the required setback distance without erosion protection measures. A minimum setback of 15 ft or 2 times the bank height,

whichever is greater, is required per the draft erosion hazard guidelines. Structural measures for erosion hazard mitigation are also presented in the guidelines.

C.4 Minimum Floor Elevation

The District already has minimum criteria for minimum finished floor elevations for all construction. All new buildings shall have a minimum finished floor elevation no less than 1 foot above the natural adjacent grade. Within a (delineated) floodplain the minimum finished floor shall be set 1 foot above the regulatory flood elevation. The Regulatory Flood Elevation is defined within the Floodplain Regulations as "(T)he elevation which is one foot above the base flood elevation for a watercourse. Where a floodway has been delineated, the base flood elevation is the higher of either the natural or encroached water surface elevation of the 100-year flow." No change to the minimum finished floor elevation criterion is recommended for the Adobe Dam/Desert Hills ADMP rules of development. This existing minimum finished floor elevation criteria should continue to be enforced in the Adobe Dam/Desert Hills ADMP study area.

C.5 Disturbance Envelope

A disturbance envelope is a contiguous spatial limit on a lot which may be altered from its natural state as part of the development of the lot. The rationale for the disturbance envelope is that the removal of vegetation and other disturbance of the natural ground results in an adverse impact on storm water runoff from the lot. Namely, rainfall is no longer intercepted by the native plants and consequently becomes runoff. In addition, plant roots and other biological activity associated with the plant increase the rate at which rainfall soaks into the soil. The combined result is an increase in both the magnitude and frequency of runoff from the disturbed area. Another consequence of the disturbance of the natural areas is a disruption and elimination of habitat for native desert species.

Hydrologic modeling of the effects of single lot development of very low density development on one acre or larger lots shows that any disturbance of the natural ground and removal of vegetation results in an adverse impact to storm water runoff. Total conversion of a 160-acre watershed from natural desert to residential land use with complete removal of vegetation results in nearly a 200% increase in the runoff magnitude generated by a 2-year rainfall event and a 50% increase in the runoff from a 100-year event. The reduction in these adverse impacts is approximately proportional to the amount of disturbed area. The details of the hydrologic analysis were presented in

a memorandum to the District dated March 25, 2003. This memorandum and HEC-1 output are provided at the back of this appendix.

A maximum disturbance area of 50% including all improvements was recommended for the ADMP development guidelines. Improvements include landscaping with permanent irrigation, impervious ground cover and/or barriers that preclude infiltration, retention, cleared and grubbed areas (such as horse corrals), and all roof-bearing structures. While this will not fully mitigate the adverse effects of development, it will reduce those effects appreciably.

Temporary disturbances in excess of the final disturbance envelope will be allowed for utility installation, temporary construction access, stockpiling, etc. Revegetation of the temporarily disturbed areas must be demonstrated before final approval of the development.

Figure C.5.1 shows examples of disturbance envelopes for some existing lots in the Desert Hills area. Table C.5.1 shows the gross lot area, the disturbed area, and the coverage of the lot by roof top or paved surfaces.

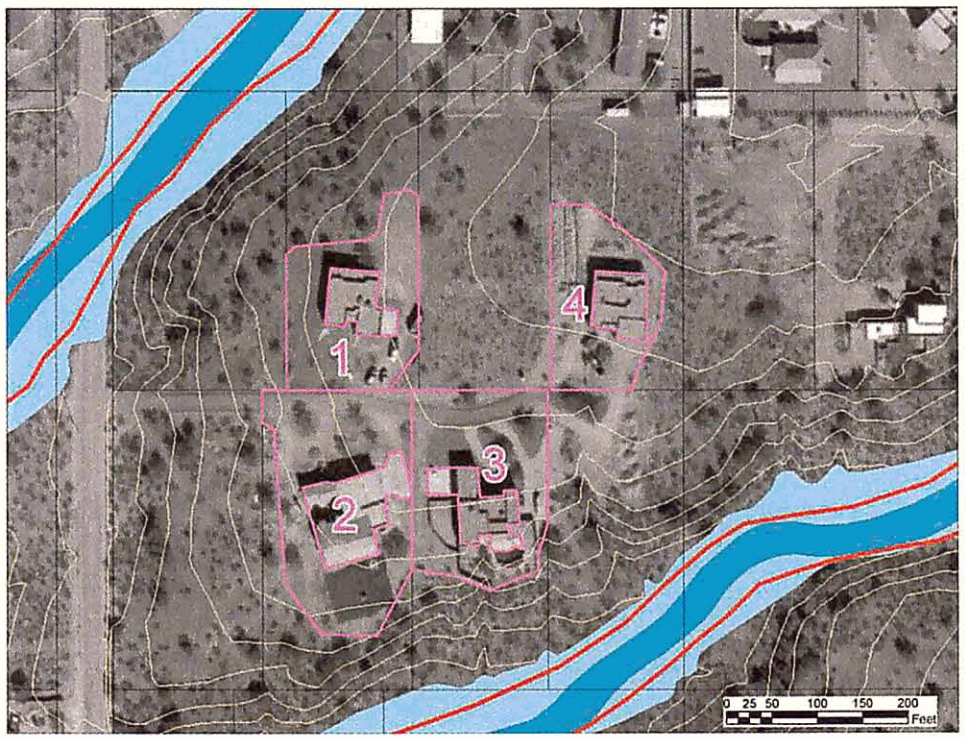


Figure C.5.1 Example Lots with Disturbance Envelopes

Table C.5.1 Summary of Example Lots with Disturbance Envelopes

Parcel Id (1)	Disturbed Area (2)	Impervious Area (3)	Total Parcel Area (4)	Percent of Parcel (5)
	(sq.ft)	(sq.ft)	(sq.ft)	%
1	25302		48180	53%
1		4214	48180	9%
2	37220		54450	68%
2		8207	54450	15%
3	30631		49500	62%
3		5239	49500	11%
4	21225		48180	44%
4		4021	48180	8%

The data for these example lots show that three of the four lots exceed the proposed 50% disturbance envelope. The "impervious area" [column (3)] relates to the maximum lot coverage discussed under retention in Section C.9, and is included in the disturbed area [column (2)].

C.6 Culverts, Driveways, Roads

Dip crossings are preferred to culvert crossings for access on driveways and local streets. Arterial streets should be designed in accordance with existing County criteria. However in addition to the design levels prescribed in those criteria, all culverts or bridged crossings should be designed to minimize disruption of sediment transport continuity upstream and downstream of the crossing. Crossings that mimic the natural channel's depth and width within the reach being crossed will be most successful. Lowering of local channel bottom elevations is also discouraged. Roadways shall be designed so as not to divert flows.

C.7 Walls, Fences, Berms

Perimeter fences shall be limited to open-type fencing (pipe rail, barb wire, etc.) for lots within drainageway influence areas or within the inundation limits of the 100-year flood along a drainageway or floodplain. Chain link or chicken wire does not constitute open-type fencing. In order to be considered "open-type" fencing, the openings must be a minimum of 8 inches in diameter. For lots not in a drainageway influence area or 100-year floodplain, solid perimeter fences that comply with current Maricopa County development standards are permitted.

"Courtyard" fences are considered acceptable immediately upslope or downslope of the residence. A "courtyard" fence is considered any fence (open-type or otherwise) or wall that surrounds an area immediately adjacent to a residential structure and is limited laterally to no more than 15 feet from the building walls in the direction perpendicular to flow (i.e. parallel to the topographic contours). The "courtyard" fence or wall may extend as far as desired if it projects from an exterior wall of the residential structure in the upslope or downslope direction parallel to flow (i.e. perpendicular to the topographic contours), see Figure C.7.1., below.

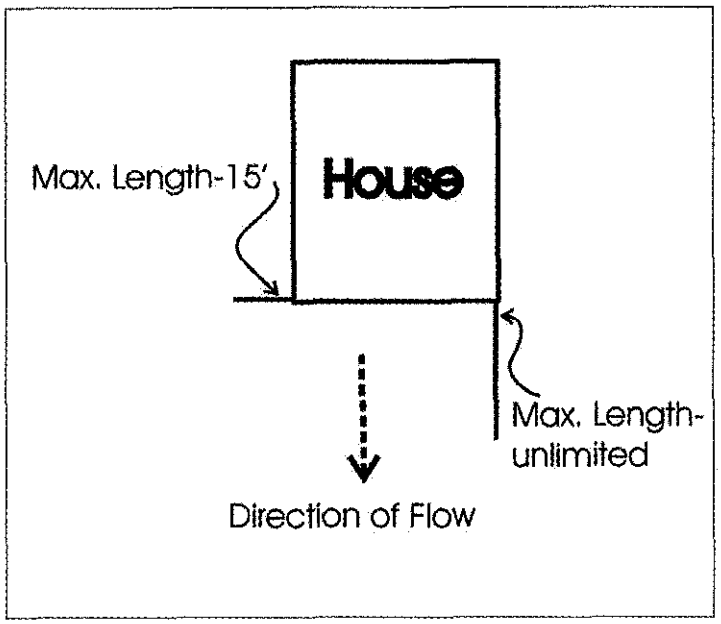


Figure C.7.1 Courtyard Walls

Closed fences, walls, or perimeter berms are not allowed without a demonstration that no adverse impact on neighboring properties results from the construction of the proposed fence, wall, or berm. That is, it can be demonstrated to the satisfaction of the Drainage Administrator that there is no increase in peak discharge, flow depth, or velocity or flow diversion as the result of the proposed improvement(s).

C.8 Retention

Although concern has been raised about the long-term assurance of single-lot retention facilities, retention may be the most effective tool available to mitigate adverse hydrologic impacts

from development. Additionally, retention may have possible complementary benefits with respect to requirements of the Clean Water Act.

Some possible criteria for retention volume for single-lot development are listed below:

- Current retention requirement for commercial, industrial, multi-family residential and subdivisions (i.e. 100-yr 2-hr which equals about 2.75" in the Desert Hills area)
- 100-yr 2-hr pre vs. post development
- Retention of runoff from biggest "typical" storms
- Retention related to runoff based on the maximum lot coverage per zoning
- Future development increases in runoff volume from hypothetical basin analyses using HEC-1

An evaluation of these criteria was conducted and is provided in detail below.

100-yr 2-hour Retention Approach

Currently all commercial, industrial, multi-family residential and subdivision developments are required to retain the 100-year 2-hour runoff volume as described in the Drainage Design Manual. In the Desert Hills portion of the ADMP area, the 100-year 2-hour point rainfall is about 2.75 inches. For a single-lot one acre type development this would equate to a requirement for about 5,290 cu. ft. of retention volume.

100-yr 2-hour Pre- vs. Post-Development Approach

Another consideration for a retention requirement might be to require single-lot developers to retain the difference in runoff volume from the pre- to post-development runoff conditions. Some examples are shown below:

- Assume C=0.53 vs. C=0.38 (Table 3.2 – new Manual); delta C = 0.15 * 2.75" = 0.41" = 1,488 cu.ft./ac
- Assume C=0.7 vs. C=0.4 (more conservative); delta C = 0.30 * 2.75 = 0.82" = 2,977 cu.ft./ac

Biggest "Typical" Storm Approach

Examination of the Carefree, Arizona maximum daily precipitation gage data (see Figure C.8.1 below) shows that consideration of a rainfall of somewhere around 2.2 inches would capture most of the biggest "typical" rainfall events. These data are from a nearly 40-year period record. This level of 2.2" matches almost exactly the 10-year 6-hour point rainfall statistics from NOAA Atlas II (Table C.8.1). If the 10-year event is representative of the "channel forming discharge," then mitigation of adverse hydrologic impacts at this level should minimize the adverse geomorphologic effects as well.

Applying the same C factor logic from the 100-year 2-hour discussion above:

- 2.2" * 0.15 = 0.33" → 0.33"/12" = 0.0275 ft * 43,560 sq.ft = 1,198 cu.ft/ac
- 2.2"* 0.30 = 0.66" → 0.66"/12" = 0.055 ft * 43,560 sq.ft = 2,396 cu.ft/ac

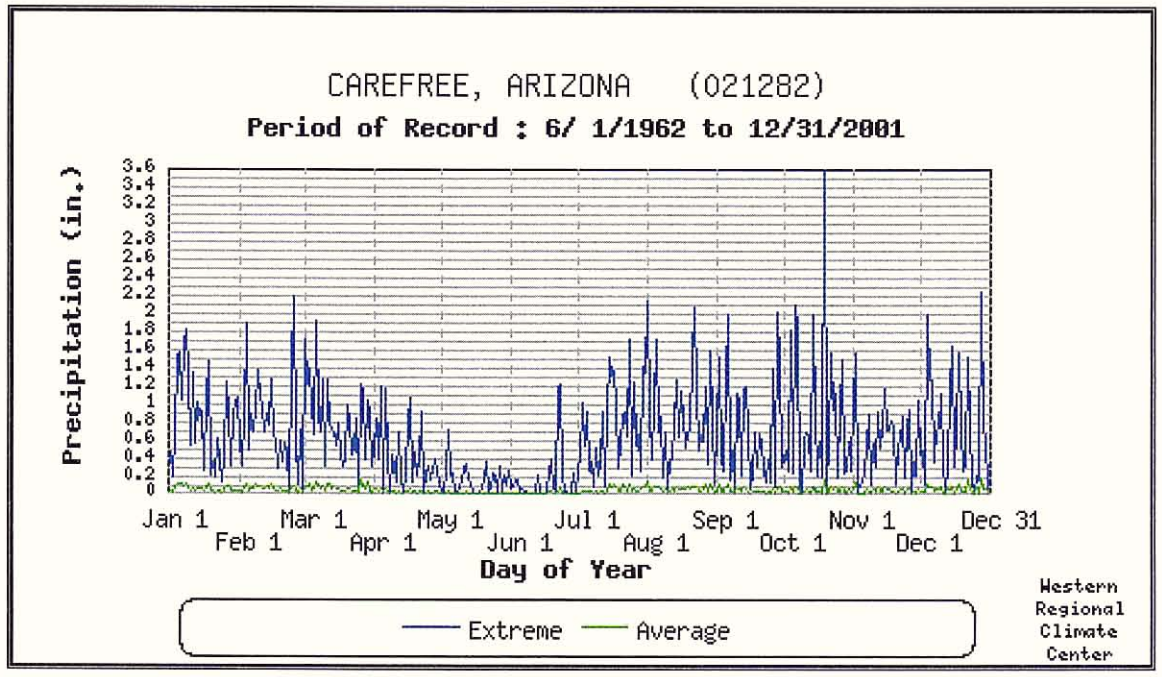


Figure C.8.1 Maximum Daily Precipitation in Carefree, AZ

Table C.8.1 Rainfall Statistics for Desert Hills Area

*** P R E F R E O U T P U T D A T A ***

PRECIPITATION FREQUENCY VALUES FOR Desert Hills Area Hydrology
POINT VALUES
RETURN PERIOD

DURATION	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR	500-YR	
5-MIN	.37	.45	.51	.59	.66	.73	.88	5-MIN
10-MIN	.56	.68	.78	.91	1.01	1.11	1.35	10-MIN
15-MIN	.68	.85	.98	1.15	1.29	1.43	1.74	15-MIN
30-MIN	.89	1.14	1.31	1.56	1.75	1.94	2.37	30-MIN
1-HR	1.09	1.41	1.63	1.94	2.18	2.42	2.97	1-HR
2-HR	1.21	1.58	1.83	2.19	2.46	2.74	3.37	2-HR
3-HR	1.29	1.69	1.97	2.35	2.65	2.95	3.64	3-HR
6-HR	1.45	1.91	2.22	2.67	3.01	3.35	4.14	6-HR
12-HR	1.63	2.17	2.55	3.07	3.47	3.88	4.80	12-HR
24-HR	1.80	2.44	2.87	3.47	3.94	4.40	5.47	24-HR

Maximum Lot Coverage Approach

Another way of looking at retention would be to consider just the impervious surfaces added to a lot. Impervious surfaces generate runoff during all but the most minimal rainfall events. The hydrologic impact of impervious surfaces is therefore more profound on the more frequent events. Mitigation of runoff from impervious surfaces would reduce the impacts of development on the magnitude and frequency of storm water runoff.

Looking at a range of possible impervious surface coverage single lot development yields the following potential retention volume criteria:

The maximum lot coverage by zoning is 15% for R-43. Therefore, 43,560 sq. ft * 0.15 = 6534 sq.ft of potential impervious surfaces. Again, the biggest "typical" storm is 2.2" or 0.183 ft and the 100-year 2-hour rainfall is 2.75" or 0.23 ft. The 100-year 6-hour point rainfall is 3.35" for the Desert Hills area, or 3.35"/12" = 0.28 ft.

So, some possible retention volumes for these three storms would be:

For R-43 (maximum lot coverage = 15%):

- 6534 * 0.183 = 1196 cu. ft. retention (per acre) — Biggest "typical" storm
- Or, 6534 * 0.230 = 1497 cu. ft retention (per acre) — 100-year 2-hour
- Or, 6534 * 0.280 =1824 cu. ft retention (per acre) — 100-year 6-hour

For R-70 (maximum lot coverage = 10%):

- 70000 * 0.1 = 7000 sq.ft * 0.183 = 1281 cu.ft — Biggest "typical" storm
- 70000 * 0.1 = 7000 sq.ft * 0.23 = 1610 cu.ft — 100-year 2-hour
- 70000 * 0.1 = 7000 sq.ft * 0.28 = 1960 cu.ft — 100-year 6-hour

For R-190 (maximum lot coverage = 5%):

- 190000*0.05 = 9500 sq. ft * 0.183 = 1739 cu. ft — Biggest "typical" storm
- 190000*0.05 = 9500 sq. ft * 0.23 = 2185 cu. ft — 100-year 2-hour
- 190000*0.05 = 9500 sq. ft * 0.28 = 2660 cu. ft — 100-year 6-hour

Hypothetical Subbasin HEC-1 Model Approach

Analysis of a hypothetical subbasin using HEC-1 shows an increase in runoff volume due to future development of about 0.30" for all return periods. Therefore, 0.30"/12 * 43560 = 1089 cu. ft / ac. This is approximately the same result via a different argument as the pre-versus post- C-factor approach for the "biggest typical storm". The result is also substantially similar to the 15% coverage argument for the "biggest typical storm". The 0.30" hypothetical subbasin result yields 1,750 cu.ft for R-70 and 4,750 cu.ft for R-190.

Table C.8.2 summarizes the possible retention criteria, the parameters associated with the estimation of the retention volumes, and the calculated retention volume for the minimum size lot in each of three zoning categories (i.e., R-43, R-70, and R-190). The recommended retention volume approach is the Maximum Lot Coverage approach. The recommended retention volume to be retained is for the 100-year 2-hour rainfall. Note that the recommended retention volume of 1,500

cu.ft. / ac for R-43 is about 28% of the volume that would be required for a similar zoning in a subdivision.

Table C.8.2. Summary of Possible Retention Criteria for Adobe ADMP

	R-43		R-70		R-190		Desert
C100	0.53		0.50		0.41		0.38
Pre vs. Post 100	0.15		0.12		0.03		
C10	0.42		0.40		0.33		0.30
Pre vs. Post 10	0.12		0.10		0.03		
Area (sq.ft.)	43560		70000		190000		
Max Lot Coverage (%)	15%		10%		5%		

	R-43		R-70		R-190	
Storm Depth (inches)	2.2	2.75	2.2	2.75	2.2	2.75
Storm Depth (feet)	0.183	0.229	0.183	0.229	0.183	0.229
	Retention Volume (cu. ft.)					
All Runoff Retained (D x A x C)	3354	5287 [1]	5133	8021 [1]	11495	17852 [1]
Pre vs Post (D x A x ΔC)	958	1497	1283	1925	1045	1306
Max. Lot Coverage (D x A x % Cover)	1198	1497	1283	1604	1742	2177
HEC-1	1089	1089	1750	1750	4750	4750

Shaded cells are the recommended retention volumes for a minimum sized lot in each zoning type.
[1] This is equivalent to the current retention requirements for subdivisions

The recommended retention volumes shown in Table C.8.2 are for the minimum sized lot in each zoning category. The recommended retention volume for each single-lot zoning category in the Adobe ADMP study area can be simplified to a volume per acre figure for any sized lot within the zoning type using 1,500 ac-ft/acre for R-43, 1,000 ac-ft/acre for R-70, and 500 ac-ft/acre for R-190. The required volume per acre decreases from R-43 to R-190 because of the reduction in maximum lot coverage allowed for each zoning category (i.e. 15% to 5%).

Lot disturbance in excess of the 50% value recommended can be allowed by providing for additional retention in direct proportion to the increased disturbance. In addition, the retention area is considered part of the disturbed area. Figure C.5.1 (see Section C.5) and Table C.8.3 show examples of disturbed areas and proposed retention volumes for some example lots in the Desert Hills area.

Table C.8.3 Retention Requirement Statistics for Example Lots in Desert Hills Area (continuation of Table C.5.1)				
Parcel ID (see Fig. C.5.1)	**"Required" Retention**	**Additional "Required" Retention**	**Total "Required" Retention**	**Retention Area assumed 1.5 ft deep**
	(cu.ft.)	(cu.ft.)	(cu.ft.)	(sq.ft)
1	1656	42	1698	1132
2	1872	344	2215	1477
3	1702	202	1904	1269
4	1656	0	1656	1104

The location and configuration of retention areas shall be shown on the site plan. In general, the same criteria and guidelines for retention facilities outlined in the Drainage Design Manual, Volume II should be followed. In particular, the location of basins shall meet the following objectives:

- Retention areas shall be located such that they effectively capture runoff from the impervious surfaces on the lot.
- Retention areas do not have to be located in a single basin; multiple retention areas are allowed.
- Retention areas shall not be placed in a regulatory floodplain or otherwise such that off-site runoff is intercepted in the retention area. The regulatory floodplain includes delineated floodplains and watercourses that have flows greater than 50 cfs during a 100-year flood.
- Approval of site suitability (with respect to percolation rates) for a standard septic system will constitute site suitability for retention.
- Retention areas may be landscaped (with appropriate types of ground cover vegetation).

C.9 Summary and Recommendations

Table C.9.1 summarizes the recommended tools and measures for the Development Guidelines for the Adobe ADMP.

Table C.9.1 Summary of Development Guidelines Criteria for Adobe ADMP

Tool	Measure	Source/Basis
Erosion Hazard Setback	▪ Function of discharge ▪ Minimum 15 ft or 2 times bank height (whichever is greater)	▪ Riverine Erosion Hazard Delineation ▪ Development Guidelines
Minimum Floor Elevation	▪ 1 ft above highest adjacent natural ground ▪ 1 ft above regulatory base flood	▪ Drainage Regulations ▪ Floodplain Regulations
Disturbance Envelope	50% of lot; additional allowed with increased retention	Consistent with current zoning regulatory environment
Culverts, driveways, roads	▪ Prefer dips ▪ Maintain sediment transport continuity ▪ Prevent base level lowering ▪ Do not divert flow	▪ Drainage Design Manual Vol. II ▪ Drainage Regulations
Walls, Fences, Berms	Open-type fencing & Courtyard fencing allowed	Floodplain Regulations
Retention	2.75"/12 x max cover for zoning (in %) x lot size (in sq.ft) = retention volume required	▪ 100-yr 2-hr ▪ Drainage Design Manual Vol. II

Drainage impacts of single-lot development need to be addressed in order to prevent unnecessary damages and public expenditures in the future. It is therefore recommended that lots crossed or within a 150-ft buffer of a drainageway be scrutinized closely by reviewers at the District. All single-lot development in the Desert Hills and New River/Cline Creek portions of the ADMP shall henceforth be required to provide the minimum retention as indicated in these Rules of Development. Minimum floor elevation criteria from the Drainage Regulations and the Floodplain Regulations should continue to be enforced. Also, the other components of the Floodplain Regulation with respect to floodplain encroachment and erosion hazard setbacks should continue to be enforced. Development will be limited to a 50% disturbance envelope on the lot unless retention volume in excess of the minimum is provided. Dip crossings for road and driveways, open type fencing, and courtyard fencing will be approved without a drainage report. Any variations from these minimum criteria will require engineering analyses that demonstrate to the satisfaction of the Drainage or Floodplain Administrator that no adverse impact to adjacent properties results from the requested variations, and that the proposed improvements will themselves be free of inundation from the 100-year flood event and protected against erosion.

APPENDIX D

References

APPENDIX D

References

Arizona Department of Water Resources, State Standards for Floodplain Management

SS1-97, Requirement for Flood Study Technical Documentation
Sets technical documentation standards for Flood Studies that are to be submitted to ADWR or FEMA.

SS2-96, Requirement for Floodplain and Floodway Delineation in Riverine Environments
Provides methodologies for estimating 100-year peak discharges, delineating 100-year floodplain limits, and determining administrative floodway boundaries for riverine floodplains in Arizona.

SS3-94, State Standard for Supercritical Flow (Floodway Modeling)
Provides guidelines to be used when modeling floodways for supercritical or near-critical flow conditions in Arizona.

SS4-95 State Standard for Identification of and Development within Sheet Flow Areas
Details minimum floodplain management standards for identification of and development within sheet flooding areas in Arizona.

SS5-96 State Standard for Watercourse System Sediment Balance
Provides guidelines for identification of and development within erosion hazard areas, watercourses with a net sediment deficit, and watercourses with a net sediment surplus. Individual guidelines for: Lateral Migration Setback Allowance, Channel Degradation Estimation, and River Stability Impacts associated with Sand and Gravel Mining.

SS6-96 State Standard for Development of Individual Residential Lots within Floodprone
Areas
Site Plan Checklist, Typical Plan and Cross-Section requirements for Individual residential lots within floodprone areas.

SS7-98 State Standard for Watercourse Bank Stabilization
Provides minimum design standards for several bank stabilization techniques.

SS8-99 State Standard for Stormwater Detention/Retention
Provides minimum criteria for sizing Detention and/or Retention facilities.

SS9-02 State Standard for Floodplain Hydraulic Modeling
Provides guidance on mathematical modeling of hydraulic processes in watercourses and floodplains.

Arizona Revised Statutes, Title 11

Arizona Revised Statues, Title 48

FCDMC, 200X, Riverine Erosion Hazard Delineation and Development Guidelines

FCDMC, 2003, Drainage Design Manual, Volume I, Hydrology, draft dated January 9, 2003.

FCDMC, 1995, Drainage Design Manual, Volume I, Hydrology, revised January 1, 1995.

FCDMC, 1996, Drainage Design Manual, Volume II, Hydraulics

FCDMC, 1986, Floodplain Regulations for Maricopa County, as revised 11/1/2000

FCDMC, 1988, The Drainage Regulation for Maricopa County, as revised 12/14/1994

Memorandum JE Fuller/ Hydrology & Geomorphology, Inc.

DATE: March 25, 2003

TO: Pat Deschamps, P.E.

FROM: Ted Lehman, P.E.

RE: HEC-1 and HECRAS analysis of effects of Disturbance Envelope concept for Development Guidelines for Adobe Dam / Desert Hills ADMP Phase I

CC: File

This memorandum briefly describes the approach and limitations of the HEC-1 and HECRAS analyses used to examine the effects of the disturbance envelope concept for the development guidelines or Rules of Development for the Adobe Dam / Desert Hills ADMP. The purpose of the analyses was to provide technical information regarding the hydrologic and hydraulic impacts of the removal of vegetation from large single lot development on a watershed.

HEC-1

Subbasins

Two hypothetical subbasins were developed for the HEC-1 analyses. The basic parameters and geometry of the basins were adopted based on examination of the middle piedmont area of the Desert Hills portion of the ADMP study area. One basin had an assumed basin area of 0.25 square miles (160 acres) (Figure 1). The second basin had an area of 1.0 square miles (640 acres) (Figure 2).

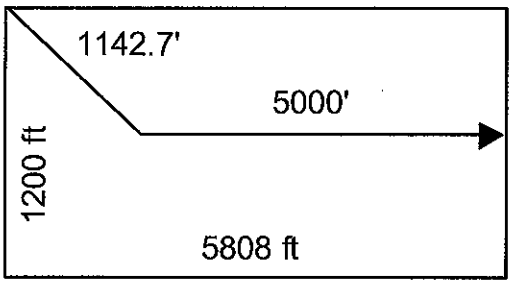


Figure 1. 160 acre hypothetical basin

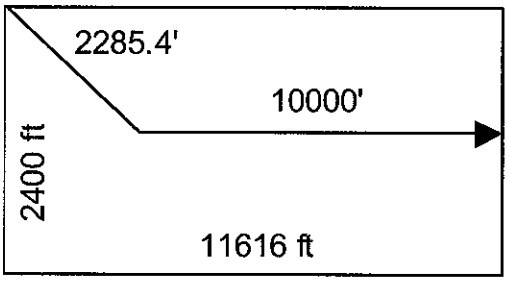


Figure 2. 640 acre hypothetical basin

Rainfall

The rainfall parameters used in the analysis was the 6-hour design storms as described in the FCDMC Drainage Design Manual. For the 160 ac basin, Pattern 1 was used for the temporal distribution. For the 640 ac basin, Pattern 1.40 was used based on the Manual's criteria. Point rainfall values were computed using PREFRE and areally reduced based on the total subbasin area for each hypothetical basin.

Soils

Examination of the XKSAT values in the Desert Hills area show a large portion of the area, especially the piedmont, is composed of clays, clay loams, and sandy clay loams.

This matches well with observations in the field. Therefore, an XKSAT value of 0.06 inches/hour (sandy clay loam) was selected for the analyses. The higher XKSAT value of the clayey soils was selected to allow the vegetation cover changes to be better expressed. The reason is that the FCDMC Drainage Design Manual methods apply an upward adjustment to XKSAT due to vegetation from a minimum adjustment of zero adjustment for a 10% vegetation cover to a 100% increase in XKSAT for 100% vegetation cover.

Vegetation Cover

Seven levels of vegetation cover impacts accompanying very low density residential (VLDR) development were examined ranging from 30% removal of vegetation to 100% removal of vegetation. The hydrologic impacts of vegetation cover changes were incorporated into the initial abstraction (IA) and XKSAT vegetation adjustment factor (Ck). Changes in these factors were computed based on a percent weighting in proportion to the change in vegetation cover. Table 1 summarizes the assumed land use parameters used in the analyses.

Roughness

Subbasin roughness was also assumed to change with changes in the degree of vegetation removal. The FCDMC method Clark Unit hydrograph approach was used in this analysis. Roughness changes were evaluated by varying Kb from Type C, moderately high roughness, to Type B, moderately low roughness proportionally to the degree of vegetation removal. Computationally this was achieved by ratioing the m and b factors and then computing the resultant Kb for each basin area. Tables 2 and 3 list the indexed values of roughness parameters for the 160 and 640 acre basins respectively.

Results

The results of the HEC-1 analyses show a significant increase in peak discharge with decreasing vegetation cover (see Tables 4 and 5). The increases are greater for the more frequent events. Discharges increase nearly linearly between about 30% to 200% from 30% vegetation removal to 100% vegetation removal in the 2-year event. For the 160 acre subbasin, the 100-year event discharge increases range from about 10% to 50% for the same range of vegetation removal (Figure 3).

The larger subbasin shows similar trends to the smaller basin, but the degree of impact on the frequent events being somewhat lesser (about 100% vs. 200%) (Figure 4).

Note that Table 4 and 5 also show the changes in discharge assuming no change in Kb with vegetation removal (VLDR1_B vs. Desert_B). The VLDR1_B vs. Desert_B results are similar to the results previously presented to the technical working group members in February and in a meeting on March 17th. These results show a much smaller increase in discharges with vegetation removal. This is because the effects on roughness are not accounted for in those analyses, only the changes in IA and adjustments to XKSAT.

Also shown are the results assuming a roughness change assuming the desert condition started in Kb Type B and smoothening to Kb Type A (VLDR1_A vs. Desert_B). This

comparison shows that if the basin is assumed to get smoother from an already relatively smooth condition, the effects on peak discharge are somewhat lesser than C to B scenario.

HECRAS

Given the significant increases in peak discharge for the 100-year event as a result of vegetation cover reduction, the impact of increases in discharge on floodplains was examined. Two HECRAS models from flood insurance studies in the Desert Hills area were used in this analysis – one for Apache Wash and the other for Desert Hills Wash. 10, 20, 30, 40, and 50 percent increases in peak discharge were modeled using the FDS models. No other changes were made to those models.

The results indicate nominal effects in computed water surface elevation, velocity, flow area, or top width for 10% increases in peak discharge (Table 6). However, at a 50% increase in peak discharge water surface elevations increased about 1 foot, velocities about 1 ft/s, flow area about 500 sq. ft., and top width about 80 feet.

Supporting Materials

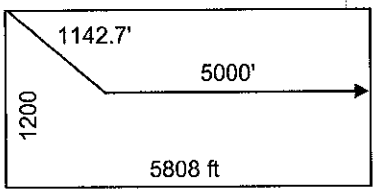
The HEC-1 model input and output, input parameter calculations, and summary of results are attached. The digital HEC-1 and RAS models are available from JEF.

Table 1. Assumed Land Use Parameters Affecting Rainfall Excess and Unit Hydrographs

LAND USE TYPE	%VEG	IA	RTIMP	DIST. ENV.	Ck	XKSAT	Adj XKSAT
DESERT	50	0.35	0	0%	1.44	0.06	0.087
RTIMP	0	0.10			1.00	0.06	0.060
DEVELOPED BARE GROUND	0	0.15	0	100%	1.00	0.06	0.060
VLDR.3	35	0.35	5%	30%	1.28	0.06	0.077
VLDR.4	30	0.30	5%	40%	1.22	0.06	0.073
VLDR.5	25	0.25	5%	50%	1.17	0.06	0.070
VLDR.6	20	0.20	5%	60%	1.11	0.06	0.067
VLDR.7	15	0.15	5%	70%	1.06	0.06	0.063
VLDR.8	10	0.10	5%	80%	1.00	0.06	0.060
VLDR1	0	0.10	5%	100%	1.00	0.06	0.060

Table 2. Kb factors for 160 acre subbasin

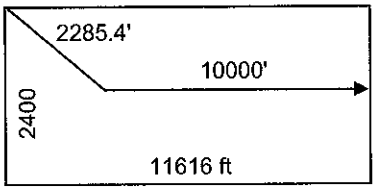
Basin Area = 0.25 sq.mi. (1200 ft x 5808 ft)
S = 0.0125 = 66.0 ft/mi
L = 6142.7 ft = 1.16 miles



		Kb factors				
		m	b	Area	DIST. ENV.	Kb
	C	-0.02500	0.150	160	0%	0.095
VLDR.3	High B	-0.02163	0.130	160	30%	0.082
VLDR.4		-0.02050	0.123	160	40%	0.078
VLDR.5		-0.01938	0.116	160	50%	0.073
VLDR.6		-0.01825	0.109	160	60%	0.069
VLDR.7		-0.01713	0.102	160	70%	0.064
VLDR.8		-0.01600	0.095	160	80%	0.060
VLDR1_B	B	-0.01375	0.080	160	100%	0.050
VLDR1_A	A	-0.00625	0.04	160	100%	0.026

Table 3. Kb factors for 640 acre subbasin

Basin Area = 1.00 sq.mi. (2400 ft x 11616 ft)
S = 0.01125 = 59.4 ft/mi
L = 12285.4 ft = 2.33 miles



		Kb factors				
		m	b	Area	DIST. ENV.	Kb
	C	-0.02500	0.150	640	0%	0.080
VLDR.3	High B	-0.02163	0.130	640	30%	0.069
VLDR.4		-0.02050	0.123	640	40%	0.065
VLDR.5		-0.01938	0.116	640	50%	0.062
VLDR.6		-0.01825	0.109	640	60%	0.058
VLDR.7		-0.01713	0.102	640	70%	0.054
VLDR.8		-0.01600	0.095	640	80%	0.050
VLDR1_B	B	-0.01375	0.080	640	100%	0.041
VLDR1_A	A	-0.00625	0.04	640	100%	0.022

Table 4. HEC-1 results for 160 acre subbasin

Basin Area = 0.25 sq.mi. (1200 ft x 5808 ft)
S = 0.0125 = 66.0 ft/mi
L = 6142.7 ft = 1.16 miles

	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
Desert_B	72	157	220	316	389	463
Desert_C	41	95	140	212	267	325
VLDR.3	54	117	167	242	302	365
VLDR.4	63	129	181	257	317	381
VLDR.5	72	143	195	273	337	401
VLDR.6	83	156	208	289	354	418
VLDR.7	95	170	224	308	374	441
VLDR.8	106	183	239	323	389	459
VLDR1B	120	204	265	356	424	497
VLDR1A	180	289	362	479	564	653
	(% diff (VLDR.# - Desert_C)/Desert_C)					
Desert_B	76%	65%	57%	49%	46%	42%
Desert_C	0%	0%	0%	0%	0%	0%
VLDR.3	32%	23%	19%	14%	13%	12%
VLDR.4	54%	36%	29%	21%	19%	17%
VLDR.5	76%	51%	39%	29%	26%	23%
VLDR.6	102%	64%	49%	36%	33%	29%
VLDR.7	132%	79%	60%	45%	40%	36%
VLDR.8	159%	93%	71%	52%	46%	41%
VLDR1_B	193%	115%	89%	68%	59%	53%
	VLDR1_A vs. Desert_B					
VLDR1_A	150%	84%	65%	52%	45%	41%
	VLDR1_B vs. Desert_B					
VLDR1_B	67%	30%	20%	13%	9%	7%

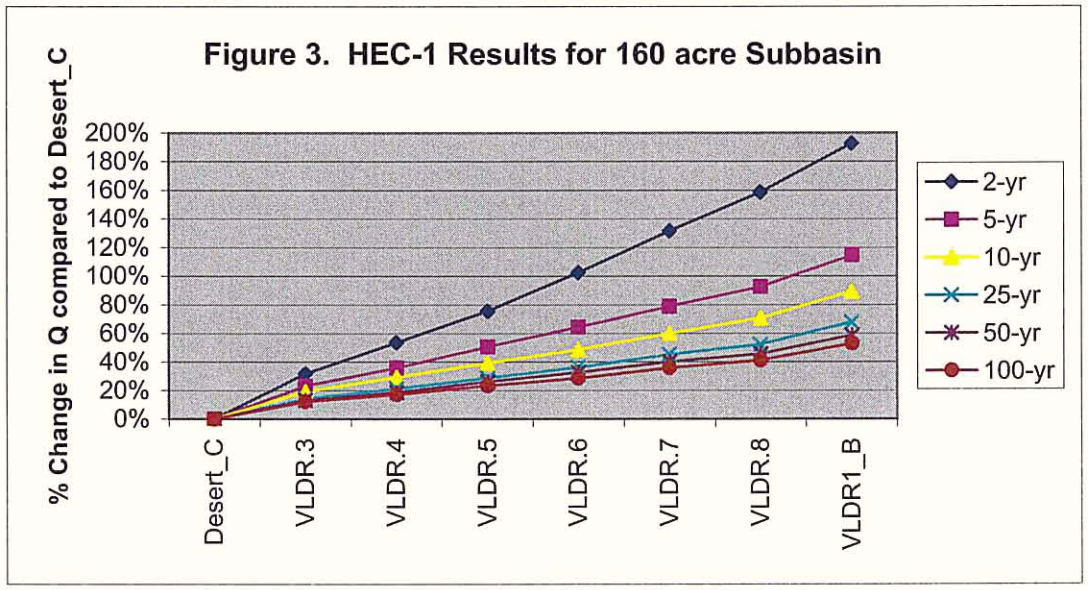


Table 5. HEC-1 results for 640 acre subbasin

Basin Area = 1.00 sq.mi. (2400 ft x 11616 ft)
S = 0.01125 = 59.4 ft/mi
L = 12285.4 ft = 2.33 miles

	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
Desert_B	166	400	592	883	1105	1329
Desert_C	154	267	350	554	725	901
VLDR.3	171	291	430	656	840	1027
VLDR.4	185	331	476	711	899	1089
VLDR.5	197	365	517	759	946	1134
VLDR.6	210	407	566	811	1002	1199
VLDR.7	238	454	621	870	1062	1259
VLDR.8	271	504	671	926	1125	1326
VLDR1B	315	572	754	1025	1239	1459
VLDR1A	484	803	1030	1358	1612	1879

=Tc=1.5

(% diff (VLDR.# - Desert_C)/Desert_C)

Desert_B	8%	50%	69%	59%	52%	48%
Desert_C	0%	0%	0%	0%	0%	0%
VLDR.3	11%	9%	23%	18%	16%	14%
VLDR.4	20%	24%	36%	28%	24%	21%
VLDR.5	28%	37%	48%	37%	30%	26%
VLDR.6	36%	52%	62%	46%	38%	33%
VLDR.7	55%	70%	77%	57%	46%	40%
VLDR.8	76%	89%	92%	67%	55%	47%
VLDR1_B	105%	114%	115%	85%	71%	62%

VLDR1_A vs. Desert_B

VLDR1_A	192%	101%	74%	54%	46%	41%

VLDR1_B vs. Desert_B

VLDR1_B	90%	43%	27%	16%	12%	10%

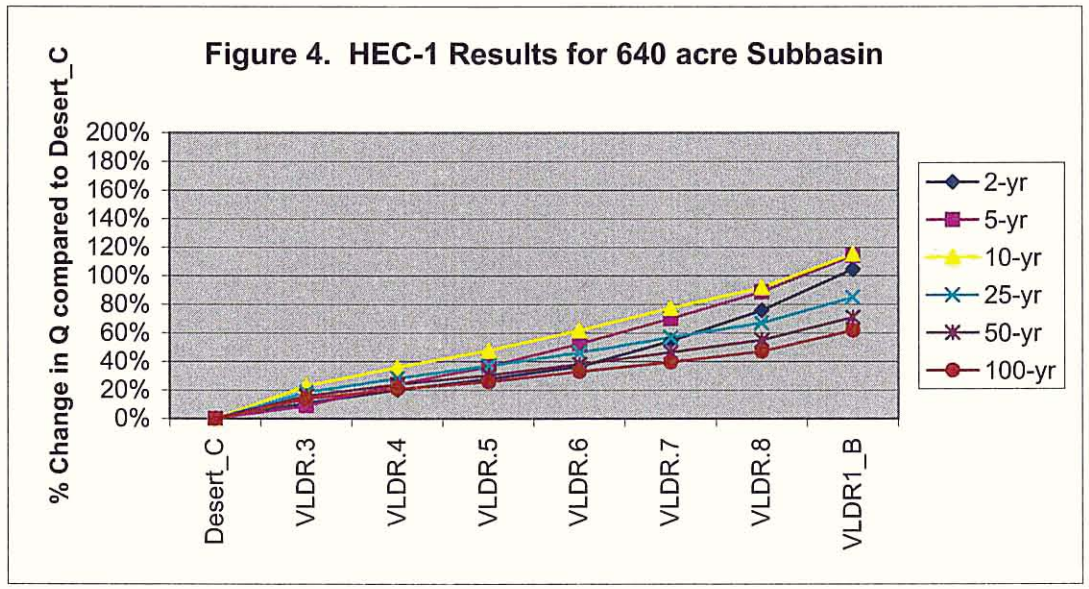


Table 6. Hydraulic Effect of Changes in Peak Discharge on Floodplains

	Existing vs. % Higher Q's - 100-year Event - Change in Variable Magnitude					
	Q Total	W.S. Elev	Vel Chnl	Flow Area	Top Width	Froude # Chl
	(cfs)	(ft)	(ft/s)	(sq ft)	(ft)	
JJ DHW	5%	0.10	0.07	68.1	8.0	0.00
AW RM 4.78 - 8.0	5%	0.12	0.13	53.6	9.6	0.00
JJ DHW	10%	0.18	0.15	121.4	14.9	0.00
AW RM 4.78 - 8.0	10%	0.24	0.21	118.0	25.3	0.00
JJ DHW	20%	0.35	0.31	238.6	34.5	0.01
AW RM 4.78 - 8.0	20%	0.45	0.43	220	38.4	0.01
JJ DHW	30%	0.51	0.44	343.3	53.3	0.01
AW RM 4.78 - 8.0	30%	0.66	0.65	321.2	57.5	0.01
JJ DHW	40%	0.65	0.57	446.8	65.6	0.01
AW RM 4.78 - 8.0	40%	0.85	0.85	417.9	69.3	0.02
JJ DHW	50%	0.79	0.7	547.5	77.3	0.01
AW RM 4.78 - 8.0	50%	1.05	1.04	515.4	82.5	0.02

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                                        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     ADOBE DAM / DESERT HILLS ADMP
          2           ID     MARCH 2003
          3           ID     JE FULLER/ HYDROLOGY & GEOMORPHOLOGY, INC.
          4           ID
          5           ID   HYPOTHETICAL SUBBASIN ANALYSIS FOR DEV. GUIDELINES
          6           ID
          7           ID    AREA = 0.25 SQ. MI. (1200' X 5808')
          8           ID    L = 6142.7 FT = 1.16 MI.
          9           ID    S = 0.0125 = 66.0 FT/MI.
         10           ID
         11           ID    DSRT_B = DESERT RANGELAND BASIN WITH Kb TYPE B
         12           ID    DSRT_C = DESERT RANGELAND BASIN WITH Kb TYPE C
         13           ID
         14           ID    THE FOLLOWING VLDR.# BASINS HAVE Kb TYPES INCREMENTALLY SMOOTHER TRANSITIONI
         15           ID    FROM Kb TYPE C (DSRT_C) TO Kb TYPE B (VLDR1B)IN PROPORTION TO ASSUMED
         16           ID    VEGETATION REMOVAL.
         17           ID
         18           ID    VLDR.3 = VERY LOW DENSITY RESIDENTIAL (1-2 AC LOTS)
         19           ID             WITH 30% VEGETATION REMOVAL ASSUMED
         20           ID    VLDR.4 = VERY LOW DENSITY RESIDENTIAL (1-2 AC LOTS)
         21           ID             WITH 40% VEGETATION REMOVAL ASSUMED
         22           ID    VLDR.5 = VERY LOW DENSITY RESIDENTIAL (1-2 AC LOTS)
         23           ID             WITH 50% VEGETATION REMOVAL ASSUMED
         24           ID    VLDR.6 = VERY LOW DENSITY RESIDENTIAL (1-2 AC LOTS)
         25           ID             WITH 60% VEGETATION REMOVAL ASSUMED
         26           ID    VLDR.7 = VERY LOW DENSITY RESIDENTIAL (1-2 AC LOTS)
         27           ID             WITH 70% VEGETATION REMOVAL ASSUMED
         28           ID    VLDR.8 = VERY LOW DENSITY RESIDENTIAL (1-2 AC LOTS)
         29           ID             WITH 80% VEGETATION REMOVAL ASSUMED
         30           ID    VLDR1B = VERY LOW DENSITY RESIDENTIAL (1-2 AC LOTS)
         31           ID             WITH 100% VEGETATION REMOVAL ASSUMED
         32           ID             Kb TYPE B
         33           ID    VLDR1A = VERY LOW DENSITY RESIDENTIAL (1-2 AC LOTS)
         34           ID             WITH 100% VEGETATION REMOVAL ASSUMED
         35           ID             Kb TYPE A
         36           ID
         37           IT       2                     300
         38           IO       5
         39           JP       6
                      *

         40           KK  DSRT_B
         41           KP       1
                      *   PLAN 1 IS THE 2-YEAR EVENT
         42           KM    SUB-BASIN DSRT_B
         43           KM    6-HOUR RAINFALL, PATTERN NO. 1.00 WAS USED TO FIND TC & R FOR THIS BASIN
         44           KM    THIS BASIN USED RAINFALL REDUCTION FACTOR OF  .997
         45           KM      L = 1.16  Kb = .050  Adj. Slope =   66.0
         46           BA    .250
         47           IN      15
         48           KM    RAINFALL DEPTH OF 1.45 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
         49           PB    1.445
         50           KM    THE FOLLOWING PC RECORD USED A 6-HOUR STORM WITH A PATTERN No. OF 1.00
         51           PC    .000    .008    .016    .025    .033    .041    .050    .058    .066    .074
         52           PC    .087    .099    .118    .138    .216    .377    .834    .911    .931    .950
1                                                HEC-1 INPUT                                                    PAGE  2

        LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10
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 53          PC    .962    .972    .983    .991   1.000
 54          LG    .350    .150   8.600    .087    .000
 55          UC    .821    .738
 56          KP       2
             *   PLAN 2 IS THE 5-YEAR EVENT
 57          KM   RAINFALL DEPTH OF 1.91 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
 58          PB   1.904
 59          UC    .604    .525
             *
 60          KP       3
             *   PLAN 3 IS THE 10-YEAR EVENT
 61          KM   RAINFALL DEPTH OF 2.22 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
 62          PB   2.213
 63          UC    .533    .457
             *
 64          KP       4
             *   PLAN 4 IS THE 25-YEAR EVENT
 65          KM   RAINFALL DEPTH OF 2.67 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
 66          PB   2.661
 67          UC    .467    .394
             *
 68          KP       5
             *   PLAN 5 IS THE 50-YEAR EVENT
 69          KM   RAINFALL DEPTH OF 3.01 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
 70          PB   3.000
 71          UC    .433    .363
             *
 72          KP       6
             *   PLAN 6 IS THE 100-YEAR EVENT
 73          KM   RAINFALL DEPTH OF 3.35 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
 74          PB   3.339
 75          UC    .408    .340
             *

 76          KK  DSRT_C
 77          KP       1
             *   PLAN 1 IS THE 2-YEAR EVENT
 78          KM   SUB-BASIN DSRT_C
 79          KM   6-HOUR RAINFALL, PATTERN NO. 1.00 WAS USED TO FIND TC & R FOR THIS BASIN
 80          KM   THIS BASIN USED RAINFALL REDUCTION FACTOR OF  .997
 81          KM     L = 1.16  Kb = .095  Adj. Slope =   66.0
 82          BA    .250
 83          IN      15
 84          KM   RAINFALL DEPTH OF 1.45 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
 85          PB   1.445
 86          KM   THE FOLLOWING PC RECORD USED A 6-HOUR STORM WITH A PATTERN No. OF 1.00
 87          PC    .000    .008    .016    .025    .033    .041    .050    .058    .066    .074
 88          PC    .087    .099    .118    .138    .216    .377    .834    .911    .931    .950
 89          PC    .962    .972    .983    .991   1.000
 90          LG    .350    .150   8.600    .087    .000
 91          UC   1.408   1.343
 92          KP       2
             *   PLAN 2 IS THE 5-YEAR EVENT
 93          KM   RAINFALL DEPTH OF 1.91 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
 94          PB   1.904
1                                          HEC-1 INPUT                                          PAGE  3

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

 95          UC   1.025    .944
             *
 96          KP       3
             *   PLAN 3 IS THE 10-YEAR EVENT
 97          KM   RAINFALL DEPTH OF 2.22 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
 98          PB   2.213
 99          UC    .879    .796
             *
100          KP       4
             *   PLAN 4 IS THE 25-YEAR EVENT
101          KM   RAINFALL DEPTH OF 2.67 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
102          PB   2.661
103          UC    .746    .663
             *
104          KP       5
             *   PLAN 5 IS THE 50-YEAR EVENT
105          KM   RAINFALL DEPTH OF 3.01 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
106          PB   3.000
107          UC    .688    .606
             *
108          KP       6
             *   PLAN 6 IS THE 100-YEAR EVENT
109          KM   RAINFALL DEPTH OF 3.35 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
110          PB   3.339
111          UC    .642    .561
             *

112          KK  VLDR.3
113          KP       1
             *   PLAN 1 IS THE 2-YEAR EVENT
114          KM   SUB-BASIN VLDR.3
115          KM   6-HOUR RAINFALL, PATTERN NO. 1.00 WAS USED TO FIND TC & R FOR THIS BASIN
116          KM   THIS BASIN USED RAINFALL REDUCTION FACTOR OF  .997
117          KM     L = 1.16  Kb = .082  Adj. Slope =   66.0
118          BA    .250
119          IN      15
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 120          KM   RAINFALL DEPTH OF 1.45 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
 121          PB   1.445
 122          KM   THE FOLLOWING PC RECORD USED A 6-HOUR STORM WITH A PATTERN No. OF 1.00
 123          PC    .000    .008    .016    .025    .033    .041    .050    .058    .066    .074
 124          PC    .087    .099    .118    .138    .216    .377    .834    .911    .931    .950
 125          PC    .962    .972    .983    .991   1.000
 126          LG    .350    .150   8.600    .077   5.000
 127          UC   1.179   1.103
              *
 128          KP       2
              *   PLAN 2 IS THE 5-YEAR EVENT
 129          KM   RAINFALL DEPTH OF 1.91 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
 130          PB   1.904
 131          UC    .875    .792
              *
 132          KP       3
              *   PLAN 3 IS THE 10-YEAR EVENT
 133          KM   RAINFALL DEPTH OF 2.22 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
 134          PB   2.213
1                                          HEC-1 INPUT                                          PAGE  4

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

 135          UC    .758    .675
              *
 136          KP       4
              *   PLAN 4 IS THE 25-YEAR EVENT
 137          KM   RAINFALL DEPTH OF 2.67 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
 138          PB   2.661
 139          UC    .663    .581
              *
 140          KP       5
              *   PLAN 5 IS THE 50-YEAR EVENT
 141          PB   3.000
 142          UC    .613    .533
              *
 143          KP       6
              *   PLAN 6 IS THE 100-YEAR EVENT
 144          KM   RAINFALL DEPTH OF 3.35 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
 145          PB   3.339
 146          UC    .571    .493
              *

 147          KK  VLDR.4
 148          KP       1
              *   PLAN 1 IS THE 2-YEAR EVENT
 149          KM   SUB-BASIN VLDR.4
 150          KM   6-HOUR RAINFALL, PATTERN NO. 1.00 WAS USED TO FIND TC & R FOR THIS BASIN
 151          KM   THIS BASIN USED RAINFALL REDUCTION FACTOR OF  .997
 152          KM     L = 1.16  Kb = .078  Adj. Slope =   66.0
 153          BA    .250
 154          IN      15
 155          KM   RAINFALL DEPTH OF 1.45 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
 156          PB   1.445
 157          KM   THE FOLLOWING PC RECORD USED A 6-HOUR STORM WITH A PATTERN No. OF 1.00
 158          PC    .000    .008    .016    .025    .033    .041    .050    .058    .066    .074
 159          PC    .087    .099    .118    .138    .216    .377    .834    .911    .931    .950
 160          PC    .962    .972    .983    .991   1.000
 161          LG    .300    .150   8.600    .073   5.000
 162          UC   1.087   1.007
              *
 163          KP       2
              *   PLAN 2 IS THE 5-YEAR EVENT
 164          KM   RAINFALL DEPTH OF 1.91 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
 165          PB   1.904
 166          UC    .817    .733
              *
 167          KP       3
              *   PLAN 3 IS THE 10-YEAR EVENT
 168          KM   RAINFALL DEPTH OF 2.22 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
 169          PB   2.213
 170          UC    .717    .634
              *
 171          KP       4
              *   PLAN 4 IS THE 25-YEAR EVENT
 172          KM   RAINFALL DEPTH OF 2.67 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
 173          PB   2.661
 174          UC    .633    .553
              *
1                                          HEC-1 INPUT                                          PAGE  5

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

 175          KP       5
              *   PLAN 5 IS THE 50-YEAR EVENT
 176          KM   RAINFALL DEPTH OF 3.01 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
 177          PB   3.000
 178          UC    .587    .509
              *
 179          KP       6
              *   PLAN 6 IS THE 100-YEAR EVENT
 180          KM   RAINFALL DEPTH OF 3.35 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
 181          PB   3.339
 182          UC    .550    .473
              *
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183          KK  VLDR.5
184          KP       1
             *   PLAN 1 IS THE 2-YEAR EVENT
185          KM   SUB-BASIN VLDR.5
186          KM   6-HOUR RAINFALL, PATTERN NO. 1.00 WAS USED TO FIND TC & R FOR THIS BASIN
187          KM   THIS BASIN USED RAINFALL REDUCTION FACTOR OF  .997
188          KM     L = 1.16  Kb = .073  Adj. Slope =   66.0
189          BA    .250
190          IN      15
191          KM   RAINFALL DEPTH OF 1.45 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
192          PB   1.445
193          KM   THE FOLLOWING PC RECORD USED A 6-HOUR STORM WITH A PATTERN No. OF 1.00
194          PC    .000    .008    .016    .025    .033    .041    .050    .058    .066    .074
195          PC    .087    .099    .118    .138    .216    .377    .834    .911    .931    .950
196          PC    .962    .972    .983    .991   1.000
197          LG    .250    .150   8.600    .070   5.000
198          UC    .992    .910
             *
199          KP       2
             *   PLAN 2 IS THE 5-YEAR EVENT
200          KM   RAINFALL DEPTH OF 1.91 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
201          PB   1.904
202          UC    .758    .675
             *
203          KP       3
             *   PLAN 3 IS THE 10-YEAR EVENT
204          KM   RAINFALL DEPTH OF 2.22 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
205          PB   2.213
206          UC    .675    .594
             *
207          KP       4
             *   PLAN 4 IS THE 25-YEAR EVENT
208          KM   RAINFALL DEPTH OF 2.67 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
209          PB   2.661
210          UC    .600    .521
             *
211          KP       5
             *   PLAN 5 IS THE 50-YEAR EVENT
212          KM   RAINFALL DEPTH OF 3.01 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
213          PB   3.000
214          UC    .554    .477
             *
1                                          HEC-1 INPUT                                          PAGE  6

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

215          KP       6
             *   PLAN 6 IS THE 100-YEAR EVENT
216          KM   RAINFALL DEPTH OF 3.35 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
217          PB   3.339
218          UC    .521    .445
             *

219          KK  VLDR.6
220          KP       1
             *   PLAN 1 IS THE 2-YEAR EVENT
221          KM   SUB-BASIN VLDR.6
222          KM   6-HOUR RAINFALL, PATTERN NO. 1.00 WAS USED TO FIND TC & R FOR THIS BASIN
223          KM   THIS BASIN USED RAINFALL REDUCTION FACTOR OF  .997
224          KM     L = 1.16  Kb = .069  Adj. Slope =   66.0
225          BA    .250
226          IN      15
227          KM   RAINFALL DEPTH OF 1.45 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
228          PB   1.445
229          KM   THE FOLLOWING PC RECORD USED A 6-HOUR STORM WITH A PATTERN No. OF 1.00
230          PC    .000    .008    .016    .025    .033    .041    .050    .058    .066    .074
231          PC    .087    .099    .118    .138    .216    .377    .834    .911    .931    .950
232          PC    .962    .972    .983    .991   1.000
233          LG    .200    .150   8.600    .067   5.000
234          UC    .913    .829
             *
235          KP       2
             *   PLAN 2 IS THE 5-YEAR EVENT
236          KM   RAINFALL DEPTH OF 1.91 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
237          PB   1.904
238          UC    .712    .630
             *
239          KP       3
             *   PLAN 3 IS THE 10-YEAR EVENT
240          KM   RAINFALL DEPTH OF 2.22 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
241          PB   2.213
242          UC    .642    .561
             *
243          KP       4
             *   PLAN 4 IS THE 25-YEAR EVENT
244          KM   RAINFALL DEPTH OF 2.67 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
245          PB   2.661
246          UC    .571    .493
             *
247          KP       5
             *   PLAN 5 IS THE 50-YEAR EVENT
248          KM   RAINFALL DEPTH OF 3.01 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
249          PB   3.000
250          UC    .529    .453
             *
251          KP       6
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                 *   PLAN 6 IS THE 100-YEAR EVENT
 252             KM   RAINFALL DEPTH OF 3.35 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
 253             PB   3.339
 254             UC    .500    .425
                 *
1                                                HEC-1 INPUT                                                    PAGE  7

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


 255             KK  VLDR.7
 256             KP       1
                 *   PLAN 1 IS THE 2-YEAR EVENT
 257             KM   SUB-BASIN VLDR.7
 258             KM   6-HOUR RAINFALL, PATTERN NO. 1.00 WAS USED TO FIND TC & R FOR THIS BASIN
 259             KM   THIS BASIN USED RAINFALL REDUCTION FACTOR OF  .997
 260             KM     L = 1.16  Kb = .064  Adj. Slope =   66.0
 261             BA    .250
 262             IN      15
 263             KM   RAINFALL DEPTH OF 1.45 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
 264             PB   1.445
 265             KM   THE FOLLOWING PC RECORD USED A 6-HOUR STORM WITH A PATTERN No. OF 1.00
 266             PC    .000    .008    .016    .025    .033    .041    .050    .058    .066    .074
 267             PC    .087    .099    .118    .138    .216    .377    .834    .911    .931    .950
 268             PC    .962    .972    .983    .991   1.000
 269             LG    .150    .150   8.600    .063   5.000
 270             UC    .829    .746
                 *
 271             KP       2
                 *   PLAN 2 IS THE 5-YEAR EVENT
 272             KM   RAINFALL DEPTH OF 1.91 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
 273             PB   1.904
 274             UC    .667    .585
                 *
 275             KP       3
                 *   PLAN 3 IS THE 10-YEAR EVENT
 276             KM   RAINFALL DEPTH OF 2.22 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
 277             PB   2.213
 278             UC    .604    .525
                 *
 279             KP       4
                 *   PLAN 4 IS THE 25-YEAR EVENT
 280             KM   RAINFALL DEPTH OF 2.67 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
 281             PB   2.661
 282             UC    .538    .461
                 *
 283             KP       5
                 *   PLAN 5 IS THE 50-YEAR EVENT
 284             KM   RAINFALL DEPTH OF 3.01 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
 285             PB   3.000
 286             UC    .500    .425
                 *
 287             KP       6
                 *   PLAN 6 IS THE 100-YEAR EVENT
 288             KM   RAINFALL DEPTH OF 3.35 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
 289             PB   3.339
 290             UC    .471    .398
                 *
1                                                HEC-1 INPUT                                                    PAGE  8

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


 291             KK  VLDR.8
 292             KP       1
                 *   PLAN 1 IS THE 2-YEAR EVENT
 293             KM   SUB-BASIN VLDR.8
 294             KM   6-HOUR RAINFALL, PATTERN NO. 1.00 WAS USED TO FIND TC & R FOR THIS BASIN
 295             KM   THIS BASIN USED RAINFALL REDUCTION FACTOR OF  .997
 296             KM     L = 1.16  Kb = .060  Adj. Slope =   66.0
 297             BA    .250
 298             IN      15
 299             KM   RAINFALL DEPTH OF 1.45 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
 300             PB   1.445
 301             KM   THE FOLLOWING PC RECORD USED A 6-HOUR STORM WITH A PATTERN No. OF 1.00
 302             PC    .000    .008    .016    .025    .033    .041    .050    .058    .066    .074
 303             PC    .087    .099    .118    .138    .216    .377    .834    .911    .931    .950
 304             PC    .962    .972    .983    .991   1.000
 305             LG    .100    .150   8.600    .060   5.000
 306             UC    .767    .683
                 *
 307             KP       2
                 *   PLAN 2 IS THE 5-YEAR EVENT
 308             KM   RAINFALL DEPTH OF 1.91 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
 309             PB   1.904
 310             UC    .629    .549
                 *
 311             KP       3
                 *   PLAN 3 IS THE 10-YEAR EVENT
 312             KM   RAINFALL DEPTH OF 2.22 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
 313             PB   2.213
 314             UC    .571    .493
                 *
 315             KP       4
                 *   PLAN 4 IS THE 25-YEAR EVENT
 316             KM   RAINFALL DEPTH OF 2.67 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
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 317          PB   2.661
 318          UC    .512    .437
              *
 319          KP       5
              *   PLAN 5 IS THE 50-YEAR EVENT
 320          KM   RAINFALL DEPTH OF 3.01 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
 321          PB   3.000
 322          UC    .479    .406
              *
 323          KP       6
              *   PLAN 6 IS THE 100-YEAR EVENT
 324          KM   RAINFALL DEPTH OF 3.35 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
 325          PB   3.339
 326          UC    .450    .378
              *
1                                          HEC-1 INPUT                                          PAGE  9

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


 327          KK  VLDR1B
 328          KP       1
              *   PLAN 1 IS THE 2-YEAR EVENT
 329          KM   SUB-BASIN VLDR1B
 330          KM   6-HOUR RAINFALL, PATTERN NO. 1.00 WAS USED TO FIND TC & R FOR THIS BASIN
 331          KM   THIS BASIN USED RAINFALL REDUCTION FACTOR OF  .997
 332          KM     L = 1.16  Kb = .050  Adj. Slope =   66.0
 333          BA    .250
 334          IN      15
 335          KM   RAINFALL DEPTH OF 1.45 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
 336          PB   1.445
 337          KM   THE FOLLOWING PC RECORD USED A 6-HOUR STORM WITH A PATTERN No. OF 1.00
 338          PC    .000    .008    .016    .025    .033    .041    .050    .058    .066    .074
 339          PC    .087    .099    .118    .138    .216    .377    .834    .911    .931    .950
 340          PC    .962    .972    .983    .991   1.000
 341          LG    .100    .150   8.600    .060   5.000
 342          UC    .667    .585
              *
 343          KP       2
              *   PLAN 2 IS THE 5-YEAR EVENT
 344          KM   RAINFALL DEPTH OF 1.91 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
 345          PB   1.904
 346          UC    .550    .473
              *
 347          KP       3
              *   PLAN 3 IS THE 10-YEAR EVENT
 348          KM   RAINFALL DEPTH OF 2.22 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
 349          PB   2.213
 350          UC    .500    .425
              *
 351          KP       4
              *   PLAN 4 IS THE 25-YEAR EVENT
 352          KM   RAINFALL DEPTH OF 2.67 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
 353          PB   2.661
 354          UC    .450    .378
              *
 355          KP       5
              *   PLAN 5 IS THE 50-YEAR EVENT
 356          KM   RAINFALL DEPTH OF 3.01 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
 357          PB   3.000
 358          UC    .425    .355
              *
 359          KP       6
              *   PLAN 6 IS THE 100-YEAR EVENT
 360          KM   RAINFALL DEPTH OF 3.35 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
 361          PB   3.339
 362          UC    .400    .332
              *
1                                          HEC-1 INPUT                                          PAGE 10

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


 363          KK  VLDR1A
 364          KP       1
              *   PLAN 1 IS THE 2-YEAR EVENT
 365          KM   SUB-BASIN VLDR1A
 366          KM   6-HOUR RAINFALL, PATTERN NO. 1.00 WAS USED TO FIND TC & R FOR THIS BASIN
 367          KM   THIS BASIN USED RAINFALL REDUCTION FACTOR OF  .997
 368          KM     L = 1.16  Kb = .026  Adj. Slope =   66.0
 369          BA    .250
 370          IN      15
 371          KM   RAINFALL DEPTH OF 1.45 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
 372          PB   1.445
 373          KM   THE FOLLOWING PC RECORD USED A 6-HOUR STORM WITH A PATTERN No. OF 1.00
 374          PC    .000    .008    .016    .025    .033    .041    .050    .058    .066    .074
 375          PC    .087    .099    .118    .138    .216    .377    .834    .911    .931    .950
 376          PC    .962    .972    .983    .991   1.000
 377          LG    .100    .150   8.600    .060   5.000
 378          UC    .412    .344
              *
 379          KP       2
              *   PLAN 2 IS THE 5-YEAR EVENT
 380          KM   RAINFALL DEPTH OF 1.91 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
 381          PB   1.904
 382          UC    .346    .283
```

```
                    *
383                 KP        3
                    *   PLAN 3 IS THE 10-YEAR EVENT
384                 KM   RAINFALL DEPTH OF 2.22 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
385                 PB   2.213
386                 UC    .321     .260
                    *
387                 KP        4
                    *   PLAN 4 IS THE 25-YEAR EVENT
388                 KM   RAINFALL DEPTH OF 2.67 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
389                 PB   2.661
390                 UC    .287     .230
                    *
391                 KP        5
                    *   PLAN 5 IS THE 50-YEAR EVENT
392                 KM   RAINFALL DEPTH OF 3.01 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
393                 PB   3.000
394                 UC    .271     .215
                    *
395                 KP        6
                    *   PLAN 6 IS THE 100-YEAR EVENT
396                 KM   RAINFALL DEPTH OF 3.35 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
397                 PB   3.339
398                 UC    .258     .204
                    *
399                 ZZ
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   21MAR03  TIME  09:41:04  *                                    *          (916) 756-1104              *
 *                                      *                                    *                                      *
 ****************************************                                    ****************************************
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ADOBE DAM / DESERT HILLS ADMP
MARCH 2003
JE FULLER/ HYDROLOGY & GEOMORPHOLOGY, INC.

HYPOTHETICAL SUBBASIN ANALYSIS FOR DEV. GUIDELINES

AREA = 0.25 SQ. MI. (1200' X 5808')
L = 6142.7 FT = 1.16 MI.
S = 0.0125 = 66.0 FT/MI.

DSRT_B = DESERT RANGELAND BASIN WITH Kb TYPE B
DSRT_C = DESERT RANGELAND BASIN WITH Kb TYPE C

THE FOLLOWING VLDR.# BASINS HAVE Kb TYPES INCREMENTALLY SMOOTHER TRANSITIONI
FROM Kb TYPE C (DSRT_C) TO Kb TYPE B (VLDR1B)IN PROPORTION TO ASSUMED
VEGETATION REMOVAL.

```
VLDR.3 = VERY LOW DENSITY RESIDENTIAL (1-2 AC LOTS)
         WITH 30% VEGETATION REMOVAL ASSUMED
VLDR.4 = VERY LOW DENSITY RESIDENTIAL (1-2 AC LOTS)
         WITH 40% VEGETATION REMOVAL ASSUMED
VLDR.5 = VERY LOW DENSITY RESIDENTIAL (1-2 AC LOTS)
         WITH 50% VEGETATION REMOVAL ASSUMED
VLDR.6 = VERY LOW DENSITY RESIDENTIAL (1-2 AC LOTS)
         WITH 60% VEGETATION REMOVAL ASSUMED
VLDR.7 = VERY LOW DENSITY RESIDENTIAL (1-2 AC LOTS)
         WITH 70% VEGETATION REMOVAL ASSUMED
VLDR.8 = VERY LOW DENSITY RESIDENTIAL (1-2 AC LOTS)
         WITH 80% VEGETATION REMOVAL ASSUMED
VLDR1B = VERY LOW DENSITY RESIDENTIAL (1-2 AC LOTS)
         WITH 100% VEGETATION REMOVAL ASSUMED
         Kb TYPE B
VLDR1A = VERY LOW DENSITY RESIDENTIAL (1-2 AC LOTS)
         WITH 100% VEGETATION REMOVAL ASSUMED
         Kb TYPE A

 38 IO          OUTPUT CONTROL VARIABLES
                      IPRNT          5  PRINT CONTROL
                      IPLOT          0  PLOT CONTROL
                      QSCAL         0.  HYDROGRAPH PLOT SCALE

    IT          HYDROGRAPH TIME DATA
                       NMIN          2  MINUTES IN COMPUTATION INTERVAL
                      IDATE      1   0  STARTING DATE
                      ITIME       0000  STARTING TIME
                         NQ        300  NUMBER OF HYDROGRAPH ORDINATES
                     NDDATE      1   0  ENDING DATE
                     NDTIME       0958  ENDING TIME
                      ICENT         19  CENTURY MARK

                 COMPUTATION INTERVAL     .03 HOURS
                      TOTAL TIME BASE    9.97 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

     JP          MULTI-PLAN OPTION
                      NPLAN            6  NUMBER OF PLANS

     JR          MULTI-RATIO OPTION
                     RATIOS OF RUNOFF
                       1.00
         WARNING EXCESS AT PONDING LESS THAN ZERO FOR PERIOD. EXCESS SET TO ZERO
1

              PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
                                FLOWS IN CUBIC FEET PER SECOND,  AREA IN SQUARE MILES
                                          TIME TO PEAK IN HOURS

                                                                  RATIOS APPLIED TO FLOWS
 OPERATION       STATION     AREA    PLAN                 RATIO 1
                                                             1.00

 HYDROGRAPH AT
+                DSRT_B       .25     1   FLOW              72.
                                         TIME             4.60
                                      2  FLOW             157.
                                         TIME             4.40
                                      3  FLOW             220.
                                         TIME             4.33
                                      4  FLOW             316.
                                         TIME             4.27
                                      5  FLOW             389.
                                         TIME             4.23
                                      6  FLOW             463.
                                         TIME             4.23

 HYDROGRAPH AT
+                DSRT_C       .25     1   FLOW              41.
                                         TIME             5.13
                                      2  FLOW              95.
                                         TIME             4.77
                                      3  FLOW             140.
                                         TIME             4.63
                                      4  FLOW             212.
                                         TIME             4.50
                                      5  FLOW             267.
                                         TIME             4.47
                                      6  FLOW             325.
                                         TIME             4.43

 HYDROGRAPH AT
+                VLDR.3       .25     1   FLOW              54.
                                         TIME             4.93
                                      2  FLOW             117.
                                         TIME             4.63
                                      3  FLOW             167.
                                         TIME             4.53
                                      4  FLOW             242.
                                         TIME             4.43
                                      5  FLOW             302.
                                         TIME             4.40
                                      6  FLOW             365.
                                         TIME             4.37

 HYDROGRAPH AT
+                VLDR.4       .25     1   FLOW              63.
                                         TIME             4.83
                                      2  FLOW             129.
                                         TIME             4.57
                                      3  FLOW             181.
                                         TIME             4.50
                                      4  FLOW             257.
                                         TIME             4.40
                                      5  FLOW             317.
                                         TIME             4.37
                                      6  FLOW             381.
                                         TIME             4.33

 HYDROGRAPH AT
+                VLDR.5       .25     1   FLOW              72.
                                         TIME             4.73
                                      2  FLOW             143.
                                         TIME             4.53
                                      3  FLOW             195.
                                         TIME             4.47
                                      4  FLOW             273.
                                         TIME             4.40
                                      5  FLOW             337.
                                         TIME             4.33
                                      6  FLOW             401.
                                         TIME             4.33

 HYDROGRAPH AT
```

```
+                    VLDR.6        .25     1   FLOW          83.
                                               TIME         4.67
                                           2   FLOW         156.
                                               TIME         4.50
                                           3   FLOW         208.
                                               TIME         4.43
                                           4   FLOW         289.
                                               TIME         4.37
                                           5   FLOW         354.
                                               TIME         4.33
                                           6   FLOW         418.
                                               TIME         4.30

 HYDROGRAPH AT
+                    VLDR.7        .25     1   FLOW          95.
                                               TIME         4.60
                                           2   FLOW         170.
                                               TIME         4.43
                                           3   FLOW         224.
                                               TIME         4.40
                                           4   FLOW         308.
                                               TIME         4.33
                                           5   FLOW         374.
                                               TIME         4.30
                                           6   FLOW         441.
                                               TIME         4.27

 HYDROGRAPH AT
+                    VLDR.8        .25     1   FLOW         106.
                                               TIME         4.53
                                           2   FLOW         183.
                                               TIME         4.40
                                           3   FLOW         239.
                                               TIME         4.37
                                           4   FLOW         323.
                                               TIME         4.30
                                           5   FLOW         389.
                                               TIME         4.27
                                           6   FLOW         459.
                                               TIME         4.27

 HYDROGRAPH AT
+                    VLDR1B        .25     1   FLOW         120.
                                               TIME         4.43
                                           2   FLOW         204.
                                               TIME         4.33
                                           3   FLOW         265.
                                               TIME         4.30
                                           4   FLOW         356.
                                               TIME         4.27
                                           5   FLOW         424.
                                               TIME         4.23
                                           6   FLOW         497.
                                               TIME         4.20

 HYDROGRAPH AT
+                    VLDR1A        .25     1   FLOW         180.
                                               TIME         4.23
                                           2   FLOW         289.
                                               TIME         4.17
                                           3   FLOW         362.
                                               TIME         4.17
                                           4   FLOW         479.
                                               TIME         4.13
                                           5   FLOW         564.
                                               TIME         4.10
                                           6   FLOW         653.
                                               TIME         4.10


*** NORMAL END OF HEC-1 ***
```

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1****************************************
 *                                      *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *
 *              JUN   1998              *
 *           VERSION 4.1                *
 *                                      *
 *  RUN DATE   21MAR03  TIME  09:40:57  *
 *                                      *
 ****************************************
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****************************************
*                                      *
*    U.S. ARMY CORPS OF ENGINEERS      *
*    HYDROLOGIC ENGINEERING CENTER     *
*          609 SECOND STREET           *
*       DAVIS, CALIFORNIA 95616        *
*           (916) 756-1104             *
*                                      *
****************************************
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```
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

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1                                    HEC-1 INPUT                                                    PAGE  1

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

  1           ID     ADOBE DAM / DESERT HILLS ADMP
  2           ID     MARCH 2003
  3           ID     JE FULLER/ HYDROLOGY & GEOMORPHOLOGY, INC.
  4           ID
  5           ID   HYPOTHETICAL SUBBASIN ANALYSIS FOR DEV. GUIDELINES
  6           ID    AREA = 1.00 SQ. MI. (2400' X 11616')
  7           ID    L = 12285.4 FT = 2.33 MI.
  8           ID    S = 0.01125 = 59.4 FT/MI.
  9           ID
 10           ID    DSRT_B = DESERT RANGELAND BASIN WITH Kb TYPE B
 11           ID    DSRT_C = DESERT RANGELAND BASIN WITH Kb TYPE C
 12           ID
 13           ID    THE FOLLOWING VLDR.# BASINS HAVE Kb TYPES INCREMENTALLY SMOOTHER TRANSITIONI
 14           ID    FROM Kb TYPE C (DSRT_C) TO Kb TYPE B (VLDR1B)IN PROPORTION TO ASSUMED
 15           ID    VEGETATION REMOVAL.
 16           ID
 17           ID    VLDR.3 = VERY LOW DENSITY RESIDENTIAL (1-2 AC LOTS)
 18           ID             WITH 30% VEGETATION REMOVAL ASSUMED
 19           ID    VLDR.4 = VERY LOW DENSITY RESIDENTIAL (1-2 AC LOTS)
 20           ID             WITH 40% VEGETATION REMOVAL ASSUMED
 21           ID    VLDR.5 = VERY LOW DENSITY RESIDENTIAL (1-2 AC LOTS)
 22           ID             WITH 50% VEGETATION REMOVAL ASSUMED
 23           ID    VLDR.6 = VERY LOW DENSITY RESIDENTIAL (1-2 AC LOTS)
 24           ID             WITH 60% VEGETATION REMOVAL ASSUMED
 25           ID    VLDR.7 = VERY LOW DENSITY RESIDENTIAL (1-2 AC LOTS)
 26           ID             WITH 70% VEGETATION REMOVAL ASSUMED
 27           ID    VLDR.8 = VERY LOW DENSITY RESIDENTIAL (1-2 AC LOTS)
 28           ID             WITH 80% VEGETATION REMOVAL ASSUMED
 29           ID    VLDR1B = VERY LOW DENSITY RESIDENTIAL (1-2 AC LOTS)
 30           ID             WITH 100% VEGETATION REMOVAL ASSUMED
 31           ID             Kb TYPE B
 32           ID    VLDR1A = VERY LOW DENSITY RESIDENTIAL (1-2 AC LOTS)
 33           ID             WITH 100% VEGETATION REMOVAL ASSUMED
 34           ID             Kb TYPE A
 35           ID
 36           IT       2                    300
 37           IO       5
 38           JP       6
              *

 39           KK  DSRT_B
 40           KP       1
              *   PLAN 1 IS THE 2-YEAR EVENT
 41           KM   SUB-BASIN DSRT_B
 42           KM   6-HOUR RAINFALL, PATTERN NO. 1.40 WAS USED TO FIND TC & R FOR THIS BASIN
 43           KM   THIS BASIN USED RAINFALL REDUCTION FACTOR OF  .987
 44           KM     L = 2.33  Kb = .041  Adj. Slope =   59.4
 45           BA   1.000
 46           IN      15
 47           KM   RAINFALL DEPTH OF 1.45 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
 48           PB   1.431
 49           KM   THE FOLLOWING PC RECORD USED A 6-HOUR STORM WITH A PATTERN No. OF 1.40
 50           PC    .000    .008    .016    .025    .033    .041    .050    .058    .066    .075
 51           PC    .087    .099    .119    .148    .230    .407    .778    .881    .919    .945
 52           PC    .957    .968    .980    .990   1.000
1                                    HEC-1 INPUT                                                    PAGE  2

LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10
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```
 53          LG    .350    .150   8.600    .087    .000
 54          UC   1.396   1.054
 55          KP       2
             *   PLAN 2 IS THE 5-YEAR EVENT
 56          KM   RAINFALL DEPTH OF 1.91 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
 57          PB   1.885
 58          UC    .992    .721
             *
 59          KP       3
             *   PLAN 3 IS THE 10-YEAR EVENT
 60          KM   RAINFALL DEPTH OF 2.22 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
 61          PB   2.191
 62          UC    .846    .604
             *
 63          KP       4
             *   PLAN 4 IS THE 25-YEAR EVENT
 64          KM   RAINFALL DEPTH OF 2.67 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
 65          PB   2.635
 66          UC    .725    .509
             *
 67          KP       5
             *   PLAN 5 IS THE 50-YEAR EVENT
 68          KM   RAINFALL DEPTH OF 3.01 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
 69          PB   2.971
 70          UC    .671    .467
             *
 71          KP       6
             *   PLAN 6 IS THE 100-YEAR EVENT
 72          KM   RAINFALL DEPTH OF 3.35 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
 73          PB   3.306
 74          UC    .629    .435
             *

 75          KK  DSRT_C
 76          KP       1
             *   PLAN 1 IS THE 2-YEAR EVENT
 77          KM   SUB-BASIN DSRT_C
 78          KM   6-HOUR RAINFALL, PATTERN NO. 1.40 WAS USED TO FIND TC & R FOR THIS BASIN
 79          KM   THIS BASIN USED RAINFALL REDUCTION FACTOR OF  .987
 80          KM     L = 2.33  Kb = .041  Adj. Slope =   59.4
 81          BA   1.000
 82          IN      15
 83          KM   RAINFALL DEPTH OF 1.45 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
 84          PB   1.431
 85          KM   THE FOLLOWING PC RECORD USED A 6-HOUR STORM WITH A PATTERN No. OF 1.40
 86          PC    .000    .008    .016    .025    .033    .041    .050    .058    .066    .075
 87          PC    .087    .099    .119    .148    .230    .407    .778    .881    .919    .945
 88          PC    .957    .968    .980    .990   1.000
 89          LG    .350    .150   8.600    .087    .000
 90          UC   1.500   1.142
             *
 91          KP       2
             *   PLAN 2 IS THE 5-YEAR EVENT
 92          KM   RAINFALL DEPTH OF 1.91 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
 93          PB   1.885
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LINE         ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

 94          UC   1.500   1.142
             *
 95          KP       3
             *   PLAN 3 IS THE 10-YEAR EVENT
 96          KM   RAINFALL DEPTH OF 2.22 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
 97          PB   2.191
 98          UC   1.479   1.124
             *
 99          KP       4
             *   PLAN 4 IS THE 25-YEAR EVENT
100          KM   RAINFALL DEPTH OF 2.67 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
101          PB   2.635
102          UC   1.233    .919
             *
103          KP       5
             *   PLAN 5 IS THE 50-YEAR EVENT
104          KM   RAINFALL DEPTH OF 3.01 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
105          PB   2.971
106          UC   1.108    .816
             *
107          KP       6
             *   PLAN 6 IS THE 100-YEAR EVENT
108          KM   RAINFALL DEPTH OF 3.35 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
109          PB   3.306
110          UC   1.021    .745
             *

111          KK  VLDR.3
112          KP       1
             *   PLAN 1 IS THE 2-YEAR EVENT
113          KM   SUB-BASIN VLDR.3
114          KM   6-HOUR RAINFALL, PATTERN NO. 1.40 WAS USED TO FIND TC & R FOR THIS BASIN
115          KM   THIS BASIN USED RAINFALL REDUCTION FACTOR OF  .987
116          KM     L = 2.33  Kb = .069  Adj. Slope =   59.4
117          BA   1.000
118          IN      15
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119          KM   RAINFALL DEPTH OF 1.45 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
120          PB   1.431
121          KM   THE FOLLOWING PC RECORD USED A 6-HOUR STORM WITH A PATTERN No. OF 1.40
122          PC    .000    .008    .016    .025    .033    .041    .050    .058    .066    .075
123          PC    .087    .099    .119    .148    .230    .407    .778    .881    .919    .945
124          PC    .957    .968    .980    .990   1.000
125          LG    .350    .150   8.600    .077   5.000
126          UC   1.500   1.142
             *
127          KP       2
             *   PLAN 2 IS THE 5-YEAR EVENT
128          KM   RAINFALL DEPTH OF 1.91 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
129          PB   1.885
130          UC   1.471   1.117
             *
131          KP       3
             *   PLAN 3 IS THE 10-YEAR EVENT
132          KM   RAINFALL DEPTH OF 2.22 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
133          PB   2.191
1                                          HEC-1 INPUT                                          PAGE  4

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

134          UC   1.263    .943
             *
135          KP       4
             *   PLAN 4 IS THE 25-YEAR EVENT
136          KM   RAINFALL DEPTH OF 2.67 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
137          PB   2.635
138          UC   1.071    .785
             *
139          KP       5
             *   PLAN 5 IS THE 50-YEAR EVENT
140          PB   2.971
141          UC    .971    .704
             *
142          KP       6
             *   PLAN 6 IS THE 100-YEAR EVENT
143          KM   RAINFALL DEPTH OF 3.35 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
144          PB   3.306
145          UC    .900    .648
             *

146          KK  VLDR.4
147          KP       1
             *   PLAN 1 IS THE 2-YEAR EVENT
148          KM   SUB-BASIN VLDR.4
149          KM   6-HOUR RAINFALL, PATTERN NO. 1.40 WAS USED TO FIND TC & R FOR THIS BASIN
150          KM   THIS BASIN USED RAINFALL REDUCTION FACTOR OF  .987
151          KM     L = 2.33  Kb = .065  Adj. Slope =   59.4
152          BA   1.000
153          IN      15
154          KM   RAINFALL DEPTH OF 1.45 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
155          PB   1.431
156          KM   THE FOLLOWING PC RECORD USED A 6-HOUR STORM WITH A PATTERN No. OF 1.40
157          PC    .000    .008    .016    .025    .033    .041    .050    .058    .066    .075
158          PC    .087    .099    .119    .148    .230    .407    .778    .881    .919    .945
159          PC    .957    .968    .980    .990   1.000
160          LG    .300    .150   8.600    .073   5.000
161          UC   1.500   1.142
             *
162          KP       2
             *   PLAN 2 IS THE 5-YEAR EVENT
163          KM   RAINFALL DEPTH OF 1.91 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
164          PB   1.885
165          UC   1.354   1.019
             *
166          KP       3
             *   PLAN 3 IS THE 10-YEAR EVENT
167          KM   RAINFALL DEPTH OF 2.22 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
168          PB   2.191
169          UC   1.175    .871
             *
170          KP       4
             *   PLAN 4 IS THE 25-YEAR EVENT
171          KM   RAINFALL DEPTH OF 2.67 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
172          PB   2.635
173          UC   1.004    .731
             *
1                                          HEC-1 INPUT                                          PAGE  5

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

174          KP       5
             *   PLAN 5 IS THE 50-YEAR EVENT
175          KM   RAINFALL DEPTH OF 3.01 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
176          PB   2.971
177          UC    .917    .661
             *
178          KP       6
             *   PLAN 6 IS THE 100-YEAR EVENT
179          KM   RAINFALL DEPTH OF 3.35 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
180          PB   3.306
181          UC    .854    .611
             *
```

```
182          KK  VLDR.5
183          KP       1
             *   PLAN 1 IS THE 2-YEAR EVENT
184          KM   SUB-BASIN VLDR.5
185          KM   6-HOUR RAINFALL, PATTERN NO. 1.40 WAS USED TO FIND TC & R FOR THIS BASIN
186          KM   THIS BASIN USED RAINFALL REDUCTION FACTOR OF  .987
187          KM     L = 2.33  Kb = .062  Adj. Slope =   59.4
188          BA   1.000
189          IN      15
190          KM   RAINFALL DEPTH OF 1.45 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
191          PB   1.431
192          KM   THE FOLLOWING PC RECORD USED A 6-HOUR STORM WITH A PATTERN No. OF 1.40
193          PC    .000    .008    .016    .025    .033    .041    .050    .058    .066    .075
194          PC    .087    .099    .119    .148    .230    .407    .778    .881    .919    .945
195          PC    .957    .968    .980    .990   1.000
196          LG    .250    .150   8.600    .070   5.000
197          UC   1.500   1.142
             *
198          KP       2
             *   PLAN 2 IS THE 5-YEAR EVENT
199          KM   RAINFALL DEPTH OF 1.91 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
200          PB   1.885
201          UC   1.271    .950
             *
202          KP       3
             *   PLAN 3 IS THE 10-YEAR EVENT
203          KM   RAINFALL DEPTH OF 2.22 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
204          PB   2.191
205          UC   1.108    .816
             *
206          KP       4
             *   PLAN 4 IS THE 25-YEAR EVENT
207          KM   RAINFALL DEPTH OF 2.67 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
208          PB   2.635
209          UC    .954    .691
             *
210          KP       5
             *   PLAN 5 IS THE 50-YEAR EVENT
211          KM   RAINFALL DEPTH OF 3.01 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
212          PB   2.971
213          UC    .879    .631
             *
1                                          HEC-1 INPUT                                          PAGE  6
LINE         ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

214          KP       6
             *   PLAN 6 IS THE 100-YEAR EVENT
215          KM   RAINFALL DEPTH OF 3.35 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
216          PB   3.306
217          UC    .825    .588
             *

218          KK  VLDR.6
219          KP       1
             *   PLAN 1 IS THE 2-YEAR EVENT
220          KM   SUB-BASIN VLDR.6
221          KM   6-HOUR RAINFALL, PATTERN NO. 1.40 WAS USED TO FIND TC & R FOR THIS BASIN
222          KM   THIS BASIN USED RAINFALL REDUCTION FACTOR OF  .987
223          KM     L = 2.33  Kb = .058  Adj. Slope =   59.4
224          BA   1.000
225          IN      15
226          KM   RAINFALL DEPTH OF 1.45 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
227          PB   1.431
228          KM   THE FOLLOWING PC RECORD USED A 6-HOUR STORM WITH A PATTERN No. OF 1.40
229          PC    .000    .008    .016    .025    .033    .041    .050    .058    .066    .075
230          PC    .087    .099    .119    .148    .230    .407    .778    .881    .919    .945
231          PC    .957    .968    .980    .990   1.000
232          LG    .200    .150   8.600    .067   5.000
233          UC   1.500   1.142
             *
234          KP       2
             *   PLAN 2 IS THE 5-YEAR EVENT
235          KM   RAINFALL DEPTH OF 1.91 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
236          PB   1.885
237          UC   1.175    .871
             *
238          KP       3
             *   PLAN 3 IS THE 10-YEAR EVENT
239          KM   RAINFALL DEPTH OF 2.22 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
240          PB   2.191
241          UC   1.033    .755
             *
242          KP       4
             *   PLAN 4 IS THE 25-YEAR EVENT
243          KM   RAINFALL DEPTH OF 2.67 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
244          PB   2.635
245          UC    .900    .648
             *
246          KP       5
             *   PLAN 5 IS THE 50-YEAR EVENT
247          KM   RAINFALL DEPTH OF 3.01 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
248          PB   2.971
249          UC    .833    .595
             *
250          KP       6
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                 *   PLAN 6 IS THE 100-YEAR EVENT
 251             KM   RAINFALL DEPTH OF 3.35 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
 252             PB   3.306
 253             UC    .779    .552
                 *
1                                          HEC-1 INPUT                                          PAGE  7

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


 254             KK  VLDR.7
 255             KP       1
                 *   PLAN 1 IS THE 2-YEAR EVENT
 256             KM   6-HOUR RAINFALL, PATTERN NO. 1.40 WAS USED TO FIND TC & R FOR THIS BASIN
 257             KM   THIS BASIN USED RAINFALL REDUCTION FACTOR OF  .987
 258             KM     L = 2.33  Kb = .054  Adj. Slope =   59.4
 259             BA   1.000
 260             IN      15
 261             KM   RAINFALL DEPTH OF 1.45 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
 262             PB   1.431
 263             KM   THE FOLLOWING PC RECORD USED A 6-HOUR STORM WITH A PATTERN No. OF 1.40
 264             PC    .000    .008    .016    .025    .033    .041    .050    .058    .066    .075
 265             PC    .087    .099    .119    .148    .230    .407    .778    .881    .919    .945
 266             PC    .957    .968    .980    .990   1.000
 267             LG    .150    .150   8.600    .063   5.000
 268             UC   1.396   1.054
                 *
 269             KP       2
                 *   PLAN 2 IS THE 5-YEAR EVENT
 270             KM   RAINFALL DEPTH OF 1.91 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
 271             PB   1.885
 272             UC   1.083    .796
                 *
 273             KP       3
                 *   PLAN 3 IS THE 10-YEAR EVENT
 274             KM   RAINFALL DEPTH OF 2.22 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
 275             PB   2.191
 276             UC    .958    .694
                 *
 277             KP       4
                 *   PLAN 4 IS THE 25-YEAR EVENT
 278             KM   RAINFALL DEPTH OF 2.67 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
 279             PB   2.635
 280             UC    .846    .604
                 *
 281             KP       5
                 *   PLAN 5 IS THE 50-YEAR EVENT
 282             KM   RAINFALL DEPTH OF 3.01 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
 283             PB   2.971
 284             UC    .788    .558
                 *
 285             KP       6
                 *   PLAN 6 IS THE 100-YEAR EVENT
 286             KM   RAINFALL DEPTH OF 3.35 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
 287             PB   3.306
 288             UC    .742    .522
                 *

 289             KK  VLDR.8
 290             KP       1
                 *   PLAN 1 IS THE 2-YEAR EVENT
 291             KM   SUB-BASIN VLDR.8
 292             KM   6-HOUR RAINFALL, PATTERN NO. 1.40 WAS USED TO FIND TC & R FOR THIS BASIN
 293             KM   THIS BASIN USED RAINFALL REDUCTION FACTOR OF  .987
1                                          HEC-1 INPUT                                          PAGE  8

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

 294             KM     L = 2.33  Kb = .050  Adj. Slope =   59.4
 295             BA   1.000
 296             IN      15
 297             KM   RAINFALL DEPTH OF 1.45 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
 298             PB   1.431
 299             KM   THE FOLLOWING PC RECORD USED A 6-HOUR STORM WITH A PATTERN No. OF 1.40
 300             PC    .000    .008    .016    .025    .033    .041    .050    .058    .066    .075
 301             PC    .087    .099    .119    .148    .230    .407    .778    .881    .919    .945
 302             PC    .957    .968    .980    .990   1.000
 303             LG    .100    .150   8.600    .060   5.000
 304             UC   1.275    .953
                 *
 305             KP       2
                 *   PLAN 2 IS THE 5-YEAR EVENT
 306             KM   RAINFALL DEPTH OF 1.91 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
 307             PB   1.885
 308             UC    .996    .725
                 *
 309             KP       3
                 *   PLAN 3 IS THE 10-YEAR EVENT
 310             KM   RAINFALL DEPTH OF 2.22 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
 311             PB   2.191
 312             UC    .896    .644
                 *
 313             KP       4
                 *   PLAN 4 IS THE 25-YEAR EVENT
 314             KM   RAINFALL DEPTH OF 2.67 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
 315             PB   2.635
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 316          UC    .796    .565
              *
 317          KP       5
              *   PLAN 5 IS THE 50-YEAR EVENT
 318          KM   RAINFALL DEPTH OF 3.01 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
 319          PB   2.971
 320          UC    .742    .522
              *
 321          KP       6
              *   PLAN 6 IS THE 100-YEAR EVENT
 322          KM   RAINFALL DEPTH OF 3.35 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
 323          PB   3.306
 324          UC    .700    .490
              *

 325          KK  VLDR1B
 326          KP       1
              *   PLAN 1 IS THE 2-YEAR EVENT
 327          KM   SUB-BASIN VLDR1B
 328          KM   6-HOUR RAINFALL, PATTERN NO. 1.40 WAS USED TO FIND TC & R FOR THIS BASIN
 329          KM   THIS BASIN USED RAINFALL REDUCTION FACTOR OF  .987
 330          KM     L = 2.33  Kb = .041  Adj. Slope =   59.4
 331          BA   1.000
 332          IN      15
 333          KM   RAINFALL DEPTH OF 1.45 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
 334          PB   1.431
 335          KM   THE FOLLOWING PC RECORD USED A 6-HOUR STORM WITH A PATTERN No. OF 1.40
1                                        HEC-1 INPUT                                          PAGE  9

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

 336          PC    .000    .008    .016    .025    .033    .041    .050    .058    .066    .075
 337          PC    .087    .099    .119    .148    .230    .407    .778    .881    .919    .945
 338          PC    .957    .968    .980    .990   1.000
 339          LG    .100    .150   8.600    .060   5.000
 340          UC   1.083    .796
              *
 341          KP       2
              *   PLAN 2 IS THE 5-YEAR EVENT
 342          KM   RAINFALL DEPTH OF 1.91 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
 343          PB   1.885
 344          UC    .858    .614
              *
 345          KP       3
              *   PLAN 3 IS THE 10-YEAR EVENT
 346          KM   RAINFALL DEPTH OF 2.22 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
 347          PB   2.191
 348          UC    .775    .549
              *
 349          KP       4
              *   PLAN 4 IS THE 25-YEAR EVENT
 350          KM   RAINFALL DEPTH OF 2.67 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
 351          PB   2.635
 352          UC    .696    .487
              *
 353          KP       5
              *   PLAN 5 IS THE 50-YEAR EVENT
 354          KM   RAINFALL DEPTH OF 3.01 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
 355          PB   2.971
 356          UC    .650    .451
              *
 357          KP       6
              *   PLAN 6 IS THE 100-YEAR EVENT
 358          KM   RAINFALL DEPTH OF 3.35 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
 359          PB   3.306
 360          UC    .613    .422
              *

 361          KK  VLDR1A
 362          KP       1
              *   PLAN 1 IS THE 2-YEAR EVENT
 363          KM   SUB-BASIN VLDR1A
 364          KM   6-HOUR RAINFALL, PATTERN NO. 1.40 WAS USED TO FIND TC & R FOR THIS BASIN
 365          KM   THIS BASIN USED RAINFALL REDUCTION FACTOR OF  .987
 366          KM     L = 2.33  Kb = .022  Adj. Slope =   59.4
 367          BA   1.000
 368          IN      15
 369          KM   RAINFALL DEPTH OF 1.45 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
 370          PB   1.431
 371          KM   THE FOLLOWING PC RECORD USED A 6-HOUR STORM WITH A PATTERN No. OF 1.40
 372          PC    .000    .008    .016    .025    .033    .041    .050    .058    .066    .075
 373          PC    .087    .099    .119    .148    .230    .407    .778    .881    .919    .945
 374          PC    .957    .968    .980    .990   1.000
 375          LG    .100    .150   8.600    .060   5.000
 376          UC    .663    .461
              *
1                                        HEC-1 INPUT                                          PAGE 10

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

 377          KP       2
              *   PLAN 2 IS THE 5-YEAR EVENT
 378          KM   RAINFALL DEPTH OF 1.91 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
 379          PB   1.885
 380          UC    .554    .378
              *
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```
381          KP       3
             *   PLAN 3 IS THE 10-YEAR EVENT
382          KM   RAINFALL DEPTH OF 2.22 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
383          PB   2.191
384          UC    .504    .340
             *
385          KP       4
             *   PLAN 4 IS THE 25-YEAR EVENT
386          KM   RAINFALL DEPTH OF 2.67 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
387          PB   2.635
388          UC    .458    .306
             *
389          KP       5
             *   PLAN 5 IS THE 50-YEAR EVENT
390          KM   RAINFALL DEPTH OF 3.01 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
391          PB   2.971
392          UC    .433    .288
             *
393          KP       6
             *   PLAN 6 IS THE 100-YEAR EVENT
394          KM   RAINFALL DEPTH OF 3.35 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
395          PB   3.306
396          UC    .408    .269
             *
397          ZZ
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   21MAR03  TIME  09:40:57  *                    *           (916) 756-1104             *
 *                                      *                    *                                      *
 ****************************************                    ****************************************

                          ADOBE DAM / DESERT HILLS ADMP
                          MARCH 2003
                          JE FULLER/ HYDROLOGY & GEOMORPHOLOGY, INC.

                         HYPOTHETICAL SUBBASIN ANALYSIS FOR DEV. GUIDELINES
                          AREA = 1.00 SQ. MI. (2400' X 11616')
                          L = 12285.4 FT = 2.33 MI.
                          S = 0.01125 = 59.4 FT/MI.

                          DSRT_B = DESERT RANGELAND BASIN WITH Kb TYPE B
                          DSRT_C = DESERT RANGELAND BASIN WITH Kb TYPE C

                          THE FOLLOWING VLDR.# BASINS HAVE Kb TYPES INCREMENTALLY SMOOTHER TRANSITIONI
                          FROM Kb TYPE C (DSRT_C) TO Kb TYPE B (VLDR1B)IN PROPORTION TO ASSUMED
                          VEGETATION REMOVAL.

                          VLDR.3 = VERY LOW DENSITY RESIDENTIAL (1-2 AC LOTS)
                                   WITH 30% VEGETATION REMOVAL ASSUMED
                          VLDR.4 = VERY LOW DENSITY RESIDENTIAL (1-2 AC LOTS)
                                   WITH 40% VEGETATION REMOVAL ASSUMED
                          VLDR.5 = VERY LOW DENSITY RESIDENTIAL (1-2 AC LOTS)
                                   WITH 50% VEGETATION REMOVAL ASSUMED
                          VLDR.6 = VERY LOW DENSITY RESIDENTIAL (1-2 AC LOTS)
                                   WITH 60% VEGETATION REMOVAL ASSUMED
                          VLDR.7 = VERY LOW DENSITY RESIDENTIAL (1-2 AC LOTS)
                                   WITH 70% VEGETATION REMOVAL ASSUMED
                          VLDR.8 = VERY LOW DENSITY RESIDENTIAL (1-2 AC LOTS)
                                   WITH 80% VEGETATION REMOVAL ASSUMED
                          VLDR1B = VERY LOW DENSITY RESIDENTIAL (1-2 AC LOTS)
                                   WITH 100% VEGETATION REMOVAL ASSUMED
                                   Kb TYPE B
                          VLDR1A = VERY LOW DENSITY RESIDENTIAL (1-2 AC LOTS)
                                   WITH 100% VEGETATION REMOVAL ASSUMED
                                   Kb TYPE A

 37 IO          OUTPUT CONTROL VARIABLES
                      IPRNT          5  PRINT CONTROL
                      IPLOT          0  PLOT CONTROL
                      QSCAL         0.  HYDROGRAPH PLOT SCALE

    IT          HYDROGRAPH TIME DATA
                       NMIN          2  MINUTES IN COMPUTATION INTERVAL
                      IDATE      1   0  STARTING DATE
                      ITIME       0000  STARTING TIME
                         NQ        300  NUMBER OF HYDROGRAPH ORDINATES
                     NDDATE      1   0  ENDING DATE
                     NDTIME       0958  ENDING TIME
                      ICENT         19  CENTURY MARK

                 COMPUTATION INTERVAL     .03 HOURS
                      TOTAL TIME BASE    9.97 HOURS

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

      JP          MULTI-PLAN OPTION
                       NPLAN            6  NUMBER OF PLANS

      JR          MULTI-RATIO OPTION
                     RATIOS OF RUNOFF
                       1.00
1

                PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
                                FLOWS IN CUBIC FEET PER SECOND,  AREA IN SQUARE MILES
                                              TIME TO PEAK IN HOURS

                                                                  RATIOS APPLIED TO FLOWS
 OPERATION        STATION      AREA    PLAN              RATIO 1
                                                            1.00

 HYDROGRAPH AT
+                 DSRT_B       1.00     1   FLOW           166.
                                            TIME           5.10
                                         2  FLOW           400.
                                            TIME           4.73
                                         3  FLOW           592.
                                            TIME           4.60
                                         4  FLOW           883.
                                            TIME           4.47
                                         5  FLOW          1105.
                                            TIME           4.43
                                         6  FLOW          1329.
                                            TIME           4.40

 HYDROGRAPH AT
+                 DSRT_C       1.00     1   FLOW           154.
                                            TIME           5.20
                                         2  FLOW           267.
                                            TIME           5.17
                                         3  FLOW           350.
                                            TIME           5.13
                                         4  FLOW           554.
                                            TIME           4.90
                                         5  FLOW           725.
                                            TIME           4.80
                                         6  FLOW           901.
                                            TIME           4.73

 HYDROGRAPH AT
+                 VLDR.3       1.00     1   FLOW           171.
                                            TIME           5.20
                                         2  FLOW           291.
                                            TIME           5.13
                                         3  FLOW           430.
                                            TIME           4.93
                                         4  FLOW           656.
                                            TIME           4.77
                                         5  FLOW           840.
                                            TIME           4.70
                                         6  FLOW          1027.
                                            TIME           4.63

 HYDROGRAPH AT
+                 VLDR.4       1.00     1   FLOW           185.
                                            TIME           5.17
                                         2  FLOW           331.
                                            TIME           5.03
                                         3  FLOW           476.
                                            TIME           4.87
                                         4  FLOW           711.
                                            TIME           4.70
                                         5  FLOW           899.
                                            TIME           4.63
                                         6  FLOW          1089.
                                            TIME           4.57

 HYDROGRAPH AT
+                 VLDR.5       1.00     1   FLOW           197.
                                            TIME           5.17
                                         2  FLOW           365.
                                            TIME           4.93
                                         3  FLOW           517.
                                            TIME           4.80
                                         4  FLOW           759.
                                            TIME           4.67
                                         5  FLOW           946.
                                            TIME           4.60
                                         6  FLOW          1134.
                                            TIME           4.57

 HYDROGRAPH AT
+                 VLDR.6       1.00     1   FLOW           210.
                                            TIME           5.13
                                         2  FLOW           407.
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                                        TIME          4.87
                                    3   FLOW          566.
                                        TIME          4.73
                                    4   FLOW          811.
                                        TIME          4.63
                                    5   FLOW         1002.
                                        TIME          4.57
                                    6   FLOW         1199.
                                        TIME          4.53

 HYDROGRAPH AT
+                   VLDR.7      1.00    1   FLOW          238.
                                        TIME          5.03
                                    2   FLOW          454.
                                        TIME          4.77
                                    3   FLOW          621.
                                        TIME          4.67
                                    4   FLOW          870.
                                        TIME          4.57
                                    5   FLOW         1062.
                                        TIME          4.53
                                    6   FLOW         1259.
                                        TIME          4.50

 HYDROGRAPH AT
+                   VLDR.8      1.00    1   FLOW          271.
                                        TIME          4.93
                                    2   FLOW          504.
                                        TIME          4.70
                                    3   FLOW          671.
                                        TIME          4.60
                                    4   FLOW          926.
                                        TIME          4.53
                                    5   FLOW         1125.
                                        TIME          4.50
                                    6   FLOW         1326.
                                        TIME          4.43

 HYDROGRAPH AT
+                   VLDR1B      1.00    1   FLOW          315.
                                        TIME          4.77
                                    2   FLOW          572.
                                        TIME          4.60
                                    3   FLOW          754.
                                        TIME          4.50
                                    4   FLOW         1025.
                                        TIME          4.43
                                    5   FLOW         1239.
                                        TIME          4.40
                                    6   FLOW         1459.
                                        TIME          4.37

 HYDROGRAPH AT
+                   VLDR1A      1.00    1   FLOW          484.
                                        TIME          4.43
                                    2   FLOW          803.
                                        TIME          4.33
                                    3   FLOW         1030.
                                        TIME          4.30
                                    4   FLOW         1358.
                                        TIME          4.23
                                    5   FLOW         1612.
                                        TIME          4.23
                                    6   FLOW         1879.
                                        TIME          4.20


 *** NORMAL END OF HEC-1 ***
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