ADOBE DAM/DESERT HILLS

AREA DRAINAGE MASTER PLAN

Part 9

Recommended Alternative Report Appendices

Volume 2

Flood Control District of Maricopa County

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ADOBE DAM/DESERT HILLS AREA DRAINAGE MASTER PLAN

RECOMMENDED ALTERNATIVE APPENDICES
PART 9, VOLUME 2

Flood Control District of Maricopa County

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ALTERNATIVES FORMULATION REPORT

Part 9, Volume 2

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- **Digital Copy of Report in PDF Format**

SECTION 1: INTRODUCTION

As part of the *Recommended Alternative Report, Part 9, Volume 1* a recommended alternative has been formulated. This report only deals with structural alternatives. Refer to Part 9, Volume 1 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 formulate the recommended alternative in the *Recommended Alternatives Report, Part 9, Volume 1* is included in this report. This report is meant to work hand in hand with the *Recommended Alternatives Report, Part 9, Volume 1.* This report functions as a technical appendix to the Part 9, Volume 1 report.

SECTION 2: DATA SOURCES

A number of data sources were needed to perform the technical backup for the recommended alternative. Data sources are listed before presenting the technical backup methodology for each site 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 Letter of Map Revision (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, 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 Number 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 Number 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, 8, and 11.

o Stakeholder and Municipality information that was provided to JE Fuller/Hydrology & Geomorphology, Inc. (JEF) and used for analyses:

- Ralph Goodall with Phoenix provided updated cost estimates for the alternatives at Site Number 1.
- Randy Randolph with the CAP 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 Maricopa County Department of Transportation (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 5, 7, 8, 9, and 10.
- Tom Loomis with the FCDMC provided GIS mapping related to his two-dimensional modeling (FLO-2D) north of the New River Road Bridge on Skunk Creek. This information was used to establish the extent of flooding 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 the 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 were provided. This information was used in many diverse ways at each of the sites analyzed and will be documented further within this report.
- 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 has been refined for the recommended alternative. 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.

3.2 Individual Site Analysis

3.2.1 Site Number 1

Problem Description – In June of 1993 Wood/ Patel contracted with 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 provided a 100-year crossing at Pinnacle Peak Road and allowed for future extension of the 35th Avenue to the north (Appendix B). In addition, its channel geometry provided 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 Phoenix 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 became 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 analyzed this breakout from Skunk Creek further and looked at the breakout effects further 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 future breakouts 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 agreed 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 the 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 incorporated 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.

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

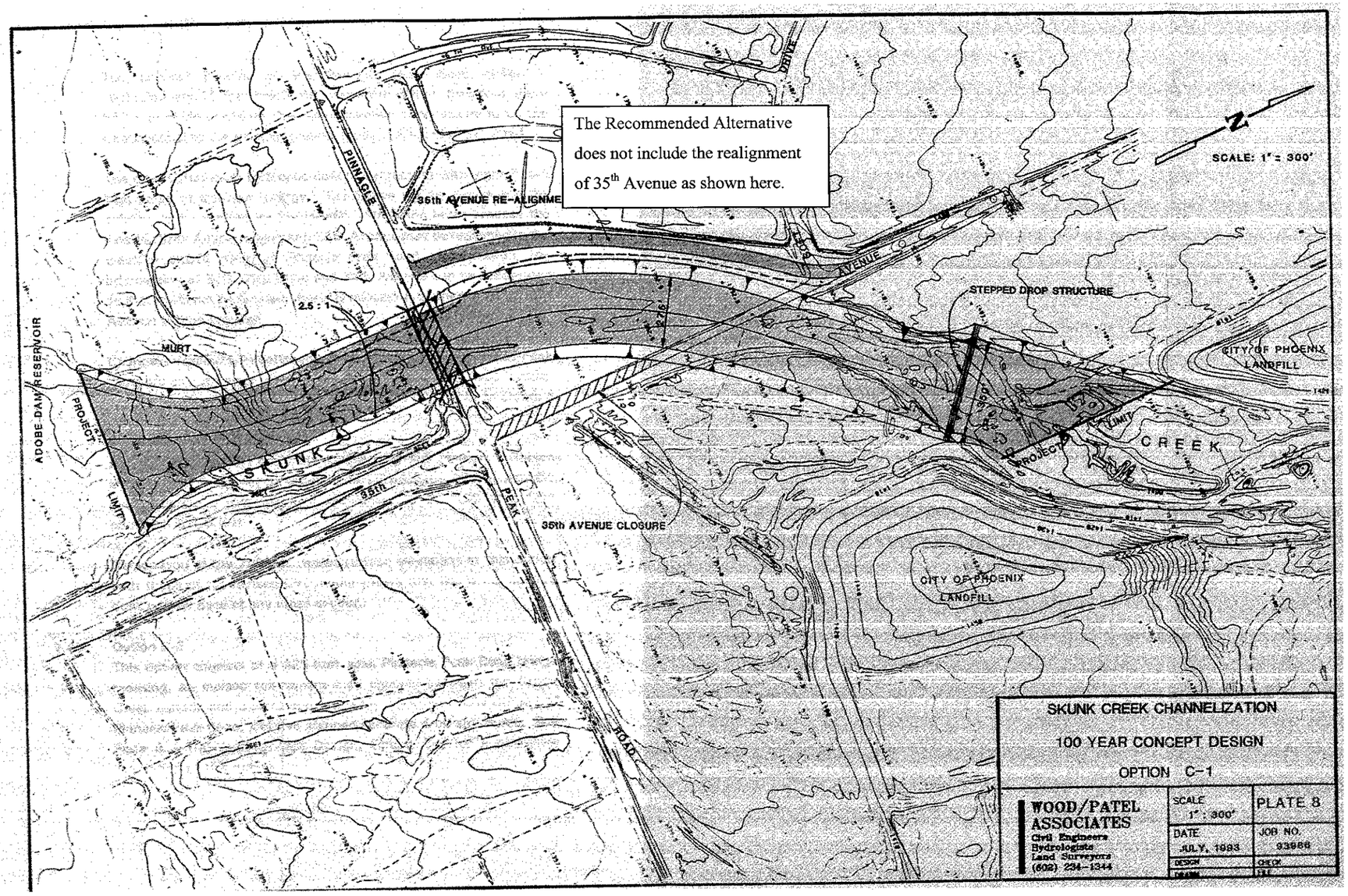


Figure 3.1

Plan View of Site Number 1

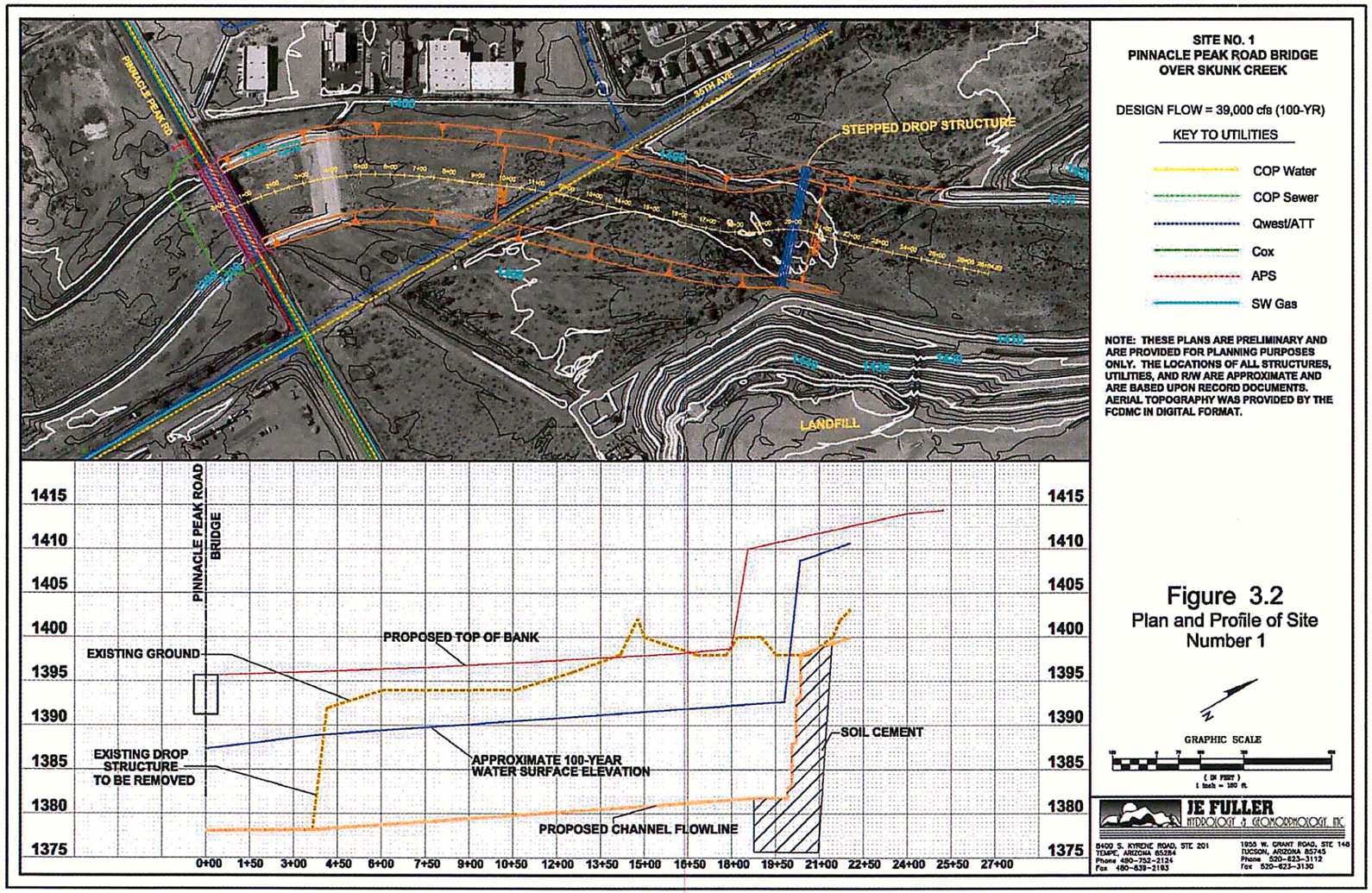


Figure 3.2

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) and to estimate the amount of discharge that breaks away from Skunk Creek in the effective Flood Insurance Study (Appendix B). 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 breaks 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.
- 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 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 Conditional Letter of Map Revision (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 was 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 conveys 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 the 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 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 extending the levees. Refer to the WCMP and the two dimensional modeling report for modeling details regarding levee extension discussed in the Problem Description section of this report.

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 in 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.

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 the 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.

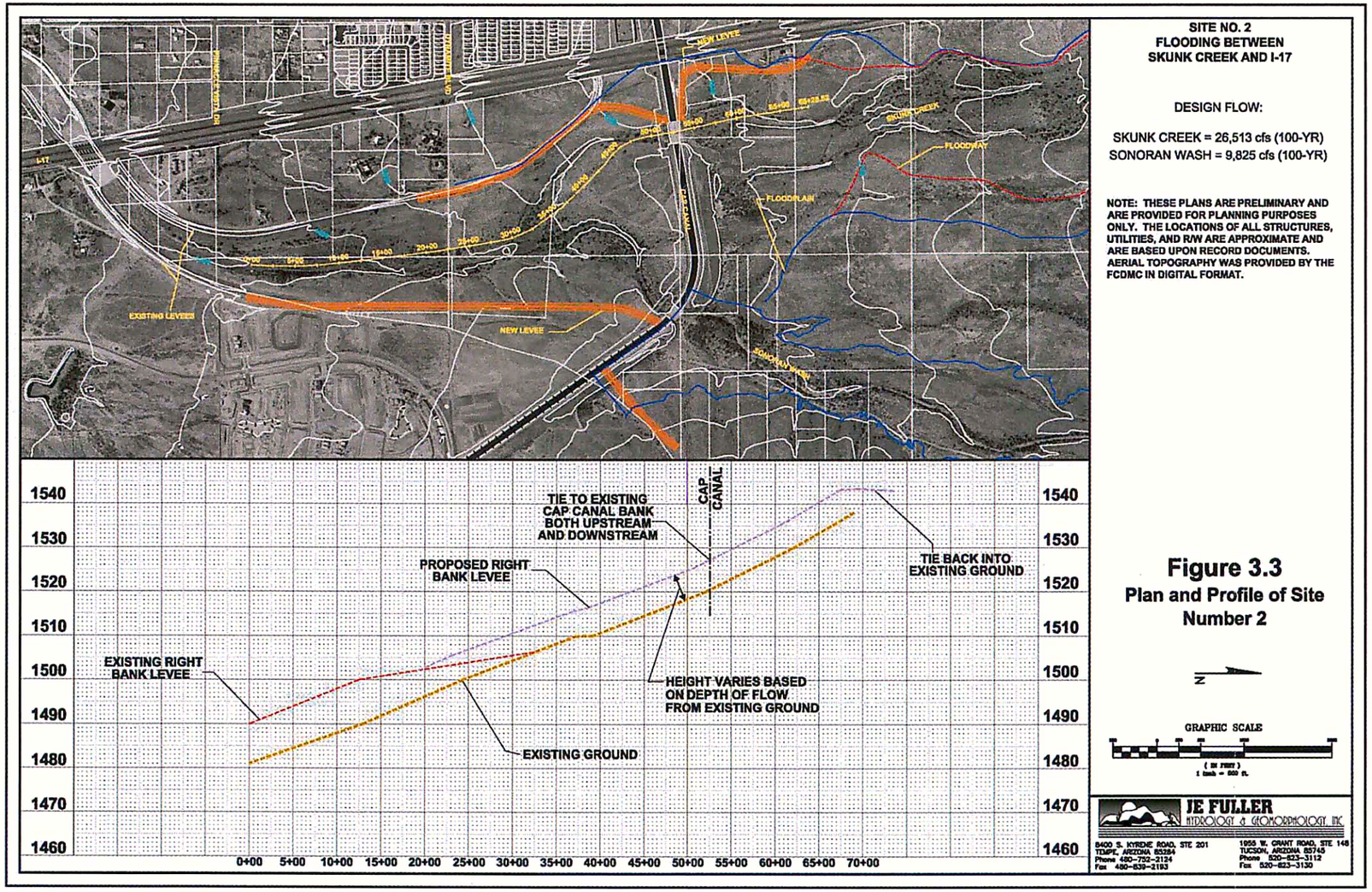


Figure 3.3

Plan and Profile of Site Number 2

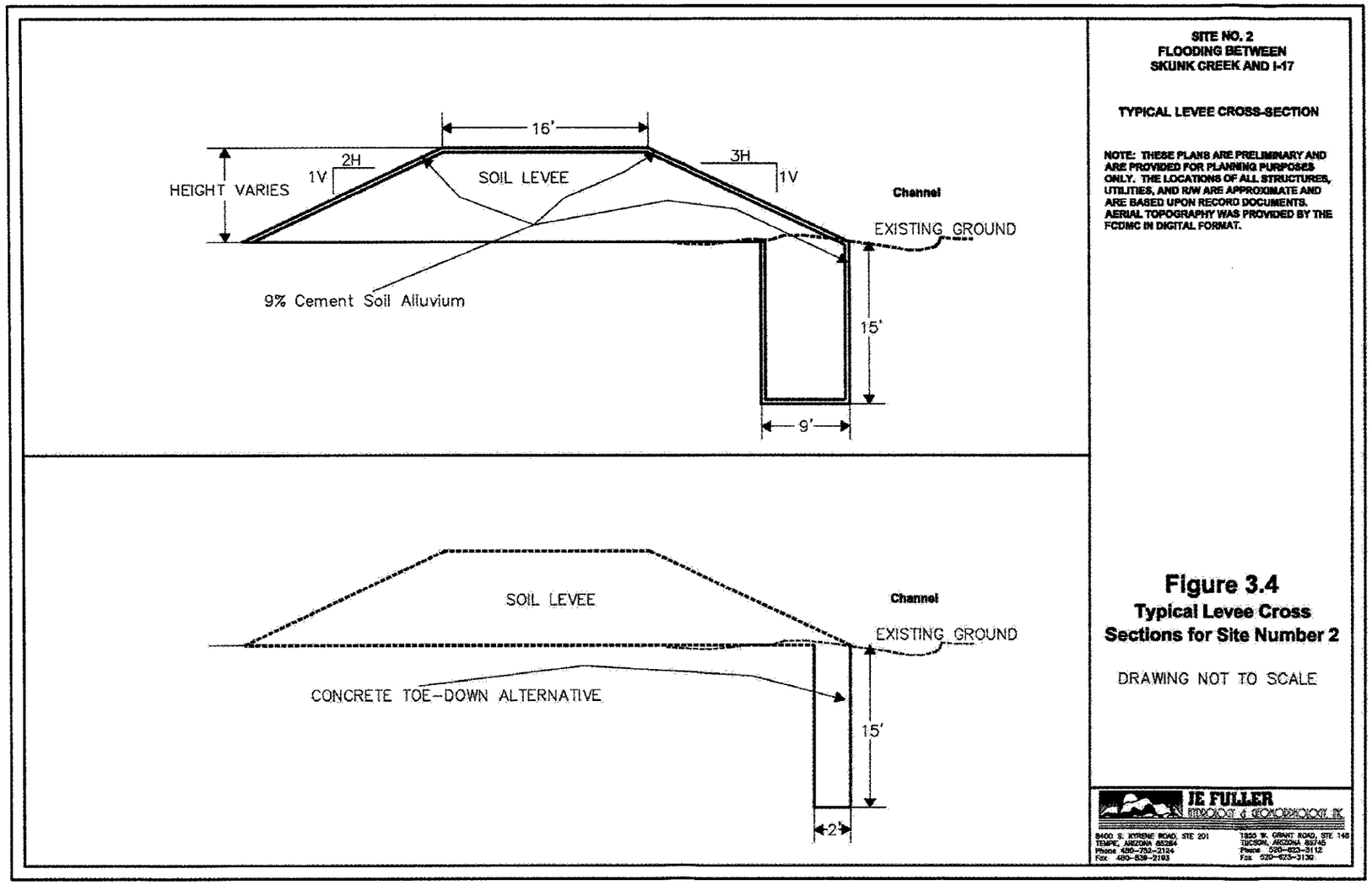


Figure 3.4

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.
Note: A 25% contingency is added for erosion protection, side slope changes, local drainage relief, etc. and any other unknown that well be determined in pre-design.

3.2.3 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) was identified by the ADMP team during the process of problem identification (Appendix B). 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 substantial 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 a HEC-1 model performed by JEF that was built in the following manner:

- 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 3.5. 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.
- 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 3.6 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. The development of design discharges will be discussed along with the description of alternatives. Refer to Figure 3.5 for a map of cross section layout within the FLO-2D modeling area. Refer to Appendix B under the Site Number 5 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 began as several individual sites that were somewhat tied into the same system. The preliminary alternatives looked at Site Number 5 in the following manner:

- For the area of Cloud Road downstream to 7th, Street. Collector channels constructed on the north side of Cloud Road funneling the water to the south side of the road into an offline detention basin was analyzed. 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.

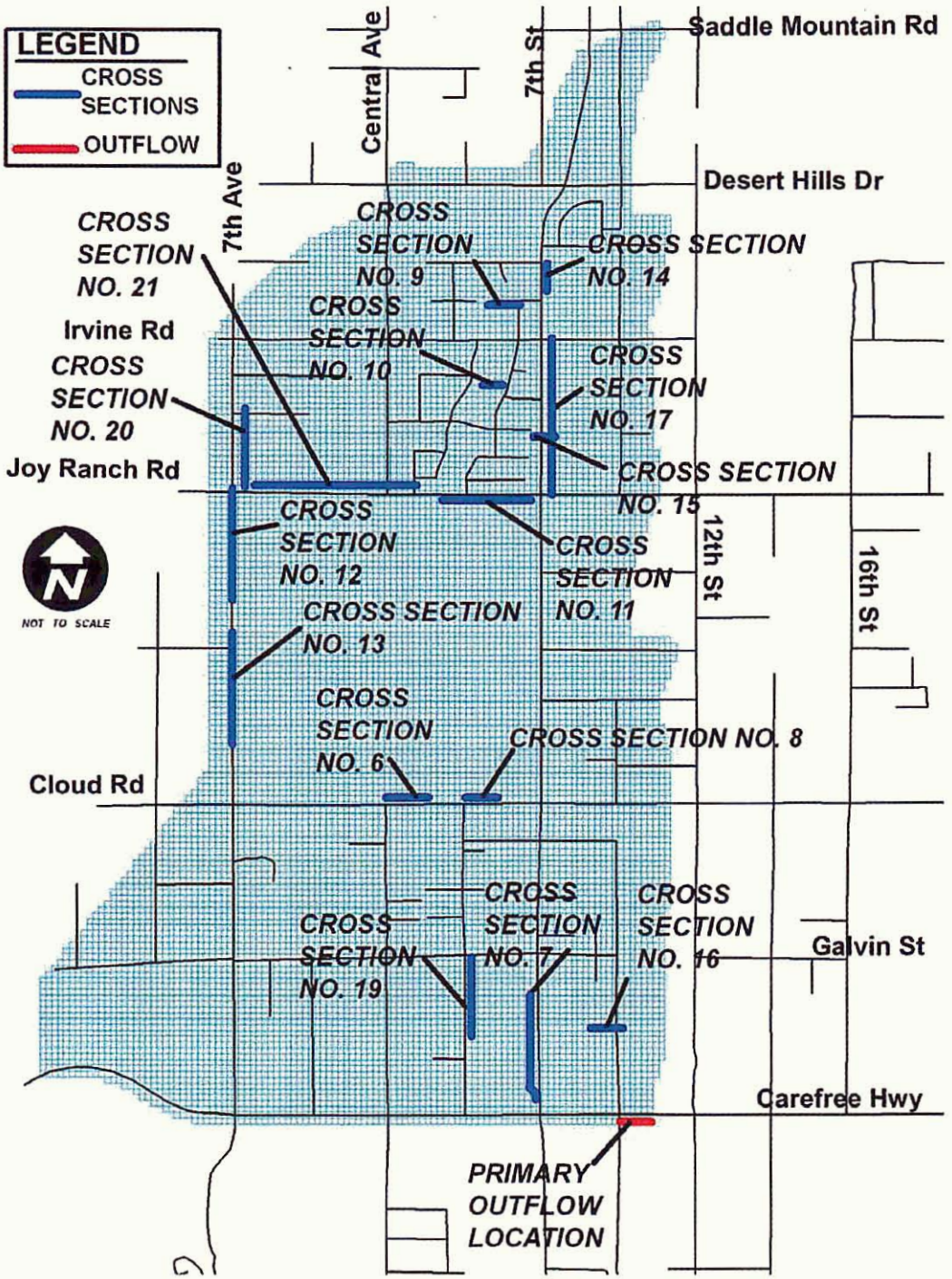


Figure 3.5

FLO-2D Cross Section Layout for Site Number 5

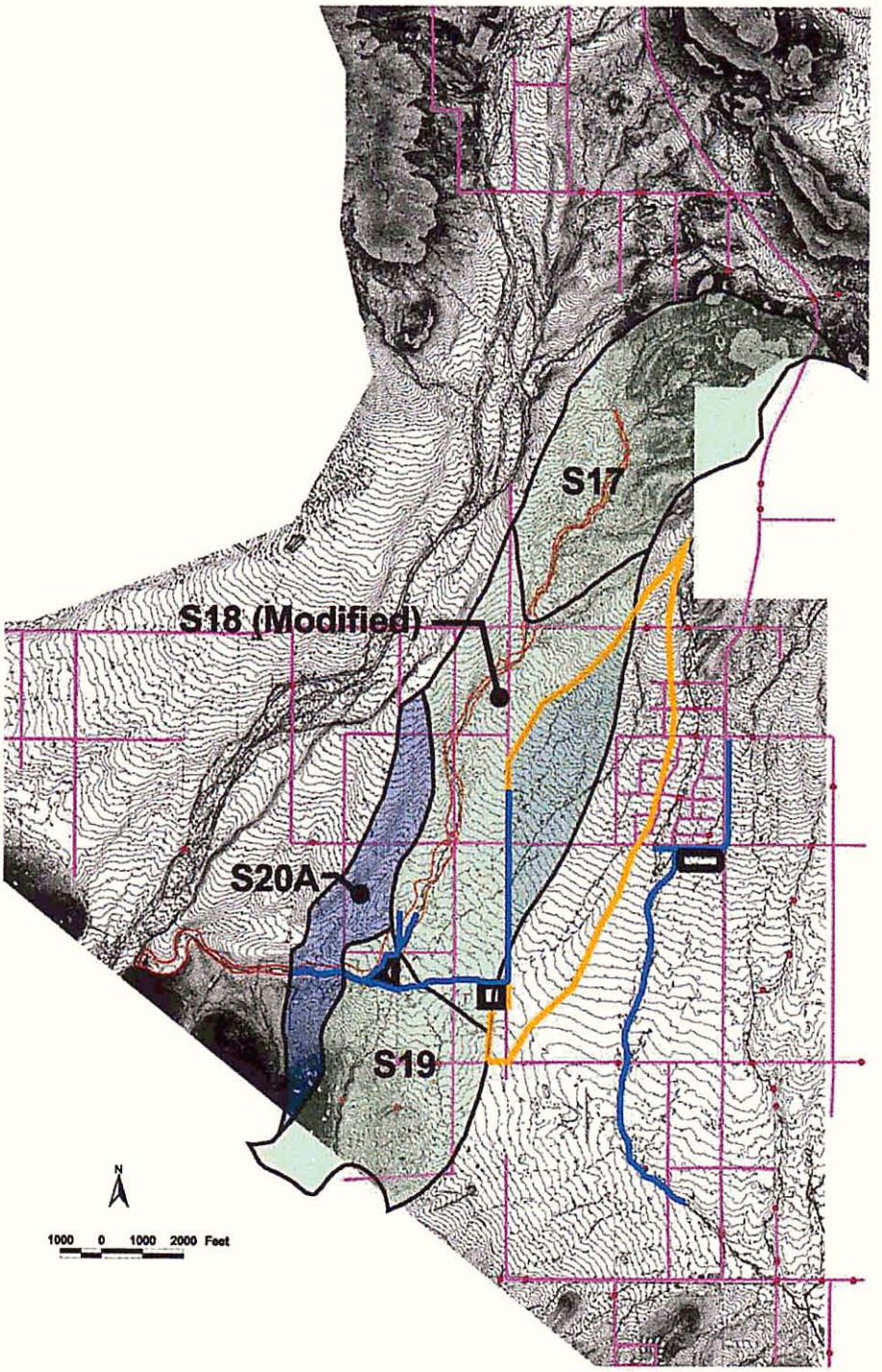


Figure 3.6

Subbasin Layout for Site Number 5

- 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 CH5A, CLV5A, and CLV5B is 1,050 cfs which is taken from cross section number 17 of the FLO-2D (Figure 3.5).

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; 1) to convey flow to the channel 5C which flows south to below Cloud Road. 2) to intercept flows crossing Joy Ranch Road from the north out of Desert Hills Estates. 3) 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 250cfs 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).

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.

The area south of Cloud road was deleted from the recommended alternative as far as structural alternatives were concerned. Floodway residences south of Cloud Road are being recommended for the Floodprone Property Acquisition Program (FPAP) as part of the recommended alternative. 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 3.7, 3.8, 3.9, and 3.10 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.

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 the 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 5.

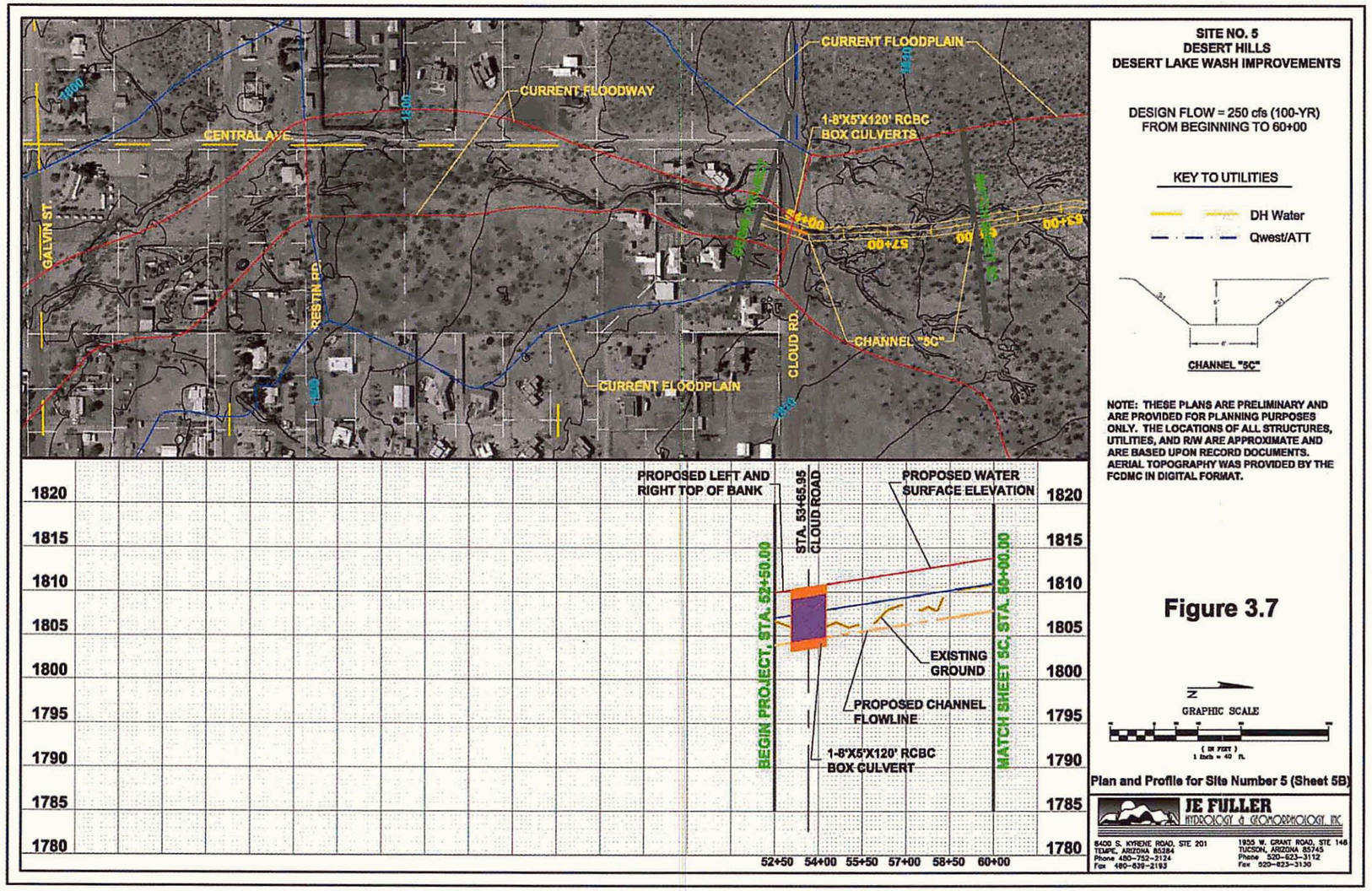


Figure 3.7

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

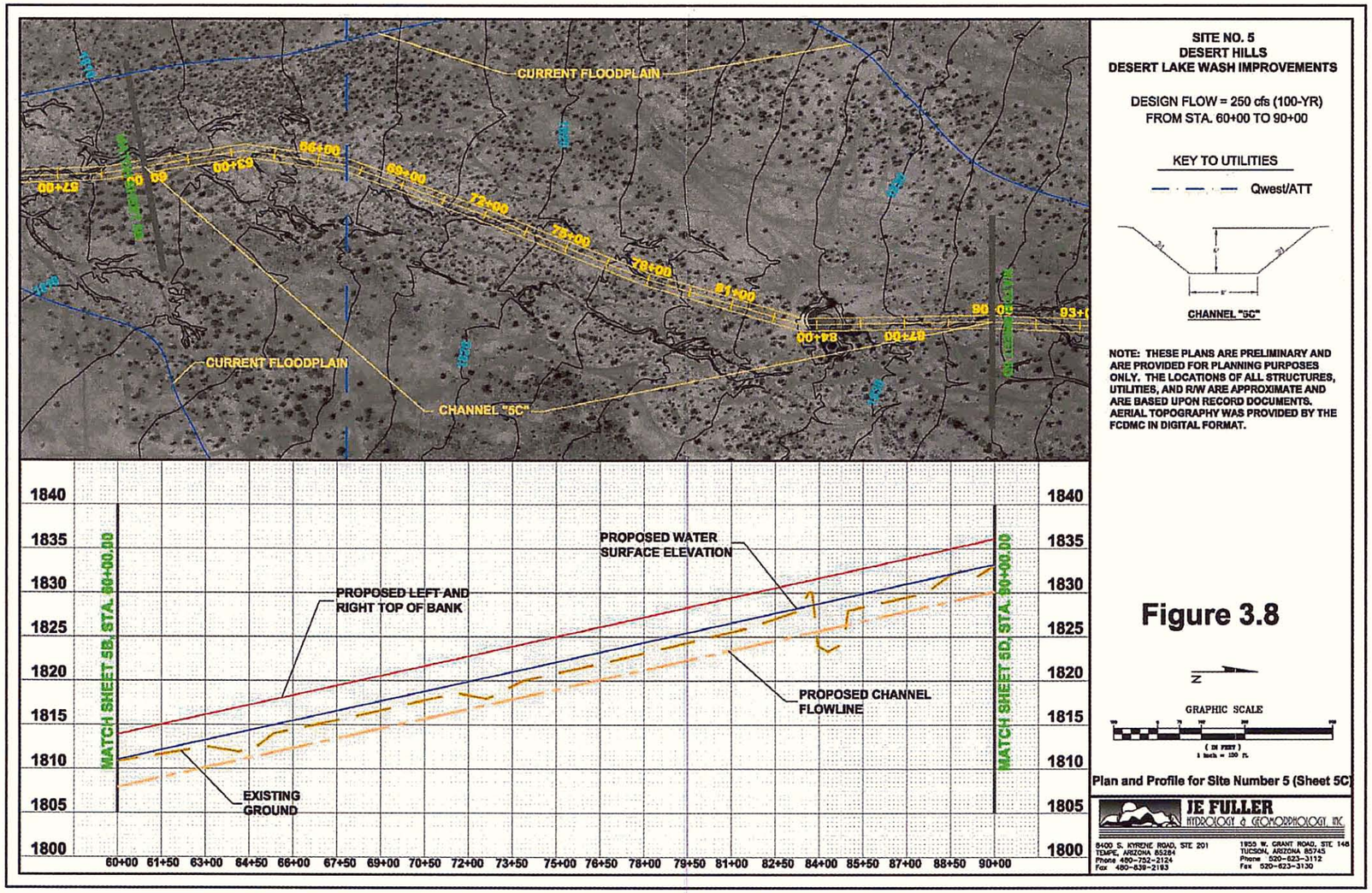


Figure 3.8

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

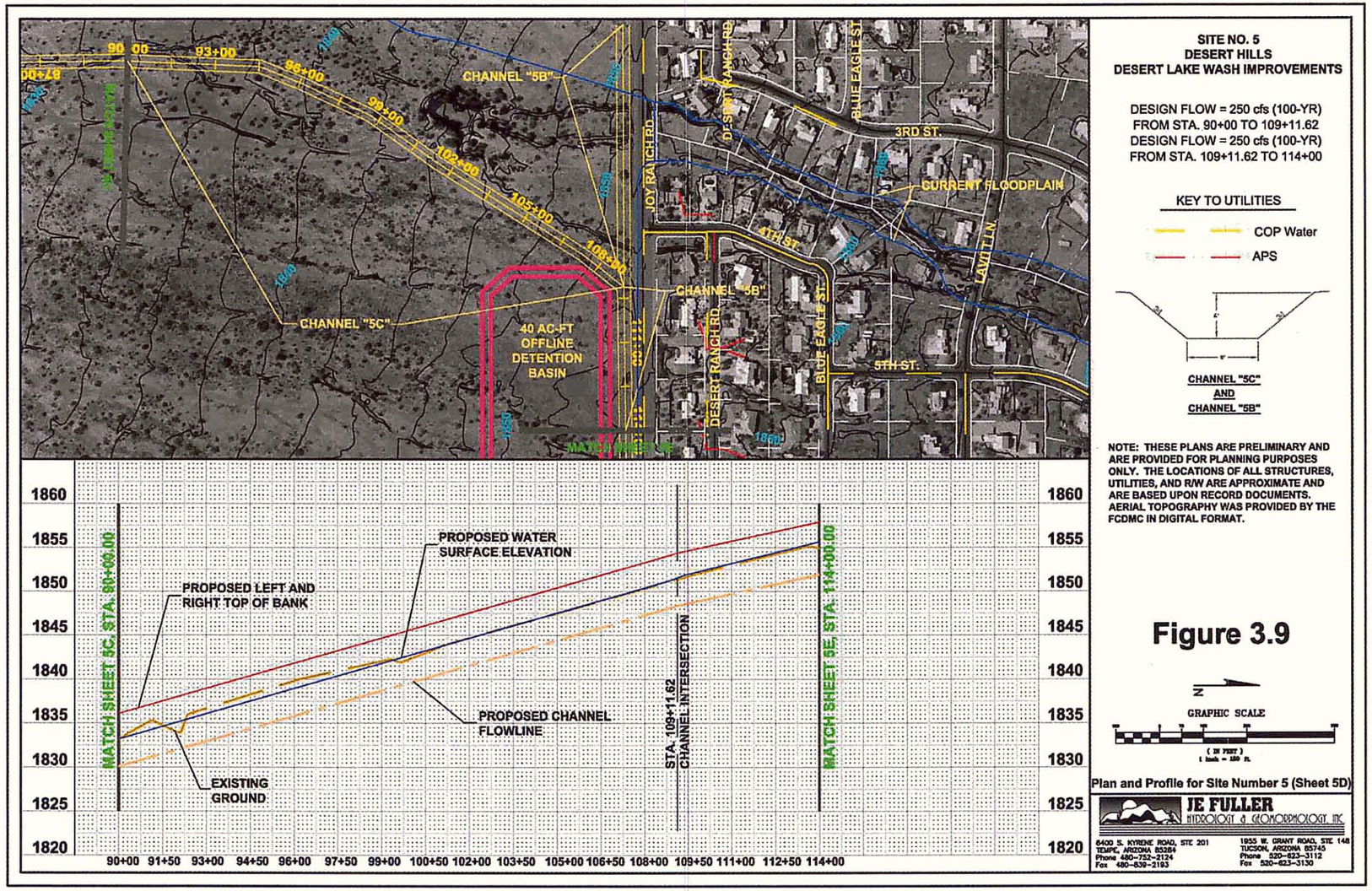


Figure 3.9

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

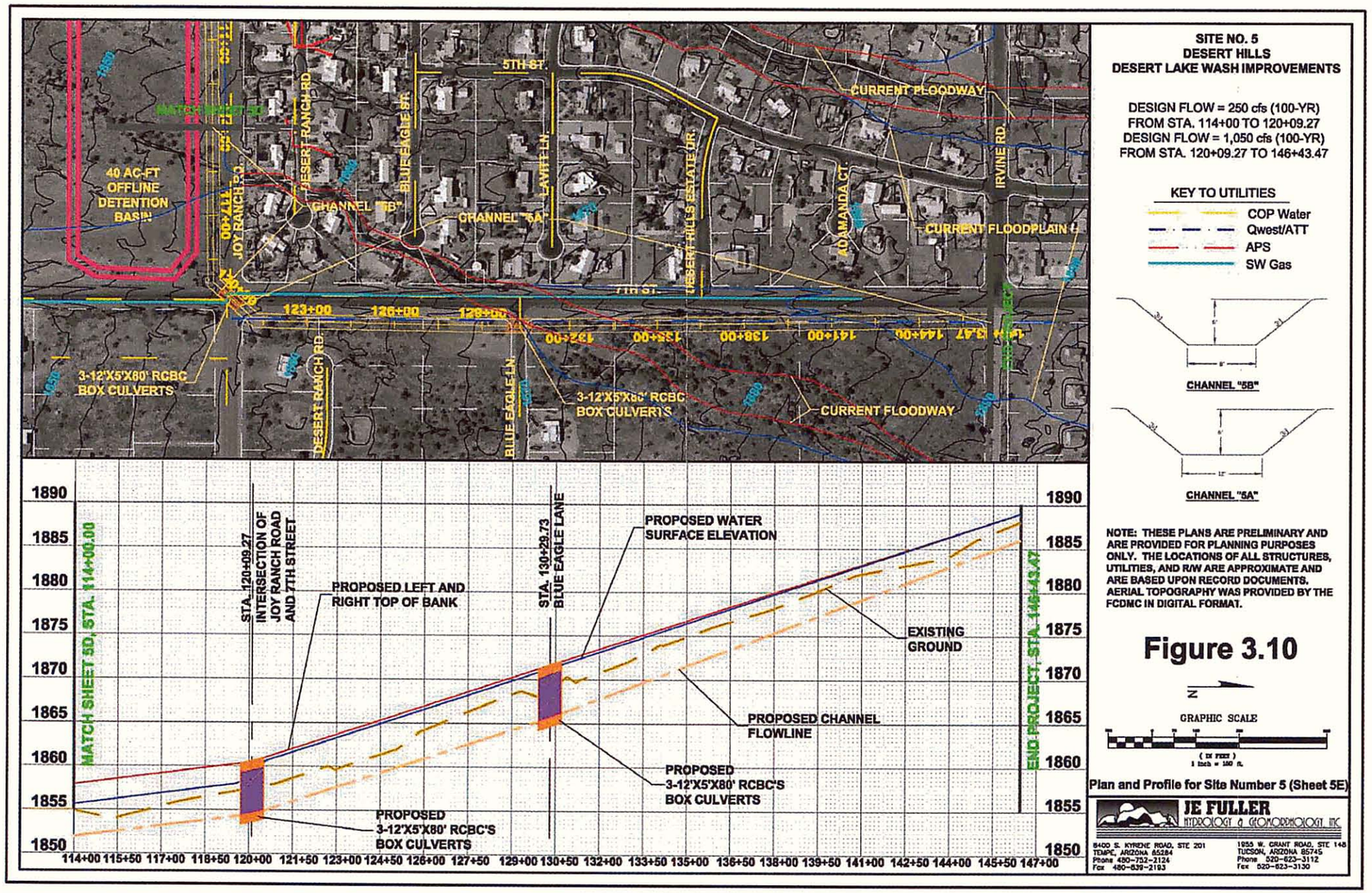


Figure 3.10

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

Table 3.7

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.
Note: A 25% contingency is added for erosion protection, side slope changes, local drainage relief, etc. and any other unknown that well be determined in pre-design.

3.2.4 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.

Although somewhat challenging, realigning 24th Street up out of Apache Wash 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.

This 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 selected as part of the recommended alternative. This alternative completely removes the flooding problem associated with Apache Wash and provides an 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 3.115 and, 3.12 for the Plan and Profiles and typical sections of Site Number 7.

Cost Estimates – Cost estimates for this alternative were performed by JEF. 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 3.8 for cost estimates for Site Number 7.

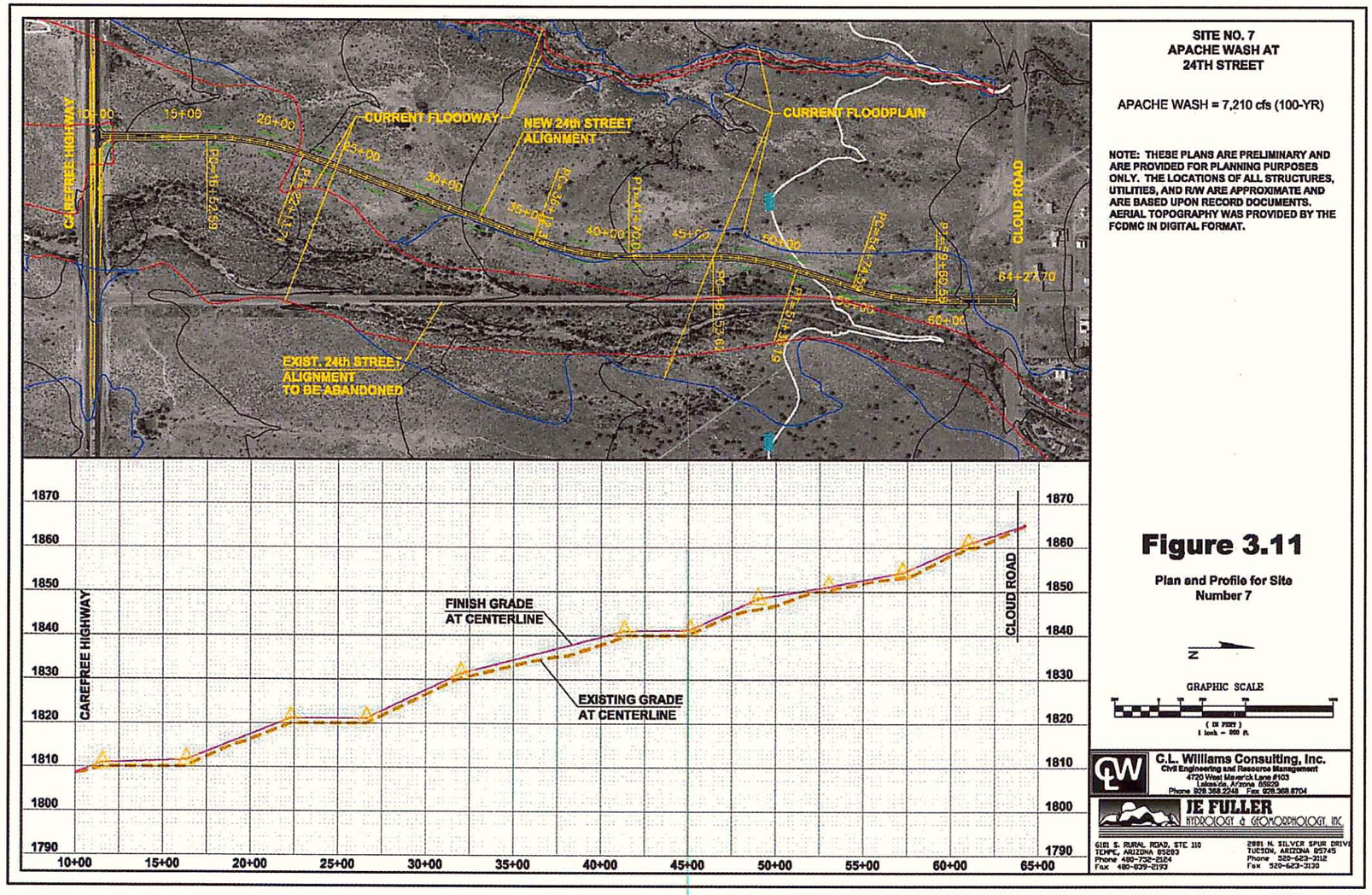


Figure 3.11

Plan and Profile for Site Number 7

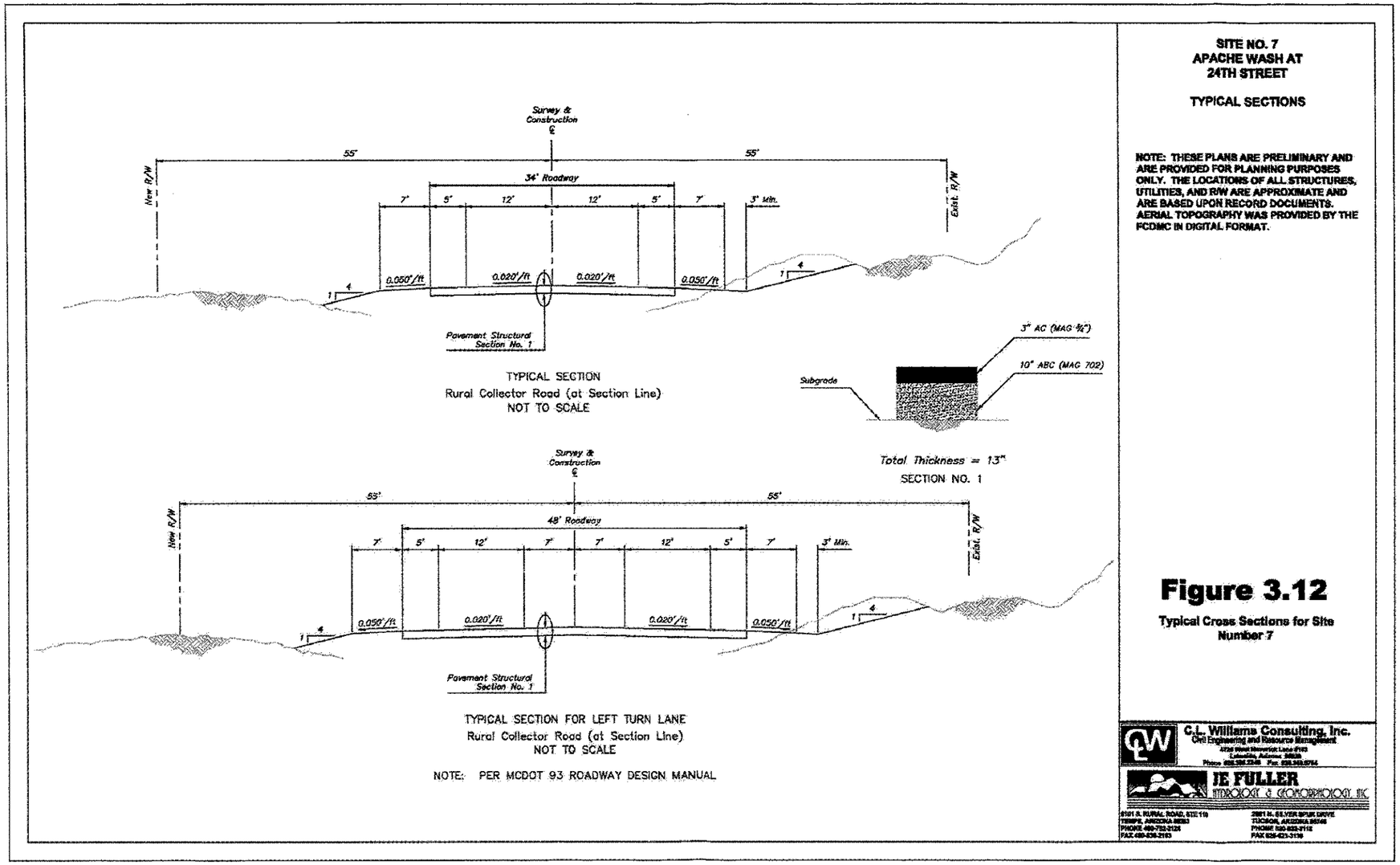


Figure 3.12

Typical Cross Sections for Site Number 7

Table 3.8

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.
Note: A 25% contingency is added for erosion protection, side slope changes, local drainage relief, etc. and any other unknown that well be determined in pre-design.

3.2.5 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 Part 8, Volume 4, Section 1, 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 (Site Number 3 that was not included in the Recommended Alternative) 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 feet 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 3.13, 3.14, and 3.15 for the Plan and Profiles and typical sections of Site Number 8.

Cost Estimates – Cost estimates for this alternative were performed by JEF. Similar to Site Number 7, 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 3.9 for cost estimates for Site Number 8.

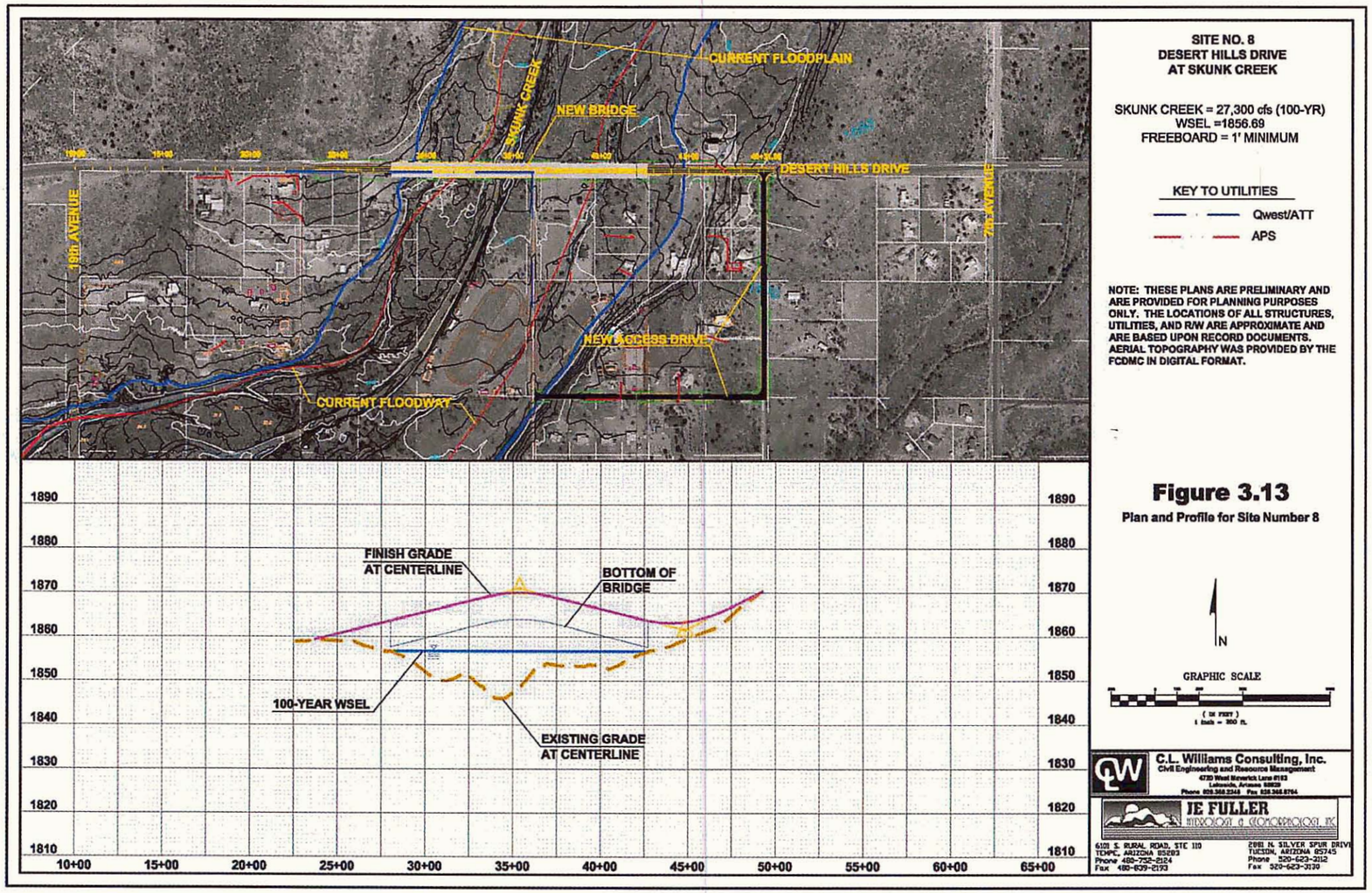


Figure 3.13

Plan and Profile for Site Number 8

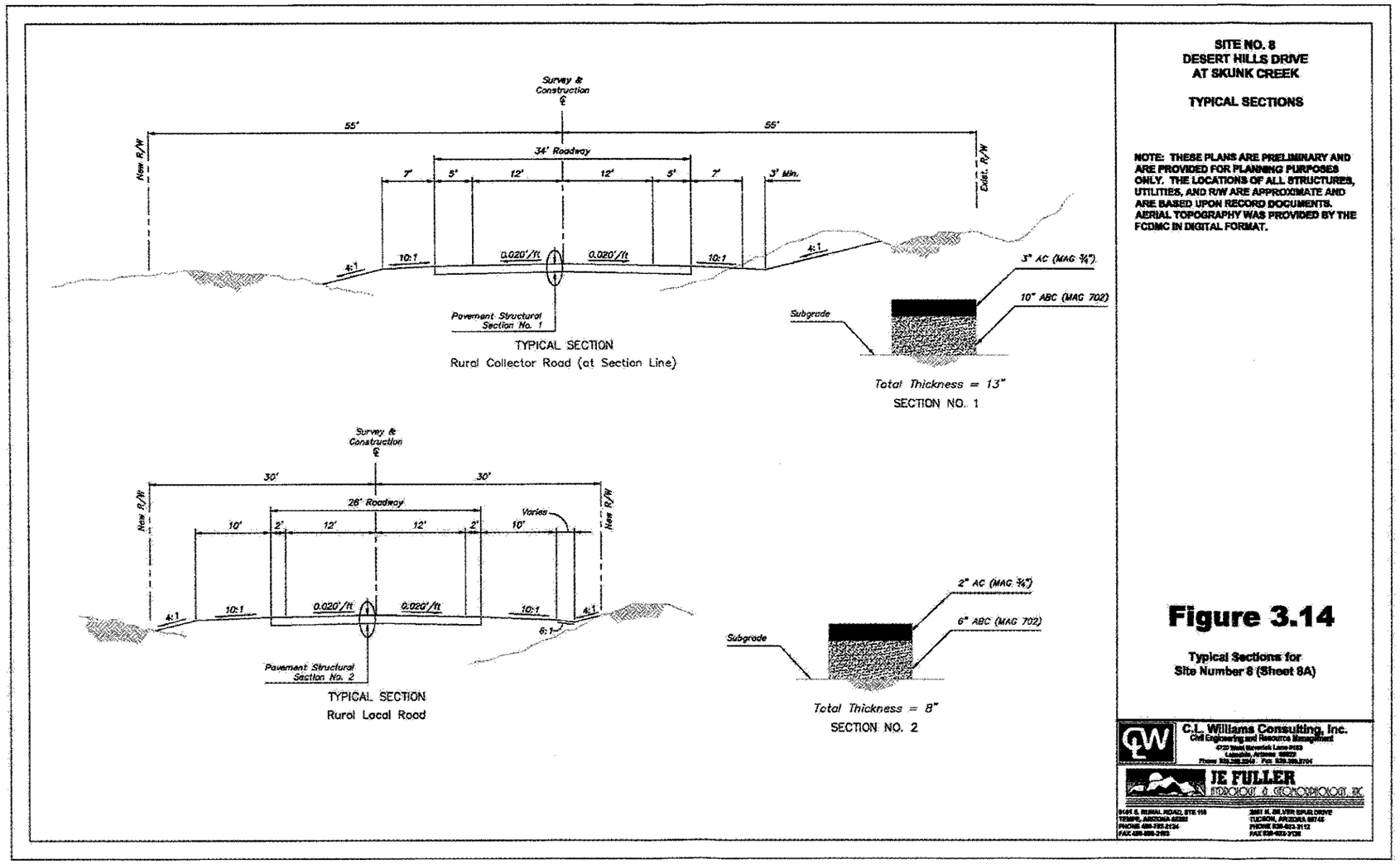


Figure 3.14

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

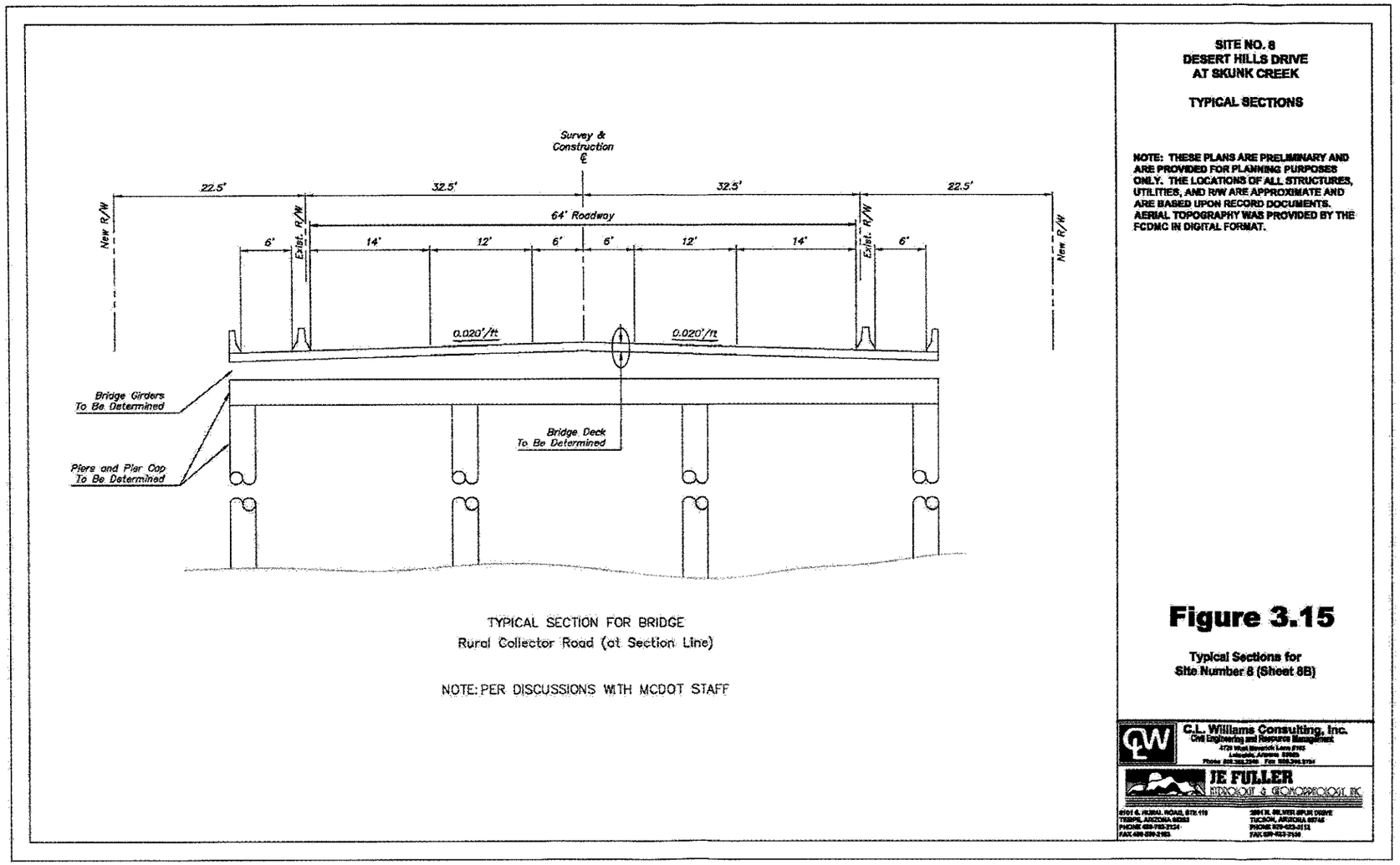


Figure 3.15

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

Table 3.9

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.
Note: A 25% contingency is added for erosion protection, side slope changes, local drainage relief, etc. and any other unknown that well be determined in pre-design.

3.2.6 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 feet at the crossing.

A 400 foot long span bridge over Rodger Creek that would span the floodplain was selected as the recommended alternative. 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.

This alternative was accepted as the recommended alternative 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, and lastly, a bridge section provides an access for the Maricopa County trail system.

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 3.16 and 3.17 for the Plan and Profiles and typical sections of Site Number 9.

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 the 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 3.10 for cost estimates for Site Number 9.

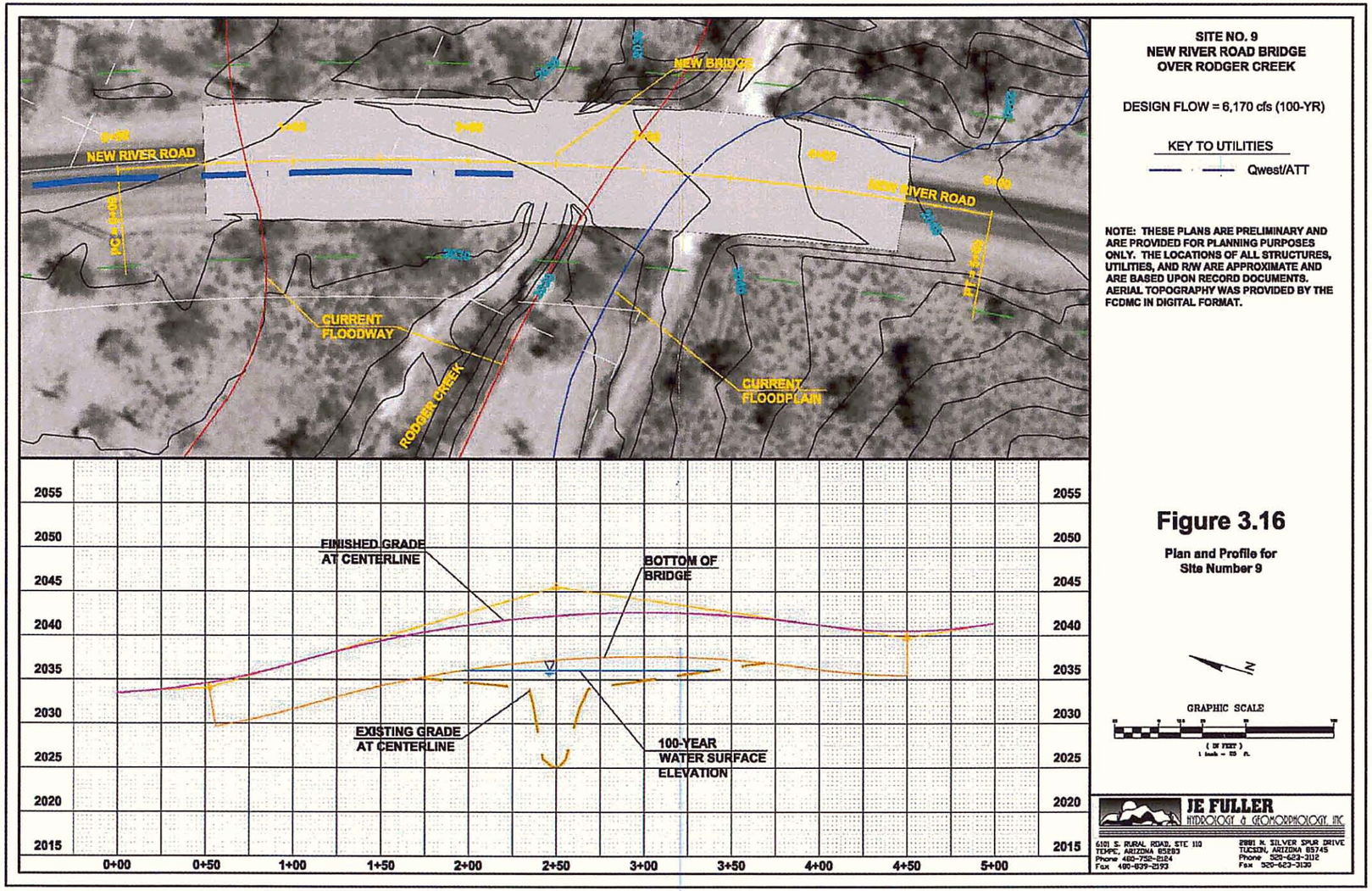


Figure 3.16

Plan and Profile for Site Number 9

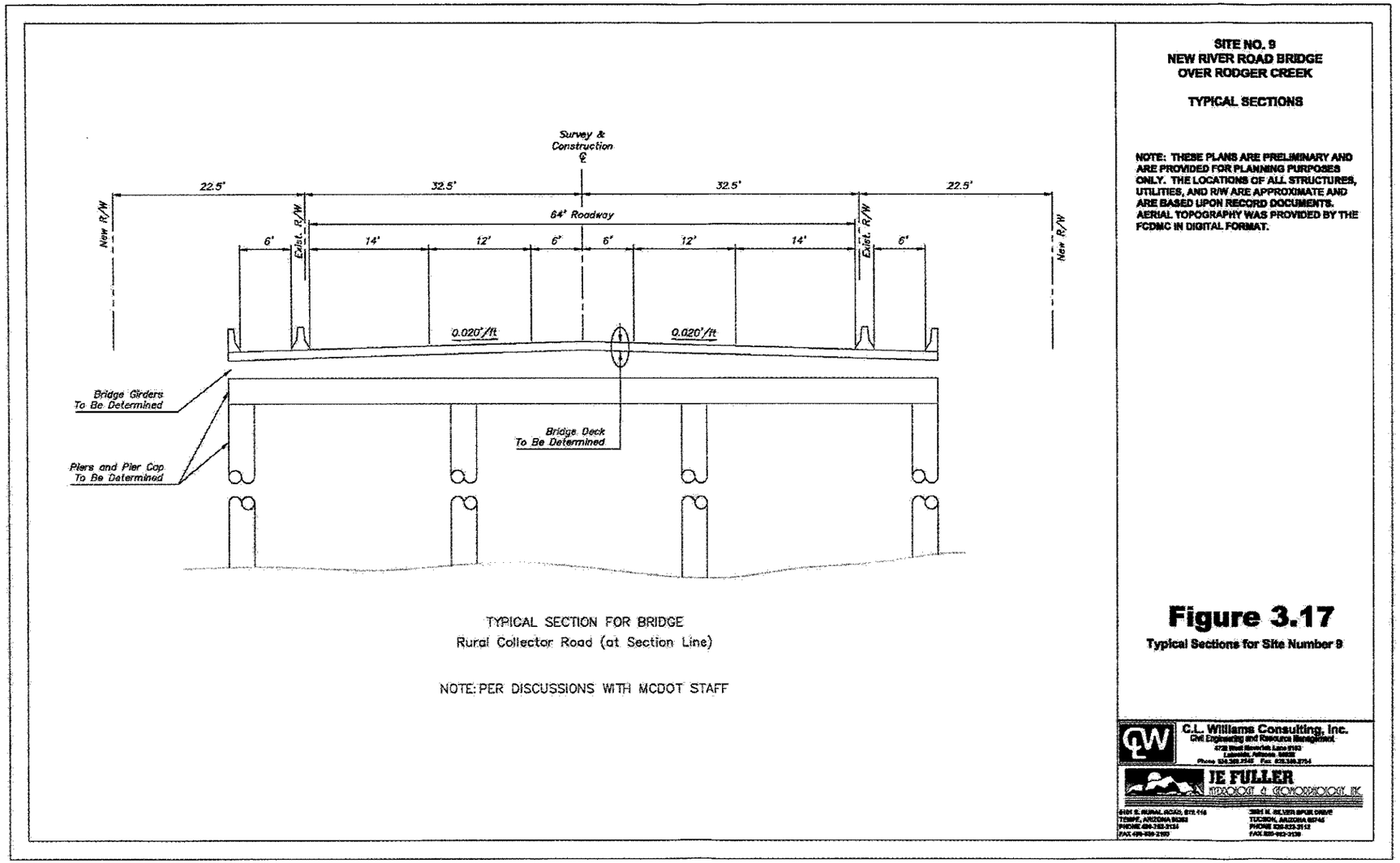


Figure 3.17

Typical Cross Sections for Site Number 9

Table 3.10
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	34000	$ 2,890,000	SF	$1.50	0	$ -	$ 722,500	$ 433,500	$ 4,046,000
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	$ 3,259,250				$ 65,340	$ 814,813	$ 488,888	**$ 4,628,290**

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
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	**$ 4,628,290**		**$ 5,201,256**

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.
Note: A 25% contingency is added for erosion protection, side slope changes, local drainage relief, etc. and any other unknown that well be determined in pre-design.

3.2.7 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 3.18.

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 alternative chosen for the recommended alternative is 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.

The terraced option was the most widely accepted alternative based on the visual aspects of the alternative. Because of these reasons, the terraced alternative is the recommended alternative for Site Number 10.

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 3.18 and 3.19 for the Plan and Profiles and typical sections of Site Number 10.

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 the 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 3.11 for cost estimates for Site Number 10.

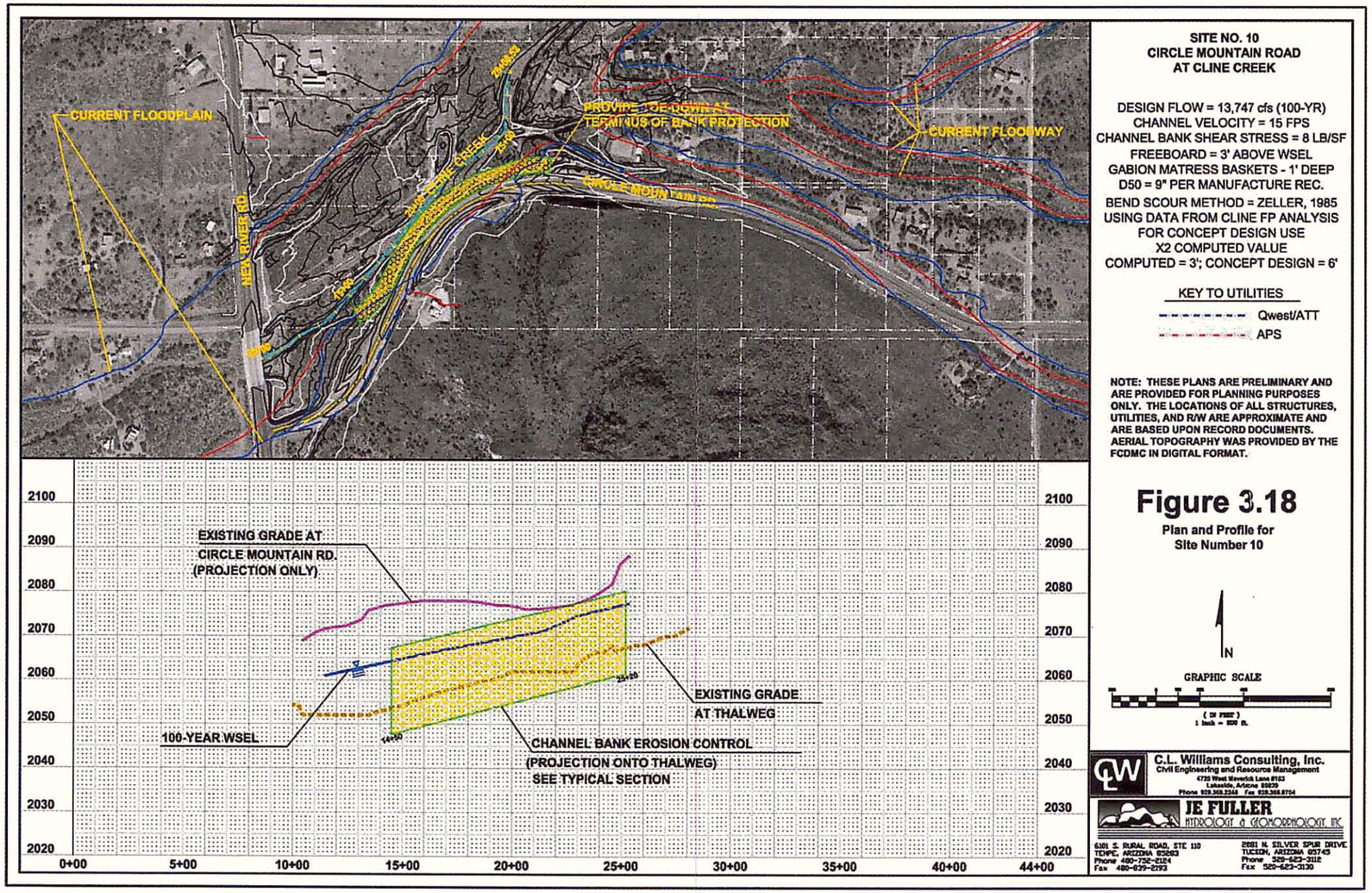


Figure 3.18

Plan and Profile for Site Number 10

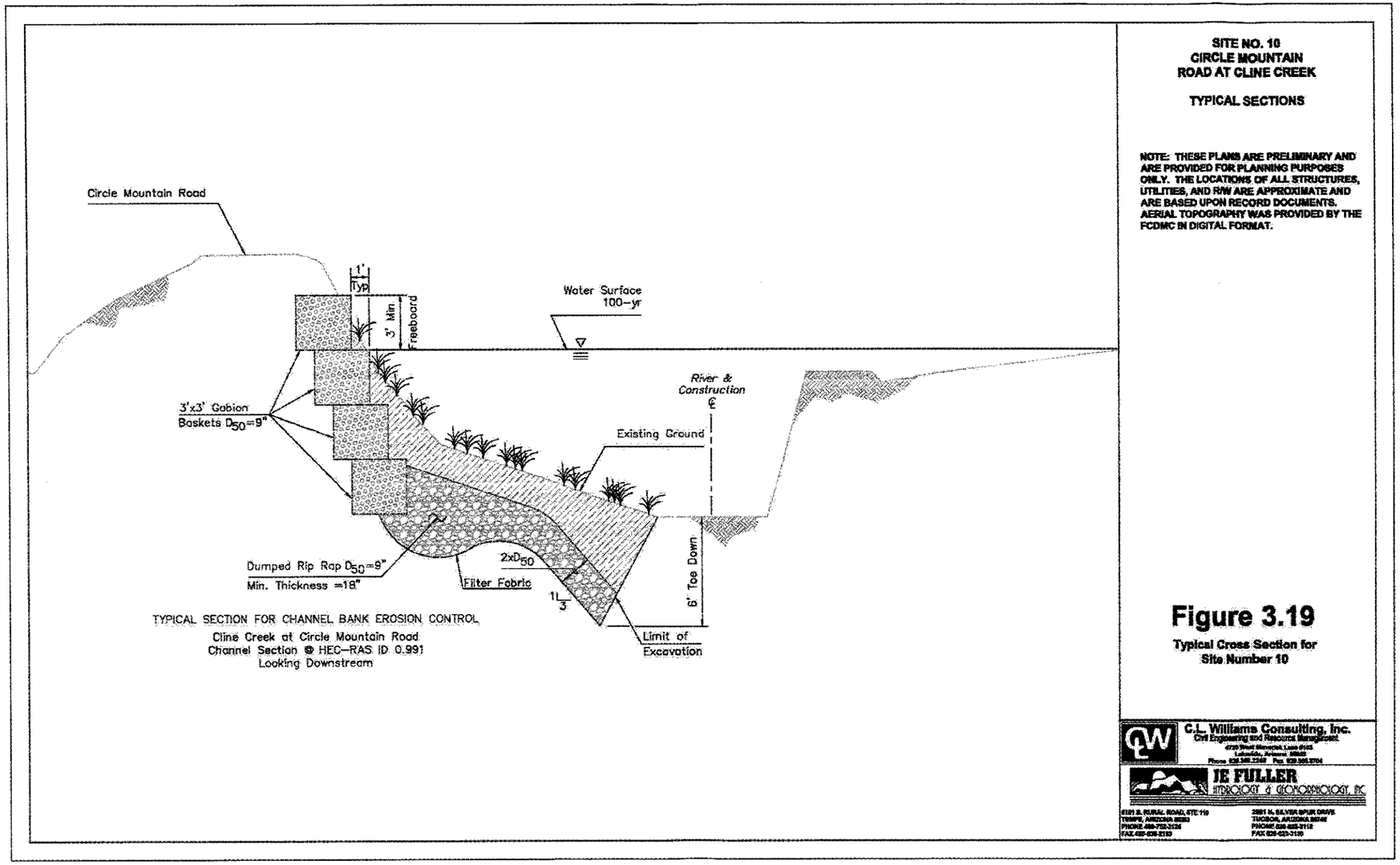


Figure 3.19

Typical Cross Sections for Site Number 10

Table 3.11
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.
Note: A 25% contingency is added for erosion protection, side slope changes, local drainage relief, etc. and any other unknown that well be determined in pre-design.

3.2.8 Site Number 11

Problem Description – During the course of the WCMP, the WCMP team identified Site Number 11 (located upstream and downstream of the New River Road Bridge at Skunk Creek) as a considerable problem area (Appendix B). The problems include; 1) Residences in the floodway. 2) Flow breakouts occurring in many locations. 3) 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; 1) 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. 2) 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 and occurs 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 which 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. 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. The selected alternative 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. 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.

This alternative was selected for the recommended alternative 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 it an all weather access in the 100-year recurrence interval. Finally, it is a less expensive alternative as compared with the other alternatives. This alternative has some challenges associated with it. The acquisition of right-of-way for the levee system may be complex, the permitting required for construction could be expensive and tricky, 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, this alternative has been carried forward as the recommended alternative for Site Number 11. 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 3.20 and 3.21 for the Plan and Profiles and typical sections of Site Number 11.

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 the 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 3.12 for cost estimates for Site Number 11.

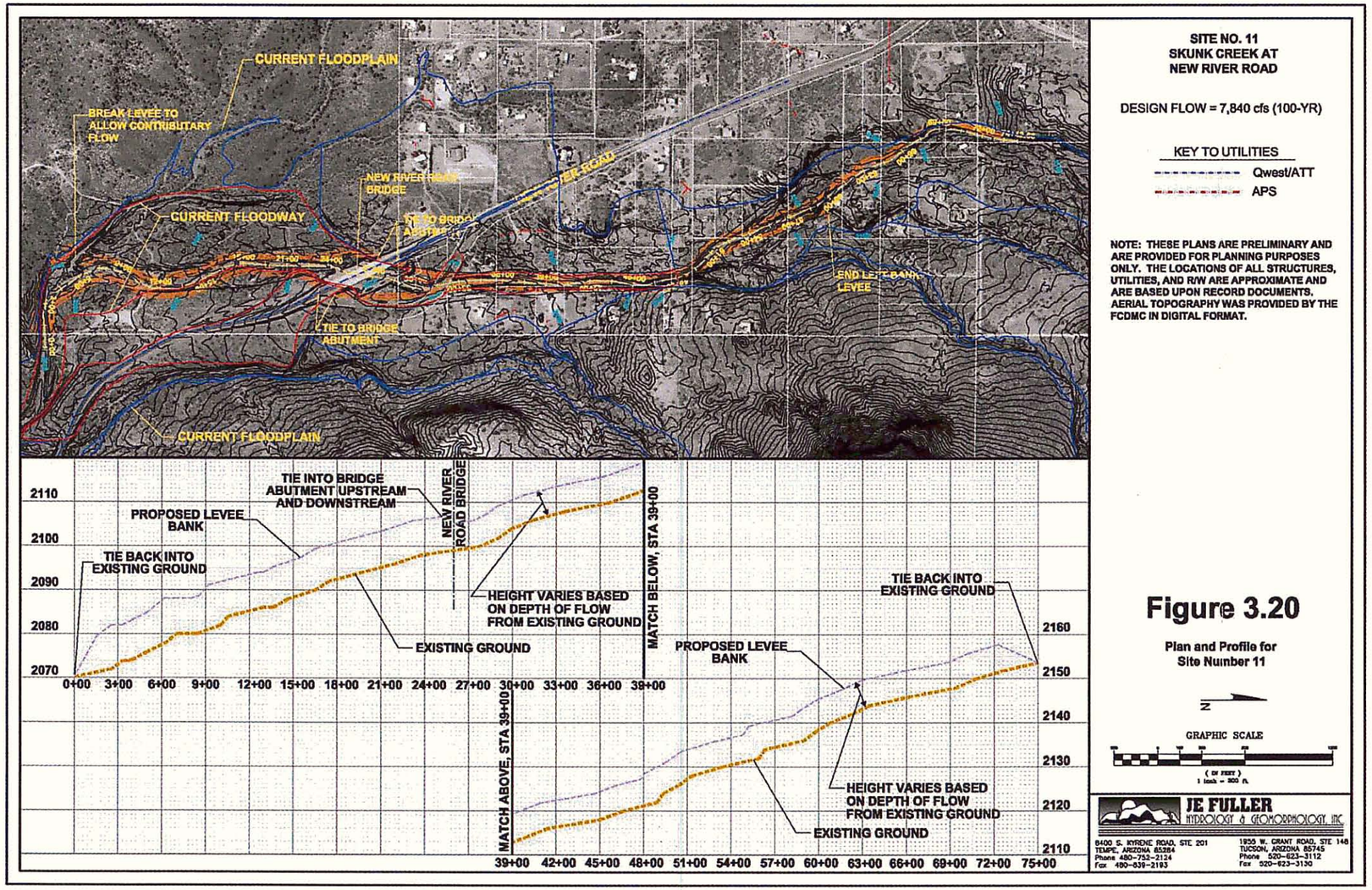


Figure 3.20

Plan and Profile for Site Number 11

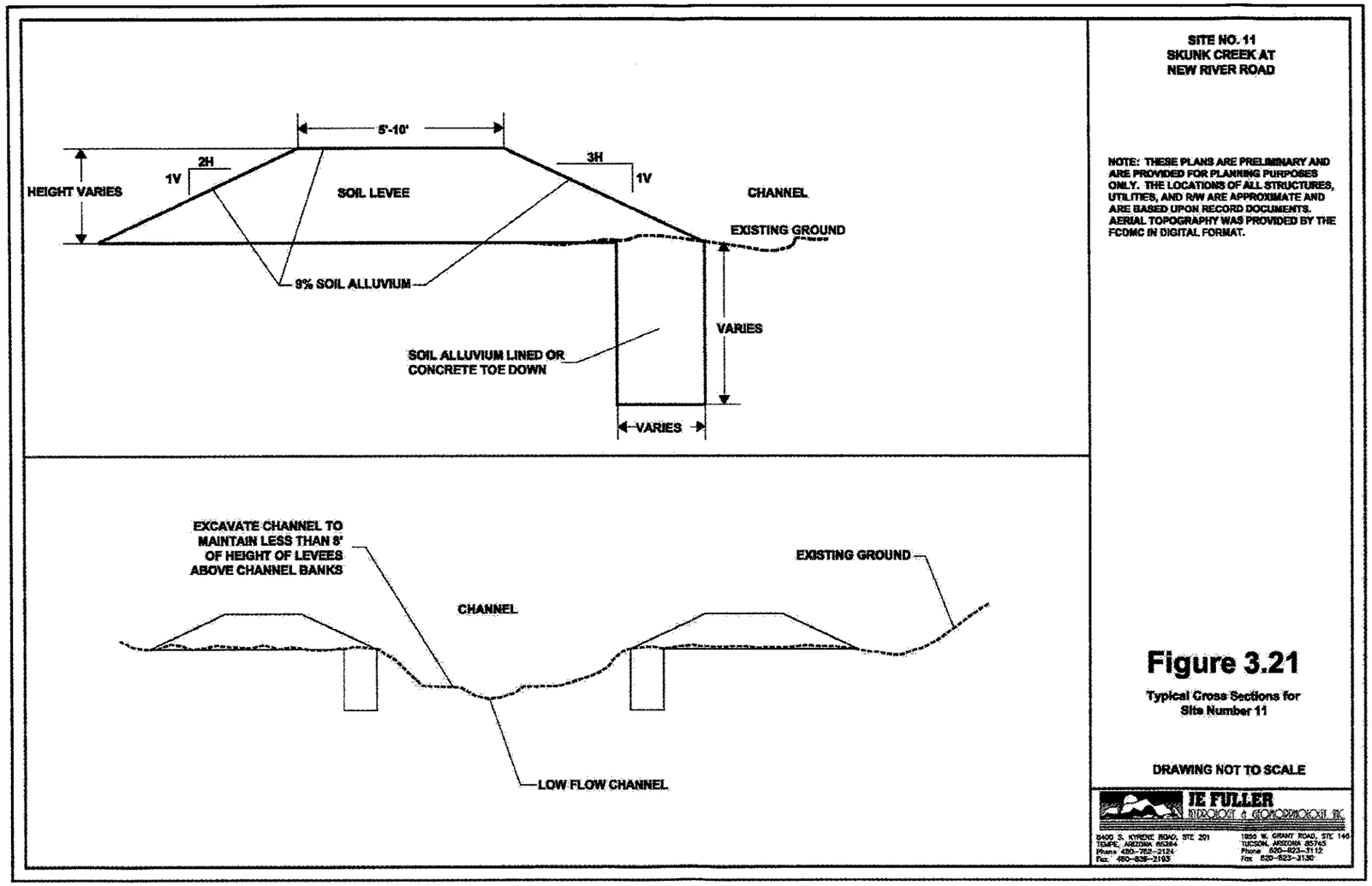


Figure 3.21

Typical Cross Sections for Site Number 11

Table 3.12
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 3.12 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.
Note: A 25% contingency is added for erosion protection, side slope changes, local drainage relief, etc. and any other unknown that well be determined in pre-design.

SECTION 4: CONCLUSIONS

During the refinement of the recommended alternative, the ADMP team looked at eight separate sites for structural measures and evaluated them qualitatively for reasonableness. The ADMP team also tried to identify any fatal flaws. Many of the original alternatives, measures, and sites were discarded for various reasons discussed within the body of this report and Part 8, Volume 4, Section 1. 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 provided a comprehensive drainage fix that would address the major flooding problems within the ADMP study area.

The sites with structural elements within the recommended alternative include 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.

7. RBF Consulting, *Conceptual Plan for Desert Hills,*July, 2004 for the Arizona State Land Department.

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.

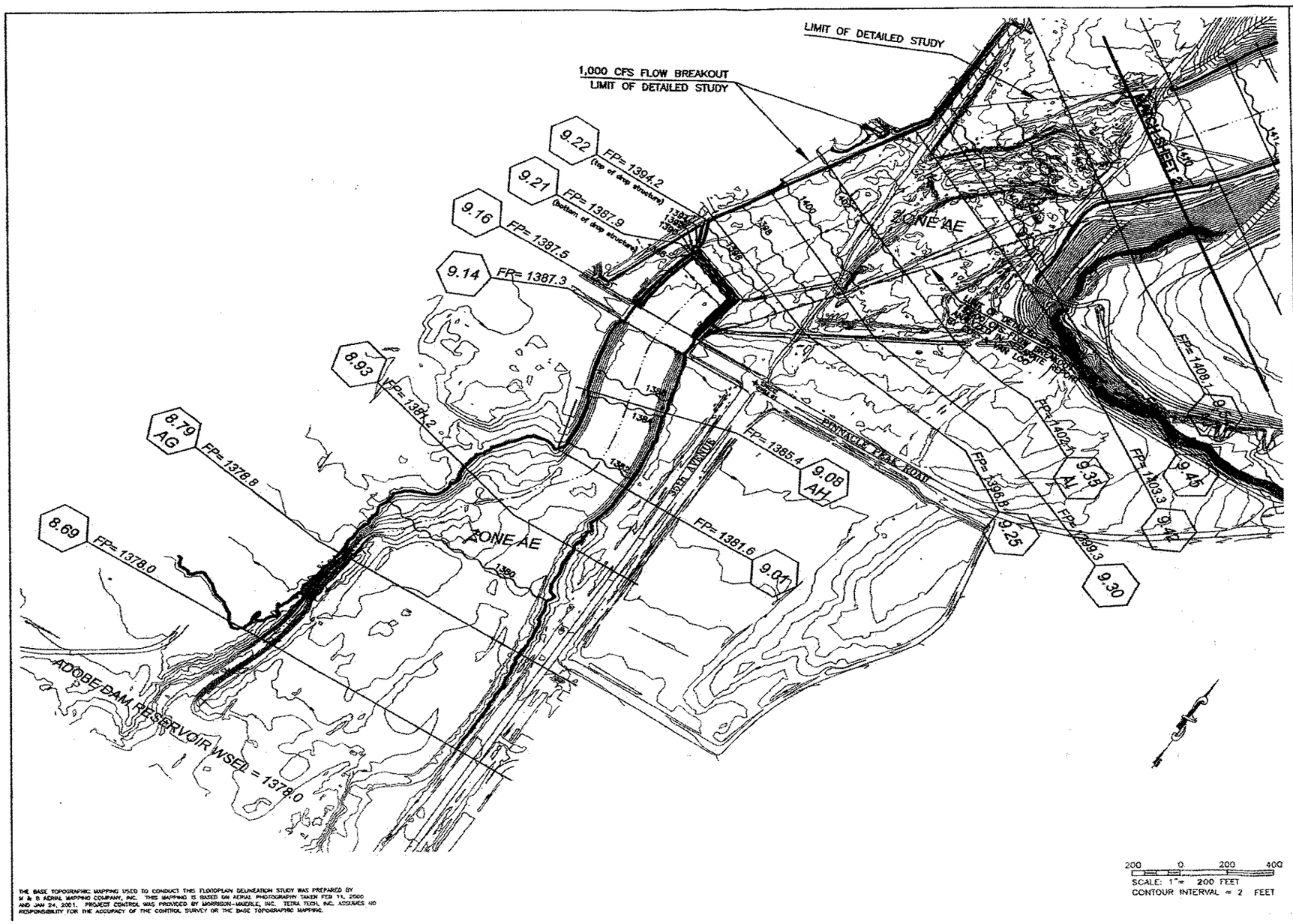
Appendix B

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:\Emch-0120\Buchanan-Skunk\Workmaps.dwg, 09/17/2002 02:13:58 PM, LML

LEGEND

100-YR FLOODPLAIN BOUNDARY	
HYDRAULIC BASE LINE	
CROSS SECTION	10 A — FP= 1483.6
ELEVATION REFERENCE MARK	ERM XXX
BASE FLOOD ELEVATION	1462
SFH ZONE DESIGNATION	ZONE AE
FLOW SPLIT BOUNDARY	

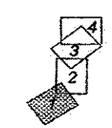
NOTE: FLOODWAY = FLOODPLAIN AT ALL LOCATIONS

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 SUPPORT GROUP

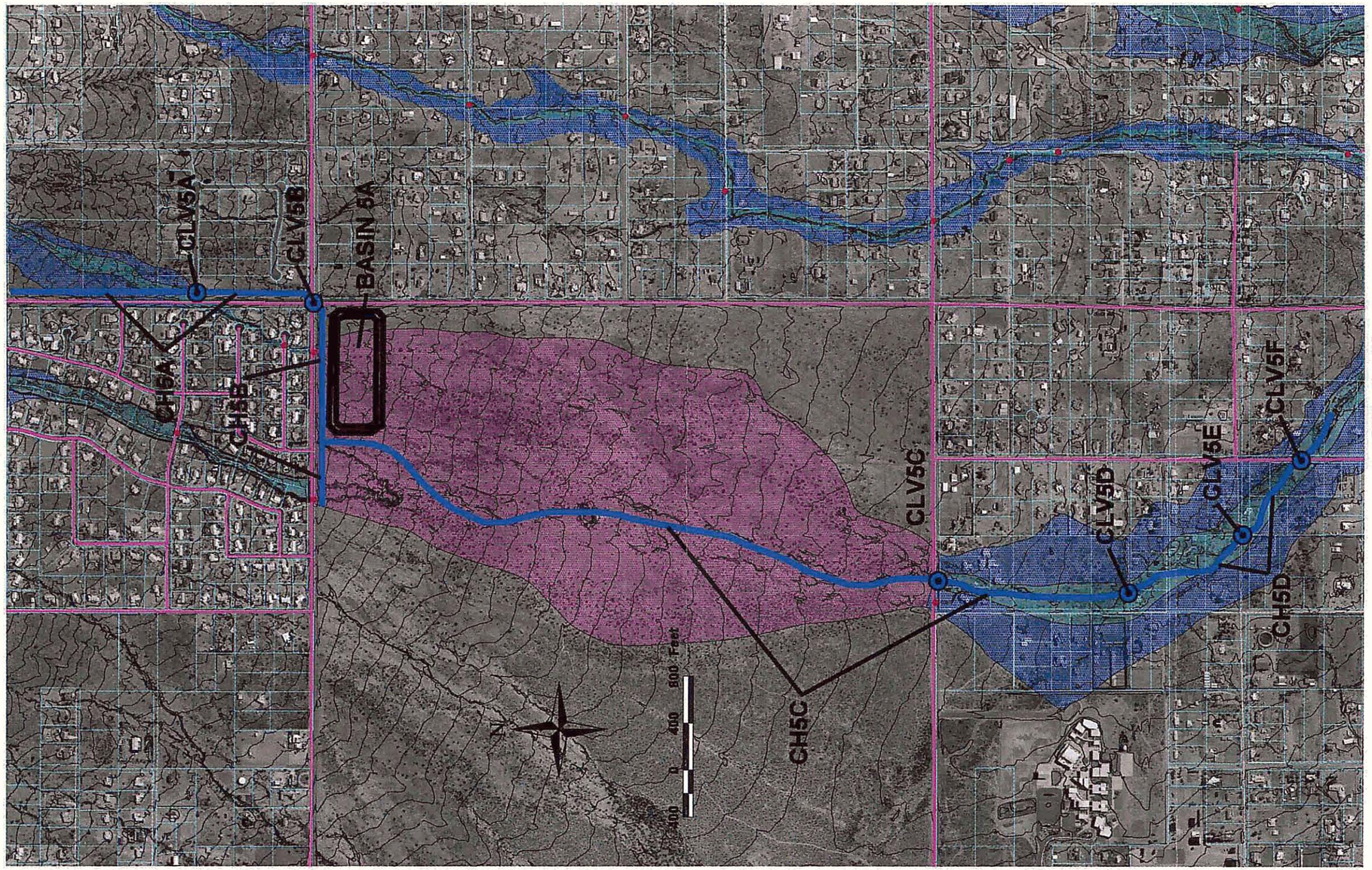
	BY	DATE
DESIGN	LML	09/2002
DESIGN CHK.	PAC	09/2002
PLANS	LML	09/2002
PLANS CHK.	PAC	09/2002

FIGURE 5-2 SHEET 1 OF 4

JE FULLER
HYDROLOGY & GEOMORPHOLOGY, INC.

Site Number 5

Conceptual Plan Layouts for Site Number 5



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 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)

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
```

```
12841      18
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   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
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   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
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   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
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   3.58     4
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   3.83    25
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   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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   3.67      36
   3.75      60
   3.83      93
   3.92     124
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   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
   0.00       0
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   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
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      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
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   2664  2739  2740  2815  2816  2891  2892  2967  2968  3043
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   3424  3499  3500  3575  3576  3577  3653  3654  3730  3731
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   4191  4192  4193  4268  4269  4343  4344  4345  4419  4420
   4494  4495  4568  4569  4570  4643  4644  4717  4718  4790
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```

```
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   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
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  13020  13108  13194  13278  13360  13559  13560  13561  13562  13563
  13564  13565
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4     16   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
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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
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3     14   8134   8135   8136   8137   8138   8139   8140   8141   8142   8143   8144   8145   8146   8147
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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
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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
```

CROSSMAX.OUT

```
 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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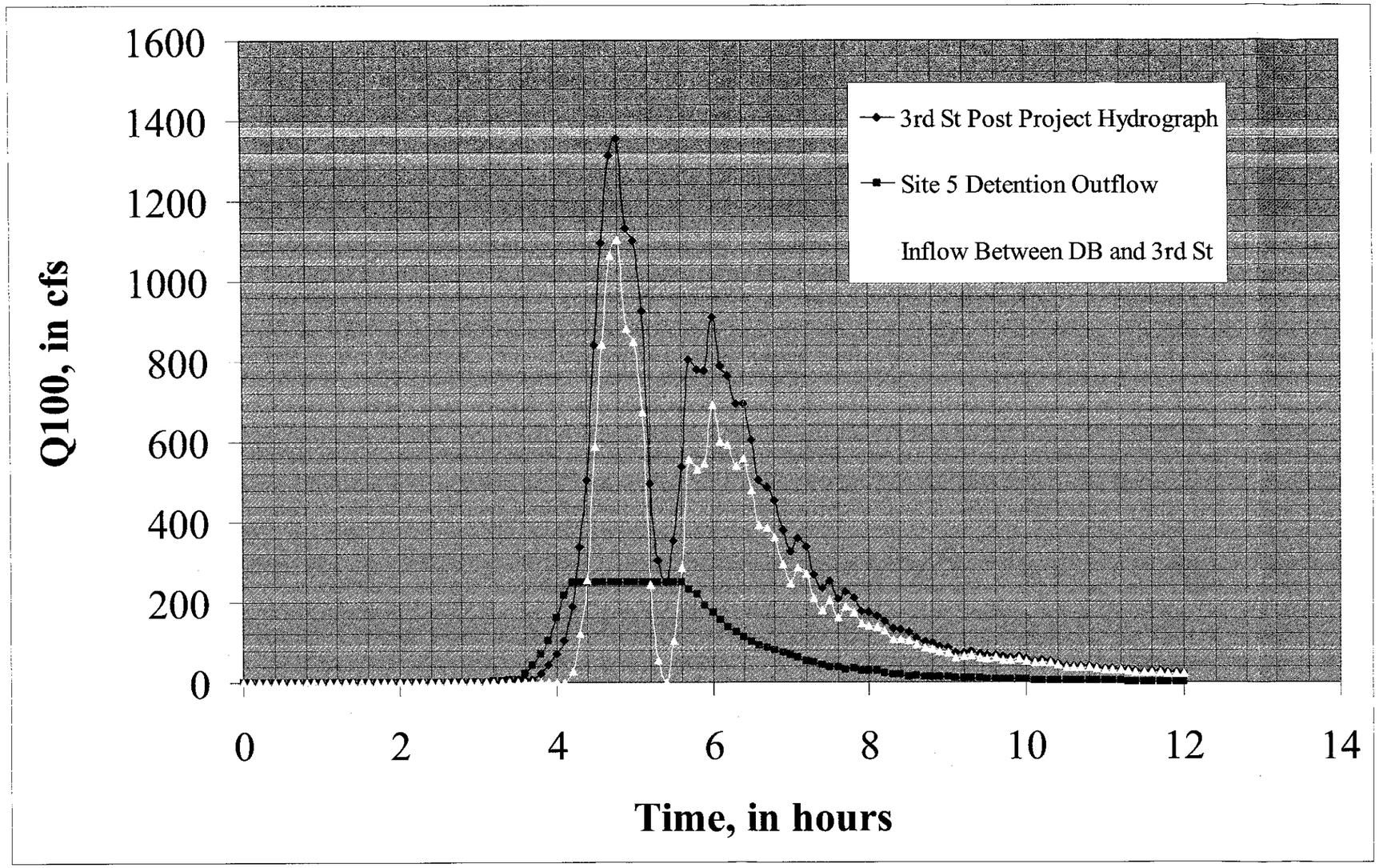
THE MAXIMUM DISCHARGE FROM NODE	3969 IS:	14.09 CFS AT TIME	5.02 HOURS WITH A MAXIMUM DEPTH OF:	0.25 FEET
THE MAXIMUM DISCHARGE FROM NODE	3970 IS:	14.44 CFS AT TIME	5.01 HOURS WITH A MAXIMUM DEPTH OF:	0.21 FEET
THE MAXIMUM DISCHARGE FROM NODE	3971 IS:	18.62 CFS AT TIME	4.93 HOURS WITH A MAXIMUM DEPTH 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

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

HEC-1 Information

HEC-1 Input File

```
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
```

```
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


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***
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                **************
                *            *
   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
                    .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

  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

                                        PEAK   TIME OF     AVERAGE FLOW FOR MAXIMUM PERIOD      BASIN     MAXIMUM
TIME OF
          OPERATION        STATION      FLOW    PEAK                                          AREA      STAGE     MAX
STAGE
+                                                          6-HOUR     24-HOUR     72-HOUR

          HYDROGRAPH AT
+                          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 CH5A
Worksheet for Trapezoidal Channel

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

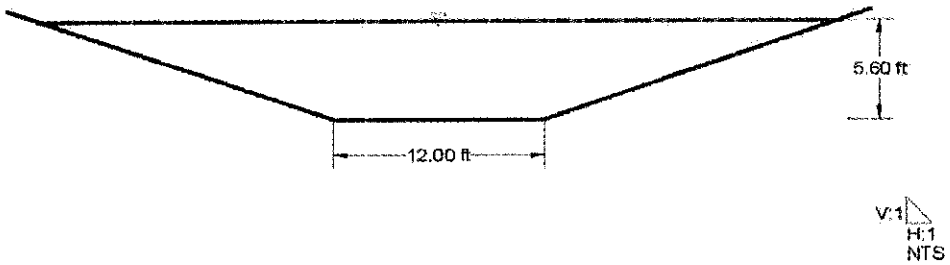
Input Data		
Mannings Coefficient	0.040	
Channel Slope	0.006000	ft/ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	12.00	ft
Discharge	1,050.00	cfs

Results		
Depth	5.60	ft
Flow Area	161.3	ft²
Wetted Perimeter	47.42	ft
Top Width	45.81	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

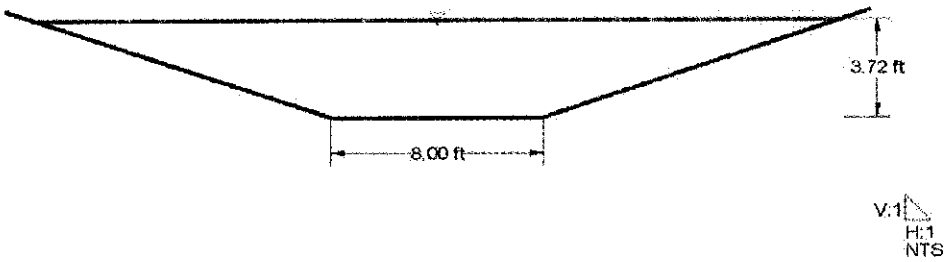
Input Data		
Mannings Coefficient	0.040	
Channel Slope	0.003000	ft/ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	8.00	ft
Discharge	250.00	cfs

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

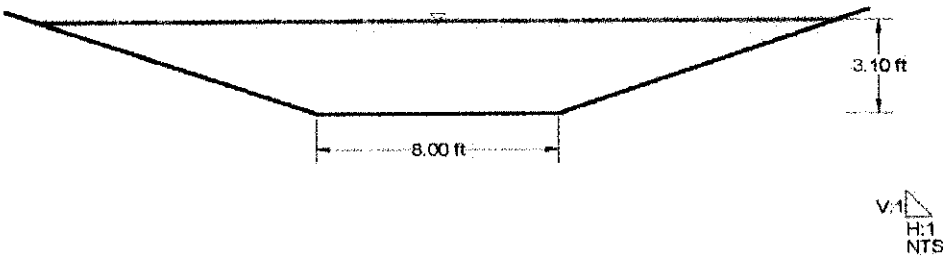
Input Data		
Mannings Coefficient	0.040	
Channel Slope	0.006500	ft/ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	8.00	ft
Discharge	250.00	cfs

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	0.58	
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

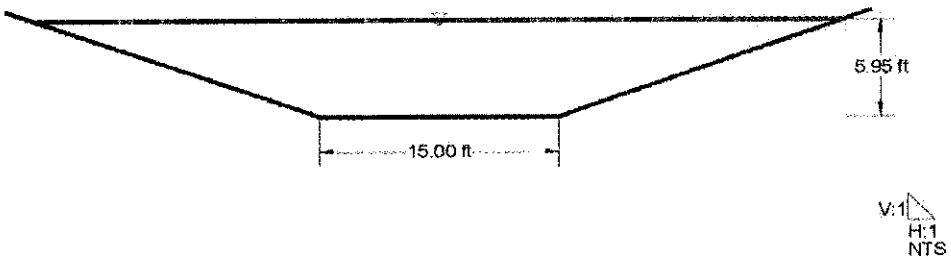
Input Data		
Mannings Coefficient	0.040	
Channel Slope	0.004000	ft/ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	15.00	ft
Discharge	1,100.00	cfs

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

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	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

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*******************************************************************************
**************************   FHWA CULVERT ANALYSIS    **************************
**************************     HY-8, VERSION 6.1      **************************
*******************************************************************************
| C |        SITE DATA          |     CULVERT SHAPE, MATERIAL, INLET            |
| U |---------------------------|-----------------------------------------------|
| L |  INLET   OUTLET  CULVERT  | BARRELS                                       |
| V |  ELEV.    ELEV.  LENGTH   | SHAPE        SPAN   RISE  MANNING   INLET     |
|NO.|  (ft)     (ft)    (ft)    | MATERIAL     (ft)   (ft)     n      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 **********
****

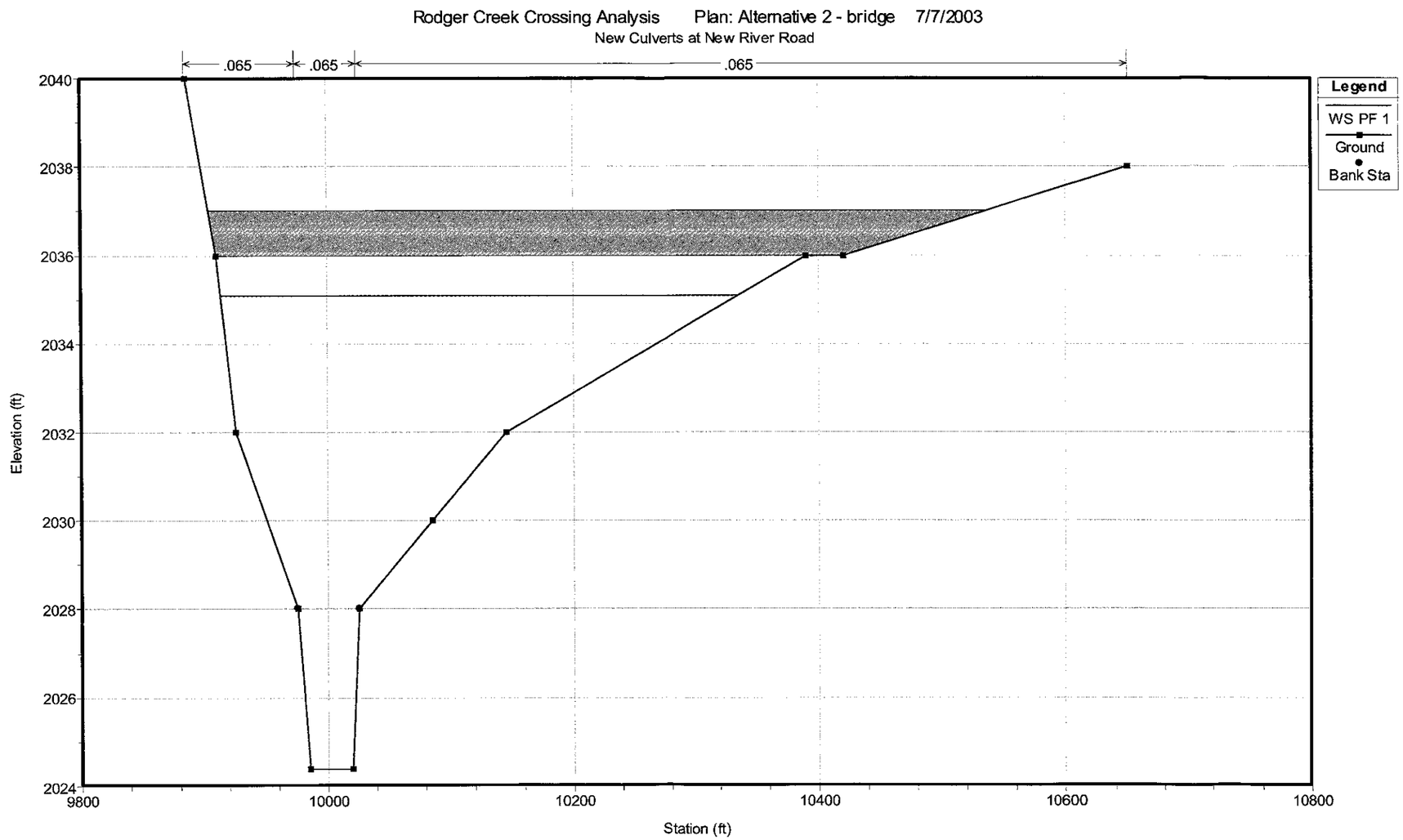
ROADWAY SURFACE	PAVED
EMBANKMENT TOP WIDTH	80.00 ft
CREST LENGTH	100.00 ft
OVERTOPPING CREST ELEVATION	16.00 ft

****

Site Number 9

HECRAS Output Cross Section Associated With New Bridge Span

For Site Number 9



Spanning bridge

Site Number 11

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

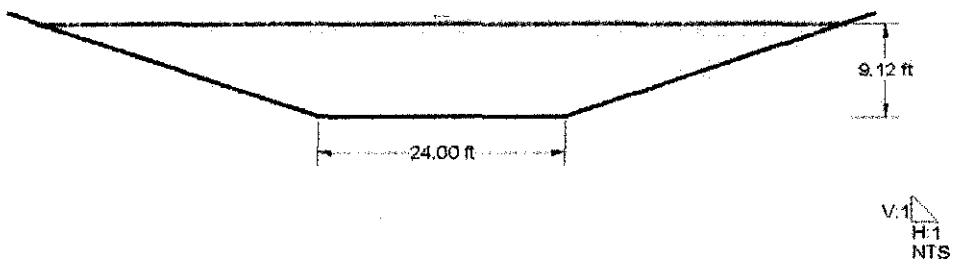
Input Data		
Mannings Coefficient	0.030	
Channel Slope	0.011133	ft/ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	24.00	ft
Discharge	7,840.00	cfs

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



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	9.63	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	

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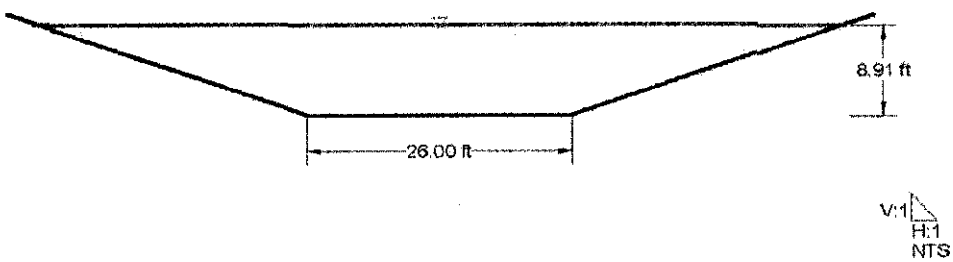
Cross Section
Cross Section for Trapezoidal Channel

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

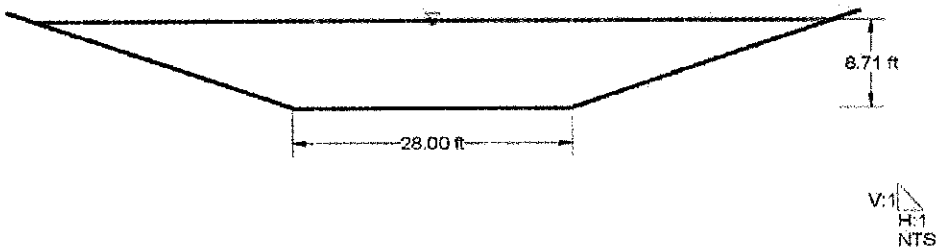
Input Data		
Mannings Coefficient	0.030	
Channel Slope	0.011133	ft/ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	28.00	ft
Discharge	7,840.00	cfs

Results		
Depth	8.71	ft
Flow Area	471.6	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	

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	8.62	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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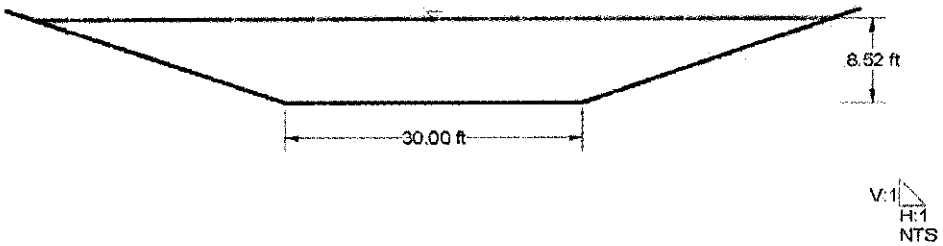
Cross Section
Cross Section for Trapezoidal Channel

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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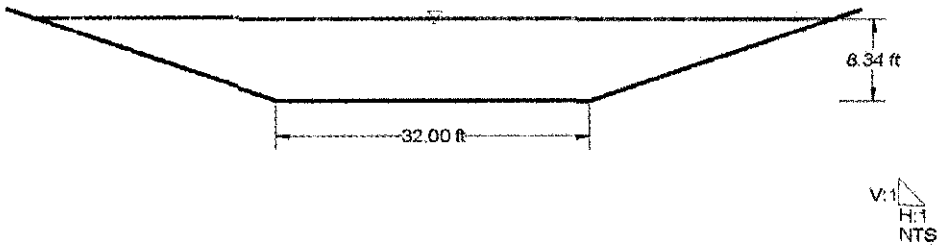
Cross Section
Cross Section for Trapezoidal Channel

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



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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

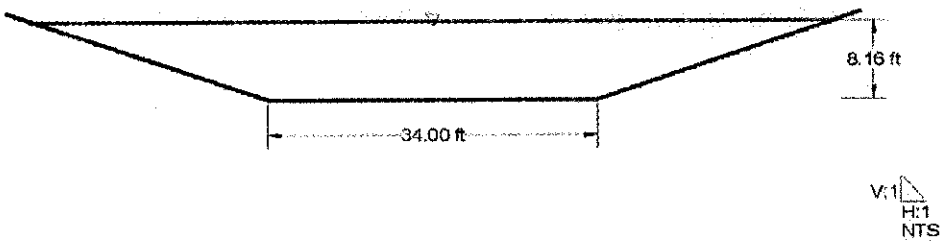
Input Data		
Mannings Coefficient	0.030	
Channel Slope	0.011133	ft/ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	34.00	ft
Discharge	7,840.00	cfs

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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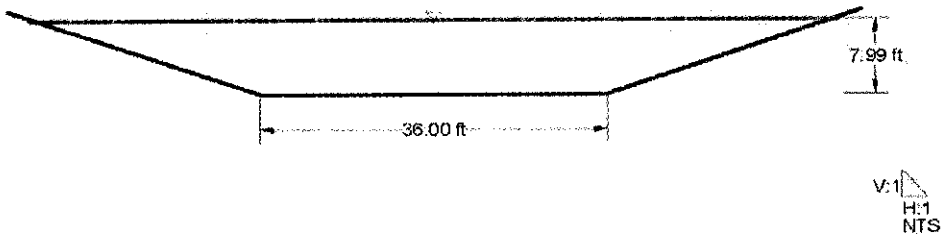
Cross Section
Cross Section for Trapezoidal Channel

Project Description	
Worksheet	Site 11 - 36'
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

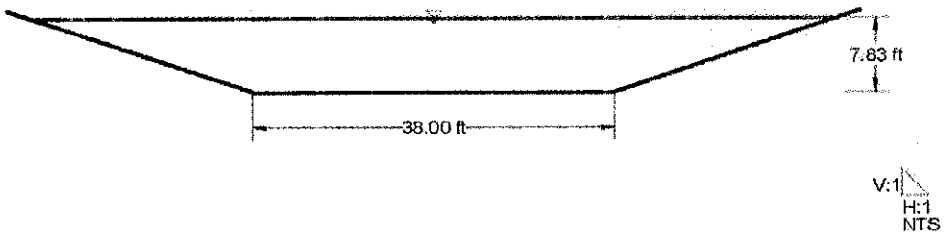
Results		
Depth	7.83	ft
Flow Area	481.4	ft²
Wetted Perimeter	87.52	ft
Top Width	84.98	ft
Critical Depth	8.68	ft
Critical Slope	0.007449	ft/ft
Velocity	16.29	ft/s
Velocity Head	4.12	ft
Specific Energy	11.95	ft
Froude Number	1.21	
Flow Type	Supercritical	

JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC.

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

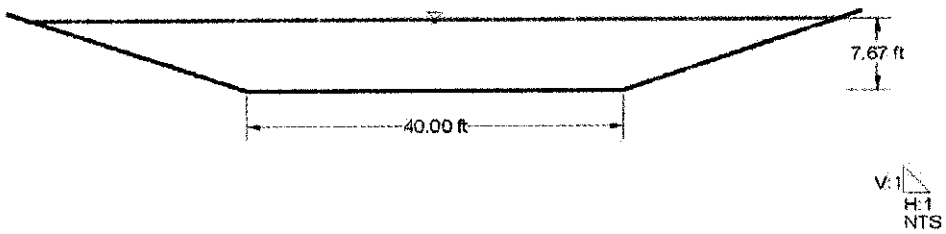
Results		
Depth	7.67	ft
Flow Area	483.7	ft²
Wetted Perimeter	88.54	ft
Top Width	86.05	ft
Critical Depth	8.52	ft
Critical Slope	0.007458	ft/ft
Velocity	16.21	ft/s
Velocity Head	4.08	ft
Specific Energy	11.76	ft
Froude Number	1.21	
Flow Type	Supercritical	

JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC.

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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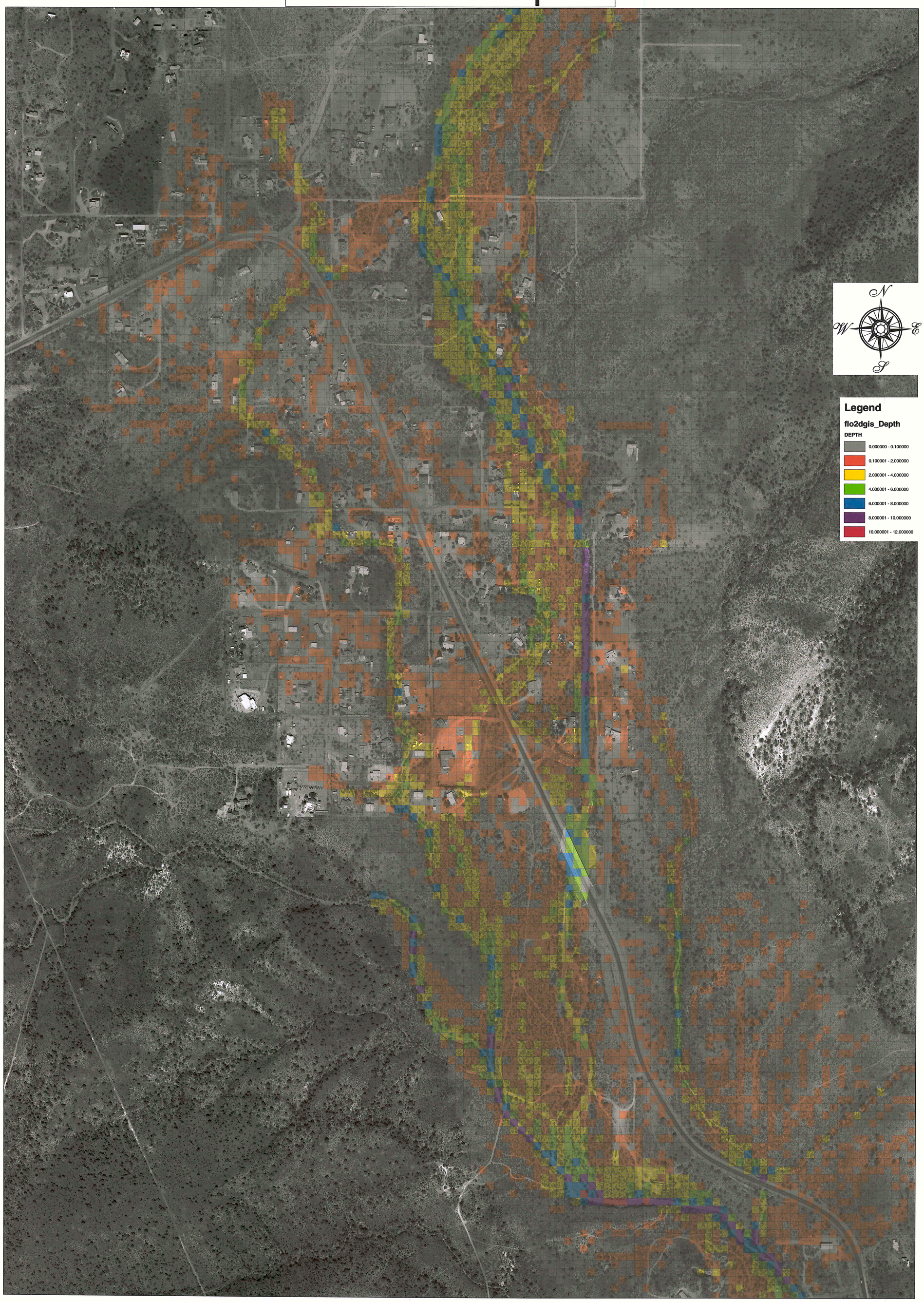
FLO-2D Exhibits for Site Number 11

Maximum Depths

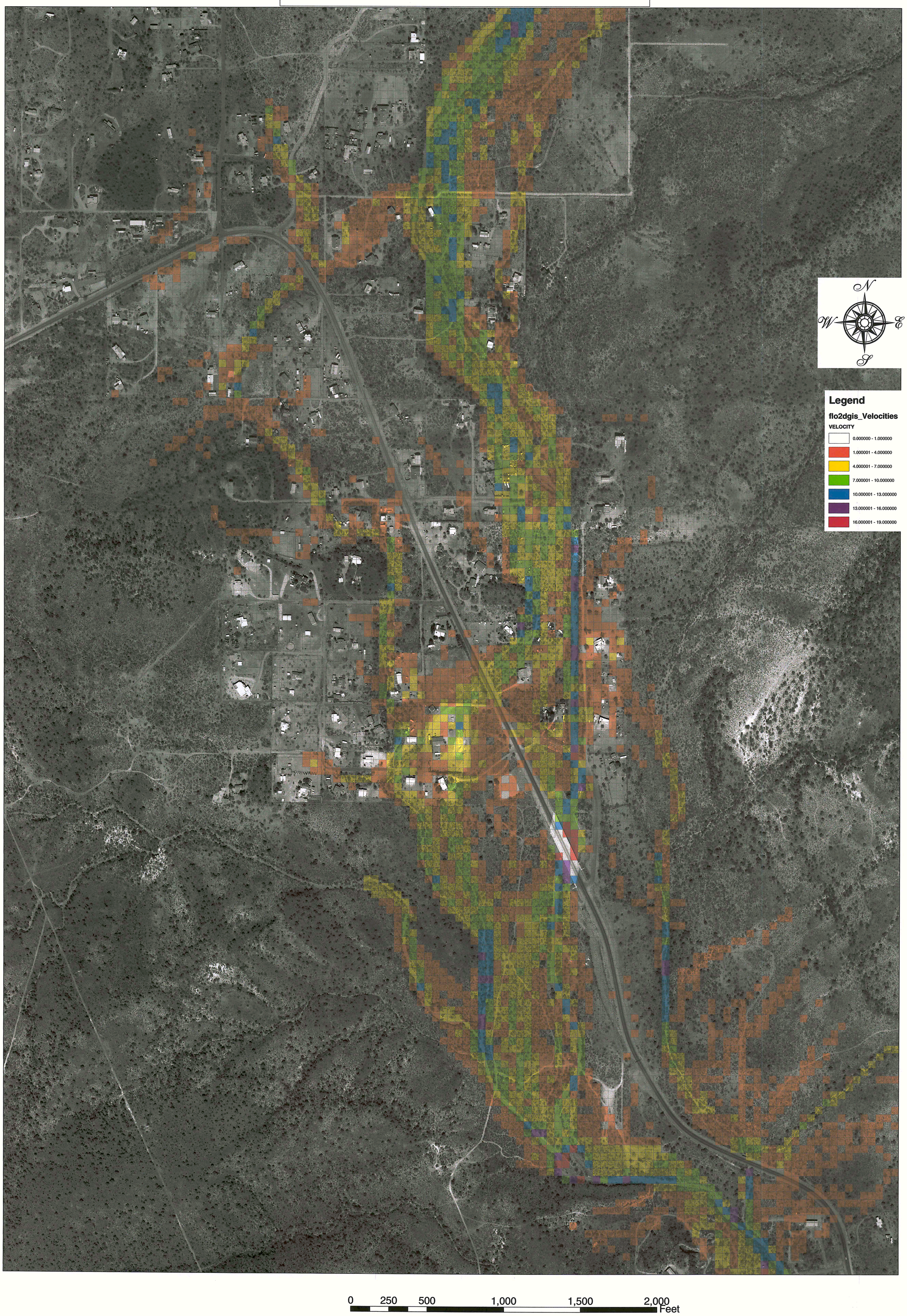
Maximum Depths



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

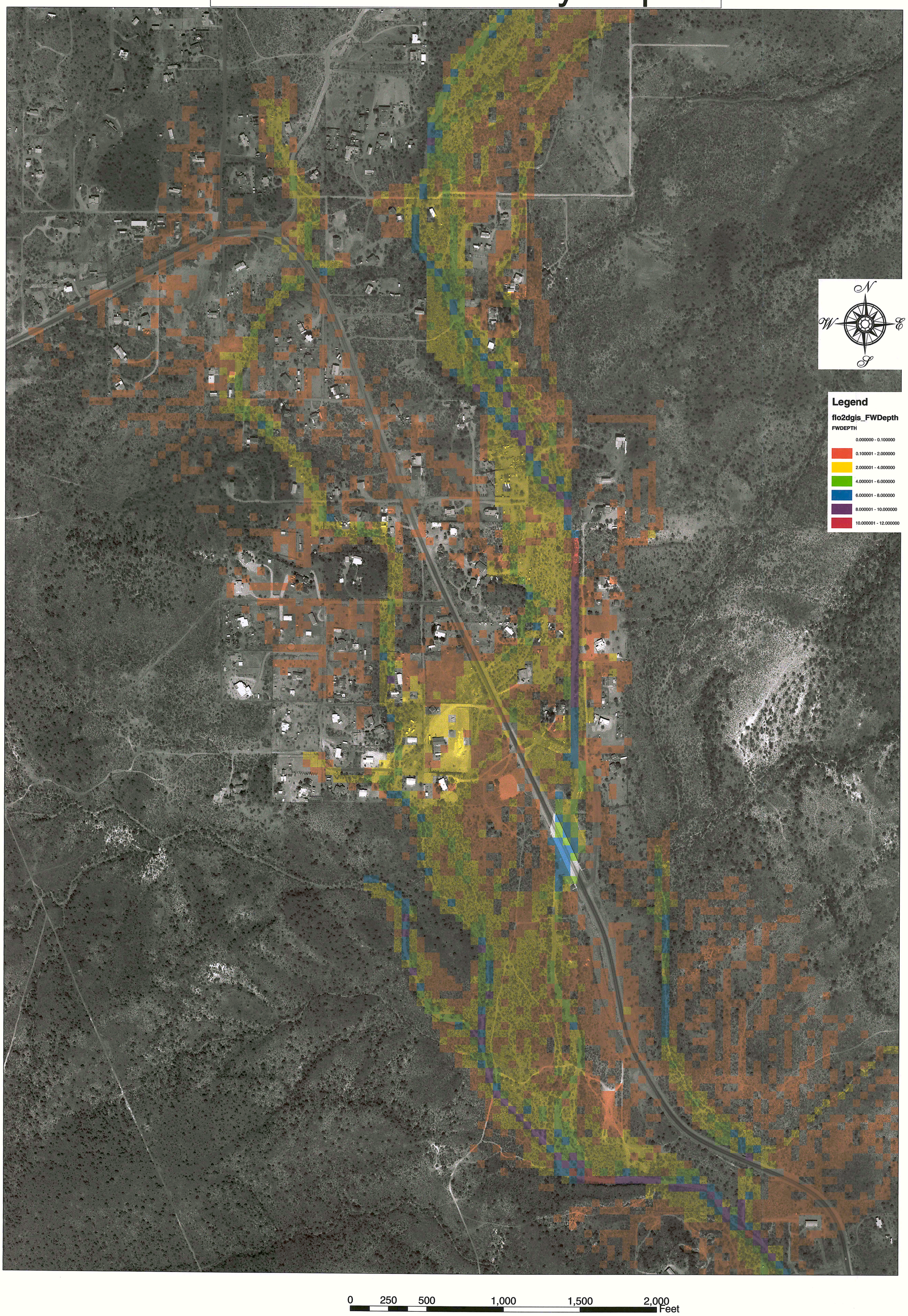
Maximum Velocities

Maximum Velocities



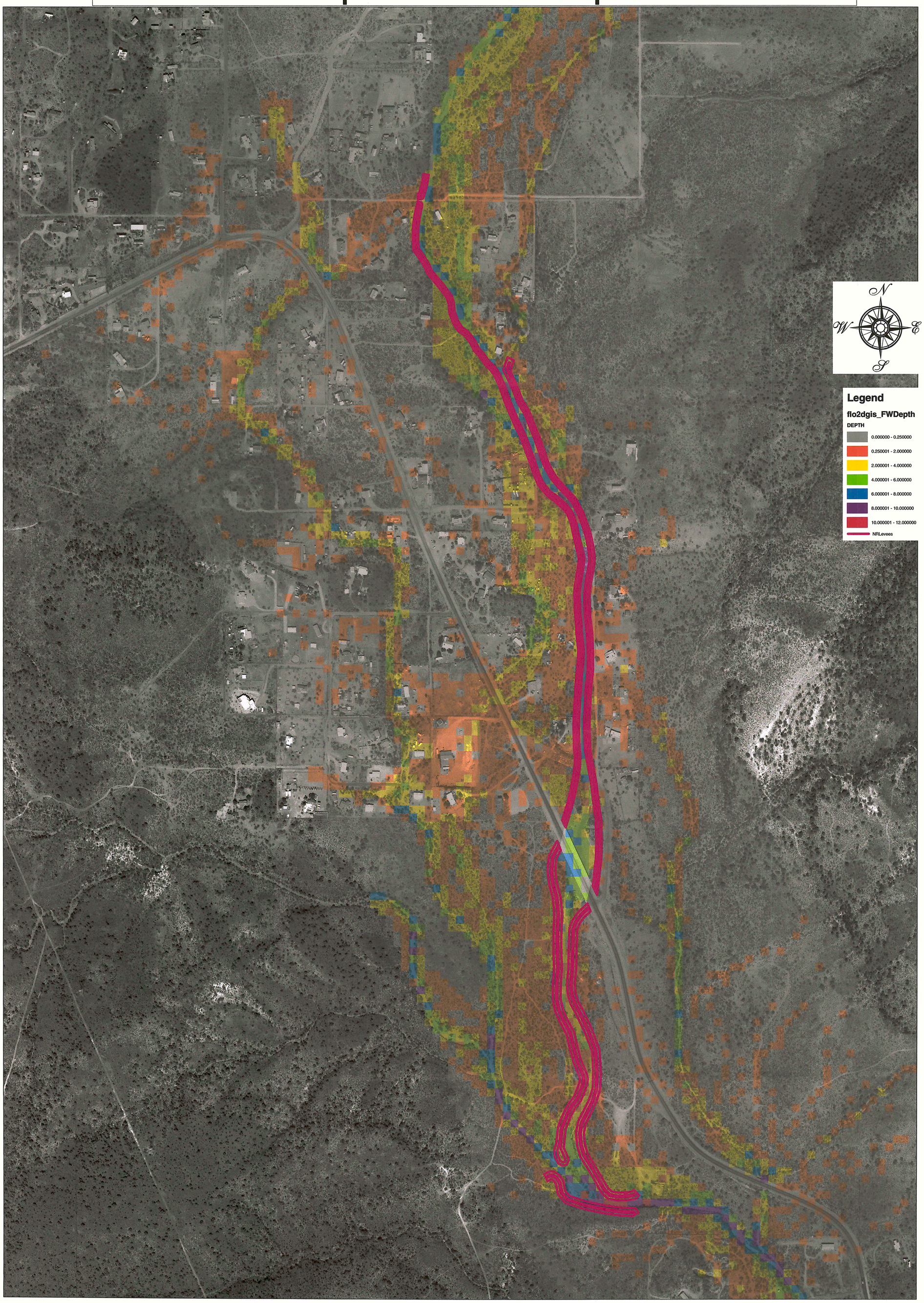
Maximum Floodway Depths

Maximum Floodway Depths



Maximum Depths with Proposed Levees

Maximum Depths With Proposed Levees



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