El Mirage Road, Bell Road to Beardsley Road – Phase B

TT103 & TT104

Drainage Report

Final Report

Prepared for:
Maricopa Department of Transportation

Prepared by:

Prestige
Engineering Consultants
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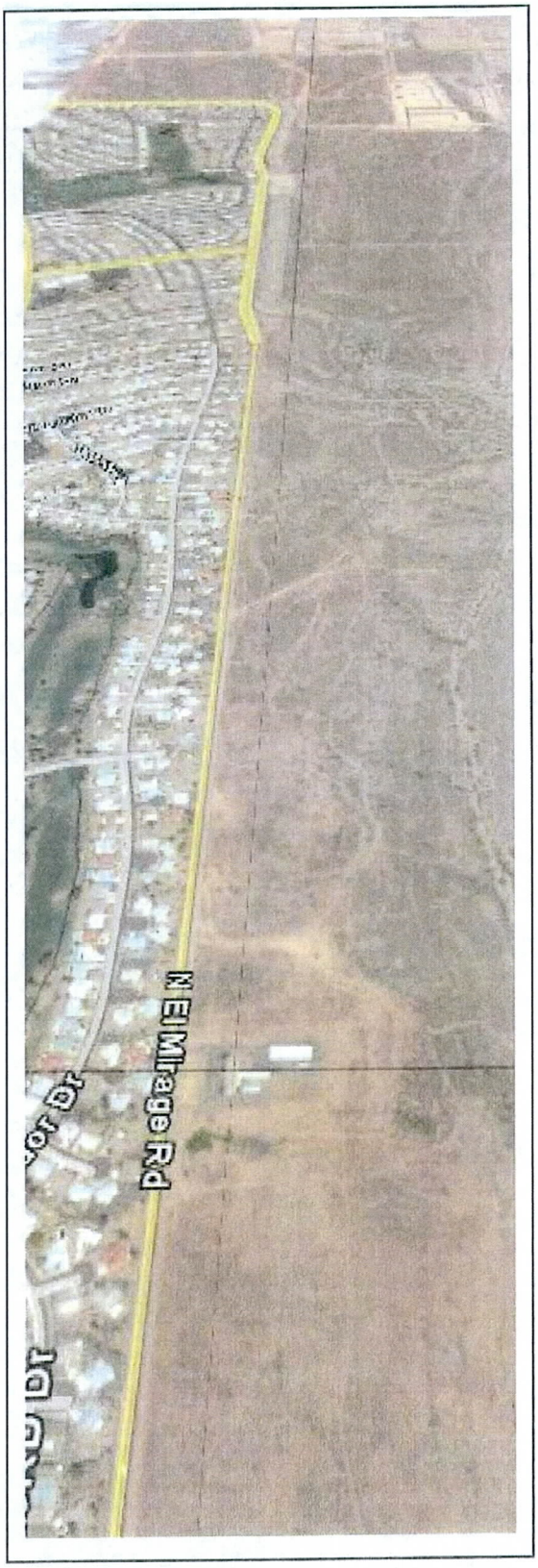
July 2009

Professional Engineer (Civil)
CERTIFICATE NO
27558
RAJU C.
CHAH
02-13-09
EXPIRES ON 12/31/11



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1. INTRODUCTION

The Maricopa County Department of Transportation (MCDOT) awarded two separate contracts for proposed El Mirage Road from Bell Road to Loop 303 in 2004. The southern portion of the project from Bell Road to Beardsley Road was awarded to Olsson Associates and the northern portion from Beardsley Road to Loop 303 Project to Wood Patel and Associates. The Wood Patel portion from Deer Valley Road to Loop 303, called Phase A was just recently constructed.

Recently, MCDOT retained JACOBS to update and complete the remaining portion called Phase B from Bell Road to Deer Valley Road as a separate contract. JACOBS retained Prestige Engineering as a drainage sub-consultant to analyze the on-site and off-site drainage for the southern portion of the project. Wood-Patel was also retained as a drainage sub-consultant to JACOBS for the northern portion of the project. The divide line between Prestige (south portion) and wood Patel (north portion) is at Sta. 122+00.

The project scope of work for southern portion includes drainage design for the portion of El Mirage Road from Bell Road (Sta. 10+00) north to Sta. 122+00 including crossing of McMicken Dam Outlet Wash. The drainage analysis includes review and design of on-site and off-site drainage impacting the roadway.

2. PURPOSE

The purpose of this drainage report is to document the effects of the on-site and off-site improvements to the existing El Mirage Road and effects of the new El Mirage Road alignment to surrounding properties. The drainage report presents a drainage analysis for the construction of proposed El Mirage Road from Bell Road to Deer Valley Road. It provides hydrologic and hydraulic calculations for the proposed box culvert crossing at McMicken Dam Outlet Wash, side drainage ditches, catch basins, cross culverts and open channels.

The proposed El Mirage Road drainage will be designed based up on Drainage Design Manual developed for the Flood Control District of Maricopa County (FCDMC) latest edition. The roadway design will meet MCDOT standards for a rural arterial street with the understanding that it will be converted into major urban arterial in the future. The rural arterial section includes 2-lanes w/ bike lane on each direction, with no curb and gutter on outside edge, no curb at the inside edge and 38' wide open median. The design speed is 55 mph. There were two drainage reports previously prepared will be the basis of this drainage report and are listed below:

- El Mirage Road, Bell Road to Beardsley Road, Drainage Report 90% Submittal, prepared by Stanley Consultant, dated September 2001.
- Candidate Assessment Report for El Mirage Road, Bell Road to Beardsley Road, prepared by Parsons, Brinkerhoff, dated January 1999.

3. PROJECT LOCATION

The project is located within Township 4 North, Range 1 West, Section 24, 25, and 36. The project is located in the unincorporated part of Maricopa County. It starts at Bell Road and continues north up to Deer Valley Road. This drainage report only covers area just north of Beardsley Road connection (Sta. 122+00). It is between Sun City West and the Agua Fria River and just north of City of Surprise. Sun City West, a retirement community, is the major contributor to the traffic on El Mirage Road. However, when the road is connected to Loop 303 to the north, it will generate far more traffic. The portion of the El Mirage Road from Deer Valley Road to Loop 303 has already been constructed and open for traffic since late 2008. Existing El Mirage Road alignment very much hugs the Sun City West property line and has only one-lane on each direction with curb and gutter on the west edge of the roadway. No curb, gutter or sidewalks on the east edge of existing El Mirage Road. It is a one way crown street, sloping from west to east. The existing Beardsley Road intersection is slightly depressed and sloped towards east. The intersection of Bell Road and El Mirage Road is currently signalized while the Beardsley connection is four-way stop sign. The existing road travels north and turns west and becomes Deer Valley Drive at about one mile north of Beardsley Road.

The proposed roadway improvements will start at the existing Bell Road intersection and as it travels north it shifts east to a new El Mirage Road alignment about 800 feet east of existing El Mirage Road alignment. As shown on Figure 1, it curves closer to the existing El Mirage Road as it approaches Beardsley Road connection. At McMicken Dam Outlet Channel, a seven (7) 10'X8' reinforced concrete box culvert (RCBC) will be provided to convey at least 50-year design flow. The remaining flow will overtop the roadway with less than 6" depth for 100-year flow. For the higher event, the roadway will be impassable and will be closed for traffic.

McMicken Dam Outlet Wash runs parallel to the existing El Mirage Road from Deer Valley Road south to about 1378 feet north of Beardsley Road. Then the wash makes a 90 degree turn to the east into Agua Fria River. The 50-yr crossing with seven (7) barrel 10'X8' RCBC with limited overtopping is proposed at this location.

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FIGURE 1
VICINITY MAP

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DATE: 10/08

JOB NO. 2008010

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4. PREVIOUS STUDIES

The following reports were obtained by Prestige Engineering for this project and the entire corridor from Bell Road to Loop 303:

4.1 Final Candidate Assessment Report:

The reports called "El Mirage Road, Beardsley Road to Loop 303 Final Candidate Assessment Report (CAR)" and "El Mirage Road, Bell Road to Beardsley Road Final CAR" was prepared by Parsons Brinckerhoff for the MCDOT Planning Department. The CAR presented several roadway alternatives. Input from the residents of Sun City West and MCDOT staff resulted in team reevaluating the proposed alignment, after the CAR was completed.

4.2 Drainage Report (90%) – El Mirage Road, Beardsley Road to Loop 303

This report was prepared by Premier Engineering to evaluate the hydrology and hydraulics of the El Mirage Road from Beardsley Road to Loop 303. This report also contained hydraulics and scour analysis for the south bridge. The report was compiled in metric units. Some of the hydraulics for the bridge openings and scour calculations will be compared with this report.

4.3 Drainage Report (90%) – El Mirage Road, Bell Road to Beardsley Road

This report was prepared by Stanley Consultants to evaluate the on-site and local off-site hydrology and hydraulics for the El Mirage Road from Bell Road to Beardsley Road. It consist of local hydrology, storm drain design, catch basins, open channels, and cross-culvert design.

5. DESIGN CRITERIA AND ASSUMPTIONS

El Mirage Road will be designed as a rural arterial street with the understanding that it will be converted into major urban arterial in near future. Hydrologic and hydraulic design for this project follows the criteria specified by MCDOT in the Scope of Work. The recommendations made in the Final Candidate Assessment Report (CAR) are also used as guidelines. Design procedures conform to Maricopa County Roadway Design Manual by MCDOT and Hydrology and Hydraulics Design Manuals by FCDMC.

The following is a summary of the major applicable drainage design criteria and assumptions for the current project:

1. The drainage plans shall conform to MCDOT format and standards and the English units shall be used;

2. The design of roadway on-site drainage shall be based on a 100-year storm event. The on-site drainage will be allowed to sheet flow into the parallel roadside ditches (east and west sides).

3. Off-site drainage culvert crossings shall be designed using 100-year peak flow rates;

4. The roadside drainage channels shall convey the 100-year onsite and offsite flows within the proposed right-of-way; The erosion controls shall be designed for the 100-year peak flows;

5. Local offsite runoff shall be estimated using the existing land use conditions and Rational Method;

6. Assume the existing drainage channel along the north side of Bell Road has sufficient capacity to convey the existing flows from the north as well as the increased flows generated by El Mirage Road without overtopping according to the final CAR.

7. Hydrology for roadway drainage design will use the Rational Method as presented in the Drainage Design Manual for Maricopa County, Volume 1, Hydrology;

8. The McMicken Dam Outlet Wash crossing will be designed to pass 50-year design discharge with no overtopping. The 100-year discharge will be checked for overtopping with less than 6" of depth over the roadway. The Standard Project Flood (SPF) event will be allowed to overtop the roadway, however, the major infrastructure will be protected from scour for this event;

9. The minimum storm drain pipe size is 18 inches.

10. Median drainage will be collected and conveyed to the west using ADOT Std. Median catch basins.

11. Control of pollutant discharge from the first flush, considered as the amount of rain equivalent to ½ inch of rain, from the onsite watershed area of runoff. The linear retention for first flush will be achieved using 6" gravel berms to allow ponding.

6. OFFSITE DRAINAGE

The offsite drainage for the project will primarily flow from the north to south, and be conveyed into the existing McMicken Dam Outlet Wash. The offsite drainage between the old El Mirage Road and the proposed El Mirage Road will be conveyed through concrete pipe culverts. Regional offsite drainage conveyed by the McMicken Dam Outlet Wash originates from the McMicken Dam to the north. Local offsite flows, conveyed by culverts crossing under the proposed roadway, originate from the area between the old and proposed El Mirage Road. No offsite drainage areas beyond this boundary are considered for the culvert crossing design.

6.1 Local Offsite Drainage

6.1.1 Peak discharges for cross culverts

Local offsite drainage is analyzed using the Rational Method as described in the Drainage Design Manual for Maricopa County, Volume I - Hydrology. The area between Sun City West and the new El Mirage Road naturally drains toward El Mirage Road. Currently, the local offsite areas are mainly undeveloped natural desert land. Medium desert vegetation can be observed near the wash banks while light to medium vegetation is found throughout the rest of the area.

The offsite drainage sub-basins are delineated according to the existing topography and the proposed roadway profiles, and they are shown in Appendix A. The 50-year and 100-year peak discharge rates were estimated with the FCDMC software RATIONAL.exe. The peak discharges are summarized in Table 1. The outputs from the software are included in Appendix B.

Table 1: Peak discharges for offsite sub-basins

Sub-basin ID	Area (ac)	Flow Path (ft)	Peak Discharge	
			50-year	*100-year*
OFF10 (Wood/Patel)	73.28	4750	136	166
OFF11	4.94	772	14	17
OFF12	1.15	965	3	4
OFF15	3.63	442	14	16
OFF16	2.5	1220	8	9
OFF17	3.45	708	12	14
OFF18	2.620	810	9	10
OFF19	4.680	472	17	21
OFF20	11.20	2193	24	30
OFF21	8.2	2016	19	23
OFF22	13.360	2936	27	33
OFF23	8.8	1417	23	27
OFF24	5.97	3840	10	13
OFF25	4.97	619	15	18
OFF26	3.7	2336	7	8
OFF27	9.210	1554	21	26

The following Table 2 summarizes the cross culvert properties, labeled from A to H on the offsite drainage exhibit included in Appendix A.

Table 2: Cross culvert properties

Culvert ID	Culvert Station	Number of Barrels	Size (in)	Discharge (cfs)	Length (ft)	Pipe Slope (ft/ft)	Headwater Depth (ft)	Outlet Velocity (fps)
A	113+26	3	48	166	210	.02857	4.41	15.69
B	92+24	1	30	24	316	0.0275	2.56	12.66
C	87+90	1	30	24	250	0.0710	2.56	17.85
D	77+59	2	24	63	117	0.0276	4.08	13.08
E	75+06	2	30	81	219	0.0365	3.68	16.10
F	51+50	1	36	83	202	0.0171	5.81	13.91
G	39+50	4	36	123	176	.00261	2.75	6.96
H	20+28	2	30	79	149	0.0201	3.62	12.52

Note: All culverts shall have grooved end with head wall inlet type.

The natural terrain to the east of new El Mirage Road generally slopes to the east away from the roadway except where near Beardsley Road and some small portions of the existing offsite areas drain toward the roadway. Roadside drainage channels on the east side of the road collect mostly the onsite runoff and convey it to the outfall washes.

The box culvert across McMicken Dam Outlet Wash was designed using HEC-RAS model and the calculations are included in Appendix E.

6.1.2 Riprap protection for culvert outlets

Riprap sizing for culver outlet protection was conducted assuming zero existing scour condition according to the procedure described in the Drainage Design Manual for Maricopa County – Volume II. The culvert inverts at outlet would be placed at ground elevation. Table 3 summarizes the median stone size for riprap at the culvert outlets. The equation used to determine riprap stone size for flat aprons, d_{50}, is:

$$d_{50} = [0.02(Q)^{4/3}] / [TW/(D)]$$

where,

d_{50} = median stone diameter, ft
Q = culvert barrel flow, cfs
D = culvert diameter, ft
TW = water depth at culvert outlet, ft

Table 3: Riprap median stone size for culvert outlet protection

Culvert ID	Discharge per Barrel Q (cfs)	Pipe Dia. (ft)	Outlet Velocity (ft/sec)	Tail Water at Outlet (ft)	Stone Size Required, D50 (ft)	Stone Size Provided, D50 (inches)
A	55	4	15.7	1.50	0.68	12
B	24	2.5	12.7	1.00	0.26	12
C	24	2.5	17.9	0.8	0.39	12
D	32	2	13.1	1.00	0.58	12
E	41	2.5	16.1	1.00	0.66	12
F	83	3	13.9	2.3	0.44	12
G	31	3.0	9.8	1.8	0.69	12
H	40	2.5	12.5	1.3	0.54	12

The riprap outlet protection lengths were calculated based on FCDMC Hydraulics Manual, Section 5.3.4. The calculations are included in Appendix D. The apron lengths were extended up to the available rights-of-way.

6.1.3 Roadside Drainage Channels

Roadside drainage channels are proposed on the west side of the new El-Mirage Road alignment between roadway stations in order to intercept the offsite runoff from the west. Existing natural washes on the east side of the roadway will provide outfalls for the west drainage channel. The proposed cross culverts are designed to convey the 100-year storm water, that accumulates as runoff from west of the site, across the proposed roadway. The ultimate outfall occurs at the historic locations along the Agua Fria River, adjacent to the proposed roadway.

Several triangular and trapezoidal roadside drainage channels or ditches were analyzed using Bentley System's FlowMaster™ software to provide a stable conveyance system for the 100-year runoff into cross culverts. Manning's equation was used to estimate the normal flow depth in the channel. A Manning's "n" value of 0.025 was applied for riprap lined channels. These roadside channels will be located adjacent to roadway embankment and shall be entirely within the existing right-of-way. In order to accommodate the side ditches within the available rights-of-way, the side slopes were modified to 4:1 at some locations instead of 6:1. All of the ditches are outside the roadway clear zone.

Generally, these ditches follow the natural terrain to the outfalls, which is from north to south. The side ditch exhibit is shown in Appendix C. Table 4 summarizes the hydraulic results for the roadside channels. The detail FlowMaster™ calculations sheets are included in Appendix C. The typical sections of the ditches were modeled using Inroads software. Final elevations were modified to daylight the ditches into the cross-culverts and/or existing washes. The minimum slope used for these ditches is 0.003 feet/feet. Most cases, the ditch slope is steeper than 0.003 except for ditch #D3, along west side from Sta. 23+00 to 26+00 where the ditch slope is 0.002 feet/feet. However, the flow spread still contains within the available rights-of-way.

The roadside channels will be lined with the loose riprap in avg. diameter of 6" and layer thickness of 12". The design calculations are included in Appendix C.

At the south end of the project, a drainage channel is proposed along the east side of El Mirage Road, which conveys offsite flows. This channel drains into an existing Bell Road channel flowing east to west. The flow will be conveyed continuously by the east roadside channel towards Bell Road to the south. The outfall for the east roadside channel is at the proposed culvert extension, provided by knockouts constructed into the box culvert walls. These will discharge into the existing concrete lined drainage channel on the north side of Bell Road. The Bell Road drainage channel is part of the regional drainage facilities. It drains easterly into the Agua Fria River.

Table 4: Summary of roadside triangular drainage channels

	Location (East or West)	Q50	Q100	S(avg.) (FT/FT)	V (ft/sec)	FLOW DEPTH (ft)	Side Slope
D1	West	3	4	.003	2.01	0.5	4
D2	East	65	79	.003	3.62	2.0	4
D3	East	6	7	.003	2.01	1	4
D4	West	66	79	.003	3.77	2	4
D5	West	59	70	.003	3.62	2	4
D6	West	40	49	.003	3.62	2	4
D7	S of Interfaith Rd	3	4	.003	2.01	1	4
D8	N of Interfaith Rd	41	71	.003	3.7	2	4
D9	West	43	52	.003	3.7	2	4
D10	East	10	11	.003	2.01	1	4
D11	West	13	15	.003	3.43	2	4

	Location (East or West)	Q50	Q100	S(avg.) (FT/FT)	V (ft/sec)	FLOW DEPTH (ft)	Side Slope
D12	West	36	41	.003	3.43	2	4
D13	East	18	20	.003	2.63	1	4
D14	East	2	3	.003	2.01	0.5	4
D15	N of Beardsley Rd	3	4	.003	2.89	1.5	4
D15.1	S. of Beardsley Rd.	15	18	.003	2.89	1.5	4
D16	S	28	33	.003	2.89	1.5	4
D17	West	28	33	.003	3.19	2	4
D18	East	8	9	.003	2.63	1.5	4
D19	West	7	9	.003	3.19	2	4
D20	East	3	4	.003	2.01	1	4
D21	East	9	10	.003	2.01	1	4
D22	West	21	24	.003	3.19	2	4
D23	West	20	23	.003	3.19	2	4
D24	East	7	8	.003	2.01	1	4
D25	West	19	22	.003	2.63	1.5	4
D26*	East	136	166	.003	5.65	2.5	4

* The offsite area contributing from Wood/Patel Portion of the project.
See Appendix C & G for the Drainage Ditch exhibit and other hydraulic calculations

The average slope was used for the design purposes. In most cases the design ditch slope exceeds average slope and thus ditch will have additional capacity than the design. The ditches are lined with loose riprap with filter fabric due to the higher velocity.

6.1.4 Beardsley Connection

A connector road will be constructed to connect the existing and proposed El Mirage Roads. It is located approximately 4000 feet south of Beardsley Road. This road essentially provides a connection between Beardsley Road from Sun City West and proposed El Mirage Road. The pavement is slightly elevated above the natural ground. The drainage from north of this roadway will be intercepted and conveyed by a roadside channel north of the pavement toward the intersection with El Mirage Road.

6.1.5 Interfaith Drive

The only developed area between Sun City West and the proposed El Mirage Road is a commercial building near Station 37+00, named "Interfaith Services". It resides in the State Land adjacent to the existing El Mirage Road. Part of the surrounding area is paved for parking. An access road is proposed from the new El Mirage Road near Station 38+57.54 and extends west for a distance about 400 feet and then turns south to the parking area. Roadside ditches will be constructed along both the north and south

sides of the road. The roadside ditches will be graded toward the El Mirage Road west drainage channel. The culverts at the northwest corner of the intersection will discharge the concentrated flow north of the access road to a wash just east of El Mirage Road.

6.2 REGIONAL OFFSITE DRAINAGE

The regional offsite flows are captured and conveyed into the existing McMicken Dam Outlet Wash, which flows from north to south. The outlet wash originates at the McMicken Dam approximately 1.5 miles north of Deer Valley Road and ultimately drains into the Agua Fria River. In addition to the dam outlet flows, the wash does capture additional overland flow along its way. The peak flows discharged by McMicken Dam from the SPF and Probable Maximum Flood (PMF) were analyzed using HEC-1 model that was developed for the Wittman Area Drainage Master Study (ADMS). According to the Wittman ADMS the peak flow for the SPF is approximately 14,000 cfs, 100-yr peak discharge is about 6,500 cfs and 50-year discharge is about 5,085 cfs.

The 100-yr floodplain limit was delineated in the Wittman ADMS using the approximate methods and is enclosed in Appendix E. The outlet wash is currently defined as Zone "AE" in Federal Emergency Management Agency (FEMA)'s Flood Insurance Rate Map (FIRM).

6.2.1 McMicken Dam Outlet Wash

The existing McMicken Dam Outlet Wash is primarily an un-lined, natural channel which is about 400' to 500' wide under the bridge and about 150' to 160' wide just north of the bridge. The channel is very well defined and about 20' to 25' deep at the lowest point. The south bank around the bend is lined with some type of concrete or shotcrete channel lining. No "as-built" plans were available for this channel lining. The effective HEC-2 model provided by the FCDMC from the Wittaman ADMS prepared by WLB Group was converted into HEC-RAS model and was utilized for the project as the corrected effective model. The old floodplain was based on 1929 datum. The elevation data for all of the HEC-2 cross-sections were adjusted by adding 2.04 feet to match the new mapping which was based on 1988 datum.

The new 1 foot contour interval topography was utilized to prepare the existing condition model with latest topographic mapping as well as to model the box culvert and other improvements. The AutoCAD Land Development Desktop computer program was used to develop a new HEC-RAS model using the previous model cross-section locations to generate ground data and reach lengths. The previous model's assessment of "n" values and expansion/contraction coefficients were used. Each HEC-RAS cross-section was re-evaluated to make sure the input data matched with the old HEC-2 model. Additional cross-sections were inserted within the model because there are not sufficient cross-sections. Since the wash made a 55 degree bend, it was made sure that the cross-sections were orientated perpendicular to the flow path and did not cross each other. A proposed box culvert was modeled at the appropriate station, and with appropriate contraction and expansion coefficients.

The 1 foot contour interval topography captured the presence of an in-channel ledge along the left bank of the main channel from cross section number 1896.01 to 1673.92 (see Figure 2). The condition at

cross section number 1673.92 is shown in the figure. The presence of the ledge initially contained the 100-year discharge in the main channel under existing and proposed conditions. This prevented the floodplain limit to extend to the left bank of the McMicken Dam Outlet Wash to match the 100-year floodplain limit of the effective model. The levee symbol was used to model this scenario by preventing HEC-RAS to put water left of the ledge when the 100-year water surface elevation is lower than the top of the ledge elevation. It was understood that the resolution of the old effective model topography did not capture the presence of this ledge. Given that the ledge was not a certified flood defense structure, and had the potential to fail during the next 100-year event, it was removed for the existing and proposed conditions models. Figure 3 shows the condition at cross section number 1673.92 after the removal of the ledge in the HEC-RAS model. The removal of the ledge was based on consultation with the FCDMC. The existing and proposed conditions 100-year flood plain limits along with that from the effective HEC RAS models, as shown in Appendix E.

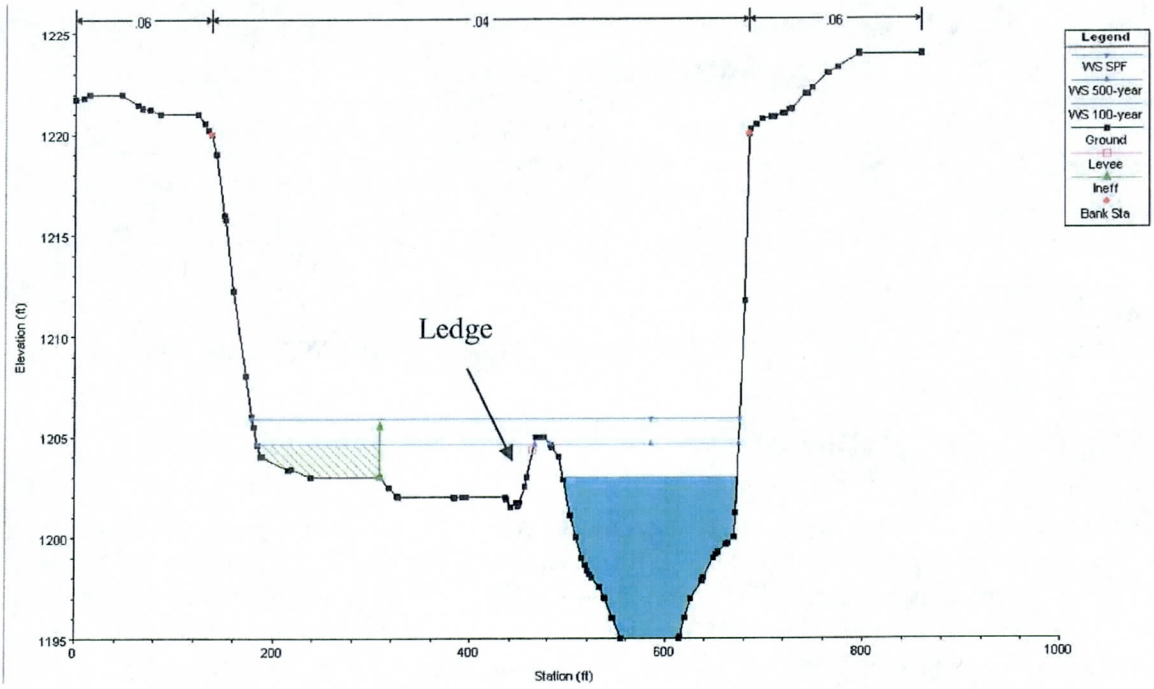


Figure 2. Cross section number 1673.92 showing the ledge that was removed

Prestige

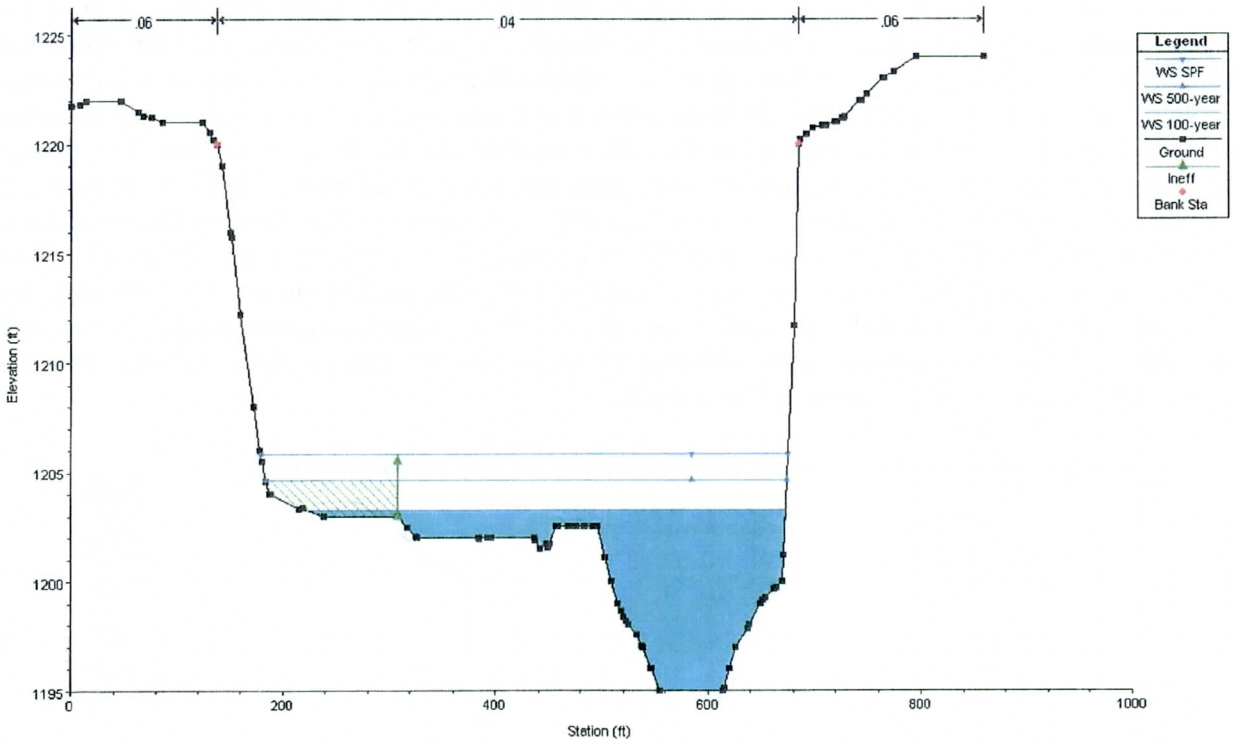


Figure 3. Condition at cross section number 1673.92 after removal of the ledge

6.2.2 BOX CULVERT HYDRAULICS

The proposed El Mirage Road alignment crosses the McMicken Dam Outlet Wash at a location where the wash is approximately 550 feet wide. The proposed seven (7) barrel box culverts 10' (wide) X 8' (height) were modeled using HEC-RAS box culvert editor. The standard Arizona Department of Transportation (ADOT) criteria were utilized for box wall thickness and other dimensions. The box culvert spans the existing low flow channel which is approximately 70' to 80' wide. For the new box crossing, revised hydraulic analysis using the new topography was conducted for both the existing condition and the proposed condition. A comparison was made between the corrected effective and the proposed condition model water surface elevations at 1988 datum.

Tables 5 and Table 6 below shows the 100-year and SPF flow water surface elevation comparison with existing and proposed condition with the box culvert. Figure 4 shows the water surface elevations at the proposed box location. The proposed box culvert does increase the existing floodplain. However, the rise in water surface still contained within the existing channel banks. The existing tops of channel banks at the box culvert area and upstream are at elevations 1220'. The 100-yr water surface elevation just upstream of the box culvert is at 1204.42'. The rise in the water surface elevation will be contained within the channel and within available MCFCD easements.

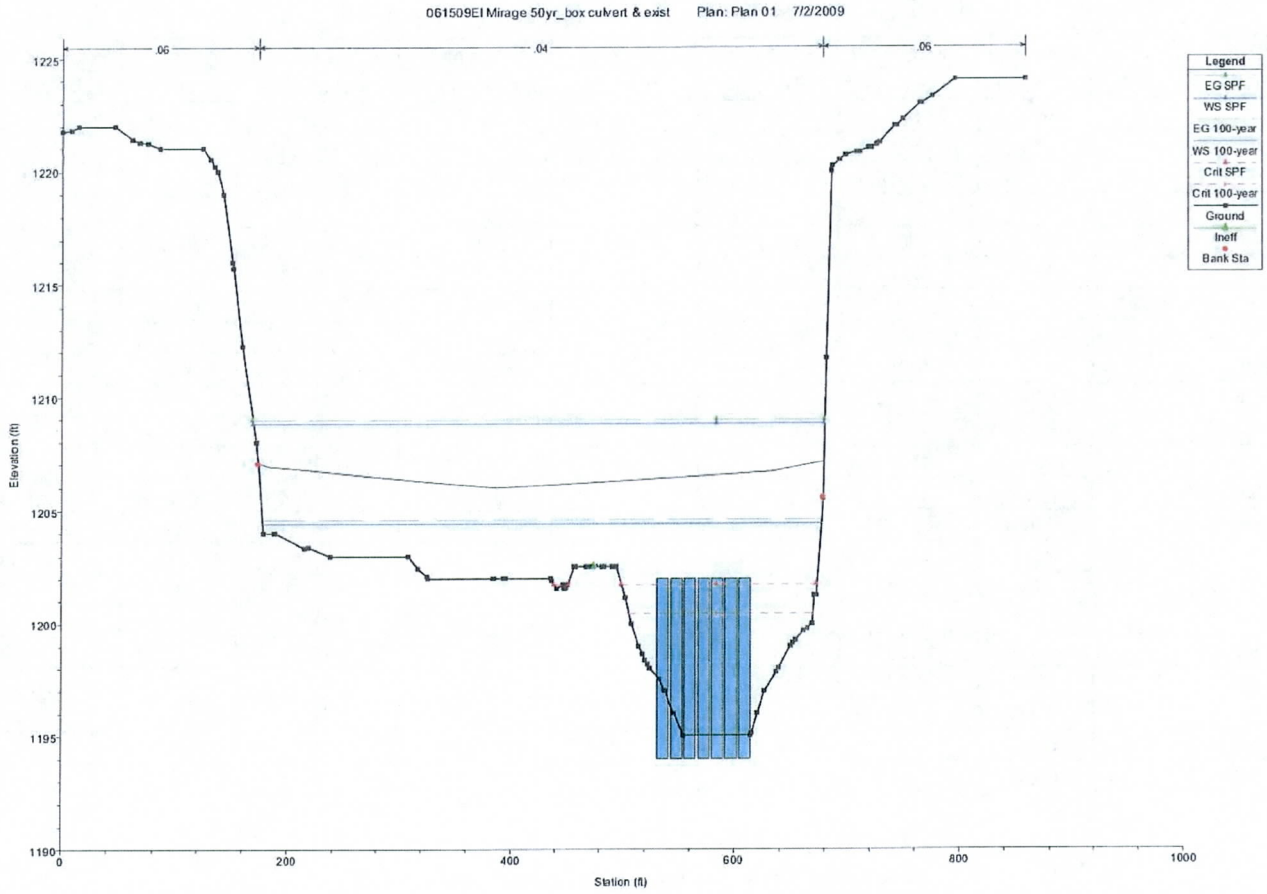


Figure 4. Water surface elevations (100-yr and SPF) at the proposed box crossing

Prestige

Table 5: 100-year water surface elevation comparison

River Sta (Prestige)	River Sta (FIS)	Discharge Q (cfs)	Min Channel Elevation (ft) (Prestige) (1988 Datum)	Min Channel Elevation (ft) (FIS) (1988 Datum)	Corrected FIS WSEL (ft) (FIS) (1988 Datum)	Existing Condition WSEL (ft) (Prestige) (1988 Datum)	Proposed Condition WSEL (ft) (Prestige) (1988 Datum)	Proposed - Existing (ft)	Proposed - Corrected (ft)
2456.91	0.746	6500	1201	1200.54	1206.85	1206.34	1206.43	0.09	-0.42
2336.64		6500	1200			1205.68	1205.85	0.17	
2256.62		6500	1200			1205.25	1205.5	0.25	
2163.94		6500	1198.42			1204.78	1205.15	0.37	
2093.51		6500	1198			1204.56	1204.99	0.43	
2009.88		6500	1196.37			1204.28	1204.88	0.6	
1941.2		6500	1196			1204.12	1204.77	0.65	
1896.01	0.647	6500	1196	1198.04	1204.53	1204.03	1204.73	0.7	0.2
1838.84		6500	1196			1203.86	1204.67	0.81	
1768.96		6500	1195.05			1203.46	1204.52	1.06	
1673.92		6500	1195			1203.09	1204.42	1.33	
1505.35	0.579	6500	1194	1194.54	1202.53	1201.56	1201.58	0.02	-0.95
1427.3		6500	1193.57			1200.7	1200.7	0	
1363.17		6500	1193			1199.81	1199.81	0	
1272.12	0.527	6500	1192	1195.04	1200.18	1199.14	1199.14	0	-1.04
1149.49		6500	1191			1197.76	1197.76	0	
1079.73		6500	1191			1196.99	1196.99	0	
1000		6500	1190			1196.91	1196.91	0	

Table 6: SPF water surface elevation comparison

2456.91	0.746	14000	1201	1200.54	1209.09	1209.57	1209.73	0.16	0.64
2336.64		14000	1200			1208.79	1209.34	0.55	
2256.62		14000	1200			1208.29	1209.13	0.84	
2163.94		14000	1198.42			1207.88	1209.04	1.16	
2093.51		14000	1198			1207.51	1208.94	1.43	
2009.88		14000	1196.37			1207.03	1208.93	1.9	
1941.2		14000	1196			1206.73	1208.9	2.17	
1896.01	0.647	14000	1196	1198.04	1206.33	1206.66	1208.9	2.24	2.57
1838.84		14000	1196			1206.51	1208.89	2.38	
1768.96		14000	1195.05			1205.5	1208.85	3.35	
1673.92		14000	1195			1205.01	1208.81	3.8	
1505.35	0.579	14000	1194	1194.54	1204.02	1203.38	1203.75	0.37	-0.27
1427.3		14000	1193.57			1202.6	1201.86	-0.74	
1363.17		14000	1193			1202.09	1201.56	-0.53	
1272.12	0.527	14000	1192	1195.04	1201.63	1201.46	1200.98	-0.48	-0.65
1149.49		14000	1191			1199.38	1198.95	-0.43	
1079.73		14000	1191			1198.9	1198.48	-0.42	
1000		14000	1190			1199.05	1198.58	-0.47	

The FIS model vertical datum was converted from 1929 to 1988 by adding 2.04 feet to effective FIS model cross section elevations. Only the FIS model river stations 0.746 and 0.647 could be closely match with the new model because the FIS model cross sections were far apart, and were not necessarily aligned perpendicular to the flow path. See Appendix E for existing and proposed HEC-RAS models.

Effect to McMicken Dam Outlet Wash:

- 50-yr Event: The proposed box culverts are designed to convey 50-yr design flow, which is 5085 cfs. The entire flow passes under the boxes and no overtopping occurs. The velocity is 9.44 ft/sec and the depth is at 9.32 feet at the outlet of the box.

- 100-yr Event: For the 100-yr event flow is 6,500 cfs, and overtopping does not occur during this event. The water surface elevation is at 1204.42 and the roadway low point elevation is at 1205.97. The velocity is 11.61 ft/sec and the depth is 10.92 feet at the outlet of the box.

- SPF Event: Since the box culverts are designed for up to 50-yr event and the SPF event flow is 14,000 cfs, overtopping occurs during this event. The water surface elevation is at 1208.81 and the roadway low point is at 1205.97. The overtopping of 2.86 feet is anticipated during SPF event. The culvert outlet velocity is 15.25 ft/sec and the depth is at15.31 feet at the outlet. The culvert flow is 8538 cfs and the weir flow is 5462 cfs.

The exhibit showing before and after 100-yr and SPF flow condition (floodplain widths) is shown on Appendix E.

6.2.3. SCOUR ANALYSES

6.2.3.1 Local Scour at the outlet of box culverts

The scour analyses at the proposed box culvert location consist of outlet scour downstream of culvert, general, bend, bed form, long term, and low flow incisement scour components at the upstream of culvert. Scour estimation was conducted for the 100-yr flow of 6,500cfs and SPF discharge of 14,000 cfs. The procedures described in the U.S. Bureau of Reclamation's (USBOR) technical guideline for computing degradation and local scour, procedure outlined in FCDMC's Hydraulics Manual as well as the Hydraulic Design of Energy Dissipators for Culverts and Channels (HEC 14), 3rd Edition were utilized for the scour design. See the scour calculations included in Appendix F.

Table 7 & Table 8 summarizes the individual scour components for 100-yr storm event and SPF storm event, and the total scour depths upstream and downstream.

Table 7: Scour depths at the outlet of the box culvert

Design Flow	Design Velocity	Depth of Scour	Width of Scout	Length of Apron
6,500 cfs	11.61 ft/sec	6.09 ft	80 ft	89.0 ft
14,000 cfs	15.25 ft/sec	7.09 ft	80 ft	91.0 ft

6.2.3.2 General Scour

The single-event general scour component was estimated for the SPF discharge using the regime equations by Neill, Lacey, and Blench (the USBOR Type-A equations). For the left side of the channel at the bend, or at the inside bend where deposition was expected due to low velocity flow, the maximum scour depth value out of Neill's equations was used. The SPF flows were used for design and bankfull conditions, respectively. The main channel was considered to be the incised channel under 100-year flow conditions. A mean grain size of 0.75 mm was estimated from the geotechnical report by Western Technologies.

Neill's Regime Equation

$$Y_f = Y_i (q_f/q_i)^m$$

$$Y_s = ZY_f$$

where:

Y_s = depth of scour below stream bed, ft
Y_f = scoured depth below the design floodwater level, ft
Y_i = average depth at bankfull discharge in incised reach, ft
q_f = design flood discharge per unit width, $ft^3/s/ft$
q_i = bankfull discharge in incised reach per unit width, $ft^3/s/ft$
m = exponent, 0.67 for sand
Z = 0.7 for severe bend condition

According to FCDMC staff suggestion, Neill's method was used for general scour because it took into account confinement in channel such as box culverts or bridges. The USBOR equations were used with severe bend conditions for south bridge. Neill's Method was used in the total general scour and toe down depth calculations at the upstream of box culvert.

6.2.3.3 Bend Scour

Bend scour was not calculated separately. Instead of that bend scour was included when calculating general scour using Neil's equation where Z = 0.7 for severe bend condition. According to our meeting with FCMC staff, the approach using Neil's equation for general scour with Z = 0.7 accounted for bend scour.

6.2.3.5 Bed Form Scour

The antidune scour equation of Kennedy referred by Simons, Li & Associates was used to estimate the bed form scour. Bed forms such as antidune form in transitional or upper regime flows, and can deform a channel bed and potentially undermine the box culvert structure and significantly change the hydraulic characteristics of the channel in terms of hydraulic roughness and sediment transport capacity. The antidune bed form scour, a direct function of channel velocity, was estimated to be 0.7 feet for SPF flow and 0.4 feet for 100-yr flow, and was added to the general scour depth at the inlet of the box culvert. Only half of the antidune bed form scour was added to the total scour depth. Kennedy's antidune scour equation is:

$$Y_{bf} = 0.027\ V^2$$

where:

Y_{bf} = bed form scour depth below original bed, ft
V = mean channel velocity, ft/s

6.2.3.5 Low Flow Incisement Scour

Typically the low flow incisement scour depth estimate is determined from field visits. The field investigation approach consists of observing or measuring the actual scour depths during a bankfull discharge in the incised channel. A field visit conducted by Prestige Engineering personnel on September 18, 2006 was inconclusive due to dry channel condition, and presence of medium to large size boulders on the main channel bed over the underlying sand bed materials. If the field visit is inconclusive, the FCDMC suggests a value of 1.5 feet of scour depth for low flow incisement. Therefore, a 1.5 feet low flow incisement scour depth was added on the final pier and toe-scour estimate.

Table 8: Scour summary (Q = 14,000cfs, SPF)

Scour Component	Total Scour (ft)	Remarks
Downstream:		
Long Term Scour	4.0	Using State Standard Eq
BOR General Scour	2.0	Neill's General Scour Eq
Bedform Scour	0.6	Kennedy Equation
Low Flow Incisement	1.5	Engineering Judgment
Sum of above components	8.1	Total Scour
Factor of Safety	2.43	30% of Total Scour Depth
Toe Down Depth D/S	10.53	Total Toe Down Depth
Recommended Depth:	**10.5**	**Design Plans**

Scour Component	Total Scour (ft)	Remarks
Upstream:		
BOR General Scour	3.5	Neill's General
Bedform Scour	0.3	Kennedy Equation
Low flow incisement	1.5	Engineering Judgment
Sum of above components	5.30	Total of above components
Factor of Safety	1.6	30% of Total Scour Depth
Toe Down Depth U/S	6.90	Toe depth upstream
Recommended Depth	**7.0**	Design Plans

The recommended scour depth at the upstream end of the box inlet apron is 7.00 feet and downstream is outlet apron is 10.50 feet. See Appendix F for all scour calculations.

6.2.3.6 Launchable Riprap Apron

To minimize the excavation upstream and downstream of the riprap aprons, a launchable riprap apron methodology was utilized.

- Upstream Launchable Apron: The volume of required riprap was calculated based on toe down depths proposed (7.0'). The launchable riprap apron will be provided 4' below existing ground. The volume required was increased by 50% to add a factor of safety. The apron length was calculated based on two times the thickness of riprap apron. 3

- Downstream Launchable Apron: The volume of the required riprap was calculated based on toe down depths proposed (10.5'). The launchable riprap apron will be provided 1' below existing ground. The volume required was increased by 50% to add a factor of safety. The apron length was calculated based on two times the thickness of riprap apron.

See Appendix F for calculations.

7. ONSITE DRAINAGE

The onsite hydrology analysis follows criteria described in the Drainage Design Manual for Maricopa County, Volume I – Hydrology. The hydraulic design of the onsite drainage facilities conforms to Volume II – Hydraulics of the Drainage Design Manual. Roadway Design Manual adopted by Maricopa County Department of Transportation is also followed.

Maricopa County's Rational Method was used to estimate the peak runoffs from the roadways. A minimum 10 minute time of concentration (Tc) was applied to all watershed areas, since the longest estimated flow path was calculated at a Tc of about 9 minutes. The point precipitation value from the isopluvial map for the 10-year, 6-hour rainfall event is 2 inches, shown in Figure 2.4 of the MCFCD Drainage Design Manual Vol. I: Hydrology. The runoff coefficient 'C' of 0.90, for asphalt pavement, was applied to the design calculations, accounting for future build-out conditions (six (6) paved lanes).

The rural roadway section does not include any curb and gutter. So, the roadway drainage will be allowed to drain off the pavement and collected along the roadside ditch designed to capture offsite as well as the onsite drainage. The onsite drainage is calculated for 100-yr storm event. No continuous storm drain system is required for the project. Once the roadway is designed as an urban arterial street with curb and gutter, the storm drain system will be required.

The design of catch basins within the median will conform to procedures described in the Flood Control District of Maricopa County Vol. II, Hydraulics Manual and FHWA's HEC-12 and 22 publications, "Drainage of Highway Pavements" and "Urban Drainage Design Manual," respectively. The effective opening is 80% for the curb opening catch basins and 50% for the grate catch basins, to account for clogging potential. The street pavement catch basins and the median catch basins conform to ADOT's standard drawings. Other references to details for roadway design and some drainage features are made to the Maricopa Association of Governments (MAG)'s standard details, in the construction documents.

The typical section of the roadway for the hydrology calculations includes three (3) 12'-lanes plus 5.5' bike lane on each direction plus 38' depressed, paved median. The roadway has a cross slope ranging from 2% to3.8%, in each direction, that rotates about the inside edge of median, as shown on the plans. The median will be sloping 20:1 for first 10' and 6:1 for remaining 9'. Appendix C shows the hydrology and hydraulic calculations, output from Flow Master ™ for the depressed medians and catch basins. The median catch basins are located upstream of median breaks to collect concentrated runoff flows. The median catch basins function as inlets in sump condition. ADOT Standard Median Catch Basin C-15.80 will be provided within the median to drain the median runoff.

8. FLOODPLAIN

The McMicken Dam Outlet Wash is currently designated as Zone "AE", which is defined as the detailed study with base flood elevation determined. According to FCDMC, any impact to the floodplain will have to be submitted to FEMA and MCFCD prior to construction. A Conditional Letter of Map Revision (CLOMR) will be prepared and submitted to MCFCD and FEMA. There is a back water impact to floodplain. However the backwater flows will still be contained within the existing wash with more than 12' of freeboard available. See attached FEMA firm map in Appendix E.

9. MAINTENANCE

Part of the watershed is undeveloped and could potentially convey a large amount of sediment. The roadside ditches will require regular cleaning to maintain the proper design grades. The gravel berms will need to be inspected minimum every six (6) months or after every rainfall events. The debris will be cleaned from the trashracks provided upstream of every culvert crossing. The box culvert shall be inspected every 6 (six) months or after every event for large accumulation of debris inside the box. The debris will required to be cleaned and removed prior to the next rainfall event.

10. REFERENCES

1. Culvert Master, Version 3.1, Bentley Systems Inc., 2006.

2. "Design Manual for Engineering Analysis of Fluvial Systems," Prepared for ADOT by Simons, Li & Associates, Inc., 1985.

3. "Drainage Design Manual for Maricopa County," Arizona, Vol. 1 Hydrology and Vol. 2 Hydraulics, Flood Control District of Maricopa County, Phoenix, AZ.

4. "Drainage of Highway Pavements," Hydraulic Engineering Circular No. 12 (HEC-12), Federal Highway Administration, March 1984.

5. El Mirage Road, Bell Road to Beardsley Road, Final Candidate Assessment Report, Parsons and Brinckerhoff, January 1999.

6. FlowMaster, Bentley Systems, Inc., 2005.

7. Geotechnical Engineering Report, El Mirage Road Bridges Over McMicken Dam Outlet Wash, Maricopa County, by Ricker-Atkinson-McBee & Associates, Inc., Tempe, Arizona.

8. "MCDOT Roadway Design Manual," Maricopa County Department of Transportation, Adopted November 3, 1993.

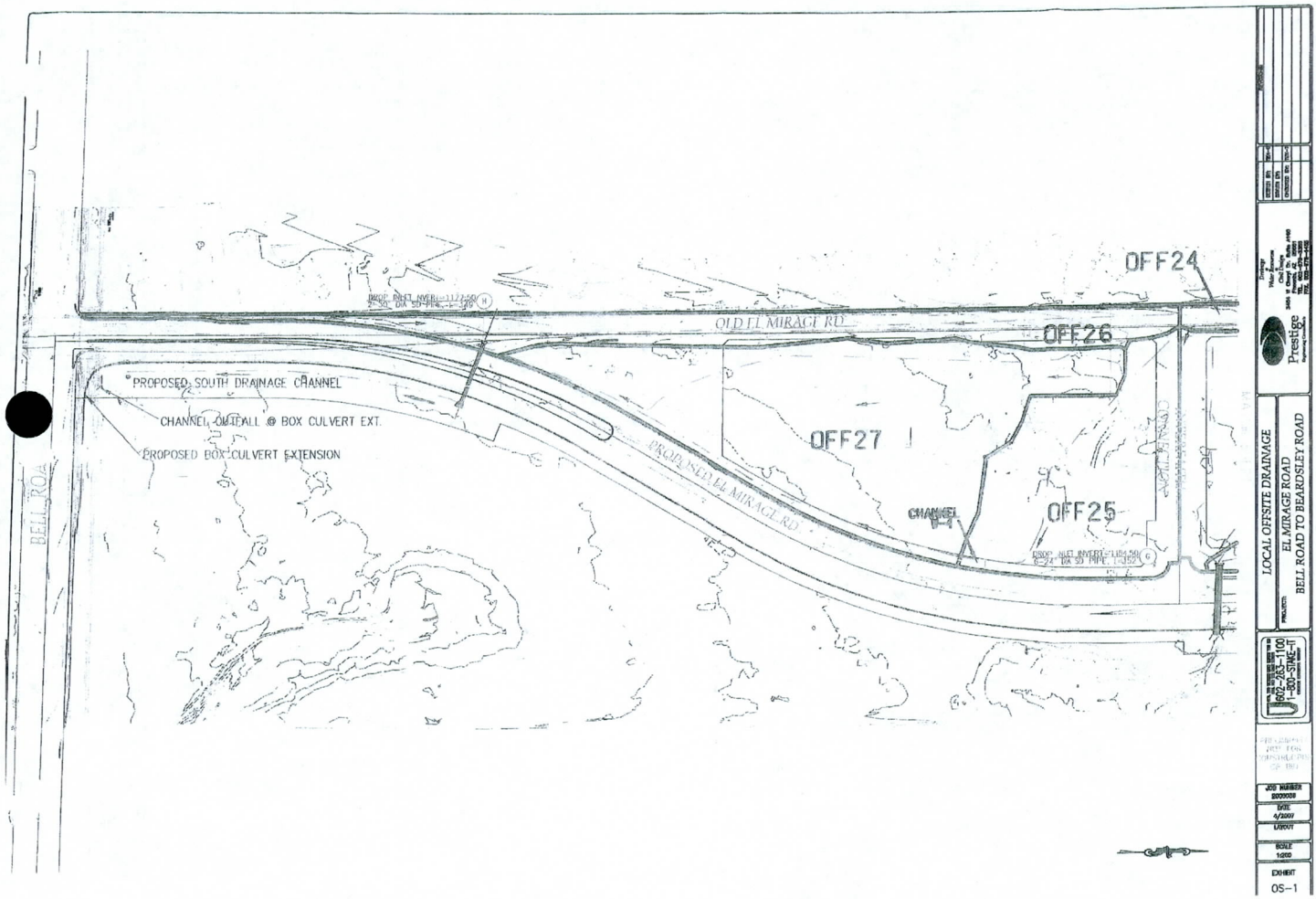
9. RATIONAL software, Flood Control District of Maricopa County, Phoenix, AZ.

10. "Uniform Standard Details for Public Works Construction," Maricopa Association of Governments, Arizona, 1998.

11. Geotechnical Evaluation, El Mirage Road South Bridge, Contract No. 2006-044, March 14, 2007

APPENDIX A

OFFSITE DRAINAGE EXHIBITS

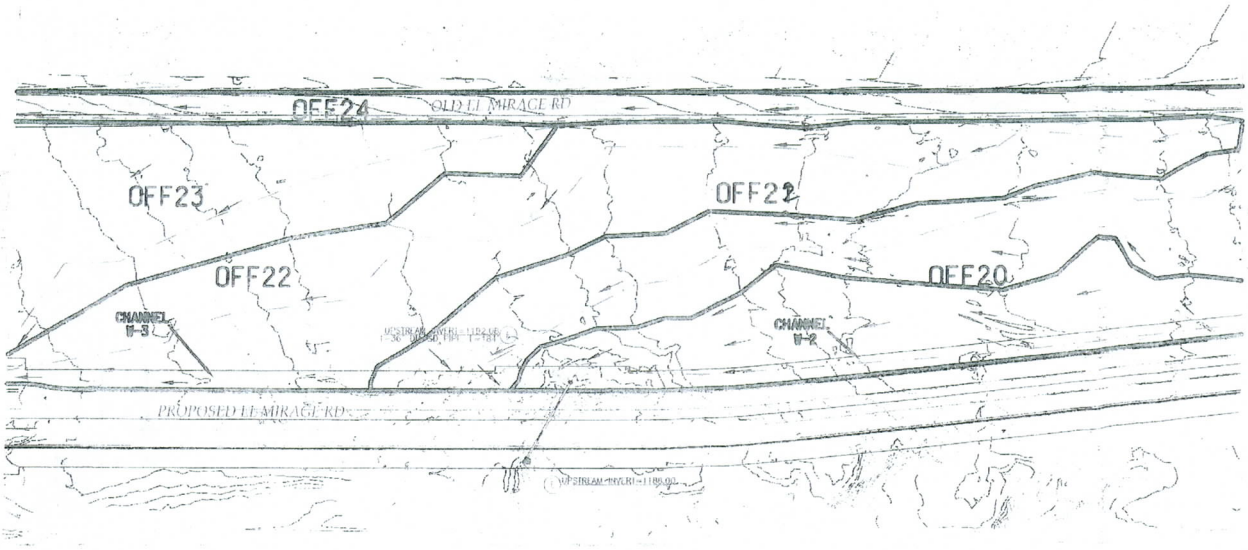


LOCAL OFFSITE DRAINAGE
EL MIRAGE ROAD
BELL ROAD TO BEARDSLEY ROAD

Prestige

602-263-1100
1-800-STAKE-IT

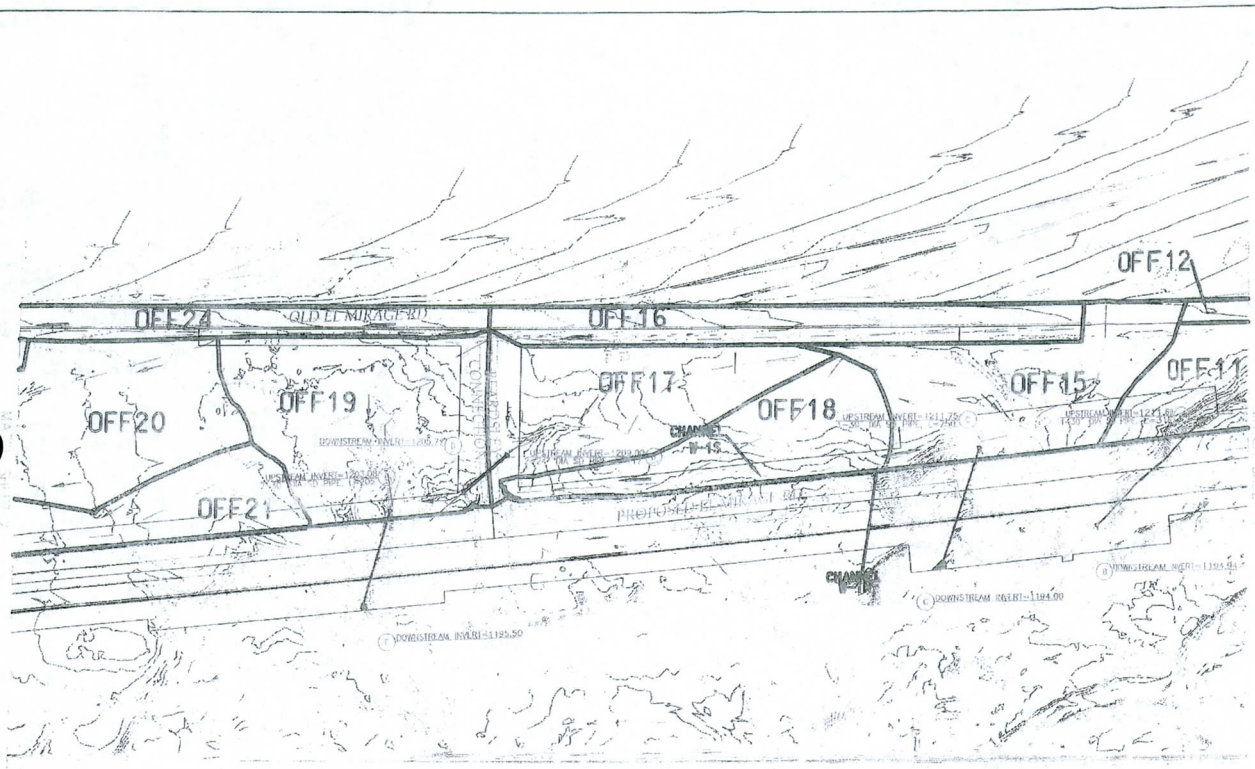
JOB NUMBER
8000008
DATE
4/2007
LAYOUT
SCALE
1:200
EXHIBIT
OS-1



LOCAL OFFSITE DRAINAGE
EL MIRAGE ROAD
BELL ROAD TO BEARDSLEY ROAD

Prestige

JOB NUMBER
2020036
DATE
4/2021
LAYOUT
SCALE
1:250
EXHIBIT
OS-2



Prestige

LOCAL OFFSITE DRAINAGE

PROJECT: EL MIRAGE ROAD
BELL ROAD TO BEARDSLEY ROAD

602-263-1100
1-800-STAKE-IT

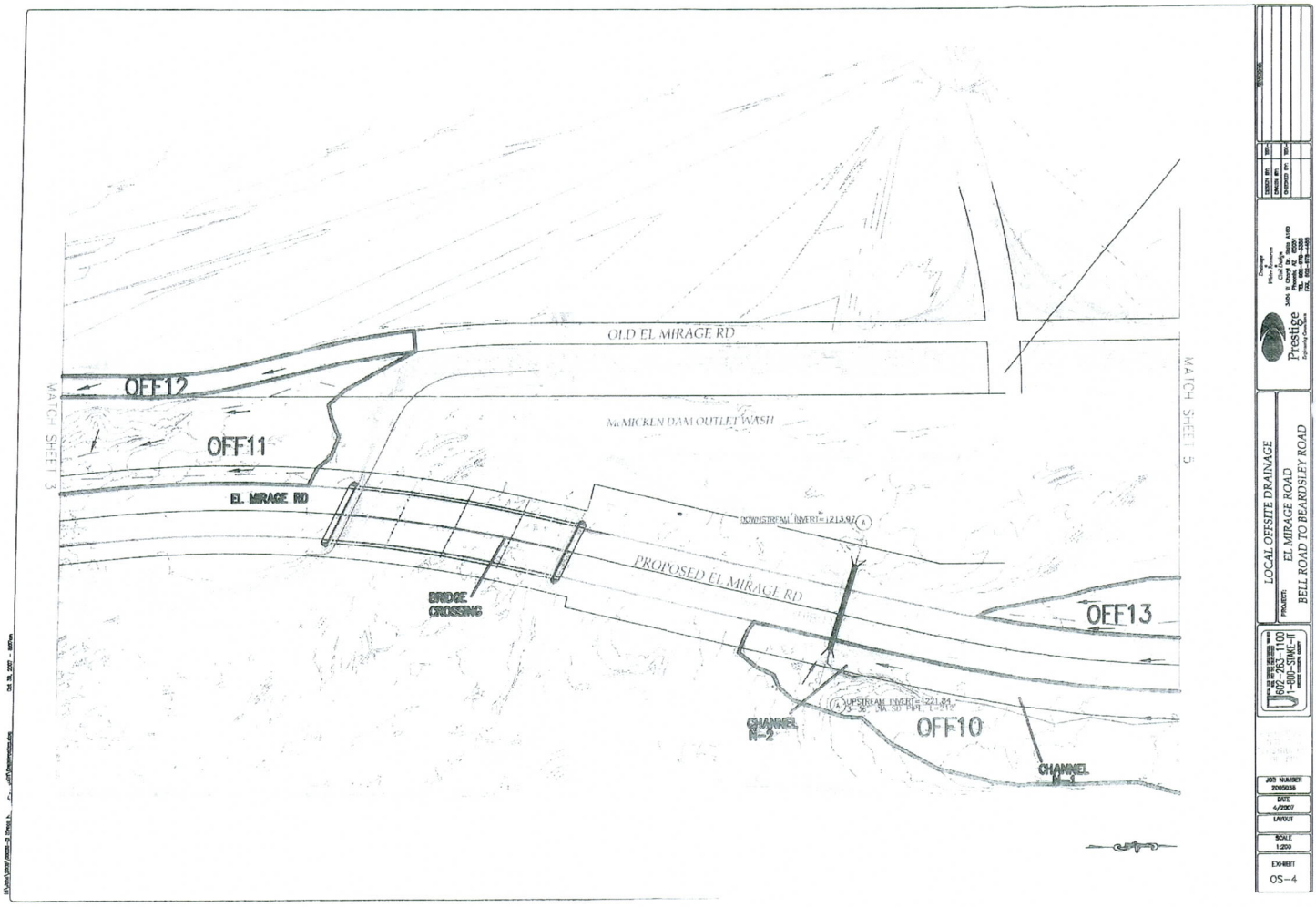
JOB NUMBER 2000039

DATE 4-2007

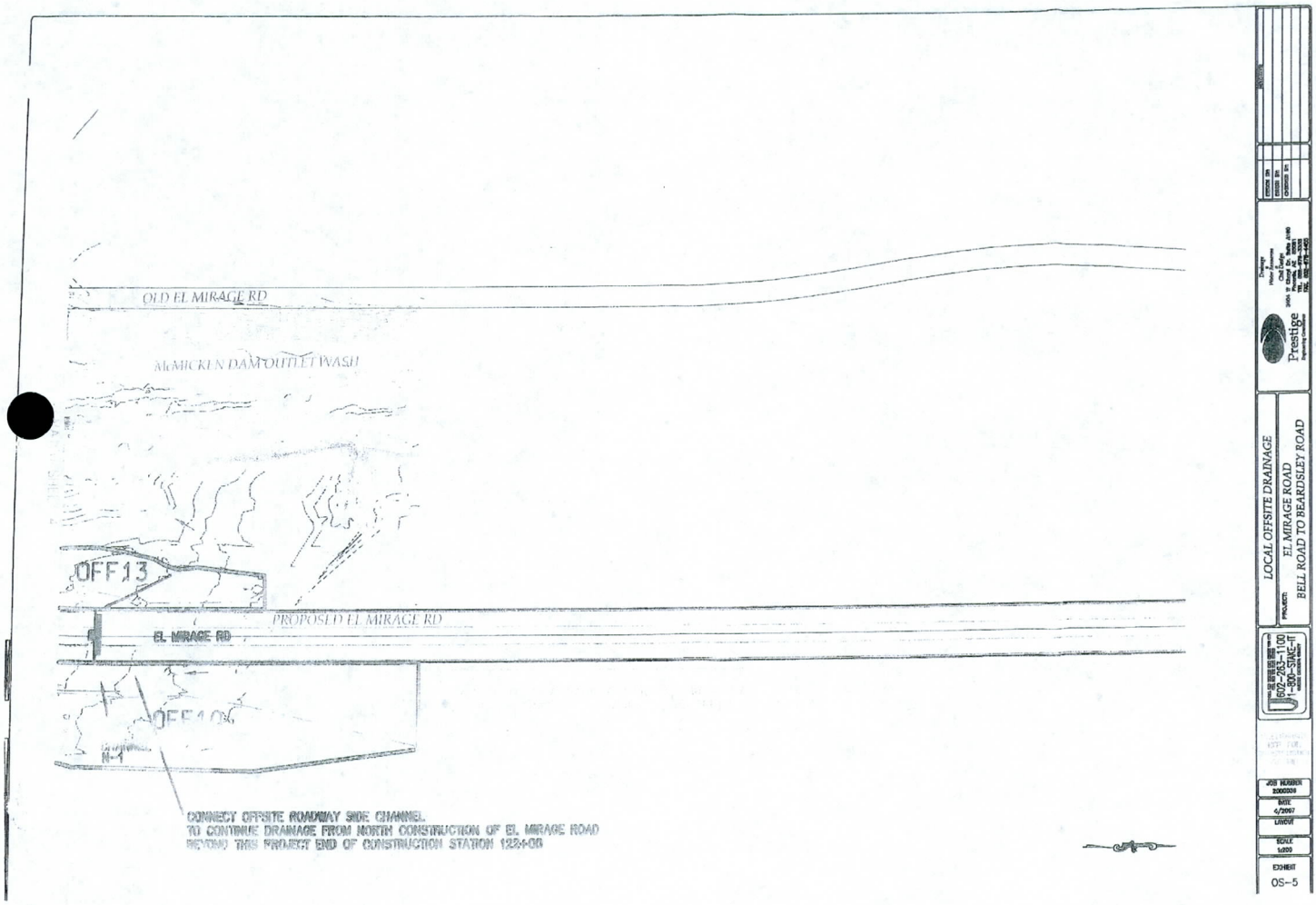
LAYOUT

SCALE 1:200

EXHIBIT OS-3



OLD EL MIRAGE RD
McMICKEN DAM OUTLET WASH
OFF12
OFF11
EL MIRAGE RD
MATCH SHEET 3
MATCH SHEET 5
DOWNSTREAM INVERT=1213.97
PROPOSED EL MIRAGE RD
BRIDGE CROSSING
OFF13
UPSTREAM INVERT=1221.84
CHANNEL N-2
OFF10
CHANNEL N-1
Prestige
LOCAL OFFSITE DRAINAGE
PROJECT:
EL MIRAGE ROAD
BELL ROAD TO BEARDSLEY ROAD
602-263-1100
1-800-STAKE-IT
JOB NUMBER
2005036
DATE
4/2007
SCALE
1:200
EXHIBIT
OS-4



LOCAL OFFSITE DRAINAGE

EL MIRAGE ROAD

BELL ROAD TO BEARDSLEY ROAD

Prestige

602-263-1100
1-800-STAKE-IT

JOB NUMBER
2000209

DATE
6/2007

LAYOUT

SCALE
1:200

EXHIBIT
OS-5

APPENDIX B

OFFSITE RUNOFF CALCULATIONS

RATIONAL FOR WINDOWS

Flood Control District of Maricopa County Rational Method

Project Information

Project Name: EL MIRAGE DRAINAGE

Project Description: OFFSITE RUNOFF CALCULATION

Drainage Point: OFF10

Location: EL MIRAGE

Drainage Basin Data

Water Course Length: 1735.00 ft

Basin Area: 9.150 acres

High Elevation: 1244.00 ft

Low Elevation: 1221.00 ft

Average Slope: 0.0133 ft/ft

Roughness, Kb: 0.0668 (B)

10-Year Runoff Coefficient: 0.400

10-Year 6 Hour Rainfall Depth: 2.07 inches

Hydrological Summary Table

Parameter	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
Q (cfs)	8	11	13	19	24	29
C	0.400	0.400	0.400	0.440	0.480	0.500
Tc (min)	19.3	16.9	15.7	14.3	13.5	12.8
i (in/hr)	2.1	3.0	3.6	4.7	5.4	6.3

RATIONAL FOR WINDOWS

Flood Control District of Maricopa County Rational Method

Project Information

Project Name: EL MIRAGE DRAINAGE

Project Description: OFFSITE RUNOFF CALCULATION

Drainage Point: OFF12

Location: EL MIRAGE

Drainage Basin Data

Water Course Length: 902.00 ft

Basin Area: 1.460 acres

High Elevation: 1244.00 ft

Low Elevation: 1238.00 ft

Average Slope: 0.0067 ft/ft

Roughness, Kb: 0.0777 (B)

10-Year Runoff Coefficient: 0.400

10-Year 6 Hour Rainfall Depth: 2.07 inches

Hydrological Summary Table

Parameter	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
Q (cfs)	1	2	2	3	4	5
C	0.400	0.400	0.400	0.440	0.480	0.500
Tc (min)	18.5	16.2	15.1	13.7	13.0	12.2
i (in/hr)	2.2	3.1	3.7	4.8	5.5	6.4

RATIONAL FOR WINDOWS

Flood Control District of Maricopa County Rational Method

Project Information

Project Name: EL MIRAGE DRAINAGE

Project Description: OFFSITE RUNOFF CALCULATION

Drainage Point: OFF13

Location: EL MIRAGE

Drainage Basin Data

Water Course Length: 774.00 ft

Basin Area: 3.610 acres

High Elevation: 1226.00 ft

Low Elevation: 1212.00 ft

Average Slope: 0.0181 ft/ft

Roughness, Kb: 0.0723 (B)

10-Year Runoff Coefficient: 0.400

10-Year 6 Hour Rainfall Depth: 2.07 inches

Hydrological Summary Table

Parameter	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
Q (cfs)	4	6	7	9	12	14
C	0.400	0.400	0.400	0.440	0.480	0.500
Tc (min)	11.0	9.7	9.0	8.3	7.8	7.4
i (in/hr)	2.8	3.9	4.7	5.9	6.8	7.9

RATIONAL FOR WINDOWS

Flood Control District of Maricopa County Rational Method

Project Information

Project Name: EL MIRAGE DRAINAGE

Project Description: OFFSITE RUNOFF CALCULATION

Drainage Point: OFF14

Location: EL MIRAGE

Drainage Basin Data

Water Course Length: 659.00 ft

Basin Area: 0.790 acres

High Elevation: 1224.00 ft

Low Elevation: 1212.00 ft

Average Slope: 0.0182 ft/ft

Roughness, Kb: 0.1526 (C)

10-Year Runoff Coefficient: 0.400

10-Year 6 Hour Rainfall Depth: 2.07 inches

Hydrological Summary Table

Parameter	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
Q (cfs)	1	1	1	2	2	3
C	0.400	0.400	0.400	0.440	0.480	0.500
Tc (min)	16.0	14.0	13.1	11.9	11.2	10.6
i (in/hr)	2.3	3.3	4.0	5.1	5.9	6.8

RATIONAL FOR WINDOWS

Flood Control District of Maricopa County Rational Method

Project Information

Project Name: EL MIRAGE DRAINAGE

Project Description: OFFSITE RUNOFF CALCULATION

Drainage Point: OFF15

Location: EL MIRAGE

Drainage Basin Data

Water Course Length: 226.00 ft

Basin Area: 1.160 acres

High Elevation: 1225.00 ft

Low Elevation: 1212.00 ft

Average Slope: 0.0575 ft/ft

Roughness, Kb: 0.0791 (B)

10-Year Runoff Coefficient: 0.400

10-Year 6 Hour Rainfall Depth: 2.07 inches

Hydrological Summary Table

Parameter	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
Q (cfs)	2	2	3	4	4	5
C	0.400	0.400	0.400	0.440	0.480	0.500
Tc (min)	5.0	5.0	5.0	5.0	5.0	5.0
i (in/hr)	3.8	5.0	5.9	7.0	8.0	9.0

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URL: http://www.engsoftwarecenter.com/rational.html

RATIONAL FOR WINDOWS

Flood Control District of Maricopa County Rational Method

Project Information

Project Name: EL MIRAGE DRAINAGE

Project Description: OFFSITE RUNOFF CALCULATION

Drainage Point: OFF16

Location: EL MIRAGE

Drainage Basin Data

Water Course Length: 147.00 ft

Basin Area: 0.490 acres

High Elevation: 1222.00 ft

Low Elevation: 1212.00 ft

Average Slope: 0.0680 ft/ft

Roughness, Kb: 0.0419 (A)

10-Year Runoff Coefficient: 0.400

10-Year 6 Hour Rainfall Depth: 2.07 inches

Hydrological Summary Table

Parameter	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
Q (cfs)	1	1	1	2	2	2
C	0.400	0.400	0.400	0.440	0.480	0.500
Tc (min)	5.0	5.0	5.0	5.0	5.0	5.0
i (in/hr)	3.8	5.0	5.9	7.0	8.0	9.0

Author: Frank M. Koo, P.E.
Email: gufrank@engsoftwarecenter.com
URL: http://www.engsoftwarecenter.com/rational.html

RATIONAL FOR WINDOWS

Flood Control District of Maricopa County Rational Method

Project Information

Project Name: EL MIRAGE DRAINAGE

Project Description: OFFSITE RUNOFF CALCULATION

Drainage Point: OFF17

Location: EL MIRAGE

Drainage Basin Data

Water Course Length: 5.39 ft

Basin Area: 5.320 acres

High Elevation: 1224.00 ft

Low Elevation: 1208.00 ft

Average Slope: 2.9685 ft/ft

Roughness, Kb: 0.0700 (B)

10-Year Runoff Coefficient: 0.400

10-Year 6 Hour Rainfall Depth: 2.07 inches

Hydrological Summary Table

Parameter	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
Q (cfs)	8	11	13	16	20	24
C	0.400	0.400	0.400	0.440	0.480	0.500
Tc (min)	5.0	5.0	5.0	5.0	5.0	5.0
i (in/hr)	3.8	5.0	5.9	7.0	8.0	9.0

RATIONAL FOR WINDOWS

Flood Control District of Maricopa County Rational Method

Project Information

Project Name: EL MIRAGE DRAINAGE

Project Description: OFFSITE RUNOFF CALCULATION

Drainage Point: OFF18

Location: EL MIRAGE (HOLD)

Drainage Basin Data

Water Course Length: 5.39 ft

Basin Area: 5.320 acres

High Elevation: 1224.00 ft

Low Elevation: 1208.00 ft

Average Slope: 2.9685 ft/ft

Roughness, Kb: 0.0700 (B)

10-Year Runoff Coefficient: 0.400

10-Year 6 Hour Rainfall Depth: 2.07 inches

Hydrological Summary Table

Parameter	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
Q (cfs)	8	11	13	16	20	24
C	0.400	0.400	0.400	0.440	0.480	0.500
Tc (min)	5.0	5.0	5.0	5.0	5.0	5.0
i (in/hr)	3.8	5.0	5.9	7.0	8.0	9.0

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RATIONAL FOR WINDOWS

Flood Control District of Maricopa County Rational Method

Project Information

Project Name: EL MIRAGE DRAINAGE

Project Description: OFFSITE RUNOFF CALCULATION

Drainage Point: OFF19

Location: EL MIRAGE

Drainage Basin Data

Water Course Length: 803.00 ft

Basin Area: 4.010 acres

High Elevation: 1220.00 ft

Low Elevation: 1210.00 ft

Average Slope: 0.0125 ft/ft

Roughness, Kb: 0.0717 (B)

10-Year Runoff Coefficient: 0.400

10-Year 6 Hour Rainfall Depth: 2.07 inches

Hydrological Summary Table

Parameter	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
Q (cfs)	4	6	7	10	12	15
C	0.400	0.400	0.400	0.440	0.480	0.500
Tc (min)	12.9	11.3	10.6	9.6	9.1	8.6
i (in/hr)	2.6	3.6	4.4	5.6	6.4	7.4

RATIONAL FOR WINDOWS

Flood Control District of Maricopa County Rational Method

Project Information

Project Name: EL MIRAGE DRAINAGE

Project Description: OFFSITE RUNOFF CALCULATION

Drainage Point: OFF20

Location: EL MIRAGE

Drainage Basin Data

Water Course Length: 782.00 ft

Basin Area: 2.490 acres

High Elevation: 1221.00 ft

Low Elevation: 1210.00 ft

Average Slope: 0.0141 ft/ft

Roughness, Kb: 0.0746 (B)

10-Year Runoff Coefficient: 0.400

10-Year 6 Hour Rainfall Depth: 2.07 inches

Hydrological Summary Table

Parameter	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
Q (cfs)	3	4	4	6	8	9
C	0.400	0.400	0.400	0.440	0.480	0.500
Tc (min)	12.4	10.9	10.2	9.3	8.8	8.3
i (in/hr)	2.7	3.7	4.4	5.7	6.5	7.5

RATIONAL FOR WINDOWS

Flood Control District of Maricopa County Rational Method

Project Information

Project Name: EL MIRAGE DRAINAGE

Project Description: OFFSITE RUNOFF CALCULATION

Drainage Point: OFF21

Location: EL MIRAGE

Drainage Basin Data

Water Course Length: 472.00 ft

Basin Area: 4.690 acres

High Elevation: 1216.00 ft

Low Elevation: 1203.00 ft

Average Slope: 0.0275 ft/ft

Roughness, Kb: 0.0708 (B)

10-Year Runoff Coefficient: 0.400

10-Year 6 Hour Rainfall Depth: 2.07 inches

Hydrological Summary Table

Parameter	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
Q (cfs)	6	9	11	14	18	21
C	0.400	0.400	0.400	0.440	0.480	0.500
Tc (min)	6.9	6.1	5.7	5.3	5.0	5.0
i (in/hr)	3.4	4.7	5.6	6.9	8.0	9.0

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RATIONAL FOR WINDOWS

Flood Control District of Maricopa County Rational Method

Project Information

Project Name: EL MIRAGE DRAINAGE

Project Description: OFFSITE RUNOFF CALCULATION

Drainage Point: OFF22

Location: EL MIRAGE

Drainage Basin Data

Water Course Length: 2160.00 ft

Basin Area: 14.560 acres

High Elevation: 1210.00 ft

Low Elevation: 1192.00 ft

Average Slope: 0.0083 ft/ft

Roughness, Kb: 0.0640 (B)

10-Year Runoff Coefficient: 0.400

10-Year 6 Hour Rainfall Depth: 2.07 inches

Hydrological Summary Table

Parameter	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
Q (cfs)	11	15	18	26	33	41
C	0.400	0.400	0.400	0.440	0.480	0.500
Tc (min)	25.7	22.6	21.0	19.1	17.9	16.9
i (in/hr)	1.8	2.6	3.1	4.0	4.8	5.6

RATIONAL FOR WINDOWS

Flood Control District of Maricopa County Rational Method

Project Information

Project Name: EL MIRAGE DRAINAGE

Project Description: OFFSITE RUNOFF CALCULATION

Drainage Point: OFF23

Location: EL MIRAGE

Drainage Basin Data

Water Course Length: 2166.00 ft

Basin Area: 4.770 acres

High Elevation: 1211.00 ft

Low Elevation: 1192.00 ft

Average Slope: 0.0088 ft/ft

Roughness, Kb: 0.0707 (B)

10-Year Runoff Coefficient: 0.400

10-Year 6 Hour Rainfall Depth: 2.07 inches

Hydrological Summary Table

Parameter	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
Q (cfs)	3	5	6	8	11	13
C	0.400	0.400	0.400	0.440	0.480	0.500
Tc (min)	27.0	23.7	22.0	20.0	18.7	17.7
i (in/hr)	1.8	2.5	3.1	3.9	4.7	5.5

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RATIONAL FOR WINDOWS

Flood Control District of Maricopa County Rational Method

Project Information

Project Name: EL MIRAGE DRAINAGE

Project Description: OFFSITE RUNOFF CALCULATION

Drainage Point: OFF24

Location: EL MIRAGE

Drainage Basin Data

Water Course Length: 2947.00 ft

Basin Area: 13.360 acres

High Elevation: 1207.00 ft

Low Elevation: 1187.00 ft

Average Slope: 0.0068 ft/ft

Roughness, Kb: 0.0645 (B)

10-Year Runoff Coefficient: 0.400

10-Year 6 Hour Rainfall Depth: 2.07 inches

Hydrological Summary Table

Parameter	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
Q (cfs)	8	12	14	21	27	33
C	0.400	0.400	0.400	0.440	0.480	0.500
Tc (min)	35.0	30.1	27.8	25.1	23.6	22.2
i (in/hr)	1.5	2.2	2.7	3.5	4.2	4.9

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RATIONAL FOR WINDOWS

Flood Control District of Maricopa County Rational Method

Project Information

Project Name: EL MIRAGE DRAINAGE

Project Description: OFFSITE RUNOFF CALCULATION

Drainage Point: OFF25

Location: EL MIRAGE

Drainage Basin Data

Water Course Length: 1406.00 ft

Basin Area: 14.100 acres

High Elevation: 1198.00 ft

Low Elevation: 1187.00 ft

Average Slope: 0.0078 ft/ft

Roughness, Kb: 0.0642 (B)

10-Year Runoff Coefficient: 0.400

10-Year 6 Hour Rainfall Depth: 2.07 inches

Hydrological Summary Table

Parameter	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
Q (cfs)	12	17	20	28	36	44
C	0.400	0.400	0.400	0.440	0.480	0.500
Tc (min)	20.2	17.8	16.5	15.0	14.1	13.3
i (in/hr)	2.1	2.9	3.6	4.6	5.3	6.2

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RATIONAL FOR WINDOWS

Flood Control District of Maricopa County Rational Method

Project Information

Project Name: EL MIRAGE DRAINAGE

Project Description: OFFSITE RUNOFF CALCULATION

Drainage Point: OFF26

Location: EL MIRAGE (Hold) ex side chnl

Drainage Basin Data

Water Course Length: 1406.00 ft

Basin Area: 1.000 acres

High Elevation: 1198.00 ft

Low Elevation: 1187.00 ft

Average Slope: 0.0078 ft/ft

Roughness, Kb: 0.0800 (B)

10-Year Runoff Coefficient: 0.400

10-Year 6 Hour Rainfall Depth: 2.07 inches

Hydrological Summary Table

Parameter	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
Q (cfs)	1	1	1	2	2	3
C	0.400	0.400	0.400	0.440	0.480	0.500
Tc (min)	23.4	20.5	19.0	17.3	16.2	15.3
i (in/hr)	1.9	2.7	3.3	4.2	5.0	5.8

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RATIONAL FOR WINDOWS

Flood Control District of Maricopa County Rational Method

Project Information

Project Name: EL MIRAGE DRAINAGE

Project Description: OFFSITE RUNOFF CALCULATION

Drainage Point: OFF27

Location: EL MIRAGE

Drainage Basin Data

Water Course Length: 762.00 ft

Basin Area: 5.000 acres

High Elevation: 1190.00 ft

Low Elevation: 1185.00 ft

Average Slope: 0.0066 ft/ft

Roughness, Kb: 0.0704 (B)

10-Year Runoff Coefficient: 0.400

10-Year 6 Hour Rainfall Depth: 2.07 inches

Hydrological Summary Table

Parameter	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
Q (cfs)	5	7	8	11	14	17
C	0.400	0.400	0.400	0.440	0.480	0.500
Tc (min)	15.7	13.8	12.9	11.7	11.1	10.5
i (in/hr)	2.4	3.3	4.0	5.1	5.9	6.9

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RATIONAL FOR WINDOWS

Flood Control District of Maricopa County Rational Method

Project Information

Project Name: EL MIRAGE DRAINAGE

Project Description: OFFSITE RUNOFF CALCULATION

Drainage Point: OFF29

Location: EL MIRAGE

Drainage Basin Data

Water Course Length: 1359.00 ft

Basin Area: 8.600 acres

High Elevation: 1187.00 ft

Low Elevation: 1182.00 ft

Average Slope: 0.0037 ft/ft

Roughness, Kb: 0.0672 (B)

10-Year Runoff Coefficient: 0.400

10-Year 6 Hour Rainfall Depth: 2.07 inches

Hydrological Summary Table

Parameter	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
Q (cfs)	6	9	10	15	19	23
C	0.400	0.400	0.400	0.440	0.480	0.500
Tc (min)	27.4	24.0	22.2	20.3	19.0	17.9
i (in/hr)	1.8	2.5	3.1	3.9	4.6	5.4

RATIONAL FOR WINDOWS

Flood Control District of Maricopa County Rational Method

Project Information

Project Name: EL MIRAGE DRAINAGE

Project Description: OFFSITE RUNOFF CALCULATION

Drainage Point: OFF30

Location: EL MIRAGE

Drainage Basin Data

Water Course Length: 699.00 ft

Basin Area: 0.700 acres

High Elevation: 1185.00 ft

Low Elevation: 1180.00 ft

Average Slope: 0.0072 ft/ft

Roughness, Kb: 0.0821 (B)

10-Year Runoff Coefficient: 0.400

10-Year 6 Hour Rainfall Depth: 2.07 inches

Hydrological Summary Table

Parameter	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
Q (cfs)	1	1	1	2	2	2
C	0.400	0.400	0.400	0.440	0.480	0.500
Tc (min)	15.9	14.0	13.0	11.8	11.2	10.6
i (in/hr)	2.4	3.3	4.0	5.1	5.9	6.9

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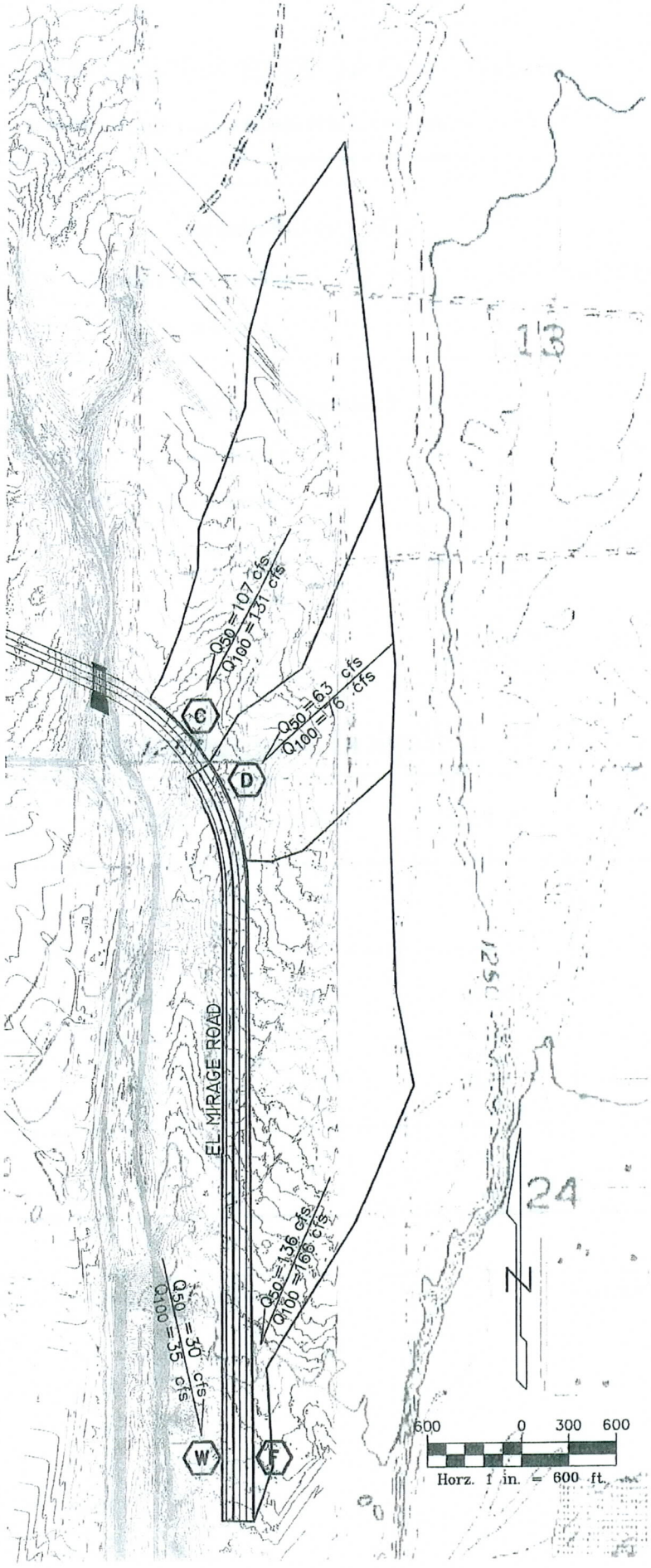

EL MIRAGE ROAD
C
D
W
F
Q50 = 107 cfs
Q100 = 131 cfs
Q50 = 63 cfs
Q100 = 76 cfs
Q50 = 136 cfs
Q100 = 166 cfs
Q50 = 30 cfs
Q100 = 35 cfs
13
24
N
600 0 300 600
Horz. 1 in. = 600 ft.

RATIONAL FOR WINDOWS

Flood Control District of Maricopa County Rational Method

Project Information

Project Name: El Mirage Rd

Project Description:

Drainage Point: F

Location: Offsite Flow 144+60

Drainage Basin Data

Water Course Length: 4750.00 ft

Basin Area: 73.280 acres

High Elevation: 1272.00 ft

Low Elevation: 1245.00 ft

Average Slope: 0.0057 ft/ft

Roughness, Kb: 0.0544 (B)

10-Year Runoff Coefficient: 0.436

10-Year 6 Hour Rainfall Depth: 2.08 inches

Hydrological Summary Table

Parameter	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
Q (cfs)	38	58	71	105	136	166
C	0.436	0.436	0.436	0.480	0.523	0.545
Tc (min)	46.7	39.6	36.6	32.8	30.7	28.9
i (in/hr)	1.2	1.8	2.2	3.0	3.6	4.1

APPENDIX C

ROADSIDE CHANNEL FLOW CALCULATIONS

El Mirage Road, Bell Road to Deer Valley Road
Rainfall Depths (inches) based on NOAA Atlas 2
PART A: Determine rainfall depths from isopluvial maps.

2-year	6-hour	$P_{2YR,6HR}$ =	1.20 inches	Input from Figure 2.2
2-year	24-hour	$P_{2YR,24HR}$ =	1.60 inches	Input from Figure 2.8
100-year	6-hour	$P_{100YR,6HR}$ =	3.200 inches	Input from Figure 2.7
100-year	24-hour	$P_{100YR,24HR}$ =	4.000 inches	Input from Figure 2.13

PART B:

2-year	1-hour	$P_{2YR,1HR} = -0.011 + 0.942 (P_{2YR,6HR})^2 / P_{2YR,6HR}$ =	0.837 inches
2-year	2-hour	$P_{2YR,2HR} = 0.341\ P_{2YR,6HR} + 0.659\ P_{2YR,1HR}$ =	0.961 inches
2-year	3-hour	$P_{2YR,3HR} = 0.569\ P_{2YR,6HR} + 0.431\ P_{2YR,1HR}$ =	1.043 inches
2-year	12-hour	$P_{2YR,12HR} = 0.500\ P_{2YR,6HR} + 0.500\ P_{2YR,24HR}$ =	1.400 inches
100-year	1-hour	$P_{100YR,6HR} = 0.494 + 0.755 (P_{100YR,6HR})^2 / P_{100YR,24HR}$ =	2.427 inches
100-year	2-hour	$P_{100YR,2HR} = 0.341\ P_{100YR,6HR} + 0.659\ P_{100YR,1HR}$ =	2.690 inches
100-year	3-hour	$P_{100YR,3HR} = 0.569\ P_{100YR,6HR} + 0.431\ P_{100YR,1HR}$ =	2.867 inches
100-year	12-hour	$P_{100YR,12HR} = 0.500\ P_{100YR,6HR} + 0.500\ P_{100YR,24HR}$ =	3.600 inches

PART C Zone = 8

Duration (minutes)	Zone's Short-Duration Rainfall Ratios			
	2-Year		100-Year	
5	A =	0.34	E =	0.30
10	B =	0.51	F =	0.46
15	C =	0.62	G =	0.59
20	D =	0.82	H =	0.80

2-year	5-min	$P_{2YR,5MIN} = A * P_{2YR,1HR}$ =	0.285
2-year	10-min	$P_{2YR,10MIN} = B * P_{2YR,1HR}$ =	0.427
2-year	15-hour	$P_{2YR,15MIN} = C * P_{2YR,1HR}$ =	0.519
2-year	30-hour	$P_{2YR,30MIN} = D * P_{2YR,1HR}$ =	0.686
100-year	5-min	$P_{100YR,5MIN} = E * P_{100YR,1HR}$ =	0.728
100-year	10-min	$P_{100YR,10MIN} = F * P_{100YR,1HR}$ =	1.116
100-year	15-hour	$P_{100YR,15MIN} = G * P_{100YR,1HR}$ =	1.432
100-year	30-hour	$P_{100YR,30MIN} = H * P_{100YR,1HR}$ =	1.941

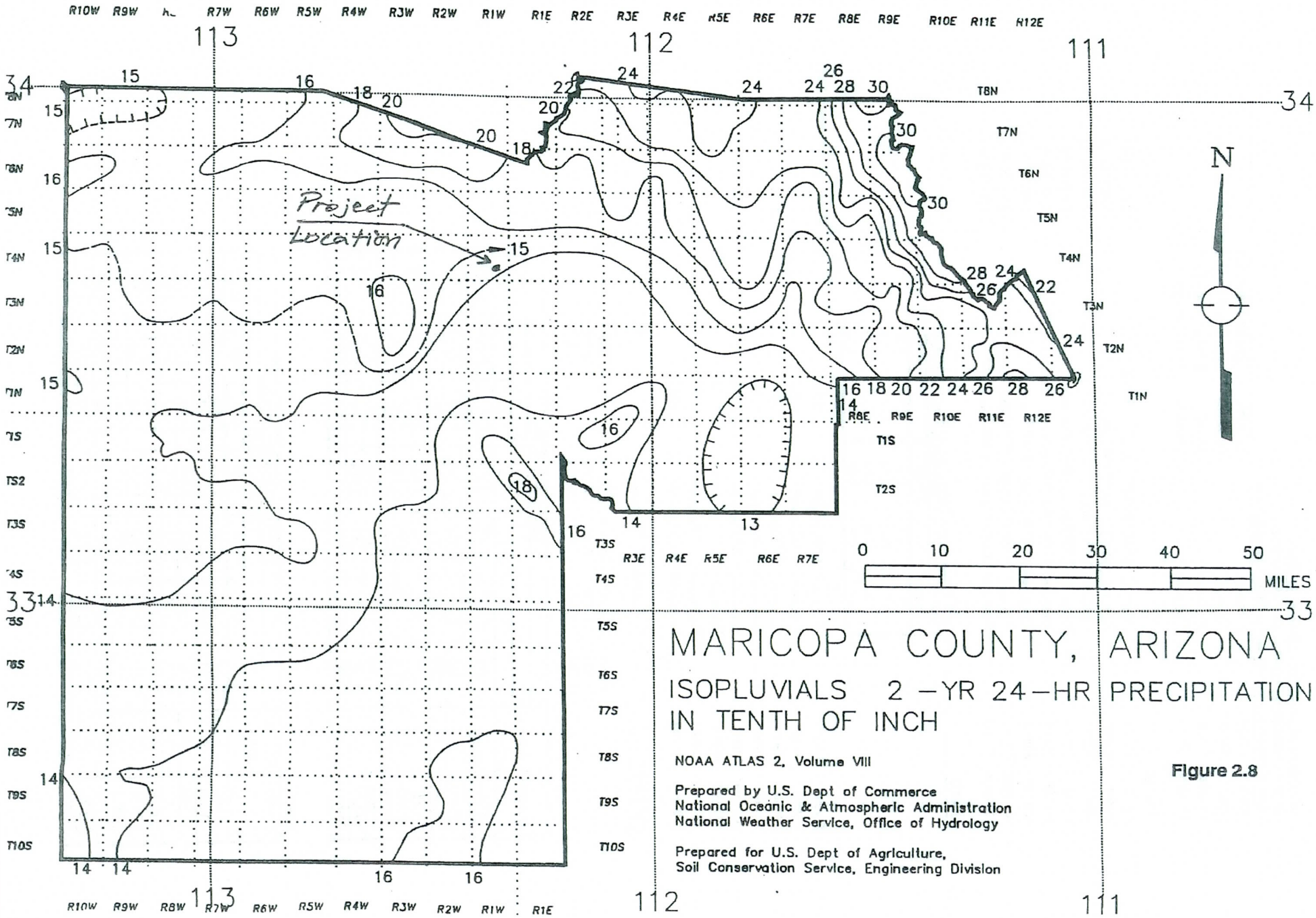
PART D & E $P_{T\text{-}YR,t\text{-}HR} = X * P_{2YR,t\text{-}HR} + Y * P_{100YR,t\text{-}HR}$

	5-year	10-year	25-year	50-year	500
X	0.674	0.496	0.293	0.146	-0.337
Y	0.278	0.449	0.669	0.835	1.381

Duration	Duration (minutes)	Rainfall Depth (inches) Frequency (years)						
		2	5	10	25	50	100	500
5-min	5	0.285	0.394	0.468	0.570	0.649	0.728	0.910
10-min	10	0.427	0.598	0.713	0.872	0.994	1.116	1.398
15-min	15	0.519	0.748	0.900	1.110	1.271	1.432	1.802
30-min	30	0.686	1.002	1.212	1.500	1.721	1.941	2.450
1-hour	60	0.837	1.239	1.505	1.869	2.149	2.427	3.069
2-hour	120	0.961	1.395	1.685	2.081	2.387	2.690	3.392
3-hour	180	1.043	1.500	1.805	2.224	2.546	2.867	3.607
6-hour	360	1.200	1.698	2.032	2.492	2.847	3.200	4.015
12-hour	720	1.400	1.944	2.311	2.819	3.210	3.600	4.500
24-hour	1440	1.600	2.190	2.590	3.145	3.574	4.000	4.985

PART F

Duration	Duration (minutes)	Rainfall Intensity (inches/hour) Frequency (years)						
		2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr	500-Yr
5-min	5	3.414	4.730	5.616	6.845	7.793	8.736	10.915
10-min	10	2.561	3.588	4.277	5.231	5.967	6.698	8.387
15-min	15	2.075	2.991	3.601	4.440	5.085	5.727	7.210
30-min	30	1.372	2.004	2.424	3.000	3.443	3.883	4.900
1-hour	60	0.837	1.239	1.505	1.869	2.149	2.427	3.069
2-hour	120	0.480	0.698	0.842	1.041	1.193	1.345	1.696
3-hour	180	0.348	0.500	0.602	0.741	0.849	0.956	1.202
6-hour	360	0.200	0.283	0.339	0.415	0.475	0.533	0.669
12-hour	720	0.117	0.162	0.193	0.235	0.268	0.300	0.375
24-hour	1440	0.067	0.091	0.108	0.131	0.149	0.167	0.208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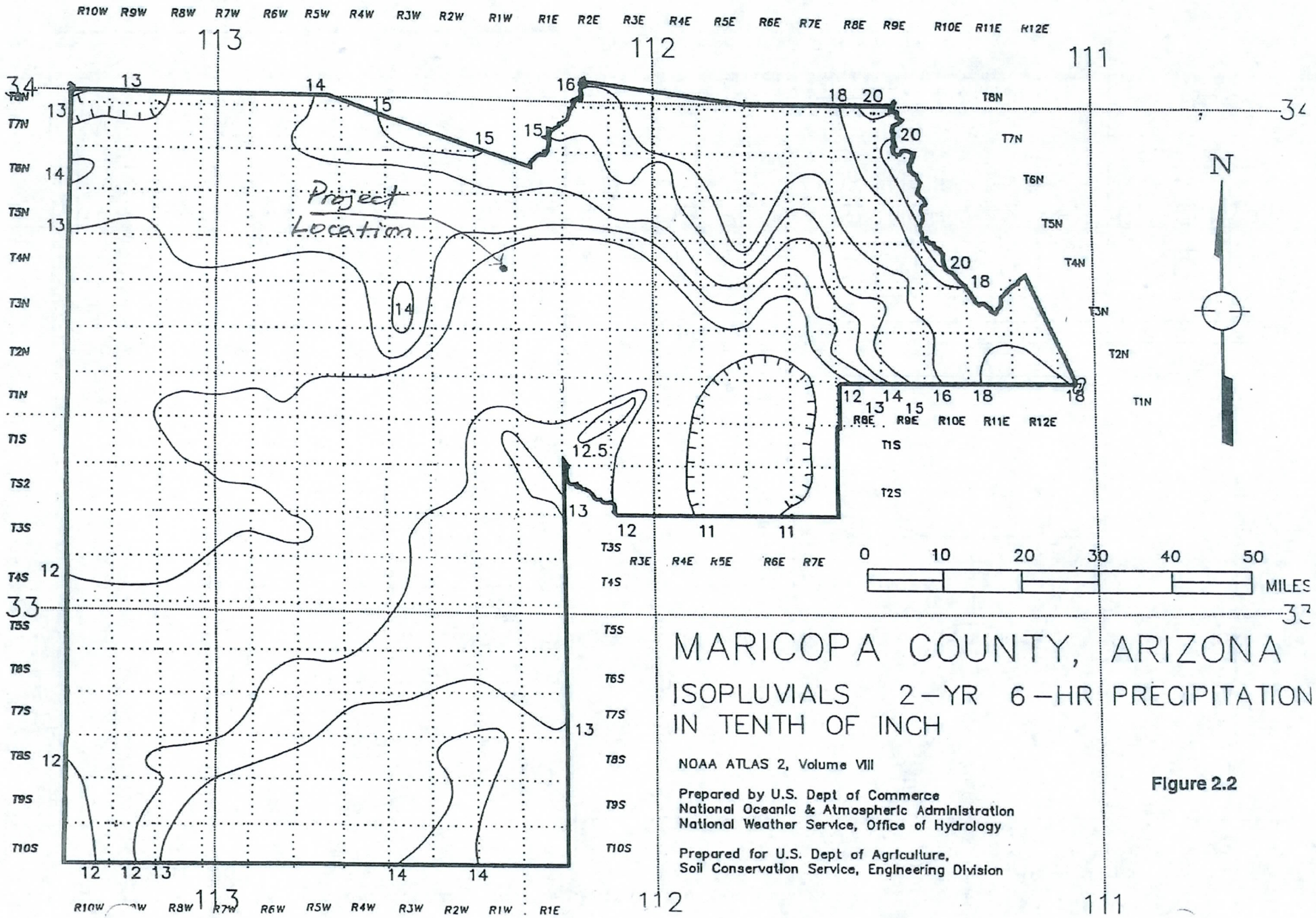
NOAA ATLAS 2, Volume VIII
Prepared by U.S. Dept of Commerce
National Oceanic & Atmospheric Administration
National Weather Service, Office of Hydrology
Prepared for U.S. Dept of Agriculture,
Soil Conservation Service, Engineering Division

Figure 2.8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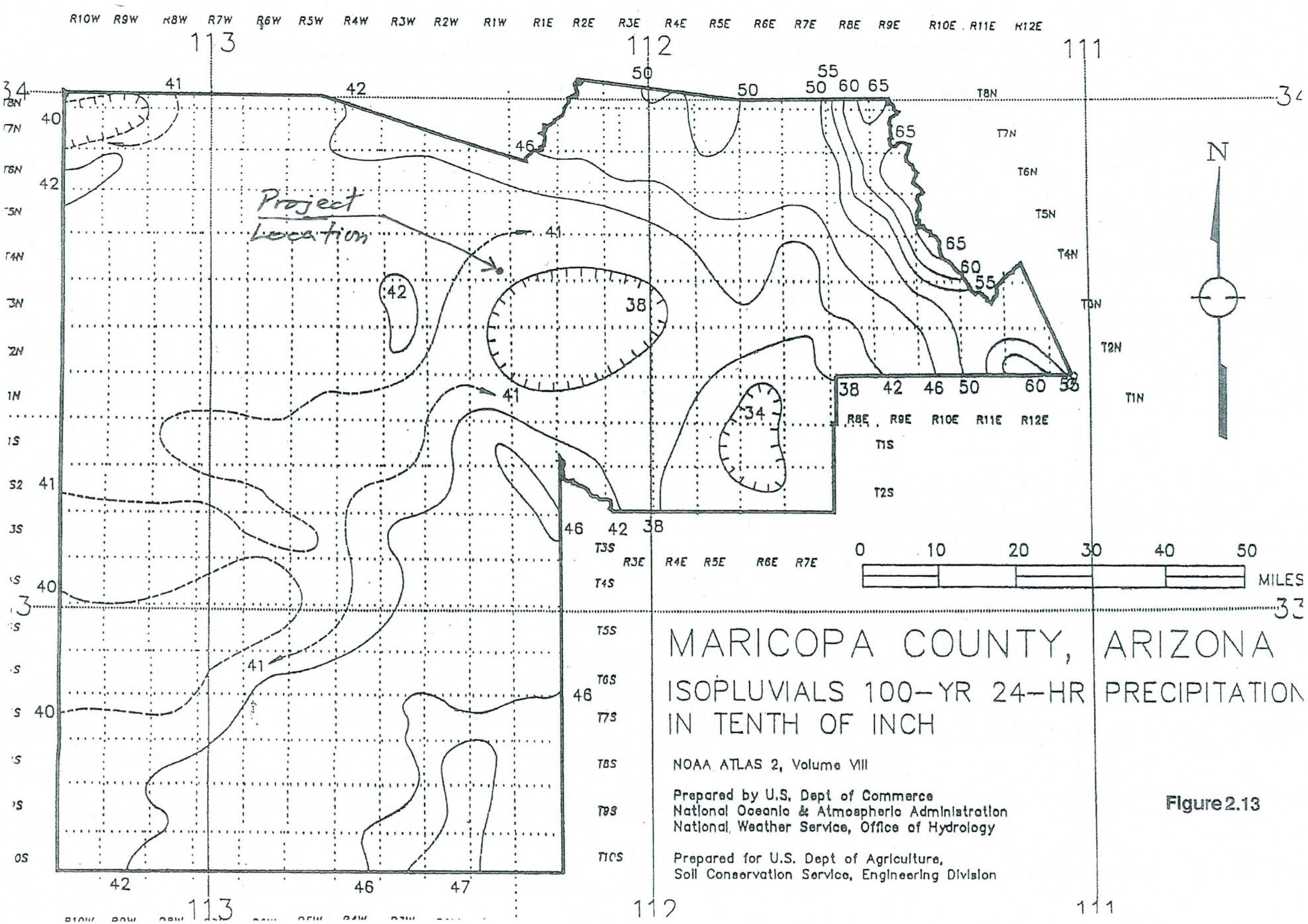
IN TENTH OF INCH
NOAA ATLAS 2, Volume VIII
Prepared by U.S. Dept of Commerce
National Oceanic & Atmospheric Administration
National Weather Service, Office of Hydrology
Prepared for U.S. Dept of Agriculture,
Soil Conservation Service, Engineering Division

Figure 2.2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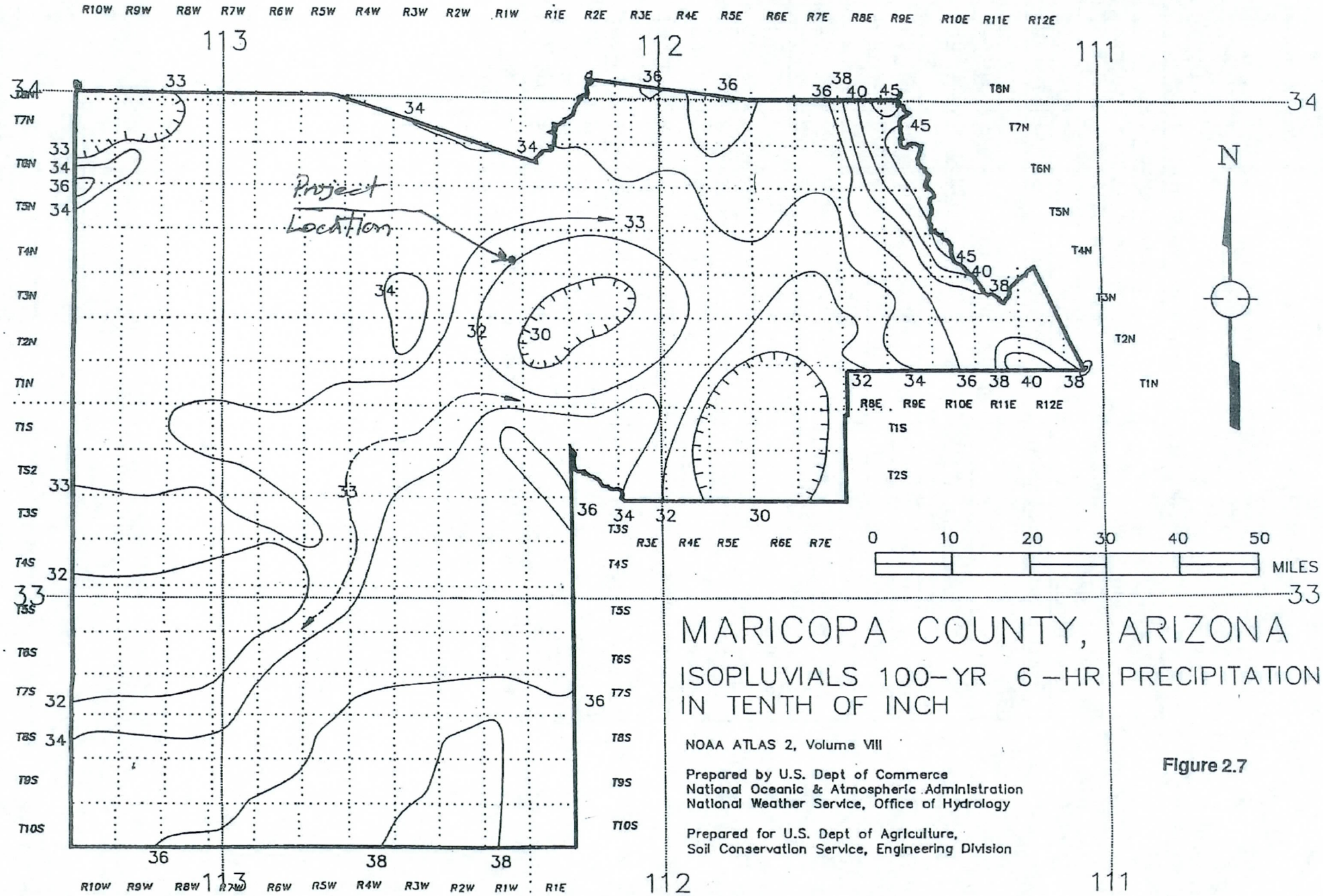
ISOPLUVIALS 100-YR 24-HR PRECIPITATION
IN TENTH OF INCH
NOAA ATLAS 2, Volume VIII
Prepared by U.S. Dept of Commerce
National Oceanic & Atmospheric Administration
National Weather Service, Office of Hydrology
Prepared for U.S. Dept of Agriculture,
Soil Conservation Service, Engineering Division

Figure 2.13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MILES
MARICOPA COUNTY, ARIZONA
ISOPLUVIALS 100-YR 6-HR PRECIPITATION
IN TENTH OF INCH
NOAA ATLAS 2, Volume VIII
Prepared by U.S. Dept of Commerce
National Oceanic & Atmospheric Administration
National Weather Service, Office of Hydrology
Prepared for U.S. Dept of Agriculture,
Soil Conservation Service, Engineering Division

Figure 2.7

"C" values used

median

Table 3.2
C Coefficients for Use with the Rational Method

Land Use	Return Period			
	2-10 Year	25 Year	50 Year	100 Year
Streets and Roads				
Paved Roads	0.75 – 0.85	0.83 – 0.94	0.90 – 0.95	0.94 – 0.95
Gravel Roadways & Shoulders	0.60 – 0.70	0.66 – 0.77	0.72 – 0.84	0.75 – 0.88
Industrial Areas				
Heavy	0.70 – 0.80	0.77 – 0.88	0.84 – 0.95	0.88 – 0.95
Light	0.60 – 0.70	0.66 – 0.77	0.72 – 0.84	0.75 – 0.88
Business Areas				
Downtown	0.75 – 0.85	0.83 – 0.94	0.90 – 0.95	0.94 – 0.95
Neighborhood	0.55 – 0.65	0.61 – 0.72	0.66 – 0.78	0.69 – 0.81
Residential Areas				
Lawns – Flat	0.10 – 0.25	0.11 – 0.28	0.12 – 0.30	0.13 – 0.31
– Steep	0.25 – 0.40	0.28 – 0.44	0.30 – 0.48	0.31 – 0.50
Suburban	0.30 – 0.40	0.33 – 0.44	0.36 – 0.48	0.38 – 0.50
Single Family	0.45 – 0.55	0.50 – 0.61	0.54 – 0.66	0.56 – 0.69
Multi-Unit	0.50 – 0.60	0.55 – 0.66	0.60 – 0.72	0.63 – 0.75
Apartments	0.60 – 0.70	0.66 – 0.77	0.72 – 0.84	0.75 – 0.88
Parks/Cemetaries	0.10 – 0.25	0.11 – 0.28	0.12 – 0.30	0.13 – 0.31
Playgrounds	0.40 – 0.50	0.44 – 0.55	0.48 – 0.60	0.50 – 0.63
Agricultural Areas	0.10 – 0.20	0.11 – 0.22	0.12 – 0.24	0.13 – 0.25
Bare Ground	0.20 – 0.30	0.22 – 0.33	0.24 – 0.36	0.25 – 0.38
Undeveloped Desert	0.30 – 0.40	0.33 – 0.44	0.36 – 0.48	0.38 – 0.50
Mountain Terrain (Slopes > 10%)	0.60 – 0.80	0.66 – 0.88	0.72 – 0.95	0.75 – 0.95

Note: Values of C for 25, 50 and 100 Year were derived using frequency adjustment factors of 1.10, 1.20, and 1.25, respectively, with an upper limit of 0.95 for C for the 2-10 Year values.

D1a – Sta. 13+00 to Sta. 17+00, L = 400'
Ditch flowing South.

Worksheet for D - 1

Project Description

Friction Method	Manning Formula
Solve For	Discharge

El. D/S = 1177.94 – 13+00
El. U/S = 1179.14 – 17+00

Input Data

Roughness Coefficient	0.025	
Channel Slope	0.00300	ft/ft , S = .00645. OK
Normal Depth	1.00	ft
Left Side Slope	4.00	ft/ft (H:V)
Right Side Slope	4.00	ft/ft (H:V)
Bottom Width	0.00	ft

Results

Discharge	8.04	ft³/s
Flow Area	4.00	ft²
Wetted Perimeter	8.25	ft
Top Width	8.00	ft
Critical Depth	0.76	ft
Critical Slope	0.01310	ft/ft
Velocity	2.01	ft/s
Velocity Head	0.06	ft
Specific Energy	1.06	ft
Froude Number	0.50	
Flow Type	Subcritical	

D1b – Sta. 17+00 to 20+00, L = 300'
Ditch flowing North
U/S El. = 1180.52'
D/S El. = 1177
S = 0.0117 ft/ft. OK

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.00	ft
Critical Depth	0.76	ft
Channel Slope	0.00300	ft/ft
Critical Slope	0.01310	ft/ft

D2- Sta. 11+00 to Sta. 20+00,

Worksheet for D - 2

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Sta 19+91 ⇒ U/S Ele: 1174.50.
Sta. 11+00 ⇒ U/S Ele. 1171.74.
Length = 872'
S = .003'/ft.
OK

Input Data

Roughness Coefficient	0.025	
Channel Slope	0.00300	ft/ft
Normal Depth	2.00	ft
Left Side Slope	4.00	ft/ft (H:V)
Right Side Slope	4.00	ft/ft (H:V)
Bottom Width	4.00	ft

Results

Discharge	86.81	ft^3/s
Flow Area	24.00	ft^2
Wetted Perimeter	20.49	ft
Top Width	20.00	ft
Critical Depth	1.54	ft
Critical Slope	0.00952	ft/ft
Velocity	3.62	ft/s
Velocity Head	0.20	ft
Specific Energy	2.20	ft
Froude Number	0.58	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	2.00	ft
Critical Depth	1.54	ft
Channel Slope	0.00300	ft/ft
Critical Slope	0.00952	ft/ft

Stg. 20+00 to 40+00.

L = 2000'.

Worksheet for D- 3

Project Description

Friction Method	Manning Formula
Solve For	Discharge

U/S Ele. 85.92
D/S Ele. 78.48

Input Data

Roughness Coefficient	0.025	
Channel Slope	0.00300	ft/ft
Normal Depth	1.00	ft
Left Side Slope	4.00	ft/ft (H:V)
Right Side Slope	4.00	ft/ft (H:V)

S = .00372. V/S

OK

Results

Discharge	8.04	ft^3/s
Flow Area	4.00	ft^2
Wetted Perimeter	8.25	ft
Top Width	8.00	ft
Critical Depth	0.76	ft
Critical Slope	0.01310	ft/ft
Velocity	2.01	ft/s
Velocity Head	0.06	ft
Specific Energy	1.06	ft
Froude Number	0.50	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.00	ft
Critical Depth	0.76	ft
Channel Slope	0.00300	ft/ft
Critical Slope	0.01310	ft/ft

Sta.. 20+00 to 26+00

Worksheet for D - 4

Project Description

D/S = 1177.50
U/S = 1186.00 @ Sta. 39+00

Friction Method	Manning Formula		
Solve For	Discharge		

Input Data

$S = \frac{8.5}{1669} = .0051$ ft/ft OK

Roughness Coefficient	0.025	
Channel Slope	0.00300	ft/ft
Normal Depth	2.00	ft
Left Side Slope	4.00	ft/ft (H:V)
Right Side Slope	4.00	ft/ft (H:V)
Bottom Width	6.00	ft

Results

Discharge	105.48	ft^3/s
Flow Area	28.00	ft^2
Wetted Perimeter	22.49	ft
Top Width	22.00	ft
Critical Depth	1.53	ft
Critical Slope	0.00931	ft/ft
Velocity	3.77	ft/s
Velocity Head	0.22	ft
Specific Energy	2.22	ft
Froude Number	0.59	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	2.00	ft
Critical Depth	1.53	ft
Channel Slope	0.00300	ft/ft
Critical Slope	0.00931	ft/ft

Worksheet for D - 5

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Roughness Coefficient	0.025	
Channel Slope	0.00300	ft/ft
Normal Depth	2.00	ft
Left Side Slope	4.00	ft/ft (H:V)
Right Side Slope	4.00	ft/ft (H:V)
Bottom Width	4.00	ft

Results

Discharge	86.81	ft^3/s
Flow Area	24.00	ft^2
Wetted Perimeter	20.49	ft
Top Width	20.00	ft
Critical Depth	1.54	ft
Critical Slope	0.00952	ft/ft
Velocity	3.62	ft/s
Velocity Head	0.20	ft
Specific Energy	2.20	ft
Froude Number	0.58	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	2.00	ft
Critical Depth	1.54	ft
Channel Slope	0.00300	ft/ft
Critical Slope	0.00952	ft/ft

Worksheet for D - 6

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Roughness Coefficient	0.025	
Channel Slope	0.00300	ft/ft
Normal Depth	2.00	ft
Left Side Slope	4.00	ft/ft (H:V)
Right Side Slope	4.00	ft/ft (H:V)
Bottom Width	4.00	ft

Results

Discharge	86.81	ft^3/s
Flow Area	24.00	ft^2
Wetted Perimeter	20.49	ft
Top Width	20.00	ft
Critical Depth	1.54	ft
Critical Slope	0.00952	ft/ft
Velocity	3.62	ft/s
Velocity Head	0.20	ft
Specific Energy	2.20	ft
Froude Number	0.58	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	2.00	ft
Critical Depth	1.54	ft
Channel Slope	0.00300	ft/ft
Critical Slope	0.00952	ft/ft

Interfaith South

Worksheet for D - 7

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Roughness Coefficient	0.025	
Channel Slope	0.00300	ft/ft
Normal Depth	1.00	ft
Left Side Slope	4.00	ft/ft (H:V)
Right Side Slope	4.00	ft/ft (H:V)

D/C

Results

Discharge	8.04	ft^3/s
Flow Area	4.00	ft^2
Wetted Perimeter	8.25	ft
Top Width	8.00	ft
Critical Depth	0.76	ft
Critical Slope	0.01310	ft/ft
Velocity	2.01	ft/s
Velocity Head	0.06	ft
Specific Energy	1.06	ft
Froude Number	0.50	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.00	ft
Critical Depth	0.76	ft
Channel Slope	0.00300	ft/ft
Critical Slope	0.01310	ft/ft

Interfaith North.

Worksheet for D- 8

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Roughness Coefficient	0.025	
Channel Slope	0.00300	ft/ft
Normal Depth	2.00	ft
Left Side Slope	4.00	ft/ft (H:V)
Right Side Slope	4.00	ft/ft (H:V)
Bottom Width	5.00	ft

Results

Discharge	96.10	ft^3/s
Flow Area	26.00	ft^2
Wetted Perimeter	21.49	ft
Top Width	21.00	ft
Critical Depth	1.53	ft
Critical Slope	0.00941	ft/ft
Velocity	3.70	ft/s
Velocity Head	0.21	ft
Specific Energy	2.21	ft
Froude Number	0.59	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	2.00	ft
Critical Depth	1.53	ft
Channel Slope	0.00300	ft/ft
Critical Slope	0.00941	ft/ft

Sta. 40+00 to 48+00

Worksheet for D - 9

u/s Ele = 1195
D/s Ele = 1188
L = 1111
S = 7/1111 = .0063 ft/ft
OK

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Roughness Coefficient	0.025	
Channel Slope	0.00300	ft/ft
Normal Depth	2.00	ft
Left Side Slope	4.00	ft/ft (H:V)
Right Side Slope	4.00	ft/ft (H:V)
Bottom Width	5.00	ft

Results

Discharge	96.10	ft^3/s
Flow Area	26.00	ft^2
Wetted Perimeter	21.49	ft
Top Width	21.00	ft
Critical Depth	1.53	ft
Critical Slope	0.00941	ft/ft
Velocity	3.70	ft/s
Velocity Head	0.21	ft
Specific Energy	2.21	ft
Froude Number	0.59	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	2.00	ft
Critical Depth	1.53	ft
Channel Slope	0.00300	ft/ft
Critical Slope	0.00941	ft/ft

Sta. 40+00 D/S = 85.92
to 51+00 U/S = 90.50 } L = 1100'

Worksheet for D- 10

Project Description

Friction Method	Manning Formula
Solve For	Discharge

$S = \frac{4.58}{1100'} = .0041$

OK

Input Data

Roughness Coefficient	0.025	
Channel Slope	0.00300	ft/ft
Normal Depth	1.00	ft
Left Side Slope	4.00	ft/ft (H:V)
Right Side Slope	4.00	ft/ft (H:V)

Results

Discharge	8.04	ft^3/s
Flow Area	4.00	ft^2
Wetted Perimeter	8.25	ft
Top Width	8.00	ft
Critical Depth	0.76	ft
Critical Slope	0.01310	ft/ft
Velocity	2.01	ft/s
Velocity Head	0.06	ft
Specific Energy	1.06	ft
Froude Number	0.50	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.00	ft
Critical Depth	0.76	ft
Channel Slope	0.00300	ft/ft
Critical Slope	0.01310	ft/ft

Worksheet for D-11

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Roughness Coefficient	0.025	
Channel Slope	0.00300	ft/ft
Normal Depth	2.00	ft
Left Side Slope	4.00	ft/ft (H:V)
Right Side Slope	4.00	ft/ft (H:V)
Bottom Width	2.00	ft

Results

Discharge	68.60	ft^3/s
Flow Area	20.00	ft^2
Wetted Perimeter	18.49	ft
Top Width	18.00	ft
Critical Depth	1.56	ft
Critical Slope	0.00981	ft/ft
Velocity	3.43	ft/s
Velocity Head	0.18	ft
Specific Energy	2.18	ft
Froude Number	0.57	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	2.00	ft
Critical Depth	1.56	ft
Channel Slope	0.00300	ft/ft
Critical Slope	0.00981	ft/ft

Sta. 51+50 – D/S = 1195

Sta. 75+00 – U/S = 1209.

L = 2215

Worksheet for D-12

Project Description

Friction Method	Manning Formula
Solve For	Discharge

$S = \frac{14}{2215} = .0063$

OK

Input Data

Roughness Coefficient	0.025	
Channel Slope	0.00300	ft/ft
Normal Depth	2.00	ft
Left Side Slope	4.00	ft/ft (H:V)
Right Side Slope	4.00	ft/ft (H:V)
Bottom Width	2.00	ft

Results

Discharge	68.60	ft^3/s
Flow Area	20.00	ft^2
Wetted Perimeter	18.49	ft
Top Width	18.00	ft
Critical Depth	1.56	ft
Critical Slope	0.00981	ft/ft
Velocity	3.43	ft/s
Velocity Head	0.18	ft
Specific Energy	2.18	ft
Froude Number	0.57	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	2.00	ft
Critical Depth	1.56	ft
Channel Slope	0.00300	ft/ft
Critical Slope	0.00981	ft/ft

Sta. 51+00 to 75+00
88.75 95.28

Worksheet for D-13 L = 2350

S = (95.28 − 88.75) / 2350
= 0.0028 ≯ .003
OK

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Roughness Coefficient	0.025	
Channel Slope	0.00300	ft/ft
Normal Depth	1.50	ft
Left Side Slope	4.00	ft/ft (H:V)
Right Side Slope	4.00	ft/ft (H:V)

Results

Discharge	23.70	ft^3/s
Flow Area	9.00	ft^2
Wetted Perimeter	12.37	ft
Top Width	12.00	ft
Critical Depth	1.17	ft
Critical Slope	0.01134	ft/ft
Velocity	2.63	ft/s
Velocity Head	0.11	ft
Specific Energy	1.61	ft
Froude Number	0.54	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.50	ft
Critical Depth	1.17	ft
Channel Slope	0.00300	ft/ft
Critical Slope	0.01134	ft/ft

Sta. 75+00

Sta. 78+19.

Worksheet for D-14

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Roughness Coefficient	0.025	
Channel Slope	0.00300	ft/ft
Normal Depth	1.00	ft
Left Side Slope	4.00	ft/ft (H:V)
Right Side Slope	4.00	ft/ft (H:V)

Results

Discharge	8.04	ft^3/s
Flow Area	4.00	ft^2
Wetted Perimeter	8.25	ft
Top Width	8.00	ft
Critical Depth	0.76	ft
Critical Slope	0.01310	ft/ft
Velocity	2.01	ft/s
Velocity Head	0.06	ft
Specific Energy	1.06	ft
Froude Number	0.50	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.00	ft
Critical Depth	0.76	ft
Channel Slope	0.00300	ft/ft
Critical Slope	0.01310	ft/ft

Worksheet for D-15.1

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Roughness Coefficient	0.025	
Channel Slope	0.00300	ft/ft
Normal Depth	1.50	ft
Left Side Slope	4.00	ft/ft (H:V)
Right Side Slope	4.00	ft/ft (H:V)
Bottom Width	2.00	ft

Results

Discharge	34.64	ft^3/s
Flow Area	12.00	ft^2
Wetted Perimeter	14.37	ft
Top Width	14.00	ft
Critical Depth	1.14	ft
Critical Slope	0.01075	ft/ft
Velocity	2.89	ft/s
Velocity Head	0.13	ft
Specific Energy	1.63	ft
Froude Number	0.55	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.50	ft
Critical Depth	1.14	ft
Channel Slope	0.00300	ft/ft
Critical Slope	0.01075	ft/ft

Worksheet for D-15

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Roughness Coefficient	0.025	
Channel Slope	0.00300	ft/ft
Normal Depth	1.00	ft
Left Side Slope	4.00	ft/ft (H:V)
Right Side Slope	4.00	ft/ft (H:V)

Results

Discharge	8.04	ft^3/s
Flow Area	4.00	ft^2
Wetted Perimeter	8.25	ft
Top Width	8.00	ft
Critical Depth	0.76	ft
Critical Slope	0.01310	ft/ft
Velocity	2.01	ft/s
Velocity Head	0.06	ft
Specific Energy	1.06	ft
Froude Number	0.50	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.00	ft
Critical Depth	0.76	ft
Channel Slope	0.00300	ft/ft
Critical Slope	0.01310	ft/ft

Worksheet for D-16

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Roughness Coefficient	0.025	
Channel Slope	0.00300	ft/ft
Normal Depth	1.50	ft
Left Side Slope	4.00	ft/ft (H:V)
Right Side Slope	4.00	ft/ft (H:V)
Bottom Width	2.00	ft

Results

Discharge	34.64	ft^3/s
Flow Area	12.00	ft^2
Wetted Perimeter	14.37	ft
Top Width	14.00	ft
Critical Depth	1.14	ft
Critical Slope	0.01075	ft/ft
Velocity	2.89	ft/s
Velocity Head	0.13	ft
Specific Energy	1.63	ft
Froude Number	0.55	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.50	ft
Critical Depth	1.14	ft
Channel Slope	0.00300	ft/ft
Critical Slope	0.01075	ft/ft

Worksheet for D-17

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Roughness Coefficient	0.025	
Channel Slope	0.00300	ft/ft
Normal Depth	2.00	ft
Left Side Slope	4.00	ft/ft (H:V)
Right Side Slope	4.00	ft/ft (H:V)

Results

Discharge	51.05	ft^3/s
Flow Area	16.00	ft^2
Wetted Perimeter	16.49	ft
Top Width	16.00	ft
Critical Depth	1.59	ft
Critical Slope	0.01024	ft/ft
Velocity	3.19	ft/s
Velocity Head	0.16	ft
Specific Energy	2.16	ft
Froude Number	0.56	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	2.00	ft
Critical Depth	1.59	ft
Channel Slope	0.00300	ft/ft
Critical Slope	0.01024	ft/ft

Worksheet for D-18

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Roughness Coefficient	0.025	
Channel Slope	0.00300	ft/ft
Normal Depth	1.50	ft
Left Side Slope	4.00	ft/ft (H:V)
Right Side Slope	4.00	ft/ft (H:V)

Results

Discharge	23.70	ft^3/s
Flow Area	9.00	ft^2
Wetted Perimeter	12.37	ft
Top Width	12.00	ft
Critical Depth	1.17	ft
Critical Slope	0.01134	ft/ft
Velocity	2.63	ft/s
Velocity Head	0.11	ft
Specific Energy	1.61	ft
Froude Number	0.54	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.50	ft
Critical Depth	1.17	ft
Channel Slope	0.00300	ft/ft
Critical Slope	0.01134	ft/ft

Worksheet for D -19

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Roughness Coefficient	0.025	
Channel Slope	0.00300	ft/ft
Normal Depth	2.00	ft
Left Side Slope	4.00	ft/ft (H:V)
Right Side Slope	4.00	ft/ft (H:V)

Results

Discharge	51.05	ft^3/s
Flow Area	16.00	ft^2
Wetted Perimeter	16.49	ft
Top Width	16.00	ft
Critical Depth	1.59	ft
Critical Slope	0.01024	ft/ft
Velocity	3.19	ft/s
Velocity Head	0.16	ft
Specific Energy	2.16	ft
Froude Number	0.56	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	2.00	ft
Critical Depth	1.59	ft
Channel Slope	0.00300	ft/ft
Critical Slope	0.01024	ft/ft

Worksheet for D-20

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Roughness Coefficient	0.025	
Channel Slope	0.00300	ft/ft
Normal Depth	1.00	ft
Left Side Slope	4.00	ft/ft (H:V)
Right Side Slope	4.00	ft/ft (H:V)

Results

Discharge	8.04	ft^3/s
Flow Area	4.00	ft^2
Wetted Perimeter	8.25	ft
Top Width	8.00	ft
Critical Depth	0.76	ft
Critical Slope	0.01310	ft/ft
Velocity	2.01	ft/s
Velocity Head	0.06	ft
Specific Energy	1.06	ft
Froude Number	0.50	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.00	ft
Critical Depth	0.76	ft
Channel Slope	0.00300	ft/ft
Critical Slope	0.01310	ft/ft

Worksheet for D - 21

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Roughness Coefficient	0.025	
Channel Slope	0.00300	ft/ft
Normal Depth	1.00	ft
Left Side Slope	4.00	ft/ft (H:V)
Right Side Slope	4.00	ft/ft (H:V)

Results

Discharge	8.04	ft^3/s
Flow Area	4.00	ft^2
Wetted Perimeter	8.25	ft
Top Width	8.00	ft
Critical Depth	0.76	ft
Critical Slope	0.01310	ft/ft
Velocity	2.01	ft/s
Velocity Head	0.06	ft
Specific Energy	1.06	ft
Froude Number	0.50	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.00	ft
Critical Depth	0.76	ft
Channel Slope	0.00300	ft/ft
Critical Slope	0.01310	ft/ft

Worksheet for D - 22

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Roughness Coefficient	0.025	
Channel Slope	0.00300	ft/ft
Normal Depth	2.00	ft
Left Side Slope	4.00	ft/ft (H:V)
Right Side Slope	4.00	ft/ft (H:V)

Results

Discharge	51.05	ft^3/s
Flow Area	16.00	ft^2
Wetted Perimeter	16.49	ft
Top Width	16.00	ft
Critical Depth	1.59	ft
Critical Slope	0.01024	ft/ft
Velocity	3.19	ft/s
Velocity Head	0.16	ft
Specific Energy	2.16	ft
Froude Number	0.56	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	2.00	ft
Critical Depth	1.59	ft
Channel Slope	0.00300	ft/ft
Critical Slope	0.01024	ft/ft

Worksheet for D - 23

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Roughness Coefficient	0.025	
Channel Slope	0.00300	ft/ft
Normal Depth	2.00	ft
Left Side Slope	4.00	ft/ft (H:V)
Right Side Slope	4.00	ft/ft (H:V)

Results

Discharge	51.05	ft^3/s
Flow Area	16.00	ft^2
Wetted Perimeter	16.49	ft
Top Width	16.00	ft
Critical Depth	1.59	ft
Critical Slope	0.01024	ft/ft
Velocity	3.19	ft/s
Velocity Head	0.16	ft
Specific Energy	2.16	ft
Froude Number	0.56	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	2.00	ft
Critical Depth	1.59	ft
Channel Slope	0.00300	ft/ft
Critical Slope	0.01024	ft/ft

Worksheet for D- 24

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Roughness Coefficient	0.025	
Channel Slope	0.00300	ft/ft
Normal Depth	1.00	ft
Left Side Slope	4.00	ft/ft (H:V)
Right Side Slope	4.00	ft/ft (H:V)

Results

Discharge	8.04	ft^3/s
Flow Area	4.00	ft^2
Wetted Perimeter	8.25	ft
Top Width	8.00	ft
Critical Depth	0.76	ft
Critical Slope	0.01310	ft/ft
Velocity	2.01	ft/s
Velocity Head	0.06	ft
Specific Energy	1.06	ft
Froude Number	0.50	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.00	ft
Critical Depth	0.76	ft
Channel Slope	0.00300	ft/ft
Critical Slope	0.01310	ft/ft

Worksheet for D - 25

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Roughness Coefficient	0.025	
Channel Slope	0.00300	ft/ft
Normal Depth	1.50	ft
Left Side Slope	4.00	ft/ft (H:V)
Right Side Slope	4.00	ft/ft (H:V)

Results

Discharge	23.70	ft^3/s
Flow Area	9.00	ft^2
Wetted Perimeter	12.37	ft
Top Width	12.00	ft
Critical Depth	1.17	ft
Critical Slope	0.01134	ft/ft
Velocity	2.63	ft/s
Velocity Head	0.11	ft
Specific Energy	1.61	ft
Froude Number	0.54	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.50	ft
Critical Depth	1.17	ft
Channel Slope	0.00300	ft/ft
Critical Slope	0.01134	ft/ft

El Mirage Road, Bell Road to Deer Va[illegible]d, Phase B

ONSITE STORM DRAIN DESIGN

El Mirage Storm L[illegible]

MCDOT Project No.: TT103 & TT104

Design Criteria:

Rainfall Intensity, 'i' (Tc<=10min):

i (2yr)=	2.56 in/hr
i (10yr)=	4.277 in/hr
i(50yr)=	5.96 in/hr
i (100yr)=	6.69 in/hr

Method: Maricopa County, Rational Method

Frequency: 10-yr, 6 hour

Rainfall depth: 2-inches (isopluvial map of area)

Manning's coeff.:

Paved: 0.9

Desert landscape: 0.4

L = Left/SB CB

C = Median CB — First Flush Re 0.5 Inch

R= Right/NB CB

Begin Station 10+00 South Limit

End Station 122+00 North Limit

	Station	Basin Area #	Area (sf)	Area (ac)	Q10 (cfs)	Q50 (cfs)	Q100 (cfs)	First Flush Vol (ac-ft)	Berm Ht (ft)	Area Req'd (sf)
L	119+00.00	1	23,803	0.546	2.10	2.93	3.29	0.009	0.50	198.35
C	117+82.12	2	31,698	0.728	2.80	3.90	4.38	0.012	0.50	264.15
L	114+00.00	3	31,031	0.712	2.74	3.82	4.29	0.012	0.50	258.59
C	114+00.00	4	24,031	0.552	2.12	2.96	3.32	0.009	0.50	200.26
R	109+63.53	5	27,904	0.641	2.47	3.44	3.86	0.011	0.50	232.53
L	109+63.53	6	27,904	0.641	2.47	3.44	3.86	0.011	0.50	232.53
R	107+00.00	7	16,664	0.383	1.47	2.05	2.30	0.006	0.50	138.87
C	107+00.00	7.1	16,520	0.379	1.46	2.03	2.28	0.006	0.50	137.67
C	98+00.00	8	41,190	0.946	3.64	5.07	5.69	0.016	0.50	343.25
R	99+00.00	9	41,639	0.956	3.68	5.13	5.76	0.016	0.50	346.99
C	95+63.73	10A	12,730	0.292	1.12	1.57	1.76	0.005	0.50	106.08
R	95+63.73	11A	14,660	0.337	1.30	1.81	2.03	0.006	0.50	122.16
C	93+00.00	10	31,432	0.722	2.78	3.87	4.34	0.012	0.50	261.93
R	93+00.00	11	32,272	0.741	2.85	3.97	4.46	0.012	0.50	268.93
L	88+50.00	12	28,128	0.646	2.49	3.46	3.89	0.011	0.50	234.40
R	88+50.00	13	28,128	0.646	2.49	3.46	3.89	0.011	0.50	234.40
L	82+50.00	14	37,497	0.861	3.31	4.62	5.18	0.014	0.50	312.48
R	82+50.00	15	37,497	0.861	3.31	4.62	5.18	0.014	0.50	312.48
L	78+50.00	16	27,260	0.626	2.41	3.36	3.77	0.010	0.50	227.17
R	78+50.00	17	25,000	0.574	2.21	3.08	3.46	0.010	0.50	208.33
L	75+55.40	16.5	19,497	0.448	1.72	2.40	2.69	0.007	0.50	162.48
R	75+55.40	17.5	18,413	0.423	1.63	2.27	2.55	0.007	0.50	153.44
L	70+00.00	18	34,712	0.797	3.07	4.27	4.80	0.013	0.50	289.27
R	70+00.00	19	34,712	0.797	3.07	4.27	4.80	0.013	0.50	289.27
L	64+00.00	20	37,500	0.861	3.31	4.62	5.18	0.014	0.50	312.50
R	64+00.00	21	37,500	0.861	3.31	4.62	5.18	0.014	0.50	312.50
L	60+05.77	22	24,640	0.566	2.18	3.03	3.41	0.009	0.50	205.33
R	60+05.77	23	24,628	0.565	2.18	3.03	3.40	0.009	0.50	205.23
L	54+99.92	24	31,507	0.723	2.78	3.88	4.35	0.012	0.50	262.56
C	54+99.92	25	31,788	0.730	2.81	3.91	4.39	0.012	0.50	264.90
L	52+39.92	26	16,176	0.371	1.43	1.99	2.24	0.006	0.50	134.80
C	52+39.92	27	16,272	0.374	1.44	2.00	2.25	0.006	0.50	135.60
L	46+00.00	28	39,999	0.918	3.53	4.93	5.53	0.015	0.50	333.33
R	46+00.00	29	39,999	0.918	3.53	4.93	5.53	0.015	0.50	333.33
C	40+00.00	30	38,362	0.881	3.39	4.72	5.30	0.015	0.50	319.68
R	40+00.00	31	37,495	0.861	3.31	4.62	5.18	0.014	0.50	312.46
L	34+00.00	32	30,174	0.693	2.67	3.72	4.17	0.012	0.50	251.45
C	34+00.00	33	37,900	0.870	3.35	4.67	5.24	0.015	0.50	315.83
L	29+00.00	34	30,655	0.704	2.71	3.77	4.24	0.012	0.50	255.46
C	29+00.00	35	31,904	0.732	2.82	3.93	4.41	0.012	0.50	265.87
C	24+04.62	36	30,838	0.708	2.73	3.80	4.26	0.012	0.50	256.98
R	24+04.62	37	31,082	0.714	2.75	3.83	4.30	0.012	0.50	259.02
C	21+00.00	38	18,844	0.433	1.67	2.32	2.60	0.007	0.50	157.03
R	21+00.00	39	17,972	0.413	1.59	2.21	2.48	0.007	0.50	149.77
C	16+15.65	40	26,430	0.607	2.34	3.25	3.65	0.010	0.50	220.25
R	16+15.65	41	25,161	0.578	2.22	3.10	3.48	0.010	0.50	209.68
C	11+80.86	42	34,060	0.782	3.01	4.19	4.71	0.013	0.50	283.83
R	11+80.86	43	33,619	0.772	2.97	4.14	4.65	0.013	0.50	280.16
	Note: FLOWS INCLUDED FOR THE MEDIAN CB BELOW ARE NOT INCLUDED IN THE FUTURE CONDIT									
L	39+24.73	30.1	10,984	0.252	0.43	0.60	0.67			

El Mirage Road - Bell Road to Deer Valley Road

On-site and Off-site Drainage Ditch Calculations

Sta. 10+00 to Sta. 122+00

Prestige Engineering Consultant
Prepared by: RCS
Checked by: KA
Date: 18-Feb

Ditch #	From Sta.	To Sta.	Type of Ditch	Flow Dir	Detpth (ft)	BW (ft)	Min. TW (ft)	Min. Slope	Q (cfs)			V (fps)	Riprap Size &		
									Q50	Q100	Capacity		D50 (ft)	Depth (ft)	
D-1	12+00	17+00	"V"	N to S	0.50	0	8	0.003	3	4	8.04	2.01	0.5	1	Olsson Project Start
D-2	11+00	20+00	"T"	N to S	2.00	4	20	0.003	65	82	86.81	3.62	0.5	1	
D-3	20+00	40+00	"V"	N to S	1.00	0	8	0.003	6	8	8.04	2.01	0.5	1	may go w/ 5:1 SS
D-4	20+00	26+00	"T"	N to S	2.00	6	22	0.003	65	82	105.48	3.77	0.5	1	
D-5	26+00	33+00	"T"	N to S	2.00	4	20	0.003	58	73	86.81	3.62	0.5	1	
D-6	33+00	39+00	"T"	N to S	2.00	4	20	0.003	40	50	86.81	3.62	0.5	1	
D-7	South of Interfaith		"V"	W to E	1.00	0	8	0.003	3	4	8.04	2.01	0.5	1	
D-8	North of Interfaith R		"T"	W to E	2.00	5	21	0.003	41	71	96.1	3.7	0.5	1	
D-9	40+00	48+00	"T"	N to S	2.00	5	21	0.003	42	54	96.1	3.7	0.5	1	
D-10	40+00	51+00	"V"	N to S	1.00	0	8	0.003	9	13	8.04	2.01	0.5	1	
D-11	48+00	51+00	"T"	N to S	2.00	2	18	0.003	13	16	68.6	3.43	0.5	1	
D-12	51+50	75+00	"T"	N to S	2.00	2	18	0.003	34	45	68.6	3.43	0.5	1	
D-13	51+00	75+00	"V"	N to S	1.00	0	12	0.003	17	24	23.7	2.63	0.5	1	
D-14	75+00	78+19	"V"	N to S	0.50	0	8	0.003	2	3	8.04	2.01	0.5	1	
D-15	N. of Beardsley Rd		"T"	N to S	1.50	2	14	0.003	25	30	34.64	2.89	0.5	1	
D-15.1	S. of Beardsley Rd		"T"	N to S	1.50	2	14	0.003	28	35	34.64	2.89	0.5	1	
D-16	S. of Beardsley Rd		"T"	W to E	1.50	2	14	0.003	25	30	34.64	2.89	0.5	1	Olsson Project End
D-17	78+00	88+00	"V"	N to S	2.00	0	16	0.003	28	35	51.05	3.19	0.5	1	Jacobs Proejct Start
D-18	78+00	88+00	"V"	N to S	1.50	0	12	0.003	7	10	23.7	2.63	0.5	1	
D-19	88+00	93+00	"V"	N to S	2.00	0	16	0.003	7	10	51.05	3.19	0.5	1	
D-20	88+00	93+00	"V"	N to S	1.00	0	8	0.003	3	5	8.04	2.01	0.5	1	
D-21	93+00	M. Wash	"V"	S to N	1.00	0	8	0.003	9	12	8.04	2.01	0.5	1	
D-22	93+00	M. Wash	"V"	S to N	2.00	0	16	0.003	20	26	51.05	3.19	0.5	1	
Within M. Wash			"V"		1.00	0	8	0.003		3	8.04	2.01	0.5	1	
Within M. Wash			"V"		1.00	0	8	0.003		3	8.04	2.01	0.5	1	
D-23	M. Wash	114+00	"V"	N to S	2.00	0	16	0.003	19	25	51.05	3.19	0.5	1	
D-24	M. Wash	114+00	"V"	N to S	1.00	0	8	0.003	7	9	8.04	2.01	0.5	1	
D-25	114+00	122+00	"V"	N to S	1.50	0	12	0.003	19	24	23.7	2.63	0.5	1	
D-26T	114+00	122+00	"T"	N to S	2.50	3	28	0.006	136	166	218.58	5.65	0.5	1	Prestige Drainage End
D-26V	114+00	122+00	"V"	N to S	2.75	0	27.5	0.006	136	166	212.36	5.62	0.5	1	Wood/Patel Drainage Start

Median Drainage Calculations

Rainfall Intensity

First Flush intensity (FF)	FF=	0.5
50-yr Storm intensity	i50 =	5.96
100-yr Storm intensity	i100 =	6.69
Median Runoff Coefficient	c =	0.72

	Width	Length	A (ac)	FF	Q50	Q100	First Flush Calculations: FF Vol. (ac-ft)	Berm Ht.	Area Needed
Median Ditch #1 Sta. 21 to Sta 35+50	38	1450	1.26	0.46	5.43	6.09	0.04	0.5	826.5
Median Ditch #2 Sta. 39 to 52	38	1300	1.13	0.41	4.87	5.46	0.03	0.5	741
Median Ditch #3 Sta. 52 to 74	38	2200	1.92	0.69	8.24	9.24	0.06	0.5	1254
Median Ditch #4 78 to 91+25	38	1325	1.16	0.42	4.96	5.57	0.03	0.5	755.25
Median Ditch #5 Sta. 91+25 to 101	38	975	0.85	0.31	3.65	4.10	0.03	0.5	555.75
Median Ditch #6 Sta 101 to 113	38	1200	1.05	0.38	4.49	5.04	0.03	0.5	684
Median Ditch #7 Sta 113 to 122	38	900	0.79	0.28	3.37	3.78	0.02	0.5	513

El Mirage Road, Bell Road to Deer Valley Road, Phase B

Project No. TT103 & TT104

Ditch Flow Calculation

Ditch No.	Contributing Drainage (On-site)	Flows in cfs		Contributing Drainage Areas (Offsite)	Flows in cfs		Total Flows in cfs	
		Q50	Q100		Q50	Q100	Q50	Q100
D1	None	0	0	D1	3	4	3	4
D2	37, 39, 41, 43	13.28	14.91	OFF25, OFF 26, OFF27	52	64	65	79
D3	37, 39	6.04	6.78	None	0	0	6	7
D4	D5	15.82	17.75	OFF25, OFF27	50	61	66	79
D5	34, 32, 30.1, 36, 35	15.82	17.75	OFF25, 1/2 of OFF27	43	52	59	70
D6	32, 30.1	4.32	4.84	OFF25	36	44	40	49
D7	1/2 Interfaith Street	3.31	4.31	None	0	0	3	4
D8	1/2 Interfaith Street	3.31	4.31	OFF23, OFF24	38	67	41	71
D9	30, 28	9.65	10.83	OFF22	33	41	43	52
D10	29, 31	9.55	10.71	None	0	0	10	11
D11	28	4.93	5.53	OFF20	8	9	13	15
D12	26, 24, 22, 20, 18	17.79	19.98	OFF21	18	21	36	41
D13	19, 21, 23, 25, 27	17.83	20.02	None	0	0	18	20
D14	17.5	2.27	2.55	None	0	0	2	3
D15	1/2 Beardsley Conn.	3.31	4.41	None	0	0	3	4
D15.1	17	3.08	3.46	OFF19	12	15	15	18
D16	1/2 Beardsley Conn.	3.31	4.41	OFF17, OFF16	22	26	25	30
D17	16, 14	7.98	8.95	OFF18	20	24	28	33
D18	15, 17	7.7	8.64	None	0	0	8	9
D19	12	3.46	3.89	OFF15	4	5	7	9
D20	13	3.46	3.89	None	0	0	3	4
D21	9, 11	9.1	10.22	None	0	0	9	10
D22	10, 8	8.94	10.03	OFF11	11.8	14.1	21	24

D23	7.1, 5, 7	7.52	8.44	1/2 of OFF10	12	14.5	20	23
D24	3, 1	6.75	7.58	None	0	0	7	8
D25	2, 4	6.86	7.7	1/2 of OFF10	12	14.5	19	22
D26	None	0	0	Wood/Patel Drainage Area	136	166	136	166

LEVEL 1 - ROCK RIPRAP DESIGN USE SECTION TRAPEZOIDAL

Level 1 Riprap Bank-Stabilization Design Parameter Description
(Refer to HEC 11 for placement requirements)

Riprap Step	Gabion Step	Determine		CHANNEL SECTION Variable	SOUTH	NORTH	Variable
1	1	Compute the **100-year discharge, Q_{100},** *per Level 1* procedures in SSA2-96 ("Requirements for Floodplain and Floodway Delineation in Riverine Environments")		Q_{100}=	63 cfs	126 cfs	Q100
2	2	Compute the **flood depth, Y,** per Level 1 procedures in SSA2-96		Y=	2.0 ft	2.5 ft	Y
			Calculated	D_{50}=	4.1 in	5.4 in	calc D50
3		*Compute the* **Median Riprap Stone Size, D_{50},** *using Figure 1.*		D_{50}=	6 in	6 in	D50
4	3	Compute the **total scour depth, d_s,** per Level 1 procedures in SSA5-96 (State Standard for Watercourse System Sediment Balance)		d_s=	3.00 ft	3.00 ft	ds
5	4	Compute the required **Height of the Bank Protection, H,** as follows: H (feet) = Y, if Y =< the existing bank height; H (feet) = The existing bank height, if Y > existing bank height		bank ht.=	6.00 ft	5.00 ft	bank ht.
				H=	2.00 ft	2.55 ft	H
6		Compute the **Riprap Layer Thickness, T,** as follows: (use w/ filter fabric) *T (feet) = 2 x D_{50} for hand-placed material* T (feet) = 3 x D_{50} for dumped material		T=	1.00 ft	1.00 ft	T
				T=	12 in	12 in	T
	5	Determine the **Wire-Tied Rock Matress thickness, T,** Using Table 5. (Use D_{50} = 8" with smallest rock greater than cage grid opening)	(Q<2500cfs)	T=	12 in	12 in	T
	6	Determine the **length** of the Toe Apron, L_a, as follows: L_a (ft)=2.24*ds (equiv. to angle of repose at scour depth)		L_a=	6.72 ft	6.72 ft	La
			(Min channel apron length)		15.00	15	
7	7	Compute the **Length of Top-of-Bank Key-In, L_k,** as the greater of the two values determined as follows: L_k (feet) = 5 x (Y-H); L_k (feet) = 2 x T		Lk1=	0 ft	0 ft	Lk1
				Lk2=	2.00 ft	2.00 ft	Lk2
				L_k=	2.00 ft	2.00 ft	Lk
		Equivalent volume of dumped riprap required for toe stabilization during scour at a 3:1 slope (Vt) per foot of width of the design D50 size of rock (CY)	Min depth of dumped riprap at 3ft wide per foot of length =>		0.35 CY/ft	0.35 CY/ft	Vt
					1.05 ft	1.05 ft	
8	8	Compute the **Width of the Bank Stabilization Cut-off, W,** as follows: W (feet) = 5 x H (This is the distance which the bank stabilization should be keyed back into the existing bank at the upstream and downstream ends of the bank stabilization in order to prevent outflanking by the streamflow.)		W=	10.00 ft	12.75 ft	W

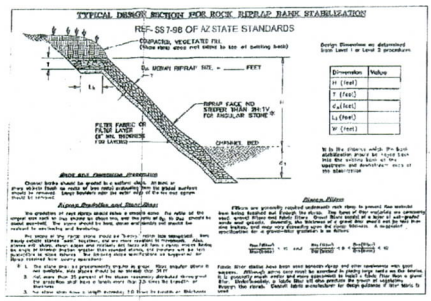
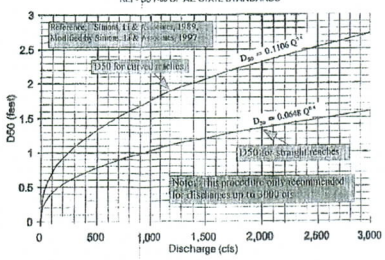


FIGURE 1
Level 1 Median Riprap Stone Size (D50)
REF- SS 7-98 OF AZ STATE STANDARDS



APPENDIX D

CROSS CULVERT CALCULATIONS

Culvert Designer/Analyzer Report
STA11+19

Peak Discharge Method: User-Specified			
Design Discharge	83.00 cfs	Check Discharge	83.00 cfs

Grades Model: Inverts			
Invert Upstream	1,171.74 ft	Invert Downstream	1,165.00 ft
Length	40.00 ft	Slope	0.168500 ft/ft
Drop	6.74 ft		

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	N/A ft

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	2-30 inch Circular	83.00 cfs	1,175.48 ft	21.65 ft/s
	Trial-2	2-36 inch Circular	83.00 cfs	1,174.99 ft	21.29 ft/s

Culvert Designer/Analyzer Report
STA11+19

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	ft	Storm Event	Design	
Computed Headwater Elev	1,175.48	ft	Discharge	83.00	cfs
Headwater Depth/Height	1.50		Tailwater Elevation	N/A	ft
Inlet Control HW Elev.	1,175.34	ft	Control Type	Entrance Control	
Outlet Control HW Elev.	1,175.48	ft			

Grades					
Upstream Invert	1,171.74	ft	Downstream Invert	1,165.00	ft
Length	40.00	ft	Constructed Slope	0.168500	ft/ft

Hydraulic Profile					
Profile	S2		Depth, Downstream	1.03	ft
Slope Type	Steep		Normal Depth	0.85	ft
Flow Regime	Supercritical		Critical Depth	2.16	ft
Velocity Downstream	21.65	ft/s	Critical Slope	0.009419	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	2.50	ft
Section Size	30 inch		Rise	2.50	ft
Number Sections	2				

Outlet Control Properties					
Outlet Control HW Elev.	1,175.48	ft	Upstream Velocity Head	1.32	ft
Ke	0.20		Entrance Loss	0.26	ft

Inlet Control Properties					
Inlet Control HW Elev.	1,175.34	ft	Flow Control	Submerged	
Inlet Type	Beveled ring, 33.7° bevels		Area Full	9.8	ft²
K	0.00180		HDS 5 Chart	3	
M	2.50000		HDS 5 Scale	B	
C	0.02430		Equation Form	1	
Y	0.83000				

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Culvert Designer/Analyzer Report
STA11+19

Design:Trial-2

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	ft	Storm Event	Design	
Computed Headwater Elev	1,174.99	ft	Discharge	83.00	cfs
Headwater Depth/Height	1.08		Tailwater Elevation	N/A	ft
Inlet Control HW Elev.	1,174.66	ft	Control Type	Entrance Control	
Outlet Control HW Elev.	1,174.99	ft			

Grades					
Upstream Invert	1,171.74	ft	Downstream Invert	1,165.00	ft
Length	40.00	ft	Constructed Slope	0.168500	ft/ft

Hydraulic Profile					
Profile	S2		Depth, Downstream	0.96	ft
Slope Type	Steep		Normal Depth	0.79	ft
Flow Regime	Supercritical		Critical Depth	2.10	ft
Velocity Downstream	21.29	ft/s	Critical Slope	0.005535	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	3.00	ft
Section Size	36 inch		Rise	3.00	ft
Number Sections	2				

Outlet Control Properties					
Outlet Control HW Elev.	1,174.99	ft	Upstream Velocity Head	0.96	ft
Ke	0.20		Entrance Loss	0.19	ft

Inlet Control Properties					
Inlet Control HW Elev.	1,174.66	ft	Flow Control	Unsubmerged	
Inlet Type	Beveled ring, 33.7° bevels		Area Full	14.1	ft²
K	0.00180		HDS 5 Chart	3	
M	2.50000		HDS 5 Scale	B	
C	0.02430		Equation Form	1	
Y	0.83000				

Culvert Designer/Analyzer Report
CULVERT STA 20+28

Peak Discharge Method: User-Specified			
Design Discharge	79.00 cfs	Check Discharge	79.00 cfs
Grades Model: Inverts			
Invert Upstream	1,177.50 ft	Invert Downstream	1,174.50 ft
Length	149.00 ft	Slope	0.020134 ft/ft
Drop	3.00 ft		
Headwater Model: Maximum Allowable HW			
Headwater Elevation	1,182.50 ft		
Tailwater Conditions: Constant Tailwater			
Tailwater Elevation	N/A ft		

	Name	Description	Discharge	HW Elev.	Velocity
	Trial-1	2-36 inch Circular	79.00 cfs	1,180.65 ft	12.48 ft/s
x	Trial-2	2-30 inch Circular	79.00 cfs	1,181.12 ft	12.52 ft/s

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Culvert Designer/Analyzer Report
CULVERT STA 20+28

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	1,182.50	ft	Storm Event	Design	
Computed Headwater Elev	1,180.65	ft	Discharge	79.00	cfs
Headwater Depth/Height	1.05		Tailwater Elevation	N/A	ft
Inlet Control HW Elev.	1,180.54	ft	Control Type	Entrance Control	
Outlet Control HW Elev.	1,180.65	ft			

Grades					
Upstream Invert	1,177.50	ft	Downstream Invert	1,174.50	ft
Length	149.00	ft	Constructed Slope	0.020134	ft/ft

Hydraulic Profile					
Profile	S2		Depth, Downstream	1.38	ft
Slope Type	Steep		Normal Depth	1.35	ft
Flow Regime	Supercritical		Critical Depth	2.05	ft
Velocity Downstream	12.48	ft/s	Critical Slope	0.005362	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	3.00	ft
Section Size	36 inch		Rise	3.00	ft
Number Sections	2				

Outlet Control Properties					
Outlet Control HW Elev.	1,180.65	ft	Upstream Velocity Head	0.92	ft
Ke	0.20		Entrance Loss	0.18	ft

Inlet Control Properties					
Inlet Control HW Elev.	1,180.54	ft	Flow Control	Unsubmerged	
Inlet Type	Beveled ring, 33.7° bevels		Area Full	14.1	ft²
K	0.00180		HDS 5 Chart	3	
M	2.50000		HDS 5 Scale	B	
C	0.02430		Equation Form	1	
Y	0.83000				

Culvert Designer/Analyzer Report
CULVERT STA 20+28

Design:Trial-2

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	1,182.50	ft	Storm Event	Design	
Computed Headwater Elev	1,181.12	ft	Discharge	79.00	cfs
Headwater Depth/Height	1.45		Tailwater Elevation	N/A	ft
Inlet Control HW Elev.	1,181.12	ft	Control Type	Inlet Control	
Outlet Control HW Elev.	1,181.10	ft			

Grades					
Upstream Invert	1,177.50	ft	Downstream Invert	1,174.50	ft
Length	149.00	ft	Constructed Slope	0.020134	ft/ft

Hydraulic Profile					
Profile	S2		Depth, Downstream	1.53	ft
Slope Type	Steep		Normal Depth	1.51	ft
Flow Regime	Supercritical		Critical Depth	2.12	ft
Velocity Downstream	12.52	ft/s	Critical Slope	0.008777	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	2.50	ft
Section Size	30 inch		Rise	2.50	ft
Number Sections	2				

Outlet Control Properties					
Outlet Control HW Elev.	1,181.10	ft	Upstream Velocity Head	1.23	ft
Ke	0.20		Entrance Loss	0.25	ft

Inlet Control Properties					
Inlet Control HW Elev.	1,181.12	ft	Flow Control	Submerged	
Inlet Type	Beveled ring, 33.7° bevels		Area Full	9.8	ft²
K	0.00180		HDS 5 Chart	3	
M	2.50000		HDS 5 Scale	B	
C	0.02430		Equation Form	1	
Y	0.83000				

Culvert Designer/Analyzer Report
CULVERT STA 39+50

Peak Discharge Method: User-Specified			
Design Discharge	123.00 cfs	Check Discharge	123.00 cfs
Grades Model: Inverts			
Invert Upstream	1,184.46 ft	Invert Downstream	1,184.00 ft
Length	176.00 ft	Slope	0.002614 ft/ft
Drop	0.46 ft		
Headwater Model: Allowable HW/Height			
Headwater Depth/Height	1,188.00		
Tailwater Conditions: Constant Tailwater			
Tailwater Elevation	N/A ft		

	Name	Description	Discharge	HW Elev.	Velocity
	Trial-1	2-36 inch Circular	123.00 cfs	1,189.68 ft	9.68 ft/s
	Trial-2	4-30 inch Circular	123.00 cfs	1,187.88 ft	7.72 ft/s
x	Trial-3	4-36 inch Circular	123.00 cfs	1,187.21 ft	6.96 ft/s

Culvert Designer/Analyzer Report
CULVERT STA 39+50

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	4,748.46	ft	Storm Event	Design	
Computed Headwater Elev	1,189.68	ft	Discharge	123.00	cfs
Headwater Depth/Height	1.74		Tailwater Elevation	N/A	ft
Inlet Control HW Elev.	1,188.79	ft	Control Type	Outlet Control	
Outlet Control HW Elev.	1,189.68	ft			

Grades					
Upstream Invert	1,184.46	ft	Downstream Invert	1,184.00	ft
Length	176.00	ft	Constructed Slope	0.002614	ft/ft

Hydraulic Profile					
Profile	CompositeM2PressureProfile		Depth, Downstream	2.53	ft
Slope Type	Mild		Normal Depth	N/A	ft
Flow Regime	Subcritical		Critical Depth	2.53	ft
Velocity Downstream	9.68	ft/s	Critical Slope	0.008114	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	3.00	ft
Section Size	36 inch		Rise	3.00	ft
Number Sections	2				

Outlet Control Properties					
Outlet Control HW Elev.	1,189.68	ft	Upstream Velocity Head	1.18	ft
Ke	0.20		Entrance Loss	0.24	ft

Inlet Control Properties					
Inlet Control HW Elev.	1,188.79	ft	Flow Control	Submerged	
Inlet Type	Beveled ring, 33.7° bevels		Area Full	14.1	ft²
K	0.00180		HDS 5 Chart	3	
M	2.50000		HDS 5 Scale	B	
C	0.02430		Equation Form	1	
Y	0.83000				

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Culvert Designer/Analyzer Report
CULVERT STA 39+50

Design:Trial-2

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	4,154.46	ft	Storm Event	Design	
Computed Headwater Elev	1,187.88	ft	Discharge	123.00	cfs
Headwater Depth/Height	1.37		Tailwater Elevation	N/A	ft
Inlet Control HW Elev.	1,187.48	ft	Control Type	Outlet Control	
Outlet Control HW Elev.	1,187.88	ft			

Grades					
Upstream Invert	1,184.46	ft	Downstream Invert	1,184.00	ft
Length	176.00	ft	Constructed Slope	0.002614	ft/ft

Hydraulic Profile					
Profile	CompositeM2PressureProfile		Depth, Downstream	1.89	ft
Slope Type	Mild		Normal Depth	N/A	ft
Flow Regime	Subcritical		Critical Depth	1.89	ft
Velocity Downstream	7.72	ft/s	Critical Slope	0.006636	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	2.50	ft
Section Size	30 inch		Rise	2.50	ft
Number Sections	4				

Outlet Control Properties					
Outlet Control HW Elev.	1,187.88	ft	Upstream Velocity Head	0.61	ft
Ke	0.20		Entrance Loss	0.12	ft

Inlet Control Properties					
Inlet Control HW Elev.	1,187.48	ft	Flow Control	Transition	
Inlet Type	Beveled ring, 33.7° bevels		Area Full	19.6	ft²
K	0.00180		HDS 5 Chart	3	
M	2.50000		HDS 5 Scale	B	
C	0.02430		Equation Form	1	
Y	0.83000				

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Culvert Designer/Analyzer Report
CULVERT STA 39+50

Design:Trial-3

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	4,748.46	ft	Storm Event	Design	
Computed Headwater Elev	1,187.21	ft	Discharge	123.00	cfs
Headwater Depth/Height	0.92		Tailwater Elevation	N/A	ft
Inlet Control HW Elev.	1,187.06	ft	Control Type	Outlet Control	
Outlet Control HW Elev.	1,187.21	ft			

Grades					
Upstream Invert	1,184.46	ft	Downstream Invert	1,184.00	ft
Length	176.00	ft	Constructed Slope	0.002614	ft/ft

Hydraulic Profile					
Profile	M2		Depth, Downstream	1.80	ft
Slope Type	Mild		Normal Depth	2.23	ft
Flow Regime	Subcritical		Critical Depth	1.80	ft
Velocity Downstream	6.96	ft/s	Critical Slope	0.004729	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	3.00	ft
Section Size	36 inch		Rise	3.00	ft
Number Sections	4				

Outlet Control Properties					
Outlet Control HW Elev.	1,187.21	ft	Upstream Velocity Head	0.50	ft
Ke	0.20		Entrance Loss	0.10	ft

Inlet Control Properties					
Inlet Control HW Elev.	1,187.06	ft	Flow Control	Unsubmerged	
Inlet Type	Beveled ring, 33.7° bevels		Area Full	28.3	ft²
K	0.00180		HDS 5 Chart	3	
M	2.50000		HDS 5 Scale	B	
C	0.02430		Equation Form	1	
Y	0.83000				

Culvert Designer/Analyzer Report
CULVERT STA 51+50

Peak Discharge Method: User-Specified			
Design Discharge	83.00 cfs	Check Discharge	83.00 cfs
Grades Model: Inverts			
Invert Upstream	1,191.46 ft	Invert Downstream	1,188.00 ft
Length	202.00 ft	Slope	0.017129 ft/ft
Drop	3.46 ft		
Headwater Model: Allowable HW/Height			
Headwater Depth/Height	1,196.00		
Tailwater Conditions: Constant Tailwater			
Tailwater Elevation	N/A ft		

	Name	Description	Discharge	HW Elev.	Velocity
	Trial-1	1-30 inch Circular	83.00 cfs	1,204.09 ft	16.95 ft/s
	Trial-2	2-30 inch Circular	83.00 cfs	1,195.25 ft	12.07 ft/s
x	Trial-3	1-36 inch Circular	83.00 cfs	1,197.27 ft	13.91 ft/s

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Culvert Designer/Analyzer Report
CULVERT STA 51+50

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	4,181.46	ft	Storm Event	Design	
Computed Headwater Elev	1,204.09	ft	Discharge	83.00	cfs
Headwater Depth/Height	5.05		Tailwater Elevation	N/A	ft
Inlet Control HW Elev.	1,200.46	ft	Control Type	Outlet Control	
Outlet Control HW Elev.	1,204.09	ft			

Grades					
Upstream Invert	1,191.46	ft	Downstream Invert	1,188.00	ft
Length	202.00	ft	Constructed Slope	0.017129	ft/ft

Hydraulic Profile					
Profile	CompositeM2PressureProfile		Depth, Downstream	2.47	ft
Slope Type	Mild		Normal Depth	N/A	ft
Flow Regime	Subcritical		Critical Depth	2.47	ft
Velocity Downstream	16.95	ft/s	Critical Slope	0.037435	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	2.50	ft
Section Size	30 inch		Rise	2.50	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	1,204.09	ft	Upstream Velocity Head	4.44	ft
Ke	0.20		Entrance Loss	0.89	ft

Inlet Control Properties					
Inlet Control HW Elev.	1,200.46	ft	Flow Control	N/A	
Inlet Type	Beveled ring, 33.7° bevels		Area Full	4.9	ft²
K	0.00180		HDS 5 Chart	3	
M	2.50000		HDS 5 Scale	B	
C	0.02430		Equation Form	1	
Y	0.83000				

Culvert Designer/Analyzer Report
CULVERT STA 51+50

Design:Trial-2

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	4,181.46	ft	Storm Event	Design	
Computed Headwater Elev	1,195.25	ft	Discharge	83.00	cfs
Headwater Depth/Height	1.52		Tailwater Elevation	N/A	ft
Inlet Control HW Elev.	1,195.25	ft	Control Type	Inlet Control	
Outlet Control HW Elev.	1,195.20	ft			

Grades					
Upstream Invert	1,191.46	ft	Downstream Invert	1,188.00	ft
Length	202.00	ft	Constructed Slope	0.017129	ft/ft

Hydraulic Profile					
Profile	S2		Depth, Downstream	1.65	ft
Slope Type	Steep		Normal Depth	1.65	ft
Flow Regime	Supercritical		Critical Depth	2.16	ft
Velocity Downstream	12.07	ft/s	Critical Slope	0.009419	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	2.50	ft
Section Size	30 inch		Rise	2.50	ft
Number Sections	2				

Outlet Control Properties					
Outlet Control HW Elev.	1,195.20	ft	Upstream Velocity Head	1.32	ft
Ke	0.20		Entrance Loss	0.26	ft

Inlet Control Properties					
Inlet Control HW Elev.	1,195.25	ft	Flow Control	N/A	
Inlet Type	Beveled ring, 33.7° bevels		Area Full	9.8	ft²
K	0.00180		HDS 5 Chart	3	
M	2.50000		HDS 5 Scale	B	
C	0.02430		Equation Form	1	
Y	0.83000				

Culvert Designer/Analyzer Report
CULVERT STA 51+50

Design:Trial-3

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	4,779.46	ft	Storm Event	Design	
Computed Headwater Elev	1,197.27	ft	Discharge	83.00	cfs
Headwater Depth/Height	1.94		Tailwater Elevation	N/A	ft
Inlet Control HW Elev.	1,197.27	ft	Control Type	Inlet Control	
Outlet Control HW Elev.	1,196.99	ft			

Grades					
Upstream Invert	1,191.46	ft	Downstream Invert	1,188.00	ft
Length	202.00	ft	Constructed Slope	0.017129	ft/ft

Hydraulic Profile					
Profile	S2		Depth, Downstream	2.36	ft
Slope Type	Steep		Normal Depth	2.34	ft
Flow Regime	Supercritical		Critical Depth	2.80	ft
Velocity Downstream	13.91	ft/s	Critical Slope	0.013391	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	3.00	ft
Section Size	36 inch		Rise	3.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	1,196.99	ft	Upstream Velocity Head	2.27	ft
Ke	0.20		Entrance Loss	0.45	ft

Inlet Control Properties					
Inlet Control HW Elev.	1,197.27	ft	Flow Control	N/A	
Inlet Type	Beveled ring, 33.7° bevels		Area Full	7.1	ft²
K	0.00180		HDS 5 Chart	3	
M	2.50000		HDS 5 Scale	B	
C	0.02430		Equation Form	1	
Y	0.83000				

Culvert Designer/Analyzer Report
CULVERT 75+06

Peak Discharge Method: User-Specified			
Design Discharge	81.00 cfs	Check Discharge	81.00 cfs

Grades Model: Inverts			
Invert Upstream	1,204.00 ft	Invert Downstream	1,196.00 ft
Length	219.00 ft	Slope	0.036530 ft/ft
Drop	8.00 ft		

Headwater Model: Allowable HW/Height	
Headwater Depth/Height	1,211.00

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	N/A ft

	Name	Description	Discharge	HW Elev.	Velocity
	Trial-1	1-30 inch Circular	81.00 cfs	1,212.65 ft	17.88 ft/s
x	Trial-2	2-30 inch Circular	81.00 cfs	1,207.68 ft	16.10 ft/s
	Trial-3	2-36 inch Circular	81.00 cfs	1,207.20 ft	16.01 ft/s

Culvert Designer/Analyzer Report
CULVERT 75+06

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	4,231.50	ft	Storm Event	Design	
Computed Headwater Elev	1,212.65	ft	Discharge	81.00	cfs
Headwater Depth/Height	3.46		Tailwater Elevation	N/A	ft
Inlet Control HW Elev.	1,212.65	ft	Control Type	Inlet Control	
Outlet Control HW Elev.	1,211.57	ft			

Grades					
Upstream Invert	1,204.00	ft	Downstream Invert	1,196.00	ft
Length	219.00	ft	Constructed Slope	0.036530	ft/ft

Hydraulic Profile					
Profile	S2		Depth, Downstream	2.17	ft
Slope Type	Steep		Normal Depth	2.13	ft
Flow Regime	Supercritical		Critical Depth	2.47	ft
Velocity Downstream	17.88	ft/s	Critical Slope	0.035516	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	2.50	ft
Section Size	30 inch		Rise	2.50	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	1,211.57	ft	Upstream Velocity Head	4.25	ft
Ke	0.20		Entrance Loss	0.85	ft

Inlet Control Properties					
Inlet Control HW Elev.	1,212.65	ft	Flow Control	Submerged	
Inlet Type	Beveled ring, 33.7° bevels		Area Full	4.9	ft²
K	0.00180		HDS 5 Chart	3	
M	2.50000		HDS 5 Scale	B	
C	0.02430		Equation Form	1	
Y	0.83000				

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Culvert Designer/Analyzer Report
CULVERT 75+06

Design:Trial-2

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	4,231.50	ft	Storm Event	Design	
Computed Headwater Elev	1,207.68	ft	Discharge	81.00	cfs
Headwater Depth/Height	1.47		Tailwater Elevation	N/A	ft
Inlet Control HW Elev.	1,207.68	ft	Control Type	Inlet Control	
Outlet Control HW Elev.	1,207.67	ft			

Grades					
Upstream Invert	1,204.00	ft	Downstream Invert	1,196.00	ft
Length	219.00	ft	Constructed Slope	0.036530	ft/ft

Hydraulic Profile					
Profile	S2		Depth, Downstream	1.27	ft
Slope Type	Steep		Normal Depth	1.27	ft
Flow Regime	Supercritical		Critical Depth	2.14	ft
Velocity Downstream	16.10	ft/s	Critical Slope	0.009090	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	2.50	ft
Section Size	30 inch		Rise	2.50	ft
Number Sections	2				

Outlet Control Properties					
Outlet Control HW Elev.	1,207.67	ft	Upstream Velocity Head	1.27	ft
Ke	0.20		Entrance Loss	0.25	ft

Inlet Control Properties					
Inlet Control HW Elev.	1,207.68	ft	Flow Control	Submerged	
Inlet Type	Beveled ring, 33.7° bevels		Area Full	9.8	ft²
K	0.00180		HDS 5 Chart	3	
M	2.50000		HDS 5 Scale	B	
C	0.02430		Equation Form	1	
Y	0.83000				

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Culvert Designer/Analyzer Report
CULVERT 75+06

Design:Trial-3

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	4,837.00	ft	Storm Event	Design	
Computed Headwater Elev	1,207.20	ft	Discharge	81.00	cfs
Headwater Depth/Height	1.07		Tailwater Elevation	N/A	ft
Inlet Control HW Elev.	1,207.06	ft	Control Type	Entrance Control	
Outlet Control HW Elev.	1,207.20	ft			

Grades					
Upstream Invert	1,204.00	ft	Downstream Invert	1,196.00	ft
Length	219.00	ft	Constructed Slope	0.036530	ft/ft

Hydraulic Profile					
Profile	S2		Depth, Downstream	1.16	ft
Slope Type	Steep		Normal Depth	1.16	ft
Flow Regime	Supercritical		Critical Depth	2.07	ft
Velocity Downstream	16.01	ft/s	Critical Slope	0.005447	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	3.00	ft
Section Size	36 inch		Rise	3.00	ft
Number Sections	2				

Outlet Control Properties					
Outlet Control HW Elev.	1,207.20	ft	Upstream Velocity Head	0.94	ft
Ke	0.20		Entrance Loss	0.19	ft

Inlet Control Properties					
Inlet Control HW Elev.	1,207.06	ft	Flow Control	Unsubmerged	
Inlet Type	Beveled ring, 33.7° bevels		Area Full	14.1	ft²
K	0.00180		HDS 5 Chart	3	
M	2.50000		HDS 5 Scale	B	
C	0.02430		Equation Form	1	
Y	0.83000				

Culvert Designer/Analyzer Report
CULVERT STA 77+59

Peak Discharge Method: User-Specified			
Design Discharge	63.00 cfs	Check Discharge	63.00 cfs
Grades Model: Inverts			
Invert Upstream	1,209.00 ft	Invert Downstream	1,205.77 ft
Length	117.00 ft	Slope	0.027607 ft/ft
Drop	3.23 ft		
Headwater Model: Allowable HW/Height			
Headwater Depth/Height	1,212.00		
Tailwater Conditions: Constant Tailwater			
Tailwater Elevation	N/A ft		

	Name	Description	Discharge	HW Elev.	Velocity
	Trial-1	1-30 inch Circular	63.00 cfs	1,215.04 ft	15.17 ft/s
x	Trial-2	2-24 inch Circular	63.00 cfs	1,213.08 ft	13.08 ft/s
	Trial-3	2-30 inch Circular	63.00 cfs	1,212.05 ft	13.10 ft/s

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Culvert Designer/Analyzer Report
CULVERT STA 77+59

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	4,239.00	ft	Storm Event	Design	
Computed Headwater Elev	1,215.04	ft	Discharge	63.00	cfs
Headwater Depth/Height	2.42		Tailwater Elevation	N/A	ft
Inlet Control HW Elev.	1,215.04	ft	Control Type	Inlet Control	
Outlet Control HW Elev.	1,214.55	ft			

Grades					
Upstream Invert	1,209.00	ft	Downstream Invert	1,205.77	ft
Length	117.00	ft	Constructed Slope	0.027607	ft/ft

Hydraulic Profile					
Profile	S2		Depth, Downstream	1.97	ft
Slope Type	Steep		Normal Depth	1.90	ft
Flow Regime	Supercritical		Critical Depth	2.41	ft
Velocity Downstream	15.17	ft/s	Critical Slope	0.020636	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	2.50	ft
Section Size	30 inch		Rise	2.50	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	1,214.55	ft	Upstream Velocity Head	2.62	ft
Ke	0.20		Entrance Loss	0.52	ft

Inlet Control Properties				
Inlet Control HW Elev.	1,215.04	ft	Flow Control	Submerged	
Inlet Type	Beveled ring, 33.7° bevels		Area Full	4.9	ft²
K	0.00180		HDS 5 Chart	3	
M	2.50000		HDS 5 Scale	B	
C	0.02430		Equation Form	1	
Y	0.83000				

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Culvert Designer/Analyzer Report
CULVERT STA 77+59

Design:Trial-2

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	3,633.00	ft	Storm Event	Design	
Computed Headwater Elev	1,213.08	ft	Discharge	63.00	cfs
Headwater Depth/Height	2.04		Tailwater Elevation	N/A	ft
Inlet Control HW Elev.	1,213.08	ft	Control Type	Inlet Control	
Outlet Control HW Elev.	1,212.85	ft			

Grades					
Upstream Invert	1,209.00	ft	Downstream Invert	1,205.77	ft
Length	117.00	ft	Constructed Slope	0.027607	ft/ft

Hydraulic Profile					
Profile	S2		Depth, Downstream	1.43	ft
Slope Type	Steep		Normal Depth	1.40	ft
Flow Regime	Supercritical		Critical Depth	1.88	ft
Velocity Downstream	13.08	ft/s	Critical Slope	0.016761	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	2.00	ft
Section Size	24 inch		Rise	2.00	ft
Number Sections	2				

Outlet Control Properties					
Outlet Control HW Elev.	1,212.85	ft	Upstream Velocity Head	1.64	ft
Ke	0.20		Entrance Loss	0.33	ft

Inlet Control Properties					
Inlet Control HW Elev.	1,213.08	ft	Flow Control	Submerged	
Inlet Type	Beveled ring, 33.7° bevels		Area Full	6.3	ft²
K	0.00180		HDS 5 Chart	3	
M	2.50000		HDS 5 Scale	B	
C	0.02430		Equation Form	1	
Y	0.83000				

Culvert Designer/Analyzer Report
CULVERT STA 77+59

Design:Trial-3

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	4,239.00	ft	Storm Event	Design	
Computed Headwater Elev	1,212.05	ft	Discharge	63.00	cfs
Headwater Depth/Height	1.22		Tailwater Elevation	N/A	ft
Inlet Control HW Elev.	1,212.04	ft	Control Type	Entrance Control	
Outlet Control HW Elev.	1,212.05	ft			

Grades					
Upstream Invert	1,209.00	ft	Downstream Invert	1,205.77	ft
Length	117.00	ft	Constructed Slope	0.027607	ft/ft

Hydraulic Profile					
Profile	S2		Depth, Downstream	1.23	ft
Slope Type	Steep		Normal Depth	1.19	ft
Flow Regime	Supercritical		Critical Depth	1.91	ft
Velocity Downstream	13.10	ft/s	Critical Slope	0.006783	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	2.50	ft
Section Size	30 inch		Rise	2.50	ft
Number Sections	2				

Outlet Control Properties					
Outlet Control HW Elev.	1,212.05	ft	Upstream Velocity Head	0.95	ft
Ke	0.20		Entrance Loss	0.19	ft

Inlet Control Properties					
Inlet Control HW Elev.	1,212.04	ft	Flow Control	Submerged	
Inlet Type	Beveled ring, 33.7° bevels		Area Full	9.8	ft²
K	0.00180		HDS 5 Chart	3	
M	2.50000		HDS 5 Scale	B	
C	0.02430		Equation Form	1	
Y	0.83000				

Culvert Designer/Analyzer Report
CULVERT STA 87+90

Peak Discharge Method: User-Specified			
Design Discharge	24.00 cfs	Check Discharge	24.00 cfs
Grades Model: Inverts			
Invert Upstream	1,211.75 ft	Invert Downstream	1,194.00 ft
Length	250.00 ft	Slope	0.071000 ft/ft
Drop	17.75 ft		
Headwater Model: Allowable HW/Height			
Headwater Depth/Height	1,216.00		
Tailwater Conditions: Constant Tailwater			
Tailwater Elevation	N/A ft		

	Name	Description	Discharge	HW Elev.	Velocity
	Trial-1	1-24 inch Circular	24.00 cfs	1,214.77 ft	18.10 ft/s
x	Trial-2	1-30 inch Circular	24.00 cfs	1,214.31 ft	17.85 ft/s

Culvert Designer/Analyzer Report
CULVERT STA 87+90

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary			
Allowable HW Elevation	3,643.75 ft	Storm Event	Design
Computed Headwater Elev	1,214.77 ft	Discharge	24.00 cfs
Headwater Depth/Height	1.51	Tailwater Elevation	N/A ft
Inlet Control HW Elev.	1,214.76 ft	Control Type	Entrance Control
Outlet Control HW Elev.	1,214.77 ft		

Grades			
Upstream Invert	1,211.75 ft	Downstream Invert	1,194.00 ft
Length	250.00 ft	Constructed Slope	0.071000 ft/ft

Hydraulic Profile			
Profile	S2	Depth, Downstream	0.88 ft
Slope Type	Steep	Normal Depth	0.88 ft
Flow Regime	Supercritical	Critical Depth	1.74 ft
Velocity Downstream	18.10 ft/s	Critical Slope	0.010303 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	2.00 ft
Section Size	24 inch	Rise	2.00 ft
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	1,214.77 ft	Upstream Velocity Head	1.07 ft
Ke	0.20	Entrance Loss	0.21 ft

Inlet Control Properties			
Inlet Control HW Elev.	1,214.76 ft	Flow Control	N/A
Inlet Type	Beveled ring, 33.7° bevels	Area Full	3.1 ft²
K	0.00180	HDS 5 Chart	3
M	2.50000	HDS 5 Scale	B
C	0.02430	Equation Form	1
Y	0.83000		

Culvert Designer/Analyzer Report
CULVERT STA 87+90

Design:Trial-2

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	4,251.75	ft	Storm Event	Design	
Computed Headwater Elev	1,214.31	ft	Discharge	24.00	cfs
Headwater Depth/Height	1.02		Tailwater Elevation	N/A	ft
Inlet Control HW Elev.	1,214.14	ft	Control Type	Entrance Control	
Outlet Control HW Elev.	1,214.31	ft			

Grades					
Upstream Invert	1,211.75	ft	Downstream Invert	1,194.00	ft
Length	250.00	ft	Constructed Slope	0.071000	ft/ft

Hydraulic Profile					
Profile	S2		Depth, Downstream	0.80	ft
Slope Type	Steep		Normal Depth	0.80	ft
Flow Regime	Supercritical		Critical Depth	1.67	ft
Velocity Downstream	17.85	ft/s	Critical Slope	0.005553	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	2.50	ft
Section Size	30 inch		Rise	2.50	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	1,214.31	ft	Upstream Velocity Head	0.74	ft
Ke	0.20		Entrance Loss	0.15	ft

Inlet Control Properties					
Inlet Control HW Elev.	1,214.14	ft	Flow Control	N/A	
Inlet Type	Beveled ring, 33.7° bevels		Area Full	4.9	ft²
K	0.00180		HDS 5 Chart	3	
M	2.50000		HDS 5 Scale	B	
C	0.02430		Equation Form	1	
Y	0.83000				

Culvert Designer/Analyzer Report
CULVERT STA 92+24

Peak Discharge Method: User-Specified			
Design Discharge	24.00 cfs	Check Discharge	24.00 cfs
Grades Model: Inverts			
Invert Upstream	1,211.69 ft	Invert Downstream	1,203.00 ft
Length	316.00 ft	Slope	0.027500 ft/ft
Drop	8.69 ft		
Headwater Model: Allowable HW/Height			
Headwater Depth/Height	1,218.00		
Tailwater Conditions: Constant Tailwater			
Tailwater Elevation	N/A ft		

	Name	Description	Discharge	HW Elev.	Velocity
	Trial-1	1-24 inch Circular	24.00 cfs	1,214.74 ft	12.67 ft/s
x	Trial-2	1-30 inch Circular	24.00 cfs	1,214.25 ft	12.66 ft/s

Culvert Designer/Analyzer Report
CULVERT STA 92+24

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	3,647.69	ft	Storm Event	Design	
Computed Headwater Elev	1,214.74	ft	Discharge	24.00	cfs
Headwater Depth/Height	1.53		Tailwater Elevation	N/A	ft
Inlet Control HW Elev.	1,214.74	ft	Control Type	Inlet Control	
Outlet Control HW Elev.	1,214.71	ft			

Grades					
Upstream Invert	1,211.69	ft	Downstream Invert	1,203.00	ft
Length	316.00	ft	Constructed Slope	0.027500	ft/ft

Hydraulic Profile					
Profile	S2		Depth, Downstream	1.16	ft
Slope Type	Steep		Normal Depth	1.16	ft
Flow Regime	Supercritical		Critical Depth	1.74	ft
Velocity Downstream	12.67	ft/s	Critical Slope	0.010303	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	2.00	ft
Section Size	24 inch		Rise	2.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	1,214.71	ft	Upstream Velocity Head	1.07	ft
Ke	0.20		Entrance Loss	0.21	ft

Inlet Control Properties					
Inlet Control HW Elev.	1,214.74	ft	Flow Control	N/A	
Inlet Type	Beveled ring, 33.7° bevels		Area Full	3.1	ft²
K	0.00180		HDS 5 Chart	3	
M	2.50000		HDS 5 Scale	B	
C	0.02430		Equation Form	1	
Y	0.83000				

Culvert Designer/Analyzer Report
CULVERT STA 92+24

Design:Trial-2

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	4,256.69	ft	Storm Event	Design	
Computed Headwater Elev	1,214.25	ft	Discharge	24.00	cfs
Headwater Depth/Height	1.02		Tailwater Elevation	N/A	ft
Inlet Control HW Elev.	1,214.14	ft	Control Type	Entrance Control	
Outlet Control HW Elev.	1,214.25	ft			

Grades					
Upstream Invert	1,211.69	ft	Downstream Invert	1,203.00	ft
Length	316.00	ft	Constructed Slope	0.027500	ft/ft

Hydraulic Profile					
Profile	S2		Depth, Downstream	1.03	ft
Slope Type	Steep		Normal Depth	1.03	ft
Flow Regime	Supercritical		Critical Depth	1.67	ft
Velocity Downstream	12.66	ft/s	Critical Slope	0.005553	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	2.50	ft
Section Size	30 inch		Rise	2.50	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	1,214.25	ft	Upstream Velocity Head	0.74	ft
Ke	0.20		Entrance Loss	0.15	ft

Inlet Control Properties					
Inlet Control HW Elev.	1,214.14	ft	Flow Control	N/A	
Inlet Type	Beveled ring, 33.7° bevels		Area Full	4.9	ft²
K	0.00180		HDS 5 Chart	3	
M	2.50000		HDS 5 Scale	B	
C	0.02430		Equation Form	1	
Y	0.83000				

Culvert Designer/Analyzer Report
CULVERT STA 113+27

Peak Discharge Method: User-Specified			
Design Discharge	166.00 cfs	Check Discharge	166.00 cfs
Grades Model: Inverts			
Invert Upstream	1,220.00 ft	Invert Downstream	1,214.00 ft
Length	210.00 ft	Slope	0.028571 ft/ft
Drop	6.00 ft		
Headwater Model: Maximum Allowable HW			
Headwater Elevation	1,225.00 ft		
Tailwater Conditions: Constant Tailwater			
Tailwater Elevation	N/A ft		

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	3-48 inch Circular	166.00 cfs	1,223.60 ft	15.50 ft/s
	Trial-2	2-48 inch Circular	166.00 cfs	1,224.26 ft	16.91 ft/s

Culvert Designer/Analyzer Report
CULVERT STA 113+27

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	1,225.00	ft	Storm Event	Design	
Computed Headwater Elev	1,223.60	ft	Discharge	166.00	cfs
Headwater Depth/Height	0.90		Tailwater Elevation	N/A	ft
Inlet Control HW Elev.	1,223.28	ft	Control Type	Entrance Control	
Outlet Control HW Elev.	1,223.60	ft			

Grades					
Upstream Invert	1,220.00	ft	Downstream Invert	1,214.00	ft
Length	210.00	ft	Constructed Slope	0.028571	ft/ft

Hydraulic Profile					
Profile	S2		Depth, Downstream	1.31	ft
Slope Type	Steep		Normal Depth	1.30	ft
Flow Regime	Supercritical		Critical Depth	2.24	ft
Velocity Downstream	15.50	ft/s	Critical Slope	0.004098	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	4.00	ft
Section Size	48 inch		Rise	4.00	ft
Number Sections	3				

Outlet Control Properties					
Outlet Control HW Elev.	1,223.60	ft	Upstream Velocity Head	0.91	ft
Ke	0.50		Entrance Loss	0.46	ft

Inlet Control Properties					
Inlet Control HW Elev.	1,223.28	ft	Flow Control	Unsubmerged	
Inlet Type	Square edge w/headwall		Area Full	37.7	ft²
K	0.00980		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	1	
C	0.03980		Equation Form	1	
Y	0.67000				

Culvert Designer/Analyzer Report
CULVERT STA 113+27

Design:Trial-2

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	1,225.00	ft	Storm Event	Design	
Computed Headwater Elev	1,224.26	ft	Discharge	166.00	cfs
Headwater Depth/Height	1.07		Tailwater Elevation	N/A	ft
Inlet Control HW Elev.	1,224.10	ft	Control Type	Entrance Control	
Outlet Control HW Elev.	1,224.26	ft			

Grades					
Upstream Invert	1,220.00	ft	Downstream Invert	1,214.00	ft
Length	210.00	ft	Constructed Slope	0.028571	ft/ft

Hydraulic Profile					
Profile	S2		Depth, Downstream	1.65	ft
Slope Type	Steep		Normal Depth	1.61	ft
Flow Regime	Supercritical		Critical Depth	2.76	ft
Velocity Downstream	16.91	ft/s	Critical Slope	0.004944	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	4.00	ft
Section Size	48 inch		Rise	4.00	ft
Number Sections	2				

Outlet Control Properties					
Outlet Control HW Elev.	1,224.26	ft	Upstream Velocity Head	1.25	ft
Ke	0.20		Entrance Loss	0.25	ft

Inlet Control Properties					
Inlet Control HW Elev.	1,224.10	ft	Flow Control	N/A	
Inlet Type	Beveled ring, 33.7° bevels		Area Full	25.1	ft²
K	0.00180		HDS 5 Chart	3	
M	2.50000		HDS 5 Scale	B	
C	0.02430		Equation Form	1	
Y	0.83000				

Bentley Systems, Inc.

Project Name: El Mirage Road, Bell Rd to Beardsley Rd
Prepared by: RCS
Checked by: KA
Date: 7/11/2009

Scour and Riprap Calculations downstream of Culverts

	Sta.	Pipe Size	Outlet Velocity	Outlet Depth	Flow Type	# of Culverts	Total Flow	Per Culvert Peak Flow	Peak Time	D.I	Scour Hole Dim Depth, Width Length		Alpha	Beta	Theta	Recommended Values Hs	Ws	Ls
H	20+28	2.5	12.52	2.12	Super	2	79	39.5	10	0.70	Hs =	2.96	1.78	0.45	0.04			
									10		Ws =	11.93	9.13	0.62	0.08			
									10		Ls =	13.40	14.36	0.95	0.12	3	12	13
G	39+51	2.5	9.8	1.89	Super	4	123	30.75	10	0.55	Hs =	2.96	1.78	0.45	0.04			
									10		Ws =	11.93	9.13	0.62	0.08			
									10		Ls =	13.40	14.36	0.95	0.12	3	12	14
F	51+90	3	13.91	2.8	Super	1	83	83	10	0.94	Hs =	4.52	1.78	0.45	0.04			
									10		Ws =	19.97	9.13	0.62	0.08			
									10		Ls =	26.79	14.36	0.95	0.12	5	20	27
E	75+06	2.5	16.1	2.14	Super	2	81	40.5	10	0.72	Hs =	3.35	1.78	0.45	0.04			
									10		Ws =	14.15	9.13	0.62	0.08			
									10		Ls =	17.41	14.36	0.95	0.12	3.5	14	17
D	77+50	2	13.08	1.88	Super	2	63	31.5	10	0.98	Hs =	3.07	1.78	0.45	0.04			
									10		Ws =	13.69	9.13	0.62	0.08			
									10		Ls =	18.64	14.36	0.95	0.12	3	14	19
C	87+90	2.5	17.85	1.67	Super	1	24	24	10	0.43	Hs =	2.65	1.78	0.45	0.04			
									10		Ws =	13.69	9.13	0.62	0.08			
									10		Ls =	10.59	14.36	0.95	0.12	3	14	11
B	92+24	2.5	12.66	1.03	Super	1	24	24	10	0.43	Hs =	2.65	1.78	0.45	0.04			
									10		Ws =	10.23	9.13	0.62	0.08			
									10		Ls =	10.59	14.36	0.95	0.12	3	10	11
A	113+27	4	15.5	1.5	Super	3	166	55.33333	10	0.30	Hs =	3.63	1.78	0.45	0.04			
									10		Ws =	13.26	9.13	0.62	0.08			
									10		Ls =	12.27	14.36	0.95	0.12	4	9	14

Assume downstream channel to be uniform gravel material
Calculations Based on FCD Hydraulics Manual, Vol. II, Jan. 28, 1996 Edition
Assume peak flow time to be 10 minutes based on hydrology calculations
Length of the apron provided in the plans were based on available rights-of-way. Riprap size were increased to compensate for shorter aprons.

APPENDIX E

EXISTING & PROPOSED HEC RAS MODELS

EXIST. COND. MODEL

existfcdmodel.rep

HEC-RAS Version 3.1.3 May 2005
U.S. Army Corp of Engineers
Hydrologic Engineering Center
609 Second Street
Davis, California

```
X     X  XXXXXX    XXXX         XXXX        XX      XXXX
X     X  X        X    X       X   X      X  X    X
X     X  X        X            X   X     X    X   X
XXXXXXX  XXXX     X       XXX  XXXX      XXXXXX    XXXX
X     X  X        X            X  X      X    X        X
X     X  X        X    X       X   X     X    X        X
X     X  XXXXXX    XXXX        X    X    X    X   XXXXX
```

```
*******************************************************************************

PROJECT DATA
Project Title: Existing FCD Floodplain Model
Project File : existfcdmodel.prj
Run Date and Time: 4/18/2007 5:06:11 PM

Project in English units

Project Description:
HEC-2 FLOODPLAIN AND FLOODWAY ANALYSIS - WITTMANN ADMS
      100-YEAR
STORM EVENT (NO ENCROACHMENT)
      MCMICKEN DAM OUTLET WASH



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

PLAN DATA

Plan Title: Converted from 1929 to 1988 Datum
Plan File : m:\Jobs\2005\05036-El Mirage Road On-Call\Engineering\HEC RAS\el mirage_cse\existfcdmodel.p02

            Geometry Title: Imported Geom 01
            Geometry File : m:\Jobs\2005\05036-El Mirage Road On-Call\Engineering\HEC RAS\el
mirage_cse\existfcdmodel.g02

            Flow Title    : Imported Flow 01
            Flow File     : m:\Jobs\2005\05036-El Mirage Road On-Call\Engineering\HEC RAS\el
mirage_cse\existfcdmodel.f01

Plan Summary Information:
Number of:  Cross Sections =   55    Multiple Openings  =    0
            Culverts       =    0    Inline Structures  =    0
            Bridges        =    0    Lateral Structures =    0

Computational Information
    Water surface calculation tolerance  =  0.01
    Critical depth calculation tolerance =  0.01
    Maximum number of iterations         =  20
    Maximum difference tolerance         =  0.3
    Flow tolerance factor                =  0.001

Computation Options
    Critical depth computed only where necessary
    Conveyance Calculation Method: At breaks in n values only
    Friction Slope Method:         Average Conveyance
    Computational Flow Regime:     Subcritical Flow

Encroachment Data
   Equal Conveyance = True
   Left Offset      =        0
   Right Offset     =        0

River = RIVER-1          Reach = Reach-1
RS      Profile           Method  Value1  Value2
```

0	PF 2	4	1	
0.107	PF 2	4	1	
0.159	PF 2	4	1	
0.238	PF 2	4	1	
0.35	PF 2	4	1	
0.437	PF 2	4	1	
0.527	PF 2	4	1	
0.579	PF 2	4	1	
0.647	PF 2	4	1	
0.746	PF 2	4	1	
0.833	PF 2	4	1	
0.946	PF 2	4	1	
1.058	PF 2	4	1	
1.169	PF 2	4	1	
1.191	PF 2	4	1	
1.213	PF 2	4	1	
1.251	PF 2	4	1	
1.286	PF 2	4	1	
1.307	PF 2	4	1	
1.381	PF 2	4	1	
1.479	PF 2	4	1	
1.593	PF 2	4	1	
1.708	PF 2	4	1	
1.788	PF 2	4	1	
1.858	PF 2	4	1	
1.949	PF 2	4	1	
2.034	PF 2	1	4970	5150
2.118	PF 2	1	4945	5145
2.208	PF 2	1	4835	5050
2.31	PF 2	1	4850	5050
2.395	PF 2	1	4880	5100
2.486	PF 2	1	4900	5085
2.588	PF 2	1	4895	5105
2.691	PF 2	1	4975	5165
2.774	PF 2	1	4950	5130
2.867	PF 2	1	4920	5160
2.937	PF 2	1	4860	5190
3.011	PF 2	1	4930	5280
3.14	PF 2	1	4870	5235
3.247	PF 2	1	4900	5200
3.354	PF 2	1	4830	5140
3.465	PF 2	1	4750	5070
3.563	PF 2	1	4700	5040
3.656	PF 2	1	4650	5100
3.737	PF 2	1	4750	5100
3.816	PF 2	1	4720	5100
3.879	PF 2	1	4850	5150
3.945	PF 2	1	4850	5090
4.015	PF 2	1	4957	5099
4.053	PF 2	1	4950	5197
4.148	PF 2	1	4953	5370
4.254	PF 2	1	4960	5303
4.36	PF 2	1	4866	5234
4.457	PF 2	1	4795	5185
4.554	PF 2	1	4890	5162

River = RIVER-1 Reach = Reach-1

RS	Profile	Method	Value1	Value2
0	PF 3	0	0	0
0.107	PF 3	0	0	0
0.159	PF 3	0	0	0
0.238	PF 3	0	0	0
0.35	PF 3	0	0	0
0.437	PF 3	0	0	0
0.527	PF 3	0	0	0
0.579	PF 3	0	0	0
0.647	PF 3	0	0	0
0.746	PF 3	0	0	0
0.833	PF 3	0	0	0
0.946	PF 3	0	0	0
1.058	PF 3	0	0	0
1.169	PF 3	0	0	0
1.191	PF 3	0	0	0
1.213	PF 3	0	0	0

1.251	PF 3	0	0	0
1.286	PF 3	0	0	0
1.307	PF 3	0	0	0
1.381	PF 3	0	0	0
1.479	PF 3	0	0	0
1.593	PF 3	0	0	0
1.708	PF 3	0	0	0
1.788	PF 3	0	0	0
1.858	PF 3	0	0	0
1.949	PF 3	0	0	0
2.034	PF 3	0	0	0
2.118	PF 3	0	0	0
2.208	PF 3	0	0	0
2.31	PF 3	0	0	0
2.395	PF 3	0	0	0
2.486	PF 3	0	0	0
2.588	PF 3	0	0	0
2.691	PF 3	0	0	0
2.774	PF 3	0	0	0
2.867	PF 3	0	0	0
2.937	PF 3	0	0	0
3.011	PF 3	0	0	0
3.14	PF 3	0	0	0
3.247	PF 3	0	0	0
3.354	PF 3	0	0	0
3.465	PF 3	0	0	0
3.563	PF 3	0	0	0
3.656	PF 3	0	0	0
3.737	PF 3	0	0	0
3.816	PF 3	0	0	0
3.879	PF 3	0	0	0
3.945	PF 3	0	0	0
4.015	PF 3	0	0	0
4.053	PF 3	0	0	0
4.148	PF 3	0	0	0
4.254	PF 3	0	0	0
4.36	PF 3	0	0	0
4.457	PF 3	0	0	0
4.554	PF 3	0	0	0

River = RIVER-1 Reach = Reach-1

RS	Profile	Method	Value1	Value2
0	PF 4	0	0	0
0.107	PF 4	0	0	0
0.159	PF 4	0	0	0
0.238	PF 4	0	0	0
0.35	PF 4	0	0	0
0.437	PF 4	0	0	0
0.527	PF 4	0	0	0
0.579	PF 4	0	0	0
0.647	PF 4	0	0	0
0.746	PF 4	0	0	0
0.833	PF 4	0	0	0
0.946	PF 4	0	0	0
1.058	PF 4	0	0	0
1.169	PF 4	0	0	0
1.191	PF 4	0	0	0
1.213	PF 4	0	0	0
1.251	PF 4	0	0	0
1.286	PF 4	0	0	0
1.307	PF 4	0	0	0
1.381	PF 4	0	0	0
1.479	PF 4	0	0	0
1.593	PF 4	0	0	0
1.708	PF 4	0	0	0
1.788	PF 4	0	0	0
1.858	PF 4	0	0	0
1.949	PF 4	0	0	0
2.034	PF 4	0	0	0
2.118	PF 4	0	0	0
2.208	PF 4	0	0	0
2.31	PF 4	0	0	0
2.395	PF 4	0	0	0
2.486	PF 4	0	0	0

2.588	PF 4	0	0	0
2.691	PF 4	0	0	0
2.774	PF 4	0	0	0
2.867	PF 4	0	0	0
2.937	PF 4	0	0	0
3.011	PF 4	0	0	0
3.14	PF 4	0	0	0
3.247	PF 4	0	0	0
3.354	PF 4	0	0	0
3.465	PF 4	0	0	0
3.563	PF 4	0	0	0
3.656	PF 4	0	0	0
3.737	PF 4	0	0	0
3.816	PF 4	0	0	0
3.879	PF 4	0	0	0
3.945	PF 4	0	0	0
4.015	PF 4	0	0	0
4.053	PF 4	0	0	0
4.148	PF 4	0	0	0
4.254	PF 4	0	0	0
4.36	PF 4	0	0	0
4.457	PF 4	0	0	0
4.554	PF 4	0	0	0

Profile Output Table - Standard Table 1

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Reach-1	4.554	PF 1	5087.00	1307.75	1316.19		1316.29	0.000360	2.72	2843.94	807.63	0.19
Reach-1	4.554	PF 2	11000.00	1307.75	1319.60		1319.91	0.000585	4.45	2471.30	264.73	0.26
Reach-1	4.554	PF 3	14000.00	1307.75	1319.94		1320.09	0.000376	3.71	6972.38	1192.78	0.21
Reach-1	4.457	PF 1	5087.00	1307.45	1316.05		1316.12	0.000290	2.27	3439.52	1223.89	0.17
Reach-1	4.457	PF 2	11000.00	1307.45	1319.45		1319.63	0.000393	3.46	3179.78	373.48	0.21
Reach-1	4.457	PF 3	14000.00	1307.45	1319.84		1319.93	0.000244	2.83	8738.31	1463.07	0.17
Reach-1	4.36	PF 1	5087.00	1306.95	1315.90		1315.97	0.000279	2.22	3515.72	1125.57	0.17
Reach-1	4.36	PF 2	11000.00	1306.95	1319.23		1319.43	0.000403	3.53	3113.01	360.07	0.21
Reach-1	4.36	PF 3	14000.00	1306.95	1319.72		1319.80	0.000241	2.86	8804.50	1487.79	0.17
Reach-1	4.254	PF 1	5087.00	1306.75	1315.41		1315.65	0.001398	3.96	1368.51	456.05	0.35
Reach-1	4.254	PF 2	11000.00	1306.75	1318.75		1319.09	0.000907	4.65	2363.59	334.21	0.31
Reach-1	4.254	PF 3	14000.00	1306.75	1319.34		1319.58	0.000710	4.36	5181.55	1146.54	0.28
Reach-1	4.148	PF 1	5087.00	1306.45	1315.29		1315.35	0.000213	2.02	3141.46	913.98	0.15
Reach-1	4.148	PF 2	11000.00	1306.45	1318.65		1318.78	0.000257	2.93	3755.71	411.89	0.17
Reach-1	4.148	PF 3	14000.00	1306.45	1319.23		1319.33	0.000219	2.84	7433.88	1145.17	0.16

* Reach-1	* 4.053	* PF 1	* 5087.00 *	1305.45 *	1314.65 *	*	1315.07 *
0.002342 *	5.15 *	1025.44 *	363.94 *	0.45 *			
* Reach-1	* 4.053	* PF 2	* 11000.00 *	1305.45 *	1317.88 *	*	1318.47 *
0.001591 *	6.17 *	1781.61 *	247.00 *	0.41 *			
* Reach-1	* 4.053	* PF 3	* 14000.00 *	1305.45 *	1318.62 *	*	1319.08 *
0.001228 *	5.91 *	3683.97 *	891.52 *	0.37 *			
*	*	*	* *	*	*	*	*
*	*	*	*	*			
* Reach-1	* 4.015	* PF 1	* 5087.00 *	1304.95 *	1313.78 *	*	1314.53 *
0.002684 *	6.97 *	730.07 *	127.59 *	0.51 *			
* Reach-1	* 4.015	* PF 2	* 11000.00 *	1304.95 *	1316.20 *	*	1317.87 *
0.004291 *	10.39 *	1058.71 *	142.00 *	0.67 *			
* Reach-1	* 4.015	* PF 3	* 14000.00 *	1304.95 *	1316.27 *	1316.27 *	1318.45 *
0.005726 *	12.22 *	1330.86 *	409.72 *	0.78 *			
*	*	*	* *	*	*	*	*
*	*	*	*	*			
* Reach-1	* 3.945	* PF 1	* 6023.00 *	1303.95 *	1312.35 *	1311.75 *	1313.20 *
0.004268 *	8.12 *	1268.68 *	544.45 *	0.64 *			
* Reach-1	* 3.945	* PF 2	* 11000.00 *	1303.95 *	1314.59 *	1313.41 *	1316.11 *
0.004657 *	10.67 *	1387.11 *	240.00 *	0.70 *			
* Reach-1	* 3.945	* PF 3	* 14000.00 *	1303.95 *	1314.77 *	1314.09 *	1315.74 *
0.003666 *	9.77 *	2963.51 *	998.68 *	0.63 *			
*	*	*	* *	*	*	*	*
*	*	*	*	*			
* Reach-1	* 3.879	* PF 1	* 6023.00 *	1300.95 *	1311.04 *	*	1311.57 *
0.004109 *	6.25 *	1225.25 *	381.82 *	0.45 *			
* Reach-1	* 3.879	* PF 2	* 11000.00 *	1300.95 *	1313.67 *	*	1314.39 *
0.003505 *	7.37 *	1867.43 *	300.00 *	0.44 *			
* Reach-1	* 3.879	* PF 3	* 14000.00 *	1300.95 *	1312.83 *	*	1313.89 *
0.006582 *	9.43 *	2460.05 *	1005.59 *	0.60 *			
*	*	*	* *	*	*	*	*
*	*	*	*	*			
* Reach-1	* 3.816	* PF 1	* 6023.00 *	1298.45 *	1309.75 *	*	1310.24 *
0.004003 *	7.11 *	1858.85 *	996.50 *	0.46 *			
* Reach-1	* 3.816	* PF 2	* 11000.00 *	1298.45 *	1312.35 *	*	1313.11 *
0.004220 *	8.89 *	2051.59 *	380.00 *	0.49 *			
* Reach-1	* 3.816	* PF 3	* 14000.00 *	1298.45 *	1311.39 *	*	1311.91 *
0.004638 *	8.72 *	3629.65 *	1151.83 *	0.51 *			
*	*	*	* *	*	*	*	*
*	*	*	*	*			
* Reach-1	* 3.737	* PF 1	* 6023.00 *	1296.45 *	1307.07 *	*	1307.85 *
0.008062 *	9.36 *	1469.46 *	855.52 *	0.63 *			
* Reach-1	* 3.737	* PF 2	* 11000.00 *	1296.45 *	1309.07 *	*	1310.40 *
0.009683 *	12.16 *	1561.48 *	350.00 *	0.72 *			
* Reach-1	* 3.737	* PF 3	* 14000.00 *	1296.45 *	1308.95 *	*	1309.53 *
0.006386 *	9.79 *	3279.65 *	1053.58 *	0.58 *			
*	*	*	* *	*	*	*	*
*	*	*	*	*			
* Reach-1	* 3.656	* PF 1	* 6023.00 *	1293.95 *	1304.85 *	*	1305.23 *
0.004401 *	6.54 *	1819.04 *	790.83 *	0.46 *			
* Reach-1	* 3.656	* PF 2	* 11000.00 *	1293.95 *	1307.91 *	*	1308.26 *
0.002399 *	6.30 *	2756.75 *	450.00 *	0.36 *			
* Reach-1	* 3.656	* PF 3	* 14000.00 *	1293.95 *	1306.77 *	*	1307.21 *
0.004397 *	7.82 *	3470.26 *	910.62 *	0.48 *			
*	*	*	* *	*	*	*	*
*	*	*	*	*			
* Reach-1	* 3.563	* PF 1	* 6023.00 *	1292.45 *	1302.23 *	*	1302.85 *
0.005298 *	8.06 *	1596.19 *	757.64 *	0.52 *			
* Reach-1	* 3.563	* PF 2	* 11000.00 *	1292.45 *	1304.88 *	*	1306.26 *
0.007247 *	11.55 *	1599.00 *	340.00 *	0.64 *			
* Reach-1	* 3.563	* PF 3	* 14000.00 *	1292.45 *	1304.03 *	*	1304.70 *
0.005933 *	9.85 *	3178.34 *	979.32 *	0.57 *			
*	*	*	* *	*	*	*	*
*	*	*	*	*			
* Reach-1	* 3.465	* PF 1	* 6023.00 *	1290.45 *	1299.36 *	*	1299.94 *
0.006301 *	7.86 *	1552.00 *	750.36 *	0.56 *			
* Reach-1	* 3.465	* PF 2	* 11000.00 *	1290.45 *	1301.93 *	*	1302.84 *
0.005938 *	9.63 *	1766.68 *	320.00 *	0.57 *			
* Reach-1	* 3.465	* PF 3	* 14000.00 *	1290.45 *	1301.66 *	*	1302.12 *
0.004446 *	8.16 *	3549.42 *	983.88 *	0.49 *			
*	*	*	* *	*	*	*	*
*	*	*	*	*			
* Reach-1	* 3.354	* PF 1	* 6023.00 *	1288.25 *	1296.98 *	*	1297.35 *
0.003087 *	5.90 *	1721.57 *	595.40 *	0.40 *			

* Reach-1	* 3.354	* PF 2	* 11000.00 *	1288.25 *	1299.13 *	*	1299.88 *
0.004153 *	8.22 *	1898.60 *	310.00 *	0.48 *			
* Reach-1	* 3.354	* PF 3	* 14000.00 *	1288.25 *	1299.33 *	*	1299.82 *
0.003390 *	7.53 *	3357.25 *	770.71 *	0.44 *			
*	*	*	*	*	*	*	*
* Reach-1	* 3.247	* PF 1	* 6023.00 *	1284.25 *	1293.62 *	*	1294.69 *
0.007627 *	9.67 *	1141.77 *	546.42 *	0.63 *			
* Reach-1	* 3.247	* PF 2	* 11000.00 *	1284.25 *	1296.20 *	*	1297.18 *
0.005494 *	10.02 *	1744.28 *	300.00 *	0.56 *			
* Reach-1	* 3.247	* PF 3	* 14000.00 *	1284.25 *	1295.49 *	*	1296.78 *
0.009301 *	12.40 *	2408.31 *	781.23 *	0.72 *			
*	*	*	*	*	*	*	*
* Reach-1	* 3.14	* PF 1	* 6023.00 *	1282.25 *	1290.66 *	*	1291.05 *
0.004803 *	6.83 *	1783.18 *	775.79 *	0.49 *			
* Reach-1	* 3.14	* PF 2	* 11000.00 *	1282.25 *	1293.31 *	*	1294.07 *
0.005119 *	8.96 *	1953.95 *	365.00 *	0.53 *			
* Reach-1	* 3.14	* PF 3	* 14000.00 *	1282.25 *	1292.82 *	*	1293.20 *
0.003843 *	7.47 *	3571.12 *	850.00 *	0.46 *			
*	*	*	*	*	*	*	*
* Reach-1	* 3.011	* PF 1	* 6023.00 *	1278.95 *	1287.86 *	*	1288.15 *
0.004333 *	6.21 *	1714.44 *	567.59 *	0.45 *			
* Reach-1	* 3.011	* PF 2	* 11000.00 *	1278.95 *	1290.53 *	*	1291.05 *
0.004188 *	7.87 *	2162.36 *	350.00 *	0.48 *			
* Reach-1	* 3.011	* PF 3	* 14000.00 *	1278.95 *	1290.11 *	*	1290.54 *
0.004736 *	8.08 *	3254.70 *	789.26 *	0.50 *			
*	*	*	*	*	*	*	*
* Reach-1	* 2.937	* PF 1	* 6023.00 *	1277.95 *	1285.91 *	*	1286.28 *
0.004768 *	6.71 *	1680.36 *	615.10 *	0.48 *			
* Reach-1	* 2.937	* PF 2	* 11000.00 *	1277.95 *	1288.93 *	*	1289.46 *
0.003578 *	7.64 *	2177.01 *	330.00 *	0.45 *			
* Reach-1	* 2.937	* PF 3	* 14000.00 *	1277.95 *	1288.07 *	*	1288.56 *
0.004913 *	8.37 *	3129.61 *	735.26 *	0.52 *			
*	*	*	*	*	*	*	*
* Reach-1	* 2.867	* PF 1	* 6023.00 *	1275.95 *	1284.38 *	*	1284.74 *
0.003337 *	5.36 *	1672.58 *	670.28 *	0.40 *			
* Reach-1	* 2.867	* PF 2	* 11000.00 *	1275.95 *	1287.24 *	*	1288.00 *
0.003597 *	7.34 *	1708.23 *	240.00 *	0.45 *			
* Reach-1	* 2.867	* PF 3	* 14000.00 *	1275.95 *	1286.19 *	*	1286.77 *
0.004412 *	7.44 *	3100.17 *	872.60 *	0.48 *			
*	*	*	*	*	*	*	*
* Reach-1	* 2.774	* PF 1	* 6023.00 *	1272.45 *	1281.25 *	*	1282.21 *
0.008983 *	8.79 *	1092.16 *	551.68 *	0.66 *			
* Reach-1	* 2.774	* PF 2	* 11000.00 *	1272.45 *	1283.82 *	*	1285.40 *
0.008442 *	10.98 *	1211.93 *	180.00 *	0.68 *			
* Reach-1	* 2.774	* PF 3	* 14000.00 *	1272.45 *	1284.00 *	*	1284.62 *
0.004812 *	8.41 *	2955.45 *	757.86 *	0.51 *			
*	*	*	*	*	*	*	*
* Reach-1	* 2.691	* PF 1	* 6023.00 *	1270.95 *	1279.21 *	*	1279.69 *
0.003516 *	5.90 *	1293.29 *	377.50 *	0.42 *			
* Reach-1	* 2.691	* PF 2	* 11000.00 *	1270.95 *	1281.80 *	*	1282.71 *
0.003949 *	7.90 *	1523.47 *	190.00 *	0.47 *			
* Reach-1	* 2.691	* PF 3	* 14000.00 *	1270.95 *	1281.71 *	*	1282.53 *
0.004334 *	8.22 *	2432.53 *	518.00 *	0.49 *			
*	*	*	*	*	*	*	*
* Reach-1	* 2.588	* PF 1	* 6023.00 *	1267.45 *	1275.74 *	*	1276.84 *
0.008441 *	9.58 *	1011.25 *	406.03 *	0.65 *			
* Reach-1	* 2.588	* PF 2	* 11000.00 *	1267.45 *	1278.54 *	*	1279.90 *
0.006900 *	10.95 *	1395.84 *	210.00 *	0.63 *			
* Reach-1	* 2.588	* PF 3	* 14000.00 *	1267.45 *	1278.18 *	*	1279.39 *
0.008079 *	11.55 *	2297.93 *	621.26 *	0.67 *			
*	*	*	*	*	*	*	*
* Reach-1	* 2.486	* PF 1	* 6023.00 *	1264.95 *	1272.67 *	*	1273.19 *
0.005074 *	6.37 *	1282.23 *	431.03 *	0.49 *			
* Reach-1	* 2.486	* PF 2	* 11000.00 *	1264.95 *	1275.31 *	*	1276.46 *
0.005720 *	8.87 *	1350.66 *	185.00 *	0.56 *			

* Reach-1	* 2.486	* PF 3	* 14000.00 *	1264.95 *	1275.67 *	*	1276.29 *
0.003914 *	7.56 *	2863.73 *	640.75 *	0.46 *			
*	*	*	* *	*	*	*	*
* Reach-1	* 2.395	* PF 1	* 6023.00 *	1260.45 *	1270.31 *	*	1270.90 *
0.004432 *	7.21 *	1274.30 *	356.61 *	0.48 *			
* Reach-1	* 2.395	* PF 2	* 11000.00 *	1260.45 *	1273.30 *	*	1274.13 *
0.003871 *	8.53 *	1724.81 *	220.00 *	0.48 *			
* Reach-1	* 2.395	* PF 3	* 14000.00 *	1260.45 *	1273.30 *	*	1274.17 *
0.004766 *	9.47 *	2641.53 *	625.00 *	0.53 *			
*	*	*	* *	*	*	*	*
* Reach-1	* 2.31	* PF 1	* 6023.00 *	1257.45 *	1267.93 *	*	1268.62 *
0.005835 *	8.32 *	1226.72 *	366.75 *	0.55 *			
* Reach-1	* 2.31	* PF 2	* 11000.00 *	1257.45 *	1270.77 *	*	1271.96 *
0.006055 *	10.59 *	1473.31 *	200.00 *	0.59 *			
* Reach-1	* 2.31	* PF 3	* 14000.00 *	1257.45 *	1271.01 *	*	1271.89 *
0.005470 *	10.22 *	2562.55 *	607.33 *	0.56 *			
*	*	*	* *	*	*	*	*
* Reach-1	* 2.208	* PF 1	* 6023.00 *	1254.95 *	1265.82 *	*	1266.25 *
0.003228 *	6.60 *	1395.42 *	314.90 *	0.41 *			
* Reach-1	* 2.208	* PF 2	* 11000.00 *	1254.95 *	1268.86 *	*	1269.52 *
0.003121 *	8.06 *	1893.80 *	215.00 *	0.43 *			
* Reach-1	* 2.208	* PF 3	* 14000.00 *	1254.95 *	1268.66 *	*	1269.34 *
0.003934 *	8.94 *	2718.81 *	504.88 *	0.48 *			
*	*	*	* *	*	*	*	*
* Reach-1	* 2.118	* PF 1	* 6273.00 *	1252.95 *	1263.82 *	*	1264.30 *
0.005298 *	6.78 *	1389.10 *	406.91 *	0.50 *			
* Reach-1	* 2.118	* PF 2	* 11000.00 *	1252.95 *	1266.34 *	*	1267.42 *
0.006261 *	9.40 *	1442.36 *	200.00 *	0.57 *			
* Reach-1	* 2.118	* PF 3	* 14000.00 *	1252.95 *	1266.89 *	*	1267.43 *
0.004002 *	7.84 *	3157.04 *	767.88 *	0.47 *			
*	*	*	* *	*	*	*	*
* Reach-1	* 2.034	* PF 1	* 6273.00 *	1249.45 *	1260.56 *	1259.76 *	1261.57 *
0.008167 *	9.74 *	978.71 *	236.60 *	0.63 *			
* Reach-1	* 2.034	* PF 2	* 11000.00 *	1249.45 *	1262.67 *	1261.39 *	1264.24 *
0.009343 *	12.20 *	1257.16 *	180.00 *	0.68 *			
* Reach-1	* 2.034	* PF 3	* 14000.00 *	1249.45 *	1263.66 *	1261.94 *	1265.07 *
0.008495 *	12.21 *	1809.99 *	313.54 *	0.68 *			
*	*	*	* *	*	*	*	*
* Reach-1	* 1.949	* PF 1	* 6273.00 *	1248.95 *	1254.41 *	1254.12 *	1256.04 *
0.019756 *	10.23 *	613.41 *	159.12 *	0.92 *			
* Reach-1	* 1.949	* PF 2	* 11000.00 *	1248.95 *	1256.27 *	1256.03 *	1258.35 *
0.019011 *	11.57 *	950.77 *	198.74 *	0.93 *			
* Reach-1	* 1.949	* PF 3	* 14000.00 *	1248.95 *	1257.09 *	1256.90 *	1259.52 *
0.018333 *	12.53 *	1129.15 *	226.71 *	0.94 *			
*	*	*	* *	*	*	*	*
* Reach-1	* 1.858	* PF 1	* 6273.00 *	1245.75 *	1251.45 *	*	1252.09 *
0.004005 *	6.41 *	978.94 *	216.48 *	0.53 *			
* Reach-1	* 1.858	* PF 2	* 11000.00 *	1245.75 *	1253.37 *	*	1254.31 *
0.004142 *	7.76 *	1417.34 *	240.91 *	0.56 *			
* Reach-1	* 1.858	* PF 3	* 14000.00 *	1245.75 *	1254.38 *	*	1255.48 *
0.004126 *	8.40 *	1669.40 *	264.91 *	0.57 *			
*	*	*	* *	*	*	*	*
* Reach-1	* 1.788	* PF 1	* 6273.00 *	1243.95 *	1249.47 *	*	1250.30 *
0.005780 *	7.30 *	859.39 *	205.83 *	0.63 *			
* Reach-1	* 1.788	* PF 2	* 11000.00 *	1243.95 *	1251.34 *	*	1252.53 *
0.005478 *	8.76 *	1256.17 *	219.51 *	0.65 *			
* Reach-1	* 1.788	* PF 3	* 14000.00 *	1243.95 *	1252.32 *	*	1253.72 *
0.005338 *	9.49 *	1485.35 *	260.92 *	0.65 *			
*	*	*	* *	*	*	*	*
* Reach-1	* 1.708	* PF 1	* 6273.00 *	1241.95 *	1247.34 *	*	1248.08 *
0.004643 *	6.87 *	913.19 *	202.94 *	0.57 *			
* Reach-1	* 1.708	* PF 2	* 11000.00 *	1241.95 *	1249.32 *	*	1250.39 *
0.004495 *	8.27 *	1329.50 *	217.71 *	0.59 *			
* Reach-1	* 1.708	* PF 3	* 14000.00 *	1241.95 *	1250.35 *	*	1251.61 *
0.004460 *	8.99 *	1559.71 *	237.54 *	0.60 *			

* Reach-1	* 1.593	* PF 1	* 6273.00 *	1239.45 *	1245.04 *	*	1245.63 *
0.003440 *	6.18 *	1015.61 *	211.48 *	0.50 *			
* Reach-1	* 1.593	* PF 2	* 11000.00 *	1239.45 *	1247.07 *	*	1247.95 *
0.003470 *	7.52 *	1462.46 *	227.68 *	0.52 *			
* Reach-1	* 1.593	* PF 3	* 14000.00 *	1239.45 *	1248.07 *	*	1249.13 *
0.003605 *	8.27 *	1693.05 *	237.86 *	0.54 *			
* Reach-1	* 1.479	* PF 1	* 6273.00 *	1237.45 *	1242.94 *	*	1243.54 *
0.003504 *	6.20 *	1015.74 *	220.78 *	0.50 *			
* Reach-1	* 1.479	* PF 2	* 11000.00 *	1237.45 *	1244.93 *	*	1245.83 *
0.003568 *	7.62 *	1444.03 *	222.88 *	0.53 *			
* Reach-1	* 1.479	* PF 3	* 14000.00 *	1237.45 *	1245.88 *	*	1246.95 *
0.003604 *	8.35 *	1720.13 *	258.61 *	0.55 *			
* Reach-1	* 1.381	* PF 1	* 6273.00 *	1235.45 *	1241.30 *	*	1241.84 *
0.003039 *	5.88 *	1067.67 *	218.53 *	0.47 *			
* Reach-1	* 1.381	* PF 2	* 11000.00 *	1235.45 *	1243.24 *	*	1244.07 *
0.003167 *	7.33 *	1501.43 *	225.00 *	0.50 *			
* Reach-1	* 1.381	* PF 3	* 14000.00 *	1235.45 *	1244.14 *	*	1245.17 *
0.003278 *	8.17 *	1761.76 *	286.62 *	0.52 *			
* Reach-1	* 1.307	* PF 1	* 6273.00 *	1234.25 *	1238.64 *	1238.21 *	1239.77 *
0.010391 *	8.56 *	737.12 *	228.71 *	0.82 *			
* Reach-1	* 1.307	* PF 2	* 11000.00 *	1234.25 *	1239.74 *	1239.56 *	1241.74 *
0.012878 *	11.35 *	968.83 *	215.00 *	0.94 *			
* Reach-1	* 1.307	* PF 3	* 14000.00 *	1234.25 *	1240.36 *	1240.36 *	1242.76 *
0.012862 *	12.51 *	1161.24 *	260.16 *	0.97 *			
* Reach-1	* 1.286	* PF 1	* 6273.00 *	1232.95 *	1236.85 *	1236.85 *	1238.28 *
0.016563 *	9.58 *	654.48 *	230.25 *	1.00 *			
* Reach-1	* 1.286	* PF 2	* 11000.00 *	1232.95 *	1238.18 *	1238.18 *	1240.17 *
0.014932 *	11.30 *	973.64 *	247.19 *	1.00 *			
* Reach-1	* 1.286	* PF 3	* 14000.00 *	1232.95 *	1238.91 *	1238.91 *	1241.19 *
0.013905 *	12.12 *	1165.23 *	275.19 *	0.99 *			
* Reach-1	* 1.251	* PF 1	* 6273.00 *	1220.95 *	1224.75 *	1224.75 *	1226.31 *
0.004067 *	10.03 *	625.52 *	202.41 *	1.01 *			
* Reach-1	* 1.251	* PF 2	* 11000.00 *	1220.95 *	1226.19 *	1226.19 *	1228.39 *
0.003655 *	11.88 *	925.60 *	213.94 *	1.01 *			
* Reach-1	* 1.251	* PF 3	* 14000.00 *	1220.95 *	1227.01 *	1227.01 *	1229.51 *
0.003440 *	12.69 *	1102.82 *	220.47 *	1.00 *			
* Reach-1	* 1.213	* PF 1	* 6273.00 *	1210.95 *	1219.54 *	*	1219.83 *
0.000290 *	4.33 *	1447.26 *	226.35 *	0.30 *			
* Reach-1	* 1.213	* PF 2	* 11000.00 *	1210.95 *	1221.47 *	*	1221.99 *
0.000391 *	5.80 *	1895.80 *	238.89 *	0.36 *			
* Reach-1	* 1.213	* PF 3	* 14000.00 *	1210.95 *	1222.50 *	*	1223.16 *
0.000428 *	6.53 *	2143.67 *	245.16 *	0.39 *			
* Reach-1	* 1.191	* PF 1	* 6273.00 *	1210.45 *	1218.03 *	1218.03 *	1219.62 *
0.004122 *	10.13 *	619.29 *	197.95 *	1.01 *			
* Reach-1	* 1.191	* PF 2	* 11000.00 *	1210.45 *	1219.50 *	1219.50 *	1221.72 *
0.003675 *	11.96 *	919.66 *	209.98 *	1.01 *			
* Reach-1	* 1.191	* PF 3	* 14000.00 *	1210.45 *	1220.31 *	1220.31 *	1222.86 *
0.003503 *	12.82 *	1091.91 *	216.57 *	1.01 *			
* Reach-1	* 1.169	* PF 1	* 6273.00 *	1209.45 *	1215.24 *	*	1216.20 *
0.001601 *	7.88 *	796.27 *	183.76 *	0.67 *			
* Reach-1	* 1.169	* PF 2	* 11000.00 *	1209.45 *	1217.06 *	*	1218.49 *
0.001634 *	9.60 *	1145.38 *	199.04 *	0.71 *			
* Reach-1	* 1.169	* PF 3	* 14000.00 *	1209.45 *	1218.05 *	*	1219.73 *
0.001630 *	10.39 *	1346.97 *	207.35 *	0.72 *			

* Reach-1	* 1.058	* PF 1	* 6273.00 *	1206.95 *	1214.04 *		*	1214.70 *
0.004054 *	6.52 *	961.39 *	208.81 *	0.54 *				
* Reach-1	* 1.058	* PF 2	* 11000.00 *	1206.95 *	1215.90 *		*	1216.91 *
0.004221 *	8.07 *	1362.56 *	221.17 *	0.57 *				
* Reach-1	* 1.058	* PF 3	* 14000.00 *	1206.95 *	1216.94 *		*	1218.13 *
0.004212 *	8.77 *	1595.81 *	228.05 *	0.58 *				
*	*	*	*	*	*	*	*	*
*	*	*	*	*				
* Reach-1	* 0.946	* PF 1	* 6522.00 *	1204.45 *	1211.48 *		*	1212.21 *
0.004347 *	6.88 *	948.57 *	200.73 *	0.56 *				
* Reach-1	* 0.946	* PF 2	* 11000.00 *	1204.45 *	1213.36 *		*	1214.41 *
0.004227 *	8.22 *	1337.72 *	210.29 *	0.57 *				
* Reach-1	* 0.946	* PF 3	* 14000.00 *	1204.45 *	1214.40 *		*	1215.65 *
0.004177 *	8.98 *	1567.33 *	221.78 *	0.59 *				
*	*	*	*	*	*	*	*	*
*	*	*	*	*				
* Reach-1	* 0.833	* PF 1	* 6522.00 *	1201.95 *	1209.21 *		*	1209.84 *
0.003526 *	6.34 *	1027.90 *	209.79 *	0.51 *				
* Reach-1	* 0.833	* PF 2	* 11000.00 *	1201.95 *	1211.18 *		*	1212.06 *
0.003483 *	7.54 *	1458.43 *	227.20 *	0.52 *				
* Reach-1	* 0.833	* PF 3	* 14000.00 *	1201.95 *	1212.28 *		*	1213.32 *
0.003434 *	8.17 *	1713.69 *	237.10 *	0.53 *				
*	*	*	*	*	*	*	*	*
*	*	*	*	*				
* Reach-1	* 0.746	* PF 1	* 6522.00 *	1200.45 *	1206.76 *		*	1207.73 *
0.006042 *	7.91 *	824.59 *	180.98 *	0.65 *				
* Reach-1	* 0.746	* PF 2	* 11000.00 *	1200.45 *	1208.30 *		*	1209.81 *
0.006990 *	9.88 *	1113.87 *	195.21 *	0.73 *				
* Reach-1	* 0.746	* PF 3	* 14000.00 *	1200.45 *	1209.00 *		*	1210.94 *
0.007985 *	11.17 *	1253.48 *	201.71 *	0.79 *				
*	*	*	*	*	*	*	*	*
*	*	*	*	*				
* Reach-1	* 0.647	* PF 1	* 6522.00 *	1197.95 *	1204.44 *		*	1204.92 *
0.004378 *	5.56 *	1173.01 *	344.16 *	0.53 *				
* Reach-1	* 0.647	* PF 2	* 11000.00 *	1197.95 *	1205.62 *		*	1206.33 *
0.005580 *	6.76 *	1627.35 *	427.14 *	0.61 *				
* Reach-1	* 0.647	* PF 3	* 14000.00 *	1197.95 *	1206.24 *		*	1207.08 *
0.005827 *	7.36 *	1901.49 *	453.44 *	0.63 *				
*	*	*	*	*	*	*	*	*
*	*	*	*	*				
* Reach-1	* 0.579	* PF 1	* 6522.00 *	1194.45 *	1202.44 *		*	1202.93 *
0.007159 *	5.65 *	1154.05 *	477.19 *	0.64 *				
* Reach-1	* 0.579	* PF 2	* 11000.00 *	1194.45 *	1203.47 *		*	1204.15 *
0.006541 *	6.64 *	1657.42 *	502.88 *	0.64 *				
* Reach-1	* 0.579	* PF 3	* 14000.00 *	1194.45 *	1203.93 *		*	1204.78 *
0.007032 *	7.40 *	1891.56 *	514.38 *	0.68 *				
*	*	*	*	*	*	*	*	*
*	*	*	*	*				
* Reach-1	* 0.527	* PF 1	* 6522.00 *	1194.95 *	1200.09 *	1199.28 *		1200.72 *
0.009128 *	6.36 *	1026.05 *	427.44 *	0.72 *				
* Reach-1	* 0.527	* PF 2	* 11000.00 *	1194.95 *	1201.01 *	1200.52 *		1201.87 *
0.010810 *	7.45 *	1477.17 *	550.99 *	0.80 *				
* Reach-1	* 0.527	* PF 3	* 14000.00 *	1194.95 *	1201.54 *		*	1202.51 *
0.009889 *	7.88 *	1775.58 *	568.58 *	0.79 *				
*	*	*	*	*	*	*	*	*
*	*	*	*	*				
* Reach-1	* 0.437	* PF 1	* 6522.00 *	1189.95 *	1196.61 *		*	1197.08 *
0.006247 *	5.51 *	1183.76 *	458.26 *	0.60 *				
* Reach-1	* 0.437	* PF 2	* 11000.00 *	1189.95 *	1197.87 *		*	1198.47 *
0.004786 *	6.24 *	1763.27 *	463.38 *	0.56 *				
* Reach-1	* 0.437	* PF 3	* 14000.00 *	1189.95 *	1198.40 *		*	1199.16 *
0.005027 *	6.96 *	2012.24 *	465.56 *	0.59 *				
*	*	*	*	*	*	*	*	*
*	*	*	*	*				
* Reach-1	* 0.35	* PF 1	* 6522.00 *	1186.45 *	1192.87 *		*	1193.57 *
0.009461 *	6.78 *	991.47 *	446.54 *	0.74 *				
* Reach-1	* 0.35	* PF 2	* 11000.00 *	1186.45 *	1193.42 *	1193.31 *		1194.81 *
0.015013 *	9.46 *	1163.01 *	386.97 *	0.96 *				
* Reach-1	* 0.35	* PF 3	* 14000.00 *	1186.45 *	1193.88 *	1193.88 *		1195.40 *
0.014682 *	10.07 *	1499.04 *	555.63 *	0.97 *				
*	*	*	*	*	*	*	*	*
*	*	*	*	*				
* Reach-1	* 0.238	* PF 1	* 6522.00 *	1181.95 *	1188.16 *		*	1188.51 *
0.007497 *	4.77 *	1366.10 *	754.48 *	0.63 *				

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 * Reach-1      * 0.238        * PF 2     * 11000.00 *   1181.95 *   1189.11 *            *   1189.54 *
 0.005404 *     5.24 *   2097.37 *    786.90 *          0.57 *
 * Reach-1      * 0.238        * PF 3     * 14000.00 *   1181.95 *   1189.55 *            *   1190.06 *
 0.005349 *     5.71 *   2450.10 *    802.07 *          0.58 *
 *              *              *          *          *          *           *           *           *
    *           *              *          *              *
 * Reach-1      * 0.159        * PF 1     *  6522.00 *   1179.95 *   1185.79 *   1184.94 *   1186.08 *
 0.004599 *     4.29 *   1521.04 *    683.81 *          0.51 *
 * Reach-1      * 0.159        * PF 2     * 11000.00 *   1179.95 *   1186.11 *            *   1186.73 *
 0.008441 *     6.32 *   1739.20 *    688.26 *          0.70 *
 * Reach-1      * 0.159        * PF 3     * 14000.00 *   1179.95 *   1186.50 *            *   1187.25 *
 0.008500 *     6.96 *   2010.72 *    692.42 *          0.72 *
 *              *              *          *          *          *           *           *           *
    *           *              *          *              *
 * Reach-1      * 0.107        * PF 1     *  6522.00 *   1177.95 *   1182.97 *   1182.97 *   1183.63 *
 0.023083 *     6.51 *   1001.59 *    806.95 *          1.03 *
 * Reach-1      * 0.107        * PF 2     * 11000.00 *   1177.95 *   1184.27 *   1183.49 *   1184.71 *
 0.006182 *     5.35 *   2057.88 *    829.69 *          0.60 *
 * Reach-1      * 0.107        * PF 3     * 14000.00 *   1177.95 *   1184.64 *   1183.82 *   1185.18 *
 0.006374 *     5.89 *   2375.79 *    846.68 *          0.62 *
 *              *              *          *          *          *           *           *           *
    *           *              *          *              *
 * Reach-1      * 0            * PF 1     *  6522.00 *   1173.95 *   1178.59 *   1177.44 *   1178.74 *
 0.002765 *     3.15 *   2067.97 *   1007.30 *          0.39 *
 * Reach-1      * 0            * PF 2     * 11000.00 *   1173.95 *   1178.07 *   1178.07 *   1178.86 *
 0.020558 *     7.11 *   1547.18 *   1002.72 *          1.01 *
 * Reach-1      * 0            * PF 3     * 14000.00 *   1173.95 *   1178.32 *   1178.32 *   1179.26 *
 0.020150 *     7.78 *   1800.47 *   1004.95 *          1.02 *
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Profile Output Table - Standard Table 2
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 * Reach        * River Sta    * Profile * E.G. Elev * W.S. Elev * Vel Head * Frctn Loss * C & E Loss *  Q
Left * Q Channel * Q Right * Top Width *
 *              *              *         *      (ft) *      (ft) *     (ft) *       (ft) *       (ft) *
(cfs) *      (cfs) *    (cfs) *      (ft) *
*****************************************************************************************************
*************************************
 * Reach-1      * 4.554        * PF 1     *   1316.29 *   1316.19 *     0.10 *       0.16 *       0.01 *
767.59 *    4319.41 *          *    807.63 *
 * Reach-1      * 4.554        * PF 2     *   1319.91 *   1319.60 *     0.31 *       0.24 *       0.04 *
   *  11000.00 *          *    264.73 *
 * Reach-1      * 4.554        * PF 3     *   1320.09 *   1319.94 *     0.15 *       0.15 *       0.02 *
4486.91 *    9513.09 *          *   1192.78 *
 *              *              *          *          *          *           *           *           *
   *           *          *          *
 * Reach-1      * 4.457        * PF 1     *   1316.12 *   1316.05 *     0.07 *       0.15 *       0.00 *
674.86 *    4412.14 *          *   1223.89 *
 * Reach-1      * 4.457        * PF 2     *   1319.63 *   1319.45 *     0.19 *       0.20 *       0.00 *
   *  11000.00 *          *    373.48 *
 * Reach-1      * 4.457        * PF 3     *   1319.93 *   1319.84 *     0.09 *       0.12 *       0.00 *
4573.56 *    9426.44 *          *   1463.07 *
 *              *              *          *          *          *           *           *           *
   *           *          *          *
 * Reach-1      * 4.36         * PF 1     *   1315.97 *   1315.90 *     0.07 *       0.30 *       0.02 *
788.59 *    4298.41 *          *   1125.57 *
 * Reach-1      * 4.36         * PF 2     *   1319.43 *   1319.23 *     0.19 *       0.33 *       0.01 *
   *  11000.00 *          *    360.07 *
 * Reach-1      * 4.36         * PF 3     *   1319.80 *   1319.72 *     0.09 *       0.21 *       0.02 *
4587.00 *    9413.00 *          *   1487.79 *
 *              *              *          *          *          *           *           *           *
   *           *          *          *
 * Reach-1      * 4.254        * PF 1     *   1315.65 *   1315.41 *     0.24 *       0.25 *       0.05 *
55.68 *    5031.32 *          *    456.05 *
 * Reach-1      * 4.254        * PF 2     *   1319.09 *   1318.75 *     0.34 *       0.25 *       0.06 *
   *  11000.00 *          *    334.21 *
 * Reach-1      * 4.254        * PF 3     *   1319.58 *   1319.34 *     0.24 *       0.20 *       0.04 *
2836.85 *   11163.15 *          *   1146.54 *
 *              *              *          *          *          *           *           *           *
   *           *          *          *
 * Reach-1      * 4.148        * PF 1     *   1315.35 *   1315.29 *     0.06 *       0.25 *       0.03 *
266.84 *    4820.16 *          *    913.98 *
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* Reach-1     * 4.148       * PF 2     *   1318.78 *   1318.65 *      0.13 *      0.26 *      0.05 *
   *  11000.00 *          *    411.89 *
* Reach-1     * 4.148       * PF 3     *   1319.33 *   1319.23 *      0.10 *      0.22 *      0.04 *
2648.29 *  11351.71 *         *   1145.17 *
*           *           *           *           *           *           *           *           *
   *           *           *           *
* Reach-1     * 4.053       * PF 1     *   1315.07 *   1314.65 *      0.41 *      0.50 *      0.03 *
17.80 *   5067.69 *    1.51 *    363.94 *
* Reach-1     * 4.053       * PF 2     *   1318.47 *   1317.88 *      0.59 *      0.49 *      0.11 *
   *  11000.00 *          *    247.00 *
* Reach-1     * 4.053       * PF 3     *   1319.08 *   1318.62 *      0.46 *      0.46 *      0.17 *
2024.81 *  11613.77 *  361.43 *    891.52 *
*           *           *           *           *           *           *           *           *
   *           *           *           *
* Reach-1     * 4.015       * PF 1     *   1314.53 *   1313.78 *      0.75 *      1.32 *      0.01 *
   *   5087.00 *          *    127.59 *
* Reach-1     * 4.015       * PF 2     *   1317.87 *   1316.20 *      1.68 *      1.72 *      0.05 *
   *  11000.00 *          *    142.00 *
* Reach-1     * 4.015       * PF 3     *   1318.45 *   1316.27 *      2.18 *      1.80 *      0.36 *
4.34 *  13060.94 *  934.72 *    409.72 *
*           *           *           *           *           *           *           *           *
   *           *           *           *
* Reach-1     * 3.945       * PF 1     *   1313.20 *   1312.35 *      0.84 *      1.53 *      0.09 *
1098.29 *   4922.03 *    2.69 *    544.45 *
* Reach-1     * 3.945       * PF 2     *   1316.11 *   1314.59 *      1.53 *      1.48 *      0.24 *
1668.83 *   9331.17 *         *    240.00 *
* Reach-1     * 3.945       * PF 3     *   1315.74 *   1314.77 *      0.97 *      1.84 *      0.01 *
4756.52 *   8755.33 *  488.15 *    998.68 *
*           *           *           *           *           *           *           *           *
   *           *           *           *
* Reach-1     * 3.879       * PF 1     *   1311.57 *   1311.04 *      0.54 *      1.32 *      0.02 *
220.76 *   5251.29 *  550.94 *    381.82 *
* Reach-1     * 3.879       * PF 2     *   1314.39 *   1313.67 *      0.71 *      1.27 *      0.00 *
1143.12 *   8901.97 *  954.91 *    300.00 *
* Reach-1     * 3.879       * PF 3     *   1313.89 *   1312.83 *      1.05 *      1.82 *      0.16 *
1690.96 *  10285.98 * 2023.06 *   1005.59 *
*           *           *           *           *           *           *           *           *
   *           *           *           *
* Reach-1     * 3.816       * PF 1     *   1310.24 *   1309.75 *      0.48 *      2.36 *      0.03 *
1319.44 *   3492.17 * 1211.39 *    996.50 *
* Reach-1     * 3.816       * PF 2     *   1313.11 *   1312.35 *      0.76 *      2.65 *      0.06 *
3449.51 *   5867.54 * 1682.95 *    380.00 *
* Reach-1     * 3.816       * PF 3     *   1311.91 *   1311.39 *      0.52 *      2.37 *      0.01 *
5901.79 *   5209.79 * 2888.42 *   1151.83 *
*           *           *           *           *           *           *           *           *
   *           *           *           *
* Reach-1     * 3.737       * PF 1     *   1307.85 *   1307.07 *      0.78 *      2.50 *      0.12 *
1582.58 *   3214.48 * 1225.94 *    855.52 *
* Reach-1     * 3.737       * PF 2     *   1310.40 *   1309.07 *      1.33 *      1.85 *      0.30 *
3350.74 *   5395.19 * 2254.08 *    350.00 *
* Reach-1     * 3.737       * PF 3     *   1309.53 *   1308.95 *      0.58 *      2.28 *      0.04 *
6856.56 *   4283.04 * 2860.40 *   1053.58 *
*           *           *           *           *           *           *           *           *
   *           *           *           *
* Reach-1     * 3.656       * PF 1     *   1305.23 *   1304.85 *      0.38 *      2.36 *      0.02 *
1864.20 *   3163.59 *  995.21 *    790.83 *
* Reach-1     * 3.656       * PF 2     *   1308.26 *   1307.91 *      0.35 *      1.89 *      0.10 *
4886.31 *   4559.17 * 1554.52 *    450.00 *
* Reach-1     * 3.656       * PF 3     *   1307.21 *   1306.77 *      0.44 *      2.49 *      0.02 *
6089.98 *   4960.27 * 2949.75 *    910.62 *
*           *           *           *           *           *           *           *           *
   *           *           *           *
* Reach-1     * 3.563       * PF 1     *   1302.85 *   1302.23 *      0.61 *      2.90 *      0.01 *
1637.89 *   3479.35 *  905.76 *    757.64 *
* Reach-1     * 3.563       * PF 2     *   1306.26 *   1304.88 *      1.38 *      3.28 *      0.14 *
3466.92 *   6756.24 *  776.84 *    340.00 *
* Reach-1     * 3.563       * PF 3     *   1304.70 *   1304.03 *      0.67 *      2.52 *      0.07 *
5842.41 *   5275.77 * 2881.82 *    979.32 *
*           *           *           *           *           *           *           *           *
   *           *           *           *
* Reach-1     * 3.465       * PF 1     *   1299.94 *   1299.36 *      0.58 *      2.53 *      0.06 *
2294.52 *   3388.77 *  339.71 *    750.36 *
* Reach-1     * 3.465       * PF 2     *   1302.84 *   1301.93 *      0.91 *      2.91 *      0.05 *
4173.64 *   5885.77 *  940.59 *    320.00 *
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* Reach-1     * 3.465       * PF 3    *   1302.12 *   1301.66 *     0.45 *      2.30 *      0.00 *
8039.23 *   4831.61 * 1129.16 *    983.88 *
*             *             *           *           *           *           *           *
   *           *           *           *
* Reach-1     * 3.354       * PF 1    *   1297.35 *   1296.98 *     0.37 *      2.59 *      0.07 *
1550.63 *   3827.25 *  645.12 *    595.40 *
* Reach-1     * 3.354       * PF 2    *   1299.88 *   1299.13 *     0.75 *      2.67 *      0.02 *
2208.34 *   7010.38 * 1781.28 *    310.00 *
* Reach-1     * 3.354       * PF 3    *   1299.82 *   1299.33 *     0.49 *      2.96 *      0.08 *
4299.92 *   6564.36 * 3135.72 *    770.71 *
*             *             *           *           *           *           *           *
   *           *           *           *
* Reach-1     * 3.247       * PF 1    *   1294.69 *   1293.62 *     1.06 *      3.43 *      0.20 *
837.77 *   4281.07 *  904.16 *    546.42 *
* Reach-1     * 3.247       * PF 2    *   1297.18 *   1296.20 *     0.98 *      3.05 *      0.07 *
1573.98 *   5985.63 * 3440.39 *    300.00 *
* Reach-1     * 3.247       * PF 3    *   1296.78 *   1295.49 *     1.29 *      3.30 *      0.27 *
2131.92 *   6878.78 * 4989.30 *    781.23 *
*             *             *           *           *           *           *           *
   *           *           *           *
* Reach-1     * 3.14        * PF 1    *   1291.05 *   1290.66 *     0.39 *      2.88 *      0.03 *
306.80 *   2932.64 * 2783.56 *    775.79 *
* Reach-1     * 3.14        * PF 2    *   1294.07 *   1293.31 *     0.76 *      2.95 *      0.07 *
1554.43 *   5512.94 * 3932.62 *    365.00 *
* Reach-1     * 3.14        * PF 3    *   1293.20 *   1292.82 *     0.38 *      2.67 *      0.00 *
1244.78 *   4336.53 * 8418.69 *    850.00 *
*             *             *           *           *           *           *           *
   *           *           *           *
* Reach-1     * 3.011       * PF 1    *   1288.15 *   1287.86 *     0.29 *      1.86 *      0.01 *
144.52 *   1912.40 * 3966.08 *    567.59 *
* Reach-1     * 3.011       * PF 2    *   1291.05 *   1290.53 *     0.51 *      1.58 *      0.00 *
547.00 *   3535.04 * 6917.96 *    350.00 *
* Reach-1     * 3.011       * PF 3    *   1290.54 *   1290.11 *     0.42 *      1.97 *      0.01 *
1352.36 *   3452.84 * 9194.80 *    789.26 *
*             *             *           *           *           *           *           *
   *           *           *           *
* Reach-1     * 2.937       * PF 1    *   1286.28 *   1285.91 *     0.37 *      1.54 *      0.00 *
1105.43 *   2600.09 * 2317.48 *    615.10 *
* Reach-1     * 2.937       * PF 2    *   1289.46 *   1288.93 *     0.53 *      1.44 *      0.02 *
1907.65 *   4462.75 * 4629.60 *    330.00 *
* Reach-1     * 2.937       * PF 3    *   1288.56 *   1288.07 *     0.49 *      1.78 *      0.01 *
3946.72 *   4419.07 * 5634.21 *    735.26 *
*             *             *           *           *           *           *           *
   *           *           *           *
* Reach-1     * 2.867       * PF 1    *   1284.74 *   1284.38 *     0.36 *      2.47 *      0.06 *
1257.23 *   4686.42 *   79.35 *    670.28 *
* Reach-1     * 2.867       * PF 2    *   1288.00 *   1287.24 *     0.76 *      2.52 *      0.08 *
699.35 *   9711.03 *  589.62 *    240.00 *
* Reach-1     * 2.867       * PF 3    *   1286.77 *   1286.19 *     0.58 *      2.14 *      0.01 *
4721.79 *   8618.52 *  659.69 *    872.60 *
*             *             *           *           *           *           *           *
   *           *           *           *
* Reach-1     * 2.774       * PF 1    *   1282.21 *   1281.25 *     0.96 *      2.38 *      0.14 *
33.71 *   4744.44 * 1244.85 *    551.68 *
* Reach-1     * 2.774       * PF 2    *   1285.40 *   1283.82 *     1.58 *      2.49 *      0.20 *
31.69 *   8662.21 * 2306.11 *    180.00 *
* Reach-1     * 2.774       * PF 3    *   1284.62 *   1284.00 *     0.63 *      2.07 *      0.02 *
555.17 *   6778.16 * 6666.67 *    757.86 *
*             *             *           *           *           *           *           *
   *           *           *           *
* Reach-1     * 2.691       * PF 1    *   1279.69 *   1279.21 *     0.48 *      2.79 *      0.06 *
221.78 *   5321.35 *  479.87 *    377.50 *
* Reach-1     * 2.691       * PF 2    *   1282.71 *   1281.80 *     0.91 *      2.76 *      0.05 *
136.07 *  10111.37 *  752.55 *    190.00 *
* Reach-1     * 2.691       * PF 3    *   1282.53 *   1281.71 *     0.82 *      3.10 *      0.04 *
1244.82 *  10413.10 * 2342.08 *    518.00 *
*             *             *           *           *           *           *           *
   *           *           *           *
* Reach-1     * 2.588       * PF 1    *   1276.84 *   1275.74 *     1.09 *      3.47 *      0.17 *
507.72 *   4459.96 * 1055.32 *    406.03 *
* Reach-1     * 2.588       * PF 2    *   1279.90 *   1278.54 *     1.37 *      3.38 *      0.07 *
1940.36 *   7237.48 * 1822.17 *    210.00 *
* Reach-1     * 2.588       * PF 3    *   1279.39 *   1278.18 *     1.21 *      2.93 *      0.18 *
3259.90 *   7346.14 * 3393.97 *    621.26 *
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* Reach-1	* 2.486	* PF 1	*	1273.19 *	1272.67 *	0.52 *	2.28 *	0.01 *	
365.65 *	4838.05 *	819.30 *	431.03 *						
* Reach-1	* 2.486	* PF 2	*	1276.46 *	1275.31 *	1.15 *	2.23 *	0.09 *	
540.73 *	10136.63 *	322.64 *	185.00 *						
* Reach-1	* 2.486	* PF 3	*	1276.29 *	1275.67 *	0.62 *	2.09 *	0.02 *	
1717.74 *	9022.00 *	3260.26 *	640.75 *						
* Reach-1	* 2.395	* PF 1	*	1270.90 *	1270.31 *	0.60 *	2.27 *	0.01 *	
1131.18 *	4200.51 *	691.31 *	356.61 *						
* Reach-1	* 2.395	* PF 2	*	1274.13 *	1273.30 *	0.83 *	2.13 *	0.04 *	
2514.13 *	7090.19 *	1395.68 *	220.00 *						
* Reach-1	* 2.395	* PF 3	*	1274.17 *	1273.30 *	0.87 *	2.28 *	0.00 *	
3192.20 *	7874.64 *	2933.17 *	625.00 *						
* Reach-1	* 2.31	* PF 1	*	1268.62 *	1267.93 *	0.70 *	2.29 *	0.08 *	
1867.65 *	3587.04 *	568.31 *	366.75 *						
* Reach-1	* 2.31	* PF 2	*	1271.96 *	1270.77 *	1.19 *	2.28 *	0.16 *	
4008.96 *	6369.77 *	621.27 *	200.00 *						
* Reach-1	* 2.31	* PF 3	*	1271.89 *	1271.01 *	0.88 *	2.49 *	0.06 *	
6251.75 *	6298.30 *	1449.94 *	607.33 *						
* Reach-1	* 2.208	* PF 1	*	1266.25 *	1265.82 *	0.44 *	1.95 *	0.00 *	
2434.76 *	3168.71 *	419.53 *	314.90 *						
* Reach-1	* 2.208	* PF 2	*	1269.52 *	1268.86 *	0.66 *	2.06 *	0.04 *	
5177.01 *	5366.84 *	456.15 *	215.00 *						
* Reach-1	* 2.208	* PF 3	*	1269.34 *	1268.66 *	0.68 *	1.87 *	0.04 *	
5274.84 *	5848.70 *	2876.46 *	504.88 *						
* Reach-1	* 2.118	* PF 1	*	1264.30 *	1263.82 *	0.49 *	2.68 *	0.05 *	
* 3787.57 *	2485.43 *	406.91 *							
* Reach-1	* 2.118	* PF 2	*	1267.42 *	1266.34 *	1.08 *	3.13 *	0.05 *	
* 7495.09 *	3504.91 *	200.00 *							
* Reach-1	* 2.118	* PF 3	*	1267.43 *	1266.89 *	0.54 *	2.28 *	0.09 *	
113.54 *	6786.27 *	7100.19 *	767.88 *						
* Reach-1	* 2.034	* PF 1	*	1261.57 *	1260.56 *	1.01 *	5.47 *	0.06 *	
* 3839.48 *	2433.52 *	236.60 *							
* Reach-1	* 2.034	* PF 2	*	1264.24 *	1262.67 *	1.57 *	5.84 *	0.05 *	
* 6054.28 *	4945.72 *	180.00 *							
* Reach-1	* 2.034	* PF 3	*	1265.07 *	1263.66 *	1.40 *	5.44 *	0.10 *	
14.09 *	6945.88 *	7040.03 *	313.54 *						
* Reach-1	* 1.949	* PF 1	*	1256.04 *	1254.41 *	1.62 *	3.66 *	0.30 *	
* 6273.00 *	*	159.12 *							
* Reach-1	* 1.949	* PF 2	*	1258.35 *	1256.27 *	2.08 *	3.70 *	0.34 *	
* 11000.00 *	*	198.74 *							
* Reach-1	* 1.949	* PF 3	*	1259.52 *	1257.09 *	2.43 *	3.64 *	0.40 *	
* 13971.51 *	28.49 *	226.71 *							
* Reach-1	* 1.858	* PF 1	*	1252.09 *	1251.45 *	0.64 *	1.77 *	0.02 *	
* 6273.00 *	*	216.48 *							
* Reach-1	* 1.858	* PF 2	*	1254.31 *	1253.37 *	0.94 *	1.75 *	0.03 *	
* 11000.00 *	*	240.91 *							
* Reach-1	* 1.858	* PF 3	*	1255.48 *	1254.38 *	1.10 *	1.73 *	0.03 *	
* 13998.26 *	1.74 *	264.91 *							
* Reach-1	* 1.788	* PF 1	*	1250.30 *	1249.47 *	0.83 *	2.19 *	0.03 *	
* 6273.00 *	*	205.83 *							
* Reach-1	* 1.788	* PF 2	*	1252.53 *	1251.34 *	1.19 *	2.10 *	0.04 *	
* 11000.00 *	*	219.51 *							
* Reach-1	* 1.788	* PF 3	*	1253.72 *	1252.32 *	1.40 *	2.07 *	0.04 *	
7.18 *	13991.46 *	1.36 *	260.92 *						

Reach-1	1.708	PF 1	1248.08	1247.34	0.73	2.40	0.04	6273.00		202.94
Reach-1	1.708	PF 2	1250.39	1249.32	1.06	2.38	0.06	11000.00		217.71
Reach-1	1.708	PF 3	1251.61	1250.35	1.26	2.42	0.06	13998.41	1.59	237.54
Reach-1	1.593	PF 1	1245.63	1245.04	0.59	2.09	0.00	6273.00		211.48
Reach-1	1.593	PF 2	1247.95	1247.07	0.88	2.12	0.00	11000.00		227.68
Reach-1	1.593	PF 3	1249.13	1248.07	1.06	2.17	0.00	13999.96	0.04	237.86
Reach-1	1.479	PF 1	1243.54	1242.94	0.60	1.68	0.02	3.54	6269.46	220.78
Reach-1	1.479	PF 2	1245.83	1244.93	0.90	1.73	0.02	11000.00		222.88
Reach-1	1.479	PF 3	1246.95	1245.88	1.07	1.77	0.01	141.19	13858.81	258.61
Reach-1	1.381	PF 1	1241.84	1241.30	0.54	2.01	0.06	6273.00		218.53
Reach-1	1.381	PF 2	1244.07	1243.24	0.83	2.22	0.12	11000.00		225.00
Reach-1	1.381	PF 3	1245.17	1244.14	1.03	2.27	0.14	49.82	13920.05	30.12	286.62
Reach-1	1.307	PF 1	1239.77	1238.64	1.14	1.46	0.03	1.43	6267.21	4.35	228.71
Reach-1	1.307	PF 2	1241.74	1239.74	2.00	1.56	0.01	11000.00		215.00
Reach-1	1.307	PF 3	1242.76	1240.36	2.40	1.51	0.04	45.71	13810.69	143.61	260.16
Reach-1	1.286	PF 1	1238.28	1236.85	1.43	1.31	0.01	6273.00		230.25
Reach-1	1.286	PF 2	1240.17	1238.18	1.98	1.18	0.02	11000.00		247.19
Reach-1	1.286	PF 3	1241.19	1238.91	2.28	1.10	0.02	13978.37	21.63	275.19
Reach-1	1.251	PF 1	1226.31	1224.75	1.56	0.14	0.38	6273.00		202.41
Reach-1	1.251	PF 2	1228.39	1226.19	2.19	0.17	0.50	11000.00		213.94
Reach-1	1.251	PF 3	1229.51	1227.01	2.50	0.18	0.55	14000.00		220.47
Reach-1	1.213	PF 1	1219.83	1219.54	0.29	0.08	0.13	6273.00		226.35
Reach-1	1.213	PF 2	1221.99	1221.47	0.52	0.10	0.17	11000.00		238.89
Reach-1	1.213	PF 3	1223.16	1222.50	0.66	0.11	0.19	0.11	13999.79	0.10	245.16
Reach-1	1.191	PF 1	1219.62	1218.03	1.59	0.28	0.19	6273.00		197.95
Reach-1	1.191	PF 2	1221.72	1219.50	2.22	0.27	0.24	11000.00		209.98
Reach-1	1.191	PF 3	1222.86	1220.31	2.55	0.26	0.26	14000.00		216.57
Reach-1	1.169	PF 1	1216.20	1215.24	0.96	1.41	0.09	6273.00		183.76

* Reach-1	* 1.169	* PF 2	* 1218.49 *	1217.06 *	1.43 *	1.45 *	0.13 *	
* 11000.00 *	*	199.04 *						
* Reach-1	* 1.169	* PF 3	* 1219.73 *	1218.05 *	1.68 *	1.45 *	0.14 *	
* 14000.00 *	*	207.35 *						
*	*	*	*	*	*	*	*	
*	*	*	*					
* Reach-1	* 1.058	* PF 1	* 1214.70 *	1214.04 *	0.66 *	2.48 *	0.01 *	
* 6273.00 *	*	208.81 *						
* Reach-1	* 1.058	* PF 2	* 1216.91 *	1215.90 *	1.01 *	2.50 *	0.00 *	
* 11000.00 *	*	221.17 *						
* Reach-1	* 1.058	* PF 3	* 1218.13 *	1216.94 *	1.20 *	2.48 *	0.01 *	
* 14000.00 *	*	228.05 *						
*	*	*	*	*	*	*	*	
*	*	*	*					
* Reach-1	* 0.946	* PF 1	* 1212.21 *	1211.48 *	0.73 *	2.34 *	0.03 *	
* 6522.00 *	*	200.73 *						
* Reach-1	* 0.946	* PF 2	* 1214.41 *	1213.36 *	1.05 *	2.30 *	0.05 *	
* 11000.00 *	*	210.29 *						
* Reach-1	* 0.946	* PF 3	* 1215.65 *	1214.40 *	1.25 *	2.27 *	0.06 *	
* 13983.52 *	16.48 *	221.78 *						
*	*	*	*	*	*	*	*	
*	*	*	*					
* Reach-1	* 0.833	* PF 1	* 1209.84 *	1209.21 *	0.63 *	2.07 *	0.03 *	
* 6522.00 *	*	209.79 *						
* Reach-1	* 0.833	* PF 2	* 1212.06 *	1211.18 *	0.88 *	2.19 *	0.06 *	
* 11000.00 *	*	227.20 *						
* Reach-1	* 0.833	* PF 3	* 1213.32 *	1212.28 *	1.04 *	2.29 *	0.09 *	
0.14 * 13999.78 *	0.08 *	237.10 *						
*	*	*	*	*	*	*	*	
*	*	*	*					
* Reach-1	* 0.746	* PF 1	* 1207.73 *	1206.76 *	0.97 *	2.66 *	0.15 *	
* 6522.00 *	*	180.98 *						
* Reach-1	* 0.746	* PF 2	* 1209.81 *	1208.30 *	1.51 *	3.24 *	0.24 *	
* 11000.00 *	*	195.21 *						
* Reach-1	* 0.746	* PF 3	* 1210.94 *	1209.00 *	1.94 *	3.53 *	0.33 *	
* 14000.00 *	*	201.71 *						
*	*	*	*	*	*	*	*	
*	*	*	*					
* Reach-1	* 0.647	* PF 1	* 1204.92 *	1204.44 *	0.48 *	1.99 *	0.00 *	
* 6522.00 *	*	344.16 *						
* Reach-1	* 0.647	* PF 2	* 1206.33 *	1205.62 *	0.71 *	2.17 *	0.01 *	
* 11000.00 *	*	427.14 *						
* Reach-1	* 0.647	* PF 3	* 1207.08 *	1206.24 *	0.84 *	2.30 *	0.00 *	
* 14000.00 *	*	453.44 *						
*	*	*	*	*	*	*	*	
*	*	*	*					
* Reach-1	* 0.579	* PF 1	* 1202.93 *	1202.44 *	0.50 *	2.20 *	0.01 *	
* 6522.00 *	*	477.19 *						
* Reach-1	* 0.579	* PF 2	* 1204.15 *	1203.47 *	0.68 *	2.26 *	0.02 *	
* 11000.00 *	*	502.88 *						
* Reach-1	* 0.579	* PF 3	* 1204.78 *	1203.93 *	0.85 *	2.26 *	0.01 *	
* 14000.00 *	*	514.38 *						
*	*	*	*	*	*	*	*	
*	*	*	*					
* Reach-1	* 0.527	* PF 1	* 1200.72 *	1200.09 *	0.63 *	3.59 *	0.05 *	
* 6522.00 *	*	427.44 *						
* Reach-1	* 0.527	* PF 2	* 1201.87 *	1201.01 *	0.86 *	3.31 *	0.08 *	
* 11000.00 *	*	550.99 *						
* Reach-1	* 0.527	* PF 3	* 1202.51 *	1201.54 *	0.97 *	3.29 *	0.06 *	
* 14000.00 *	*	568.58 *						
*	*	*	*	*	*	*	*	
*	*	*	*					
* Reach-1	* 0.437	* PF 1	* 1197.08 *	1196.61 *	0.47 *	3.49 *	0.02 *	
* 6522.00 *	*	458.26 *						
* Reach-1	* 0.437	* PF 2	* 1198.47 *	1197.87 *	0.60 *	3.59 *	0.08 *	
* 11000.00 *	*	463.38 *						
* Reach-1	* 0.437	* PF 3	* 1199.16 *	1198.40 *	0.75 *	3.67 *	0.08 *	
* 14000.00 *	*	465.56 *						
*	*	*	*	*	*	*	*	
*	*	*	*					
* Reach-1	* 0.35	* PF 1	* 1193.57 *	1192.87 *	0.71 *	4.95 *	0.11 *	
55.69 * 6466.31 *		* 446.54 *						
* Reach-1	* 0.35	* PF 2	* 1194.81 *	1193.42 *	1.39 *	4.98 *	0.29 *	
* 11000.00 *	*	386.97 *						

* Reach-1	* 0.35	* PF 3	* 1195.40 *	1193.88 *	1.53 *	4.89 *	0.31 *
460.69 *	13539.31 *	*	555.63 *				
* Reach-1	* 0.238	* PF 1	* 1188.51 *	1188.16 *	0.35 *	2.42 *	0.02 *
*	6522.00 *	*	754.48 *				
* Reach-1	* 0.238	* PF 2	* 1189.54 *	1189.11 *	0.43 *	2.79 *	0.02 *
*	11000.00 *	*	786.90 *				
* Reach-1	* 0.238	* PF 3	* 1190.06 *	1189.55 *	0.51 *	2.78 *	0.02 *
*	14000.00 *	*	802.07 *				
* Reach-1	* 0.159	* PF 1	* 1186.08 *	1185.79 *	0.29 *	2.41 *	0.04 *
*	6522.00 *	*	683.81 *				
* Reach-1	* 0.159	* PF 2	* 1186.73 *	1186.11 *	0.62 *	1.97 *	0.05 *
*	11000.00 *	*	688.26 *				
* Reach-1	* 0.159	* PF 3	* 1187.25 *	1186.50 *	0.75 *	2.01 *	0.06 *
*	14000.00 *	*	692.42 *				
* Reach-1	* 0.107	* PF 1	* 1183.63 *	1182.97 *	0.66 *	3.44 *	0.15 *
*	6522.00 *	*	806.95 *				
* Reach-1	* 0.107	* PF 2	* 1184.71 *	1184.27 *	0.44 *	5.82 *	0.03 *
*	11000.00 *	*	829.69 *				
* Reach-1	* 0.107	* PF 3	* 1185.18 *	1184.64 *	0.54 *	5.89 *	0.04 *
*	14000.00 *	*	846.68 *				
* Reach-1	* 0	* PF 1	* 1178.74 *	1178.59 *	0.15 *	*	*
*	6522.00 *	*	1007.30 *				
* Reach-1	* 0	* PF 2	* 1178.86 *	1178.07 *	0.78 *	*	*
*	11000.00 *	*	1002.72 *				
* Reach-1	* 0	* PF 3	* 1179.26 *	1178.32 *	0.94 *	*	*
*	14000.00 *	*	1004.95 *				

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ERRORS WARNINGS AND NOTES
Errors Warnings and Notes for Plan : 1988Datum

River: RIVER-1 Reach: Reach-1 RS: 4.554 Profile: PF 3
Warning:The cross-section end points had to be extended vertically for the computed water surface.
River: RIVER-1 Reach: Reach-1 RS: 4.457 Profile: PF 3
Warning:The cross-section end points had to be extended vertically for the computed water surface.
River: RIVER-1 Reach: Reach-1 RS: 4.36 Profile: PF 1
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: RIVER-1 Reach: Reach-1 RS: 4.36 Profile: PF 2
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: RIVER-1 Reach: Reach-1 RS: 4.36 Profile: PF 3
Warning:The cross-section end points had to be extended vertically for the computed water surface.
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: RIVER-1 Reach: Reach-1 RS: 4.254 Profile: PF 1
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: RIVER-1 Reach: Reach-1 RS: 4.254 Profile: PF 2
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: RIVER-1 Reach: Reach-1 RS: 4.254 Profile: PF 3
Warning:The cross-section end points had to be extended vertically for the computed water surface.
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: RIVER-1 Reach: Reach-1 RS: 4.148 Profile: PF 1
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7

HEC-RAS Plan: 1988Datum River: RIVER-1 Reach: Reach-1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach-1	4.554	PF 1	5087.00	1307.75	1316.19		1316.29	0.000360	2.72	2843.94	807.63	0.19
Reach-1	4.554	PF 2	11000.00	1307.75	1319.60		1319.91	0.000585	4.45	2471.30	264.73	0.26
Reach-1	4.554	PF 3	14000.00	1307.75	1319.94		1320.09	0.000376	3.71	6972.38	1192.78	0.21
Reach-1	4.457	PF 1	5087.00	1307.45	1316.05		1316.12	0.000290	2.27	3439.52	1223.89	0.17
Reach-1	4.457	PF 2	11000.00	1307.45	1319.45		1319.63	0.000393	3.46	3179.78	373.48	0.21
Reach-1	4.457	PF 3	14000.00	1307.45	1319.84		1319.93	0.000244	2.83	8738.31	1463.07	0.17
Reach-1	4.36	PF 1	5087.00	1306.95	1315.90		1315.97	0.000279	2.22	3515.72	1125.57	0.17
Reach-1	4.36	PF 2	11000.00	1306.95	1319.23		1319.43	0.000403	3.53	3113.01	360.07	0.21
Reach-1	4.36	PF 3	14000.00	1306.95	1319.72		1319.80	0.000241	2.86	8804.50	1487.79	0.17
Reach-1	4.254	PF 1	5087.00	1306.75	1315.41		1315.65	0.001398	3.96	1368.51	456.05	0.35
Reach-1	4.254	PF 2	11000.00	1306.75	1318.75		1319.09	0.000907	4.65	2363.59	334.21	0.31
Reach-1	4.254	PF 3	14000.00	1306.75	1319.34		1319.58	0.000710	4.36	5161.55	1146.54	0.28
Reach-1	4.148	PF 1	5087.00	1306.45	1315.29		1315.35	0.000213	2.02	3141.46	913.98	0.15
Reach-1	4.148	PF 2	11000.00	1306.45	1318.65		1318.78	0.000257	2.93	3755.71	411.89	0.17
Reach-1	4.148	PF 3	14000.00	1306.45	1319.23		1319.33	0.000219	2.84	7433.88	1145.17	0.16
Reach-1	4.053	PF 1	5087.00	1305.45	1314.65		1315.07	0.002342	5.15	1025.44	363.94	0.45
Reach-1	4.053	PF 2	11000.00	1305.45	1317.88		1318.47	0.001591	6.17	1781.61	247.00	0.41
Reach-1	4.053	PF 3	14000.00	1305.45	1318.62		1319.08	0.001228	5.91	3683.97	891.52	0.37
Reach-1	4.015	PF 1	5087.00	1304.95	1313.78		1314.53	0.002684	6.97	730.07	127.59	0.51
Reach-1	4.015	PF 2	11000.00	1304.95	1316.20		1317.87	0.004291	10.39	1058.71	142.00	0.67
Reach-1	4.015	PF 3	14000.00	1304.95	1316.27	1316.27	1318.45	0.005726	12.22	1330.86	409.72	0.78
Reach-1	3.945	PF 1	6023.00	1303.95	1312.35	1311.75	1313.20	0.004268	8.12	1268.68	544.45	0.64
Reach-1	3.945	PF 2	11000.00	1303.95	1314.59	1313.41	1316.11	0.004657	10.67	1387.11	240.00	0.70
Reach-1	3.945	PF 3	14000.00	1303.95	1314.77	1314.09	1315.74	0.003666	9.77	2963.51	998.68	0.63
Reach-1	3.879	PF 1	6023.00	1300.95	1311.04		1311.57	0.004109	6.25	1225.25	381.82	0.45
Reach-1	3.879	PF 2	11000.00	1300.95	1313.67		1314.39	0.003505	7.37	1867.43	300.00	0.44
Reach-1	3.879	PF 3	14000.00	1300.95	1312.83		1313.89	0.005582	9.43	2460.05	1005.59	0.60
Reach-1	3.816	PF 1	6023.00	1298.45	1309.75		1310.24	0.004003	7.11	1858.85	996.50	0.46
Reach-1	3.816	PF 2	11000.00	1298.45	1312.35		1313.11	0.004220	8.89	2051.59	380.00	0.49
Reach-1	3.816	PF 3	14000.00	1298.45	1311.39		1311.91	0.004638	8.72	3629.65	1151.83	0.51
Reach-1	3.737	PF 1	6023.00	1296.45	1307.07		1307.85	0.008062	9.36	1469.46	855.52	0.63
Reach-1	3.737	PF 2	11000.00	1296.45	1309.07		1310.40	0.009683	12.16	1561.48	350.00	0.72
Reach-1	3.737	PF 3	14000.00	1296.45	1308.95		1309.53	0.006386	9.79	3279.65	1053.58	0.58
Reach-1	3.656	PF 1	6023.00	1293.95	1304.85		1305.23	0.004401	6.54	1819.04	790.83	0.46
Reach-1	3.656	PF 2	11000.00	1293.95	1307.91		1308.26	0.002399	6.30	2756.75	450.00	0.36
Reach-1	3.656	PF 3	14000.00	1293.95	1306.77		1307.21	0.004397	7.82	3470.26	910.62	0.48
Reach-1	3.563	PF 1	6023.00	1292.45	1302.23		1302.85	0.005298	8.06	1596.19	757.64	0.52
Reach-1	3.563	PF 2	11000.00	1292.45	1304.88		1306.26	0.007247	11.55	1599.00	340.00	0.64
Reach-1	3.563	PF 3	14000.00	1292.45	1304.03		1304.70	0.005933	9.85	3178.34	979.32	0.57
Reach-1	3.465	PF 1	6023.00	1290.45	1299.36		1299.94	0.006301	7.86	1552.00	750.36	0.56
Reach-1	3.465	PF 2	11000.00	1290.45	1301.93		1302.84	0.005938	9.63	1766.68	320.00	0.57
Reach-1	3.465	PF 3	14000.00	1290.45	1301.66		1302.12	0.004446	8.16	3549.42	983.88	0.49
Reach-1	3.354	PF 1	6023.00	1288.25	1296.98		1297.35	0.003087	5.90	1721.57	595.40	0.40
Reach-1	3.354	PF 2	11000.00	1288.25	1299.13		1299.88	0.004153	8.22	1898.60	310.00	0.48
Reach-1	3.354	PF 3	14000.00	1288.25	1299.33		1299.82	0.003390	7.53	3357.25	770.71	0.44
Reach-1	3.247	PF 1	6023.00	1284.25	1293.62		1294.69	0.007627	9.67	1141.77	546.42	0.63
Reach-1	3.247	PF 2	11000.00	1284.25	1296.20		1297.18	0.005494	10.02	1744.28	300.00	0.56
Reach-1	3.247	PF 3	14000.00	1284.25	1295.49		1296.78	0.009301	12.40	2408.31	781.23	0.72
Reach-1	3.14	PF 1	6023.00	1282.25	1290.66		1291.05	0.004803	6.83	1783.18	775.79	0.49
Reach-1	3.14	PF 2	11000.00	1282.25	1293.31		1294.07	0.005119	8.96	1953.95	365.00	0.53
Reach-1	3.14	PF 3	14000.00	1282.25	1292.82		1293.20	0.003843	7.47	3571.12	850.00	0.46
Reach-1	3.011	PF 1	6023.00	1278.95	1287.86		1288.15	0.004333	6.21	1714.44	567.59	0.45
Reach-1	3.011	PF 2	11000.00	1278.95	1290.53		1291.05	0.004188	7.87	2162.36	350.00	0.48
Reach-1	3.011	PF 3	14000.00	1278.95	1290.11		1290.54	0.004736	8.08	3254.70	789.26	0.50
Reach-1	2.937	PF 1	6023.00	1277.95	1285.91		1286.28	0.004768	6.71	1680.36	615.10	0.48
Reach-1	2.937	PF 2	11000.00	1277.95	1288.93		1289.46	0.003578	7.64	2177.01	330.00	0.45
Reach-1	2.937	PF 3	14000.00	1277.95	1288.07		1288.56	0.004913	8.37	3129.61	735.26	0.52

HEC-RAS Plan: 1988Datum River: RIVER-1 Reach: Reach-1 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach-1	2.867	PF 1	6023.00	1275.95	1284.36		1284.74	0.003337	5.36	1672.58	670.28	0.40
Reach-1	2.867	PF 2	11000.00	1275.95	1287.24		1288.00	0.003597	7.34	1708.23	240.00	0.45
Reach-1	2.667	PF 3	14000.00	1275.95	1285.19		1286.77	0.004412	7.44	3100.17	872.60	0.48
Reach-1	2.774	PF 1	6023.00	1272.45	1281.25		1282.21	0.008983	8.79	1092.16	551.68	0.66
Reach-1	2.774	PF 2	11000.00	1272.45	1283.82		1285.40	0.008442	10.98	1211.93	180.00	0.68
Reach-1	2.774	PF 3	14000.00	1272.45	1284.00		1284.62	0.004812	8.41	2955.45	757.86	0.51
Reach-1	2.691	PF 1	6023.00	1270.95	1279.21		1279.69	0.003516	5.90	1293.29	377.50	0.42
Reach-1	2.691	PF 2	11000.00	1270.95	1281.80		1282.71	0.003949	7.90	1523.47	190.00	0.47
Reach-1	2.691	PF 3	14000.00	1270.95	1281.71		1282.53	0.004334	8.22	2432.53	518.00	0.49
Reach-1	2.588	PF 1	6023.00	1267.45	1275.74		1276.84	0.008441	9.58	1011.25	406.03	0.65
Reach-1	2.588	PF 2	11000.00	1267.45	1278.54		1279.90	0.006900	10.95	1395.84	210.00	0.63
Reach-1	2.588	PF 3	14000.00	1267.45	1276.18		1279.39	0.008079	11.55	2297.93	621.26	0.67
Reach-1	2.486	PF 1	6023.00	1264.95	1272.67		1273.19	0.005074	6.37	1282.23	431.03	0.49
Reach-1	2.486	PF 2	11000.00	1264.95	1275.31		1276.46	0.005720	8.87	1350.66	185.00	0.56
Reach-1	2.486	PF 3	14000.00	1264.95	1275.67		1276.29	0.003914	7.56	2863.73	640.75	0.46
Reach-1	2.395	PF 1	6023.00	1260.45	1270.31		1270.90	0.004432	7.21	1274.30	356.61	0.48
Reach-1	2.395	PF 2	11000.00	1260.45	1273.30		1274.13	0.003871	8.53	1724.81	220.00	0.48
Reach-1	2.395	PF 3	14000.00	1260.45	1273.30		1274.17	0.004766	9.47	2641.53	625.00	0.53
Reach-1	2.31	PF 1	6023.00	1257.45	1267.93		1268.62	0.005835	8.32	1226.72	366.75	0.55
Reach-1	2.31	PF 2	11000.00	1257.45	1270.77		1271.96	0.006055	10.59	1473.31	200.00	0.59
Reach-1	2.31	PF 3	14000.00	1257.45	1271.01		1271.89	0.005470	10.22	2562.55	607.33	0.56
Reach-1	2.208	PF 1	6023.00	1254.95	1265.82		1266.25	0.003226	6.60	1395.42	314.90	0.41
Reach-1	2.208	PF 2	11000.00	1254.95	1268.86		1269.52	0.003121	8.06	1893.80	215.00	0.43
Reach-1	2.208	PF 3	14000.00	1254.95	1266.66		1269.34	0.003934	8.94	2718.81	504.88	0.48
Reach-1	2.118	PF 1	6273.00	1252.95	1263.82		1264.30	0.005298	6.78	1389.10	406.91	0.50
Reach-1	2.118	PF 2	11000.00	1252.95	1266.34		1267.42	0.006261	9.40	1442.36	200.00	0.57
Reach-1	2.118	PF 3	14000.00	1252.95	1266.89		1267.43	0.004002	7.84	3157.04	767.88	0.47
Reach-1	2.034	PF 1	6273.00	1249.45	1260.56	1259.76	1261.57	0.008167	9.74	978.71	236.60	0.63
Reach-1	2.034	PF 2	11000.00	1249.45	1262.67	1261.39	1264.24	0.009343	12.20	1257.16	180.00	0.66
Reach-1	2.034	PF 3	14000.00	1249.45	1263.66	1261.94	1265.07	0.008495	12.21	1809.99	313.54	0.68
Reach-1	1.949	PF 1	6273.00	1248.95	1254.41	1254.12	1256.04	0.019756	10.23	613.41	159.12	0.92
Reach-1	1.949	PF 2	11000.00	1248.95	1256.27	1256.03	1258.35	0.019011	11.57	950.77	198.74	0.93
Reach-1	1.949	PF 3	14000.00	1248.95	1257.09	1256.90	1259.52	0.018333	12.53	1129.15	226.71	0.94
Reach-1	1.858	PF 1	6273.00	1245.75	1251.45		1252.09	0.004005	6.41	978.94	216.48	0.53
Reach-1	1.858	PF 2	11000.00	1245.75	1253.37		1254.31	0.004142	7.76	1417.34	240.91	0.56
Reach-1	1.858	PF 3	14000.00	1245.75	1254.38		1255.48	0.004126	8.40	1669.40	264.91	0.57
Reach-1	1.788	PF 1	6273.00	1243.95	1249.47		1250.30	0.005780	7.30	859.39	205.83	0.63
Reach-1	1.788	PF 2	11000.00	1243.95	1251.34		1252.53	0.005478	8.76	1256.17	219.51	0.65
Reach-1	1.788	PF 3	14000.00	1243.95	1252.32		1253.72	0.005338	9.49	1485.35	260.92	0.65
Reach-1	1.708	PF 1	6273.00	1241.95	1247.34		1248.08	0.004643	6.87	913.19	202.94	0.57
Reach-1	1.708	PF 2	11000.00	1241.95	1249.32		1250.39	0.004495	8.27	1329.50	217.71	0.59
Reach-1	1.708	PF 3	14000.00	1241.95	1250.35		1251.61	0.004460	8.99	1559.71	237.54	0.60
Reach-1	1.593	PF 1	6273.00	1239.45	1245.04		1245.63	0.003440	6.18	1015.61	211.48	0.50
Reach-1	1.593	PF 2	11000.00	1239.45	1247.07		1247.95	0.003470	7.52	1462.46	227.68	0.52
Reach-1	1.593	PF 3	14000.00	1239.45	1248.07		1249.13	0.003605	8.27	1693.05	237.86	0.54
Reach-1	1.479	PF 1	6273.00	1237.45	1242.94		1243.54	0.003504	6.20	1015.74	220.78	0.50
Reach-1	1.479	PF 2	11000.00	1237.45	1244.93		1245.83	0.003568	7.62	1444.03	222.88	0.53
Reach-1	1.479	PF 3	14000.00	1237.45	1245.88		1246.95	0.003604	8.35	1720.13	256.61	0.55
Reach-1	1.381	PF 1	6273.00	1235.45	1241.30		1241.84	0.003039	5.88	1067.67	218.53	0.47
Reach-1	1.381	PF 2	11000.00	1235.45	1243.24		1244.07	0.003167	7.33	1501.43	225.00	0.50
Reach-1	1.381	PF 3	14000.00	1235.45	1244.14		1245.17	0.003278	8.17	1761.76	286.62	0.52
Reach-1	1.307	PF 1	6273.00	1234.25	1238.64	1238.21	1239.77	0.010391	8.56	737.12	228.71	0.82
Reach-1	1.307	PF 2	11000.00	1234.25	1239.74	1239.56	1241.74	0.012878	11.35	968.83	215.00	0.94
Reach-1	1.307	PF 3	14000.00	1234.25	1240.36	1240.36	1242.76	0.012862	12.51	1161.24	260.16	0.97
Reach-1	1.286	PF 1	6273.00	1232.95	1236.85	1236.85	1238.28	0.016563	9.58	654.48	230.25	1.00
Reach-1	1.286	PF 2	11000.00	1232.95	1238.18	1238.18	1240.17	0.014932	11.30	973.64	247.19	1.00
Reach-1	1.286	PF 3	14000.00	1232.95	1238.91	1238.91	1241.19	0.013905	12.12	1165.23	275.19	0.99

HEC-RAS Plan: 1988Datum River: RIVER-1 Reach: Reach-1 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach-1	1.251	PF 1	6273.00	1220.95	1224.75	1224.75	1226.31	0.004067	10.03	625.52	202.41	1.01
Reach-1	1.251	PF 2	11000.00	1220.95	1226.19	1226.19	1228.39	0.003655	11.88	925.60	213.94	1.01
Reach-1	1.251	PF 3	14000.00	1220.95	1227.01	1227.01	1229.51	0.003440	12.69	1102.82	220.47	1.00
Reach-1	1.213	PF 1	6273.00	1210.95	1219.54		1219.83	0.000290	4.33	1447.26	226.35	0.30
Reach-1	1.213	PF 2	11000.00	1210.95	1221.47		1221.99	0.000391	5.80	1895.80	238.89	0.36
Reach-1	1.213	PF 3	14000.00	1210.95	1222.50		1223.16	0.000428	6.53	2143.67	245.16	0.39
Reach-1	1.191	PF 1	6273.00	1210.45	1218.03	1218.03	1219.62	0.004122	10.13	619.29	197.95	1.01
Reach-1	1.191	PF 2	11000.00	1210.45	1219.50	1219.50	1221.72	0.003675	11.96	919.66	209.98	1.01
Reach-1	1.191	PF 3	14000.00	1210.45	1220.31	1220.31	1222.66	0.003503	12.82	1091.91	216.57	1.01
Reach-1	1.169	PF 1	6273.00	1209.45	1215.24		1216.20	0.001601	7.88	796.27	183.76	0.67
Reach-1	1.169	PF 2	11000.00	1209.45	1217.06		1218.49	0.001634	9.60	1145.38	199.04	0.71
Reach-1	1.169	PF 3	14000.00	1209.45	1218.05		1219.73	0.001630	10.39	1346.97	207.35	0.72
Reach-1	1.058	PF 1	6273.00	1206.95	1214.04		1214.70	0.004054	6.52	961.39	208.81	0.54
Reach-1	1.058	PF 2	11000.00	1206.95	1215.90		1216.91	0.004221	8.07	1362.56	221.17	0.57
Reach-1	1.058	PF 3	14000.00	1206.95	1216.94		1218.13	0.004212	8.77	1595.81	228.05	0.58
Reach-1	0.946	PF 1	6522.00	1204.45	1211.48		1212.21	0.004347	6.88	948.57	200.73	0.56
Reach-1	0.946	PF 2	11000.00	1204.45	1213.36		1214.41	0.004227	8.22	1337.72	210.29	0.57
Reach-1	0.946	PF 3	14000.00	1204.45	1214.40		1215.65	0.004177	8.98	1567.33	221.78	0.59
Reach-1	0.833	PF 1	6522.00	1201.95	1209.21		1209.84	0.003526	6.34	1027.90	209.79	0.51
Reach-1	0.833	PF 2	11000.00	1201.95	1211.18		1212.06	0.003483	7.54	1458.43	227.20	0.52
Reach-1	0.833	PF 3	14000.00	1201.95	1212.28		1213.32	0.003434	8.17	1713.69	237.10	0.53
Reach-1	0.746	PF 1	6522.00	1200.45	1206.76		1207.73	0.006042	7.91	824.59	180.98	0.65
Reach-1	0.746	PF 2	11000.00	1200.45	1208.30		1209.81	0.006990	9.88	1113.87	195.21	0.73
Reach-1	0.746	PF 3	14000.00	1200.45	1209.00		1210.94	0.007985	11.17	1253.48	201.71	0.79
Reach-1	0.647	PF 1	6522.00	1197.95	1204.44		1204.92	0.004378	5.56	1173.01	344.16	0.53
Reach-1	0.647	PF 2	11000.00	1197.95	1205.52		1206.33	0.005580	6.76	1627.35	427.14	0.61
Reach-1	0.647	PF 3	14000.00	1197.95	1206.24		1207.08	0.005827	7.36	1901.49	453.44	0.63
Reach-1	0.579	PF 1	6522.00	1194.45	1202.44		1202.93	0.007159	5.65	1154.05	477.19	0.64
Reach-1	0.579	PF 2	11000.00	1194.45	1203.47		1204.15	0.006541	6.64	1657.42	502.88	0.64
Reach-1	0.579	PF 3	14000.00	1194.45	1203.93		1204.78	0.007032	7.40	1891.56	514.38	0.68
Reach-1	0.527	PF 1	6522.00	1194.95	1200.09	1199.28	1200.72	0.009128	6.36	1026.05	427.44	0.72
Reach-1	0.527	PF 2	11000.00	1194.95	1201.01	1200.52	1201.87	0.010810	7.45	1477.17	550.99	0.80
Reach-1	0.527	PF 3	14000.00	1194.95	1201.54		1202.51	0.009889	7.88	1775.58	568.58	0.79
Reach-1	0.437	PF 1	6522.00	1189.95	1196.61		1197.08	0.006247	5.51	1183.76	458.26	0.60
Reach-1	0.437	PF 2	11000.00	1189.95	1197.87		1198.47	0.004786	6.24	1763.27	463.38	0.56
Reach-1	0.437	PF 3	14000.00	1189.95	1198.40		1199.16	0.005027	6.96	2012.24	465.56	0.59
Reach-1	0.35	PF 1	6522.00	1186.45	1192.87		1193.57	0.009461	6.78	991.47	446.54	0.74
Reach-1	0.35	PF 2	11000.00	1186.45	1193.42	1193.31	1194.81	0.015013	9.46	1163.01	386.97	0.96
Reach-1	0.35	PF 3	14000.00	1186.45	1193.88	1193.88	1195.40	0.014682	10.07	1499.04	555.63	0.97
Reach-1	0.238	PF 1	6522.00	1181.95	1188.16		1188.51	0.007497	4.77	1366.10	754.48	0.63
Reach-1	0.238	PF 2	11000.00	1181.95	1189.11		1189.54	0.005404	5.24	2097.37	786.90	0.57
Reach-1	0.238	PF 3	14000.00	1181.95	1189.55		1190.06	0.005349	5.71	2450.10	802.07	0.58
Reach-1	0.159	PF 1	6522.00	1179.95	1185.79	1184.94	1186.08	0.004599	4.29	1521.04	683.81	0.51
Reach-1	0.159	PF 2	11000.00	1179.95	1186.11		1186.73	0.008441	6.32	1739.20	688.26	0.70
Reach-1	0.159	PF 3	14000.00	1179.95	1186.50		1187.25	0.008500	6.96	2010.72	692.42	0.72
Reach-1	0.107	PF 1	6522.00	1177.95	1182.97	1182.97	1183.63	0.023083	6.51	1001.59	806.95	1.03
Reach-1	0.107	PF 2	11000.00	1177.95	1184.27	1183.49	1184.71	0.006182	5.35	2057.88	829.69	0.60
Reach-1	0.107	PF 3	14000.00	1177.95	1184.64	1183.82	1185.18	0.006374	5.89	2375.79	846.68	0.62
Reach-1	0	PF 1	6522.00	1173.95	1178.59	1177.44	1178.74	0.002765	3.15	2067.97	1007.30	0.39
Reach-1	0	PF 2	11000.00	1173.95	1178.07	1178.07	1178.86	0.020558	7.11	1547.18	1002.72	1.01
Reach-1	0	PF 3	14000.00	1173.95	1178.32	1178.32	1179.26	0.020150	7.78	1800.47	1004.95	1.02

Proposed Cond. HEC-RAS
7-10'x8' RCBC

HEC-RAS Version 3.1.3 May 2005
U.S. Army Corp of Engineers
Hydrologic Engineering Center
609 Second Street
Davis, California

```
X     X  XXXXXX    XXXX        XXXX       XX      XXXX
X     X  X        X    X       X   X     X  X     X
X     X  X        X            X   X    X    X    X
XXXXXXX  XXXX     X       XXX  XXXX     XXXXXX    XXXX
X     X  X        X            X  X     X    X        X
X     X  X        X    X       X   X    X    X        X
X     X  XXXXXX    XXXX        X    X   X    X   XXXXX
```

PROJECT DATA
Project Title: 061509El Mirage 50yr_box culvert & exist
Project File : 061509_ElMirage.prj
Run Date and Time: 7/2/2009 9:02:09 AM

Project in English units

PLAN DATA

Plan Title: Plan 01
Plan File : m:\Jobs\2008\2008010 - ElMirage Rd Final Design Phase B - Jacob\Engineering\Calcs\HEC-RAS\061509_ElMirage.p01

Geometry Title: 50yrbox-10X8' RBCmod061509
Geometry File : m:\Jobs\2008\2008010 - ElMirage Rd Final Design Phase B - Jacob\Engineering\Calcs\HEC-RAS\061509_ElMirage.g16

Flow Title : Flow 01
Flow File : m:\Jobs\2008\2008010 - ElMirage Rd Final Design Phase B - Jacob\Engineering\Calcs\HEC-RAS\061509_ElMirage.f01

Plan Description:
7-10'X8' RCBC with low point of roadway at Ele 1205.

Plan Summary Information:

Number of:	Cross Sections	= 18	Multiple Openings	=	0
	Culverts	= 1	Inline Structures	=	0
	Bridges	= 0	Lateral Structures	=	0

Computational Information

Water surface calculation tolerance	= 0.01
Critical depth calculation tolerance	= 0.01
Maximum number of iterations	= 20
Maximum difference tolerance	= 0.3
Flow tolerance factor	= 0.001

Computation Options
Critical depth computed only where necessary
Conveyance Calculation Method: At breaks in n values only
Friction Slope Method: Average Conveyance
Computational Flow Regime: Subcritical Flow

FLOW DATA

Flow Title: Flow 01
Flow File : m:\Jobs\2008\2008010 - ElMirage Rd Final Design Phase B - Jacob\Engineering\Calcs\HEC-RAS\061509_ElMirage.f01

Flow Data (cfs)

River	Reach	RS	100-year	500-year	SPF	10-year
el mirage	2	2456.913	6500	11000	14000	2917

PF 5
5085

Boundary Conditions

River	Reach	Profile	Upstream	Downstream
el mirage	2	100-year		Normal S = 0.00276
el mirage	2	500-year		Normal S = 0.00276
el mirage	2	SPF		Normal S = 0.00276

GEOMETRY DATA

Geometry Title: 50yrbox-10X8' RBCmod061509
Geometry File : m:\Jobs\2008\2008010 - ElMirage Rd Final Design Phase B - Jacob\Engineering\Calcs\HEC-RAS\061509_ElMirage.g16

CROSS SECTION

RIVER: el mirage
REACH: 2 RS: 2456.913

INPUT
Description:
Station Elevation Data num= 101

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1226	18.44	1226	20.75	1225.91	24.33	1225.88	24.36	1225.88
31.57	1225.86	35.85	1225.86	36.68	1225.88	38.14	1225.88	44.44	1225.87
45.71	1225.86	51.64	1225.77	52.96	1225.76	53.38	1225.75	58.25	1225.67
65.26	1225.48	73.22	1225.25	74.67	1225.22	80.13	1225	80.41	1225
87.63	1224.34	88.78	1224.26	88.8	1224.26	91.6	1224	92.05	1224
95.34	1223.51	103.32	1221.08	103.7	1221	103.71	1221	105.72	1220
109.75	1218	110.26	1217.74	114.45	1215.58	122.78	1212	146.79	1212
151.12	1212.06	154.85	1212.07	155.38	1212.1	159.74	1212.22	173.95	1213
192.67	1213	192.69	1213	196.77	1213	198.33	1212.14	198.71	1211.92
203.17	1209.45	207.57	1207	208.57	1206.68	210.36	1206	217.6	1204.02
217.68	1204	217.75	1203.99	218.08	1203.94	224.85	1203	231.21	1202.53
231.56	1202.5	232.29	1202.44	237.97	1202	241.36	1202	248.49	1201.78
259.77	1201.25	265.13	1201	352.37	1201	355.67	1201.17	368.69	1202
375.43	1202.44	392.76	1203	398.54	1203	403.07	1203.47	405.54	1204
416.91	1206.52	418.85	1207	419.47	1207.16	422.73	1208	426.23	1209
429.73	1210	433.27	1211.01	436.77	1212	437.64	1212.27	439.97	1213
444.68	1214.56	449.64	1216.21	452.12	1217	452.64	1217.18	455.03	1218
462.2	1221.22	463.94	1222	466.18	1223	466.8	1223.28	468.34	1224
470.49	1225	471.5	1225.52	472.39	1225.69	472.42	1225.7	474.1	1226
476.45	1226	487.41	1226.68	492.94	1227	516.56	1227.76	523.89	1228
539.29	1228								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.06	192.69	.04	472.42	.06

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
192.69	472.42	120.94 120.27	120.79	.1	.3

CROSS SECTION

RIVER: el mirage
REACH: 2 RS: 2336.644

INPUT
Description:
Station Elevation Data num= 101

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1222.62	42.78	1222.17	48.87	1222	53.25	1221.42	54.58	1221.23
54.82	1221.22	55.27	1221.15	55.46	1221.12	56.53	1221	60.4	1221
69.54	1220.61	71.7	1220.83	73.58	1221	75.75	1221	80.69	1220.33
82.53	1220	86.64	1218.8	89.31	1218.09	89.61	1218.09	89.96	1217.93
92.33	1217	93.91	1216.38	108.1	1211	109.94	1211	110.23	1211.09
111.32	1211.39	111.37	1211.41	112.21	1211.6	118.3	1211.38	121.91	1211.52
122.59	1211.53	130.28	1211.71	131.18	1211.74	135.91	1211.68	136.06	1211.66
136.75	1211.67	143.94	1211.78	145.25	1211.8	146.38	1212	147.83	1212
147.85	1212	151.02	1212	151.43	1211.91	151.9	1211.83	156.98	1211
157.02	1211	170.36	1206.02	170.41	1206	177.08	1204.18	177.9	1204
178.46	1203.86	182.48	1203	187.56	1202.08	187.95	1202	189.63	1201.95
190.17	1201.94	196.07	1201.77	210.81	1201.35	216.07	1201.21	223.02	1201
226.23	1201	245.26	1200.29	254.07	1200	282.07	1200	298.85	1200.45
310.24	1200.72	320.65	1201	320.81	1201	322.77	1201.06	353.4	1202
356.1	1202	365.19	1202.81	367.32	1203	368.83	1203.34	370.79	1203.78
383.1	1207	384.24	1207.32	386.59	1208	400.04	1212	401.25	1212.39
403.16	1213	415.34	1217	418.02	1217.96	418.13	1218	419.63	1218.63
428.2	1222	430.78	1223	433.29	1224	434.93	1224.97	435	1225
435.13	1225.02	435.57	1225.11	435.58	1225.11	440.15	1226	445.33	1226
458.16	1226.46	475.1	1227	485.08	1227	488	1227.45	491.57	1228
495.13	1228								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.06	147.85	.04	435.57	.06

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
147.85	435.57	92.18 80.03	81.89	.1	.3

CROSS SECTION

RIVER: el mirage

REACH: 2 RS: 2256.617

INPUT
Description:
Station Elevation Data num= 100

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1221.95	7.46	1221.95	7.93	1221.94	16.13	1221.9	18.29	1221.84
22.29	1221.78	23.62	1221.75	29.24	1221.53	40.4	1221	40.82	1221
47.91	1220.17	49.4	1220	50.45	1219.88	55.19	1219.56	55.73	1219.51
58.82	1219	63.84	1218	65.38	1217.7	69.56	1217.34	74.35	1218
75.48	1218.14	77.17	1218.44	78.38	1218.63	80.14	1218.85	81.82	1219
84.73	1219	89.11	1218.62	91.5	1218.53	91.58	1218.53	91.6	1218.53
97.11	1218.53	99.81	1218.48	101.33	1218.51	103.57	1218.46	106.99	1218.46
108.41	1218.43	109.03	1218.43	110.68	1218.42	119.18	1218	120.75	1218
123.15	1217.7	128.31	1217	133.71	1214.72	135.23	1214.41	135.45	1214.26
135.83	1214	140.37	1210.87	141.75	1209.92	145.51	1207.32	148.52	1205.24
148.76	1205	148.81	1204.98	148.97	1204.95	149.08	1204.93	149.18	1204.91
153.35	1204	163.45	1202.58	168.42	1202	168.5	1202	169.72	1201.9
172.51	1201.67	181.49	1201	181.61	1201	183.34	1200.95	213.34	1200
280	1200	302.3	1200.65	304.89	1200.73	308.16	1200.81	315.02	1201
328.42	1201	333.87	1201.32	345.9	1202	350.43	1202.82	351.47	1203
365.95	1207	365.99	1207.01	369.34	1208	380.65	1211.38	382.73	1212
382.79	1212.02	385.82	1212.97	385.91	1213	398.63	1217	398.65	1217.01
401.06	1218	410.14	1222	412.42	1223	414.68	1224	414.84	1224.06
417.37	1225	419.68	1225.18	428.42	1225.87	430.15	1226	431.69	1226.05
435.11	1226.13	467.52	1226.97	468.57	1226.99	468.78	1227	476.26	1227

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.06	128.31	.04	417.37	.06

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
128.31	417.37	758.09	92.68	91.55	.1	.3

CROSS SECTION

RIVER: el mirage
REACH: 2 RS: 2163.937

INPUT
Description:
Station Elevation Data num= 100

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1219.47	1.87	1219.35	1.89	1219.35	7.81	1219	9.52	1218.77
11.6	1218	14.17	1217	19.92	1214.76	22.37	1214	22.87	1213.82
25.11	1213	26.24	1212.57	30.34	1211	34.12	1209.56	39.8	1208.09
40.15	1208	40.42	1207.92	40.48	1207.91	40.75	1207.83	43.85	1207
45.77	1207	49.69	1206.24	51.11	1206.31	53.25	1206.1	57.49	1206.43
58.78	1206.51	62.59	1206.71	63	1206.74	64.49	1206.82	65.48	1206.86
77.55	1206.23	80.46	1206.06	81.09	1206	81.69	1205.93	85.9	1205.67
87.72	1205.65	93.2	1205.19	94.81	1205	97.55	1204.61	101.63	1204
105.25	1203.47	108.1	1203	108.5	1203	115.98	1202	118.18	1201.71
123.55	1201	124.76	1201	150.96	1200.01	151.27	1200	151.96	1200
157.95	1199.71	169.31	1199	194.06	1199	198.72	1198.42	206.19	1198.56
209.73	1199	209.98	1199	226.33	1199.43	246.44	1200	252.52	1200
267.97	1200.64	278.86	1201	280.45	1201	293.94	1201.99	294.14	1202
294.21	1202.01	303.78	1203	306.39	1203.64	307.89	1204	311.74	1204.94
314.98	1205.77	315.92	1206	316.64	1206.2	319.58	1207	321.53	1207.6
327.58	1209.45	332.96	1211	334.25	1211.4	336.23	1212	344.07	1214.48
348.75	1216	349.55	1216.3	351.56	1217	356.16	1218.93	356.34	1219
357.06	1219.3	361.07	1221	362.02	1221.4	363.43	1222	364.66	1222.51
365.81	1223	367.64	1223.8	368.08	1224	368.89	1224.11	373.68	1224.78
375.14	1225	383.24	1226	393.78	1226	411.54	1226.55	416.17	1226.76

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.06	9.52	.04	368.89	.06

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
9.52	368.89	1	70.43	69.23	.1	.3

Ineffective Flow num= 1

Sta L	Sta R	Elev	Permanent
0	64.49	1207.51	F

CROSS SECTION

RIVER: el mirage
REACH: 2 RS: 2093.506

INPUT
Description:
Station Elevation Data num= 99

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1220.15	2.97	1220	4.11	1220	4.12	1220	7.75	1219.63
13.71	1219	14.65	1218.74	17.41	1218	24.15	1216.19	26.25	1215.45
27.49	1215	28.96	1214.44	31.17	1213.61	37.9	1211	38.19	1210.89
40.39	1210	41.68	1209.48	45.34	1208	47.7	1207.23	48.35	1207
52.39	1206.45	55.28	1206	57.9	1205.53	60.89	1205	69.43	1205
79.13	1205.56	84.4	1205.78	86.8	1205.88	90.05	1206	91.65	1206.22

96.82	1207	99.9	1207.55	103.27	1208	103.85	1208.08	105.65	1208
123.55	1208	125.03	1207.93	127.53	1207.76	130.11	1207.57	139.66	1207
144.22	1206.26	149.99	1204.64	163.65	1202.01	169.19	1201	172.19	1200.57
176.77	1200	182.01	1199.56	200.02	1199	204.41	1199	230.86	1198.04
231.96	1198	256.16	1198	256.32	1198.03	261.07	1199	294.16	1199
305.34	1199.46	318.39	1200	318.9	1200	329.5	1200.41	345.07	1201
347.46	1201.48	349.92	1202	374.97	1208.8	375.54	1209	375.74	1209
378.24	1209.87	379.35	1210.24	385.17	1212	385.34	1212	385.76	1212.18
400.35	1216.59	401.85	1217	402.64	1217	404.06	1217.53	405.16	1218
405.6	1218.13	406.56	1218.37	406.78	1218.43	406.82	1218.44	408.56	1219
410.94	1219.99	410.97	1220	411.24	1220.13	411.45	1220.22	411.87	1220.4
412.99	1220.91	415.33	1222	417.52	1223	418	1223.25	418.31	1223.44
419.18	1224	421.46	1224.32	421.96	1224.42	426.53	1225	432.84	1225.4
450.14	1226	467.82	1226	469.06	1225.84	471.86	1225.49		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.06	13.71	.04	418.31	.06

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
13.71	418.31	1 83.63	89.95	.1	.3

Ineffective Flow num= 1

Sta L	Sta R	Elev	Permanent
0	92.35	1207.27	F

CROSS SECTION

RIVER: el mirage
REACH: 2 RS: 2009.877

INPUT
Description: Start of Bank Protection
Station Elevation Data num= 94

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1221	3.75	1221	15.62	1220.27	18.17	1220	18.62	1220
22.26	1219.55	23.6	1219.44	23.62	1219.44	25.72	1219.25	27.02	1219
28.97	1218.16	29.97	1217.65	37.45	1215	38.85	1214.39	39.89	1214
42.19	1213.03	45.02	1211.9	50.03	1210	57.39	1207.3	59.59	1207
61.73	1206.84	66.79	1206	79.53	1205	80.86	1205	81.58	1204.97
91.52	1204	95.29	1204	99.46	1204.41	102.63	1204.62	104.3	1204.81
119.09	1205.16	137.99	1205.69	146.45	1206	148.59	1206	154.12	1206.48
159.81	1206.47	167.55	1206.66	176.58	1206.5	184.33	1206.64	191.01	1206.79
194.07	1206.71	198.47	1206.77	200.75	1206.86	201.69	1206.85	206.53	1207
211.47	1207	217.85	1206.63	226.33	1206	228.16	1206	228.57	1206
233.65	1205	241.71	1202	246.86	1201	248.7	1200.68	253.73	1200
265.25	1199	268.9	1198.54	271.4	1198.34	274.79	1198	275.09	1197.95
282.24	1197.71	297.6	1197.1	299.9	1197.04	301.85	1196.87	314.04	1196.37
319.15	1197	328.43	1197	336.25	1199.23	338.83	1199.74	340.6	1200
351.44	1201	357.54	1201	358.63	1200.74	360.02	1200.47	362.75	1200
367.51	1199	393.5	1199	446.5	1200	457	1207	472.39	1212
473.21	1212.29	487.3	1216.79	489.19	1217.31	491.03	1218	498.09	1221.65
502.92	1224.65	505.22	1224.79	505.24	1224.79	508.54	1225	509.32	1225
521.43	1225.6	528.77	1226	558.41	1227	561	1227		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.06	27.02	.04	457	.06

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
27.02	457	1 68.68	122.68	.1	.3

Ineffective Flow num= 2

Sta L	Sta R	Elev	Permanent
0	154.12	1206.89	F
357.54	561	1201.5	F

Left Levee Station= 137.99 Elevation= 1205.69

CROSS SECTION

RIVER: el mirage
REACH: 2 RS: 1941.198

INPUT
Description:
Station Elevation Data num= 97

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1221	1.72	1221	11.98	1220.31	17.23	1220	18.45	1220
20.06	1219.63	20.08	1219.63	21.02	1219.41	23.19	1219	23.99	1218.66
25.62	1218	32.79	1215.26	36.59	1213.84	44.6	1210.33	51.14	1207.6
57.69	1206	58.07	1206	63.85	1205.1	64.36	1205	65.37	1205
73.64	1204.59	79.17	1204.38	86.48	1204	98.19	1204	117.35	1204.79
125.37	1205	126.81	1205	141.7	1205.51	148.57	1205.62	155.65	1205.84
156.82	1205.85	157.65	1205.81	158.97	1205.9	161.21	1205.94	162.67	1206
197.3	1206	199.34	1205.66	200.55	1205.5	210.51	1205.11	211.82	1205
215.52	1205	218.77	1204.53	219.62	1204.52	225.8	1204	228.11	1204
233.67	1204.57	236.13	1204.46	239.84	1204.54	240.36	1204.52	242.53	1204.36
243.84	1204.4	247.73	1204.71	254.81	1205	265.17	1205	266.82	1204.9
277.8	1204.27	280.38	1204	283.32	1203	286.43	1202	290.1	1201
297.3	1199	305.66	1198	311.3	1197.18	313	1197	314.06	1196.8
314.77	1196.73	316.93	1196.66	318.44	1196.52	327.59	1196	338.29	1196

354.12	1197	356.79	1197	387.59	1198	391.36	1198	397.71	1198.24		
409.76	1199	412.6	1199.74	413.77	1200	461.34	1200	493.75	1201		
502	1206.5	502.76	1207.64	507.17	1209	514.07	1211	517.85	1212.13		
524.25	1214	539.32	1219	544.82	1221.06	548.72	1223	552.68	1225		
553.85	1225.09	553.86	1225.09	566.24	1226	604.53	1227	612.1	1228		
612.21	1228	615.88	1227.35								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.06	20.08	.04	502	.06

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
20.08	502	1	45.19	125.58	.1	.3

Ineffective Flow num= 1

Sta L	Sta R	Elev	Permanent
0	161.21	1206.4	F

Left Levee Station= 254.81 Elevation= 1205

CROSS SECTION

RIVER: el mirage
REACH: 2 RS: 1896.011

INPUT
Description:
Station Elevation Data num= 98

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1221	7.72	1221	20.67	1220	21.14	1219.93	23	1219.67
26	1219	29.69	1217.62	37.13	1214.48	45.4	1210.7	54.89	1207.54
60.46	1206	65.97	1205	68.64	1204.58	75.93	1204	105.09	1204
109.98	1204.13	125.41	1204.36	128.21	1204.47	138.59	1204.69	152.29	1204.85
160.57	1205	163.7	1205	165.41	1205.11	171.58	1205.29	181.19	1205.12
182.01	1205.14	188.08	1205.06	195.18	1204.67	198.9	1204.63	205.23	1204.32
207.91	1204.38	208.66	1204.28	209.77	1204.28	215.05	1204.12	216.89	1204
220.4	1203.69	224.35	1203.75	225.24	1203.7	227.11	1203.7	237.99	1203
240.6	1202.79	242.61	1202.77	244.22	1202.72	251.6	1202.76	256.32	1203
261.07	1203.43	264.96	1203.46	272.76	1203.22	278.42	1203.78	279.84	1203.78
283.33	1203.78	285.51	1203.78	294.69	1203.78	298.14	1203.78	300.09	1203.78
302.3	1203.29	306.58	1202	309.49	1201	317.35	1198	323.36	1198
333.56	1197	340.23	1196	385.83	1196	387.19	1196.54	390.28	1198
395.63	1198.58	397.1	1199	451.61	1199	458.87	1199.38	469.27	1200
474.16	1200	485.14	1200.44	494.15	1201	497.93	1201.33	501.35	1201.54
506.64	1202	508.86	1202	526	1202.1	532	1206	544.69	1209
548.51	1210	575.22	1216.38	584.25	1218.6	585.9	1219.08	587.93	1220
589.22	1220.45	590.63	1221	596.78	1223.18	601.1	1225.02	601.12	1225.03
603.44	1226	606.26	1226	621.02	1226.81	625.07	1227	664.94	1228
673.38	1228	679.7	1227	681.93	1227				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.06	23	.04	532	.06

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
23	532	1	57.17	103.77	.1	.3

Ineffective Flow num= 1

Sta L	Sta R	Elev	Permanent
0	171.58	1206.27	F

Left Levee Station= 128.21 Elevation= 1204.47

CROSS SECTION

RIVER: el mirage
REACH: 2 RS: 1838.837

INPUT
Description:
Station Elevation Data num= 99

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1221	9.56	1221	22.08	1220.03	22.11	1220.03	22.52	1220
28.05	1219	38	1215	43.77	1213	43.91	1213	56.86	1207.45
62.11	1206	68.94	1204.84	72.56	1204	96.9	1204	108.99	1203.74
117.32	1203.82	126.95	1203.71	129.39	1203.53	131.13	1203.62	138.7	1203.46
144.33	1203.66	148.07	1203.67	151.46	1203.77	152.53	1203.85	159.64	1204
165.2	1203.95	172.26	1203.57	179.81	1203.01	180.51	1203	182.47	1203.12
198.92	1203.15	201.32	1203	211.81	1203	238.86	1202	239.74	1202
242.9	1202.16	268.3	1203	292.65	1203	294.56	1203.18	295.26	1203.2
302.07	1203.2	304.16	1203.2	306.82	1203.2	320.45	1203.2	323.88	1203.2
328	1202	329.54	1201.09	329.64	1201	329.95	1201	331.79	1200.66
336.49	1200	347.5	1198	356.62	1197	384.11	1196	417.83	1196
426.2	1197	434.11	1197.61	439.81	1198	457.55	1198.39	471.09	1199
472.59	1199	476.77	1199.13	493.55	1200	495.34	1200	498.42	1200.13
513.03	1201	518.59	1202	518.77	1202	552	1202.1	558	1206
558.11	1207.93	560.38	1208	562.09	1208.13	572.6	1209.37	579.93	1210
581.33	1210	586.74	1210.44	589.59	1211.2	596.64	1214.47	599.73	1216
607.68	1220.15	611.77	1223	613.06	1223.96	615.22	1226	618.82	1226.64
619.45	1226.81	619.48	1226.82	620.17	1227	629.09	1227	634.03	1226
656.32	1226	671.22	1227	688.45	1227	706.46	1227.46	732.11	1228
746.57	1228	749.46	1227.61	753.01	1227	766.68	1227		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.06	28.05	.04	558	.06

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
28.05	558	1 69.88	147.25	.1	.3

Ineffective Flow num= 1

Sta L	Sta R	Elev	Permanent
0	182.47	1206.22	F

CROSS SECTION

RIVER: el mirage
REACH: 2 RS: 1768.958

INPUT
Description: Lt Abutment Sta. 43, Rt Abutment Sta. 548 (Soil Cement 1.5:1)
Station Elevation Data num= 95

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1221	9.13	1221	20.59	1220.13	22.16	1220	27.6	1219
35.32	1216	37.43	1215.36	43	1210	51.3	1204.47	71.83	1204
82.09	1204	103.08	1203.49	108.39	1203.54	132.3	1203.16	134.56	1203
146.67	1203	156.98	1203.3	158.61	1203.28	163.43	1203	202.34	1203
203.44	1202.95	213.95	1202	254.8	1202	288.32	1202.67	313.33	1202.67
316.66	1202.73	320.98	1202.88	323.92	1203	330.98	1203	341.9	1203
347.16	1203	356.81	1200	358.24	1199.78	362.37	1199	369.55	1198
371.78	1197.63	376.45	1197	386.43	1196.68	411.12	1196	419.36	1196
436.44	1195.3	444.12	1195.05	450.97	1195.78	454.06	1196.23	458.71	1197
468.64	1198	487.63	1199	489.16	1199	502.76	1200	503.16	1200.28
504.4	1201	510.8	1201.85	541.8	1202	548	1206	560.5	1209
572.42	1210.44	581.23	1211	592.18	1217.63	601.3	1220.6	602.21	1221
606.99	1221	610.1	1220.23	610.67	1220.16	610.71	1220.16	611.77	1220.24
615.81	1221	619.49	1221.33	626.38	1221.77	628.66	1222	634.36	1222
651.44	1222.5	663.95	1222	671.79	1222	674.36	1222.08	688.87	1222.85
691.39	1223.04	692.52	1223.39	694.52	1223.6	703.98	1223.4	715.56	1223.72
720.86	1223.81	725.32	1224	743.16	1223.9	763.72	1223.64	774.15	1223.63
795.21	1224	802.27	1225	814.52	1226	827.35	1226.6	838.26	1227
865.48	1227.68	876.37	1227.87	877.67	1228	881.77	1228	891.75	1226.43

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.06	43	.04	548	.06

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
43	548	695.78	95.04	187.79	.1	.3

Ineffective Flow num= 1

Sta L	Sta R	Elev	Permanent
0	188.93	1205.74	F

CROSS SECTION

RIVER: el mirage
REACH: 2 RS: 1673.921

INPUT
Description: Lt. Abut. 174.33, Rt Abut. 679.00
Station Elevation Data num= 100

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1221.76	8.39	1221.83	14.41	1222	46.71	1222	62.01	1221.44
67.64	1221.27	75.3	1221.23	85.84	1221	124.47	1221	130.96	1220.53
134.72	1220.22	137.41	1220	143	1219	151	1216	151.63	1215.74
159.91	1212.23	172.17	1208	174.33	1207	178.83	1204	188.21	1204
189.17	1204	215.12	1203.33	218.6	1203.36	238.61	1203	307.99	1203
317.45	1202.46	325.28	1202.1	326.54	1202	383.84	1202	384.48	1201.98
384.76	1202	392.97	1202	393.65	1202.01	396.17	1202	435.94	1202
436.8	1201.91	441.41	1201.53	447.05	1201.72	447.9	1201.57	448.88	1201.56
449.73	1201.61	450.97	1201.74	451.06	1201.74	456.4	1202.55	458.77	1202.55
468.16	1202.55	472.64	1202.55	476.14	1202.55	482.95	1202.55	484.28	1202.55
491.18	1202.55	495.42	1202.55	503.19	1201.13	508.36	1200	515.04	1199
518.1	1198.63	520.51	1198.38	522.35	1198.17	524.84	1198	533.29	1197.54
538.11	1197.03	538.9	1196.98	545.65	1196	546.79	1196	555.32	1195
614.08	1195	614.79	1195.09	620.08	1196	626.08	1197	637.14	1197.85
638.86	1198	649.32	1199	651.33	1199.14	653.98	1199.26	661.69	1199.65
664.53	1199.74	669.49	1200	670.88	1201.22	672.58	1201.23	679	1205.5
681.54	1211.71	686.55	1220	687.28	1220.19	693.16	1220.46	698.71	1220.72
708.45	1220.83	711.68	1220.85	719.1	1221	721.84	1221	726.81	1221.17
727.45	1221.18	729.28	1221.25	743.06	1222	744.59	1222	750.16	1222.29
764.72	1223	766.07	1223	775.65	1223.31	796.32	1224	859.24	1224

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.06	174.33	.04	679	.06

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
174.33	679	142.11	168.58	174.27	.1	.3

Ineffective Flow num= 1

Sta L	Sta R	Elev	Permanent
0	475	1202.55	F

CULVERT

RIVER: el mirage
REACH: 2 RS: 1663.921

INPUT
Description:
Distance from Upstream XS = 10
Deck/Roadway Width = 148
Weir Coefficient = 2.6
Upstream Deck/Roadway Coordinates
num= 6

Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord
0	1209.75		183.5	1206.89		387	1205.96	
635	1206.65		685	1207.2		800	1207.67	

Upstream Bridge Cross Section Data
Station Elevation Data num= 100

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1221.76	8.39	1221.83	14.41	1222	46.71	1222	62.01	1221.44
67.64	1221.27	75.3	1221.23	85.84	1221	124.47	1221	130.96	1220.53
134.72	1220.22	137.41	1220	143	1219	151	1216	151.63	1215.74
159.91	1212.23	172.17	1208	174.33	1207	178.83	1204	188.21	1204
189.17	1204	215.12	1203.33	218.6	1203.36	238.61	1203	307.99	1203
317.45	1202.46	325.28	1202.1	326.54	1202	383.84	1202	384.48	1201.98
384.76	1202	392.97	1202	393.65	1202.01	396.17	1202	435.94	1202
436.8	1201.91	441.41	1201.53	447.05	1201.72	447.9	1201.57	448.88	1201.56
449.73	1201.61	450.97	1201.74	451.06	1201.74	456.4	1202.55	458.77	1202.55
468.16	1202.55	472.64	1202.55	476.14	1202.55	482.95	1202.55	484.28	1202.55
491.18	1202.55	495.42	1202.55	503.19	1201.13	508.36	1200	515.04	1199
518.1	1198.63	520.51	1198.38	522.35	1198.17	524.84	1198	533.29	1197.54
538.11	1197.03	538.9	1196.98	545.65	1196	546.79	1196	555.32	1195
614.08	1195	614.79	1195.09	620.08	1196	626.08	1197	637.14	1197.85
638.86	1198	649.32	1199	651.33	1199.14	653.98	1199.26	661.69	1199.65
664.53	1199.74	669.49	1200	670.88	1201.22	672.58	1201.23	679	1205.5
681.54	1211.71	686.55	1220	687.28	1220.19	693.16	1220.46	698.71	1220.72
708.45	1220.83	711.68	1220.85	719.1	1221	721.84	1221	726.81	1221.17
727.45	1221.18	729.28	1221.25	743.06	1222	744.59	1222	750.16	1222.29
764.72	1223	766.07	1223	775.65	1223.31	796.32	1224	859.24	1224

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.06	174.33	.04	679	.06

Bank Sta: Left Right Coeff Contr. Expan.
174.33 679 .1 .3
Ineffective Flow num= 1

Sta L	Sta R	Elev	Permanent
0	475	1202.55	F

Downstream Deck/Roadway Coordinates
num= 6

Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord
0	1209.28		183.5	1205.44		387	1204.19	
635	1204.88		685	1205.43		800	1206.04	

Downstream Bridge Cross Section Data
Station Elevation Data num= 92

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1224.54	10.86	1224	17.34	1223.53	36.5	1222.33	42.58	1222
50.97	1221.74	86.66	1220.95	118.5	1220.67	128.63	1221	135.81	1221
143.55	1220.59	149.88	1219.88	149.9	1219.88	155.39	1219	170.13	1211.45
174.21	1209.44	177.69	1207.95	183.55	1206	189.15	1205	210	1205
214.5	1202	237.36	1202	239.21	1202	245.35	1201.72	260.13	1201.27
265.13	1201.55	271.64	1202	279.13	1202	289.06	1201.79	317.85	1201.37
327.21	1201.39	347.52	1201.61	372.31	1201.46	391.22	1201	414.63	1201
424.06	1200.42	434.48	1200	438.61	1200	447.98	1199.14	450.28	1199
458.53	1199	459.4	1199.18	462.85	1199.62	465.12	1200	465.84	1200
479.15	1200	487.29	1199.41	491.7	1199	496.29	1199	504.25	1200
520.35	1200.26	533.2	1200.17	545.56	1200.55	559.45	1200.78	587.59	1200.26
596.91	1200	602.91	1200	612.56	1199.35	616.43	1199	622.26	1198.36
624.69	1198	631.86	1196.28	632.74	1196	636.64	1195	642.47	1195
647	1194.78	669.79	1194	686.84	1194	688.25	1194.36	691.58	1197
707.65	1198	713.5	1198.1	724	1205	737.09	1214.26	738.04	1214.71
740.63	1216.12	741.26	1216.32	743.9	1217.7	744.65	1218	748.02	1219
753.34	1219.67	753.37	1219.67	769.6	1221.67	772.6	1221.99	777.2	1222
797.04	1223	800.95	1223.28	805.17	1223.42	811.09	1223.5	830.26	1224
841.35	1224.19	854.16	1224.28						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.06	210	.04	724	.06

Bank Sta: Left Right Coeff Contr. Expan.
210 724 .1 .3
Ineffective Flow num= 1

Sta L	Sta R	Elev	Permanent
0	372.31	1203.25	F

Left Levee Station= 271.64 Elevation= 1202

Upstream Embankment side slope = 0 horiz. to 1.0 vertical
Downstream Embankment side slope = 0 horiz. to 1.0 vertical
Maximum allowable submergence for weir flow = .95
Elevation at which weir flow begins = 1202
Energy head used in spillway design =
Spillway height used in design =
Weir crest shape = Broad Crested

Number of Culverts = 1

Culvert Name	Shape	Rise	Span
Culvert #1	Box	8	10

FHWA Chart # 8 - flared wingwalls
FHWA Scale # 1 - Wingwall flared 30 to 75 deg.
Solution Criteria = Highest U.S. EG

Culvert Upstrm Dist	Length	Top n	Bottom n	Depth Blocked	Entrance Loss Coef	Exit Loss Coef
10	148	.013	.013	0	.2	1

Number of Barrels = 7
Upstream Elevation = 1194
Centerline Stations

Sta.	Sta.	Sta.	Sta.	Sta.	Sta.	Sta.
537	549	561	573	585	597	609

Downstream Elevation = 1193.5
Centerline Stations

Sta.	Sta.	Sta.	Sta.	Sta.	Sta.	Sta.
622	634	646	658	670	682	694

CROSS SECTION

RIVER: el mirage
REACH: 2 RS: 1505.346

INPUT
Description: End of Bank Protection
Station Elevation Data num= 92

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1224.54	10.86	1224	17.34	1223.53	36.5	1222.33	42.58	1222
50.97	1221.74	86.66	1220.95	118.5	1220.67	128.63	1221	135.81	1221
143.55	1220.59	149.88	1219.88	149.9	1219.88	155.39	1219	170.13	1211.45
174.21	1209.44	177.69	1207.95	183.55	1206	189.15	1205	210	1205
214.5	1202	237.36	1202	239.21	1202	245.35	1201.72	260.13	1201.27
265.13	1201.55	271.64	1202	279.13	1202	289.06	1201.79	317.85	1201.37
327.21	1201.39	347.52	1201.61	372.31	1201.46	391.22	1201	414.63	1201
424.06	1200.42	434.48	1200	438.61	1200	447.98	1199.14	450.28	1199
458.53	1199	459.4	1199.18	462.85	1199.62	465.12	1200	465.84	1200
479.15	1200	487.29	1199.41	491.7	1199	496.29	1199	504.25	1200
520.35	1200.26	533.2	1200.17	545.56	1200.55	559.45	1200.78	587.59	1200.26
596.91	1200	602.91	1200	612.56	1199.35	616.43	1199	622.26	1198.36
624.69	1198	631.86	1196.28	632.74	1196	636.64	1195	642.47	1195
647	1194.78	669.79	1194	686.84	1194	688.25	1194.36	691.58	1197
707.65	1198	713.5	1198.1	724	1205	737.09	1214.26	738.04	1214.71
740.63	1216.12	741.26	1216.32	743.9	1217.7	744.65	1218	748.02	1219
753.34	1219.67	753.37	1219.67	769.6	1221.67	772.6	1221.99	777.2	1222
797.04	1223	800.95	1223.28	805.17	1223.42	811.09	1223.5	830.26	1224
841.35	1224.19	854.16	1224.28						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.06	210	.04	724	.06

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
210	724	86.44	78.04 1644.92	.1	.3

Ineffective Flow num= 1

Sta L	Sta R	Elev	Permanent
0	372.31	1203.25	F

Left Levee Station= 271.64 Elevation= 1202

CROSS SECTION

RIVER: el mirage
REACH: 2 RS: 1427.304

INPUT
Description:
Station Elevation Data num= 101

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1221.33	6.69	1221	7.11	1221	25.39	1220.1	30.94	1220
37.52	1220	44.35	1219.73	48.21	1219.68	67.3	1219.08	67.31	1219.08
68.86	1219	69.59	1219	70.63	1218.64	74.79	1218	77.16	1217.08
88.46	1211	91.22	1209.6	94.42	1208.47	98.66	1206.71	99.98	1206
105.41	1205	110.04	1204.3	119.37	1203.28	121.27	1203	123.87	1202.89
139.25	1202.46	158.19	1201.86	174.68	1201.25	181.95	1201	201.28	1201
208.25	1200.69	210.99	1200.73	214.36	1200	214.86	1200	217.56	1200.37
219.24	1200.41	221.11	1200.4	229.17	1200.61	230.53	1200.62	242.71	1200.3
261.31	1200.43	283.98	1200.18	296.11	1200	454.76	1200	458.24	1199.6
467.98	1199.28	472.79	1199	475.75	1198.56	479.5	1198.55	482.59	1198.43
486.14	1198.44	487.12	1198.49	490.32	1198.52	494.05	1198.43	494.89	1198.31
497.58	1198.36	498.93	1198.22	503.23	1198	535.08	1198	543.67	1197.43
549.7	1197	557.36	1196.2	562.78	1195.68	570.72	1195	571.57	1194.88

579.33	1194	585.73	1193.64	597.98	1193.57	600.89	1193.67	604.99	1194
609.12	1194	614.53	1194.71	618.57	1195	624.3	1195.75	626.76	1196
633.47	1196	634.67	1196.16	640.19	1197	647.37	1197	648.97	1197.74
652.98	1199.29	664.34	1206.66	665.59	1207.39	670.53	1210.53	672.57	1211.72
673.01	1212	673.52	1213.26	677.97	1217	678.52	1217.31	679.37	1218
680.61	1218.66	681.09	1219	682.75	1219.74	682.78	1219.75	683.33	1220
689.89	1220.8	691.88	1221	694.8	1221.19	703.32	1222	719.42	1223.06
719.93	1223.07								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.06	70.63	.04	682.78	.06

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
70.63	682.78	81.03	64.14	1	.1	.3

Ineffective Flow num= 1

Sta L	Sta R	Elev	Permanent
0	315.25	1202.27	F

CROSS SECTION

RIVER: el mirage
REACH: 2 RS: 1363.170

INPUT
Description:
Station Elevation Data num= 101

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1221.8	6.1	1221.54	17.45	1221	25.26	1220.29	28.88	1220
31.06	1220	36.09	1219.71	38.6	1219.61	46.74	1219	56.48	1218.47
57.03	1218.46	67.52	1218	80.6	1218	80.63	1218	81.55	1218
86.78	1217	96.59	1213.12	98.08	1212.43	111.41	1206	117.62	1205
118.67	1204.81	124.31	1204	127.28	1203.52	129.93	1203	140.21	1202.52
153.28	1202.18	157.91	1202	165.92	1202	204.81	1201.32	232.27	1201.48
234.87	1201.34	240.28	1201.23	243.29	1201	251.51	1200.05	252.11	1200
287.44	1200	306.23	1199.46	318.36	1199	468.43	1199	470.91	1198.97
484.52	1199	496.91	1199	508.39	1198.09	509.72	1198	544.35	1197.38
564.06	1197	568.22	1197	576.9	1196	584.27	1196	596.22	1195
596.79	1194.89	598.22	1194.75	603.86	1194	604.45	1194	608.77	1193.55
613.65	1193	629.49	1193	637.26	1193.72	639.44	1194	641.74	1194.21
649.57	1195	653.89	1195.6	664.7	1196	675.71	1196	675.91	1196.02
679.59	1197	683.64	1198	700.66	1198	703.74	1199	706.12	1199.82
706.46	1200	707.23	1200.55	707.63	1201	709.68	1202.62	710.19	1203
717.38	1208.22	721.56	1211	722.08	1211.26	722.6	1211.47	724.98	1211.78
725.95	1212	727.15	1213	728.47	1214	734.46	1218.13	736.16	1219
736.75	1219.25	738.38	1220	738.78	1220	741.49	1220.21	741.51	1220.21
747.09	1220.65	750.86	1221	761.44	1221.77	765.2	1222	770.5	1222.22
774.14	1222.39	780.28	1222.79	783.93	1223	786.86	1223	792.07	1223.15
794.91	1223.2								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.06	80.6	.04	741.49	.06

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
80.6	741.49	82.77	91.05	1	.1	.3

Ineffective Flow num= 2

Sta L	Sta R	Elev	Permanent
0	359.51	1201.22	F
683.64	794.91	1201.22	F

CROSS SECTION

RIVER: el mirage
REACH: 2 RS: 1272.123

INPUT
Description:
Station Elevation Data num= 101

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1220.13	10.47	1219.96	16.42	1219.8	23.25	1219.76	27.15	1219.69
43.38	1219	44.09	1219	64.72	1218	67.38	1217.72	74.84	1217
75.34	1216.92	75.37	1216.91	80.78	1216	83.45	1215.51	83.97	1215.5
86.21	1215	93.9	1212	94.79	1211.44	102.59	1207	105.52	1206
111.59	1204	117.22	1203	125.94	1202.33	130.92	1202	134.35	1202
157.05	1201.56	170.99	1201.49	190.81	1201.31	214.29	1201.21	225.04	1201.12
233.09	1201	248.36	1201	254.15	1200.94	283.59	1200.77	318.1	1201
322.79	1200.9	327.31	1200.97	344.2	1200.83	350.69	1201	372.91	1201
380.96	1200.3	388.88	1200	396.25	1200	397.64	1199.75	400.99	1199
419.78	1198.18	421.45	1198.15	423	1198	453.29	1198	456.35	1197
539.17	1197	546.82	1196.53	553.62	1196	595	1196	599.81	1195.77
613.37	1195	617.26	1194	619.15	1193.72	621.93	1193	628.84	1192.18
632.21	1192	650.38	1192	654.66	1193.5	656.3	1194	660.06	1195
662.6	1195.13	679.32	1195.3	679.81	1195	688.03	1195	692.2	1196
692.9	1196.22	695.95	1197	708.59	1197	709.98	1196.73	715.72	1197
739.65	1197	739.93	1196.92	744.51	1196	768.95	1196	771.99	1197
774.81	1197.31	779.28	1198	781.07	1198.36	785.74	1199.84	789.23	1200.57
793.09	1202	793.61	1202.33	802.03	1209.83	803.67	1209.83	813.38	1220
815.51	1220.21	822.39	1221	828.95	1221.27	839.17	1223.02	839.2	1223.03

```
  839.34 1223.05  846.34 1222.11  865.15    1223  871.03 1222.54  876.36 1222.64
  879.49 1222.66

Manning's n Values          num=       3
     Sta   n Val      Sta   n Val      Sta   n Val
       0     .06    75.37     .04   815.51     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right      Coeff Contr.   Expan.
         75.37  815.51           303.42  122.64       1              .1       .3
Ineffective Flow      num=       2
   Sta L   Sta R    Elev  Permanent
       0  396.25    1202          F
  739.65  879.49  1200.7          F

CROSS SECTION


RIVER: el mirage
REACH: 2                    RS: 1149.487

INPUT
Description:
Station Elevation Data     num=      99
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
       0  1204.19     2.47     1204     7.76     1204    13.08  1203.68    19.18   1204.5
   20.07  1204.56    22.76     1205    23.79  1205.28     31.7  1206.77    35.28  1207.29
   50.77     1207    58.38  1204.63    61.04  1204.05    64.88     1203     71.1  1202.05
   76.55     1202    97.02  1201.06    99.84     1201   122.88     1201   140.46  1200.13
  142.37  1200.21   143.33  1200.18   148.25  1200.39   158.13  1200.51   161.16  1200.42
  164.54  1200.13   168.94  1200.07   169.95     1200   241.97     1200   249.95  1199.14
  250.83     1199   282.92  1199.54   296.12     1200   302.16     1200   312.03  1200.15
  334.71  1200.11   344.81     1200   401.62     1200   407.15  1199.56   411.34     1199
  413.57     1198    417.1  1197.34    418.1     1197   425.65     1196   449.82     1196
  454.15     1195   471.34     1195   492.63     1196   584.26     1196   587.65  1195.83
  595.39     1195   599.19     1194   607.29     1193   609.57  1192.33   610.95     1192
   612.3   1191.8   619.55     1191   639.53     1191   640.86  1191.46    641.5  1191.51
  646.02  1192.68   647.98  1193.32   649.12     1194   651.66     1195   664.56  1196.68
  667.72     1197   680.31     1197  683.02  1196.36   685.32  1196.56   691.72  1196.32
  696.27     1196   708.56     1196  713.65  1195.76      728  1195.41   743.42   1195.8
  747.78  1195.79   759.19     1196   775.31     1196   777.42  1195.78    778.5  1195.84
  780.09  1195.74      795  1195.46   800.03  1195.53   811.16     1195   828.51     1195
  832.11     1194   834.96     1194   846.95  1194.95   852.04  1196.57   856.23  1198.39
  867.84  1203.85   874.94  1207.64   881.02  1211.36   883.89  1212.52    896.6     1219
  903.21  1219.52   908.98  1219.88   918.47   1220.3   940.57  1221.02

Manning's n Values          num=       3
     Sta   n Val      Sta   n Val      Sta   n Val
       0     .06    50.77     .04   918.47     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right      Coeff Contr.   Expan.
         50.77  918.47                  1   69.75       1              .1       .3
Ineffective Flow      num=       2
   Sta L   Sta R    Elev  Permanent
       0  401.62  1201.5          F
  775.31  940.57  1201.5          F

CROSS SECTION


RIVER: el mirage
REACH: 2                    RS: 1079.733

INPUT
Description:
Station Elevation Data     num=     101
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
       0     1203     12.9     1203    18.42  1202.32    20.64     1202    26.16     1202
   26.18     1202    68.24     1202    89.58     1201   118.05     1201   122.11  1200.35
  127.24  1200.41   132.02  1200.63   136.05  1200.72   141.94  1200.54   145.66  1200.24
  151.06     1200   187.13     1200   211.87  1199.46   229.67     1199   280.41     1199
  290.91  1198.52   297.56     1199   336.72  1199.31   359.93     1199    385.9  1198.88
  390.78     1197   395.01     1196    400.1     1195   407.58     1195   407.97   1195.1
  410.56  1195.25   418.76     1195   423.74  1194.33   424.89     1194   429.78     1194
   435.6     1195   477.46     1195    496.3  1195.52   526.99  1195.77   539.77     1196
  587.74     1196   589.68  1195.82   596.92     1195   601.66  1193.62   606.85  1192.64
  616.06  1191.32   620.85     1191   646.52     1191   648.28  1191.34   654.54     1194
  655.24  1194.49   656.92     1195   659.66     1196   672.57     1196   675.32  1196.16
  676.97     1196   742.23     1196   770.15     1195    788.9  1194.52   803.13     1194
   826.7     1194   830.82   1194.5   836.23  1194.72   838.93  1194.62   845.34   1194.6
  849.47  1194.65   857.16     1194   866.24     1194    867.9  1193.43   869.62     1193
   883.2     1193    892.5     1197   894.44     1198   899.25  1200.69   907.47  1205.45
  915.12  1208.98    918.9   1210.2   920.34  1210.51    931.9  1213.58   938.29  1214.47
  939.94   1214.6   941.57     1215   942.18     1215   945.91  1215.54   952.78  1216.14
   959.9     1217   963.88  1217.29    968.9  1217.79   968.94  1217.79   971.64  1217.83
  972.34   1217.8   977.26  1217.98   983.06     1217   986.06  1216.42   988.56  1216.08
  990.34  1215.75   992.91  1215.59   995.88     1216  1006.21  1219.18  1010.81     1220
 1018.72  1220.22

Manning's n Values          num=       3
     Sta   n Val      Sta   n Val      Sta   n Val
       0     .06    68.24     .04   963.88     .06
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Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
68.24 963.88 51.06 79.73 95 .1 .3
Ineffective Flow num= 2
Sta L Sta R Elev Permanent
0 385.9 1201 F
849.47 1018.72 1201 F

CROSS SECTION

RIVER: el mirage
REACH: 2 RS: 1000.000

INPUT
Description:
Station Elevation Data num= 100

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1221	4.61	1221	25.22	1220	65.56	1218.7	94.19	1216.22
94.23	1216.22	98.03	1216	99.33	1215.67	103.01	1214	121.18	1206.7
126.69	1204.23	130.57	1203	142.88	1202	145.49	1202	164.99	1201
194.73	1200	203.54	1199.36	212.57	1199	220.04	1198	222.55	1198
225.09	1198.38	236.97	1198.92	252.13	1198.46	256.09	1199	282.21	1198.95
292.32	1198	326.14	1198	331.79	1197.55	338.04	1197.86	357.93	1197
365.3	1196	366.9	1195.58	372.93	1195	376.98	1195	384.2	1197
386.3	1197.38	397.51	1198	433.25	1198	436.75	1196	439.31	1195
448.01	1193.93	454.26	1193.57	457.94	1193	478.55	1193	489.95	1194
509.54	1194	527.82	1194.27	546.07	1195	581.51	1195.07	596.66	1196
637.13	1196	643.92	1196	657.85	1195	664.7	1194	670.11	1192.35
673.08	1191	688.68	1190	697.17	1190	699.87	1190.36	712.08	1191
715.52	1192	716.69	1192.62	720.38	1194	733.99	1196	740.51	1196
746.52	1195.16	750.66	1195	794.65	1195	811.63	1194	831.62	1195
834.89	1195	848.43	1194.23	849.97	1194	923.97	1194	932.45	1193
979.23	1193	990.86	1192.44	1007.28	1192.95	1010.26	1193.54	1016.41	1194
1030.34	1194	1054.73	1196.81	1058.74	1196.77	1065.92	1197.33	1074.47	1198.39
1082.28	1198.86	1097.69	1201.83	1099.04	1201.9	1105.49	1202.21	1113.23	1204.18
1127.64	1209.49	1132.62	1211.54	1136.88	1212.71	1142.87	1214.98	1150.56	1217.22
1152.99	1217.21	1159.43	1217.65	1169.6	1217.62	1178.89	1217.35	1186.24	1217.58

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.06	98.03	.04	1099.04	.06

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
98.03 1099.04 0 0 0 .1 .3
Ineffective Flow num= 2
Sta L Sta R Elev Permanent
0 433.35 1202 F
1016.41 1186.24 1202 F

SUMMARY OF MANNING'S N VALUES

River:el mirage

Reach	River Sta.	n1	n2	n3
2	2456.913	.06	.04	.06
2	2336.644	.06	.04	.06
2	2256.617	.06	.04	.06
2	2163.937	.06	.04	.06
2	2093.506	.06	.04	.06
2	2009.877	.06	.04	.06
2	1941.198	.06	.04	.06
2	1896.011	.06	.04	.06
2	1838.837	.06	.04	.06
2	1768.958	.06	.04	.06
2	1673.921	.06	.04	.06
2	1663.921	Culvert		
2	1505.346	.06	.04	.06
2	1427.304	.06	.04	.06
2	1363.170	.06	.04	.06
2	1272.123	.06	.04	.06
2	1149.487	.06	.04	.06
2	1079.733	.06	.04	.06
2	1000.000	.06	.04	.06

SUMMARY OF REACH LENGTHS

River: el mirage

Reach	River Sta.	Left	Channel	Right
2	2456.913	120.94	120.27	120.79
2	2336.644	92.18	80.03	81.89
2	2256.617	758.09	92.68	91.55
2	2163.937	1	70.43	69.23

2	2093.506	1	83.63	89.95
2	2009.877	1	68.68	122.68
2	1941.198	1	45.19	125.58
2	1896.011	1	57.17	103.77
2	1838.837	1	69.88	147.25
2	1768.958	695.78	95.04	187.79
2	1673.921	142.11	168.58	174.27
2	1663.921	Culvert		
2	1505.346	86.44	78.04	1644.92
2	1427.304	81.03	64.14	1
2	1363.170	82.77	91.05	1
2	1272.123	303.42	122.64	1
2	1149.487	1	69.75	1
2	1079.733	51.06	79.73	95
2	1000.000	0	0	0

SUMMARY OF CONTRACTION AND EXPANSION COEFFICIENTS
River: el mirage

Reach	River Sta.	Contr.	Expan.
2	2456.913	.1	.3
2	2336.644	.1	.3
2	2256.617	.1	.3
2	2163.937	.1	.3
2	2093.506	.1	.3
2	2009.877	.1	.3
2	1941.198	.1	.3
2	1896.011	.1	.3
2	1838.837	.1	.3
2	1768.958	.1	.3
2	1673.921	.1	.3
2	1663.921	Culvert	
2	1505.346	.1	.3
2	1427.304	.1	.3
2	1363.170	.1	.3
2	1272.123	.1	.3
2	1149.487	.1	.3
2	1079.733	.1	.3
2	1000.000	.1	.3

Profile Output Table - Standard Table 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl
Flow Area	Top Width	Froude # Chl							
(ft/s)	(sq ft)	(ft)	(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	
2	2456.913	100-year	6500.00	1201.00	1206.43		1207.21	0.005072	
7.10	915.32	207.26	0.60						
2	2456.913	SPF	14000.00	1201.00	1209.73		1210.87	0.003875	
8.58	1631.42	226.09	0.56						
2	2456.913	10-year	2917.00	1201.00	1204.54		1205.00	0.005433	
5.43	537.53	192.26	0.57						
2	2336.644	100-year	6500.00	1200.00	1205.85		1206.61	0.004816	
6.99	930.56	207.75	0.58						
2	2336.644	SPF	14000.00	1200.00	1209.34		1210.40	0.003480	
8.26	1695.07	229.65	0.54						
2	2336.644	10-year	2917.00	1200.00	1203.86		1204.33	0.005622	
5.48	532.47	192.66	0.58						
2	2256.617	100-year	6500.00	1200.00	1205.50		1206.22	0.004553	
6.81	954.86	212.39	0.57						
2	2256.617	SPF	14000.00	1200.00	1209.13		1210.12	0.003101	
7.96	1758.23	230.24	0.51						
2	2256.617	10-year	2917.00	1200.00	1203.34		1203.84	0.006535	
5.71	510.95	194.60	0.62						
2	2163.937	100-year	6500.00	1198.42	1205.15	1203.43	1205.81	0.004068	
6.50	999.48	219.00	0.54						
2	2163.937	SPF	14000.00	1198.42	1209.04	1205.65	1209.78	0.002623	
6.92	2023.65	290.08	0.46						
2	2163.937	10-year	2917.00	1198.42	1202.54	1201.96	1203.15	0.008456	
6.26	465.78	187.32	0.70						
2	2093.506	100-year	6500.00	1198.00	1204.99	1202.71	1205.53	0.002868	
5.93	1096.83	212.17	0.46						
2	2093.506	SPF	14000.00	1198.00	1208.94	1204.94	1209.57	0.002374	
6.35	2203.33	332.36	0.43						

2	2093.506	10-year	2917.00	1198.00	1202.16	1201.24	1202.63	0.005487
5.50	530.84	187.64	0.58					
2	2009.877	100-year	6500.00	1196.37	1204.88	1202.08	1205.30	0.001969
5.20	1249.32	219.84	0.38					
2	2009.877	SPF	14000.00	1196.37	1208.93	1204.18	1209.35	0.001590
5.20	2694.84	409.97	0.36					
2	2009.877	10-year	2917.00	1196.37	1201.83	1201.20	1202.20	0.004211
4.87	598.50	206.66	0.50					
2	1941.198	100-year	6500.00	1196.00	1204.77	1201.76	1205.16	0.001842
5.01	1296.69	230.30	0.37					
2	1941.198	SPF	14000.00	1196.00	1208.90	1203.87	1209.22	0.001164
4.53	3094.91	458.84	0.31					
2	1941.198	10-year	2917.00	1196.00	1201.55	1200.32	1201.91	0.004040
4.82	605.08	206.50	0.50					
2	1896.011	100-year	6500.00	1196.00	1204.73	1201.65	1205.05	0.002157
4.52	1437.05	410.27	0.39					
2	1896.011	SPF	14000.00	1196.00	1208.90	1204.13	1209.16	0.000881
4.07	3453.96	493.47	0.27					
2	1896.011	10-year	2917.00	1196.00	1201.31	1200.09	1201.72	0.004435
5.13	568.60	189.09	0.52					
2	1838.837	100-year	6500.00	1196.00	1204.67	1201.35	1204.92	0.001682
4.03	1613.69	486.27	0.34					
2	1838.837	SPF	14000.00	1196.00	1208.89	1203.86	1209.10	0.000662
3.67	3821.89	515.04	0.24					
2	1838.837	10-year	2917.00	1196.00	1201.07	1199.68	1201.47	0.004096
5.07	574.91	183.86	0.51					
2	1768.958	100-year	6500.00	1195.05	1204.52	1201.13	1204.79	0.001866
4.23	1536.34	494.46	0.36					
2	1768.958	SPF	14000.00	1195.05	1208.85	1203.84	1209.05	0.000644
3.64	3861.46	515.14	0.23					
2	1768.958	10-year	2917.00	1195.05	1200.67	1199.35	1201.16	0.004442
5.65	516.57	149.16	0.53					
2	1673.921	100-year	6500.00	1195.00	1204.42	1200.50	1204.61	0.001525
3.48	1866.27	499.17	0.32					
2	1673.921	SPF	14000.00	1195.00	1208.81	1203.50	1208.99	0.000532
3.43	4082.21	510.52	0.21					
2	1673.921	10-year	2917.00	1195.00	1200.37	1198.63	1200.76	0.003433
5.04	578.38	163.23	0.47					
2	1663.921	Culvert						
2	1505.346	100-year	6500.00	1194.00	1201.58	1201.16	1202.38	0.010458
7.17	906.20	406.80	0.78					
2	1505.346	SPF	14000.00	1194.00	1203.75	1202.68	1204.52	0.005843
7.01	1996.15	510.23	0.62					
2	1505.346	10-year	2917.00	1194.00	1199.57	1198.79	1200.46	0.011060
7.55	386.19	141.60	0.81					
2	1427.304	100-year	6500.00	1193.57	1200.70	1200.35	1201.54	0.010913
7.33	886.45	445.36	0.80					
2	1427.304	SPF	14000.00	1193.57	1201.86	1201.86	1203.72	0.014997
10.94	1280.08	498.73	1.00					
2	1427.304	10-year	2917.00	1193.57	1198.96	1198.36	1199.61	0.008998
6.49	449.57	179.07	0.72					
2	1363.170	100-year	6500.00	1193.00	1199.81	1199.58	1200.77	0.012843
7.85	827.63	412.08	0.87					
2	1363.170	SPF	14000.00	1193.00	1201.56	1201.23	1202.60	0.009872
8.18	1711.40	517.02	0.79					
2	1363.170	10-year	2917.00	1193.00	1198.42	1197.80	1199.05	0.008492
6.38	457.52	197.66	0.70					
2	1272.123	100-year	6500.00	1192.00	1199.14	1198.43	1199.81	0.007473
6.55	992.37	383.16	0.67					
2	1272.123	SPF	14000.00	1192.00	1200.98	1199.98	1201.90	0.005608
7.69	1820.89	511.79	0.63					
2	1272.123	10-year	2917.00	1192.00	1197.91	1197.31	1198.28	0.006763
4.94	590.69	325.08	0.61					
2	1149.487	100-year	6500.00	1191.00	1197.76	1197.51	1198.62	0.012486
7.46	871.78	439.90	0.84					
2	1149.487	SPF	14000.00	1191.00	1198.95	1198.95	1200.74	0.015328

10.73	1304.23	445.97		1.00					
2		1149.487	10-year	2917.00	1191.00	1196.98	1196.54	1197.36	0.008490
4.91	594.11	421.91		0.66					
2		1079.733	100-year	6500.00	1191.00	1196.99	1196.75	1197.70	0.012565
6.79	957.97	501.64		0.83					
2		1079.733	SPF	14000.00	1191.00	1198.48	1197.96	1199.61	0.009720
8.51	1645.50	508.36		0.79					
2		1079.733	10-year	2917.00	1191.00	1195.79	1195.74	1196.47	0.019399
6.62	440.33	342.41		0.97					
2		1000.000	100-year	6500.00	1190.00	1196.91	1195.50	1197.15	0.002764
3.92	1658.80	650.72		0.41					
2		1000.000	SPF	14000.00	1190.00	1198.58	1196.68	1199.02	0.002762
5.32	2632.74	810.53		0.44					
2		1000.000	10-year	2917.00	1190.00	1195.70	1194.53	1195.84	0.002760
2.99	975.21	553.82		0.38					

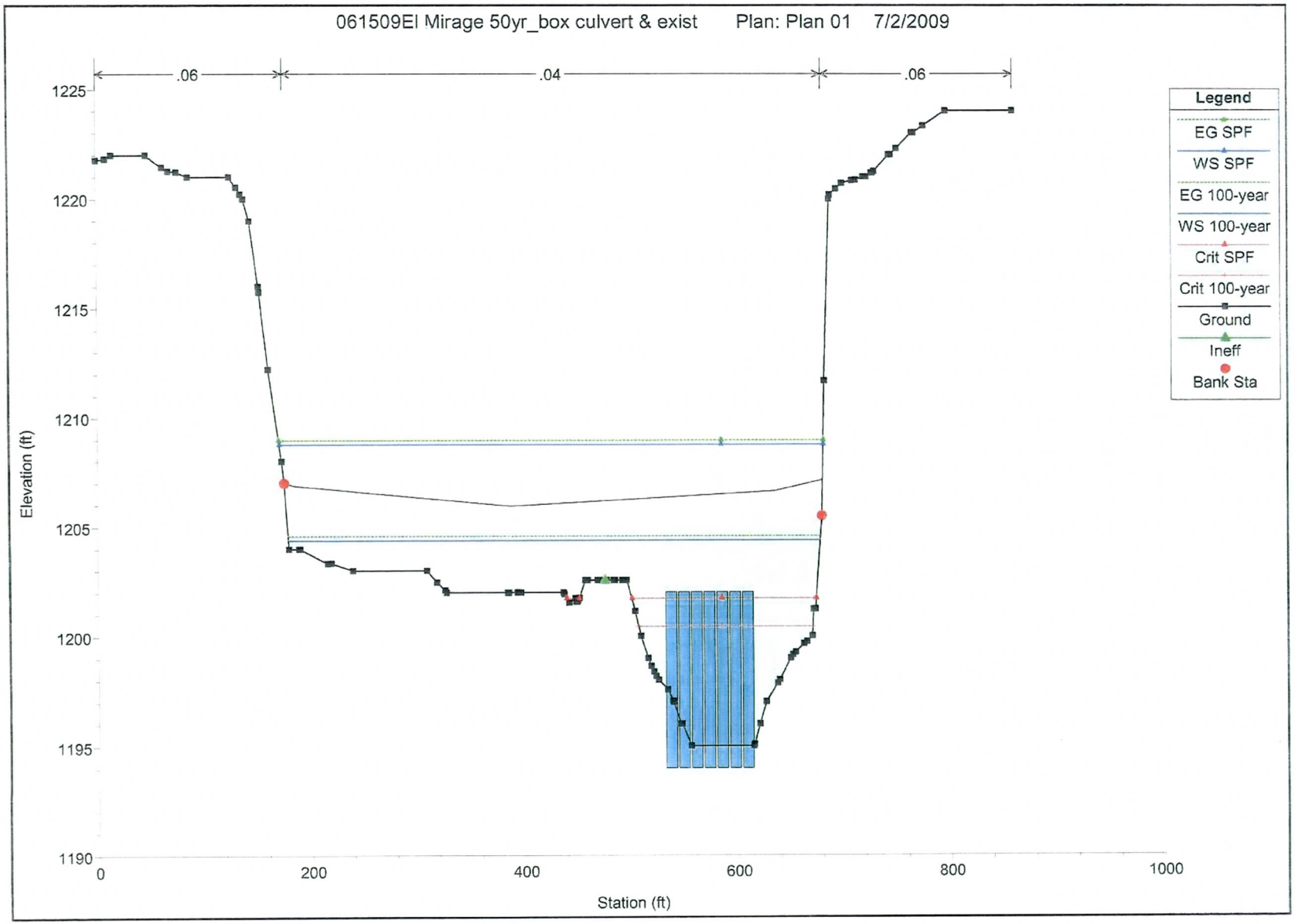
Profile Output Table - Standard Table 2

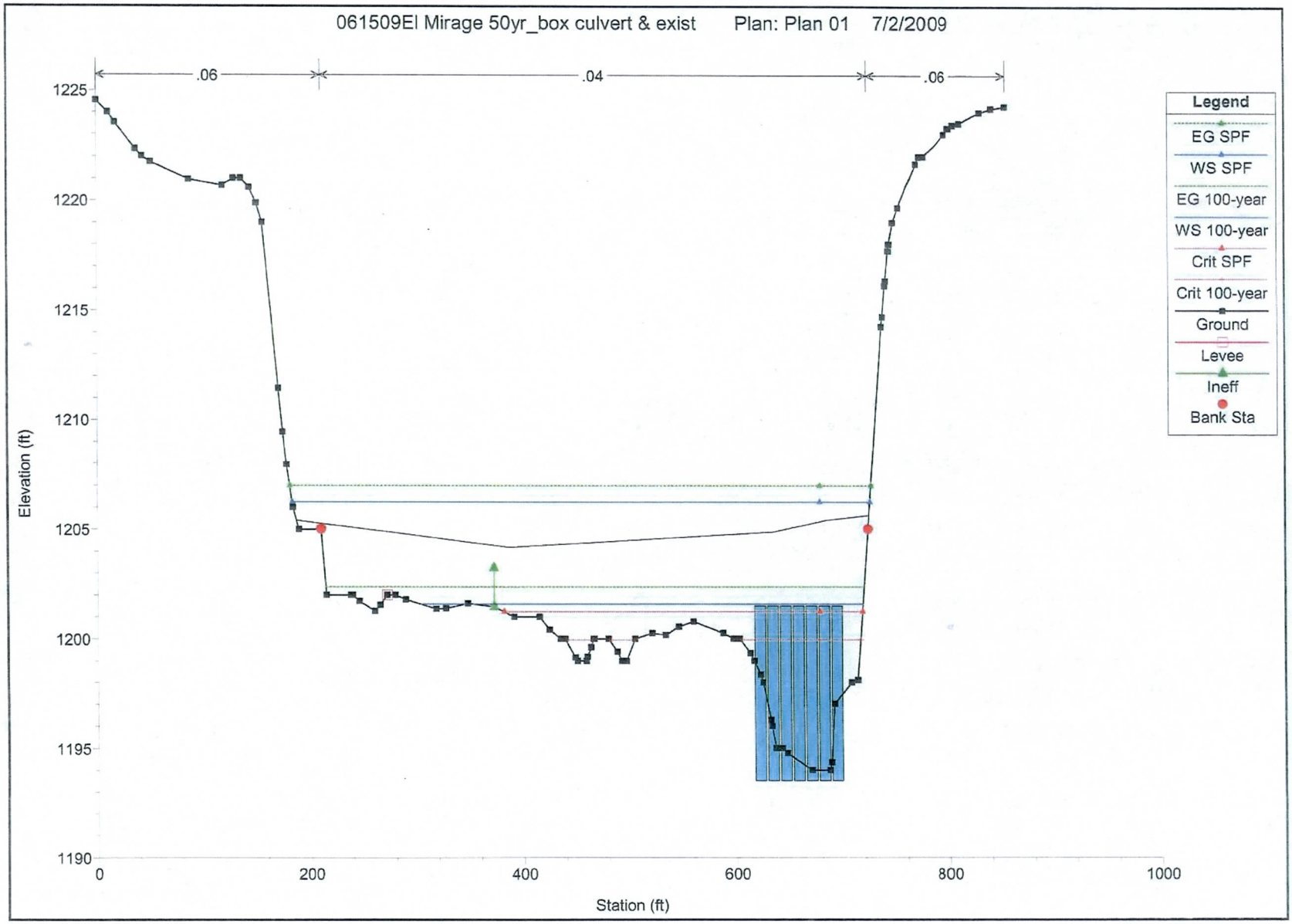
Reach	River Sta	Profile	E.G. Elev	W.S. Elev	Vel Head	Frctn Loss	C & E Loss	Q Left	Q Channel
Q Right	Top Width		(ft)	(ft)	(ft)	(ft)	(ft)	(cfs)	(cfs)
(cfs)	(ft)								
2	2456.913	100-year	1207.21	1206.43	0.78	0.59	0.01		6500.00
	207.26								
2	2456.913	SPF	1210.87	1209.73	1.14	0.44	0.03		14000.00
	226.09								
2	2456.913	10-year	1205.00	1204.54	0.46	0.66	0.00		2917.00
	192.26								
2	2336.644	100-year	1206.61	1205.85	0.76	0.37	0.01		6500.00
	207.75								
2	2336.644	SPF	1210.40	1209.34	1.06	0.26	0.02		14000.00
	229.65								
2	2336.644	10-year	1204.33	1203.86	0.47	0.48	0.00		2917.00
	192.66								
2	2256.617	100-year	1206.22	1205.50	0.72	0.40	0.02		6500.00
	212.39								
2	2256.617	SPF	1210.12	1209.13	0.98	0.26	0.07		14000.00
	230.24								
2	2256.617	10-year	1203.84	1203.34	0.51	0.69	0.01		2917.00
	194.60								
2	2163.937	100-year	1205.81	1205.15	0.66	0.24	0.03		6500.00
	219.00								
2	2163.937	SPF	1209.78	1209.04	0.74	0.18	0.03		14000.00
	290.08								
2	2163.937	10-year	1203.15	1202.54	0.61	0.47	0.04		2917.00
	187.32								
2	2093.506	100-year	1205.53	1204.99	0.55	0.20	0.04		6500.00
	212.17								
2	2093.506	SPF	1209.57	1208.94	0.63	0.16	0.06		14000.00
	332.36								
2	2093.506	10-year	1202.63	1202.16	0.47	0.40	0.03		2917.00
	187.64								
2	2009.877	100-year	1205.30	1204.88	0.42	0.13	0.01		6500.00
	219.84								
2	2009.877	SPF	1209.35	1208.93	0.42	0.09	0.03		13994.69
5.31	409.97								
2	2009.877	10-year	1202.20	1201.83	0.37	0.28	0.00		2917.00
	206.66								
2	1941.198	100-year	1205.16	1204.77	0.39	0.09	0.02		6500.00
	230.30								
2	1941.198	SPF	1209.22	1208.90	0.32	0.05	0.02		13997.34
2.66	458.84								
2	1941.198	10-year	1201.91	1201.55	0.36	0.19	0.00		2917.00
	206.50								
2	1896.011	100-year	1205.05	1204.73	0.32	0.11	0.02		6500.00
	410.27								
2	1896.011	SPF	1209.16	1208.90	0.26	0.04	0.01		13983.53
16.47	493.47								

2	1896.011	10-year	1201.72	1201.31	0.41	0.24	0.00		2917.00
	189.09								
2	1838.837	100-year	1204.92	1204.67	0.25	0.12	0.00		6500.00
	486.27								
2	1838.837	SPF	1209.10	1208.89	0.21	0.05	0.00		13997.53
2.47	515.04								
2	1838.837	10-year	1201.47	1201.07	0.40	0.30	0.01		2917.00
	183.86								
2	1768.958	100-year	1204.79	1204.52	0.28	0.16	0.03		6500.00
	494.46								
2	1768.958	SPF	1209.05	1208.85	0.21	0.06	0.01		13986.81
13.19	515.14								
2	1768.958	10-year	1201.16	1200.67	0.50	0.37	0.03		2917.00
	149.16								
2	1673.921	100-year	1204.61	1204.42	0.19				6500.00
	499.17								
2	1673.921	SPF	1208.99	1208.81	0.18			1.82	13997.24
0.94	510.52								
2	1673.921	10-year	1200.76	1200.37	0.39				2917.00
	163.23								
2	1663.921		Culvert						
2	1505.346	100-year	1202.38	1201.58	0.80	0.83	0.00		6500.00
	406.80								
2	1505.346	SPF	1204.52	1203.75	0.76	0.69	0.11		14000.00
	510.23								
2	1505.346	10-year	1200.46	1199.57	0.89	0.78	0.07		2917.00
	141.60								
2	1427.304	100-year	1201.54	1200.70	0.83	0.76	0.01		6500.00
	445.36								
2	1427.304	SPF	1203.72	1201.86	1.86	0.77	0.25		14000.00
	498.73								
2	1427.304	10-year	1199.61	1198.96	0.65	0.56	0.01		2917.00
	179.07								
2	1363.170	100-year	1200.77	1199.81	0.96	0.88	0.09		6500.00
	412.08								
2	1363.170	SPF	1202.60	1201.56	1.04	0.66	0.04		14000.00
	517.02								
2	1363.170	10-year	1199.05	1198.42	0.63	0.69	0.08		2917.00
	197.66								
2	1272.123	100-year	1199.81	1199.14	0.67	1.17	0.02		6500.00
	383.16								
2	1272.123	SPF	1201.90	1200.98	0.92	1.07	0.09		14000.00
	511.79								
2	1272.123	10-year	1198.28	1197.91	0.38	0.93	0.00		2917.00
	325.08								
2	1149.487	100-year	1198.62	1197.76	0.86	0.87	0.04		6500.00
	439.90								
2	1149.487	SPF	1200.74	1198.95	1.79	0.84	0.20		14000.00
	445.97								
2	1149.487	10-year	1197.36	1196.98	0.37	0.86	0.03		2917.00
	421.91								
2	1079.733	100-year	1197.70	1196.99	0.71	0.41	0.14		6500.00
	501.64								
2	1079.733	SPF	1199.61	1198.48	1.12	0.37	0.21		14000.00
	508.36								
2	1079.733	10-year	1196.47	1195.79	0.68	0.46	0.16		2917.00
	342.41								
2	1000.000	100-year	1197.15	1196.91	0.24				6500.00
	650.72								
2	1000.000	SPF	1199.02	1198.58	0.44				14000.00
	810.53								
2	1000.000	10-year	1195.84	1195.70	0.14				2917.00
	553.82								

Profile Output Table - Four XS Culvert

Reach	River Sta	Profile	E.G. Elev	W.S. Elev	Vel Head	Frctn Loss	C & E Loss	Q Left	Q Channel
Q Right	Top Width		(ft)	(ft)	(ft)	(ft)	(ft)	(cfs)	(cfs)
(cfs)	(ft)								
2	1768.958	100-year	1204.79	1204.52	0.28	0.16	0.03		6500.00
	494.46								
2	1768.958	SPF	1209.05	1208.85	0.21	0.06	0.01		13986.81
13.19	515.14								
2	1768.958	10-year	1201.16	1200.67	0.50	0.37	0.03		2917.00
	149.16								
2	1673.921	100-year	1204.61	1204.42	0.19				6500.00
	499.17								
2	1673.921	SPF	1208.99	1208.81	0.18			1.82	13997.24
0.94	510.52								
2	1673.921	10-year	1200.76	1200.37	0.39				2917.00
	163.23								
2	1663.921		Culvert						
2	1505.346	100-year	1202.38	1201.58	0.80	0.83	0.00		6500.00
	406.80								
2	1505.346	SPF	1204.52	1203.75	0.76	0.69	0.11		14000.00
	510.23								
2	1505.346	10-year	1200.46	1199.57	0.89	0.78	0.07		2917.00
	141.60								
2	1427.304	100-year	1201.54	1200.70	0.83	0.76	0.01		6500.00
	445.36								
2	1427.304	SPF	1203.72	1201.86	1.86	0.77	0.25		14000.00
	498.73								
2	1427.304	10-year	1199.61	1198.96	0.65	0.56	0.01		2917.00
	179.07								


061509El Mirage 50yr_box culvert & exist Plan: Plan 01 7/2/2009
.06
.04
.06
1225
1220
1215
1210
1205
1200
1195
1190
Elevation (ft)
0
200
400
600
800
1000
Station (ft)
Legend
EG SPF
WS SPF
EG 100-year
WS 100-year
Crit SPF
Crit 100-year
Ground
Ineff
Bank Sta


061509El Mirage 50yr_box culvert & exist Plan: Plan 01 7/2/2009
.06
.04
.06
1225
1220
1215
1210
1205
1200
1195
1190
Elevation (ft)
0
200
400
600
800
1000
Station (ft)
Legend
EG SPF
WS SPF
EG 100-year
WS 100-year
Crit SPF
Crit 100-year
Ground
Levee
Ineff
Bank Sta

HEC-RAS Plan: Plan061509 River: el mirage Reach: 2

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
2	2456.913	100-year	6500.00	1201.00	1206.43		1207.21	0.005068	7.10	915.55	207.26	0.60
2	2456.913	SPF	14000.00	1201.00	1209.73		1210.87	0.003874	8.58	1631.58	226.10	0.56
2	2336.644	100-year	6500.00	1200.00	1205.85		1206.61	0.004810	6.98	930.94	207.77	0.58
2	2336.644	SPF	14000.00	1200.00	1209.34		1210.40	0.003478	8.26	1695.30	229.65	0.54
2	2256.617	100-year	6500.00	1200.00	1205.51		1206.23	0.004544	6.80	955.40	212.41	0.57
2	2256.617	SPF	14000.00	1200.00	1209.13		1210.12	0.003100	7.96	1758.48	230.24	0.51
2	2163.937	100-year	6500.00	1198.42	1205.15	1203.43	1205.81	0.004059	6.50	1000.23	219.04	0.54
2	2163.937	SPF	14000.00	1198.42	1209.04	1205.65	1209.78	0.002622	6.92	2024.01	290.09	0.46
2	2093.506	100-year	6500.00	1198.00	1204.99	1202.71	1205.54	0.002861	5.92	1097.63	212.20	0.46
2	2093.506	SPF	14000.00	1198.00	1208.94	1204.94	1209.57	0.002373	6.35	2203.78	332.37	0.43
2	2009.877	100-year	6500.00	1196.37	1204.88	1202.08	1205.30	0.001965	5.20	1250.20	219.86	0.38
2	2009.877	SPF	14000.00	1196.37	1208.93	1204.18	1209.35	0.001589	5.20	2695.44	409.98	0.36
2	1941.198	100-year	6500.00	1196.00	1204.77	1201.76	1205.16	0.001838	5.01	1297.70	230.38	0.37
2	1941.198	SPF	14000.00	1196.00	1208.91	1203.87	1209.22	0.001163	4.53	3095.58	458.85	0.31
2	1896.011	100-year	6500.00	1196.00	1204.73	1201.65	1205.05	0.002150	4.52	1438.61	410.79	0.38
2	1896.011	SPF	14000.00	1196.00	1208.90	1204.13	1209.16	0.000881	4.07	3454.68	493.48	0.27
2	1838.837	100-year	6500.00	1196.00	1204.67	1201.35	1204.92	0.001675	4.02	1615.56	486.30	0.34
2	1838.837	SPF	14000.00	1196.00	1208.89	1203.86	1209.10	0.000662	3.67	3822.64	515.06	0.24
2	1768.958	100-year	6500.00	1195.05	1204.52	1201.13	1204.80	0.001858	4.23	1538.34	494.48	0.36
2	1768.958	SPF	14000.00	1195.05	1208.85	1203.84	1209.06	0.000644	3.64	3862.28	515.15	0.23
2	1673.921	100-year	6500.00	1195.00	1204.42	1200.50	1204.61	0.001517	3.48	1869.44	499.19	0.32
2	1673.921	SPF	14000.00	1195.00	1208.81	1203.50	1208.99	0.000532	3.43	4083.02	510.53	0.21
2	1663.921		Culvert									
2	1505.346	100-year	6500.00	1194.00	1201.58	1201.12	1202.36	0.009969	7.07	919.62	408.60	0.76
2	1505.346	SPF	14000.00	1194.00	1203.76	1202.65	1204.51	0.005727	6.97	2008.66	510.24	0.62

HEC-RAS Plan: Plan061509 River: el mirage Reach: 2 (Continued)

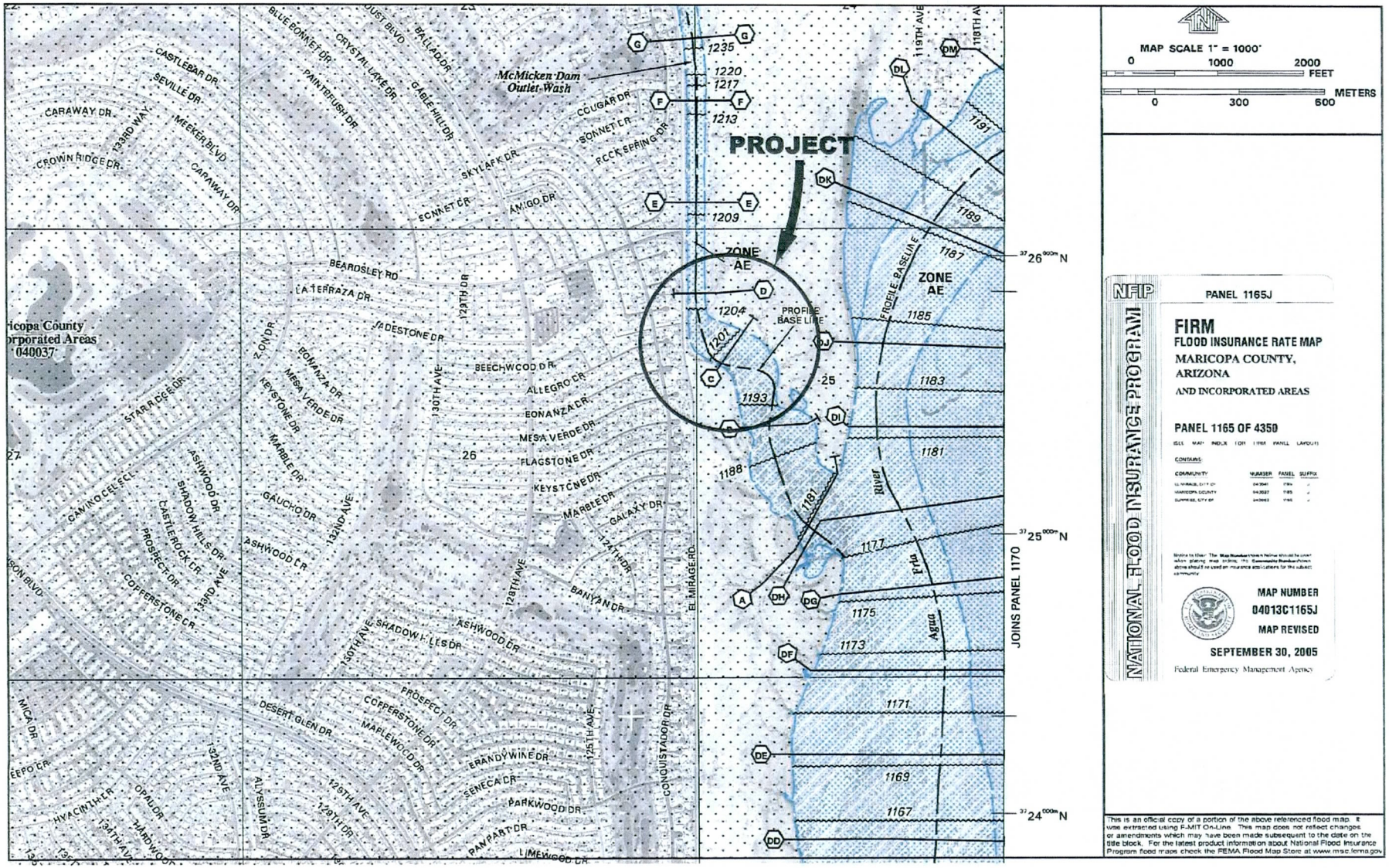
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
2	1427.304	100-year	6500.00	1193.57	1200.70	1200.35	1201.54	0.010913	7.33	886.45	445.36	0.80
2	1427.304	SPF	14000.00	1193.57	1201.86	1201.86	1203.72	0.014997	10.94	1280.08	498.73	1.00
2	1363.170	100-year	6500.00	1193.00	1199.81	1199.58	1200.77	0.012843	7.85	827.63	412.08	0.87
2	1363.170	SPF	14000.00	1193.00	1201.56	1201.23	1202.60	0.009872	8.18	1711.40	517.02	0.79
2	1272.123	100-year	6500.00	1192.00	1199.14	1198.43	1199.81	0.007473	6.55	992.37	383.16	0.67
2	1272.123	SPF	14000.00	1192.00	1200.98	1199.98	1201.90	0.005608	7.69	1820.89	511.79	0.63
2	1149.487	100-year	6500.00	1191.00	1197.76	1197.51	1198.62	0.012486	7.46	871.78	439.90	0.84
2	1149.487	SPF	14000.00	1191.00	1198.95	1198.95	1200.74	0.015328	10.73	1304.23	445.97	1.00
2	1079.733	100-year	6500.00	1191.00	1196.99	1196.75	1197.70	0.012565	6.79	957.97	501.64	0.83
2	1079.733	SPF	14000.00	1191.00	1198.48	1197.96	1199.61	0.009720	8.51	1645.50	508.36	0.79
2	1000.000	100-year	6500.00	1190.00	1196.91	1195.50	1197.15	0.002764	3.92	1658.80	650.72	0.41
2	1000.000	SPF	14000.00	1190.00	1198.58	1196.68	1199.02	0.002762	5.32	2632.74	810.53	0.44

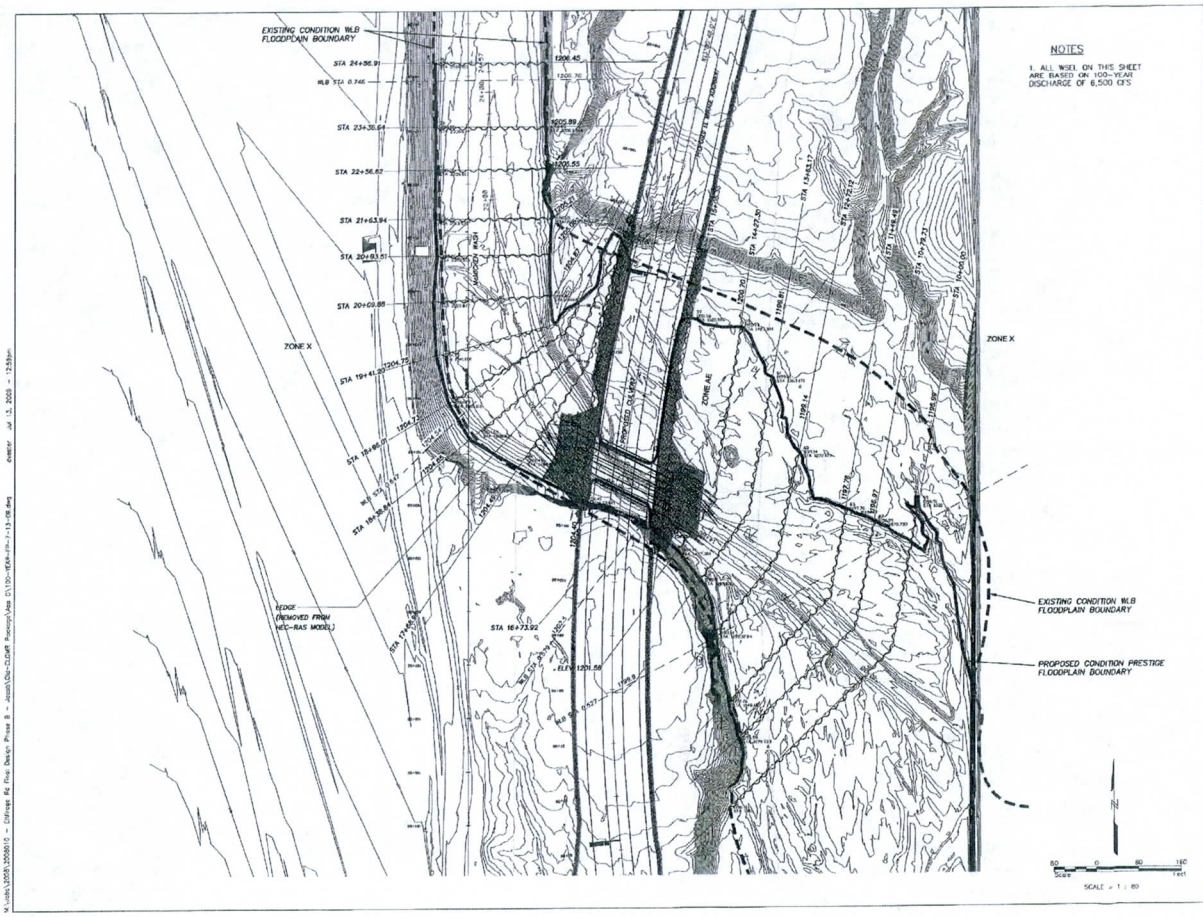
HEC-RAS Plan: Plan061509 River: el mirage Reach: 2

Reach	River Sta	Profile	E.G. Elev	W.S. Elev	Vel Head	Frctn Loss	C & E Loss	Q Left	Q Channel	Q Right	Top Width
			(ft)	(ft)	(ft)	(ft)	(ft)	(cfs)	(cfs)	(cfs)	(ft)
2	2456.913	100-year	1207.21	1206.43	0.78	0.59	0.01		6500.00		207.26
2	2456.913	SPF	1210.87	1209.73	1.14	0.44	0.03		14000.00		226.10
2	2336.644	100-year	1206.61	1205.85	0.76	0.37	0.01		6500.00		207.77
2	2336.644	SPF	1210.40	1209.34	1.06	0.26	0.02		14000.00		229.65
2	2256.617	100-year	1206.23	1205.51	0.72	0.40	0.02		6500.00		212.41
2	2256.617	SPF	1210.12	1209.13	0.98	0.26	0.07		14000.00		230.24
2	2163.937	100-year	1205.81	1205.15	0.66	0.24	0.03		6500.00		219.04
2	2163.937	SPF	1209.78	1209.04	0.74	0.18	0.03		14000.00		290.09
2	2093.506	100-year	1205.54	1204.99	0.54	0.20	0.04		6500.00		212.20
2	2093.506	SPF	1209.57	1208.94	0.63	0.16	0.06		14000.00		332.37
2	2009.877	100-year	1205.30	1204.88	0.42	0.13	0.01		6500.00		219.86
2	2009.877	SPF	1209.35	1208.93	0.42	0.09	0.03		13994.68	5.32	409.98
2	1941.198	100-year	1205.16	1204.77	0.39	0.09	0.02		6500.00		230.38
2	1941.198	SPF	1209.22	1208.91	0.32	0.05	0.02		13997.33	2.67	458.85
2	1896.011	100-year	1205.05	1204.73	0.32	0.11	0.02		6500.00		410.79
2	1896.011	SPF	1209.16	1208.90	0.26	0.04	0.01		13983.51	16.49	493.48
2	1838.837	100-year	1204.92	1204.67	0.25	0.12	0.00		6500.00		486.30
2	1838.837	SPF	1209.10	1208.89	0.21	0.05	0.00		13997.52	2.48	515.06
2	1768.958	100-year	1204.80	1204.52	0.28	0.16	0.03		6500.00		494.48
2	1768.958	SPF	1209.06	1208.85	0.21	0.06	0.01		13986.79	13.21	515.15
2	1673.921	100-year	1204.61	1204.42	0.19				6500.00		499.19
2	1673.921	SPF	1208.99	1208.81	0.18			1.82	13997.24	0.94	510.53
2	1663.921		Culvert								
2	1505.346	100-year	1202.36	1201.58	0.78	0.81	0.01		6500.00		408.60
2	1505.346	SPF	1204.51	1203.76	0.75	0.68	0.11		14000.00		510.24
2	1427.304	100-year	1201.54	1200.70	0.83	0.76	0.01		6500.00		445.36
2	1427.304	SPF	1203.72	1201.86	1.86	0.77	0.25		14000.00		498.73
2	1363.170	100-year	1200.77	1199.81	0.96	0.88	0.09		6500.00		412.08
2	1363.170	SPF	1202.60	1201.56	1.04	0.66	0.04		14000.00		517.02
2	1272.123	100-year	1199.81	1199.14	0.67	1.17	0.02		6500.00		383.16
2	1272.123	SPF	1201.90	1200.98	0.92	1.07	0.09		14000.00		511.79
2	1149.487	100-year	1198.62	1197.76	0.86	0.87	0.04		6500.00		439.90
2	1149.487	SPF	1200.74	1198.95	1.79	0.84	0.20		14000.00		445.97
2	1079.733	100-year	1197.70	1196.99	0.71	0.41	0.14		6500.00		501.64
2	1079.733	SPF	1199.61	1198.48	1.12	0.37	0.21		14000.00		508.36
2	1000.000	100-year	1197.15	1196.91	0.24				6500.00		650.72
2	1000.000	SPF	1199.02	1198.58	0.44				14000.00		810.53

HEC-RAS Plan: Plan061509 River: el mirage Reach: 2

Reach	River Sta	Profile	E.G. Elev	W.S. Elev	Vel Head	Frctn Loss	C & E Loss	Q Left	Q Channel	Q Right	Top Width
			(ft)	(ft)	(ft)	(ft)	(ft)	(cfs)	(cfs)	(cfs)	(ft)
2	1768.958	100-year	1204.80	1204.52	0.28	0.16	0.03		6500.00		494.48
2	1768.958	500-year	1207.96	1207.79	0.17	0.06	0.01		10996.18	3.82	509.12
2	1768.958	SPF	1209.06	1208.85	0.21	0.06	0.01		13986.79	13.21	515.15
2	1768.958	10-year	1201.14	1200.63	0.51	0.39	0.03		2917.00		148.97
2	1768.958	PF 5	1203.50	1203.13	0.37	0.35	0.02		5085.00		400.81
2	1673.921	100-year	1204.61	1204.42	0.19				6500.00		499.19
2	1673.921	500-year	1207.90	1207.75	0.15			0.17	10999.50	0.33	507.20
2	1673.921	SPF	1208.99	1208.81	0.18			1.82	13997.24	0.94	510.53
2	1673.921	10-year	1200.72	1200.31	0.41				2917.00		162.92
2	1673.921	PF 5	1203.14	1202.82	0.32				5085.00		363.82
2	1663.921		Culvert								
2	1505.346	100-year	1202.36	1201.58	0.78	0.81	0.01		6500.00		408.60
2	1505.346	500-year	1203.76	1202.59	1.17	0.78	0.01		11000.00		506.72
2	1505.346	SPF	1204.51	1203.76	0.75	0.68	0.11		14000.00		510.24
2	1505.346	10-year	1200.41	1199.58	0.83	0.74	0.05		2917.00		141.65
2	1505.346	PF 5	1201.84	1201.20	0.65	0.81	0.00		5085.00		335.05
2	1427.304	100-year	1201.54	1200.70	0.83	0.76	0.01		6500.00		445.36
2	1427.304	500-year	1202.96	1201.74	1.22	0.72	0.02		11000.00		495.40
2	1427.304	SPF	1203.72	1201.86	1.86	0.77	0.25		14000.00		498.73
2	1427.304	10-year	1199.61	1198.96	0.65	0.56	0.01		2917.00		179.07
2	1427.304	PF 5	1201.03	1200.34	0.69	0.78	0.01		5085.00		396.62


PROJECT
McMicken Dam Outlet Wash
ZONE AE
PROFILE BASE LINE
JOINS PANEL 1170
MAP SCALE 1" = 1000'
0 1000 2000 FEET
0 300 600 METERS
NFIP
NATIONAL FLOOD INSURANCE PROGRAM
PANEL 1165J
FIRM
FLOOD INSURANCE RATE MAP
MARICOPA COUNTY, ARIZONA
AND INCORPORATED AREAS
PANEL 1165 OF 4350
MAP NUMBER
04013C1165J
MAP REVISED
SEPTEMBER 30, 2005
Federal Emergency Management Agency
This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov



NOTES

1. ALL WSEL ON THIS SHEET ARE BASED ON 100-YEAR DISCHARGE OF 6,500 CFS

F.H.W.A. REGION	STATE	PROJECT NO.	SHEET NO.	TOTAL SHEETS	RECORD DRAWING
9	AZ	69999	1	2	

Prestige Engineering Consultants

MARICOPA COUNTY
DEPARTMENT OF TRANSPORTATION
ENGINEERING DIVISION

IN COOPERATION WITH
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

PROPOSED EL MIRAGE ROAD
CULVERT CROSSING AT McMICKEN WASH

LEGEND

- PRE-PROJECT 100-YR FLOODPLAIN BOUNDARY
- HYDRAULIC BASE LINE WITH RIVER STATIONING (24+00 … 13+00)
- POST PROJECT 100 YR FLOOD PLAIN
- CROSS SECTION
- BASE FLOOD ELEVATION (1350)
- BANK PROTECTION
- RIVER STATION — STA 24+56.91
- FLOOD INSURANCE ZONE — ZONE AE

Q_{100} = 6,500 CFS
Q_{SPF} = 14,000 CFS

NO.	REVISION	BY	DATE
1			
2			
3			

MARICOPA COUNTY
DEPARTMENT OF TRANSPORTATION
ENGINEERING DIVISION

PROPOSED EL MIRAGE ROAD CULVERT
AT McMICKEN CHANNEL CROSSING

DESIGNED	RAJ SHAH	05/09
DRAWN	G. CHAGOLLA	05/09
CHECKED	KOFI AWUMAH	05/09

EL MIRAGE ROAD CULVERT CROSSING AT McMICKEN WASH — SHEET 1 OF 2

TRACS NO. ----------

M:\Jobs\25551\255510 - Cliffrose Rd Proj Design Phase B - 2020\Civil\CLDraft Planning\Area D\30-HEA-HPA-7-13-08.dwg 6:46:07 AM, July 13, 2009 - 1:2.5dwg

F.H.W.A. REGION	STATE	PROJECT NO.	SHEET NO.	TOTAL SHEETS	RECORD DRAWING
9	AZ	68993	2	2	

Prestige Engineering Consultants

MARICOPA COUNTY
DEPARTMENT OF TRANSPORTATION
ENGINEERING DIVISION

IN COOPERATION WITH
FLOOD CONTROL DISRICT OF MARICOPA COUNTY

PROPOSED EL MIRAGE ROAD
CULVERT CROSSING AT McMICKEN WASH

LEGEND

PRE-PROJECT SPF FLOODPLAIN BOUNDARY

HYDRAULIC BASE LINE WITH RIVER STATIONING (12+00, 13+00)

POST PROJECT SPF FLOOD PLAIN

CROSS SECTION

RIVER STATION — STA 24+56.91

Q_{100} = 6,500 CFS
Q_{SPF} = 14,000 CFS

NO.	REVISION	BY	DATE

MARICOPA COUNTY
DEPARTMENT OF TRANSPORTATION
ENGINEERING DIVISION

PROPOSED EL MIRAGE ROAD CULVERT
AT McMICKEN CHANNEL CROSSING
SPF FLOWS

	BY	DATE
DESIGNED	RAJ SHAH	06/09
DRAWN	G. CHAGOLLA	06/09
CHECKED	KOFI AWUMAH	06/09

EL MIRAGE ROAD CULVERT CROSSING AT McMICKEN WASH — SHEET 2 OF 2

TRACS NO. ___________

APPENDIX F

SCOUR CALCULATIONS

Prestige
Engineering Consultants
3404 W. Cheryl Dr, A160, Phoenix, AZ 85051 Phone: (602) 978 3355 Fax: (602) 978 4455

Project: El Mirage Rd Page: 1 of ___
Project Number: _____ Detail: Scour Summary
Computed By: _____ Date: _____
Checked By: _____ Date: _____

El Mirage Road Scour for SPF Event:

* D/S Scour Component:

Long Term Scour	=	4.0 ft
General Scour	=	2.0 ft
Bed form Scour	=	0.6 ft
Low Flow Incisement	=	1.5 ft
		8.1 ft
Factor of Safety (1.3)		2.43
		10.53 ft

Use 10.5'

* U/S Scour Component:

General Scour	=	3.5 ft
Bed form Scour	=	0.3 ft
low flow Incisement	=	1.5 ft
		5.3 ft
Factor of Safety (1.3)	=	1.60 ft
		6.90 ft

Use 7'

Prestige
Engineering Consultants
3404 W. Cheryl Dr, A160, Phoenix, AZ 85051 Phone: (602) 978 3355 Fax: (602) 978 4455

Project: El Mirage South Box Page: 1 of ___
Project Number: ___ Detail: Scour Calcs
Computed By: ___ Date: ___
Checked By: ___ Date: ___

Cohesive Soils.

Scour geometry is calculated using following:

$$\text{Depth} = \frac{h_s}{y_e} = \alpha_e \left(\frac{q}{g^{1/2} y_e^{5/2}}\right)^{\beta} \left(\frac{t}{316}\right)^{\theta}$$

$$\text{Width} = \frac{W_s}{y_e} = \alpha_e \left(\frac{q}{g^{1/2} y_e^{5/2}}\right)^{\beta} \left(\frac{t}{316}\right)^{\theta}$$

$$\text{Length} = \frac{L_s}{y_e} = \alpha_e \left(\frac{q}{g^{1/2} y_e^{5/2}}\right)^{\beta} \left(\frac{t}{316}\right)^{\theta}$$

$y_e = \left(\frac{A}{2}\right)^{0.5}$ for non-circular culverts.

Hydraulic Data:

For SPF Flow: $Q_D = 14,000$ cfs.

$Q_{HI} = 7,811$ cfs, $Q_{per\,box} = \frac{7,811}{7} = 1116$ cfs

$V_{per\,box} = \frac{1116}{10 \times 8} = 13.95 \frac{ft}{sec}$

Mat'l Gradation $\Gamma = \left(\frac{D_{84}}{D_{16}}\right)^{0.5}$,

$D_{84} = 60$ mm See Geotech Report
$D_{16} = 0.3$ mm
$D_{50} = 2.5$ mm & 3.0 mm

$\Gamma = \left(\frac{60}{0.3}\right)^{0.5} = 14.14$

$y_e = \left(\frac{A}{2}\right)^{0.5} = \left(\frac{10 \times 8}{2}\right)^{0.5} = (40)^{0.5} = 6.32$

Prestige
Engineering Consultants
3404 W. Cheryl Dr, A160, Phoenix, AZ 85051 Phone: (602) 978 3355 Fax: (602) 978 4455

Project: _____ Page: 2 of ___
Project Number: _____ Detail: _____
Computed By: _____ Date: _____
Checked By: _____ Date: _____

From Table 5.4 page 5-68
Use equ for Graded Sand, D_{50} = 2 mm, eq. V-2

	α_e	β	θ
Depth	0.75	0.85	0.07
Width	4.78	0.76	0.06
Length	12.62	0.41	0.04
Volume	12.94	2.09	0.19

$$D.I = \frac{q}{\sqrt{g}\, y_c^{5/2}} = \frac{1116}{\sqrt{32.2}\,(6.32)^{5/2}} = 1.95$$

h_s = scour depth = $y_c \times \alpha_e\, DI^{\beta} \times (t/t_0)^{\theta}$

$= 6.32 \times 0.75 \times 1.95^{0.85} \left(\frac{30}{316}\right)^{0.07}$

$= 7.09$ ft

W_s = Width of scour hole = $y_c \times \alpha_e\, DI^{\beta} \times (t/t_0)^{\theta}$

$= 6.32 \times 4.78 \times 1.95^{0.76} \times (0.09)^{0.06}$

$= 43.4$ ft

L_s = Length of scour hole = $y_c \times \alpha_e\, DI^{\beta} \times (t/t_0)^{\theta}$

$= 6.32 \times 12.62 \times 1.95^{0.41} (0.09)^{0.04}$

$= 90.8$ ft say 91 feet

Vol = $y_c \times \alpha_e\, DI^{\beta} \times (t/t_0)^{\theta}$

$= 6.32 \times 12.94 \times 1.95^{2.09} \times (0.09)^{0.19} = 209$ CY

Prestige
Engineering Consultants
3404 W. Cheryl Dr, A160, Phoenix, AZ 85051 Phone: (602) 978 3355 Fax: (602) 978 4455

Project: _____ Page: 2a of ___

Project Number: _____ Detail: _____

Computed By: _____ Date: _____

Checked By: _____ Date: _____

For 100-yr flow.

$$DI = \frac{Q}{\sqrt{g}\, y_e^{5/2}} = \frac{928.6}{\sqrt{32.2} \times (6.32)^{5/2}} = 1.63$$

$$y_e = \left(\frac{A}{2}\right)^{0.5} = \left(\frac{10 \times 8}{2}\right)^{0.5} = 6.32$$

$$\frac{t}{t_0} = \frac{30}{316} = 0.095$$

h_s = scour depth = $y_e \times \alpha_e \times DI^{\beta} \times (t/t_0)^{\theta}$

$= 6.32 \times 0.75 \times 1.63^{0.85} \times (0.095)^{0.07}$

$= 6.09$ ft

h_s = SAY 6'

$W_s = y_e \times \alpha_e \times DI^{\beta} \times t/t_0^{\theta}$

$= 6.32 \times 4.78 \times 1.63^{0.76} \times 0.095^{0.04}$

$= 38'$

$L_s = y_e \times \alpha_e \times DI^{\beta} \times (t/t_0)^{\theta}$

$= 6.32 \times 12.62 \times 1.63^{0.41} \times 0.095^{0.04}$

$= 88.7$ ft

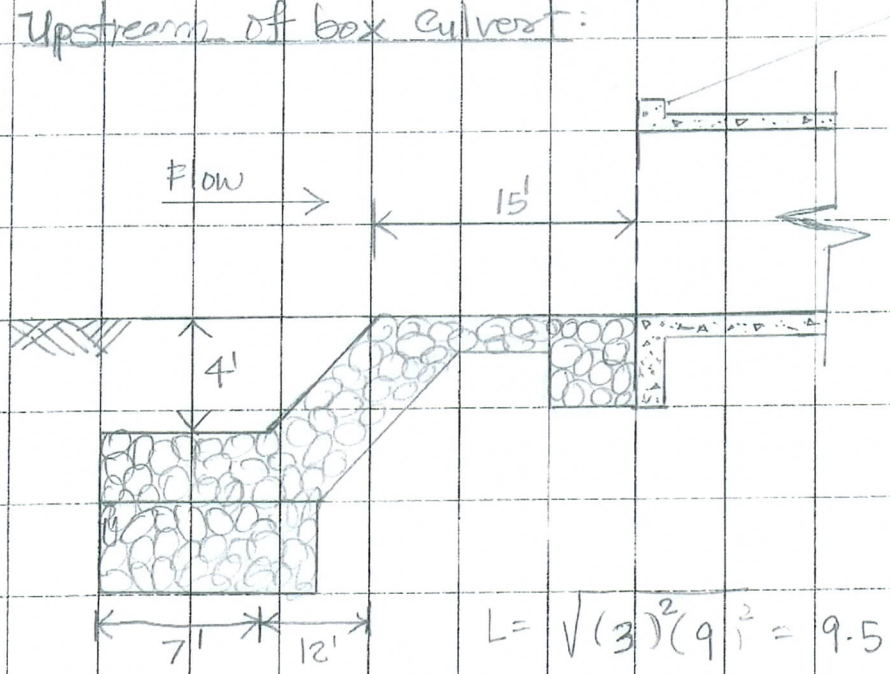
SAY 89'

Prestige
Engineering Consultants
3404 W. Cheryl Dr, A160, Phoenix, AZ 85051 Phone: (602) 978 3355 Fax: (602) 978 4455

Project: El Mirage Road, Page: 3 of ___
Project Number: _____ Detail: Scour Protection
Computed By: _____ Date: _____
Checked By: _____ Date: _____

Launchable Riprap Calculations:

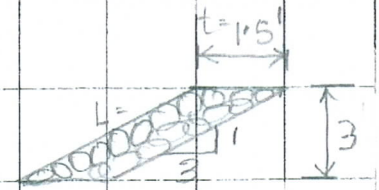
Upstream of box culvert:



Width = 80'

Total Toe down = 7'

Launchable Depth = 3'



$L = \sqrt{(3)^2 + (9)^2} = 9.5'$

Scour hole

Volume Req'd = $9.5' \times 1.5' \times 80'$

$= 1138\ ft^3$

Increased Vol by 50% = $1.5 \times 1138 = 1708\ ft^3$

Equivalent length = $80' \times 3.0' \times L = 1708\ ft^3$

$L = 1708 / 80' \times 3' = 7'$

⇒ Launchable pad dimension = 3' thick × 7' Long × 80' wide

Prestige
Engineering Consultants
3404 W. Cheryl Dr, A160, Phoenix, AZ 85051 Phone: (602) 978 3355 Fax: (602) 978 4455

Project: _____ Page: 4 of ___

Project Number: _____ Detail: _____

Computed By: _____ Date: _____

Checked By: _____ Date: _____

Downstream dimension of launchable pad

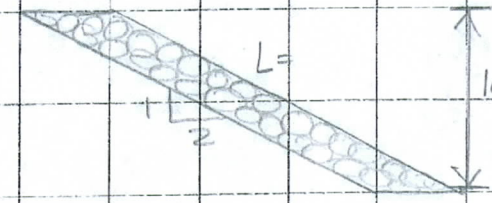
Total D/s Scour depth = 10.5'

Riprap thickness = 1.5' = 18"

Width = 80'

scour hole geometry

$L = \sqrt{(10.5)^2 + (21)^2} = 23.5'$



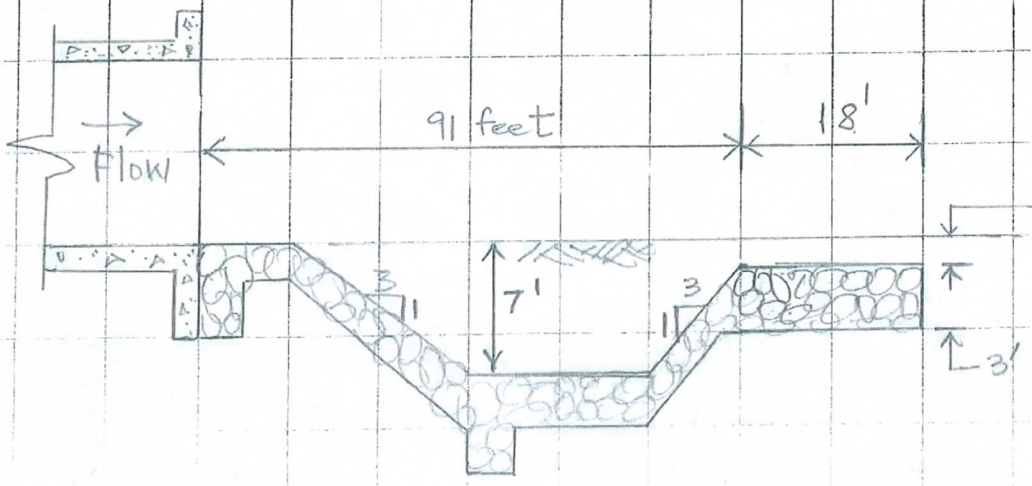
Vol. Req'd = $23.5' \times 1.5' \times 80' = 2820\ ft^3$

Increase Vol by 50% = $2820 \times 1.5 = 4230\ ft^3$

Equivalent length = $80' \times 3' \times L = 4230\ ft^3$

$L = 4230 / 80' \times 3' = 17.6'$

⇒ Launchable pad dimension = 3' thick × 18' long × 80' wide



Prestige Engineering
Long Term Scour (Arizona State Standard Method)
6/22/2009
Engr.: Raj Shah, P.E.
Reviewed by: Kofi Awumah, Ph. D., P.E.
McMicken Wash Bend at El-Mirage Road
U.S. Units

Prestige
Engineering Consultants

Y = 0.02[Q(100)]^0.6

SPF

Discharge	Long term scour
(cfs)	(ft)
6500	3.9

Recommend: **4.0**

Note: The method is used when no downstream controls exist, which was the case for the study reach.

Reference: ADWR, State Standard for Watercourse System Sediment Balance, ADWR State Standard 5-96, September, 1996.

Prestige Engineering
Antidune and Dune (Bed form) Scour
22-Jun-09
Prep by: Raj Shah, P.E.
Chkeced by: Kofi Awumah, Ph. D., P.E.
McMicken Wash Bend at El-Mirage Road
U.S. Units

SPF Upstream of Culvert

XS Id Number	Design Q cfs	Channel Velocity, ft/s	**Antidune scour = 1/2 * 0.027 * V^2 (using Channel Velocity), feet**	Hydraulic Depth, ft	**Simon's Senturk Dune Height (ft)**
2009.877	14000	5.2	**0.4**	6.66	**0.3**
1941.198	14000	4.5	**0.3**	6.81	**0.3**
1896.011	14000	4.1	**0.2**	7.14	**0.4**
1838.837	14000	3.7	**0.2**	7.56	**0.4**
1768.958	14000	3.6	**0.2**	7.64	**0.4**
1673.921	14000	3.4	**0.2**	8.08	**0.4**
		Recommend	**0.2**		**0.3**

SPF Downstream of Culvert

XS Id Number	Design Q cfs	Channel Velocity, ft/s	**Antidune scour = 1/2 * 0.027 * V^2 (using Channel Velocity), feet**	Hydraulic Depth, ft	**Simon's Senturk Duen Height (ft)**
1505.346	14000	7.0	**0.7**	3.91	**0.2**
1427.304	14000	10.9	**1.6**	3.75	**0.2**
1363.17	14000	8.2	**0.9**	3.31	**0.1**
1272.123	14000	7.7	**0.8**	4.62	**0.2**
		Recommend	**0.6**		**0.1**

Reference: Simons, Li & Associates, Inc. (1985). "Design Manual for Engineering Analysis of Fluvial Systems," preprared for ADOT, Phoenix, AZ

Prestige Engineering
23-Jun-09
Engr.: Iftekhar Ahmed, Ph.D., P.E.
Revised by: Raj Shah, P.E.
McMicken Wash Bend at El-Mirage Road: SPF Design Discharge.
BOR Genral Scour or Toe-down Upstream of Culvert
U.S. Units

		10-yr			Main Channel		Main Channel	SPF			Top Width	Hydraulic Depth				
XS Id Number	Reach Type	Incised / Bankfull Q cfs	Flow Area (sq ft)	Max Flow Depth (ft)	Incised / Bankfull Width	Incised / Bankfull q cfs/ft	Avg Depth at bankfull discharge (ft)	Design Q cfs	Flow Area (sq ft)	Max Flow Depth (ft)	Design Channel Width (ft)	Design Flow / Width	Avg Depth (ft)	Channel Velocity	Neill Z (p. 36 USBR)	**Neill - Incised Method (ft)**
	(See Note Below)	Qi	A	D	Wi	qi	di		A	D		qf	dm	Vm	Zn	ds = di*((qf/qi)^m* Zn
2009.877	3	2917	598.5	5.46	109.615	26.61	2.9	14000	2689.14	12.56	214.10	65.39	6.66	5.2	0.7	3.71
1941.198	3	2917	605.08	5.55	109.023	26.76	2.9	14000	3090.93	12.9	239.61	58.43	6.81	4.5	0.7	3.46
1896.011	3	2917	568.6	5.31	107.081	27.24	3.0	14000	3436.16	12.9	266.37	52.56	7.14	4.1	0.7	3.27
1838.837	3	2917	574.91	5.07	113.394	25.72	3.1	14000	3815.71	12.89	296.02	47.29	7.56	3.7	0.7	3.29
1768.958	3	2917	516.57	5.62	91.9164	31.74	3.5	14000	3844.57	13.8	278.59	50.25	7.64	3.6	0.7	3.30
1673.921	3	2917	578.38	5.37	107.706	27.08	3.5	14000	4076.2	13.81	295.16	47.43	8.08	3.4	0.7	3.61

3.439812

3.5 feet

Note:

Material Erodibility: 1-Cohesive&Easily erodible; 2-Cohesive&Average; 3-Cohesive&Resistant material; 4-Non-Cohesive

Reach Type: 1-Straight; 2-Moderate Bend; 3-Severe Bend; 4-90 deg Bend; 5-Vertical rock/Wall

McMicken Wash Bend at El-Mirage Road: SPF Design Discharge.
BOR Genral Scour or Toe-down Downstream of Culvert
U.S. Units

		100-yr			Main Channel		Main Channel	SPF			Top Width	Hydraulic Depth				
XS Id Number	Reach Type	Incised / Bankfull Q cfs	Flow Area (sq ft)	Max Flow Depth (ft)	Incised / Bankfull Width	Incised / Bankfull q cfs/ft	Avg Depth at bankfull discharge (ft)	Design Q cfs	Flow Area (sq ft)	Max Flow Depth (ft)	Design Channel Width	Design Flow / Width	Average Depth	Channel Velocity	Neill Z (p. 36 USBR)	**Neill - Incised Method (ft)**
	(See Note Below)	Qi	A	D	Wi	qi	di		A	D		qf	dm	Vm	Zn	ds = di*((qf/qi)^m* Zn
1505.346	1	2917	386.19	5.57	69.3339	42.07	2.73	14000	1996.15	9.75	204.73	68.38	3.91	7.0	0.5	1.89
1427.304	1	2917	449.57	5.39	83.4082	34.97	2.5	14000	1280.08	8.29	154.41	90.67	3.75	10.9	0.5	2.38
1363.17	1	2917	457.52	5.42	84.4133	34.56	2.6	14000	1711.4	8.56	199.93	70.02	3.31	8.2	0.5	2.05
1272.123	1	2917	590.69	5.9	100.117	29.14	2.1	14000	1820.89	8.98	202.77	69.04	4.62	7.7	0.5	1.84

2.037129

2.0 feet

Note:

Material Erodibility: 1-Cohesive&Easily erodible; 2-Cohesive&Average; 3-Cohesive&Resistant material; 4-Non-Cohesive

Reach Type: 1-Straight; 2-Moderate Bend; 3-Severe Bend; 4-90 deg Bend; 5-Vertical rock/Wall

Plan: Plan061509 el mirage 2 RS: 2009.877 Profile: 10-year

E.G. Elev (ft)	1202.20	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.37	Wt. n-Val.		0.040	
W.S. Elev (ft)	1201.83	Reach Len. (ft)	1.00	68.68	122.68
Crit W.S. (ft)	1201.20	Flow Area (sq ft)		598.50	
E.G. Slope (ft/ft)	0.004211	Area (sq ft)		598.50	
Q Total (cfs)	2917.00	Flow (cfs)		2917.00	
Top Width (ft)	206.66	Top Width (ft)		206.66	
Vel Total (ft/s)	4.87	Avg. Vel. (ft/s)		4.87	
Max Chl Dpth (ft)	5.46	Hydr. Depth (ft)		2.90	
Conv. Total (cfs)	44952.7	Conv. (cfs)		44952.7	
Length Wtd. (ft)	68.68	Wetted Per. (ft)		208.18	
Min Ch El (ft)	1196.37	Shear (lb/sq ft)		0.76	
Alpha	1.00	Stream Power (lb/ft s)		3.68	
Frctn Loss (ft)	0.28	Cum Volume (acre-ft)		13.20	
C & E Loss (ft)	0.00	Cum SA (acres)		5.57	

Plan: Plan061509 el mirage 2 RS: 1941.198 Profile: 10-year

E.G. Elev (ft)	1201.91	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.36	Wt. n-Val.		0.040	
W.S. Elev (ft)	1201.55	Reach Len. (ft)	1.00	45.19	125.58
Crit W.S. (ft)	1200.32	Flow Area (sq ft)		605.08	
E.G. Slope (ft/ft)	0.004040	Area (sq ft)		605.08	
Q Total (cfs)	2917.00	Flow (cfs)		2917.00	
Top Width (ft)	206.50	Top Width (ft)		206.50	
Vel Total (ft/s)	4.82	Avg. Vel. (ft/s)		4.82	
Max Chl Dpth (ft)	5.55	Hydr. Depth (ft)		2.93	
Conv. Total (cfs)	45892.9	Conv. (cfs)		45892.9	
Length Wtd. (ft)	45.19	Wetted Per. (ft)		207.41	
Min Ch El (ft)	1196.00	Shear (lb/sq ft)		0.74	
Alpha	1.00	Stream Power (lb/ft s)		3.55	
Frctn Loss (ft)	0.19	Cum Volume (acre-ft)		12.25	
C & E Loss (ft)	0.00	Cum SA (acres)		5.24	

Plan: Plan061509 el mirage 2 RS: 1896.011 Profile: 10-year

E.G. Elev (ft)	1201.72	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.41	Wt. n-Val.		0.040	
W.S. Elev (ft)	1201.31	Reach Len. (ft)	1.00	57.17	103.77
Crit W.S. (ft)	1200.09	Flow Area (sq ft)		568.60	
E.G. Slope (ft/ft)	0.004435	Area (sq ft)		568.60	
Q Total (cfs)	2917.00	Flow (cfs)		2917.00	
Top Width (ft)	189.09	Top Width (ft)		189.09	
Vel Total (ft/s)	5.13	Avg. Vel. (ft/s)		5.13	
Max Chl Dpth (ft)	5.31	Hydr. Depth (ft)		3.01	
Conv. Total (cfs)	43802.4	Conv. (cfs)		43802.4	
Length Wtd. (ft)	57.17	Wetted Per. (ft)		190.41	
Min Ch El (ft)	1196.00	Shear (lb/sq ft)		0.83	
Alpha	1.00	Stream Power (lb/ft s)		4.24	
Frctn Loss (ft)	0.24	Cum Volume (acre-ft)		11.64	
C & E Loss (ft)	0.00	Cum SA (acres)		5.04	

Plan: Plan061509 el mirage 2 RS: 1838.837 Profile: 10-year

E.G. Elev (ft)	1201.47	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.40	Wt. n-Val.		0.040	
W.S. Elev (ft)	1201.07	Reach Len. (ft)	1.00	69.88	147.25
Crit W.S. (ft)	1199.68	Flow Area (sq ft)		574.91	
E.G. Slope (ft/ft)	0.004096	Area (sq ft)		574.91	
Q Total (cfs)	2917.00	Flow (cfs)		2917.00	
Top Width (ft)	183.86	Top Width (ft)		183.86	
Vel Total (ft/s)	5.07	Avg. Vel. (ft/s)		5.07	
Max Chl Dpth (ft)	5.07	Hydr. Depth (ft)		3.13	
Conv. Total (cfs)	45579.7	Conv. (cfs)		45579.7	
Length Wtd. (ft)	69.88	Wetted Per. (ft)		184.39	
Min Ch El (ft)	1196.00	Shear (lb/sq ft)		0.80	
Alpha	1.00	Stream Power (lb/ft s)		4.05	
Frctn Loss (ft)	0.30	Cum Volume (acre-ft)		10.89	
C & E Loss (ft)	0.01	Cum SA (acres)		4.79	

Plan: Plan061509 el mirage 2 RS: 1768.958 Profile: 10-year

E.G. Elev (ft)	1201.16	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.50	Wt. n-Val.		0.040	
W.S. Elev (ft)	1200.67	Reach Len. (ft)	695.78	95.04	187.79
Crit W.S. (ft)	1199.35	Flow Area (sq ft)		516.57	
E.G. Slope (ft/ft)	0.004442	Area (sq ft)		516.57	
Q Total (cfs)	2917.00	Flow (cfs)		2917.00	
Top Width (ft)	149.16	Top Width (ft)		149.16	
Vel Total (ft/s)	5.65	Avg. Vel. (ft/s)		5.65	
Max Chl Dpth (ft)	5.62	Hydr. Depth (ft)		3.46	
Conv. Total (cfs)	43767.7	Conv. (cfs)		43767.7	
Length Wtd. (ft)	95.04	Wetted Per. (ft)		149.97	
Min Ch El (ft)	1195.05	Shear (lb/sq ft)		0.96	
Alpha	1.00	Stream Power (lb/ft s)		5.39	
Frctn Loss (ft)	0.37	Cum Volume (acre-ft)		10.02	
C & E Loss (ft)	0.03	Cum SA (acres)		4.53	

Plan: Plan061509 el mirage 2 RS: 1673.921 Profile: 10-year

E.G. Elev (ft)	1200.76	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.39	Wt. n-Val.		0.040	
W.S. Elev (ft)	1200.37	Reach Len. (ft)	142.11	168.58	174.27
Crit W.S. (ft)	1198.63	Flow Area (sq ft)		578.38	
E.G. Slope (ft/ft)	0.003433	Area (sq ft)		578.38	
Q Total (cfs)	2917.00	Flow (cfs)		2917.00	
Top Width (ft)	163.23	Top Width (ft)		163.23	
Vel Total (ft/s)	5.04	Avg. Vel. (ft/s)		5.04	
Max Chl Dpth (ft)	5.37	Hydr. Depth (ft)		3.54	
Conv. Total (cfs)	49783.9	Conv. (cfs)		49783.9	
Length Wtd. (ft)	168.58	Wetted Per. (ft)		163.98	
Min Ch El (ft)	1195.00	Shear (lb/sq ft)		0.76	
Alpha	1.00	Stream Power (lb/ft s)		3.81	
Frctn Loss (ft)		Cum Volume (acre-ft)		8.82	
C & E Loss (ft)		Cum SA (acres)		4.18	

Plan: Plan061509 el mirage 2 RS: 1505.346 Profile: 10-year

E.G. Elev (ft)	1200.46	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.89	Wt. n-Val.		0.040	
W.S. Elev (ft)	1199.57	Reach Len. (ft)	86.44	78.04	1644.92
Crit W.S. (ft)	1198.79	Flow Area (sq ft)		386.19	
E.G. Slope (ft/ft)	0.011060	Area (sq ft)		386.19	
Q Total (cfs)	2917.00	Flow (cfs)		2917.00	
Top Width (ft)	141.60	Top Width (ft)		141.60	
Vel Total (ft/s)	7.55	Avg. Vel. (ft/s)		7.55	
Max Chl Dpth (ft)	5.57	Hydr. Depth (ft)		2.73	
Conv. Total (cfs)	27737.6	Conv. (cfs)		27737.6	
Length Wtd. (ft)	78.04	Wetted Per. (ft)		143.65	
Min Ch El (ft)	1194.00	Shear (lb/sq ft)		1.86	
Alpha	1.00	Stream Power (lb/ft s)		14.02	
Frctn Loss (ft)	0.78	Cum Volume (acre-ft)		6.96	
C & E Loss (ft)	0.07	Cum SA (acres)		3.59	

Plan: Plan061509 el mirage 2 RS: 1427.304 Profile: 10-year

E.G. Elev (ft)	1199.61	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.65	Wt. n-Val.		0.040	
W.S. Elev (ft)	1198.96	Reach Len. (ft)	81.03	64.14	1.00
Crit W.S. (ft)	1198.36	Flow Area (sq ft)		449.57	
E.G. Slope (ft/ft)	0.008998	Area (sq ft)		449.57	
Q Total (cfs)	2917.00	Flow (cfs)		2917.00	
Top Width (ft)	179.07	Top Width (ft)		179.07	
Vel Total (ft/s)	6.49	Avg. Vel. (ft/s)		6.49	
Max Chl Dpth (ft)	5.39	Hydr. Depth (ft)		2.51	
Conv. Total (cfs)	30751.9	Conv. (cfs)		30751.9	
Length Wtd. (ft)	64.14	Wetted Per. (ft)		179.92	
Min Ch El (ft)	1193.57	Shear (lb/sq ft)		1.40	
Alpha	1.00	Stream Power (lb/ft s)		9.11	
Frctn Loss (ft)	0.56	Cum Volume (acre-ft)		6.21	
C & E Loss (ft)	0.01	Cum SA (acres)		3.31	

Plan: Plan061509 el mirage 2 RS: 1363.170 Profile: 10-year

E.G. Elev (ft)	1199.05	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.63	Wt. n-Val.		0.040	
W.S. Elev (ft)	1198.42	Reach Len. (ft)	82.77	91.05	1.00
Crit W.S. (ft)	1197.80	Flow Area (sq ft)		457.52	
E.G. Slope (ft/ft)	0.008492	Area (sq ft)		464.86	
Q Total (cfs)	2917.00	Flow (cfs)		2917.00	
Top Width (ft)	197.66	Top Width (ft)		197.66	
Vel Total (ft/s)	6.38	Avg. Vel. (ft/s)		6.38	
Max Chl Dpth (ft)	5.42	Hydr. Depth (ft)		2.55	
Conv. Total (cfs)	31654.4	Conv. (cfs)		31654.4	
Length Wtd. (ft)	91.05	Wetted Per. (ft)		180.00	
Min Ch El (ft)	1193.00	Shear (lb/sq ft)		1.35	
Alpha	1.00	Stream Power (lb/ft s)		8.59	
Frctn Loss (ft)	0.69	Cum Volume (acre-ft)		5.54	
C & E Loss (ft)	0.08	Cum SA (acres)		3.03	

Plan: Plan061509 el mirage 2 RS: 1272.123 Profile: 10-year

E.G. Elev (ft)	1198.28	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.38	Wt. n-Val.		0.040	
W.S. Elev (ft)	1197.91	Reach Len. (ft)	303.42	122.64	1.00
Crit W.S. (ft)	1197.31	Flow Area (sq ft)		590.69	
E.G. Slope (ft/ft)	0.006763	Area (sq ft)		651.65	
Q Total (cfs)	2917.00	Flow (cfs)		2917.00	
Top Width (ft)	325.08	Top Width (ft)		325.08	
Vel Total (ft/s)	4.94	Avg. Vel. (ft/s)		4.94	
Max Chl Dpth (ft)	5.90	Hydr. Depth (ft)		2.06	
Conv. Total (cfs)	35471.0	Conv. (cfs)		35471.0	
Length Wtd. (ft)	122.64	Wetted Per. (ft)		287.40	
Min Ch El (ft)	1192.00	Shear (lb/sq ft)		0.87	
Alpha	1.00	Stream Power (lb/ft s)		4.29	
Frctn Loss (ft)	0.93	Cum Volume (acre-ft)		4.37	
C & E Loss (ft)	0.00	Cum SA (acres)		2.48	

Plan: Plan061509 el mirage 2 RS: 2009.877 Profile: 100-year

E.G. Elev (ft)	1205.30	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.42	Wt. n-Val.		0.040	
W.S. Elev (ft)	1204.88	Reach Len. (ft)	1.00	68.68	122.68
Crit W.S. (ft)	1202.08	Flow Area (sq ft)		1249.32	
E.G. Slope (ft/ft)	0.001969	Area (sq ft)		1249.32	
Q Total (cfs)	6500.00	Flow (cfs)		6500.00	
Top Width (ft)	219.84	Top Width (ft)		219.84	
Vel Total (ft/s)	5.20	Avg. Vel. (ft/s)		5.20	
Max Chl Dpth (ft)	8.51	Hydr. Depth (ft)		5.68	
Conv. Total (cfs)	146472.2	Conv. (cfs)		146472.2	
Length Wtd. (ft)	68.68	Wetted Per. (ft)		222.82	
Min Ch El (ft)	1196.37	Shear (lb/sq ft)		0.69	
Alpha	1.00	Stream Power (lb/ft s)		3.59	
Frctn Loss (ft)	0.13	Cum Volume (acre-ft)		30.02	
C & E Loss (ft)	0.01	Cum SA (acres)		10.09	

Plan: Plan061509 el mirage 2 RS: 1941.198 Profile: 100-year

E.G. Elev (ft)	1205.16	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.39	Wt. n-Val.		0.040	
W.S. Elev (ft)	1204.77	Reach Len. (ft)	1.00	45.19	125.58
Crit W.S. (ft)	1201.76	Flow Area (sq ft)		1296.69	
E.G. Slope (ft/ft)	0.001842	Area (sq ft)		1296.69	
Q Total (cfs)	6500.00	Flow (cfs)		6500.00	
Top Width (ft)	230.30	Top Width (ft)		230.30	
Vel Total (ft/s)	5.01	Avg. Vel. (ft/s)		5.01	
Max Chl Dpth (ft)	8.77	Hydr. Depth (ft)		5.63	
Conv. Total (cfs)	151450.9	Conv. (cfs)		151450.9	
Length Wtd. (ft)	45.19	Wetted Per. (ft)		232.59	
Min Ch El (ft)	1196.00	Shear (lb/sq ft)		0.64	
Alpha	1.00	Stream Power (lb/ft s)		3.21	
Frctn Loss (ft)	0.09	Cum Volume (acre-ft)		28.02	
C & E Loss (ft)	0.02	Cum SA (acres)		9.74	

Plan: Plan061509 el mirage 2 RS: 1896.011 Profile: 100-year

E.G. Elev (ft)	1205.05	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.32	Wt. n-Val.		0.040	
W.S. Elev (ft)	1204.73	Reach Len. (ft)	1.00	57.17	103.77
Crit W.S. (ft)	1201.65	Flow Area (sq ft)		1437.05	
E.G. Slope (ft/ft)	0.002157	Area (sq ft)		1474.85	
Q Total (cfs)	6500.00	Flow (cfs)		6500.00	
Top Width (ft)	410.27	Top Width (ft)		410.27	
Vel Total (ft/s)	4.52	Avg. Vel. (ft/s)		4.52	
Max Chl Dpth (ft)	8.73	Hydr. Depth (ft)		4.28	
Conv. Total (cfs)	139946.2	Conv. (cfs)		139946.2	
Length Wtd. (ft)	57.17	Wetted Per. (ft)		338.57	
Min Ch El (ft)	1196.00	Shear (lb/sq ft)		0.57	
Alpha	1.00	Stream Power (lb/ft s)		2.59	
Frctn Loss (ft)	0.11	Cum Volume (acre-ft)		26.58	
C & E Loss (ft)	0.02	Cum SA (acres)		9.40	

Plan: Plan061509 el mirage 2 RS: 1838.837 Profile: 100-year

E.G. Elev (ft)	1204.92	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.25	Wt. n-Val.		0.040	
W.S. Elev (ft)	1204.67	Reach Len. (ft)	1.00	69.88	147.25
Crit W.S. (ft)	1201.35	Flow Area (sq ft)		1613.69	
E.G. Slope (ft/ft)	0.001682	Area (sq ft)		1713.96	
Q Total (cfs)	6500.00	Flow (cfs)		6500.00	
Top Width (ft)	486.27	Top Width (ft)		486.27	
Vel Total (ft/s)	4.03	Avg. Vel. (ft/s)		4.03	
Max Chl Dpth (ft)	8.67	Hydr. Depth (ft)		4.32	
Conv. Total (cfs)	158497.9	Conv. (cfs)		158497.9	
Length Wtd. (ft)	69.88	Wetted Per. (ft)		375.33	
Min Ch El (ft)	1196.00	Shear (lb/sq ft)		0.45	
Alpha	1.00	Stream Power (lb/ft s)		1.82	
Frctn Loss (ft)	0.12	Cum Volume (acre-ft)		24.49	
C & E Loss (ft)	0.00	Cum SA (acres)		8.82	

Plan: Plan061509 el mirage 2 RS: 1768.958 Profile: 100-year

E.G. Elev (ft)	1204.79	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.28	Wt. n-Val.		0.040	
W.S. Elev (ft)	1204.52	Reach Len. (ft)	695.78	95.04	187.79
Crit W.S. (ft)	1201.13	Flow Area (sq ft)		1536.34	
E.G. Slope (ft/ft)	0.001866	Area (sq ft)		1679.57	
Q Total (cfs)	6500.00	Flow (cfs)		6500.00	
Top Width (ft)	494.46	Top Width (ft)		494.46	
Vel Total (ft/s)	4.23	Avg. Vel. (ft/s)		4.23	
Max Chl Dpth (ft)	9.46	Hydr. Depth (ft)		4.31	
Conv. Total (cfs)	150470.8	Conv. (cfs)		150470.8	
Length Wtd. (ft)	95.04	Wetted Per. (ft)		358.87	
Min Ch El (ft)	1195.05	Shear (lb/sq ft)		0.50	
Alpha	1.00	Stream Power (lb/ft s)		2.11	
Frctn Loss (ft)	0.16	Cum Volume (acre-ft)		21.76	
C & E Loss (ft)	0.03	Cum SA (acres)		8.03	

Plan: Plan061509 el mirage 2 RS: 1673.921 Profile: 100-year

E.G. Elev (ft)	1204.61	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.19	Wt. n-Val.		0.040	
W.S. Elev (ft)	1204.42	Reach Len. (ft)	142.11	168.58	174.27
Crit W.S. (ft)	1200.50	Flow Area (sq ft)		1866.27	
E.G. Slope (ft/ft)	0.001525	Area (sq ft)		1866.27	
Q Total (cfs)	6500.00	Flow (cfs)		6500.00	
Top Width (ft)	499.17	Top Width (ft)		499.17	
Vel Total (ft/s)	3.48	Avg. Vel. (ft/s)		3.48	
Max Chl Dpth (ft)	9.42	Hydr. Depth (ft)		3.74	
Conv. Total (cfs)	166443.9	Conv. (cfs)		166443.9	
Length Wtd. (ft)	168.58	Wetted Per. (ft)		501.69	
Min Ch El (ft)	1195.00	Shear (lb/sq ft)		0.35	
Alpha	1.00	Stream Power (lb/ft s)		1.23	
Frctn Loss (ft)		Cum Volume (acre-ft)		17.90	
C & E Loss (ft)		Cum SA (acres)		6.95	

Plan: Plan061509 el mirage 2 RS: 1505.346 Profile: 100-year

E.G. Elev (ft)	1202.38	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.80	Wt. n-Val.		0.040	
W.S. Elev (ft)	1201.58	Reach Len. (ft)	86.44	78.04	1644.92
Crit W.S. (ft)	1201.16	Flow Area (sq ft)		906.20	
E.G. Slope (ft/ft)	0.010458	Area (sq ft)		912.29	
Q Total (cfs)	6500.00	Flow (cfs)		6500.00	
Top Width (ft)	406.80	Top Width (ft)		406.80	
Vel Total (ft/s)	7.17	Avg. Vel. (ft/s)		7.17	
Max Chl Dpth (ft)	7.58	Hydr. Depth (ft)		2.62	
Conv. Total (cfs)	63561.2	Conv. (cfs)		63561.2	
Length Wtd. (ft)	78.04	Wetted Per. (ft)		349.28	
Min Ch El (ft)	1194.00	Shear (lb/sq ft)		1.69	
Alpha	1.00	Stream Power (lb/ft s)		12.15	
Frctn Loss (ft)	0.83	Cum Volume (acre-ft)		12.52	
C & E Loss (ft)	0.00	Cum SA (acres)		5.19	

Plan: Plan061509 el mirage 2 RS: 1427.304 Profile: 100-year

E.G. Elev (ft)	1201.54	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.83	Wt. n-Val.		0.040	
W.S. Elev (ft)	1200.70	Reach Len. (ft)	81.03	64.14	1.00
Crit W.S. (ft)	1200.35	Flow Area (sq ft)		886.45	
E.G. Slope (ft/ft)	0.010913	Area (sq ft)		931.44	
Q Total (cfs)	6500.00	Flow (cfs)		6500.00	
Top Width (ft)	445.36	Top Width (ft)		445.36	
Vel Total (ft/s)	7.33	Avg. Vel. (ft/s)		7.33	
Max Chl Dpth (ft)	7.13	Hydr. Depth (ft)		2.61	
Conv. Total (cfs)	62222.7	Conv. (cfs)		62222.7	
Length Wtd. (ft)	64.14	Wetted Per. (ft)		341.28	
Min Ch El (ft)	1193.57	Shear (lb/sq ft)		1.77	
Alpha	1.00	Stream Power (lb/ft s)		12.98	
Frctn Loss (ft)	0.76	Cum Volume (acre-ft)		10.87	
C & E Loss (ft)	0.01	Cum SA (acres)		4.43	

Plan: Plan061509 el mirage 2 RS: 1363.170 Profile: 100-year

E.G. Elev (ft)	1200.77	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.96	Wt. n-Val.		0.040	
W.S. Elev (ft)	1199.81	Reach Len. (ft)	82.77	91.05	1.00
Crit W.S. (ft)	1199.58	Flow Area (sq ft)		827.63	
E.G. Slope (ft/ft)	0.012843	Area (sq ft)		906.01	
Q Total (cfs)	6500.00	Flow (cfs)		6500.00	
Top Width (ft)	412.08	Top Width (ft)		412.08	
Vel Total (ft/s)	7.85	Avg. Vel. (ft/s)		7.85	
Max Chl Dpth (ft)	6.81	Hydr. Depth (ft)		2.55	
Conv. Total (cfs)	57356.6	Conv. (cfs)		57356.6	
Length Wtd. (ft)	91.05	Wetted Per. (ft)		324.80	
Min Ch El (ft)	1193.00	Shear (lb/sq ft)		2.04	
Alpha	1.00	Stream Power (lb/ft s)		16.05	
Frctn Loss (ft)	0.88	Cum Volume (acre-ft)		9.51	
C & E Loss (ft)	0.09	Cum SA (acres)		3.80	

Plan: Plan061509 el mirage 2 RS: 1272.123 Profile: 100-year

E.G. Elev (ft)	1199.81	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.67	Wt. n-Val.		0.040	
W.S. Elev (ft)	1199.14	Reach Len. (ft)	303.42	122.64	1.00
Crit W.S. (ft)	1198.43	Flow Area (sq ft)		992.37	
E.G. Slope (ft/ft)	0.007473	Area (sq ft)		1104.90	
Q Total (cfs)	6500.00	Flow (cfs)		6500.00	
Top Width (ft)	383.16	Top Width (ft)		383.16	
Vel Total (ft/s)	6.55	Avg. Vel. (ft/s)		6.55	
Max Chl Dpth (ft)	7.14	Hydr. Depth (ft)		2.92	
Conv. Total (cfs)	75191.3	Conv. (cfs)		75191.3	
Length Wtd. (ft)	122.64	Wetted Per. (ft)		340.67	
Min Ch El (ft)	1192.00	Shear (lb/sq ft)		1.36	
Alpha	1.00	Stream Power (lb/ft s)		8.90	
Frctn Loss (ft)	1.17	Cum Volume (acre-ft)		7.41	
C & E Loss (ft)	0.02	Cum SA (acres)		2.97	

Plan: Plan061509 el mirage 2 RS: 2009.877 Profile: SPF

E.G. Elev (ft)	1209.35	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.42	Wt. n-Val.		0.040	0.060
W.S. Elev (ft)	1208.93	Reach Len. (ft)	1.00	68.68	122.68
Crit W.S. (ft)	1204.18	Flow Area (sq ft)		2689.14	5.71
E.G. Slope (ft/ft)	0.001590	Area (sq ft)		2689.14	5.71
Q Total (cfs)	14000.00	Flow (cfs)		13994.69	5.31
Top Width (ft)	409.97	Top Width (ft)		404.04	5.93
Vel Total (ft/s)	5.20	Avg. Vel. (ft/s)		5.20	0.93
Max Chl Dpth (ft)	12.56	Hydr. Depth (ft)		6.66	0.96
Conv. Total (cfs)	351089.5	Conv. (cfs)		350956.3	133.2
Length Wtd. (ft)	68.70	Wetted Per. (ft)		408.37	6.23
Min Ch El (ft)	1196.37	Shear (lb/sq ft)		0.65	0.09
Alpha	1.00	Stream Power (lb/ft s)		3.40	0.08
Frctn Loss (ft)	0.09	Cum Volume (acre-ft)	0.04	60.44	0.16
C & E Loss (ft)	0.03	Cum SA (acres)	0.04	11.73	0.14

Plan: Plan061509 el mirage 2 RS: 1941.198 Profile: SPF

E.G. Elev (ft)	1209.22	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.32	Wt. n-Val.		0.040	0.060
W.S. Elev (ft)	1208.90	Reach Len. (ft)	1.00	45.19	125.58
Crit W.S. (ft)	1203.87	Flow Area (sq ft)		3090.93	3.98
E.G. Slope (ft/ft)	0.001164	Area (sq ft)		3090.93	3.98
Q Total (cfs)	14000.00	Flow (cfs)		13997.34	2.66
Top Width (ft)	458.84	Top Width (ft)		453.98	4.86
Vel Total (ft/s)	4.52	Avg. Vel. (ft/s)		4.53	0.67
Max Chl Dpth (ft)	12.90	Hydr. Depth (ft)		6.81	0.82
Conv. Total (cfs)	410393.6	Conv. (cfs)		410315.5	78.1
Length Wtd. (ft)	45.24	Wetted Per. (ft)		457.56	5.66
Min Ch El (ft)	1196.00	Shear (lb/sq ft)		0.49	0.05
Alpha	1.00	Stream Power (lb/ft s)		2.22	0.03
Frctn Loss (ft)	0.05	Cum Volume (acre-ft)	0.04	55.88	0.14
C & E Loss (ft)	0.02	Cum SA (acres)	0.04	11.05	0.12

Plan: Plan061509 el mirage 2 RS: 1896.011 Profile: SPF

E.G. Elev (ft)	1209.16	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.26	Wt. n-Val.		0.040	0.060
W.S. Elev (ft)	1208.90	Reach Len. (ft)	1.00	57.17	103.77
Crit W.S. (ft)	1204.13	Flow Area (sq ft)		3436.16	17.80
E.G. Slope (ft/ft)	0.000881	Area (sq ft)		3436.16	17.80
Q Total (cfs)	14000.00	Flow (cfs)		13983.53	16.47
Top Width (ft)	493.47	Top Width (ft)		481.20	12.27
Vel Total (ft/s)	4.05	Avg. Vel. (ft/s)		4.07	0.93
Max Chl Dpth (ft)	12.90	Hydr. Depth (ft)		7.14	1.45
Conv. Total (cfs)	471554.9	Conv. (cfs)		471000.0	554.9
Length Wtd. (ft)	57.20	Wetted Per. (ft)		484.79	12.61
Min Ch El (ft)	1196.00	Shear (lb/sq ft)		0.39	0.08
Alpha	1.01	Stream Power (lb/ft s)		1.59	0.07
Frctn Loss (ft)	0.04	Cum Volume (acre-ft)	0.04	52.50	0.11
C & E Loss (ft)	0.01	Cum SA (acres)	0.04	10.56	0.10

Plan: Plan061509 el mirage 2 RS: 1838.837 Profile: SPF

E.G. Elev (ft)	1209.10	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.21	Wt. n-Val.		0.040	0.060
W.S. Elev (ft)	1208.89	Reach Len. (ft)	1.00	69.88	147.25
Crit W.S. (ft)	1203.86	Flow Area (sq ft)		3815.71	6.18
E.G. Slope (ft/ft)	0.000662	Area (sq ft)		3815.71	6.18
Q Total (cfs)	14000.00	Flow (cfs)		13997.53	2.47
Top Width (ft)	515.04	Top Width (ft)		504.50	10.54
Vel Total (ft/s)	3.66	Avg. Vel. (ft/s)		3.67	0.40
Max Chl Dpth (ft)	12.89	Hydr. Depth (ft)		7.56	0.59
Conv. Total (cfs)	544103.6	Conv. (cfs)		544007.4	96.2
Length Wtd. (ft)	69.92	Wetted Per. (ft)		507.50	12.42
Min Ch El (ft)	1196.00	Shear (lb/sq ft)		0.31	0.02
Alpha	1.00	Stream Power (lb/ft s)		1.14	0.01
Frctn Loss (ft)	0.05	Cum Volume (acre-ft)	0.04	47.74	0.08
C & E Loss (ft)	0.00	Cum SA (acres)	0.04	9.92	0.07

Plan: Plan061509 el mirage 2 RS: 1768.958 Profile: SPF

E.G. Elev (ft)	1209.05	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.21	Wt. n-Val.		0.040	0.060
W.S. Elev (ft)	1208.85	Reach Len. (ft)	695.78	95.04	187.79
Crit W.S. (ft)	1203.84	Flow Area (sq ft)		3844.57	16.90
E.G. Slope (ft/ft)	0.000644	Area (sq ft)		3844.57	16.90
Q Total (cfs)	14000.00	Flow (cfs)		13986.81	13.19
Top Width (ft)	515.14	Top Width (ft)		503.27	11.87
Vel Total (ft/s)	3.63	Avg. Vel. (ft/s)		3.64	0.78
Max Chl Dpth (ft)	13.80	Hydr. Depth (ft)		7.64	1.42
Conv. Total (cfs)	551637.9	Conv. (cfs)		551118.1	519.8
Length Wtd. (ft)	95.13	Wetted Per. (ft)		507.17	12.20
Min Ch El (ft)	1195.05	Shear (lb/sq ft)		0.30	0.06
Alpha	1.01	Stream Power (lb/ft s)		1.11	0.04
Frctn Loss (ft)	0.06	Cum Volume (acre-ft)	0.04	41.59	0.05
C & E Loss (ft)	0.01	Cum SA (acres)	0.04	9.11	0.03

Plan: Plan061509 el mirage 2 RS: 1673.921 Profile: SPF

E.G. Elev (ft)	1208.99	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.18	Wt. n-Val.	0.060	0.040	0.060
W.S. Elev (ft)	1208.81	Reach Len. (ft)	142.11	168.58	174.27
Crit W.S. (ft)	1203.50	Flow Area (sq ft)	3.77	4076.20	2.24
E.G. Slope (ft/ft)	0.000532	Area (sq ft)	3.77	4076.20	2.24
Q Total (cfs)	14000.00	Flow (cfs)	1.82	13997.24	0.94
Top Width (ft)	510.52	Top Width (ft)	4.50	504.67	1.35
Vel Total (ft/s)	3.43	Avg. Vel. (ft/s)	0.48	3.43	0.42
Max Chl Dpth (ft)	13.81	Hydr. Depth (ft)	0.84	8.08	1.65
Conv. Total (cfs)	606781.5	Conv. (cfs)	78.9	606662.1	40.6
Length Wtd. (ft)	168.58	Wetted Per. (ft)	4.86	508.30	3.57
Min Ch El (ft)	1195.00	Shear (lb/sq ft)	0.03	0.27	0.02
Alpha	1.00	Stream Power (lb/ft s)	0.01	0.92	0.01
Frctn Loss (ft)		Cum Volume (acre-ft)	0.01	32.95	0.00
C & E Loss (ft)		Cum SA (acres)	0.01	8.01	0.00

Plan: Plan061509 el mirage 2 RS: 1505.346 Profile: SPF

E.G. Elev (ft)	1204.52	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.76	Wt. n-Val.		0.040	
W.S. Elev (ft)	1203.75	Reach Len. (ft)	86.44	78.04	1644.92
Crit W.S. (ft)	1202.68	Flow Area (sq ft)		1996.15	
E.G. Slope (ft/ft)	0.005843	Area (sq ft)		1996.15	
Q Total (cfs)	14000.00	Flow (cfs)		14000.00	
Top Width (ft)	510.23	Top Width (ft)		510.23	
Vel Total (ft/s)	7.01	Avg. Vel. (ft/s)		7.01	
Max Chl Dpth (ft)	9.75	Hydr. Depth (ft)		3.91	
Conv. Total (cfs)	183147.6	Conv. (cfs)		183147.6	
Length Wtd. (ft)	78.04	Wetted Per. (ft)		514.26	
Min Ch El (ft)	1194.00	Shear (lb/sq ft)		1.42	
Alpha	1.00	Stream Power (lb/ft s)		9.93	
Frctn Loss (ft)	0.69	Cum Volume (acre-ft)		21.20	
C & E Loss (ft)	0.11	Cum SA (acres)		6.05	

Plan: Plan061509 el mirage 2 RS: 1427.304 Profile: SPF

E.G. Elev (ft)	1203.72	Element	Left OB	Channel	Right OB
Vel Head (ft)	1.86	Wt. n-Val.		0.040	
W.S. Elev (ft)	1201.86	Reach Len. (ft)	81.03	64.14	1.00
Crit W.S. (ft)	1201.86	Flow Area (sq ft)		1280.08	
E.G. Slope (ft/ft)	0.014997	Area (sq ft)		1482.68	
Q Total (cfs)	14000.00	Flow (cfs)		14000.00	
Top Width (ft)	498.73	Top Width (ft)		498.73	
Vel Total (ft/s)	10.94	Avg. Vel. (ft/s)		10.94	
Max Chl Dpth (ft)	8.29	Hydr. Depth (ft)		3.75	
Conv. Total (cfs)	114321.5	Conv. (cfs)		114321.5	
Length Wtd. (ft)	64.14	Wetted Per. (ft)		343.40	
Min Ch El (ft)	1193.57	Shear (lb/sq ft)		3.49	
Alpha	1.00	Stream Power (lb/ft s)		38.17	
Frctn Loss (ft)	0.77	Cum Volume (acre-ft)		18.08	
C & E Loss (ft)	0.25	Cum SA (acres)		5.14	

Plan: Plan061509 el mirage 2 RS: 1363.170 Profile: SPF

E.G. Elev (ft)	1202.60	Element	Left OB	Channel	Right OB
Vel Head (ft)	1.04	Wt. n-Val.		0.040	
W.S. Elev (ft)	1201.56	Reach Len. (ft)	82.77	91.05	1.00
Crit W.S. (ft)	1201.23	Flow Area (sq ft)		1711.40	
E.G. Slope (ft/ft)	0.009872	Area (sq ft)		1711.40	
Q Total (cfs)	14000.00	Flow (cfs)		14000.00	
Top Width (ft)	517.02	Top Width (ft)		517.02	
Vel Total (ft/s)	8.18	Avg. Vel. (ft/s)		8.18	
Max Chl Dpth (ft)	8.56	Hydr. Depth (ft)		3.31	
Conv. Total (cfs)	140901.3	Conv. (cfs)		140901.3	
Length Wtd. (ft)	91.05	Wetted Per. (ft)		518.69	
Min Ch El (ft)	1193.00	Shear (lb/sq ft)		2.03	
Alpha	1.00	Stream Power (lb/ft s)		16.64	
Frctn Loss (ft)	0.66	Cum Volume (acre-ft)		15.73	
C & E Loss (ft)	0.04	Cum SA (acres)		4.39	

Plan: Plan061509 el mirage 2 RS: 1272.123 Profile: SPF

E.G. Elev (ft)	1201.90	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.92	Wt. n-Val.		0.040	
W.S. Elev (ft)	1200.98	Reach Len. (ft)	303.42	122.64	1.00
Crit W.S. (ft)	1199.98	Flow Area (sq ft)		1820.89	
E.G. Slope (ft/ft)	0.005608	Area (sq ft)		1846.16	
Q Total (cfs)	14000.00	Flow (cfs)		14000.00	
Top Width (ft)	511.79	Top Width (ft)		511.79	
Vel Total (ft/s)	7.69	Avg. Vel. (ft/s)		7.69	
Max Chl Dpth (ft)	8.98	Hydr. Depth (ft)		4.62	
Conv. Total (cfs)	186949.0	Conv. (cfs)		186949.0	
Length Wtd. (ft)	122.64	Wetted Per. (ft)		396.30	
Min Ch El (ft)	1192.00	Shear (lb/sq ft)		1.61	
Alpha	1.00	Stream Power (lb/ft s)		12.37	
Frctn Loss (ft)	1.07	Cum Volume (acre-ft)		12.02	
C & E Loss (ft)	0.09	Cum SA (acres)		3.32	

Prestige
Engineering Consultants
3404 W. Cheryl Dr, A160, Phoenix, AZ 85051 Phone: (602) 978 3355 Fax: (602) 978 4455

Project: El Mirage Road Page: 1 of 4

Project Number: _____ Detail: Quantity Calcs

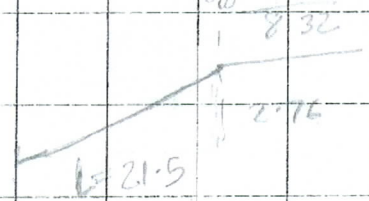
Computed By: _____ Date: _____

Checked By: _____ Date: _____

Gabion Mattress quantity Calcs:

Start Station: 101+25
End Station 106+50
} L = 525'

Section @ Sta 100



Avg West

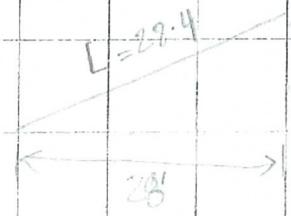
L = 30.4', Along roadway = 525'

Volume for West embankment: 525 × 30.4

= 16065 ft²

= 1785 SY

Avg East



L = 28.4', Along roadway = 525'

Volume for east embankment: 525 × 28.4

= 14910 ft²

= 1657 SY

Prestige
Engineering Consultants

Project: _____ Page: 2 of 4

Project Number: _____ Detail: _____

Computed By: _____ Date: _____

Checked By: _____ Date: _____

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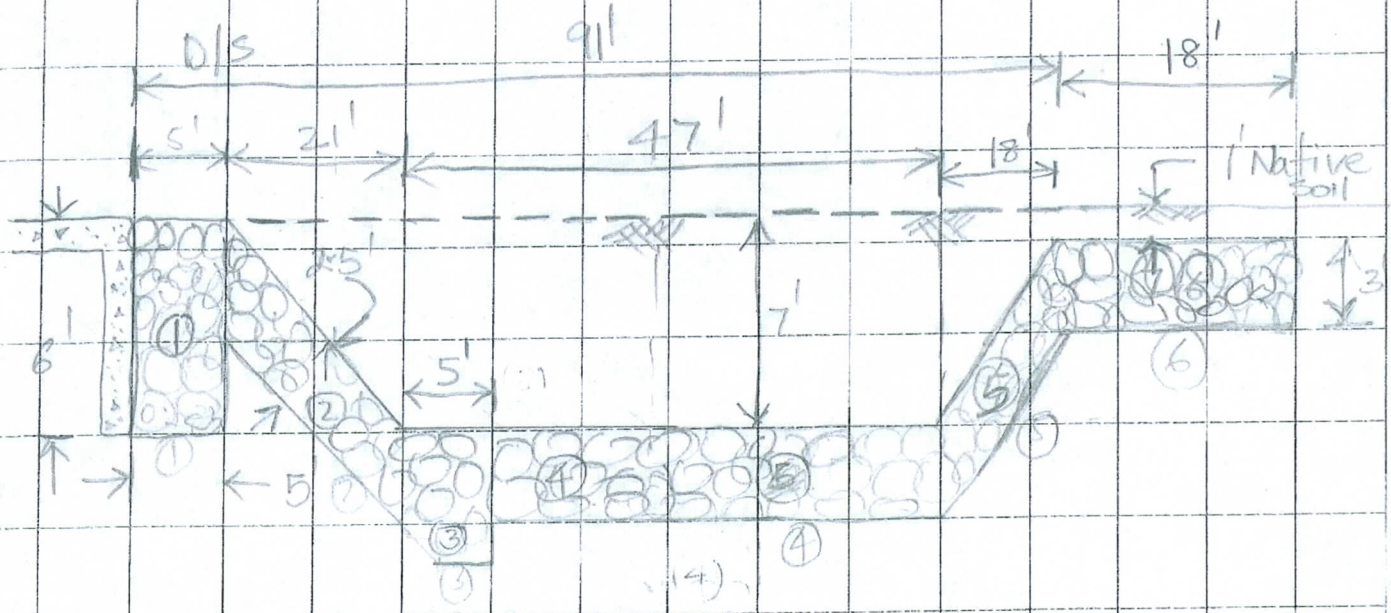
Riprap Protection.



①	6 x 5' x 80'	=	2400	ft³
②	22.1 x 25' x 80'	=	4427	ft³
③	5' x 2' x 80'	=	800	ft³
④	47' x 15' x 80'	=	5640	ft³
⑤	19' x 15' x 80'	=	2277	ft³
⑥	18' x 3' x 80'	=	4320	ft³
			19864 ft³	= 736 CY

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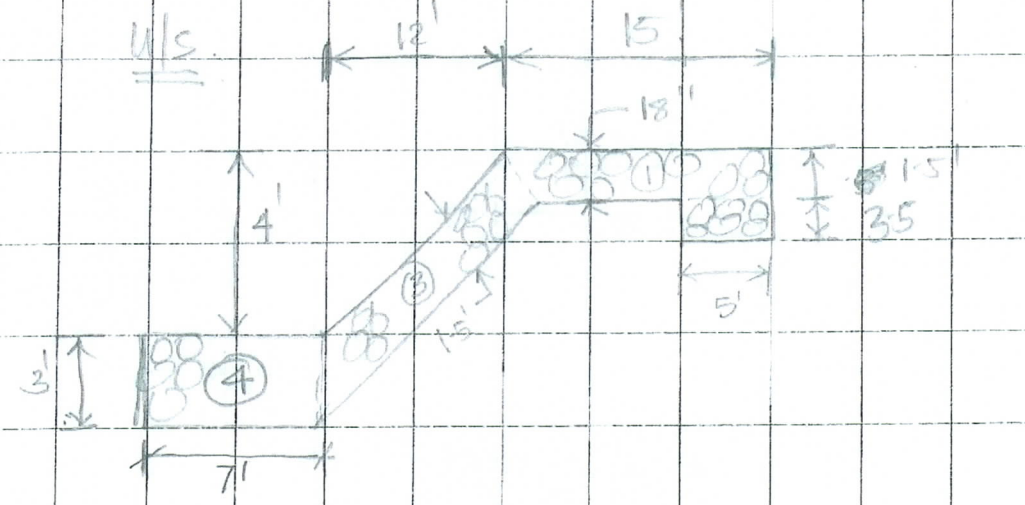
Project: _____ Page: 3 of 4

Project Number: _____ Detail: _____

Computed By: _____ Date: _____

Checked By: _____ Date: _____

Riprap Protection @ U/S.



① $15' \times 80' \times 1.5' = 1800\ ft^3$

② $5' \times 3.5' \times 80' = 1400\ ft^3$

③ $12.6' \times 1.5' \times 80' = 1518\ ft^3$

④ $7' \times 3' \times 80' = 1680\ ft^3$

$6398\ ft^3 = 237\ CY$

Prestige
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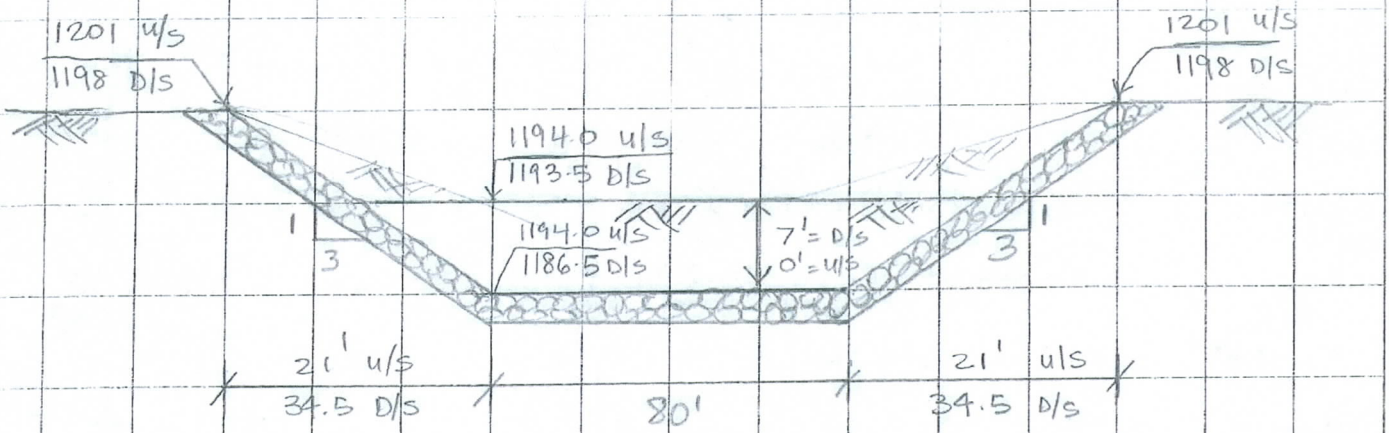
Project: EL MIRAGE Page: 4 of 4

Project Number: _____ Detail: _____

Computed By: _____ Date: _____

Checked By: _____ Date: _____



U/S RIPRAP QUANTITY:

$$L = \sqrt{(21)^2 + 7^2} = 22.1$$

$$\text{Volume} = 2 \times (22.1 \times 1.5' \times 42') = \frac{2785 \text{ ft}^3}{27} = 103 \text{ CY}$$

D/S RIPRAP QUANTITY:

$$L = \sqrt{(34.5)^2 + 11.5^2} = 36.4 \text{ ft}$$

$$\text{Volume} = 2 \times (36.4 \times 1.5' \times 115') = \frac{12558 \text{ ft}^3}{27} = 465 \text{ CY}$$

Total Riprap for Box Culvert Apron:

U/S = 103 + 237 = 340 CY

D/S = 465 + 736 = 1201 CY

1541 CY RIPRAP, $D_{50} = 12''$, $T = 18''$ w/ Filter Fabric

MEETING NOTES

No. 1

Date/Time: April 7, 2009 1:00 p.m.

Place: Flood Control District of Maricopa County (FCDMC), New River Conf. Room

Project: El Mirage Road, Bell Road to Deer Valley Road, Phase B

Attendees: See attached sign-in sheet

Notes By: Raj Shah

The following meeting notes set forth our understanding of the discussions and decisions made at this meeting. If you have any questions, additions, or comments, please contact the writer immediately. If we do not hear from you within 5 days, we will assume that our understandings are the same. We are proceeding based on the contents of these meeting notes.

Introductions

Everyone made self introductions.

Angie said MCDOT has funding for this portion of the project and anticipating bidding the project on September 2009.

Raj said Jacob is prime roadway designer and Prestige Engineering and Wood/Patel are assisting as drainage sub-consultant to Jacob.

Pre-final submittal is due April 20th, 2009 and final by end of June 2009 to support the September 2009 bid date.

McMicken Dam Outlet Wash

Raj explained the south box culvert crossing and described how the length of the apron came about at the inlet and at the outlet.

Jeff explained the north box culvert crossing and described how the length of the apron came about at the inlet and outlet.

Jeff said within their portion, MCDOT would have to do additional channel grading work because the SPF flows are outside the FCDMC easements.

The channel grading required upstream of the box will still be outside the 404 limits.

Jeff asked Bing if there was any documentation for the inlet apron design for the Williams Road.

Bing said mainly it was the general scour, bed form scour and if applicable bend scour. Since the box culvert acts as a grade control, long term degredation would not be applicable.

Angie requested if the plans can show the rights-of-way ownership.

Jeff asked if the roadway embankments need to be protected for 100-yr event or SPF event.

MCDOT said they are okay with protecting the roadway approaches for up to 100-yr event. It does not need to be protected up to SPF event. MCDOT is requiring that the roadway embankment be protected for the 100-year design storm and not require reconstruction as a result of overtopping.

FCD staff as well as MCDOT staff requested that there will be cut-off walls, MAG Standard Detail 552 at the edge of pavements (median and upstream pavement edges – 2 feet deep; and, downstream 4 feet deep). The FCD concurred that the roadway downstream riprap erosion protection toe down depths would be designed based on grade control

FCD staff asked if the median will be protected with the riprap or not.

Raj mentioned that same size of riprap will be provided within the median so, that 100-yr overtopping does not cause any damage to inside edge of the pavements.

Raj said a ADOT Std. Median Catch basin is provided in the median so that any ponding flows can drain through the median.

Jeff said there low flow crossing is almost at grade, however, roadway superelevation will require the side slopes to be protected with riprap for up to 100-yr level storm.

Bing requested that the riprap protection just above the box culvert be designed for the SPF event so it does not wash out and clog the box culvert. The remaining low flow crossing roadway embankment can be designed for 100-yr flow.

FCDMC staff agreed on type of protection to be designed at the inlet, outlet and for the roadway crossing. The riprap layout was agreed to be similar to the layout used and approved at Williams Road.

First Flush Retention

Raj explained the first flush retention approach on the south part of the project.

He said the roadway gradient and the parallel ditch gradient is very steep at the south end of the project (about 0.6%). Plus the rights-of-way is very limited so, there are no opportunities to provide first flush retention along the side.

Raj said if FCDMC staff is okay with using the gravel berm that is 6" high across the ditch bottom on regular interval as necessary.

Matt Ohler said FCDMC is okay with that approach. He said in one case ADEQ allowed ADOT to simply write a letter stating that ADOT will sweep (clean) the roadway more frequently in lieu of providing first flush retention. He said if MCDOT can also provide similar letter, first flush retention equirement can be waived.

Jeff explained the first flush system within their portion of the project. He said since their part of the project is fairly flat (0.02%), they are using ADOT Standard median dike that is 1' high to retain flows within side ditches. They used similar approach within Phase A segment of the roadway.

Matt said he is okay with both approaches for first flush retention.

Angie asked if we can submit one extra set of plans and Drainage Report for Lynn Thomas.

CLOMR

Jeff asked if CLOMR needs to be for ultimate condition (6-lanes) or design condition (4-lanes).

Lynn said whatever will cause the greatest negative impact to the existing floodplain, we should consider that and prepare CLOMR based on it.

Permits

Angie said MCDOT will be required to obtain: 1) Floodplain Use Permit, 2) Rights-of-way Permit and 3) Drainage easements for box culvert inlet and outlet aprons.

Angie said she will provide information regarding how much bond that the contractor will have to provide as part of the rights-of-way use permit. She said that information may need to be added in Special Provision.

Open Agenda

Angie also stated to make sure the rights-of-way is tied down to 2 (two) section corners.

Mike Ramirez mentioned that FCDMC will need a dedicated maintenance road to access the channel from both the crossings.

Raj said both the crossings are at grade crossing which allows easy access to the channel. The side slopes are 6:1 and are easily traversable. If we have a riprap along the side slope we may have to provide smooth surface.

Jeff summarized previous discussions with Steve Waters regarding the potential installation of a new alert gage upstream of the Deer Valley crossing. The FCD did not believe an additional alert gage is needed at this location. There is an existing FCD alert gage at Williams Road (1/2 mile north) and very little additional contributing area would be added to the proposed gage at Deer Valley. However, the alert trigger point may need to be reevaluated considering the capacity of the downstream box culvert crossings.

Meeting adjourned around 2:30 PM.

COMPUTING DEGRADATION AND LOCAL SCOUR

by

Ernest L. Pemberton
Joseph M. Lara

TECHNICAL GUIDELINE FOR
BUREAU OF RECLAMATION

SI METRIC

SEDIMENTATION AND RIVER HYDRAULICS SECTION
HYDROLOGY BRANCH
DIVISION OF PLANNING TECHNICAL SERVICES
ENGINEERING AND RESEARCH CENTER

DENVER, COLORADO

JANUARY 1984

y_d = 1.15 ft

y_d = 0.351 m

It is difficult to determine the distance that degradation will extend downstream when an armoring condition is the limiting factor. With the assumption that the degraded and existing slopes are the same, degradation can be predicted to extend downstream until the volume of material degraded from the channel plus tributary contributions equals the estimated annual volume of eroded material multiplied by some time period usually equal to the economic life of the structure in the following equation form:

$$V_g = V_A T \qquad (12)$$

where:

V_g = Total volume of degradation, ft^3 (m^3)
V_A = Estimated annual volume of eroded material, ft^3/yr (m^3/a)
T = Time in years (equals 100 years for most USBR studies)

The actual physical process of degradation begins at the dam and continues downstream with the depth of degradation diminishing in proportion to the sediment load picked up below the dam. As the upstream reach becomes armored, degradation, and, consequently, channel pickup is reduced and the next reach downstream is subjected to a similar degradation process until it armors, after which the process moves on down river.

In the more sophisticated mathematical models degradation computations are made by dividing the stream into reaches. An initial step is to compute the volume of sediment carried out of each reach by the riverflows over a specified time frame. The difference between the volume of material transported out of the reach and that brought into the reach from the immediate upstream reach would determine the degradation in the reach.

DEGRADATION LIMITED BY A STABLE SLOPE

The limiting or stable slope method for computing degradation is based on the degrading process controlled by zero or negligible transport of the material forming the bed of the stream channel. It can be applied to cases where the amount of coarse material is insufficient to form an armoring layer on the channel bed.

The stable slope is determined by application of several methods such as (1) Schoklitsch bedload equation (Shulits, 1935) for conditions of zero bedload transport, (2) Meyer-Peter, Muller (1948) bedload equation for beginning transport, (3) Shields (1936) diagram for no motion, and (4) Lane's (1952) relationship for critical tractive force assuming clear water-flow in canals. Other bedload equations are equally as applicable as the Schoklitsch or Meyer-Peter, Muller equations for zero bedload transport. However, many of these involve trial and error computations until a slope is found to produce negligible bedload transport.

Stable slope computations are made for the dominant discharge which is defined as the flow effecting the ultimate shape and hydraulics of the channel.

Schoklitsch Method

The Schoklitsch equation for zero bedload transport is expressed as follows:

$$S_L = K\left(\frac{DB}{Q}\right)^{3/4} \qquad (13)$$

where:

S_L = Stable slope, ft/ft (m/m)
K = 0.00174 inch-pound units (0.000293 metric units)
D = Mean particle size, mm
B = Channel width, ft (m)
Q = Dominant discharge, ft^3/s (m^3/s)

Meyer-Peter, Muller Method

Limiting slope computations by the Meyer-Peter, Muller beginning transport equation are:

$$S_L = \frac{K\left(\frac{Q}{Q_B}\right)\left(\frac{n_s}{D_{90}^{1/6}}\right)^{3/2} D}{d} \qquad (14)$$

where:

S_L = Stable slope, ft/ft (m/m)
K = 0.19 inch-pound units (0.058 metric units)
$\frac{Q}{Q_B}$ = Ratio of total flow in ft^3/s (m^3/s) to flow over bed of stream in ft^3/s (m^3/s). Usually defined at dominant discharge where $\frac{Q}{Q_B} = 1$ for wide channels
D_{90} = Particle size at which 90 percent of bed material by weight is finer
n_s = Manning's "n" for bed of stream
D = Mean particle size, mm
d = Mean depth, ft (m)

Shields Diagram Method

The use of Shields diagram for computing a stable slope involves the relationship of the boundary Reynold's number R_* varying with the dimensionless shear stress T_* shown on figure 5 as follows:

$$R_* = \frac{U_* D}{\upsilon} \qquad (15)$$

shown in table 6 varies from a design flood estimated on a frequency basis from 50 to 100 years. This pertains to an adequate waterway for passage of the floodflow peak. The scour calculations for these same structures are always made for a 100-year flood peak. The use of the 100-year flood peak for scour is based on variability of channel hydraulics, bed material, and general complexity of the erosive process. The exception in the use of the 100-year flood peak for estimating scour would be the scour hole immediately below a large dam or a major structure where loss of structure could involve lives or represent a catastrophic event. In this case, the scour for use in design should be determined for a flow equal to 50 percent of the structure design flood.

Equation Types A and B (See Table 6)

Natural river channel scour estimates are required in design of a buried pipe, buried canal siphon, or a bankline structure. For most siphon crossings of a river, the cost of burying a siphon will dictate either the selection of a natural narrow reach of river or a restriction in width created by constructing canal bankline levees across a portion of the flood plain. A summary of available methods for computing scour at constrictions is given by Neill (1973). The four methods for estimating general scour at constricted waterways described by Neill (1973) are considered the proper approach for estimating scour for use in either design of a siphon crossing or where general scour is needed of the riverbed for a bankline structure. The four methods supplemented with Reclamation's procedure for application are given below:

Field measurments of scour method. - This method consists of observing or measuring the actual scoured depths either at the river under investigation or a similar type river. The measurements are taken during as high a flow as possible to minimize the influence of extrapolation.

A Reclamation unpublished study by Abbott (1963) analyzed U.S. Geological Survey discharge measurement notes from several streams in the southwestern United States, including the Galisteo Creek at Domingo, New Mexico, and developed an empirical curve enveloping observed scour at the gaging station. This envelope curve for use in siphon design was further supported by observed scour from crest-stage and scour gages on Gallegos, Kutz, Largo, Chaco, and Gobernador Canyons in northwest New Mexico collected during the period from 1963 to 1969. The scour gages consisted of a series of deeply anchored buried flexible tapes across the channel section that were resurveyed after a flood to determine the depth of scour at a specific location. The results of these measurements are shown on figure 8 along with the envelope curve for Galisteo Creek that support scour estimates for wide sandbed (D_{50} varying from 0.5 to 0.7 mm) ephemeral streams in the southwestern United States by the equation.

$$d_s = K\ (q)^{0.24} \qquad (24)$$

where:

d_s = Depth of scour below streambed, ft (m)
K = 2.45 inch-pound units (1.32 metric units)
q = Unit water discharge, ft^3/s per ft of width (m^3/s per m of width)

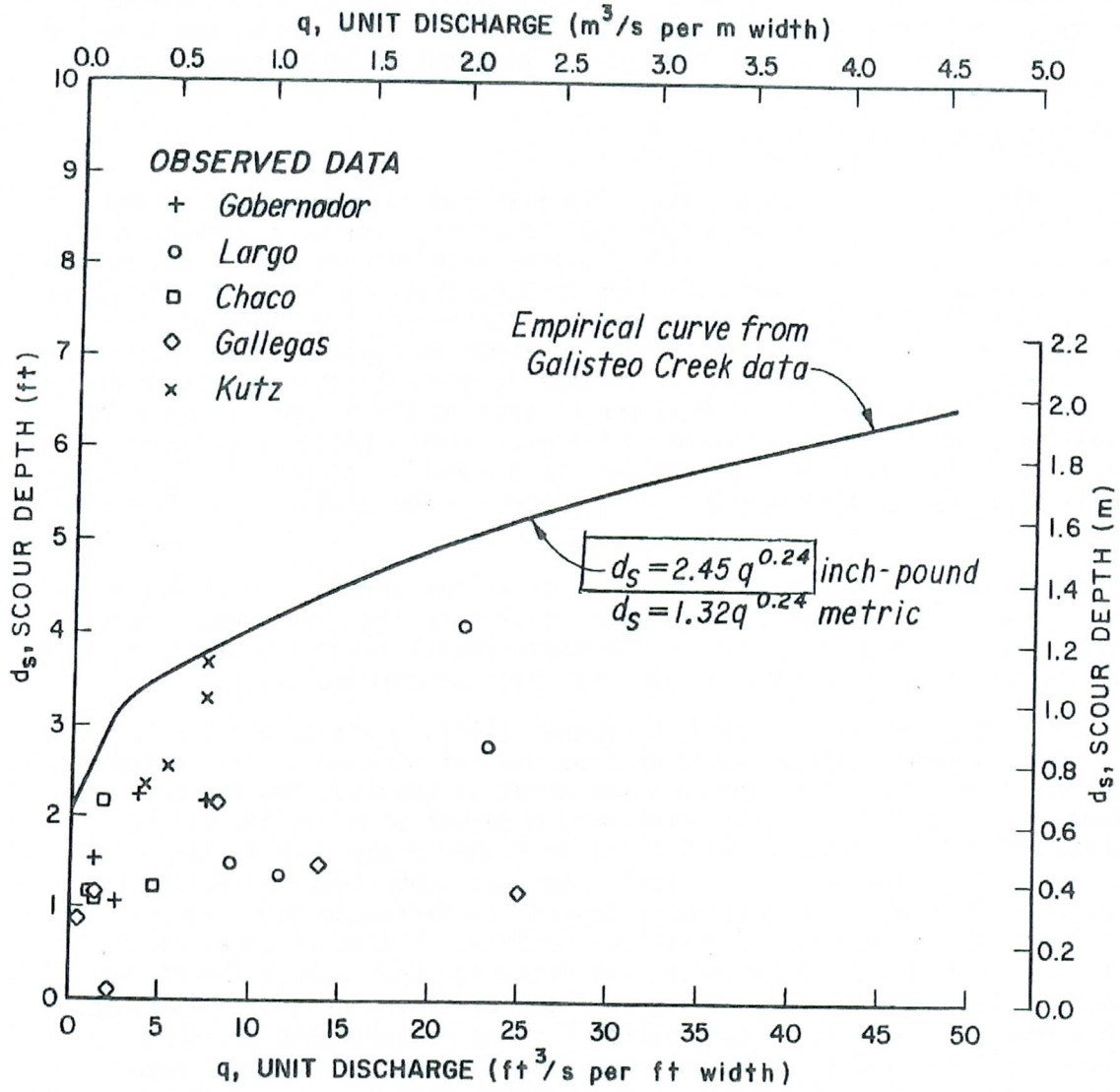


Figure 8. - Navajo Indian Irrigation Project - scour versus unit discharge.

The use of equation 24 except as a check on other methods would be limited to channels similar to those observed on relatively steep slopes ranging from 0.004 to 0.008 ft/ft (m/m). Because of shallow depths of flow and medium to coarse sand size bed material the bedload transport should also be very high.

Regime equations supported by field measurements method. - This approach as suggested by Neill (1973) on recommendations by Blench (1969) involves obtaining field measurements in an incised reach of river from which the bankfull discharge and hydraulics can be determined. From the bankfull hydraulics in the incised reach of river, the flood depths can be computed by:

$$d_f = d_i \left(\frac{q_f}{q_i}\right)^m \qquad (25)$$

where:

d_f = Scoured depth below design floodwater level
d_i = Average depth at bankfull discharge in incised reach
q_f = Design flood discharge per unit width
q_i = Bankfull discharge in incised reach per unit width
m = Exponent varying from 0.67 for sand to 0.85 for coarse gravel

This method has been expanded for Reclamation use to include the empirical regime equation by Lacey (1930) and the method of zero bed-sediment transport by Blench (1969) in the form of the Lacey equation:

$$d_m = 0.47 \left(\frac{Q}{f}\right)^{1/3} = .47 \left(\frac{q^2}{f}\right)^{\frac{1}{3}} \qquad (26)$$

where:

d_m = Mean depth at design discharge, ft (m)
Q = Design discharge, ft^3/s (m^3/s)
f = Lacey's silt factor equals $1.76 (D_m)^{1/2}$ where D_m equal mean grain size of bed material in millimeters

and the Blench equation for "zero bed factor":

$$d_{fo} = \frac{q_f^{2/3}}{F_{bo}^{1/3}} \qquad (27)$$

where:

d_{fo} = Depth for zero bed sediment transport, ft (m)
q_f = Design flood discharge per unit width, ft^3/s per ft (m^3/s per m)
F_{bo} = Blench's "zero bed factor" in ft/s^2 (m/s^2) from figure 9

The maximum natural channel scour depth for design of any structure placed below the streambed (i.e., siphon) or along the bank of a channel must

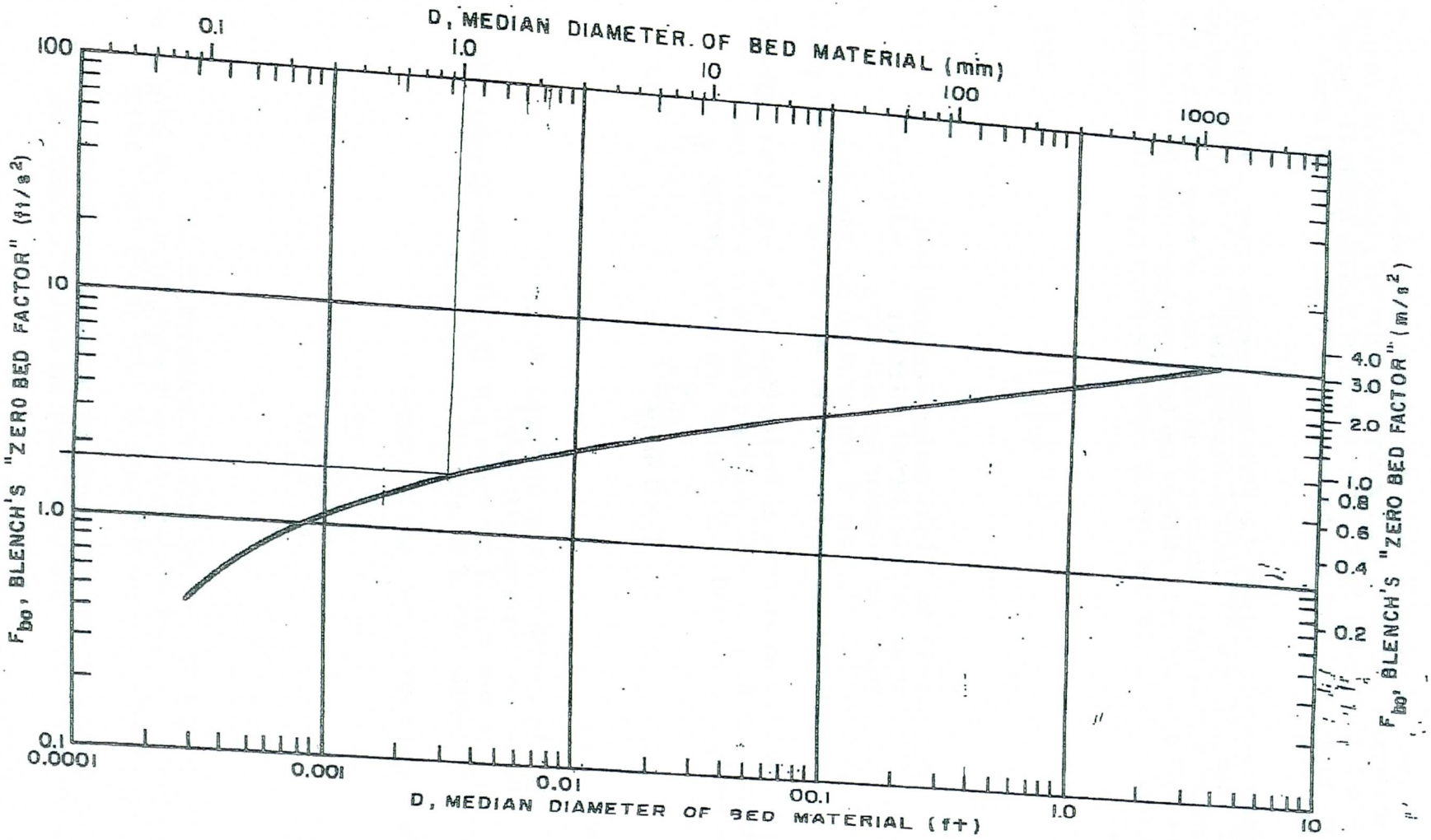


CHART FOR ESTIMATING F_{bo} (AFTER BLENCH)

Figure 9. - Chart for estimating F_{bo} (after Blench, 1969).

consider the probable concentration of floodflows in some portion of the natural channel. Equations 25, 26, or 27 for predicting this maximum depth are to be adjusted by the empirical multiplying factors, Z, shown for formula Types A and B (table 6), in table 7. An illustration of maximum scour depth associated with a flood discharge is shown in a sketch of a natural channel, figure 10. As shown in table 7 and on figure 10, the d_s equals depth of scour below streambed.

$$d_s = Z\ d_f \quad (28)$$

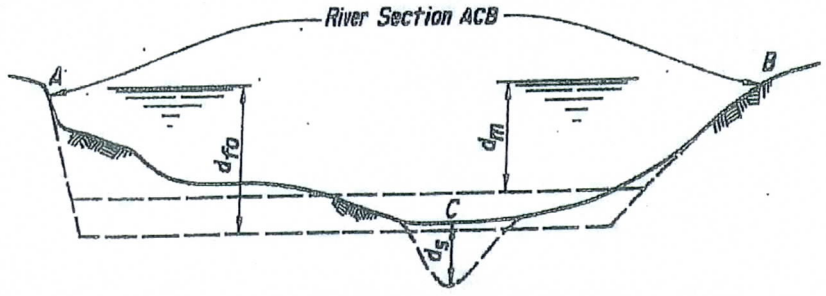
$$d_s = Z\ d_m \quad (29)$$

$$d_s = Z\ d_{fo} \quad (30)$$

Table 7. - Multiplying factors, Z, for use in scour depths by regime equations

Condition	Value of Z		
	Neill $d_s = Z\ d_f$	Lacey $d_s = Z\ d_m$	Blench $d_s = Z\ d_{fo}$
Equation Types A and B			
Straight reach	0.5	0.25	1/ 0.6
Moderate bend	0.6	0.5	
Severe bend	0.7	0.75	
Right angle bends		1.0	1.25
Vertical rock bank or wall		1.25	
Equation Types C and D			
Nose of piers	1.0		0.5 to 1.0
Nose of guide banks	0.4 to 0.7	1.50 to 1.75	1.0 to 1.75
Small dam or control across river		1.5	0.75 to 1.25

1/ Z value selected by USBR for use on bends in river.



NOTE: $d_{fo} > d_f > d_m$. Point C is low point of natural section.

Figure 10. - Sketch of natural channel scour by regime method.

and uncertainties of deep excavation that can frequently encounter groundwater.

The main advantage of the second method is the elimination of relatively deep excavation and related water control. The most frequently used material for providing adjustable toe protection is riprap placed at the toe of the bank in a weighted riprap configuration. The riprap moves downslope, as scour occurs, to form a protective cover. Figure 6.8a shows the desirable configuration for a weighted riprap toe. Other materials utilized are gabion mattresses (see Figure 6.8b). These mattresses are anchored to the bank protection and their riverward ends are allowed to lower as scour occurs. Studies by Linder (1976) and the U.S. Army Corps of Engineers (1981) on riprap toe protection arrived at the following conclusions:

1. Volume of rock in the weighted riprap toe is probably the most significant factor in determining the success of the weighted riprap toe.

2. Toe shape has a definite influence on performance. Thin toes do not release rock fast enough, which results in poor slope coverage. Thick toes release rock at a greater rate than is needed. The thickness of the recommended toe ranges from two to three times the thickness of the riprap bank protection. The recommended toe shape is shown in Figure 6.8a.

3. Complex toe designs that are difficult to construct are not necessary.

4. Downslope rock movement occurred without significant movement in the downstream direction.

5. Results from modeling and the subsequent prototypes show that the recommended weighted toe designs launch at a slope slightly steeper than 2:1.

6. Toe volume in the physical model was approximately equal to the volume needed to extend the bank protection to the maximum scour depth at a 2:1 slope. Linder (1976) recommends a toe volume equal to 1.5 times the volume of extending the bank protection to the maximum scour depth.

Weighted riprap toes have been used successfully for many years. However, success has not been universal. A common factor among the failures appears to be the presence of impinged flow on the bank. Therefore, the guidelines herein apply chiefly to flow conditions parallel to the bank. Where impinged flow is likely, then analyses must be made to determine an appropriate additional level of protection for such flow conditions.

The scour hole geometry varies with tailwater conditions with the maximum scour geometry occurring at tailwater depths less than half the culvert diameter with the maximum depth of scour (h_s) occurring at a location approximately 0.4 L_s downstream of the culvert outlet, where L_s is the length of scour.

Empirical equations defining the relationship between the culvert discharge intensity (defined on page 5-71), time, and the length, width, depth, and volume of scour hole are presented for the maximum or extreme scour case. The dimensionless scour hole geometry is shown in Figure 5.45.

Cohesionless Material: The general expression for determining scour geometry in a cohesionless soil for a circular pipe flowing full is:

$$\textit{Dimensionless Scour Geometry} = \alpha\left(\frac{Q}{g^{1/2}D^{5/2}}\right)^{\beta}\left(\frac{t}{t_o}\right)^{\theta} \qquad (5.10)$$

The values for the coefficients α_e, β, and θ, can be found in Table 5.4.

For noncircular or partly full culverts, the diameter D can be replaced by an equivalent depth, y_e:

$$y_e = (A/2)^{1/2} \qquad (5.11)$$

A is the cross sectional area of flow. Modifying Equation 5.10 to include the equivalent depth results in the general expression:

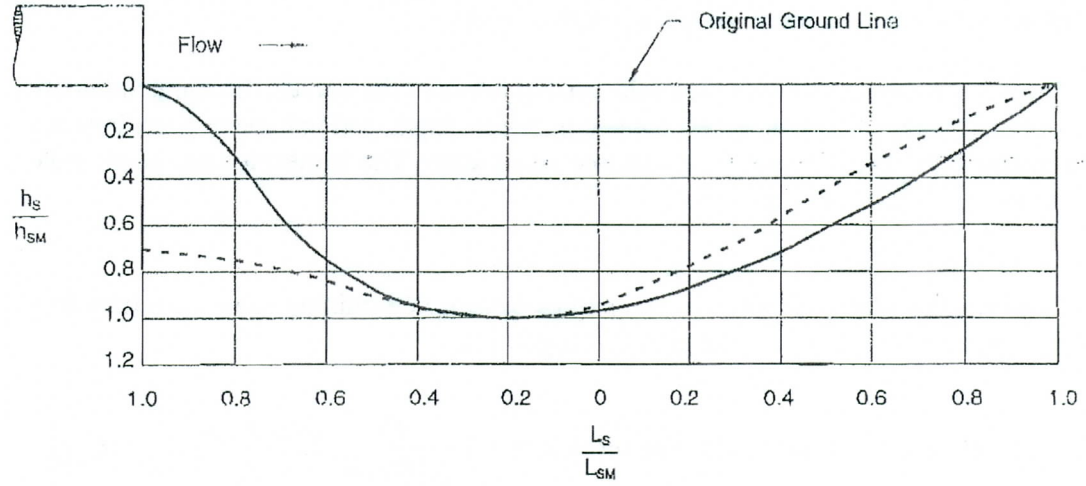
$$\textit{Dimensionless Scour Geometry} = \alpha_e\left(\frac{Q}{g^{1/2}y_e^{5/2}}\right)^{\beta}\left(\frac{t}{t_o}\right)^{\theta} \qquad (5.12)$$

where:

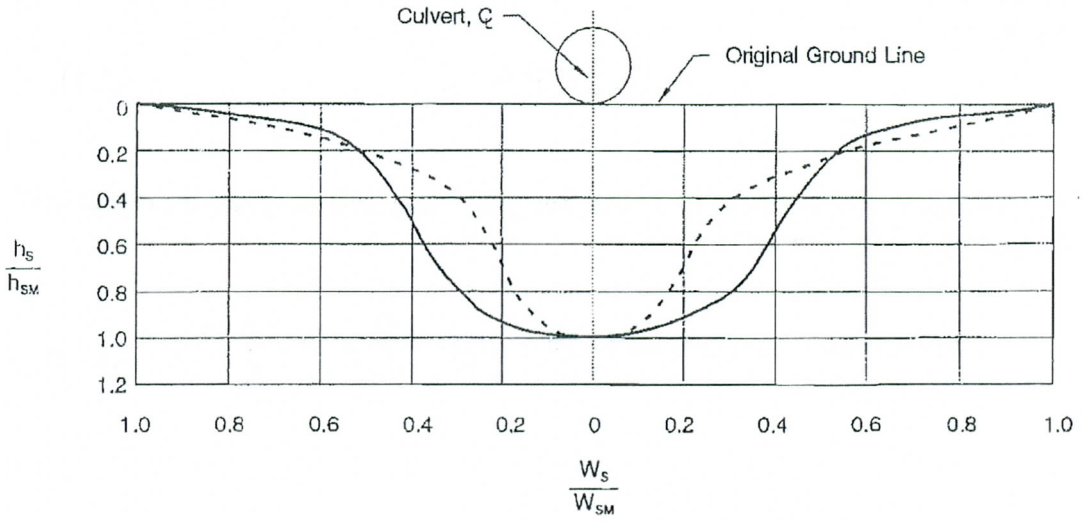
$$\alpha_e = \alpha\,0.63^{(2.5\beta-1)} \quad \textit{for } h_s,\ W_s, \textit{ and } L_s \qquad (5.13)$$

$$\alpha_e = \alpha\,0.63^{(2.5\beta-3)} \quad \textit{for } V_s \qquad (5.14)$$

Dimensionless Centerline Profile



Dimensionless Cross Section at 0.4 L_{SM}



Legend:

h_S = Depth of scour
h_{SM} = Maximum depth of scour
W_S = Width of scour
W_{SM} = Maximum width of scour
L_S = Length of scour
L_{SM} = Maximum length of scour
——— Maximum Tailwater
- - - - - Minimum Tailwater

Figure 5.45
Dimensionless Scour Hole Geometry

Table 5.4
Experimental Coefficients for Culvert Outlet Scour
(USDOT, FHWA, HEC-14, 1983)

Material	Nominal Grain Size d_{50}, mm	Scour Equation (below)	Depth, h_s				Width, W_s				Length, L_s				Volume, V_s			
			α	β	θ	α_e	α	β	θ	α_e	α	β	θ	α_e	α	β	θ	α_e
Uniform Sand	0.20	V-1 or V-2	2.72	0.375	0.10	2.79	11.73	0.92	0.15	6.44	16.82	0.71	0.125	11.75	203.36	2.0	0.375	80.71
Uniform Sand	2.0	V-1 or V-2	1.86	0.45	0.09	1.76	8.44	0.57	0.06	6.94	18.28	0.51	0.17	16.10	101.48	1.41	0.34	79.62
Graded Sand	2.0	V-1 or V-2	1.22	0.85	0.07	0.75	7.25	0.76	0.06	4.78	12.77	0.41	0.04	12.62	36.17	2.09	0.19	12.94
Uniform Gravel	8.0	V-1 or V-2	1.78	0.45	0.04	1.68	9.13	0.62	0.08	7.08	14.36	0.95	0.12	7.61	65.91	1.86	0.19	12.15
Graded Gravel	8.0	V-1 or V-2	1.49	0.50	0.03	1.33	8.76	0.89	0.10	4.97	13.09	0.62	0.07	10.15	42.31	2.28	0.17	32.82
Cohesive Sandy Clay 60% Sand PI 15	0.15	V-1 or V-2	1.86	0.57	0.10	1.53	8.63	0.35	0.07	9.14	15.30	0.43	0.09	14.78	79.73	1.42	0.23	61.84
Clay PI 5-16	Various	V-3 or V-4	0.86	0.18	0.10	1.37	3.55	0.17	0.07	5.63	2.82	0.33	0.09	4.48	0.62	0.93	0.23	2.48

Equations

V-1. **For Circular Culverts.** Cohesionless material or the 0.15mm cohesive sandy clay:

$$\left[\frac{h_s}{D}, \frac{W_s}{D}, \frac{L_s}{D}, \text{or } \frac{V_s}{D^3}\right] = \alpha\left(\frac{Q}{\sqrt{g}\,D^{5/2}}\right)^{\beta}\left(\frac{t}{t_o}\right)^{\theta}$$

where t_o = 316 min.

V-2. **For Other Culvert Shapes.** Same material as above:

$$\left[\frac{h_s}{y_e}, \frac{W_s}{y_e}, \frac{L_s}{y_e}, \text{or } \frac{V_s}{y_e^3}\right] = \alpha_e\left(\frac{Q}{\sqrt{g}\,y_e^{5/2}}\right)^{\beta}\left(\frac{t}{t_o}\right)^{\theta}$$

where t_o = 316 min.

V-3. **For Circular Culverts.** Cohesive sandy clay with PI = 5-16:

$$\left[\frac{h_s}{D}, \frac{W_s}{D}, \frac{L_s}{D}, \text{or } \frac{V_s}{D^3}\right] = \alpha\left(\frac{\rho V^2}{\tau_c}\right)^{\beta}\left(\frac{t}{t_o}\right)^{\theta}$$

where t_o = 316 min.

V-4. **For Other Culvert Shapes.** Cohesive sandy clay with PI = 5-16:

$$\left[\frac{h_s}{y_e}, \frac{W_s}{y_e}, \frac{L_s}{y_e}, \text{or } \frac{V_s}{y_e^3}\right] = \alpha_e\left(\frac{\rho V^2}{\tau_c}\right)^{\beta}\left(\frac{t}{t_o}\right)^{\theta}$$

where t_o = 316 min.

Gradation: The cohesionless bed materials presented in Table 5.4 are categorized as either uniform (U) or graded (G). The grain size distribution is determined by performing a sieve analysis (ASTM DA22-63). The standard deviation (σ) is computed as:

$$\sigma = (d_{84}/d_{16})^{1/2} \tag{5.15}$$

where the values of d_{84} and d_{16} are extracted from the grain size distribution. If $\sigma \leq 1.5$, the material is considered to be uniform; if $\sigma > 1.5$, the material is classified as graded.

Cohesive Soils: If the cohesive soil is a sandy clay similar to the one tested at Colorado State University by Abt, et al, Equations 5.10 or 5.12 and the appropriate coefficients in Table 5.4 can be used to estimate the scour hole dimensions. The sandy clay tested had 58 percent sand, 27 percent clay, 15 percent silt, and 1 percent organic matter; had a mean grain size of 0.15 mm, and had a plasticity index (PI) of 15.

Since Equations 5.10 and 5.12 do not include soil characteristics, they can only be used for soils similar to the ones tested. Shear number expressions, that related scour to the critical shear stress of the soil, were derived to have a wider range of applicability for cohesive soils besides the one specific sandy clay that was tested.

The shear number expressions for circular culverts are:

$$h_s/D,\ W_s/D,\ L_s/D,\ or\ V_s/D^3 = \alpha(\rho V^2/\tau_c)^{\beta}(t/t_o)^{\theta} \tag{5.16}$$

and for other shaped culverts:

$$h_s/y_e,\ W_s/D,\ L_s/y_e,\ or\ V_s/y_e^3 = \alpha_e(\rho V^2/\tau_c)^{\beta}(t/t_o)^{\theta} \tag{5.17}$$

where:

$$\alpha_e = \alpha/(0.63) \quad for\ h_s,\ W_s,\ and\ L_s \tag{5.18}$$

$$\alpha_e = \alpha/(0.63)^3 \quad for\ V_s \tag{5.19}$$

The values of the coefficients α, β, θ and α_e in Equations 5.16 and 5.17 are presented in Table 5.4.

The critical tractive shear stress is defined as:

$$\tau_c = 0.001(S_v + 180)\ \tan(30 + 1.73PI) \qquad (5.20)$$

where S_v is the saturated shear strength in pounds per square inch and PI is the Plasticity Index from the Atterberg limits.

It is recommended that Equations 5.16 and 5.17 be limited to sandy clay soils with a plasticity index of 5 to 16.

Time of Scour: The time of scour is estimated based upon a knowledge of peak flow duration. Lacking this knowledge, it is recommended that a time of 30 minutes be used in Equations 5.10, 5.12, 5.16, and 5.17. The tests indicate that approximately two-thirds to three-fourths of the maximum scour occurs in the first 30 minutes of the flow duration.

It should be noted that the exponents for the time parameter in Table 5.4 reflect the relatively flat part of the scour-time relationship and are not applicable for the first 30 minutes of the scour process.

Headwalls: Installation of headwalls flush with the culvert outlet moves the scour hole downstream. However, the magnitude of the scour geometries remain essentially the same as for the case without the headwall. The headwall should extend to a depth equal to the maximum depth of scour.

Summary: The prediction equations presented in this section are intended to serve along with field reconnaissance as guidance for determining the need for energy dissipators at culvert outlets. Remember that the equations assume that grade control exists whether it be manmade or natural, and do not include long-term channel degradation of the downstream channel. The equations are based on tests which were conducted to determine maximum scour for the given condition and therefore represent what might be termed worst case scour geometries. The procedure presented is from *Hydraulic Design of Energy Dissipators for Culverts and Channels* (USDOT, FHWA, HEC-14, 1983).

5.3.3.2 Scour Hole Geometry Calculation Procedures:

For Cohesionless and Cohesive Soils:

1. Using the appropriate methodology from Volume I, Hydrology, perform a hydrologic analysis of the drainage path in which the culvert is located or is to be placed. Estimate the magnitude and duration of the peak discharge. Express the discharge in cfs and the duration in minutes then determine the discharge intensity and equivalent depth.

The discharge intensity is:

$$D.I. = Q/(g^{1/2}D^{5/2}) \qquad \text{Circular culverts flowing full}$$

$$D.I. = Q/(g^{1/2}y_e^{5/2}) \qquad \text{for other shapes}$$

where Equation 5.11 is used to determine the equivalent depth:

$$y_e = (A/2)^{1/2}$$

For Cohesionless Materials, or 0.15mm Sandy Clay:

2. Compute the discharge intensity when the culvert is flowing at the peak discharge.

3. Determine scour coefficients from Table 5.4.

4. Use Equation 5.10 or 5.12 to compute the scour hole dimensions with t_o=316:

$$h_s/D,\ W_s/D,\ L_s/D,\ or\ V_s/D^3 = \alpha\left(\frac{Q}{g^{1/2}D^{5/2}}\right)^{\beta}\left(\frac{t}{316}\right)^{\theta}$$

$$h_s/y_e,\ W_s/y_e,\ L_s/y_e,\ V_s/y_e^3 = \alpha_e\left(\frac{Q}{g^{1/2}y_e^{5/2}}\right)^{\beta}\left(\frac{t}{316}\right)^{\theta}$$

For Other Cohesive Materials with PI From 5 to 16:

2. a. Compute the culvert outlet velocity in ft/sec.

   b. Obtain a soil sample at the proposed culvert location.

   c. Perform Atterberg limits tests and determine the plasticity index, PI (ASTM D423-36).

   d. Saturate a sample and perform an unconfined compressive test (ASTM D211-66-76) to determine the saturated shear stress, S_v, lb/in^2.

e. Compute the critical tractive shear strength, τ_c, from Equation 5.20.

f. Compute the modified shear number, Sn_{mod} ($\rho V^2/\tau_c$).

3. Determine scour coefficients from Table 5.4.

4. Use equation 5.16 or 5.17 to compute the desired scour hole dimensions, use t_o = 316 minutes.

For circular culverts:

$$h_s/D,\ W_s/D,\ L_s/D,\ or\ V_s/D^3 = \alpha(\rho V^2/\tau_c)^{\beta}\ (t/316)^{\theta}$$

or, for noncircular culverts:

$$h_s/y_e,\ W_s/y_e,\ L_s/y_e,\ or\ V_s/y_e^3 = \alpha_e(\rho V^2/\tau_c)^{\beta}\ (t/316)^{\theta}$$

Two example problems on the computation of the geometry of the scour hole are presented in the next section. The example problems are from HEC-14 (USDOT, FHWA, 1983).

5.3.3.3 Example Scour Hole Calculations for Cohesionless Material: Determine the scour geometry—maximum depth, width, length and volume of scour—for a proposed circular 30-inch C.M.P. discharging an estimated 50 cfs when flowing full. The downstream channel is composed of a graded gravel material.

1. The duration of the peak discharge of 50 cfs is not known. Therefore, a peak flow duration of 30 minutes will be estimated.

2. The circular, 30-inch C.M.P. at 50 cfs will have a discharge intensity of

$$D.I. = 50 / (g^{1/2}\ (30/12)^{5/2}) = 50 / ((5.67)(2.5)^{5/2}) = \underline{0.89}$$

3. The coefficients of scour obtained from Table 5.4 are:

	α	β	θ
Depth of Scour	1.49	0.50	0.03
Width of Scour	8.76	0.89	0.10
Length of Scour	13.09	0.62	0.07
Volume of Scour	42.31	2.28	0.17

4. Using Equation 5.10 with t_o = 316 minutes, the scour hole dimensions are:

   $h_s/D, W_s/D, L_s/D$, or $V_s/D^3 = \alpha\,(Q/g^{1/2}\,D^{5/2})^{\beta}\,(t/316)^{\theta}$

   Depth: $h_s/D = 1.49\,(0.89)^{0.50}\,(0.09)^{0.03}$

   $h_s = (1.31)(2.5) = \underline{3.28\ ft}$

   Width: $W_s/D = 8.76\,(0.89)^{0.89}\,(0.09)^{0.10}$

   $W_s = (6.21)(2.5) = \underline{15.5\ ft}$

   Length: $L_s/D = 13.09\,(0.89)^{0.62}\,(0.09)^{0.07}$

   $L_s = (10.29)(2.5) = \underline{25.72\ ft}$

   Volume: $V_s/D^3 = 42.31\,(0.89)^{2.28}\,(0.09)^{0.17}$

   $V_s = (21.54)(15.63) = \underline{336.67\ ft^3}$

5. Using Figure 5.45, the location of the maximum scour is defined as occuring at:

   $0.4(L_s) = 0.4\,(25.72) = \underline{10.3\ ft}$ downstream of the culvert outlet.

5.3.3.4 Example Scour Hole Calculations for a Cohesive Material: Determine the scour geometry, maximum depth, width, length, and volume of scour for an existing circular 24-inch C.M.P. discharging an estimated 40 cfs when flowing full. The downstream channel is composed of a sandy-clay material.

1. The duration of the peak discharge of 40 cfs is not known. Therefore, a peak flow duration of 30 minutes will be estimated.

2. a. The average velocity at the culvert outlet is:

   $V = Q/A = 40.0/3.14 = \underline{12.74\ fps}$

   b-e. The sandy-clay material was tested and found to have a PI of 12 and a saturated shear strength (S_v) of 240 psi. The critical tractive shear can be estimated by substituting into Equation 5.20.

   $\tau_c = 0.001(240 + 180)\tan(30 + 1.73(12))$

$\tau_c = 0.001(420) \tan(50.76) = \underline{0.51\ lb/ft^2}$

f. The modified shear number $Sn_{mod} = (\rho V^2/\tau_c)$ is:

$Sn_{mod} = 1.94\ (12.74)^2/0.51 = \underline{617.4}$

3. The experimental coefficients α, β, θ from Table 5.4 are:

	α	β	θ
Depth	0.86	0.18	0.10
Width	3.55	0.17	0.07
Length	2.82	0.33	0.09
Volume	0.62	0.93	0.23

4. Using Equation 5.16 with $t_o = 316$ minutes, the scour hole dimensions are:

$h_s/D, W_s/D, L_s/D$, or $V_s/D^3 = \alpha\ (\rho V^2/\tau_c)^\beta\ (t/316)^\theta$

Depth: $h_s/D = 0.86\ (617.4)^{0.18}\ (0.09)^{0.10}$

$h_s = (2.14)(2) = \underline{4.30\ ft}$

Width: $W_s/D = 3.55\ (617.4)^{0.17}\ (0.09)^{0.07}$

$W_s = (8.94)(2) = \underline{17.9\ ft}$

Length: $L_s/D = 2.82\ (617.4)^{0.33}\ (0.09)^{0.09}$

$L_s = (18.92)(2) = \underline{37.8\ ft}$

Volume: $V_s/D^3 = 0.62\ (617.4)^{0.93}\ (0.09)^{0.23}$

$V_s = (140.3)(8) = \underline{1122.5\ ft^3}$

5. Location of maximum depth of scour (Figure 5.45)

$0.4\ L_s = 0.4(37.8) = \underline{15.1\ ft}$ downstream of culvert outlet.

5.3.4 Protection at Culvert Outlets

5.3.4.1 Riprap Apron: Riprap aprons placed downstream of culverts provide protection against scour immediately around the culvert as well as providing for the uniform spreading of the flow and decreasing the flow velocity, thus mitigating downstream damages.

These riprap aprons may be designed as simple horizontal aprons as shown in Figure 5.46, with tapered sides of 2:1 for minimum tailwater and 5:1 for maximum tailwater. Minimum tailwater is assumed when the tailwater depth is less than half the culvert height. Maximum tailwater is assumed when the tailwater depth is greater than half the culvert height.

A simplified approach for providing protection downstream of culverts is presented in the next two sections. For more thorough methods see Section 7.4.

5.3.4.2 Riprap Apron Dimension Design Procedures:

1. The length of the apron (L_a) is determined using the following empirical relationships that were developed for the U.S. Environmental Protection Agency (1976):

$$L_a = \frac{1.8Q}{D^{3/2}} + 7D \quad for\ TW < \frac{D}{2} \tag{5.21}$$

and:

$$L_a = \frac{3Q}{D^{3/2}} + 7D \quad for\ TW > \frac{D}{2} \tag{5.22}$$

where D is the maximum inside culvert width (ft), Q is the pipe discharge (cfs), and TW is the tailwater depth (ft).

2. Where there is no well defined channel downstream of the apron, the width, W_a, of the outlet and of the apron (as shown in Figure 5.46) should be as follows:

$$W_a = 3D + 0.4L_a \quad for\ TW \geq \frac{D}{2} \tag{5.23}$$

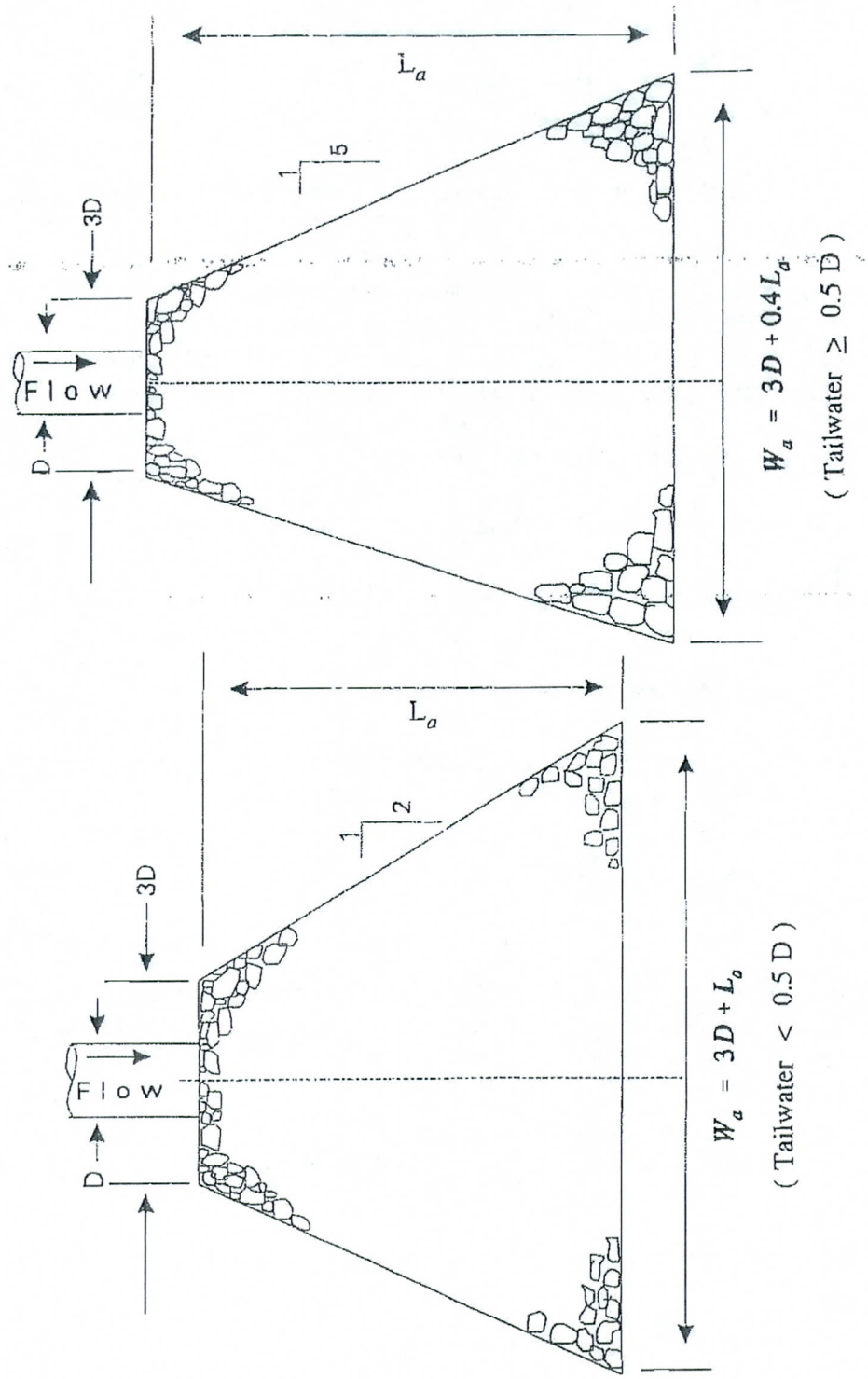


Figure 5.46
Configuration of Conduit Outlet Protection
(U.S. EPA, 1976)

and:

$$W_a = 3D + L_a \quad for\ TW < \frac{D}{2} \tag{5.24}$$

The width of the apron at the culvert outlet should be at least 3 times the culvert width.

3. Where there is a well-defined channel downstream of the apron, the bottom width of the apron should be at least equal to the bottom width of the channel and the lining should extend at least one foot above the tailwater elevation and at least two-thirds of the vertical conduit dimension above the invert.

4. The side slopes should be 2:1 or flatter.

5. The bottom grade should be level.

6. There should be overfall at the end of the apron or culvert.

5.3.4.3. Riprap Apron Stone Size:

1. The median stone diameter (d_{50}) is determined from the following equation:

$$d_{50} = \frac{0.02(Q)^{4/3}}{TW(D)} \tag{5.25}$$

2. Existing scour holes may be used where flat aprons are impractical. Figure 5.47 shows the general design of a scour hole. The stone diameter is determined using the following equations:

$$d_{50} = \frac{0.0125(Q)^{4/3}}{TW(D)} \quad for\ y_s = \frac{D}{2} \tag{5.26}$$

also,

$$d_{50} = \frac{0.0082(Q)^{4/3}}{TW(D)} \quad for\ y_s = D \tag{5.27}$$

where y_s is the depth of the scour hole below the culvert invert. If the depth of scour isn't known it can be determined using the procedures in Section 5.3.3.1.

3. The other riprap or gabion requirements are as indicated in Chapter 6 for channel linings.

4. Filter fabric or granular bedding shall be provided under riprap or gabion apron protection.

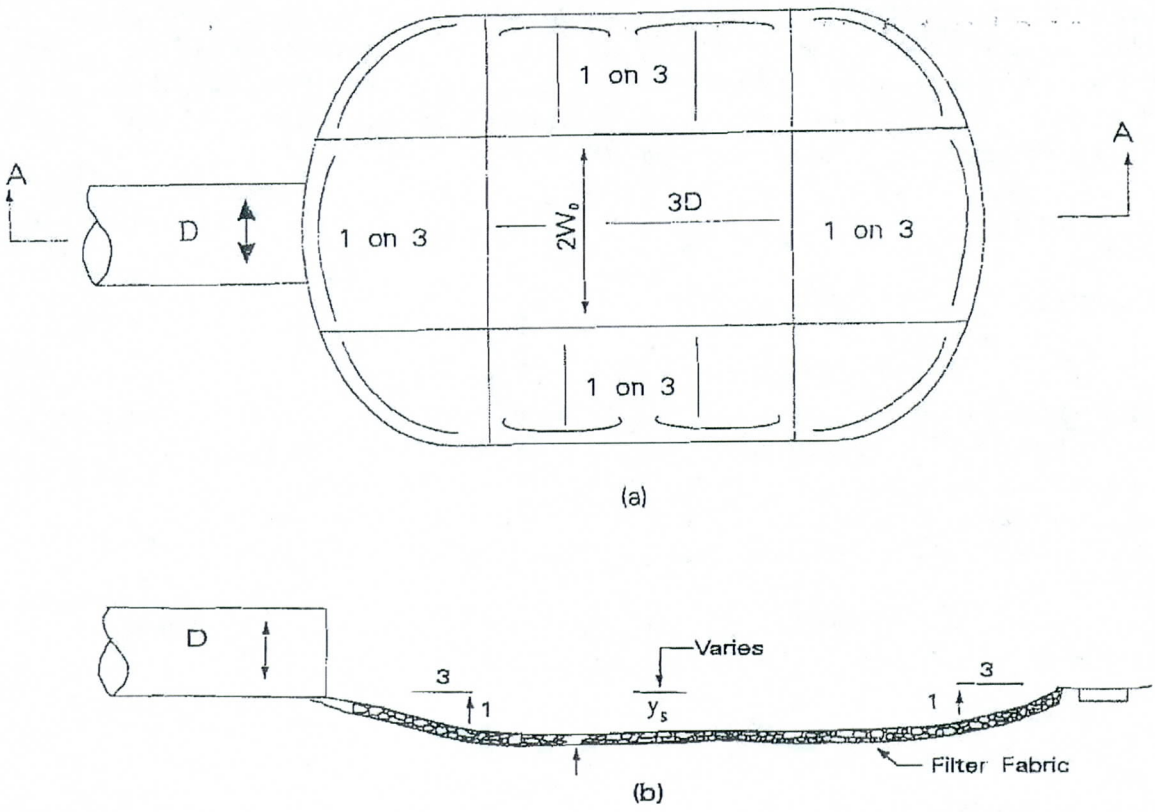


Figure 5.47
Preformed Scour Hole (a) plan and (b) section
(ASCE, 1975)

5.4 Inverted Siphons

5.4.1 General

Because of the resulting physical conditions, inverted siphons are rarely used in urban drainage; however, due to the flat topography and a large number of canals in Maricopa County, the designer may have to consider using an inverted siphon.

Inverted siphons are used to convey water by gravity under canals, roads, railroads, other structures, and depressions. An inverted siphon is a closed conduit designed to run full and under pressure. When flowing at design capacity, the structure should operate without excess head.

For canal structures, inverted siphons are economical, easily designed and built, and have proven to be a reliable means of water conveyance. However, because of sediment and debris present in stormwater, maintenance can be a significant negative factor. In addition, canals run more or less continually and can be drained between periods of use, but inverted siphons for stormwater do not operate on a regular cycle. If water is left to stand, significant health hazards could result. Inverted siphons shall be considered only when permitted by the jurisdictional agency.

5.4.2 Design Criteria

All pipe should be designed for water-tight joints. Velocity in the conduit should be a minimum of 5.0 fps to prevent sedimentation. The minimum cover over the conduit should exceed 3.0 feet. Inlet and outlet structures are required, and the facility shall meet the requirements for safety described in Section 5.2.2.12. Pipe collars and blow-off structures may be required as determined by the jurisdictional agency. Air vents, after the entrance, should be used unless the agency agrees with eliminating the vents.

At a minimum, the designer should compute losses for the entrance and outlet (including trash racks), pipe friction, and losses at bends and transitions.

5.4.3 Design Procedure

A design procedure and design examples are contained in *Design of Small Canal Structures* (USBR 1974). Taking into consideration conditions that are more specific to urban drainage described before, this publication can be used for most applications in Maricopa County.

Raju Shah

From: Richard M. Waskowsky - FCDX [rmw@mail.maricopa.gov]
Sent: Tuesday, June 23, 2009 3:03 PM
To: Raju Shah
Cc: Angie Hardesty - FCDX
Subject: RE: Revised calcs - South McMicken Outlet Wash Crossing

Raj,

Thanks for sending the revisions. The numbers look good. Please use the results with the 10-year event for the Neill general scour. The only thing I saw was that some of the headings do not match what is shown in the spreadsheet. For example, "Top Width" is shown where the average width is now used. In the final submittal, please make sure the headings match.

Thanks again,
Richard

From: Raju Shah [mailto:RShah@prestigeengineering.com]
Sent: Tuesday, June 23, 2009 11:41 AM
To: Richard M. Waskowsky - FCDX
Cc: Angie Hardesty - FCDX
Subject: RE: Revised calcs - South McMicken Outlet Wash Crossing

Richard:
You are correct. I did find a 10-yr event in the HEC-RAS model so, it was very quick to run it and get the info to compare. Please see attached calcs and RAS model.

I think it takes care of items 1 through 5. Let me know if you have any further questions.

Thxs.

Raj Shah, P.E.
Prestige Engineering Consultant, LLC
3404 W. Cheryl Dr, Suite A170
Phoenix, AZ 85051
(602) 978 3355 X-101
(602) 999 6635 Cell

From: Richard M. Waskowsky - FCDX [mailto:rmw@mail.maricopa.gov]
Sent: Monday, June 22, 2009 4:49 PM
To: Raju Shah
Cc: Angie Hardesty - FCDX
Subject: RE: Revised calcs - South McMicken Outlet Wash Crossing

Hi Raj,

Thanks for sending the revisions. Comments 1, 3 and 4 look good. However, for the Neill general scour, I noticed a couple of things.

1) The bankfull discharge can be taken as the 10-year event.
2) The D50 values are different (for upstream and downstream) when it appears that they should be the same. However, the D50 is not used in the Neill equation and can be removed from the spreadsheet.

3) In the downstream calculation, the reach type is still marked as a severe bend when the Z-factor for a straight reach is used. The reach type should match the z-factor.
4) Some of the hydraulic variables do not match the HEC-RAS model. For example, the hydraulic depth at cross-section 1673.921 is given as 6.09 feet while in the HEC-RAS model the hydraulic depth is 7.09 feet.
5) To find the unit flow rate, an average width is better because sometimes the top width becomes too large when there is wide shallow overbank flow. The average width can be found with the flow area divided by the max flow depth.

If you have any questions, please let me know.

Thanks again,
Richard

From: Raju Shah [mailto:RShah@prestigeengineering.com]
Sent: Monday, June 22, 2009 2:47 PM
To: Richard M. Waskowsky - FCDX
Cc: Angie Hardesty - FCDX; Jeff Minch
Subject: Revised calcs - South McMicken Outlet Wash Crossing

Richard:
Please see attached calculations revised per your comment.

1) For the long-term scour, the 100-year flow rate should be used in the calculation.
Answer: We changed the flow rate to 6,500 cfs for 100-yr flow.
2) For general scour, only the Neill equation should be used. The other equations can be removed and all the variables for the Neill equation should be shown in the spreadsheet. Also, there may be an error in the averaging in the downstream general scour spreadsheet.
Answer: Only Neill's equation is used. All other variables removed. The averaging at d/s general scour corrected.
3) In the downstream bedform scour calculations, the heading for the dune height is incorrect.
Answer: Downstream Bedform scour heading changed to match upstream Bedform scour.
4) In the launchable calculations, the slope to calculate the launch volume can be 2:1, rather than 3:1 (from the 1996 FCD Hydraulics Manual, page 6-52).
Answer: Modified calcs to reflect 2:1 slope.

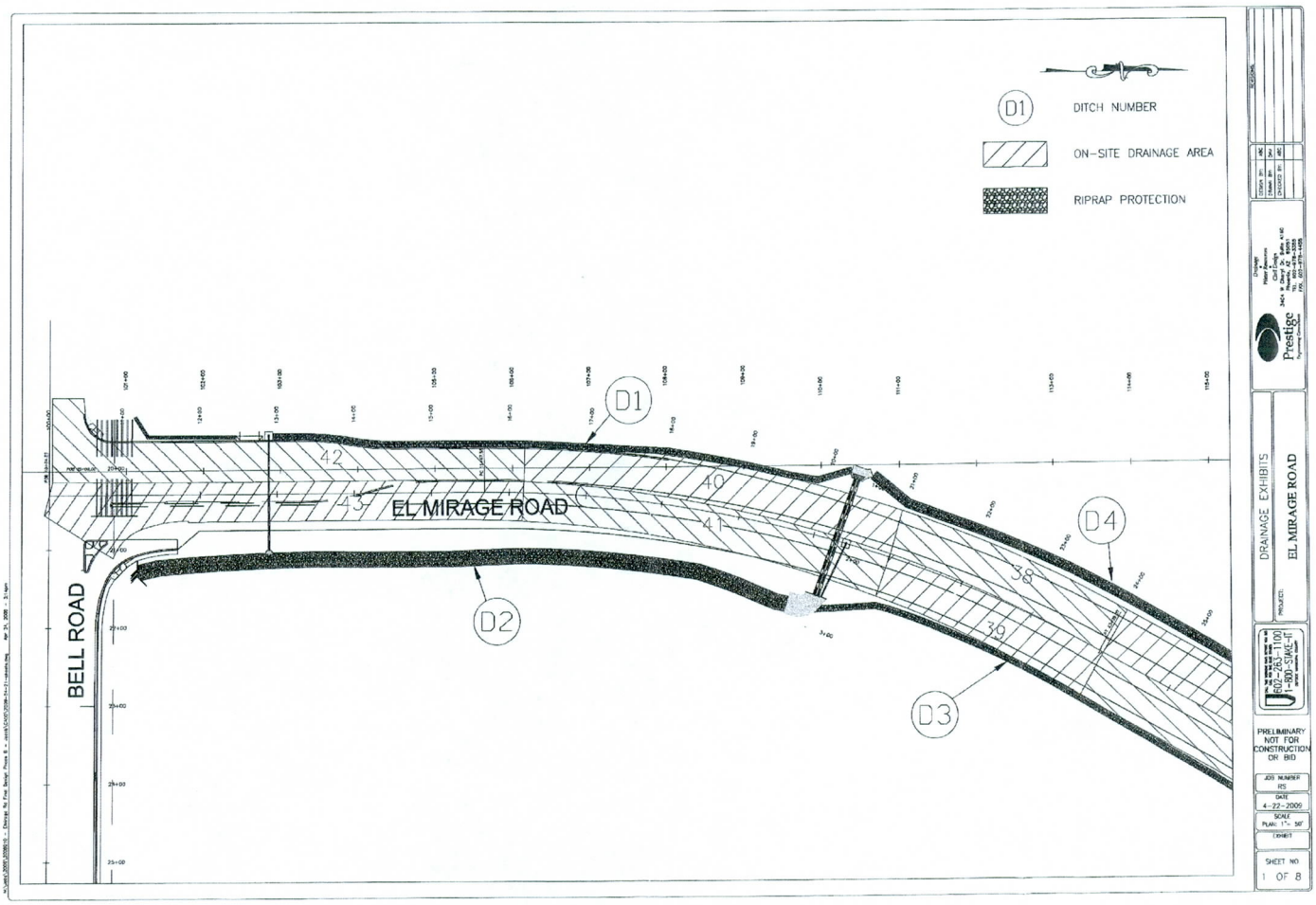
See attached calculations and let me know if you have additional questions.

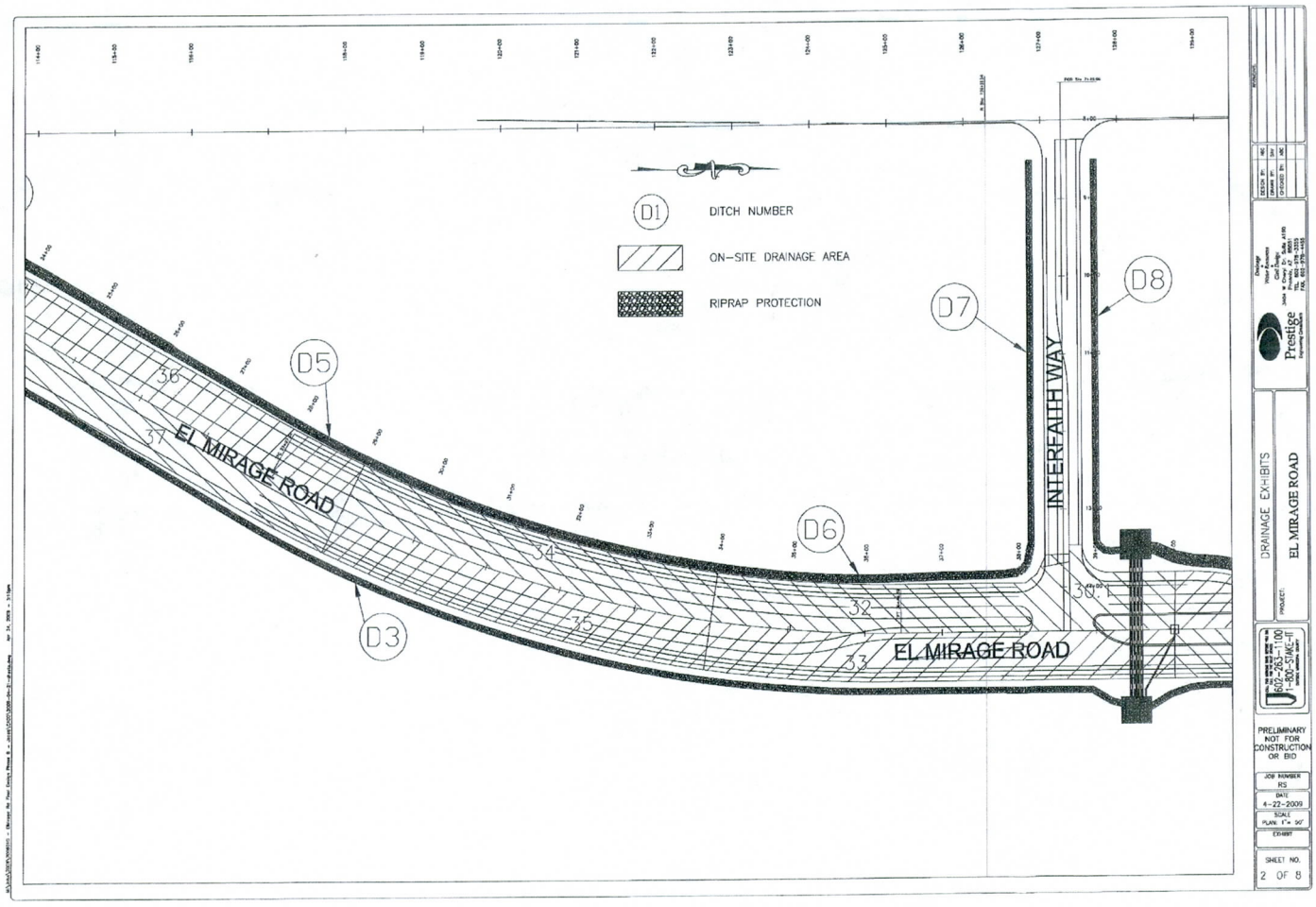
Thxs.

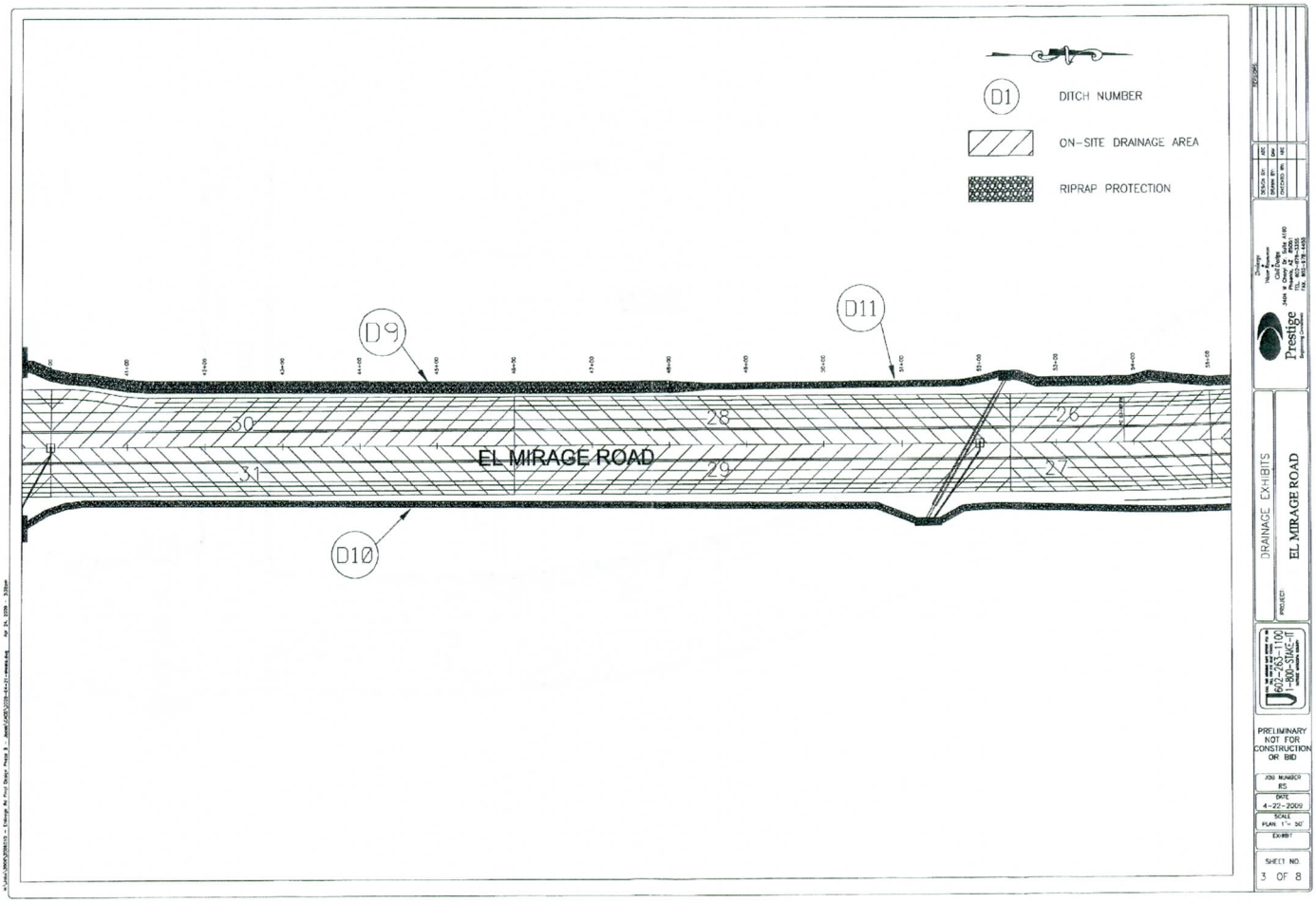
Raj Shah, P.E.
Prestige Engineering Consultant, LLC
3404 W. Cheryl Dr, Suite A170
Phoenix, AZ 85051
(602) 978 3355 X-101
(602) 999 6635 Cell

APPENDIX G

ONSITE SUB-BASIN DRAINAGE AREA EXHIBITS


D1
DITCH NUMBER
ON-SITE DRAINAGE AREA
RIPRAP PROTECTION
EL MIRAGE ROAD
BELL ROAD
D1
D2
D3
D4
42
43
40
41
38
39
DRAINAGE EXHIBITS
EL MIRAGE ROAD
PRELIMINARY
NOT FOR
CONSTRUCTION
OR BID
SHEET NO.
1 OF 8


D1
DITCH NUMBER
ON-SITE DRAINAGE AREA
RIPRAP PROTECTION
D3
D5
D6
D7
D8
INTERFAITH WAY
EL MIRAGE ROAD
EL MIRAGE ROAD
36
37
34
35
32
33
30.1
DRAINAGE EXHIBITS
EL MIRAGE ROAD
PRELIMINARY
NOT FOR
CONSTRUCTION
OR BID
JOB NUMBER
RS
DATE
4-22-2009
SCALE
PLAN: 1"= 50'
EXHIBIT
SHEET NO.
2 OF 8



DRAINAGE EXHIBITS

EL MIRAGE ROAD

PRELIMINARY NOT FOR CONSTRUCTION OR BID

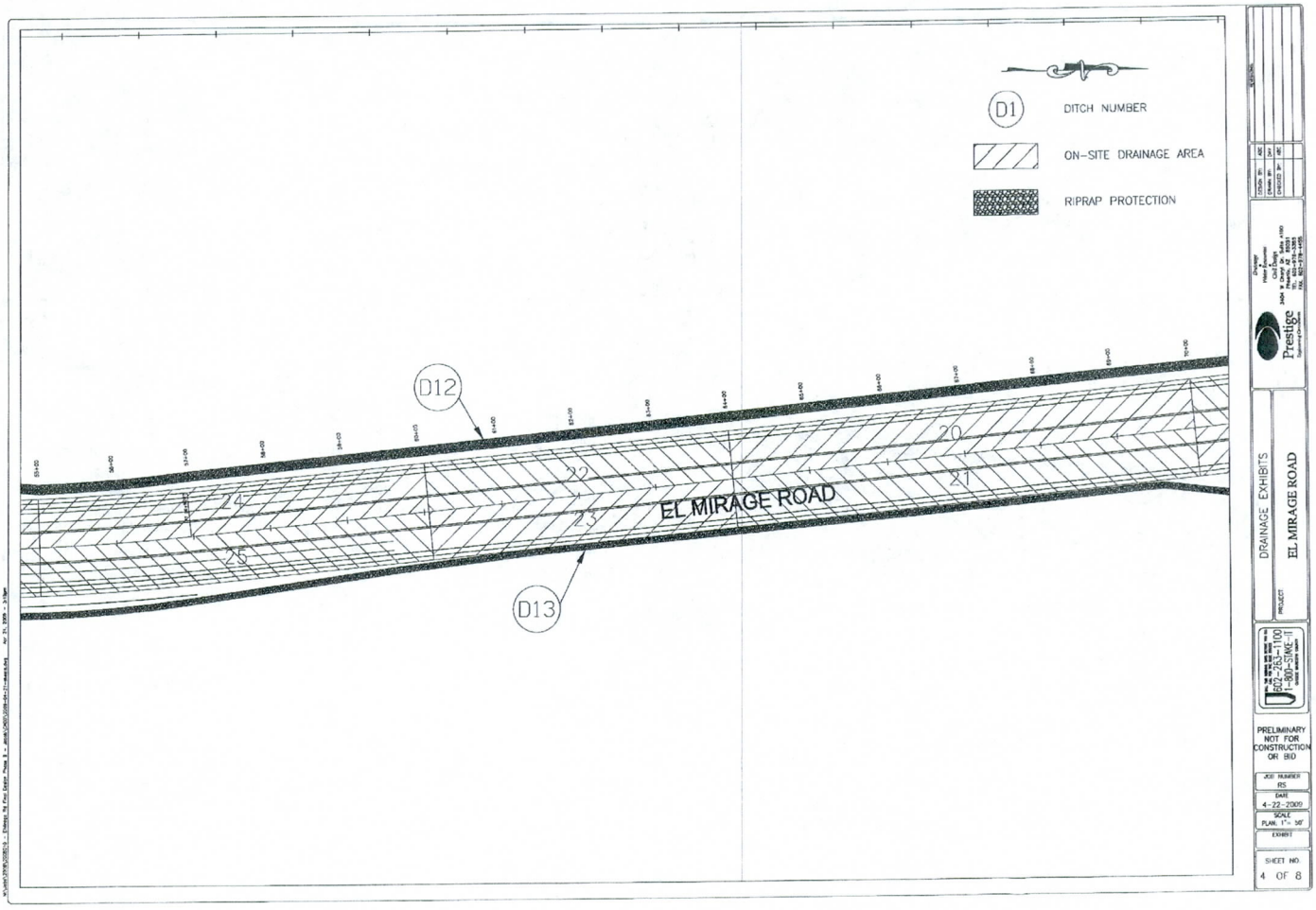
JOB NUMBER 85

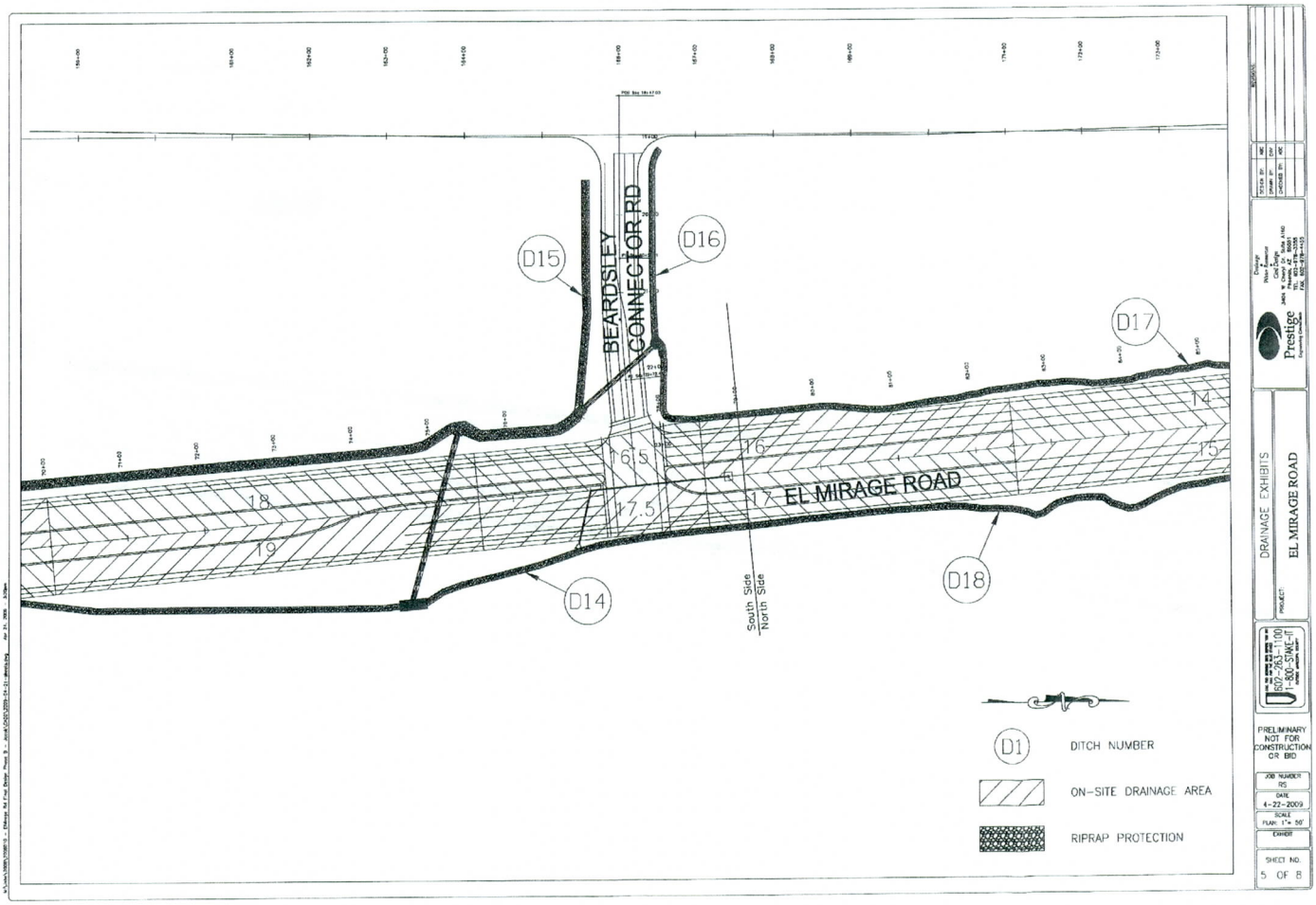
DATE 4-22-2009

SCALE PLAN 1"= 50'

EXHIBIT

SHEET NO. 3 OF 8


D1
DITCH NUMBER
ON-SITE DRAINAGE AREA
RIPRAP PROTECTION
D12
D13
EL MIRAGE ROAD
20
21
22
23
24
25
DRAINAGE EXHIBITS
PROJECT
EL MIRAGE ROAD
PRELIMINARY
NOT FOR
CONSTRUCTION
OR BID
JOB NUMBER
05
DATE
4-22-2009
SCALE
PLAN 1"= 50'
EXHIBIT
SHEET NO.
4 OF 8



DRAINAGE EXHIBITS

PROJECT: EL MIRAGE ROAD

Prestige

PRELIMINARY NOT FOR CONSTRUCTION OR BID

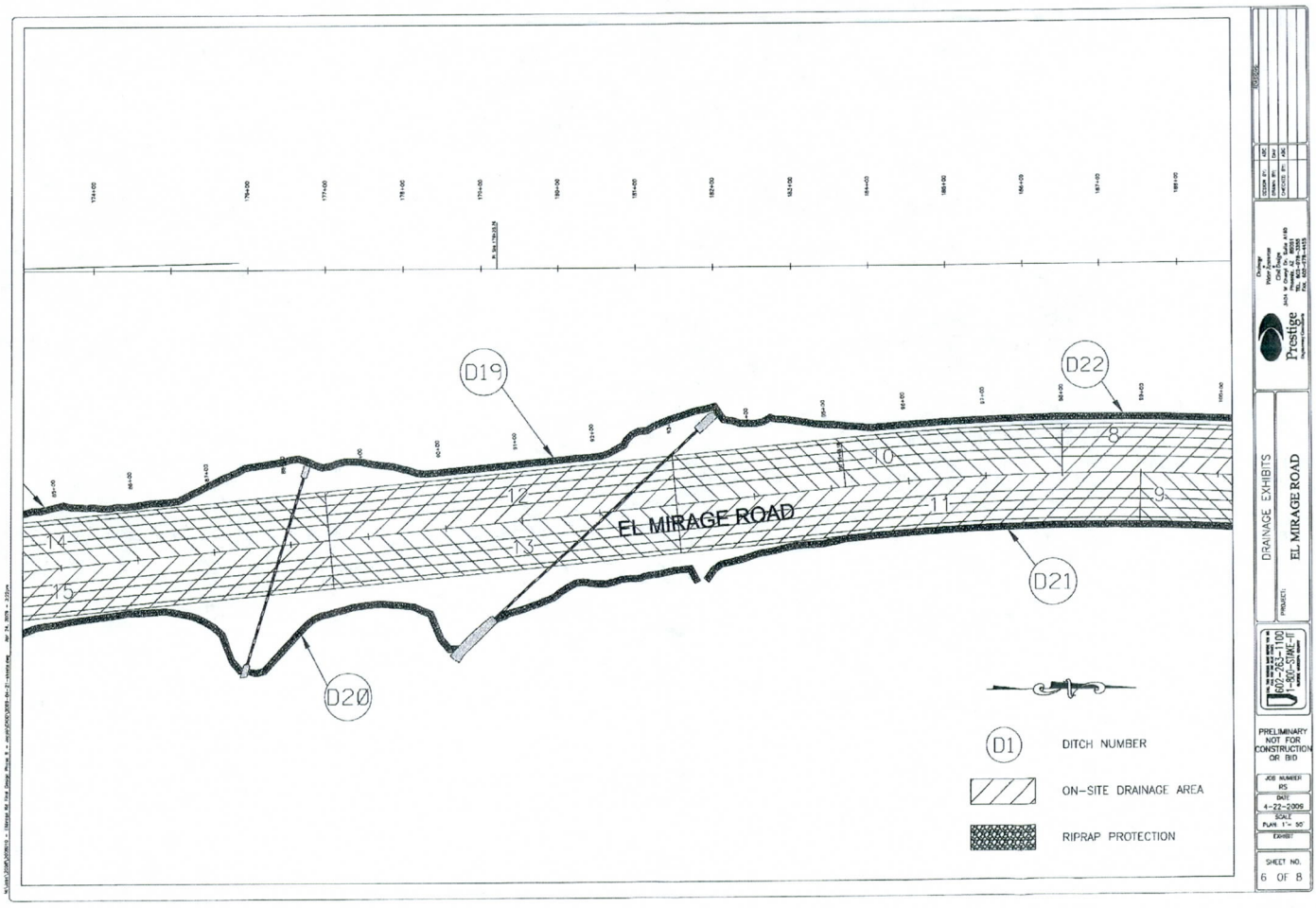
JOB NUMBER 05

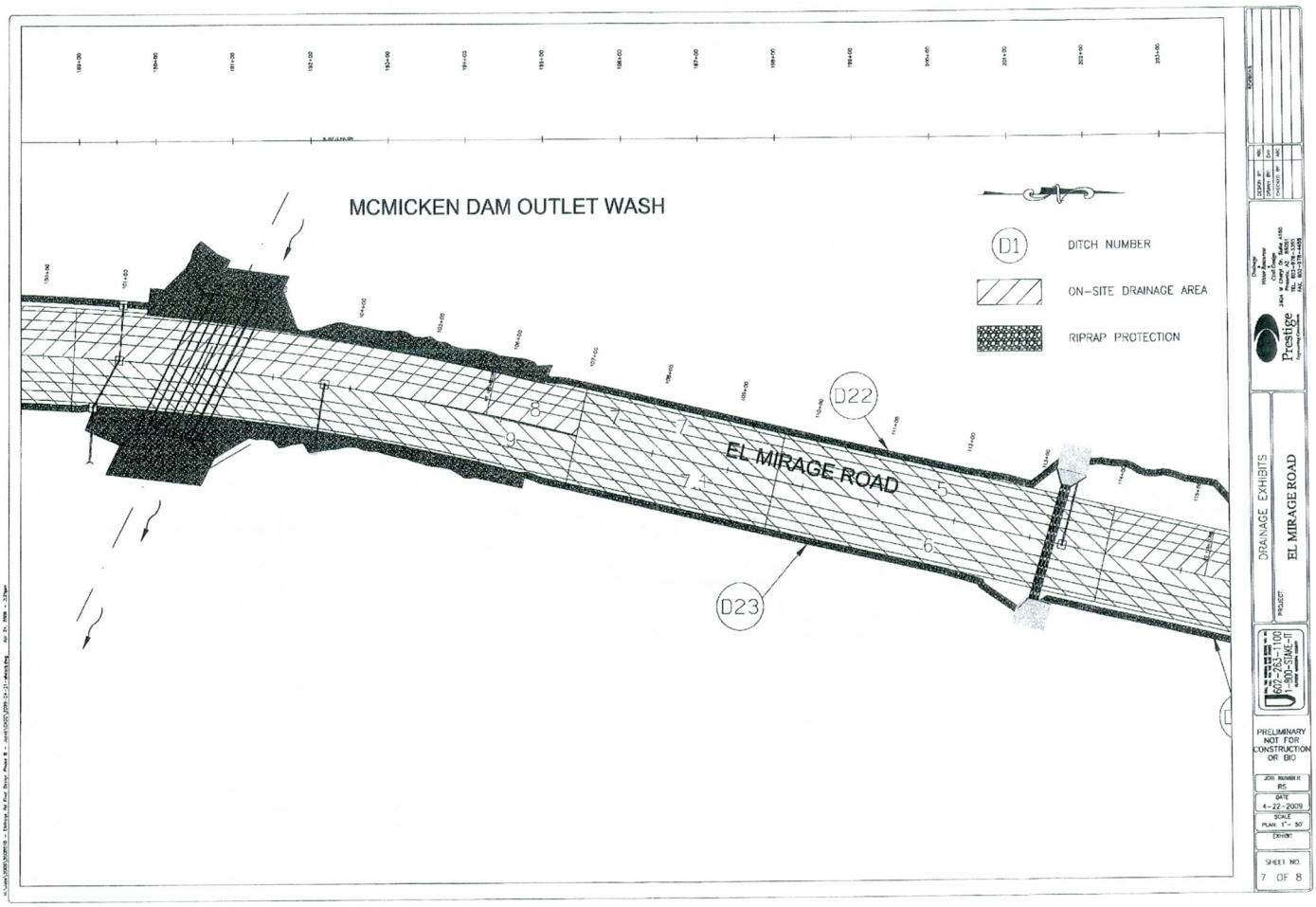
DATE 4-22-2009

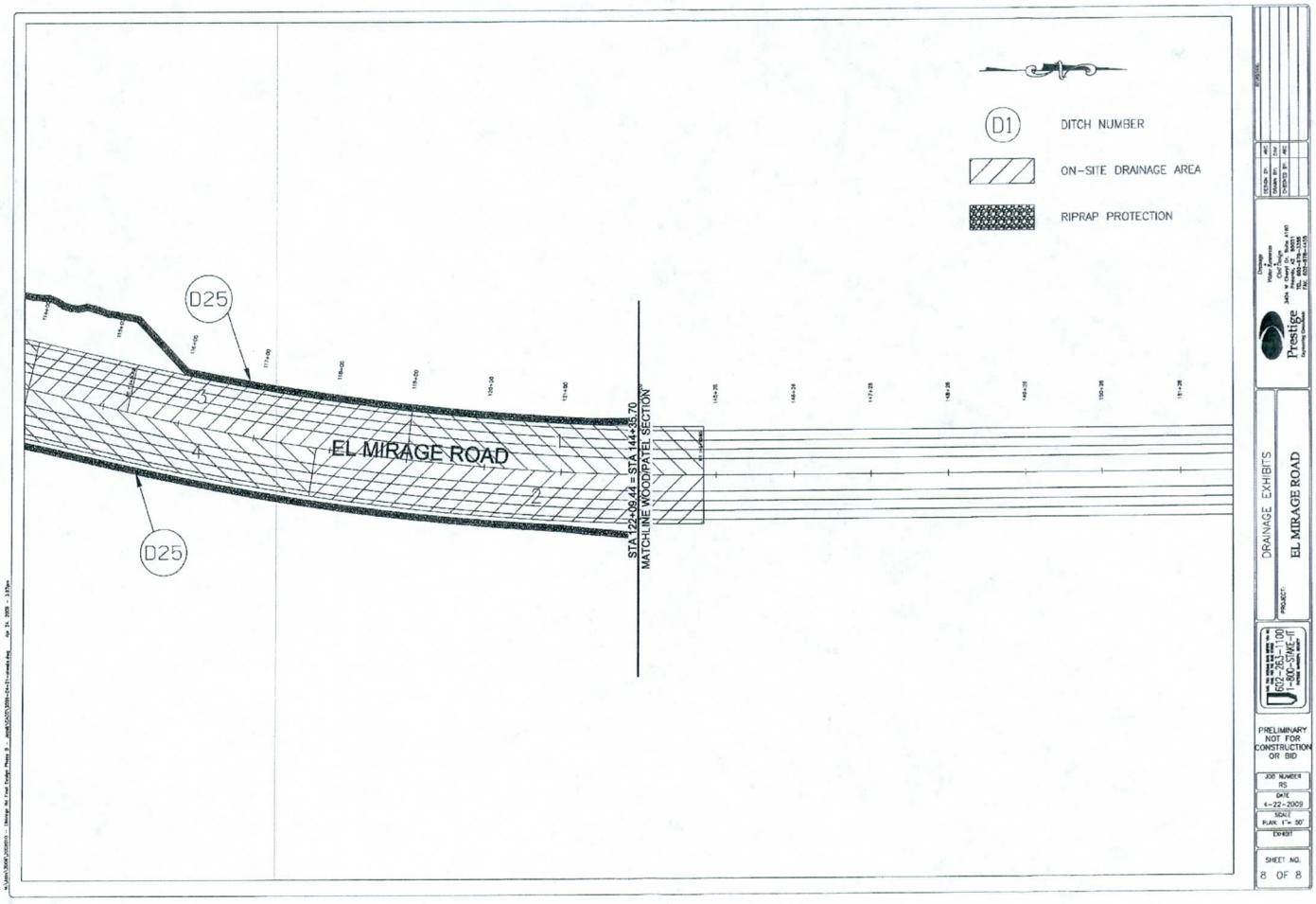
SCALE PLAN: 1" = 50'

EXHIBIT

SHEET NO. 5 OF 8


D19
D22
D20
D21
EL MIRAGE ROAD
D1
DITCH NUMBER
ON-SITE DRAINAGE AREA
RIPRAP PROTECTION
DRAINAGE EXHIBITS
EL MIRAGE ROAD
PRELIMINARY
NOT FOR
CONSTRUCTION
OR BID
JOB NUMBER
RS
DATE
4-22-2009
SCALE
PLAN 1"= 50'
EXHIBIT
SHEET NO.
6 OF 8


MCMICKEN DAM OUTLET WASH
D1
DITCH NUMBER
ON-SITE DRAINAGE AREA
RIPRAP PROTECTION
D22
D23
EL MIRAGE ROAD
DRAINAGE EXHIBITS
PROJECT:
EL MIRAGE ROAD
PRELIMINARY
NOT FOR
CONSTRUCTION
OR BID
JOB NUMBER
RS
DATE
4-22-2009
SCALE
PLAN: 1"= 50'
EXHIBIT
SHEET NO.
7 OF 8
Prestige


D1
DITCH NUMBER
ON-SITE DRAINAGE AREA
RIPRAP PROTECTION
D25
D25
EL MIRAGE ROAD
STA 122+09.44 = STA 144+35.70
MATCHLINE WOOD/PATEL SECTION
DRAINAGE EXHIBITS
EL MIRAGE ROAD
PRELIMINARY
NOT FOR
CONSTRUCTION
OR BID
SHEET NO.
8 OF 8

APPENDIX H

ONSITE STORM DRAIN CALCULATIONS

Median Drainage Calculations

Rainfall Intensity

First Flush intensity (FF)	FF=	0.5
50-yr Storm intensity	i50 =	5.96
100-yr Storm intensity	i100 =	6.69
Median Runoff Coefficient	c =	0.72

	Width	Length	A (ac)	FF	Q50	Q100
Median Ditch #1 Sta. 21 to Sta 35+50	38	1450	1.26	0.46	5.43	6.09
Median Ditch #2 Sta. 39 to 52	38	1300	1.13	0.41	4.87	5.46
Median Ditch #3 Sta. 52 to 74	38	2200	1.92	0.69	8.24	9.24
Median Ditch #4 78 to 91+25	38	1325	1.16	0.42	4.96	5.57
Median Ditch #5 Sta. 91+25 to 101	38	975	0.85	0.31	3.65	4.10
Median Ditch #6 Sta 101 to 113	38	1200	1.05	0.38	4.49	5.04
Median Ditch #7 Sta 113 to 122	38	900	0.79	0.28	3.37	3.78

Worksheet for Ditch Inlet Sta 21+00

Project Description

Solve For	Efficiency

Input Data

Roughness Coefficient	0.025	
Slope	0.00300	ft/ft
Left Side Slope	4.00	ft/ft (H:V)
Right Side Slope	4.00	ft/ft (H:V)
Bottom Width	2.00	ft
Discharge	6.09	ft^3/s
Grate Width	2.00	ft
Grate Length	3.00	ft
Grate Type	P-50 mm (P-1-7/8")	
Clogging	50.00	%

Options

Grate Flow Option	Exclude None

Results

Efficiency	99.21	%
Intercepted Flow	6.04	ft^3/s
Bypass Flow	0.05	ft^3/s
Flow Area	2.63	ft^2
Wetted Perimeter	4.37	ft
Top Width	2.57	ft
Velocity	2.32	ft/s
Splash Over Velocity	6.99	ft/s
Frontal Flow Factor	1.00	
Side Flow Factor	0.94	
Grate Flow Ratio	0.87	
Active Grate Length	1.50	ft
Critical Depth	0.64	ft
Critical Slope	0.01745	ft/ft
Froude Number	0.40	
Flow Type	Subcritical	
Specific Energy	1.23	ft
Velocity Head	0.08	ft
Depth	1.15	ft

Worksheet for Ditch Inlet Sta 39+00

Project Description

Solve For	Efficiency

Input Data

Roughness Coefficient	0.025	
Slope	0.00300	ft/ft
Left Side Slope	4.00	ft/ft (H:V)
Right Side Slope	4.00	ft/ft (H:V)
Bottom Width	2.00	ft
Discharge	6.09	ft^3/s
Grate Width	2.00	ft
Grate Length	3.00	ft
Grate Type	P-50 mm (P-1-7/8")	
Clogging	50.00	%

Options

Grate Flow Option	Exclude None

Results

Efficiency	99.21	%
Intercepted Flow	6.04	ft^3/s
Bypass Flow	0.05	ft^3/s
Flow Area	2.63	ft^2
Wetted Perimeter	4.37	ft
Top Width	2.57	ft
Velocity	2.32	ft/s
Splash Over Velocity	6.99	ft/s
Frontal Flow Factor	1.00	
Side Flow Factor	0.94	
Grate Flow Ratio	0.87	
Active Grate Length	1.50	ft
Critical Depth	0.64	ft
Critical Slope	0.01745	ft/ft
Froude Number	0.40	
Flow Type	Subcritical	
Specific Energy	1.23	ft
Velocity Head	0.08	ft
Depth	1.15	ft

Worksheet for Ditch Inlet Sta 52+00

Project Description

Solve For	Efficiency

Input Data

Roughness Coefficient	0.025	
Slope	0.00300	ft/ft
Left Side Slope	4.00	ft/ft (H:V)
Right Side Slope	4.00	ft/ft (H:V)
Bottom Width	2.00	ft
Discharge	9.24	ft^3/s
Grate Width	2.00	ft
Grate Length	3.00	ft
Grate Type	P-50 mm (P-1-7/8")	
Clogging	50.00	%

Options

Grate Flow Option	Exclude None

Results

Efficiency	98.81	%
Intercepted Flow	9.13	ft^3/s
Bypass Flow	0.11	ft^3/s
Flow Area	3.59	ft^2
Wetted Perimeter	5.11	ft
Top Width	2.76	ft
Velocity	2.57	ft/s
Splash Over Velocity	6.99	ft/s
Frontal Flow Factor	1.00	
Side Flow Factor	0.93	
Grate Flow Ratio	0.84	
Active Grate Length	1.50	ft
Critical Depth	0.84	ft
Critical Slope	0.01773	ft/ft
Froude Number	0.40	
Flow Type	Subcritical	
Specific Energy	1.61	ft
Velocity Head	0.10	ft
Depth	1.51	ft

Worksheet for Ditch Inlet Sta 78+00

Project Description

Solve For	Efficiency

Input Data

Roughness Coefficient	0.025	
Slope	0.00300	ft/ft
Left Side Slope	4.00	ft/ft (H:V)
Right Side Slope	4.00	ft/ft (H:V)
Bottom Width	2.00	ft
Discharge	5.57	ft^3/s
Grate Width	2.00	ft
Grate Length	3.00	ft
Grate Type	P-50 mm (P-1-7/8")	
Clogging	50.00	%

Options

Grate Flow Option	Exclude None

Results

Efficiency	99.28	%
Intercepted Flow	5.53	ft^3/s
Bypass Flow	0.04	ft^3/s
Flow Area	2.46	ft^2
Wetted Perimeter	4.23	ft
Top Width	2.54	ft
Velocity	2.27	ft/s
Splash Over Velocity	6.99	ft/s
Frontal Flow Factor	1.00	
Side Flow Factor	0.94	
Grate Flow Ratio	0.88	
Active Grate Length	1.50	ft
Critical Depth	0.61	ft
Critical Slope	0.01742	ft/ft
Froude Number	0.41	
Flow Type	Subcritical	
Specific Energy	1.16	ft
Velocity Head	0.08	ft
Depth	1.08	ft

Worksheet for Ditch Inlet Sta 101+00

Project Description

Solve For	Efficiency

Input Data

Roughness Coefficient	0.025	
Slope	0.00300	ft/ft
Left Side Slope	4.00	ft/ft (H:V)
Right Side Slope	4.00	ft/ft (H:V)
Bottom Width	2.00	ft
Discharge	4.10	ft^3/s
Grate Width	2.00	ft
Grate Length	3.00	ft
Grate Type	P-50 mm (P-1-7/8")	
Clogging	50.00	%

Options

Grate Flow Option	Exclude None

Results

Efficiency	99.48	%
Intercepted Flow	4.08	ft^3/s
Bypass Flow	0.02	ft^3/s
Flow Area	1.96	ft^2
Wetted Perimeter	3.82	ft
Top Width	2.44	ft
Velocity	2.09	ft/s
Splash Over Velocity	6.99	ft/s
Frontal Flow Factor	1.00	
Side Flow Factor	0.95	
Grate Flow Ratio	0.90	
Active Grate Length	1.50	ft
Critical Depth	0.50	ft
Critical Slope	0.01740	ft/ft
Froude Number	0.41	
Flow Type	Subcritical	
Specific Energy	0.95	ft
Velocity Head	0.07	ft
Depth	0.88	ft

Worksheet for Ditch Inlet Sta 103+00

Project Description

Solve For	Efficiency

Input Data

Roughness Coefficient	0.025	
Slope	0.00300	ft/ft
Left Side Slope	4.00	ft/ft (H:V)
Right Side Slope	4.00	ft/ft (H:V)
Bottom Width	2.00	ft
Discharge	5.78	ft^3/s
Grate Width	2.00	ft
Grate Length	3.00	ft
Grate Type	P-50 mm (P-1-7/8")	
Clogging	50.00	%

Options

Grate Flow Option	Exclude None

Results

Efficiency	99.25	%
Intercepted Flow	5.74	ft^3/s
Bypass Flow	0.04	ft^3/s
Flow Area	2.53	ft^2
Wetted Perimeter	4.29	ft
Top Width	2.55	ft
Velocity	2.29	ft/s
Splash Over Velocity	6.99	ft/s
Frontal Flow Factor	1.00	
Side Flow Factor	0.94	
Grate Flow Ratio	0.88	
Active Grate Length	1.50	ft
Critical Depth	0.62	ft
Critical Slope	0.01743	ft/ft
Froude Number	0.41	
Flow Type	Subcritical	
Specific Energy	1.19	ft
Velocity Head	0.08	ft
Depth	1.11	ft

Worksheet for Ditch Inlet Sta 113+00

Project Description

Solve For	Efficiency

Input Data

Roughness Coefficient	0.025	
Slope	0.00300	ft/ft
Left Side Slope	4.00	ft/ft (H:V)
Right Side Slope	4.00	ft/ft (H:V)
Bottom Width	2.00	ft
Discharge	3.78	ft^3/s
Grate Width	2.00	ft
Grate Length	3.00	ft
Grate Type	P-50 mm (P-1-7/8")	
Clogging	50.00	%

Options

Grate Flow Option	Exclude None

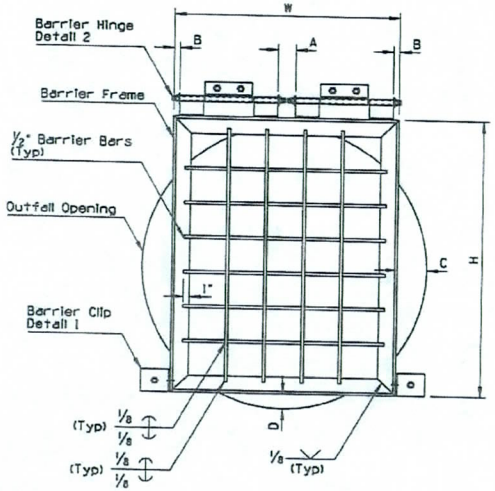
Results

Efficiency	99.52	%
Intercepted Flow	3.76	ft^3/s
Bypass Flow	0.02	ft^3/s
Flow Area	1.85	ft^2
Wetted Perimeter	3.73	ft
Top Width	2.42	ft
Velocity	2.04	ft/s
Splash Over Velocity	6.99	ft/s
Frontal Flow Factor	1.00	
Side Flow Factor	0.95	
Grate Flow Ratio	0.91	
Active Grate Length	1.50	ft
Critical Depth	0.47	ft
Critical Slope	0.01741	ft/ft
Froude Number	0.41	
Flow Type	Subcritical	
Specific Energy	0.90	ft
Velocity Head	0.06	ft
Depth	0.84	ft

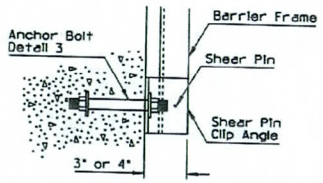
APPENDIX I

ADOT STANDARD DETAILS

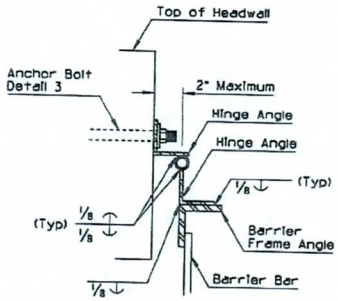
NO	DESCRIPTION OF REVISIONS	MADE BY	DATE
1	RENAMED STANDARD	RLF	9/04
2	MODIFIED TABLE MEASUREMENT FORMAT	RLF	9/04
3	MODIFIED STEEL QUANTITIES	RLF	9/04
4			



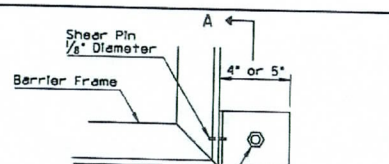
PIPE ACCESS BARRIER FRONT ELEVATION



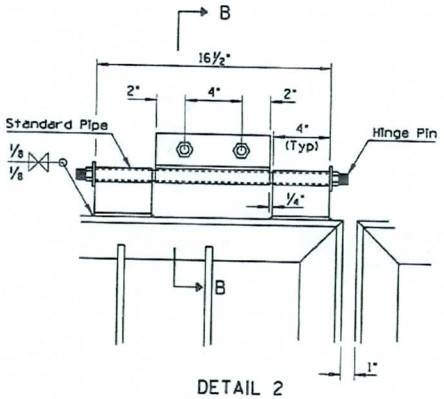
SECTION A-A



SECTION B-B



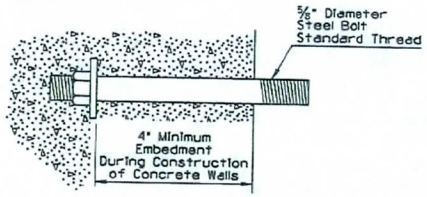
DETAIL 1



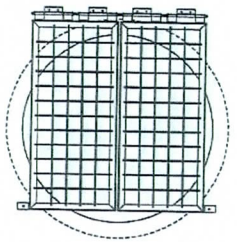
DETAIL 2

GENERAL NOTES

1. All shear pin angles shall fit snug and true to face. Cover with waterproof grease prior to installation of pin.
2. Shear pin holes in the angle shall be drilled for a tight fit of the pins.
3. Both ends of the shear pins shall be peened after installation.
4. Shear pin material shall be commercially pure aluminum wire alloy 1100, Temper O, Federal Spec QQ-A411.
5. Galvanize all ferrous parts after fabrication.
6. Frame and hinge angles shall have the outstanding legs out.
7. All steel shall be in accordance with ASTM A36.
8. Barrier bars shall be equally spaced.
9. Hinge pin material shall be bolt stock and threaded on both ends so nut and lock washer are flush with the lower angle. Cover pin with waterproof grease prior to installation. Upset or damage exposed threads after installation.
10. All welding shall be in accordance with Std Spec 604-3.06.



DETAIL 3



INSTALLATION DETAIL FOR DOUBLE GATES

ACCESS BARRIER GATE DIMENSION SCHEDULE ②

Outfall Pipe ID (in)	Number of Barrier Gates	Frame Angles	Shear Pin Clip Angles	Hinge Pin Diameter (in)	Hinge Angles	Hinge Std Pipe Diameter (in)	Number & Length of Vertical Bars	Number & Length of Horizontal Bars	H (in)	W (in)	A (in)	B (in)	C (in)	D (in)	③ Structural Steel (Lbs)
30	1	2 x2 x¼	4 x4 x¼	½	2 x2 x¼	¾	4-31	4-34	33	36	3	0	-3	2	80
36	1	2 x2 x¼	4 x4 x¼	½	2 x2 x¼	¾	4-31	4-34	33	36	3	0	0	3.5	80
42	1	2 x2 x¼	4 x4 x¼	½	2 x2 x¼	¾	4-41	5-34	43	36	3	0	3	0.5	90
48	1	3 x3 x7/16	5 x3 x¼	¾	2½ x2½ x¼	1	4-46	6-34	50	38	3	1	5	1	180
54	1	3 x3 x7/16	5 x3 x¼	¾	2½ x2½ x¼	1	5-52	7-40	56	44	5	3	5	2	205
60	1	3 x3 x7/16	5 x3 x¼	¾	2½ x2½ x¼	1	6-58	8-46	62	50	9	4	5	3	235
66	1	3 x3 x7/16	5 x3 x¼	¾	2½ x2½ x¼	1	7-64	9-52	68	56	11	6	5	4	265
72	2	3 x3 x7/16	5 x3 x¼	¾	2½ x2½ x¼	1	4-69 *	9-34 *	73	38	3	1	-2.5	5	445
78	2	3 x3 x7/16	5 x3 x¼	¾	2½ x2½ x¼	1	4-75 *	10-34 *	79	38	3	1	0.5	5	470
84	2	3 x3 x7/16	5 x3 x¼	¾	2½ x2½ x¼	1	4-81 *	11-34 *	85	38	3	1	3.5	5	495
90	2	3 x3 x7/16	5 x3 x¼	¾	2½ x2½ x¼	1	4-87 *	12-36 *	91	40	3	2	4.5	5	525
96	2	3 x3 x7/16	5 x3 x¼	¾	2½ x2½ x¼	1	5-93 *	13-39 *	97	43	4	3	4.5	5	580

* Per Gate

APPROVED FOR DESIGN: Mary Vipraio

APPROVED FOR DISTRIBUTION:

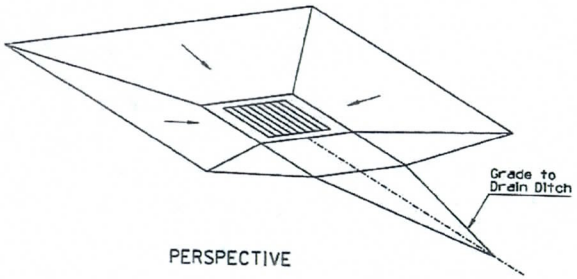
STATE OF ARIZONA
DEPARTMENT OF TRANSPORTATION
ROADWAY STANDARD DRAWINGS

REV. 9/04

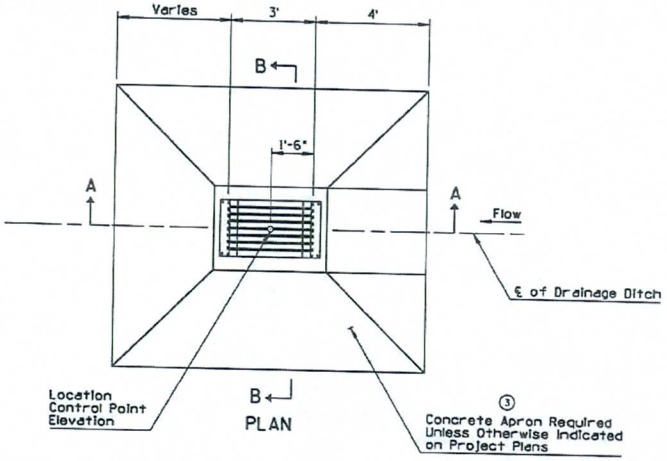
STORM DRAIN ①
OUTLET BARRIER GATE

DRAWING NO. ① C-13.75

NO	DESCRIPTION OF REVISIONS	MADE BY	DATE
1	REVISED CLEAR COVER	RLF	9/04
2	REVISED THICKNESS SPECIFICATION	RLF	9/04
3	ADDED CONCRETE REQUIREMENT	RLF	9/04
4			



PERSPECTIVE



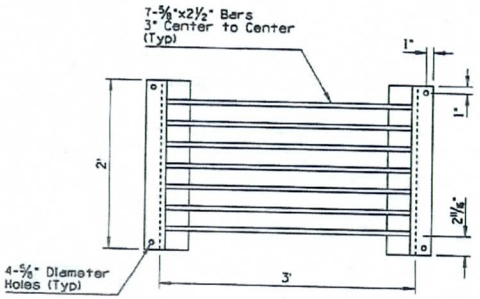
PLAN

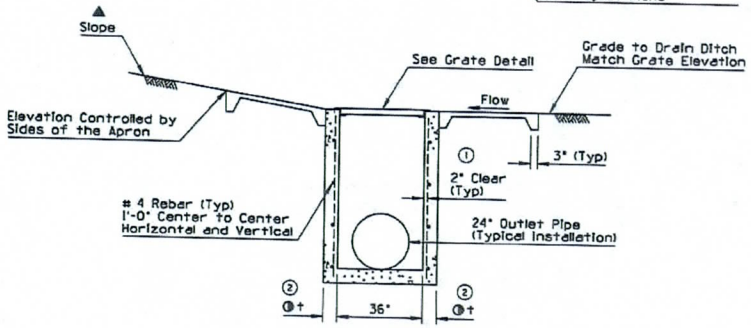
GENERAL NOTES

1. All concrete shall be Class B.
2. Grate and frame shall be fabricated of structural steel in accordance with ASTM A36.
3. All welding shall be in accordance with Std Spec 604-3.06.
4. Grate assembly shall be given one shop coat of Number 1 paint.

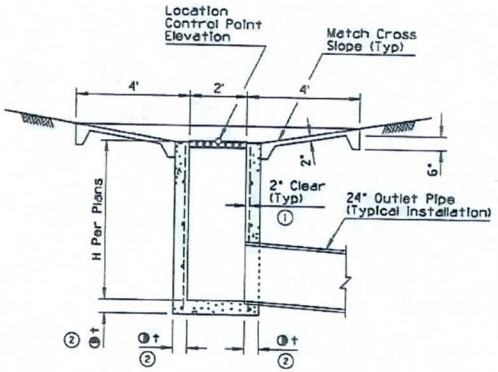
▲ Apron slopes shall match the natural flow line of the ditch. No additional depression will be allowed.

② ③ t = 6" when H is 8' or less
8" when H is greater than 8'

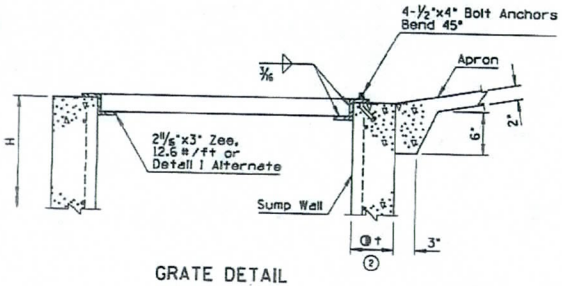




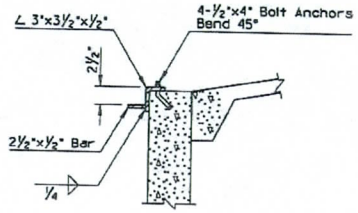
SECTION A-A



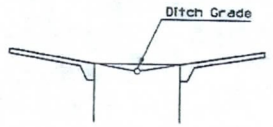
SECTION B-B



GRATE DETAIL



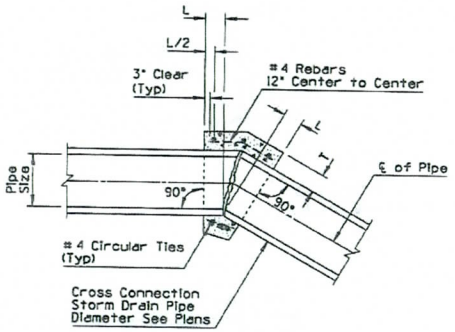
DETAIL 1



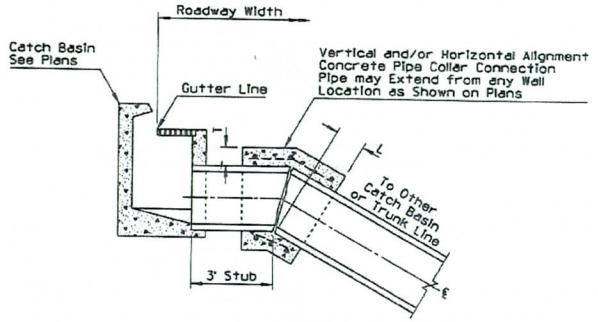
DITCH GRADE DETAIL

APPROVED FOR DESIGN: Mary Viparina	STATE OF ARIZONA DEPARTMENT OF TRANSPORTATION ROADWAY STANDARD DRAWINGS	REV. 9/04
APPROVED FOR DISTRIBUTION: John Semmens	CATCH BASIN FLUSH	DRAWING NO. C-15.80

NO.	DESCRIPTION OF REVISIONS	MADE BY	DATE
1	MODIFIED TABLE VALUES	RLF	9/04
2	MODIFIED GENERAL NOTE 2	RLF	9/04
3	ADDED CALLOUT	RLF	9/04
4			



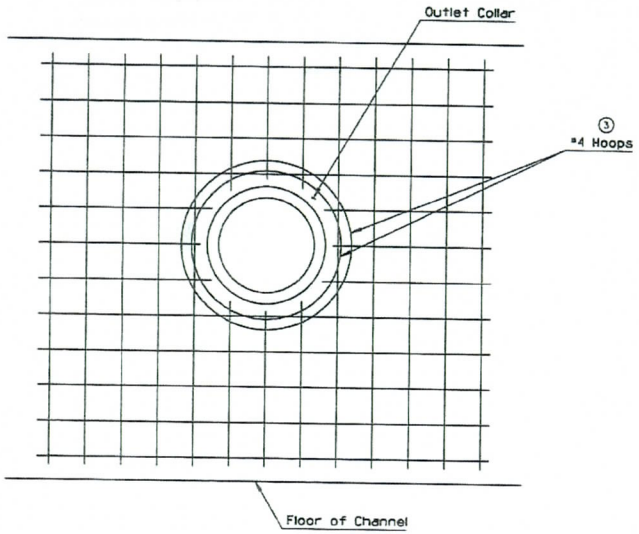
CONCRETE PIPE COLLAR

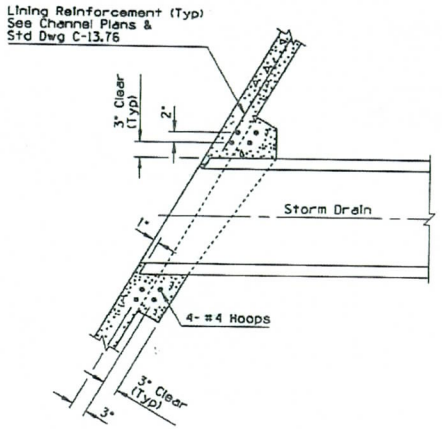


TYPICAL LATERAL CONNECTIONS TO CATCH BASINS WITH CONCRETE COLLARS

GENERAL NOTES

1. All concrete shall be Class B.
2. ② All rebar shall conform to Std Spec 1003-1.2.
3. All rebar shall have 3" minimum clear cover.
4. A concrete collar shall be required where pipes of different diameters or materials are joined or where the design change in alignment or grade exceeds that allowed for a standard joint.
5. When pipes of different diameters are joined with a concrete collar, "L" & "T" shall be those of the larger diameter.
6. The diameter of the circular ties shall be the outside diameter of pipe + T.
7. Pipe ends to be trimmed such that the maximum distance between pipes at any point is 2".





OUTLET COLLAR DETAIL

①

PIPE COLLAR TABLE			
Pipe Size (In)	L (Ft-In)	T (In)	#4 Ties
12	1-0	4	3
18	1-0	5	3
24	1-0	6	3
30	1-6	8	3
36	1-6	8	3
42	1-9	10	4
48	1-9	10	4
52	1-9	10	4
60	1-9	11	4
66	2-0	11	5
72	2-0	14	5
78	2-0	14	5
84	2-3	16	5
96	2-3	16	5

APPROVED FOR DESIGN: May Vipavina	STATE OF ARIZONA DEPARTMENT OF TRANSPORTATION ROADWAY STANDARD DRAWINGS	REV. 9/04
APPROVED FOR DISTRIBUTION:	PIPE COLLAR DETAILS	DRAWING NO. C-13.80

PLAN

Skew ∠	θ1	θ2
0°	70°	70°
5°	75°	65°
10°	80°	60°
15°	85°	55°
20°	90°	50°

2 : 1 Slope – Dimensions

Skew ∠	0°					5°					10°					15°					20°				
Height H	8'	9'	10'	11'	12'	8'	9'	10'	11'	12'	8'	9'	10'	11'	12'	8'	9'	10'	11'	12'	8'	9'	10'	11'	12'
A	2'0	2'-1	2'-2	2'-3	2'-4	2'-0	2'-1	2'-2	2'-3	2'-4	2'-0	2'-1	2'-2	2'-3	2'-4	2'-0	2'-1	2'-2	2'-3	2'-4	2'-0	2'-1	2'-2	2'-3	2'-4
B	1'-4	1'-5	1'-6	1'-7	1'-8	1'-4	1'-5	1'-6	1'-7	1'-8	1'-4	1'-5	1'-6	1'-7	1'-8	1'-4	1'-5	1'-6	1'-7	1'-8	1'-4	1'-5	1'-6	1'-7	1'-8
C	1'-10	2'-2	2'-6	3'-0	3'-8	1'-11	2'-3	2'-7	3'-2	3'-10	1'-11	2'-4	2'-8	3'-3	4'-0	2'-0	2'-5	2'-9	3'-5	4'-1	2'-1	2'-6	2'-10	3'-6	4'-3
D	5'-2	5'-8	6'-2	6'-10	7'-8	5'-3	5'-9	6'-3	7'-0	7'-10	5'-3	5'-10	6'-4	7'-1	8'-0	5'-4	5'-11	6'-5	7'-3	8'-1	5'-5	6'-0	6'-6	7'-4	8'-3
E	14'-6	16'-0	17'-6	19'-0	20'-6	14'-0	15'-6	17'-0	18'-6	20'-0	14'-0	15'-6	17'-0	18'-6	20'-0	13'-6	15'-0	16'-6	18'-0	19'-6	13'-6	15'-0	16'-6	18'-0	19'-6
F	3'-9	4'-3	4'-10	5'-7	6'-6	3'-10	4'-5	4'-11	5'-9	6'-9	3'-10	4'-6	5'-0	5'-11	6'-11	4'-0	4'-7	5'-2	6'-1	7'-1	4'-1	4'-9	5'-3	6'-2	7'-3
G	14'-6	16'-0	17'-6	19'-0	20'-6	14'-6	16'-6	18'-0	19'-6	21'-0	15'-0	17'-0	18'-6	20'-0	22'-0	15'-6	17'-6	19'-0	21'-0	22'-6	16'-6	18'-6	20'-0	22'-0	23'-6
J	3'-9	4'-3	4'-10	5'-7	6'-6	3'-10	4'-5	4'-11	5'-9	6'-9	3'-10	4'-6	5'-0	5'-11	6'-11	4'-0	4'-7	5'-2	6'-1	7'-1	4'-1	4'-9	5'-3	6'-2	7'-3
K	1'-10½	1'-11⅜	2'-0⅜	2'-1½	2'-2½	1'-10½	1'-11⅜	2'-0½	2'-1⅝	2'-2¾	1'-10½	1'-11⅝	2'-0⅜	2'-2	2'-3⅛	1'-11	2'-0¼	2'-1½	2'-2⅝	2'-3⅞	1'-11¾	2'-1⅛	2'-2⅜	2'-3¾	2'-5
L	2'-3	2'-7	2'-10	3'-2	3'-5	2'-4	2'-7	2'-10	3'-2	3'-5	2'-2	2'-5	2'-8	2'-11	3'-3	2'-4	2'-7	2'-10	3'-1	3'-4	2'-4	2'-7	2'-10	3'-1	3'-4
M	2'-3	2'-7	2'-10	3'-2	3'-5	2'-6	2'-7	2'-11	3'-3	3'-7	2'-7	2'-8	3'-1	3'-5	3'-6	2'-9	2'-11	3'-3	3'-6	3'-10	2'-9	3'-0	3'-5	3'-8	4'-1
N	1'-10½	1'-11⅜	2'-0⅜	2'-1½	2'-2½	1'-10½	1'-11½	2'-0½	2'-1½	2'-2⅝	1'-10½	1'-11¾	2'-0⅝	2'-1⅞	2'-2⅝	1'-11¼	2'-0¼	2'-1¼	2'-2⅝	2'-3⅝	2'-0	2'-1	2'-2	2'-3	2'-4

4 : 1 Slope – Dimensions

Skew ∠	0°					5°					10°					15°					20°				
Height H	8'	9'	10'	11'	12'	8'	9'	10'	11'	12'	8'	9'	10'	11'	12'	8'	9'	10'	11'	12'	8'	9'	10'	11'	12'
A	2'-0	2'-1	2'-2	2'-3	2'-4	2'-0	2'-1	2'-2	2'-3	2'-4	2'-0	2'-1	2'-2	2'-3	2'-4	2'-0	2'-1	2'-2	2'-3	2'-4	2'-0	2'-1	2'-2	2'-3	2'-4
B	1'-4	1'-5	1'-6	1'-7	1'-8	1'-4	1'-5	1'-6	1'-7	1'-8	1'-4	1'-5	1'-6	1'-7	1'-8	1'-4	1'-5	1'-6	1'-7	1'-8	1'-4	1'-5	1'-6	1'-7	1'-8
C	1'-8	2'-0	2'-4	2'-10	3'-6	1'-9	2'-1	2'-5	2'-11	3'-6	1'-9	2'-1	2'-5	2'-11	3'-7	1'-9	2'-1	2'-5	3'-0	3'-8	1'-10	2'-2	2'-6	3'-0	3'-8
D	5'-0	5'-6	6'-0	6'-8	7'-6	5'-1	5'-7	6'-1	6'-9	7'-6	5'-1	5'-7	6'-1	6'-9	7'-7	5'-1	5'-7	6'-1	6'-10	7'-8	5'-2	5'-8	6'-2	6'-10	7'-8
E	22'-6	25'-0	27'-6	30'-0	32'-6	22'-0	24'-6	27'-0	29'-6	32'-0	22'-0	24'-0	26'-6	29'-0	31'-6	21'-6	24'-0	26'-6	29'-0	31'-0	21'-6	24'-0	26'-6	29'-0	31'-0
F	3'-6	4'-1	4'-7	5'-4	6'-4	3'-8	4'-2	4'-9	5'-5	6'-4	3'-8	4'-2	4'-9	5'-5	6'-5	3'-8	4'-2	4'-9	5'-7	6'-6	3'-9	4'-3	4'-10	5'-7	6'-6
G	22'-6	25'-0	27'-6	30'-0	32'-6	23'-0	25'-6	28'-0	30'-6	33'-0	23'-6	26'-0	28'-6	31'-0	34'-0	24'-0	27'-0	29'-6	32'-0	35'-0	25'-0	28'-0	30'-6	33'-6	36'-0
J	3'-6	4'-1	4'-7	5'-4	6'-4	3'-8	4'-2	4'-9	5'-5	6'-4	3'-8	4'-2	4'-9	5'-5	6'-5	3'-8	4'-2	4'-9	5'-7	6'-6	3'-9	4'-3	4'-10	5'-7	6'-6
K	1'-10½	1'-11⅜	2'-0⅜	2'-1½	2'-2½	1'-10½	1'-11⅜	2'-0½	2'-1⅝	2'-2¾	1'-10½	1'-11⅜	2'-0⅜	2'-2	2'-3⅛	1'-11	2'-0¼	2'-1½	2'-2⅝	2'-3⅞	1'-11¾	2'-1⅛	2'-2⅜	2'-3¾	2'-5
L	3'-9	4'-2	4'-7	5'-0	5'-5	3'-9	4'-2	4'-7	4'-11	5'-4	3'-8	4'-2	4'-6	4'-11	5'-4	3'-9	4'-1	4'-6	4'-10	5'-4	3'-8	4'-1	4'-5	4'-10	5'-4
M	3'-9	4'-2	4'-7	5'-0	5'-5	3'-10	4'-3	4'-9	5'-2	5'-7	4'-0	4'-5	4'-11	5'-4	5'-8	4'-2	4'-6	5'-0	5'-6	5'-11	4'-3	4'-8	5'-3	5'-8	6'-2
N	1'-10½	1'-11⅜	2'-0⅜	2'-1½	2'-2½	1'-10½	1'-11½	2'-0½	2'-1½	2'-2⅝	1'-10½	1'-11¾	2'-0⅝	2'-1⅞	2'-2⅝	1'-11¼	2'-0¼	2'-1¼	2'-2⅝	2'-3⅝	2'-0	2'-1	2'-2	2'-3	2'-4

6 : 1 Slope – Dimensions

Skew ∠	0°	5°	10°	15°	20°
Height H	8'	8'	8'	8'	8'
A	2'-0	2'-0	2'-0	2'-0	2'-0
B	1'-4	1'-4	1'-4	1'-4	1'-4
C	1'-8	1'-8	1'-8	1'-9	1'-9
D	5'-0	5'-0	5'-0	5'-1	5'-1
E	28'-0	27'-6	27'-0	27'-0	27'-0
F	3'-6	3'-6	3'-6	3'-8	3'-8
G	28'-0	28'-0	29'-0	29'-6	30'-6
J	3'-6	3'-6	3'-6	3'-8	3'-8
K	1'-10½	1'-10½	1'-10½	1'-11	1'-11½
L	4'-8	4'-8	4'-8	4'-7	4'-7
M	4'-8	4'-10	4'-11	5'-0	5'-2
N	1'-10½	1'-10½	1'-10½	1'-11½	2'-0

SECTION A-A

SECTION B-B

SECTION C-C

SECTION D-D

SHORT WING ELEVATION

LONG WING ELEVATION

Height H		'c' Bars										Dim 'X'	* 'd' Bars		
		Short Wing Skew ∠					Long Wing Skew ∠						Short Wing		Long Wing
		0°	5°	10°	15°	20°	0°	5°	10°	15°	20°		0° to 10°	15° & 20°	0° to 20°
2:1 Slope	8'	2-#5	2-#5	2-#5	-	-	2-#5	2-#5	2-#5	3-#5	3-#5	2'-0	-	-	-
	9'	4-#5	4-#5	4-#5	3-#5	2-#5	4-#5	4-#5	4-#5	5-#5	5-#5	3'-0	-	-	-
	10'	6-#6	6-#6	5-#6	5-#6	4-#6	6-#6	7-#6	7-#6	7-#6	8-#6	4'-3	-	-	-
	11'	8-#7	8-#7	7-#7	6-#7	6-#7	8-#7	9-#7	9-#7	10-#7	10-#7	6'-9	5-#6	4-#6	5-#6
	12'	9-#7	8-#7	7-#7	6-#7	6-#7	9-#7	9-#7	9-#7	10-#7	10-#7	6'-9	8-#6	6-#6	8-#6
4:1 Slope	9'	6-#5	6-#5	5-#5	4-#5	3-#5	6-#5	6-#5	6-#5	7-#5	7-#5	3'-0	-	-	-
	10'	10-#5	10-#5	9-#5	8-#5	7-#5	10-#5	10-#5	11-#5	11-#5	12-#5	4'-0	-	-	-
	11'	14-#6	14-#6	13-#6	12-#6	12-#6	14-#6	15-#6	15-#6	16-#6	17-#6	5'-3	9-#6	8-#6	10-#6
	12'	14-#7	14-#7	13-#7	12-#7	11-#7	14-#7	14-#7	15-#7	16-#7	17-#7	6'-9	13-#6	12-#6	15-#6

* 'd' bars alternate with 'a' bars at high end of wall.

Height H	'a' bars	'b' bars
8'	#5	#5
9'	#5	#5
10'	#6	#5
11'	#5	#5
12'	#6	#6

NOTE :

For General Notes and Miscellaneous Details see B-01.10.
For Headwall Quantities see B-05.10, B-05.20 and B-05.30.

DESIGN APPROVED
T.D. Dav[illegible]
APPROVED FOR DISTRIBUTION
T.A. Bryant, II.

ARIZONA
DEPARTMENT OF TRANSPORTATION
HIGHWAYS DIVISION
STANDARD DRAWINGS

OUTLET WINGS
CULVERT HEIGHT 8' to 12'
SKEW 0° to 20°

REVISION 7-88

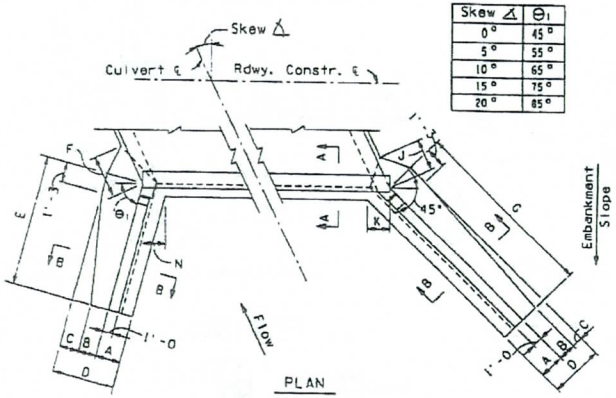
STANDARD NO. B-04.20

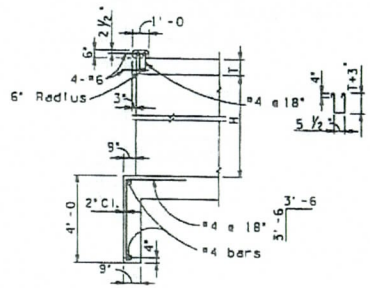
NO	DESCRIPTION OF REVISIONS	MADE BY	DATE
1	Revised cutoff wall	J.W.	6-88
2			
3			
4			

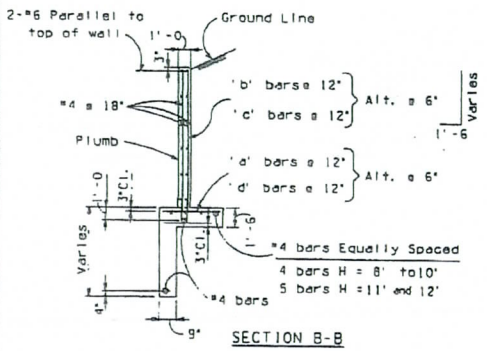
DESIGN
DRAWN
CHECKED

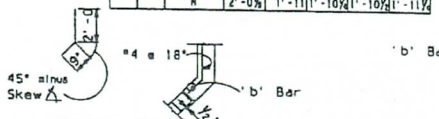
CADD FILENAME: ZFA
VIEW NAME:

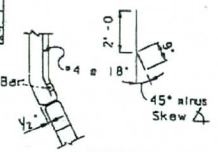
Skew Δ	θ_1
0°	45°
5°	55°
10°	65°
15°	75°
20°	85°

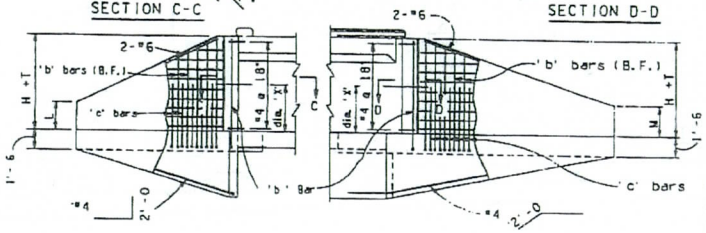












Skew Δ	0°					5°					10°					15°					20°				
Height H	8'	9'	10'	11'	12'	8'	9'	10'	11'	12'	8'	9'	10'	11'	12'	8'	9'	10'	11'	12'	8'	9'	10'	11'	12'
2 : 1 Slope Dimensions A	2'-0	2'-1	2'-2	2'-3	2'-4	2'-0	2'-1	2'-2	2'-3	2'-4	2'-0	2'-1	2'-2	2'-3	2'-4	2'-0	2'-1	2'-2	2'-3	2'-4	2'-0	2'-1	2'-2	2'-3	2'-4
B	1'-4	1'-5	1'-6	1'-9	1'-11	1'-4	1'-5	1'-6	1'-7	1'-9	1'-4	1'-5	1'-6	1'-7	1'-9	1'-4	1'-5	1'-6	1'-7	1'-8	1'-4	1'-5	1'-6	1'-7	1'-8
C	2'-2	2'-7	3'-0	3'-6	4'-2	2'-2	2'-7	3'-0	3'-8	4'-4	2'-2	2'-7	3'-0	3'-8	4'-5	2'-2	2'-7	3'-0	3'-8	4'-5	2'-2	2'-7	3'-0	3'-8	4'-5
D	5'-6	6'-1	6'-8	7'-6	8'-5	5'-6	6'-1	6'-8	7'-6	8'-5	5'-6	6'-1	6'-8	7'-6	8'-5	5'-6	6'-1	6'-8	7'-6	8'-5	5'-6	6'-1	6'-8	7'-6	8'-5
E	13'-0	14'-6	16'-0	17'-0	18'-6	12'-6	14'-0	15'-6	16'-6	18'-0	12'-6	13'-6	15'-0	16'-6	18'-0	12'-6	14'-0	15 -0	16'-6	18'-0	13'-0	14'-6	15'-6	17'-0	18'-6
F	4'-8	5'-4	6'-1	7'-1	8'-3	4'-7	5'-4	6'-0	7'-1	8'-3	4'-7	5'-3	5'-11	7'-0	8'-2	4'-6	5'-2	5'-10	6'-10	8'-0	4'-4	5'-0	5'-8	6'-8	7'-9
G	13'-0	14'-6	16'-0	17'-0	18'-6	13'-6	15'-0	16'-6	18'-0	19'-6	14'-6	16'-0	17'-6	19'-0	20'-6	15'-0	17'-0	18'-6	20'-0	22'-0	16'-0	18'-0	19'-6	21'-6	23'-6
J	4'-8	5'-4	6'-1	7'-1	8'-3	4'-7	5'-4	6'-0	7'-1	8'-3	4'-7	5'-3	5'-11	7'-0	8'-2	4'-6	5'-2	5'-10	6'-10	8'-0	4'-4	5'-0	5'-8	6'-8	7'-9
K	2'-0½	2'-2⅜	2'-3⅞	2'-5⅝	2'-6⅝	2'-0⅛	2'-2⅛	2'-3⅞	2'-5⅛	2'-6⅝	2'-0⅛	2'-2⅛	2'-3¾	2'-5⅞	2'-6⅝	2'-0⅛	2'-2⅜	2'-3¾	2'-5⅞	2'-6⅝	2'-0⅛	2'-2⅜	2'-3¾	2'-5⅞	2'-6⅝
L	4'-6	4'-11	5'-5	6'-1	6'-6	3'-11	4'-4	4'-9	5'-4	5'-8	3'-5	3'-11	4'-3	4'-7	4'-11	3'-0	3'-4	3'-10	4'-1	4'-4	2'-7	2'-10	3'-4	3'-7	3'-10
M	4'-6	4'-11	5'-5	6'-1	6'-6	4'-3	4'-9	5'-3	5'-8	6'-2	3'-11	4'-5	4'-11	5'-4	5'-10	3'-9	4'-1	4'-6	5'-0	5'-3	3'-5	3'-8	4'-2	4'-6	4'-9
N	2'-0½	2'-2⅜	2'-3⅞	2'-5⅛	2'-6⅝	1'-11	2'-0⅛	2'-1⅞	2'-2⅝	2'-3⅜	1'-10½	1'-11⅜	2'-0⅛	2'-1⅞	2'-2⅞	1'-10½	1'-11½	2'-0⅛	2'-1⅞	2'-2⅝	1'-11⅛	2'-0¼	2'-1⅞	2'-2⅝	2'-3¾

Skew Δ	0°					5°					10°					15°					20°				
Height H	8'	9'	10'	11'	12'	8'	9'	10'	11'	12'	8'	9'	10'	11'	12'	8'	9'	10'	11'	12'	8'	9'	10'	11'	12'
4 : 1 Slope Dimensions A	2'-0	2'-1	2'-2	2'-3	2'-4	2'-0	2'-1	2'-2	2'-3	2'-4	2'-0	2'-1	2'-2	2'-3	2'-4	2'-0	2'-1	2'-2	2'-3	2'-4	2'-0	2'-1	2'-2	2'-3	2'-4
B	1'-8	1'-11	2'-2	2'-5	2'-8	1'-6	1'-9	2'-0	2'-3	2'-6	1'-5	1'-8	1'-11	2'-2	2'-4	1'-4	1'-6	1'-9	1'-11	2'-2	1'-4	1'-5	1'-6	1'-8	1'-10
C	1'-6	1'-8	1'-10	2'-3	2'-9	1'-8	1'-10	2'-0	2'-5	2'-11	1'-9	1'-11	2'-1	2'-6	3'-1	1'-10	2'-1	2'-3	2'-9	3'-3	1'-10	2'-2	2'-6	3'-0	3'-7
D	5'-2	5'-8	6'-2	6'-11	7'-9	5'-2	5'-8	6'-2	6'-11	7'-9	5'-2	5'-8	6'-2	6'-11	7'-9	5'-2	5'-8	6'-2	6'-11	7'-9	5'-2	5'-8	6'-2	6'-11	7'-9
E	17'-0	19'-0	21'-0	23'-0	25'-0	17'-6	19'-6	21'-0	23'-0	25'-0	18'-0	19'-6	21'-6	23'-6	25'-6	18'-6	20'-6	22'-6	24'-6	26'-6	20'-0	22'-0	24'-0	26'-6	28'-6
F	4'-2	4'-9	5'-4	6'-3	7'-4	4'-2	4'-9	5'-4	6'-3	7'-4	4'-1	4'-8	5'-3	6'-2	7'-3	4'-0	4'-7	5'-2	6'-1	7'-1	3'-11	4'-5	5'-0	5'-11	6'-11
G	17'-0	19'-0	21'-0	23'-0	25'-0	18'-6	20'-6	22'-6	24'-6	26'-6	19'-6	22'-0	24'-0	26'-0	28'-6	21'-6	23'-6	26'-0	28'-6	30'-6	23'-6	26'-0	28'-6	31'-0	34'-0
J	4'-2	4'-9	5'-4	6'-3	7'-4	4'-2	4'-9	5'-4	6'-3	7'-4	4'-1	4'-8	5'-3	6'-2	7'-3	4'-0	4'-7	5'-2	6'-1	7'-1	3'-11	4'-5	5'-0	5'-11	6'-11
K	2'-0½	2'-2⅜	2'-3⅞	2'-5⅝	2'-6⅝	2'-0⅛	2'-2⅛	2'-3⅞	2'-5⅛	2'-6⅝	2'-0⅛	2'-2⅛	2'-3¾	2'-5⅞	2'-6⅝	2'-0⅛	2'-2⅜	2'-3¾	2'-5⅞	2'-6⅝	2'-0⅛	2'-2⅜	2'-3¾	2'-5⅞	2'-6⅝
L	6'-1	6'-8	7'-4	8'-0	8'-8	5'-6	6'-1	6'-9	7'-4	7'-11	5'-0	5'-8	6'-2	6'-9	7'-3	4'-7	5'-1	5'-8	6'-2	6'-8	4'-1	4'-7	5'-1	5'-6	6'-0
M	6'-1	6'-8	7'-4	8'-0	8'-8	5'-10	6'-5	7'-1	7'-9	8'-5	5'-7	6'-2	6'-10	7'-6	8'-0	5'-3	5'-11	6'-6	7'-0	7'-8	4'-11	5'-6	6'-0	6'-7	7'-1
N	2'-0½	2'-2⅜	2'-3⅞	2'-5⅝	2'-6⅝	1'-11	2'-0⅛	2'-1⅞	2'-2⅝	2'-3⅜	1'-10½	1'-11⅜	2'-0⅛	2'-1⅞	2'-2⅞	1'-10½	1'-11½	2'-0⅛	2'-1⅞	2'-2⅝	1'-11⅛	2'-0¼	2'-1⅞	2'-2⅝	2'-3¾

Skew Δ	0°	5°	10°	15°	20°
Height H	8'	8'	8'	8'	8'
6 : 1 Slope Dimensions A	2'-0	2'-0	2'0	2'-0	2'-0
B	1'-11	1'-10	1'-9	1'-8	1'-6
C	1'-2	1'-3	1'-4	1'-5	1'-7
D	5'-1	5'-1	5'-1	5'-1	5'-1
E	19'-6	20'-0	21'-0	22'-0	24'-0
F	4'-1	4'-0	4'-0	3'-11	3'-9
G	19'-6	21'-0	22'-6	24'-6	27'-6
J	4'-1	4'-0	4'-0	3'-11	3'-9
K	2'-0⅞	2'-0⅞	2'-0⅞	2'-0⅞	2'-0⅞
L	6'-9	6'-4	5'-11	5'-6	5'-1
M	6'-9	6'-7	6'-5	6'-2	5'-10
N	2'-0⅜	1'-11	1'-10½	1'-10½	1'-11⅞

Height H	'a' bars	'b' bars
8'	#5	#5
9'	#6	#5
10'	#6	#5
11'	#6	#5
12'	#6	#6

	Height H	'c' Bars Short Wing Skew Δ 0°	5°	10°	15°	20°	Long Wing Rail	Dim. 'X'	'd' Bars Short Wing 0° to 10°	15° & 20°	Long Wing 0° to 20°
2:1 Slope	8'	3-#5	3-#5	2-#5	2-#5	-	3-#5	2'-0	-	-	-
	9'	5-#5	4-#5	3-#5	3-#5	2-#5	5-#5	3'-0	-	-	-
	10'	8-#6	7-#6	6-#6	5-#6	4-#6	8-#6	4'-3	3-#5	-	3-#5
	11'	11-#7	10-#7	9-#7	7-#7	6-#7	11-#7	5'-9	6-#5	5-#5	6-#5
	12'	11-#7	10-#7	9-#7	7-#7	6-#7	11-#7	6'-9	9-#7	7-#6	9-#7
4:1 Slope	9'	7-#5	6-#5	6-#5	5-#5	4-#5	7-#5	3'-0	-	-	-
	10'	12-#5	11-#5	10-#5	9-#5	8-#5	12-#5	4'-0	-	-	-
	11'	18-#7	17-#7	16-#7	15-#7	14-#7	18-#7	5-3	11-#5	9-#5	11-#5
	12'	18-#7	17-#7	16-#7	15-#7	14-#7	18-#7	6'-3	11-#6	11-#6	11-#6

'd' bars alternate with 'a' bars at high end of wall.

NOTE :

For General Notes and Miscellaneous Details see B-01.10.
For Headwall Quantities see B-05.10, B-05.20 and B-05.30.

DESIGN APPROVED
APPROVED FOR DISTRIBUTION

ARIZONA DEPARTMENT OF TRANSPORTATION
HIGHWAYS DIVISION
STANDARD DRAWINGS

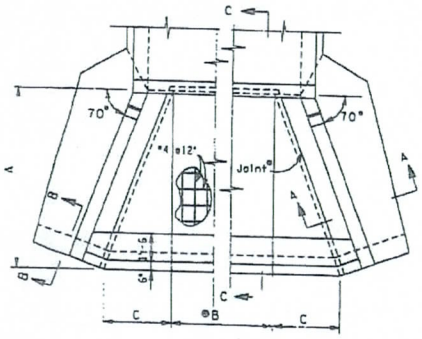
INLET WINGS
CULVERT HEIGHT 8' to 12'
SKEW 0° to 20°

REVISION

STANDARD NO. B-04.40

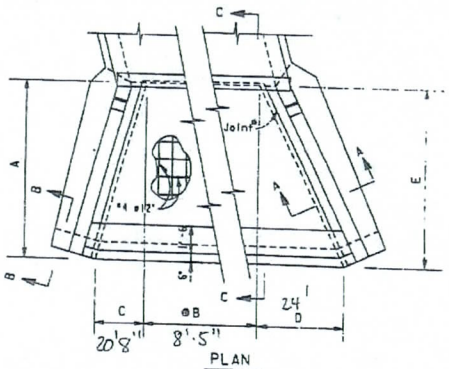
DESIGN
DRAWN
CHECKED

CADD FILENAME= EPA
VIEW NAME=



PLAN

Apron for 0° skew box culvert



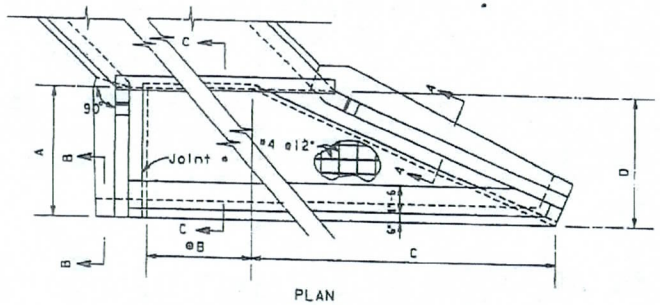
PLAN

Apron for 0° to 15° skew box culvert

Span	△											
	0° Skew	5° Skew	10° Skew	15° Skew	20° Skew	25° Skew	30° Skew	35° Skew	40° Skew	45° Skew
6'	6'-8	6'-8¼	6'-9¼	6'-10⅞	7'-1⅞	7'-4¼	7'-8⅜	8'-1½	8'-8⅜	9'-5⅛
8'	8'-9	8'-9⅝	8'-10⅝	9'-0¼	9'-3¼	9'-7⅛	10'-1⅞	10'-8⅜	11'-5⅛	12'-4⅞
10'	10'-11	10'-11⅞	11'-1	11'-3⅜	11'-7⅜	12'-0⅞	12'-7⅛	13'-3⅜	14'-3	15'-5¼
12'	13'-1	13'-1⅝	13'-3¾	13'-6⅞	13'-11⅞	14'-5⅛	15'-1⅛	15'-11⅝	17'-1	18'-6

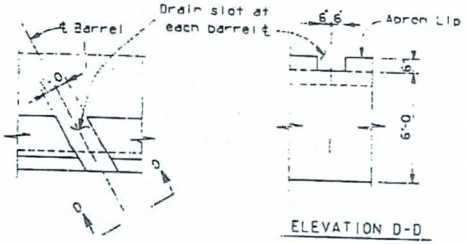
* Optional construction joint. Apron may be poured with wingwall footings and bottom slab of barrel.

⊕ Dimension varies with number of barrels. △ equals length to be added to dimension "B" for each additional barrel.



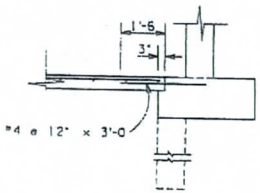
PLAN

Apron for 20° to 45° skew box culvert

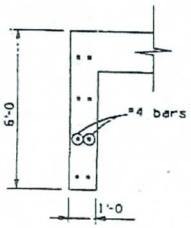


ELEVATION D-D

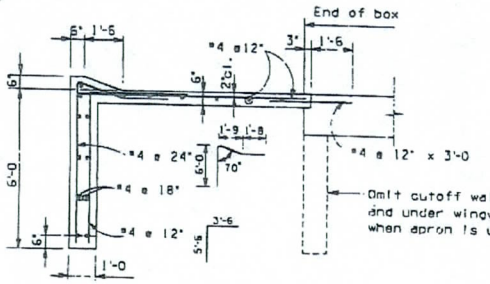
APRON DRAIN DETAIL



SECTION A-A



SECTION B-B



SECTION C-C

NOTES:

For General Notes and miscellaneous details see B-01.10.

See B-06.20, B-06.30 and B-06.40 for apron dimensions and quantities.

The apron quantities take into consideration the cutoff walls being omitted along outlet headwall and shall be used on new box culverts only.

NO.	DESCRIPTION OF REVISIONS	DATE BY	DES
	2. Revised cutoff wall & D table	J.M.	6-93
	1. Cutoff wall location Section C-C	J.M.	4-92
	3.		
	4.		
	5.		

REVISED	
DESIGN	
CHECKED	

CADD FILENAME = PW-
NEW NAME=

DESIGN APPROVED

APPROVED FOR DISTRIBUTION

ARIZONA
DEPARTMENT OF TRANSPORTATION
HIGHWAYS DIVISION
STANDARD DRAWINGS

REVISION 4-93

CUTLET APRON DETAILS

STANDARD NO. B-06.10

DIMENSIONS

Span	Hgt.	0° Skew A	0° Skew B	0° Skew C	5° Skew A	5° Skew B	5° Skew C	5° Skew D	5° Skew E	10° Skew A	10° Skew B	10° Skew C	10° Skew D	10° Skew E	15° Skew A	15° Skew B	15° Skew C	15° Skew D	15° Skew E
6'	3'	12'-3 7/8	4'-8 1/4	4'-5 1/2	12'-5 1/2	4'-8 1/2	3'-4 1/8	5'-6 3/8	11'-11 1/2	12'-0 7/8	4'-9 1/8	2'-1 1/2	6'-11 1/2	12'-0 1/8	12'-1	4'-10 1/8	1'-0 5/8	8'-4 1/8	11'-11
	4'	15'-0 3/8	4'-8 1/4	5'-5 7/8	15'-4 3/8	4'-8 1/2	4'-1 3/8	7'-0 5/8	15'-1 5/8	15'-0 3/8	4'-9 1/8	2'-7 3/4	8'-5 1/4	14'-7 1/4	15'-0 3/8	4'-10 1/8	1'-3 3/8	10'-0 3/4	14'-4 1/2
	5'	17'-10 7/8	4'-8 1/4	6'-6 1/8	18'-3 1/8	4'-8 1/2	4'-10 5/8	8'-3 7/8	17'-10 1/2	17'-11 7/8	4'-9 1/8	3'-2 1/8	10'-2 1/4	17'-7 5/8	18'-0 3/4	4'-10 1/8	1'-7	12'-0 3/8	17'-2 3/8
	6'	20'-8 5/8	4'-8 1/4	7'-6 1/2	21'-1 7/8	4'-8 1/2	5'-8	9'-7 1/8	20'-6 5/8	20'-11 1/2	4'-9 1/8	3'-8 3/8	11'-8 1/4	20'-2 3/8	21'-0 5/8	4'-10 1/8	1'-10 1/2	13'-9 1/2	19'-8 3/8
	7'	23'-6 3/8	4'-8 1/4	8'-6 3/4	24'-0 5/8	4'-8 1/2	6'-5 3/8	10'-10 3/8	23'-3 1/2	23'-10 7/8	4'-9 1/8	4'-2 1/2	13'-2 1/4	22'-10	24'-0 1/2	4'-10 1/8	2'-1 1/4	15'-9 5/8	22'-6 3/8
8'	3'	12'-3 7/8	6'-10 1/4	4'-5 1/2	12'-5 1/2	6'-10 1/2	3'-4 1/8	5'-6 3/8	11'-11 1/2	12'-0 7/8	6'-11 1/2	2'-1 1/2	6'-11 1/2	12'-0 1/8	12'-1	7'-1 1/8	1'-0 5/8	8'-4 1/8	11'-11
	4'	15'-0 3/8	6'-10 1/4	5'-5 7/8	15'-4 3/8	6'-10 1/2	4'-1 3/8	7'-0 5/8	15'-1 5/8	15'-0 3/8	6'-11 1/2	2'-7 3/4	8'-5 1/4	14'-7 1/4	15'-0 3/8	7'-1 1/8	1'-3 3/8	10'-0 3/4	14'-4 1/2
	5'	17'-10 7/8	6'-10 1/4	6'-6 1/8	18'-3 1/8	6'-10 1/2	4'-10 5/8	8'-3 7/8	17'-10 1/2	17'-11 7/8	6'-11 1/2	3'-2 1/8	10'-2 1/4	17'-7 5/8	18'-0 3/4	7'-1 1/8	1'-7	12'-0 3/8	17'-2 3/8
	6'	20'-8 5/8	6'-10 1/4	7'-6 1/2	21'-1 7/8	6'-10 1/2	5'-8	9'-7 1/8	20'-6 5/8	20'-11 1/2	6'-11 1/2	3'-8 3/8	11'-8 1/4	20'-2 3/8	21'-0 5/8	7'-1 1/8	1'-10 1/2	13'-9 1/2	19'-8 3/8
	7'	23'-6 3/8	6'-10 1/4	8'-6 3/4	24'-0 5/8	6'-10 1/2	6'-5 3/8	10'-10 3/8	23'-3 1/2	23'-10 7/8	6'-11 1/2	4'-2 1/2	13'-2 1/4	22'-10	24'-0 1/2	7'-1 1/8	2'-1 1/4	15'-9 5/8	22'-6 3/8
	8'	27'-0	5'-9 1/2	9'-9 3/8	27'-1	5'-9 5/8	7'-3 1/8	12'-2 3/4	26'-2 5/8	26'-11 1/2	5'-10 1/2	4'-9	15'-0 3/8	26'-1 3/8	27'-0 1/8	5'-11 3/4	2'-4 3/8	17'-8 3/4	25'-3 3/4
10'	3'	12'-3 7/8	9'-0 1/4	4'-5 1/2	12'-5 1/2	9'-0 5/8	3'-4 1/8	5'-6 3/8	11'-11 1/2	12'-0 7/8	9'-1 3/8	2'-1 1/2	6'-11 1/2	12'-0 1/8	12'-1	9'-4	1'-0 5/8	8'-4 1/8	11'-11
	4'	15'-0 3/8	9'-0 1/4	5'-5 7/8	15'-4 3/8	9'-0 5/8	4'-1 3/8	7'-0 5/8	15'-1 5/8	15'-0 3/8	9'-1 3/8	2'-7 3/4	8'-5 1/4	14'-7 1/4	15'-0 3/8	9'-4	1'-3 3/8	10'-0 3/4	14'-4 1/2
	5'	17'-10 7/8	9'-0 1/4	6'-6 1/8	18'-3 1/8	9'-0 5/8	4'-10 5/8	8'-3 7/8	17'-10 1/2	17'-11 7/8	9'-1 3/8	3'-2 1/8	10'-2 1/4	17'-7 5/8	18'-0 3/4	9'-4	1'-7	12'-0 3/8	17'-2 3/8
	6'	20'-8 5/8	9'-0 1/4	7'-6 1/2	21'-1 7/8	9'-0 5/8	5'-8	9'-7 1/8	20'-6 5/8	20'-11 1/2	9'-1 3/8	3'-8 3/8	11'-8 1/4	20'-2 3/8	21'-0 5/8	9'-4	1'-10 1/2	13'-9 1/2	19'-8 3/8
	7'	23'-6 3/8	9'-0 1/4	8'-6 3/4	24'-0 5/8	9'-0 5/8	6'-5 3/8	10'-10 3/8	23'-3 1/2	23'-10 7/8	9'-1 3/8	4'-2 1/2	13'-2 1/4	22'-10	24'-0	9'-4	2'-1 1/4	15'-9 5/8	22'-6 3/8
	8'	27'-0	7'-11 1/2	9'-9 3/8	27'-1	7'-11 3/4	7'-3 1/8	12'-2 3/4	26'-2 5/8	26'-11 1/2	8'-0 3/8	4'-9	15'-0 3/8	26'-1 3/8	27'-0 1/8	8'-2 3/8	2'-4 3/8	17'-8 3/4	25'-3 3/4
12'	8'	27'-0	10'-3 1/2	9'-9 3/8	27'-1	10'-3 5/8	7'-3 1/8	12'-2 3/4	26'-2 5/8	26'-11 1/2	10'-5 1/4	4'-9	15'-0 3/8	26'-1 3/8	27'-0 1/8	10'-7 3/8	2'-4 3/8	17'-8 3/4	25'-3 3/4

Span	Hgt.	20° Skew A	20° Skew B	20° Skew C	20° Skew D	25° Skew A	25° Skew B	25° Skew C	25° Skew D	30° Skew A	30° Skew B	30° Skew C	30° Skew D
6'	3'	12'-0	4'-11 3/4	9'-5 3/8	11'-3 3/8	11'-0	5'-2 5/8	10'-11 1/2	10'-11 1/2	10'-0	5'-6 3/8	12'-5 3/4	10'-5 3/8
	4'	15'-0	4'-11 3/4	11'-8 3/8	13'-11 3/8	13'-6	5'-2 5/8	13'-5 1/4	13'-5 1/4	12'-6	5'-6 3/8	15'-6 1/2	13'-0 1/2
	5'	18'-0	4'-11 3/4	13'-11 3/8	16'-8	16'-0	5'-2 5/8	15'-10 3/8	15'-10 3/8	14'-6	5'-6 3/8	18'-2 3/8	15'-3 1/2
	6'	21'-0	4'-11 3/4	15'-11	18'-11 3/8	19'-0	5'-2 5/8	18'-4 5/8	18'-4 5/8	17'-0	5'-6 3/8	20'-10 3/8	17'-6 1/2
	7'	24'-0	4'-11 3/4	18'-2	21' 7 3/4	21'-6	5'-2 5/8	20'-10 3/8	20'-10 3/8	19'-6	5'-6 3/8	23'-7	19'-9 1/2
8'	3'	12'-0	7'-3 3/8	9'-5 3/8	11'-3 3/8	11'-0	7'-7 3/8	10'-11 1/2	10'-11 1/2	10'-0	8'-0 3/8	12'-5 3/4	10'-5 3/8
	4'	15'-0	7'-3 3/8	11'-8 3/8	13'-11 3/8	13'-6	7'-7 3/8	13'-5 1/4	13'-5 1/4	12'-6	8'-0 3/8	15'-6 1/2	13'-0 1/2
	5'	18'-0	7'-3 3/8	13'-11 3/8	16'-8	16'-0	7'-7 3/8	15'-10 3/8	15'-10 3/8	14'-6	8'-0 3/8	18'-2 3/8	15'-3 1/2
	6'	21'-0	7'-3 3/8	15'-11	18'-11 3/8	19'-0	7'-7 3/8	18'-4 5/8	18'-4 5/8	17'-0	8'-0 3/8	20'-10 3/8	17'-6 1/2
	7'	24'-0	7'-3 3/8	18'-2	21'-7 3/4	21'-6	7'-7 3/8	20'-10 3/8	20'-10 3/8	19'-6	8'-0 3/8	23'-7	19'-9 1/2
	8'	27'-0	6'-1 1/2	20'-8 1/4	24' 7 3/4	24'-0	6'-4 5/8	23'-8 1/4	23'-8 1/4	22'-0	6'-9	26'-8 3/8	22'-5 3/8
10'	3'	12'-0	9'-7	9'-5 3/8	11'-3 3/8	11'-0	10'-0	10'-11 1/2	10'-11 1/2	10'-0	10'-6 3/8	12'-5 3/4	10'-5 3/8
	4'	15'-0	9'-7	11'-8 3/8	13'-11 3/8	13'-6	10'-0	13'-5 1/4	13'-5 1/4	12'-6	10'-6 3/8	15'-6 1/2	13'-0 1/2
	5'	18'-0	9'-7	13'-11 3/8	16'-8	16'-0	10'-0	15'-10 3/8	15'-10 3/8	14'-6	10'-6 3/8	18'-2 3/8	15'-3 1/2
	6'	21'-0	9'-7	15'-11	18'-11 3/8	19'-0	10'-0	18'-4 5/8	18'-4 5/8	17'-0	10'-6 3/8	20'-10 3/8	17'-6 1/2
	7'	24'-0	9'-7	18'-2	21'-7 3/4	21-6	10'-0	20'-10 3/8	20'-10 3/8	19'-6	10'-6 3/8	23'-7	19'-9 1/2
	8'	27'-0	8'-5 1/4	20'-8 1/4	24'-7 3/4	24'-0	8'-9 1/2	23'-8 1/4	23'-8 1/4	22'-0	9'-3	26'-8 3/8	22'-5 3/8
12'	8'	27'-0	10'-11	20'-8 1/4	24'-7 3/4	24'-0	11'-4 3/8	23'-8 1/4	23'-8 1/4	22'-0	11'-11 3/8	26'-8 3/8	22'-5 3/8

Span	Hgt.	35° Skew A	35° Skew B	35° Skew C	35° Skew D	40° Skew A	40° Skew B	40° Skew C	40° Skew D	45° Skew A	45° Skew B	45° Skew C	45° Skew D
6'	3'	9'-0	5'-10 3/8	14'-5 3/8	10'-1 3/8	8'-6	6'-4 1/2	16'-1 1/4	9'-3 3/8	8'-0	6'-11 1/8	18'-3 3/8	8'-6 1/2
	4'	11'-6	5'-10 3/8	17'-3 3/8	12'-1 1/2	10'-6	6'-4 1/2	19'-6 3/8	11'-3 3/8	10'-0	6'-11 1/8	21'-11 3/8	10'-2 3/4
	5'	13'-6	5'-10 3/8	20'-7 1/8	14'-5	12'-6	6'-4 1/2	23'-0 3/8	13'-3 3/8	12'-0	6'-11 1/8	25'-6 3/8	11'-11 1/2
	6'	15'-6	5'-10 3/8	23'-5 1/2	16'-5 7/8	14'-6	6'-4 1/2	26'-6	15'-3 3/8	13'-6	6'-11 1/8	29'-7 3/4	13'-9 3/8
	7'	18'-0	5'-10 3/8	26'-8 3/8	18'-8 3/8	16'-6	6'-4 1/2	29'-11 1/2	17'-3 3/8	15'-6	6'-11 1/8	33'-3 3/8	15'-6 1/4
8'	3'	9'-0	8'-6 5/8	14'-5 3/8	10'-1 3/8	8'-6	9'-2 3/8	16'-1 1/4	9'-3 3/8	8'-0	9'-11 3/8	18'-3 3/8	8'-6 1/2
	4'	11'-6	8'-6 5/8	17'-3 3/8	12'-1 1/2	10'-6	9'-2 3/8	19'-6 3/8	11'-3 3/8	10'-0	9'-11 3/8	21'-11 3/8	10'-2 3/4
	5'	13'-6	8'-6 5/8	20'-7 1/8	14'-5	12'-6	9'-2 3/8	23'-0 3/8	13'-3 3/8	12'-0	9'-11 3/8	25'-6 3/8	11'-11 1/2
	6'	15'-6	8'-6 5/8	23'-5 1/2	16'-5 7/8	14'-6	9'-2 3/8	26'-6	15'-3 3/8	13'-6	9'-11 3/8	29'-7 3/4	13'-9 3/8
	7'	18'-0	8'-6 5/8	26'-8 3/8	18'-8 3/8	16'-6	9'-2 3/8	29'-11 1/2	17'-3 3/8	15'-6	9'-11 3/8	33'-3 3/8	15'-6 1/4
	8'	20'-0	7'-2 1/2	30'-2 1/4	21'-1 3/8	18'-6	7'-8 3/8	33'-8 3/8	19'-5 3/4	17'-6	8'-3 3/4	37'-10 1/2	17'-7 3/8
10'	3'	9'-0	11'-2 3/8	14'-5 3/8	10'-1 3/8	8'-6	12'-0 3/8	16'-1 1/4	9'-3 3/8	8'-0	13'-0 3/4	18'-3 3/8	8'-6 1/2
	4'	11'-5	11'-2 3/8	17'-3 3/8	12'-1 1/2	10'-6	12'-0 3/8	19'-6 3/8	11'-3 3/8	10'-0	13'-0 3/4	21'-11 3/8	10'-2 3/4
	5'	13'-6	11'-2 3/8	20'-7 1/8	14'-5	12'-6	12'-0 3/8	23'-0 3/8	13'-3 3/8	12'-0	13'-0 3/4	25'-6 3/8	11'-11 1/2
	6'	15'-6	11'-2 3/8	23'-5 1/2	16'-5 7/8	14'-6	12'-0 3/8	26'-6	15'-3 3/8	13'-6	13'-0 3/4	29'-7 3/4	13'-9 3/8
	7'	18'-0	11'-2 3/8	26'-8 3/8	18'-8 3/8	16'-6	12'-0 3/8	29'-11 1/2	17'-3 3/8	15'-6	13'-0 3/4	33'-3 3/8	15'-6 1/4
	8'	20'-0	9'-9 3/8	30'-2 1/4	21'-1 3/8	18'-6	10'-6 3/8	33'-8 3/8	19'-5 3/4	17'-6	11'-4 1/2	37'-10 1/2	17'-7 3/8
12'	8'	20'-0	12'-8 1/2	30'-2 1/4	21'-1 3/8	18'-6	13'-6 3/8	33'-8 3/8	19'-5 3/4	17'-6	14'-0 1/8	37'-10 1/2	17'-7 3/8

QUANTITIES

Span	Hgt.	0° Conc. C.Y. 1Bbl.	0° Δc	0° Steel lb. 1Bbl.	0° Δs	5° Conc. C.Y. 1Bbl.	5° Δc	5° Steel lbs. 1Bbl.	5° Δs	10° Conc. C.Y. 1Bbl.	10° Δc	10° Steel lbs. 1Bbl.	10° Δs	15° Conc. C.Y. 1Bbl.	15° Δc	15° Steel lbs. 1Bbl.	15° Δs	20° Conc. C.Y. 1Bbl.	20° Δc	20° Steel lbs. 1Bbl.	20° Δs
6'	3'	0.47	1.75	69	143	0.47	1.75	69	143	0.49	1.75	70	143	0.53	1.78	75	146	0.54	1.78	74	146
	4'	0.73	2.10	104	169	0.75	2.13	108	171	0.75	2.10	105	169	0.79	2.13	108	172	0.84	2.15	111	174
	5'	1.04	2.45	147	195	1.07	2.47	151	197	1.09	2.47	152	197	1.15	2.50	156	199	1.20	2.53	158	202
	6'	1.46	2.79	199	221	1.50	2.82	203	223	1.52	2.82	203	223	1.57	2.85	205	225	1.63	2.87	205	228
	7'	1.98	3.14	258	247	2.03	3.17	262	249	2.05	3.17	261	249	2.17	3.22	269	253	2.24	3.24	268	255
8'	3'	1.09	2.36	115	186	1.09	2.37	114	186	1.11	2.37	116	186	1.16	2.40	121	190	1.18	2.41	121	190
	4'	1.47	2.82	159	220	:.50	2.86	163	223	1.48	2.82	159	220	1.54	2.86	163	223	1.60	2.90	167	227
	5'	1.89	3.28	210	254	1.93	3.32	215	257	1.95	3.31	216	257	2.01	3.35	220	260	2.08	3.39	223	263
	6'	2.42	3.73	270	288	2.47	3.77	274	291	2.49	3.77	274	291	2.55	3.81	277	294	2.62	3.84	278	297
	7'	3.06	4.19	337	322	3.12	4.23	342	325	3.13	4.23	341	325	3.27	4.30	351	330	3.35	4.33	350	333
	8'	4.05	4.75	378	364	3.99	4.71	370	361	4.07	4.75	377	363	4.16	4.78	377	366	4.33	4.85	385	372
10'	3'	1.78	3.02	166	232	1.78	3.02	166	232	1.80	3.02	168	232	1.86	3.07	174	236	1.88	3.08	173	237
	4'	2.28	3.59	219	274	2.32	3.64	224	278	2.29	3.59	219	275	2.36	3.64	225	279	2.43	3.69	230	283
	5'	2.82	4.16	280	317	2.87	4.21	285	320	2.89	4.20	286	320	2.96	4.25	291	324	3.04	4.30	295	328
	6'	3.47	4.73	348	359	3.53	4.77	354	363	3.55	4.77	354	363	3.63	4.82	357	366	3.71	4.87	359	370
	7'	4.23	5.30	425	401	4.30	5.34	430	405	4.31	5.34	429	405	4:47	5.43	441	412	4.56	5.48	441	416
	8'	5.37	6.00	477	453	5.29	5.95	468	450	5.39	5.99	475	453	5.49	6.04	477	457	5.68	6.12	486	464
	9'	6.29	6.57	559	496	6.30	6.57	558	496	6.32	6.57	555	496	6.51	6.66	566	503	6.72	6.74	573	510
	10'	7.31	7.15	647	539	7.32	7.15	646	539	7.33	7.14	641	539	7.54	7.23	650	546	7.79	7.31	655	552
12'	8'	6.73	7.29	576	543	6.64	7.23	566	539	6.75	7.28	574	543	6.86	7.34	576	547	7.07	7.45	587	556

Span	Hgt.	25° Conc. C.Y. 1Bbl.	25° Δc	25° Steel lbs. 1Bbl.	25° Δs	30° Conc. C.Y. 1Bbl.	30° Δc	30° Steel lbs. 1Bbl.	30° Δs	35° Conc. C.Y. 1Bbl.	35° Δc	35° Steel lbs. 1Bbl.	35° Δs	40° Conc. C.Y. 1Bbl.	40° Δc	40° Steel lbs. 1Bbl.	40° Δs	45° Conc. C.Y. 1Bbl.	45° Δc	45° Steel lbs. 1Bbl.	45° Δs
6'	3'	0.98	1.76	106	145	1.40	1.73	137	144	1.85	1.73	173	144	2.23	1.74	202	147	2.65	1.78	237	151
	4'	1.38	2.10	150	170	1.94	2.09	194	171	2.41	2.07	228	170	2.91	2.06	267	170	3.42	2.10	304	175
	5'	1.83	2.43	203	195	2.48	2.40	252	193	3.10	2.39	299	194	3.67	2.39	341	194	4.29	2.42	381	198
	6'	2.42	2.81	265	223	3.14	2.73	320	218	3.85	2.69	369	216	4.62	2.71	424	218	5.36	2.72	473	221
	7'	3.14	3.15	335	248	4.02	3.07	396	243	4.92	3.06	461	243	5.72	3.03	518	242	6.55	3.04	568	244
8'	3'	1.61	2.38	152	188	2.02	2.35	183	187	2.48	2.35	220	188	2.86	2.38	249	190	3.31	2.43	285	195
	4'	2.12	2.83	205	221	2.68	2.83	249	222	3.15	2.80	282	221	3.66	2.80	321	221	4.18	2.85	360	227
	5'	2.68	3.27	266	255	3.32	3.22	314	252	3.94	3.22	361	252	4.52	3.22	403	253	5.15	3.28	444	258
	6'	3.39	3.76	337	291	4.10	3.67	390	285	4.79	3.62	439	282	5.57	3.64	495	285	6.32	3.67	544	287
	7'	4.23	4.20	415	324	5.09	4.11	474	318	5.98	4.09	539	317	6.78	4.07	596	316	7.61	4.09	647	319
	8'	5.27	4.68	459	359	6.21	4.59	528	353	7.18	4.53	598	349	8.12	4.51	661	349	9.19	4.56	728	354
10'	3'	2.31	3.04	205	235	2.72	3.01	235	233	3.17	3.02	272	234	3.57	3.05	302	237	4.04	3.13	339	243
	4'	2.93	3.60	266	276	3.50	3.60	310	277	3.97	3.57	343	275	4.48	3.58	382	276	5.02	3.65	423	283
	5'	3.61	4.15	335	317	4.24	4.10	383	314	4.87	4.10	430	314	5.45	4.11	473	315	6.11	4.18	516	322
	6'	4.46	4.76	416	363	5.14	4.65	468	355	5.83	4.60	516	351	6.62	4.64	573	355	7.38	4.67	623	358
	7'	5.41	5.32	503	404	6.25	5.21	561	396	7.14	5.19	626	395	7.94	5.16	682	394	8.79	5.20	734	397
	8'	6.57	5.91	557	448	7.49	5.81	624	441	8.45	5.73	693	436	9.39	5.71	756	435	10.48	5.79	825	441
	9'	7.67	6.47	650	490	8.88	6.41	737	485	9.97	6.33	813	480	10.90	6.25	875	475	12.22	6.36	960	483
	10'	9.01	7.09	754	536	10.17	6.91	842	522	11.36	6.84	924	518	12.66	6.86	1009	520	13.96	6.90	1090	523
12'	8'	7.93	7.20	654	537	8.82	7.08	720	528	9.77	7.00	788	522	10.72	6.98	851	521	11.83	7.08	921	528

NOTATIONS:

Δc = Apron concrete quantity per additional barrel.

Δs = Apron steel quantity per additional barrel.

NO	DESCRIPTION OF REVISIONS	MADE BY	DATE
1	Revised Quantities	C.H.	6-89
2			
3			
4			

DESIGN
DRAWN
CHECKED

CADD FILENAME= 27A
VIEW NAME=

DESIGN APPROVED: T.D. Davis

APPROVED FOR DISTRIBUTION: T.A. Bryant, II.

ARIZONA
DEPARTMENT OF TRANSPORTATION
HIGHWAYS DIVISION
STANDARD DRAWINGS

OUTLET APRON
DIMENSIONS & QUANTITIES
6 : 1 SLOPE

REVISION: 7-88

STANDARD NO. B-06.40