FINAL DRAINAGE REPORT
FOR THE
SABINO CANYON/TANQUE VERDE
INTERSECTION IMPROVEMENTS

February 16, 2011

Prepared for:

City of Tucson

Prepared by:

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FINAL DRAINAGE REPORT
FOR THE
SABINO CANYON/ TANQUE VERDE
INTERSECTION IMPROVEMENTS

Location:

A portion of Sections 31 and 32 of
Township 13 South, Range 15 East and
A portion of Sections 5 and 6 of
Township 14 South, Range15 East,
Gila & Salt River Meridian
City of Tucson, Arizona

Prepared for:

City of Tucson

February 16, 2011

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2	Existing Hydraulic Structures
3	Channel Analysis
4	Stormdrain Design
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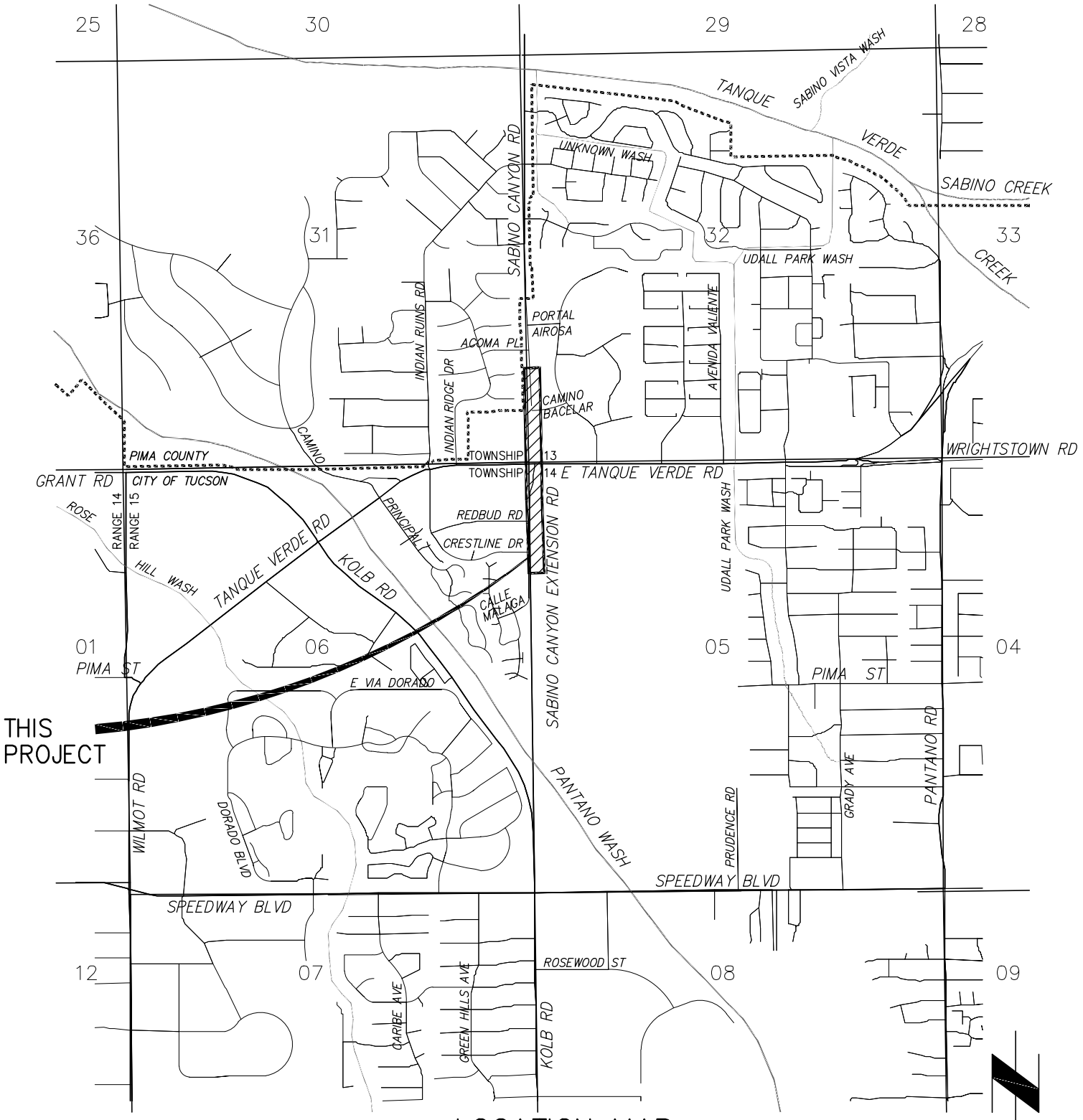
1.0 INTRODUCTION

This document will serve as the drainage report for the proposed improvements at the intersection of Sabino Canyon Road and Tanque Verde Road. The intersection improvements are the first portion of a larger project that will connect Sabino Canyon Road with Kolb Road to the south. The proposed improvements north of the intersection include widening along the west side of Sabino Canyon Road. South of the intersection, the proposed improvements include a four lane curbed divided roadway that extends approximately 1200 feet to just beyond the intersection with Crestline Drive. Other improvements include extension of an existing stormdrain system, a berm that prevents offsite runoff generated at Morris K. Udall Park from discharging onto the roadway during low flow events, and water harvesting basins that discharges excess flow into the extended stormdrain.

The proposed roadway and improvements to the existing roadways are located in Sections 31 and 32 of Township 13 South, Range 15 East and Sections 5 and 6 of Township 14 South, Range 15 East (G&SRM) within the City of Tucson, AZ. A Location Map is provided as Figure 1.

The project extents are depicted on FEMA FIRM Panels 04019C2252K and 04019C1665K and are located within a Zone X (unshaded) flood hazard area. Per the FIRM Panel legend, Zone X (unshaded) indicates areas outside the 500-year floodplain. Figure 2, FEMA FIRM PANELS is provided showing the approximate project boundary overlaid on the effective FIRM Panels.

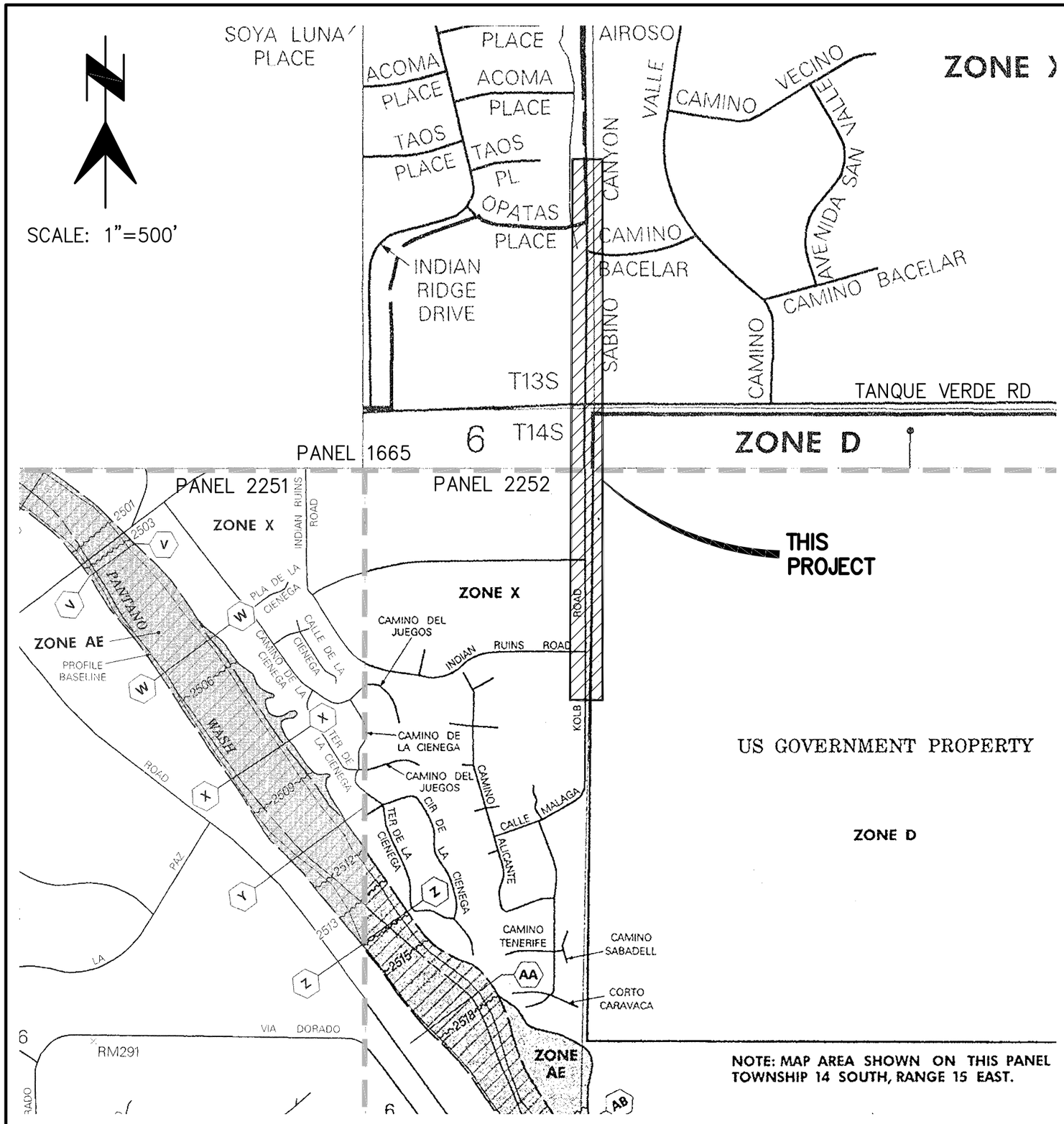


LOCATION MAP

Sections 31 & 32, T-13-S, R-15-E
Sections 5 & 6, T-14-S, R-15-E
City of Tucson, Pima County, Arizona
G & S.R.M.

FIGURE 1

Scale 3"=1mi



NOTE: MAP AREA SHOWN ON THIS PANEL TOWNSHIP 14 SOUTH, RANGE 15 EAST.

LEGEND

SPECIAL FLOOD HAZARD AREAS INUNDATED BY 100-YEAR FLOOD

- **ZONE A** No base flood elevations determined.
- **ZONE AE** Base flood elevations determined.
- **ZONE AH** Flood depths of 1 to 3 feet (usually areas of ponding); base flood elevations determined.
- **ZONE AO** Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
- **ZONE A99** To be protected from 100-year flood by Federal flood protection system under construction ; no base flood elevations determined.
- **ZONE V** Coastal flood with velocity hazard (wave action); no base flood elevations determined.
- **ZONE VE** Coastal flood with velocity hazard (wave action); base flood elevations determined.

FLOODWAY AREAS IN ZONE AE

OTHER FLOOD AREAS

- **ZONE X** Areas of 500-year flood; areas of 100-year flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 100-year flood.

OTHER AREAS

- **ZONE X** Areas determined to be outside 500-year floodplain.
- **ZONE D** Areas in which flood hazards are undetermined.

Floodway Boundary

Zone D Boundary

Boundary Dividing Special Flood Hazard Zones, and Boundary Dividing Areas of Different Coastal Base Flood Elevations Within Special Flood Hazard Zones.

513 — Base Flood Elevation Line; Elevation in Feet. See Map Index for Elevation Datum.

D — D — Cross Section Line

(EL 987) — Base Flood Elevation in Feet Where Uniform Within Zone. See Map Index for Elevation Datum.

RM7 — Elevation Reference Mark

M2 — River Mile

97°07'30", 32°22'30" — Horizontal Coordinates Based on North American Datum of 1927 (NAD 27) Projection.

NOTES

This map is for use in administering the National Flood Insurance Program; it does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size, or all planimetric features outside Special Flood Hazard Areas. The community map repository should be consulted for more detailed data on BFE's, and for any information on floodway delineations, prior to use of this map for property purchase or construction purposes.

Areas of Special Flood Hazard (100-year flood) include Zones A, AE, A1-A30, AH, AO, A99, V, VE and V1-V30.

Certain areas not in Special Flood Hazard Areas may be protected by flood control structures.

Boundaries of the floodways were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the Federal Emergency Management Agency.

Floodway widths in some areas may be too narrow to show to scale. Refer to Floodway Data Table where floodway width is shown at 1/20 inch.

Coastal base flood elevations apply only landward of 0.0 NGVD, and include the effects of wave action; these elevations may also differ significantly from those developed by the National Weather Service for hurricane evacuation planning.

Corporate limits shown are current as of the date of this map. The user should contact appropriate community officials to determine if corporate limits have changed subsequent to the issuance of this map.

This map may incorporate approximate boundaries of Coastal Barrier Resource System Units and /or Otherwise Protected Areas established under the Coastal Barrier Improvement Act of 1990 (PL 101-591).

For community map revision history prior to countywide mapping, see Section 6.0 of the Flood Insurance Study Report.

For adjoining map panels and base map source see separately printed Map Index.

MAP REPOSITORY
Refer to Repository Listing on Map Index

EFFECTIVE DATE OF
COUNTYWIDE FLOOD INSURANCE RATE MAP:
FEBRUARY 8, 1999

NATIONAL FLOOD INSURANCE PROGRAM

FIRM
FLOOD INSURANCE RATE MAP

PIMA COUNTY, ARIZONA AND INCORPORATED AREAS

PANEL 1665 OF 4700
(SEE MAP INDEX FOR PANELS NOT PRINTED)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
TUCSON, CITY OF	040076	1665	K
PIMA COUNTY, UNINCORPORATED AREAS	040073	1665	K

MAP NUMBER 04019C1665 K

EFFECTIVE DATE: FEBRUARY 8, 1999

Federal Emergency Management Agency

NATIONAL FLOOD INSURANCE PROGRAM

FIRM
FLOOD INSURANCE RATE MAP

PIMA COUNTY, ARIZONA AND INCORPORATED AREAS

PANEL 2251 OF 4700
(SEE MAP INDEX FOR PANELS NOT PRINTED)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
TUCSON, CITY OF	040076	2251	K

MAP NUMBER 04019C2251 K

EFFECTIVE DATE: FEBRUARY 8, 1999

Federal Emergency Management Agency

NATIONAL FLOOD INSURANCE PROGRAM

FIRM
FLOOD INSURANCE RATE MAP

PIMA COUNTY, ARIZONA AND INCORPORATED AREAS

PANEL 2252 OF 4700
(SEE MAP INDEX FOR PANELS NOT PRINTED)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
PIMA COUNTY, UNINCORPORATED AREAS	040073	2252	K

MAP NUMBER 04019C2252 K

EFFECTIVE DATE: FEBRUARY 8, 1999

Federal Emergency Management Agency

PSOMAS
800 E. Wetmore Road, Suite 110
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FEMA FIRM PANELS
FOR
SABINO CANYON / TANQUE VERDE INTERSECTION IMPROVEMENTS
FIGURE 2

2.0 HYDROLOGIC ANALYSIS

The City of Tucson Modified Rational Method was used in the hydrologic analysis of both onsite and offsite watersheds for this project to estimate peak discharges for the 100-year storm event under existing and proposed conditions. Where design dictated the use of a 10-year design storm event, a ratio of 0.50 was applied to the 100-year peak discharge per Table 4.5 of the Standards Manual for Drainage Design and Floodplain Management in Tucson, Arizona (SMDDFM, Reference 1).

Existing conditions watersheds were delineated using a combination of digital topography with one foot contour intervals that included recent topography flown specifically for this project as well as 2005 Pima Association of Governments (PAG) topography. The digital topography was also used to determine the flow lengths for each watershed and the elevation change over the watershed. Aerial photography obtained from PAG (2005) was used to determine the vegetative cover, imperviousness, and basin factor of each watershed. Soils data was obtained from the NRCS Soil Survey for Pima County, Arizona, Eastern Part (AZ669). These parameters were then used to calculate peak discharges for each watershed. To determine the peak discharges under proposed conditions, watershed parameters were modified according to the proposed design. Parameters that changed under proposed conditions were watershed areas, lengths and imperviousness percentages. Table 1 summarizes the existing conditions hydrologic analysis. Table 2 summarizes the proposed conditions hydrologic analysis. Watershed delineations and design storm discharges are depicted on Figure 3 for existing conditions and Figure 4 for proposed conditions. Calculation sheets are provided in Appendix 1 for both existing and proposed conditions.

Table 1

HYDROLOGIC ANALYSIS – EXISTING CONDITIONS

Watershed ID	Area	Length	Slope	Basin Factor	Runoff Coefficient	Impervious	Q_{10}	Q_{100}
	(ac)	(ft)	(%)	(-)	(-)	(%)	(cfs)	(cfs)
OS1	9.59	1340	1.1	0.048	0.84	60	26	52
OS2	12.22	1970	1.0	0.052	0.72	15	27	53
OS3	13.23	1626	1.0	0.052	0.67	15	28	56
N1	1.12	433	2.1	0.055	0.62	5	3	7
N2	0.08	350	1.1	0.048	0.82	60	3	6
N3	0.77	233	4.3	0.048	0.92	90	3	7
N3.1	0.48	388	0.8	0.055	0.62	30	1	3
N4	2.96	944	1.1	0.055	0.65	1	8	15
N4.1	0.23	197	1.5	0.055	0.62	0	1	1
N4.2	0.49	461	1.1	0.048	0.94	85	2	4
N5	3.65	552	1.6	0.050	0.69	25	12	24
N5.1	0.49	401	1.5	0.055	0.62	20	1	3
N6	1.83	355	2.3	0.050	0.69	25	6	12
N7	0.82	350	1.4	0.055	0.62	5	2	5
N8	1.07	473	2.3	0.048	0.94	100	5	10
N8.1	1.07	417	2.6	0.048	0.94	100	5	10
N9	2.06	608	1.5	0.052	0.73	45	7	14
N10	1.38	730	1.2	0.048	0.92	90	7	12
N11	1.03	372	1.6	0.048	0.93	90	5	9
N12	1.30	481	1.4	0.048	0.93	90	6	12
N13	1.66	1292	0.6	0.048	.092	100	6	12

Table 2

HYDROLOGIC ANALYSIS – DEVELOPED CONDITIONS

Watershed ID	Area	Length	Slope	Basin Factor	Runoff Coefficient	Impervious	Q_{10}	Q_{100}
	(ac)	(ft)	(%)	(-)	(-)	(%)	(cfs)	(cfs)
OS1	9.59	1340	1.1	0.048	0.84	60	26	52
OS2	12.23	1970	1.1	0.052	0.72	15	27	53
OS3	13.23	1626	1.1	0.052	0.67	15	28	56
N1	1.12	433	2.1	0.055	0.62	5	3	7
N2	0.88	404	1.0	0.048	0.92	90	4	8
N3	0.77	233	4.3	0.048	0.92	90	3	7
N3.1	0.48	388	0.8	0.048	0.92	90	2	4
N4	2.96	944	1.1	0.055	0.65	1	8	15
N4.1	0.63	559	5.5	0.048	0.94	100	3	6
N5	3.65	552	1.6	0.048	0.73	35	13	25
N5.1	0.49	401	1.5	0.048	0.92	100	2	4
N6	1.53	354.6	2.3	0.048	0.73	35	4	11
N6.1	0.22	244	2.0	0.048	0.94	100	1	2
N7	0.82	350	1.4	0.048	0.82	60	3	7
N8	1.07	473	2.3	0.048	0.94	100	5	10
N8.1	1.07	417	2.6	0.052	0.73	45	5	10
N9	2.06	608	1.5	0.052	0.73	45	7	14
N10	1.65	730	1.2	0.048	0.92	90	6	14
N11	1.03	372	1.6	0.048	0.93	90	5	9
N12	1.30	481	1.4	0.048	0.93	90	6	12
N13	1.66	1292	0.6	0.048	.092	100	6	12

Offsite flows originate from both the east and west sides of Sabino Canyon Road. North of the intersection of Sabino Canyon Road and Tanque Verde Road, runoff from both the east and west sides of the roadway is collected at transverse grates across the driveways to the commercial shopping areas and were not calculated as it is assumed that they were designed correctly to collect 100% of the runoff and will be replaced with similarly sized grates. Peak discharges generated within the roadway along the western side of the road north of the intersection were calculated under existing and proposed conditions (N10, N11, and N12) in order to quantify the increase in peak discharge caused by the widening. South of the intersection, offsite runoff from the east (Watersheds OS1, OS2, OS3) originates within the Morris K. Udall Park and is directed into detention basins along the west side of the park. Flow discharges from these basins through pipe culverts and overflow weirs that are located above the pipes. Under existing conditions, outflow from these basins is conveyed north

where it enters an existing stormdrain system located at concentration point N1. Under proposed conditions, flow adjacent to the detention basins is still directed north, however it will enter the stormdrain system via a new drop inlet structure. Runoff from the west (Watersheds N5, N6, N8, N8.1, and N9) originates on commercial and residential land and flows across the roadway under existing conditions where it is then conveyed to the north and enters the existing stormdrain at concentration point N1. Under proposed conditions, this flow will be collected at area grates located in water harvesting basins and transverse grates located at the two commercial driveways just south of the intersection, and directed into an extension of the existing storm drain. Watersheds N1, N4, and half of N7 are undeveloped land east of the proposed roadway that conveys flow towards concentration N1. Watersheds N2, N3, N3.1, N4.1, N4.1, N5.1 and N6.1 are generally undeveloped land under existing conditions that slope towards the northeast directing flow towards concentration point N1, however under proposed conditions, are the watersheds containing the roadway improvements. Runoff from these watersheds will be collected at catch basins and area grates and directed into the proposed storm drain extension.

A direct summation of the peak discharges during the 100-year storm event shows an increase in total peak discharge during the 100-year storm event of 11 cfs. This would yield a maximum 7.3% increase assuming the existing basins at Udall Park provided complete retention. If it is assumed that they provide no detention, the increase would be 3.6%. The basins have both low flow outlets and weirs for overtopping which suggests that there is outflow from the basins in any event so the overall increase would be somewhere between the two values. Analysis of the existing basins was not performed. Appendix 1 contains a summary of the stormdrain volume calculations and the hydrograph used for the increased volume determination.

Figure 3, Existing conditions Watershed Map, depicts the existing conditions watershed delineations and concentration points. Figure 4, Developed Conditions Watershed Map, depicts the proposed conditions watershed delineations, stormdrain extension and inlets.

3.0 EXISTING HYDRAULIC STRUCTURES

3.1 Existing Detention Basins

There are three existing detention basins located along the western side of Morris K. Udall Park that collect and detain runoff from the offsite watersheds within the park (Watersheds OS1, OS2, and OS3). Each basin has a pipe outlet and grouted riprap overflow weir. A hydrologic and hydraulic report for these structures was not available and the project topography did not sufficiently cover each basin so an independent hydraulic analysis of each basin was not performed. The lack of available data results in an unknown discharge from each basin and an assumption being made that the entire peak discharge during the 100-year storm event exits each basin.

3.2 Existing Stormdrain

An existing stormdrain system is located within the project limits that begins upstream at the southeast corner of the intersection of Sabino Canyon Road and Tanque Verde Road at concentration point N1. At the upstream end of the system is a drop inlet into a 54" RCP. The system extends to the north along Sabino Canyon Road collecting roadway and offsite runoff, eventually discharging through a 72" RCP into the Tanque Verde Wash. The as-built drawings for this system were obtained from Pima County Mapguide and show a design discharge of 166 cfs at the upstream end of the system. The design storm event of the existing stormdrain system was not identified on the as-builts, however it is comparable to the 10-year storm event peak discharge of 156 cfs calculated by direct summation of the existing conditions hydrologic analysis. Utilizing the record drawings to determine pipe sizes, lengths, inverts, and depth of cover, a hydraulic model was developed to analyze the existing mainline. This analysis shows that the existing conditions hydraulic grade line would be just above the crown of the pipe at the inlet using a junction loss coefficient of 1.0. The inlet acts more like a culvert however, and analyzing the upstream most segment of pipe as a culvert and setting the tailwater conditions to the elevation of the HGL at the downstream end of this segments, a headwater elevation of 2526.33 is necessary to convey the 166 cfs used as the design discharge. At this water surface elevation, there would be ponding at depths of over

two feet in Sabino Canyon Road south of the intersection. During larger events, the ponding depth would increase until reaching the elevation at the centerline of Tanque Verde Road where it would then spill north along Sabino Canyon Road. The centerline of Tanque Verde Road in the intersection is at an elevation of 2527.00. Therefore, during the design event, water will pond to this elevation and during larger storm events will overflow to the north along Sabino Canyon. A copy of the as-builts for the existing storm drain system is provided in Appendix 2 as well as culvert calculation sheet.

4.0 PROPOSED DRAINAGE DESIGN

4.1 WATER HARVESTING

Water harvesting basins will be utilized along the west side of the roadway to collect offsite and pavement runoff which will then be conveyed through area grates into the proposed stormdrain system. The three concentration points that discharge from the water harvesting basins into the stormdrain system are N5, N6, and N9. The area grate at concentration point N5 will require two PC/COT EF-1 grates, at N9 two PC/COT EF-1 grates will be needed and the area grate at concentration point N6 will require one PC/COT EF-1 grates. The grates at concentration points N5 and N9 require a minimum of 1.1 ft. of ponding to occur in order to convey the 100-year storm event. The grate at concentration point N6 requires 0.75 ft of ponding to convey the 100-year storm event peak discharge. Grate inlet calculation sheets are provided in Appendix 4.

4.2 CHANNEL DESIGN

Along the east side of the roadway is an area that conveys basin outlet flow which will be formed between the detention basins and a proposed berm that will be located behind the sidewalk along Sabino Canyon Road for approximately 400 feet south of Tanque Verde Road. This conveyance area has been labeled as “Channel 1” within this report and will discharge into a drop inlet into the proposed stormdrain system. A bus pullout has been located near concentration point OS2 that will require modifications be made to the detention basin at OS2 in order to convey flow from the south (OS3 and N7) around the pullout and to

the north within Channel 1. The bottom width between the bus pullout and basin shall be a minimum of 20 feet and the basin shall be reconstructed to the same elevation that currently exists. The basin weir and low flow outlet shall also be reconstructed to match existing conditions. The modifications to this basin should provide a minimal amount of overall loss in total basin volume. A HEC-RAS model was created to model the flow within Channel 1. Cross sections were cut every 50' along the roadway centerline alignment. The proposed berm was modeled in each cross section and the modifications to the basin near the bus pullout were also modeled. HEC-RAS output is provided in Appendix 3. Table 3 summarizes the HEC-RAS analysis along Channel 1, with the cross section number corresponding to the station of that cross section along the centerline. This channel was modeled to demonstrate that the berm was set at an elevation sufficient to separate potential runoff along the east side of the roadway from entering the road. During a large storm event, such as the 100-year storm event, where the stormdrain does not have capacity to convey all the flow, the area will be ponded to an elevation of 2527.

Table 3
HEC-RAS SUMMARY

River Sta	Q Total	Min Ch El	W.S. Elev	Vel Chnl
	(cfs)	(ft)	(ft)	(ft/s)
6100	62	2533.05	2533.77	2.84
6050	62	2532.7	2533.28	2.66
6000	62	2532	2532.56	3.29
5950	62	2531.11	2531.95	1.96
5900	62	2530.71	2531.83	1.96
5850	62	2530.37	2531.82	1.09
5800	115	2530.26	2531.25	4.85
5750	115	2529.55	2530.7	4.53
5700	115	2528.96	2529.85	4.05
5650	115	2528.39	2529.23	3.65
5600	115	2527.47	2528.78	3.03
5550	115	2527.43	2528.13	3.9
5500	115	2526.8	2527.92	2.31
5450	115	2526.6	2527.76	2.37
5400	131	2526.13	2527.28	4.14
5350	131	2525.9	2526.99	3.01
5300	131	2525.45	2526.57	3.84
5250	131	2524.92	2526.36	3.07
5200	131	2524.54	2526.27	2.41
5150	189	2524.37	2525.94	3.71

4.3 Pavement Drainage

Pavement drainage has been designed to meet the requirement set in Section X of the SMDDFM that states that during the 10-year storm event, at least one lane be kept free from runoff. Five catch basins (CB2,CB3,CB5,CB7, CB11), three scuppers (SC1, SC2, SC3) and two transverse grates (CB4, CB6) have been located and sized along the curbed segment of roadway in order to meet these requirements. Scupper SC3 will not be constructed as part of this project, however, will be constructed when the southern portion of the project is built. It has been included in this report since it is associated with conveyance of flow that enters the proposed storm drain system. SC1 will be constructed at the southwest corner of the intersection that will replace an existing scupper that drains the parking lot from the commercial lot to the south. No calculations were performed for this scupper. The transverse grates are sized to ensure 100% capture of runoff during the 100-year storm event. In order to

size the transverse grates, normal depth flow calculations were performed to determine the depth and velocity of flow across the grates. Figure 10.5 from the City of Tucson manual was then used to check that the velocity was below the splash over velocity for the proposed grate width of 4 ft. The velocity of flow over the grates is just under 4 fps and the splash over velocity is roughly 6.5 fps. North of the intersection, where the roadway is being widened along the western side, calculations were performed to verify that the increased runoff due to the widening would still allow for one lane free of flow. The calculations show that the spread is increased from 18 ft to 19 ft, keeping the flow contained within the turn lanes and leaving a travel lane free of flow. There are also two transverse grates that will be reconstructed north of the intersection that collect runoff from the commercial lot at the northwest corner of the intersection. No calculations were performed for these grates as it is assumed they are designed correctly. Catch basin and scupper sizing and the resulting spread are summarized in Table 4. The proposed roadway is two lanes in each direction, and the maximum spread is 10 feet, which is less than a single lane width resulting in the required one lane free of flow during the 10-year storm event. Inlet sizing calculation sheets are provided in Appendix 4.

Table 4
PAVEMENT DRAINAGE INLET DESIGN

Inlet ID	Inlet Type	Minimum Length	Q_{DESIGN}	Spread
		(ft)	(cfs)	(ft)
CB2	Catch Basin (at sag)	16	4	9
CB3	Catch Basin (at sag)	24	3	6
CB5	Catch Basin (on grade)	14	2	9
CB7	Catch Basin (on grade)	14	3	10
SC2	Scupper (on grade)	14	2	9
SC3	Scupper (on grade)	12	2	8
CB4	Transverse Grate	4	10	N/A
CB6	Transverse Grate	4	10	N/A
CB11	Catch Basin (on grade)	20	6	16

4.4 STORMDRAIN

The proposed stormdrain extension will connect to the existing 54" pipe in the intersection of Tanque Verde Road and Sabino Canyon Road. The mainline will extend to the south to Crestline Drive with laterals originating at catch basins, area grates, and transverse grates. The laterals connect to the mainline at manholes. Design discharges entering the system include 100-year peak discharges for offsite flows combined with 10-year peak discharges from the proposed roadway. At concentration point N1, the difference between the design discharge shown on the as-built plans of 166 cfs and the discharges collected by the proposed storm drain extension is 79 cfs. This value is used as the design discharge that will be conveyed from Channel 1 into stormdrain system at this location through a drop inlet structure similar to that of existing conditions. Table 5 summarizes the stormdrain hydraulic analysis. Output from the hydraulic model is provided in Appendix 4. Layout of the proposed storm drain extension is shown on Figure 4, Developed Conditions Watershed Map.

Table 5
STORMDRAIN ANALYSIS

Hydraflow Line No.	Upstream Structure	Diameter (in)	Length (ft)	Upstream HGL	Velocity (fps)	Q_{DESIGN} (cfs)
13	Drop Inlet	54	165.24	2524.51	10.44	166
14	MH2	54	26.86	2525.41	5.51	87.60
15	MH3	54	102.88	2525.81	5.05	80.30
16	MH4	54	102.88	2526.15	4.44	70.60
17	MH5	48	64.88	2526.45	5.45	68.45
18	MH6	42	76.65	2527.03	7.12	68.45
19	MH7	36	85.58	2528.09	8.31	58.75
20	CB9	36	219.42	2529.51	5.97	42.20
21	MH8	24	204.92	2530.24	4.04	12.70
22	CB10	24	202.63	2531.13	4.04	12.70
23	CB2	24	9.08	2525.65	2.32	7.30
24	CB3	24	123.69	2525.76	1.08	3.40
25	CB4	30	163.59	2526.10	1.98	9.70
26	CB5	24	134.98	2526.31	0.68	2.15
27	CB6	24	80.9	2527.57	3.09	9.70
28	CB7	24	50.91	2528.64	0.88	2.75
29	CB8	24	56.91	2528.84	4.39	13.80
30	CB11	24	69.05	2523.36	1.83	5.75

The proposed stormdrain system will provide a more efficient method for conveying flow into the existing stormdrain system, collecting the runoff at numerous locations rather than one as under existing conditions, each of which was specifically sized for 10-year or 100-year peak discharge values. The new proposed drop inlet structure will now be required to convey less than under existing conditions as a significant portion of the flow will already be in the system.

The ability of the stormdrain system to convey this flow is dependent on the downstream conditions. Assumptions that have to be made in order for the flow to be conveyed within this system are as follows:

1) The design discharges shown on the existing plans are correct and have not been increased by development.
2) No additional connections to the mainline have been made since the design.
3) There is no clogging within the pipe.

During the 10-year storm event, due to the improved inlet conditions along the proposed stormdrain, the ponding at the intersection should occur outside the roadway. During larger events, ponding within the roadway will still occur, however the roadway profile has been adjusted such that the low point is at an elevation greater 2526.00 which will result in less than 1 foot of ponding within the travel lanes during larger storm events where the runoff will spill over Tanque Verde Road and continue north along Sabino Canyon Road.

4.5 Erosion Protection

Erosion protection is recommended at three locations within the project limits where roadway runoff discharges onto natural ground. One location is downstream of the Crestline Drive dip section on the east side of the roadway where basin OS3 outflow and local drainage from watershed N7 will pass over the roadway. A normal depth calculation of the dip section was performed and shows a velocity over the roadway of 3.88 ft/s. Rock riprap protection with a

D_{50} = 6" is recommended for a minimum length of 10 ft downstream of the roadway. The other locations will be at the outlet of the two scuppers at concentration points N5.1 and N6.1 where rock riprap with a D_{50} = 6" and a minimum length of 5 ft is recommended. West consultant computer program based on HEC_11 was used to estimate riprap sizing and splashpad lengths. For each of the three locations, a rectangular culvert scenario was chosen within the program and the width and height were based on the scupper length and height for the two scuppers and the top width and depth of flow within the dip section along Crestline Drive. The purpose of the calculation sheet is to show that the minimum D_{50} required is less than the 6" recommended. The calculation sheet is provided in Appendix 5.

5.0 SUMMARY AND CONCLUSIONS

This report discusses the drainage design associated with the Sabino Canyon Road and Tanque Verde Road intersection improvements which are part of a larger project that will extend Sabino Canyon Road south to an intersection with Kolb Road. Construction of catch basins, transverse grates, area grates, and a scupper are necessary in order to convey flow into a proposed storm drain extension and maintain one lane free of travel during the 10-year design storm event. Roadside channels will also be constructed in order to convey flow to the proposed area grates.

Three detention basins are located along the east side of the project at the Morris K. Udall Park that no existing reports were able to be obtained for. There was also not enough topography flown for the project in order to be able to analyze the basins. For these reasons, it is assumed that the detention basins do not reduce the peak discharge and that the stormdrain system will only accept flows up to the design discharge of 166 cfs shown on the as-built plans of the existing system downloaded from Pima County Mapguide.

No FEMA floodplains exist within the project limits. With the assumption that the detention basins do not reduce peak flow, there will be a discharge greater than 100 cfs along the eastern side of the existing and proposed roadway, however the regulatory floodplains have

not been mapped for this area since the true peak discharge is unknown. Water surface elevations were provided based on a HEC-RAS model that show that given the assumed peak discharge based on no detention water will be contained within Channel 1 and will not flow onto the roadway. Channel 1 is formed between the existing detention basins and a proposed berm.

The drainage design concept presented in this Drainage Report was designed with the intent that drainage affecting the project will be handled in a manner that does not conflict with any federal, state and/or county regulations intended to protect adjacent properties and/or the project itself from adverse impacts during design storm events specified in the current regulations, which is the current standard in the industry. This Engineer's Statement is not to be interpreted as expanding its scope of work under the relevant contract

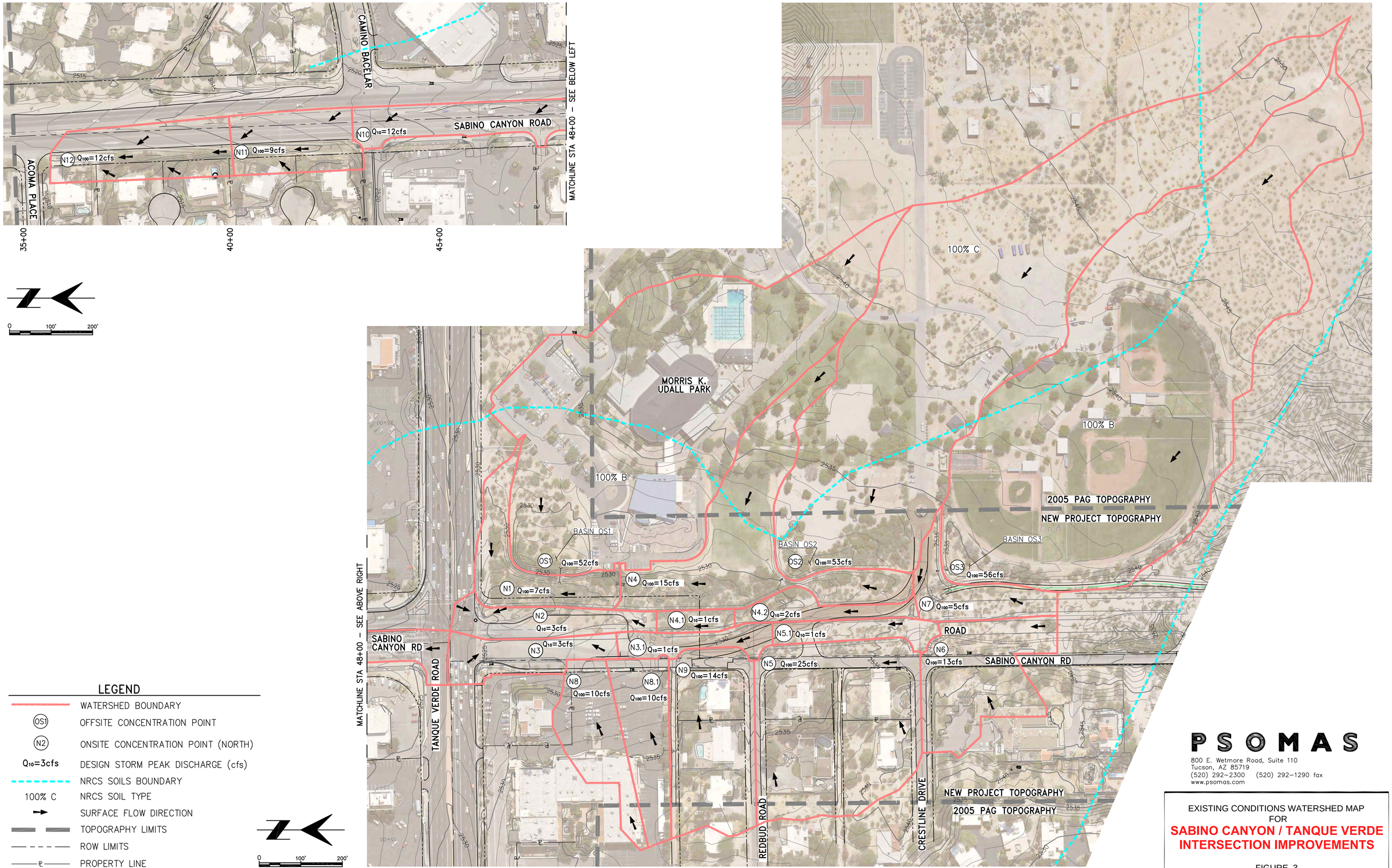
6.0 REFERENCES

1) Simons, Li & Associates, Inc.; *Standards Manual for Drainage Design and Floodplain Management in Tucson, Arizona*; City of Tucson Department of Transportation Engineering Division, Revised July 1998.

2) Natural Resources Conservation Service. *Soil Survey for Pima County, Arizona, Eastern Part (AZ669).* Version 6, September 8, 2008.

3) Pima County MapGuide

http://www.dot.co.pima.az.us/gis/maps/mapguide/mgmap.cfm?path=/gis/maps/mapguide/dotmap65.mwf



LEGEND

- WATERSHED BOUNDARY
- (OS1) OFFSITE CONCENTRATION POINT
- (N2) ONSITE CONCENTRATION POINT (NORTH)
- Q_{10}=3cfs DESIGN STORM PEAK DISCHARGE (cfs)
- NRCS SOILS BOUNDARY
- 100% C NRCS SOIL TYPE
- SURFACE FLOW DIRECTION
- TOPOGRAPHY LIMITS
- ROW LIMITS
- PROPERTY LINE

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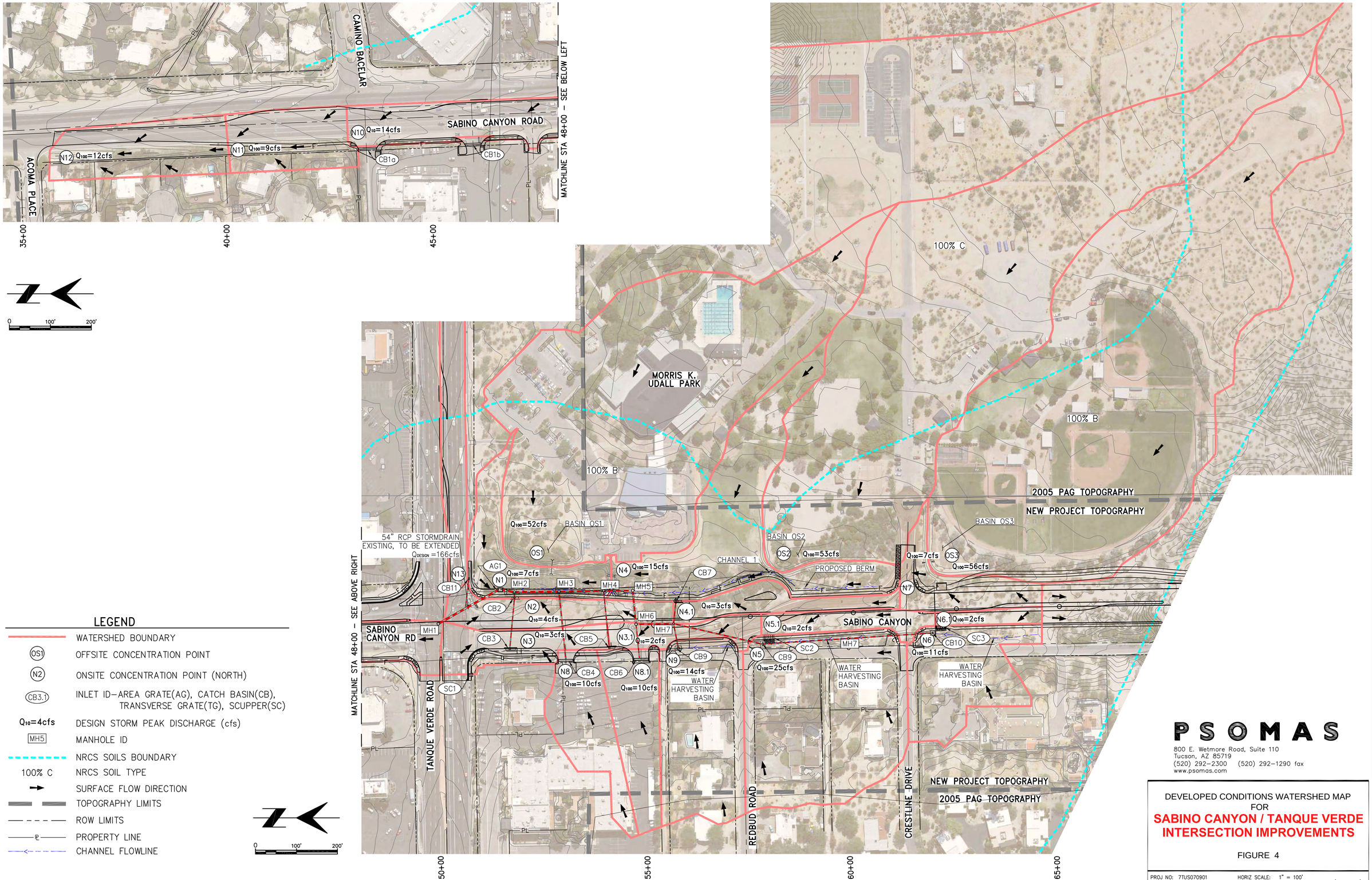
EXISTING CONDITIONS WATERSHED MAP
FOR
SABINO CANYON / TANQUE VERDE INTERSECTION IMPROVEMENTS

FIGURE 3

PROJ NO:	7TUS070901	HORIZ SCALE:	1" = 100'
DATE:	JUNE 2010	CONTOUR INTERVAL:	1'

I:\7TUS070901\HYDRO\DRAINAGE\SHEETS\North Project\FIG 3-1 Check Remme Wed, 02 Jun 2010, 3:01pm Last Saved By: Oremme



LEGEND

- WATERSHED BOUNDARY
- (OS1) OFFSITE CONCENTRATION POINT
- (N2) ONSITE CONCENTRATION POINT (NORTH)
- (CB3.1) INLET ID–AREA GRATE(AG), CATCH BASIN(CB), TRANSVERSE GRATE(TG), SCUPPER(SC)
- Q_{10}=4cfs DESIGN STORM PEAK DISCHARGE (cfs)
- [MH5] MANHOLE ID
- NRCS SOILS BOUNDARY
- 100% C NRCS SOIL TYPE
- SURFACE FLOW DIRECTION
- TOPOGRAPHY LIMITS
- ROW LIMITS
- PROPERTY LINE
- CHANNEL FLOWLINE

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DEVELOPED CONDITIONS WATERSHED MAP
FOR
SABINO CANYON / TANQUE VERDE INTERSECTION IMPROVEMENTS

FIGURE 4

PROJ NO: 7TUS070901 HORIZ SCALE: 1" = 100'
DATE: JUNE 2010 CONTOUR INTERVAL: 1'

T:\7TUS070901\HYDRO\DRAINAGE\SHEETS\North Project\FIG 4_Dev Watershed.dwg FIG 4-1 John Oliver Tue, 15 Feb 2011, 10:06am Last Saved By: joliver

APPENDIX 1

HYDROLOGIC ANALYSIS

EXISTING CONDITIONS

City of Tucson

Hydrologic Data Sheet for Computing 100-year Peak Discharge (Q_{p100})

1. Project Name and Location: Kolb/Sabino Canyon Road Extention
2. Drainage Concentration Point: OS1
3. *Watershed Area (A) at Drainage Concentration Point: 9.59 acres
4. Length of Hydraulically Longest Watercourse (Lc): 1338.9 ft.
5. Length from center of Watershed Area (Lca) along Lc: 669.4 ft.

For (Check One):
- [x] Existing Condtions†
- [ ] Future Conditions†

6. Change in Length Factors - ft / Change in Elevation Factors - ft

a. ΔL_1:	1338.9	$(\Delta L_1)^3$:	2.4E+09	ΔH_1:	14.0	$(\Delta L_1)^3/\Delta H_1$:	1.7E+08
b. ΔL_2:		$(\Delta L_2)^3$:		ΔH_2:		$(\Delta L_2)^3/\Delta H_2$:	
c. ΔL_3:		$(\Delta L_3)^3$:		ΔH_3:		$(\Delta L_3)^3\Delta H_3$:	
d. ΔL_4:		$(\Delta L_4)^3$:		ΔH_4:		$(\Delta L_4)^3/\Delta H_4$:	

7. $$G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2} = 13092.8 + ___ + ___ + ___ = \mathbf{13092.8}$$

8. Mean Slope $(S_c) = (L_c/G)^2 = (\ 1338.9\ /\ 13092.8\ )^2 =$ 1.05% ft./ft.

9. Areally reduced 100-year, one-hour rainfall depth ($P_{1,100}$): 3.00 inches.

	Subarea 1	Subarea 2	Subarea 3	Weighted Watershed Parameters
10. Watersheds Type(s) (% of Total Area):	Nat (40%)	Nat (60%)	( )	
11. Basin Factor ($n_{b,100}$):	0.048	0.048		n_{bw100} = 0.048
12. Soil Types, in %:	100% B	100%C		
13. Imperviousnes (%):	60%	60%		I_w = 60.0%
14. Runoff Coefficient (C_{w100}):	0.82	0.86		C_{w100} = 0.84
15. Contrib. Area Factor (F_{Ac}):	0.8	0.8		F_{Acw} = 0.80

16. **Time of Concentration (T_{c100}): 10.0 minutes, determined from:

$$T_{c100} = \left(\frac{0.23 n_{bw100}\left(L_c L_{ca}\right)^{0.3}}{\left(S_c P_{1,100} C_{w100}\right)^{0.4}} + 1.31\right)^{1.61} \quad \text{when } 5 \le Tc100 \le 180.$$

17. At T_{c100}, 100-year Rainfall Intensity $(i_{100}) = (4P_{1,100})/(1+0.05T_{c100})$ = 8.0 inches/hour.
18. 100-Year Peak $(Q_{p100}) = (C_{w100})(i_{100})(F_{Acw})A$= 0.84 x 8.00 x 0.8 x 9.6 = 51.6 cfs.
19. For Other Return Periods

	2-Year	10-year	25-Year	50-Year
Ratio to 100-Year Peak:	0.22	0.50	0.70	0.90
Q (Cubic feet/second)	11	26	36	46
Tc (minutes {Eqn. 4.5}):	18.4	13.3	11.6	10.5

*A may not exceed 6,400 acres (10 square miles) in size. **T_{c100} may not exceed 180 minutes. If $T_{c100} \le 5$, set T_{c100} = 5 minutes.

NOTE: Indicate whether hydrologic computations are for "Future Conditions" or "Existing Conditions" by checking the appropriate box above.

Prepared by: JP Checked by: _____ Company: Psomas Date: 05/27/10

City of Tucson

Hydrologic Data Sheet for Computing 100-year Peak Discharge (Q_{p100})

1. Project Name and Location: Kolb/Sabino Canyon Road Extention
2. Drainage Concentration Point: OS2
3. *Watershed Area (A) at Drainage Concentration Point: 12.22 acres
4. Length of Hydraulically Longest Watercourse (Lc): 1970.5 ft.
5. Length from center of Watershed Area (Lca) along Lc: 985.3 ft.

For (Check One):
- [x] Existing Condtions†
- [ ] Future Conditions†

6. Change in Length Factors - ft / Change in Elevation Factors - ft

a. ΔL_1:	1970.5	$(\Delta L_1)^3$:	7.7E+09	ΔH_1:	20.5	$(\Delta L_1)^3/\Delta H_1$: 3.7E+08
b. ΔL_2:		$(\Delta L_2)^3$:		ΔH_2:		$(\Delta L_2)^3/\Delta H_2$:
c. ΔL_3:		$(\Delta L_3)^3$:		ΔH_3:		$(\Delta L_3)^3\Delta H_3$:
d. ΔL_4:		$(\Delta L_4)^3$:		ΔH_4:		$(\Delta L_4)^3/\Delta H_4$:

7. $$G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2} = 19319.3 + ___ + ___ + ___ = \mathbf{19319.3}$$

8. Mean Slope $(S_c) = (L_c/G)^2 = ($ 1970.5 / 19319.3 $)^2 =$ 1.04% ft./ft.

9. Areally reduced 100-year, one-hour rainfall depth ($P_{1,100}$): 3.00 inches.

	Subarea 1	Subarea 2	Subarea 3	Weighted Watershed Parameters
10. Watersheds Type(s) (% of Total Area):	Nat (27%)	Nat (73%)	( )	
11. Basin Factor ($n_{b,100}$):	0.052	0.052		n_{bw100} = 0.052
12. Soil Types, in %:	100% B	100%C		
13. Imperviousnes (%):	15%	15%		I_w = 15.0%
14. Runoff Coefficient (C_{w100}):	0.65	0.74		C_{w100} = 0.72
15. Contrib. Area Factor (F_{Ac}):	0.9	0.9		F_{Acw} = 0.90

16. **Time of Concentration (T_{c100}): 15.7 minutes, determined from:

$$T_{c100} = \left(\frac{0.23 n_{bw100}\left(L_c L_{ca}\right)^{0.3}}{\left(S_c P_{1,100} C_{w100}\right)^{0.4}} + 1.31\right)^{1.61} \quad \text{when } 5 \le Tc100 \le 180.$$

17. At T_{c100}, 100-year Rainfall Intensity (i_{100}) = $(4P_{1,100})/(1+0.05T_{c100})$ = 6.7 inches/hour.
18. 100-Year Peak (Q_{p100}) = $(C_{w100})(i_{100})(F_{Acw})A$= 0.72 x 6.70 x 0.9 x 12.2 = 53.1 cfs.
19. For Other Return Periods

	2-Year	10-year	25-Year	50-Year
Ratio to 100-Year Peak:	0.13	0.41	0.61	0.79
Q (Cubic feet/second)	7	22	32	42
Tc (minutes {Eqn. 4.5}):	35.4	22.4	19.1	17.2

*A may not exceed 6,400 acres (10 square miles) in size. **$T_{c\,100}$ may not exceed 180 minutes. If $T_{c\,100} \le 5$, set $T_{c\,100} = 5$ minutes.

NOTE: Indicate whether hydrologic computations are for "Future Conditions" or "Existing Conditions" by checking the appropriate box above.

Prepared by: JP Checked by: _____ Company: Psomas Date: 05/27/10

City of Tucson

Hydrologic Data Sheet for Computing 100-year Peak Discharge (Q_{p100})

1. Project Name and Location: Kolb/Sabino Canyon Road Extention
2. Drainage Concentration Point: OS3
3. *Watershed Area (A) at Drainage Concentration Point: 13.23 acres
4. Length of Hydraulically Longest Watercourse (Lc): 1626.3 ft.
5. Length from center of Watershed Area (Lca) along Lc: 813.1 ft.

For (Check One):
- [x] Existing Condtions†
- [ ] Future Conditions†

6. Change in Length Factors - ft / Change in Elevation Factors - ft

a. ΔL_1:	1626.3	$(\Delta L_1)^3$:	4.3E+09	ΔH_1:	16.0	$(\Delta L_1)^3/\Delta H_1$: 2.7E+08
b. ΔL_2:		$(\Delta L_2)^3$:		ΔH_2:		$(\Delta L_2)^3/\Delta H_2$:
c. ΔL_3:		$(\Delta L_3)^3$:		ΔH_3:		$(\Delta L_3)^3\Delta H_3$:
d. ΔL_4:		$(\Delta L_4)^3$:		ΔH_4:		$(\Delta L_4)^3/\Delta H_4$:

7. $$G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2} = 16395.4 + ___ + ___ + ___ = \mathbf{16395.4}$$

8. Mean Slope $(S_c) = (L_c/G)^2 = ($ 1626.3 / 16395.4 $)^2 =$ 0.98% ft./ft.

9. Areally reduced 100-year, one-hour rainfall depth ($P_{1,100}$): 3.00 inches.

	Subarea 1	Subarea 2	Subarea 3	Weighted Watershed Parameters
10. Watersheds Type(s) (% of Total Area):	Nat (82%)	Nat (18%)	( )	
11. Basin Factor ($n_{b,100}$):	0.052	0.052		n_{bw100} = 0.052
12. Soil Types, in %:	100% B	100%C		
13. Imperviousnes (%):	15%	15%		I_w = 15.0%
14. Runoff Coefficient (C_{w100}):	0.65	0.74		C_{w100} = 0.67
15. Contrib. Area Factor (F_{Ac}):	0.9	0.9		F_{Acw} = 0.90

16. **Time of Concentration (T_{c100}): 14.5 minutes, determined from:

$$T_{c100} = \left(\frac{0.23 n_{bw100}\left(L_c L_{ca}\right)^{0.3}}{\left(S_c P_{1,100} C_{w100}\right)^{0.4}} + 1.31\right)^{1.61} \quad \text{when } 5 \le Tc100 \le 180.$$

17. At T_{c100}, 100-year Rainfall Intensity (i_{100}) = $(4P_{1,100})/(1+0.05T_{c100})$ = 7.0 inches/hour.
18. 100-Year Peak (Q_{p100}) = $(C_{w100})(i_{100})(F_{Acw})A$= 0.67 x 7.00 x 0.9 x 13.2 = 55.8 cfs.
19. For Other Return Periods

	2-Year	10-year	25-Year	50-Year
Ratio to 100-Year Peak:	0.13	0.41	0.61	0.79
Q (Cubic feet/second)	7	23	34	44
Tc (minutes {Eqn. 4.5}):	32.8	20.7	17.6	15.9

*A may not exceed 6,400 acres (10 square miles) in size. **$T_{c\,100}$ may not exceed 180 minutes. If $T_{c\,100} \le 5$, set $T_{c\,100} = 5$ minutes.

NOTE: Indicate whether hydrologic computations are for "Future Conditions" or "Existing Conditions" by checking the appropriate box above.

Prepared by: JP Checked by: _____ Company: Psomas Date: 05/27/10

City of Tucson

Hydrologic Data Sheet for Computing 100-year Peak Discharge (Q_{p100})

1. Project Name and Location: Kolb/Sabino Canyon Road Extention
2. Drainage Concentration Point: N1
3. *Watershed Area (A) at Drainage Concentration Point: 1.12 acres
4. Length of Hydraulically Longest Watercourse (Lc): 433.0 ft.
5. Length from center of Watershed Area (Lca) along Lc: 216.5 ft.

For (Check One):
- [x] Existing Condtions†
- [ ] Future Conditions†

6. Change in Length Factors - ft / Change in Elevation Factors - ft

a. ΔL_1:	433.0	$(\Delta L_1)^3$:	8.1E+07	ΔH_1:	9.0	$(\Delta L_1)^3/\Delta H_1$:	9.0E+06
b. ΔL_2:		$(\Delta L_2)^3$:		ΔH_2:		$(\Delta L_2)^3/\Delta H_2$:	
c. ΔL_3:		$(\Delta L_3)^3$:		ΔH_3:		$(\Delta L_3)^3\Delta H_3$:	
d. ΔL_4:		$(\Delta L_4)^3$:		ΔH_4:		$(\Delta L_4)^3/\Delta H_4$:	

7. $G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2}$ = 3003.4 + ____ + ____ + ____ = **3003.4**

8. Mean Slope $(S_c) = (L_c/G)^2 =$ (433.0 / 3003.4)^2 = 2.08% ft./ft.

9. Areally reduced 100-year, one-hour rainfall depth ($P_{1,100}$): 3.00 inches.

	Subarea 1	Subarea 2	Subarea 3	Weighted Watershed Parameters
10. Watersheds Type(s) (% of Total Area):	Nat (100%)	Nat (0%)	( )	
11. Basin Factor ($n_{b,100}$):	0.055	0.055		n_{bw100} = 0.055
12. Soil Types, in %:	100% B	100%C		
13. Imperviousnes (%):	5%	5%		I_w = 5.0%
14. Runoff Coefficient (C_{w100}):	0.62	0.71		C_{w100} = 0.62
15. Contrib. Area Factor (F_{Ao}):	1	1		F_{Acw} = 1.00

16. **Time of Concentration (T_{c100}): 5.1 minutes, determined from:

$$T_{c100} = \left(\frac{0.23 n_{bw100}\left(L_c L_{ca}\right)^{0.3}}{\left(S_c P_{1,100} C_{w100}\right)^{0.4}} + 1.31\right)^{1.61} \quad \text{when } 5 \le Tc100 \le 180.$$

17. At T_{c100}, 100-year Rainfall Intensity (i_{100}) = $(4P_{1,100})/(1+0.05T_{c100})$ = 9.6 inches/hour.
18. 100-Year Peak (Q_{p100}) = $(C_{w100})(i_{100})(F_{Acw})A$= 0.62 x 9.60 x 1.0 x 1.1 = 6.7 cfs.
19. For Other Return Periods

	2-Year	10-year	25-Year	50-Year
Ratio to 100-Year Peak:	0.22	0.50	0.70	0.90
Q (Cubic feet/second)	1	3	5	6
Tc (minutes {Eqn. 4.5}):	9.3	6.7	5.9	5.3

*A may not exceed 6,400 acres (10 square miles) in size. **T_{c100} may not exceed 180 minutes. If $T_{c100} \le 5$, set T_{c100} = 5 minutes.

NOTE: Indicate whether hydrologic computations are for "Future Conditions" or "Existing Conditions" by checking the appropriate box above.

Prepared by: JP Checked by: ____ Company: Psomas Date: 05/27/10

City of Tucson

Hydrologic Data Sheet for Computing 100-year Peak Discharge (Q_{p100})

1. Project Name and Location: Kolb/Sabino Canyon Road Extention
2. Drainage Concentration Point: N2
3. *Watershed Area (A) at Drainage Concentration Point: 0.78 acres
4. Length of Hydraulically Longest Watercourse (Lc): 350.1 ft.
5. Length from center of Watershed Area (Lca) along Lc: 175.0 ft.

For (Check One):
- [x] Existing Condtions†
- [ ] Future Conditions†

6. Change in Length Factors - ft / Change in Elevation Factors - ft

a. ΔL_1:	350.1	$(\Delta L_1)^3$:	4.3E+07	ΔH_1:	4.0	$(\Delta L_1)^3/\Delta H_1$:	1.1E+07
b. ΔL_2:		$(\Delta L_2)^3$:		ΔH_2:		$(\Delta L_2)^3/\Delta H_2$:	
c. ΔL_3:		$(\Delta L_3)^3$:		ΔH_3:		$(\Delta L_3)^3\Delta H_3$:	
d. ΔL_4:		$(\Delta L_4)^3$:		ΔH_4:		$(\Delta L_4)^3/\Delta H_4$:	

7. $$G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2} = 3275.1 + ___ + ___ + ___ = \mathbf{3275.1}$$

8. Mean Slope $(S_c) = (L_c/G)^2 = (\ 350.1\ /\ 3275.1\ )^2 =$ 1.14% ft./ft.

9. Areally reduced 100-year, one-hour rainfall depth ($P_{1,100}$): 3.00 inches.

	Subarea 1	Subarea 2	Subarea 3	Weighted Watershed Parameters
10. Watersheds Type(s) (% of Total Area):	Road (100%)	Road (0%)	( )	
11. Basin Factor ($n_{b,100}$):	0.048	0.048		n_{bw100} = 0.048
12. Soil Types, in %:	100% B	100%C		
13. Imperviousnes (%):	60%	60%		I_w = 60.0%
14. Runoff Coefficient (C_{w100}):	0.82	0.86		C_{w100} = 0.82
15. Contrib. Area Factor (F_{Ao}):	1	1		F_{Acw} = 1.00

16. **Time of Concentration (T_{c100}): 4.6 minutes, determined from:

$$T_{c100} = \left(\frac{0.23 n_{bw100}\left(L_c L_{ca}\right)^{0.3}}{\left(S_c P_{1,100} C_{w100}\right)^{0.4}} + 1.31\right)^{1.61} \quad \text{when } 5 \le Tc100 \le 180.$$

17. At T_{c100}, 100-year Rainfall Intensity (i_{100}) = $(4P_{1,100})/(1+0.05T_{c100})$ = 9.6 inches/hour.
18. 100-Year Peak (Q_{p100}) = $(C_{w100})(i_{100})(F_{Acw})A$ = 0.82 x 9.60 x 1.0 x 0.8 = 6.1 cfs.
19. For Other Return Periods

	2-Year	10-year	25-Year	50-Year
Ratio to 100-Year Peak:	0.22	0.50	0.70	0.90
Q (Cubic feet/second)	1	3	4	6
Tc (minutes {Eqn. 4.5}):	8.4	6.0	5.3	4.8

*A may not exceed 6,400 acres (10 square miles) in size. **T_{c100} may not exceed 180 minutes. If $T_{c100} \le 5$, set T_{c100} = 5 minutes.

NOTE: Indicate whether hydrologic computations are for "Future Conditions" or "Existing Conditions" by checking the appropriate box above.

Prepared by: JP Checked by: _____ Company: Psomas Date: 05/27/10

City of Tucson

Hydrologic Data Sheet for Computing 100-year Peak Discharge (Q_{p100})

1. Project Name and Location: Kolb/Sabino Canyon Road Extention
2. Drainage Concentration Point: N3
3. *Watershed Area (A) at Drainage Concentration Point: 0.77 acres
4. Length of Hydraulically Longest Watercourse (Lc): 232.6 ft.
5. Length from center of Watershed Area (Lca) along Lc: 116.3 ft.

For (Check One):
- [x] Existing Condtions†
- [ ] Future Conditions†

6. Change in Length Factors - ft / Change in Elevation Factors - ft

a. ΔL_1:	232.6	$(\Delta L_1)^3$:	1.3E+07	ΔH_1:	3.0	$(\Delta L_1)^3/\Delta H_1$:	4.2E+06
b. ΔL_2:		$(\Delta L_2)^3$:		ΔH_2:		$(\Delta L_2)^3/\Delta H_2$:	
c. ΔL_3:		$(\Delta L_3)^3$:		ΔH_3:		$(\Delta L_3)^3\Delta H_3$:	
d. ΔL_4:		$(\Delta L_4)^3$:		ΔH_4:		$(\Delta L_4)^3/\Delta H_4$:	

7. $$G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2} = 2048.0 + ___ + ___ + ___ = \mathbf{2048.0}$$

8. Mean Slope $(S_c) = (L_c/G)^2 =$ (232.6 / 2048.0)^2 = 1.29% ft./ft.

9. Areally reduced 100-year, one-hour rainfall depth ($P_{1,100}$): 3.00 inches.

	Subarea 1	Subarea 2	Subarea 3		
10. Watersheds Type(s) (% of Total Area):	Road (100%)	Road (0%)	( )	Weighted Watershed Parameters	
11. Basin Factor ($n_{b,100}$):	0.048	0.048		n_{bw100} =	0.048
12. Soil Types, in %:	100% B	100%C			
13. Imperviousnes (%):	90%	90%		I_w =	90.0%
14. Runoff Coefficient (C_{w100}):	0.92	0.93		C_{w100} =	0.92
15. Contrib. Area Factor (F_{Ac}):	1	1		F_{Acw} =	1.00

16. **Time of Concentration (T_{c100}): 3.6 minutes, determined from:

$$T_{c100} = \left(\frac{0.23 n_{bw100}\left(L_c L_{ca}\right)^{0.3}}{\left(S_c P_{1,100} C_{w100}\right)^{0.4}} + 1.31\right)^{1.61} \quad \text{when } 5 \le Tc100 \le 180.$$

17. At T_{c100}, 100-year Rainfall Intensity (i_{100}) = $(4P_{1,100})/(1+0.05T_{c100})$ = 9.6 inches/hour.
18. 100-Year Peak (Q_{p100}) = $(C_{w100})(i_{100})(F_{Acw})A$= 0.92 x 9.60 x 1.0 x 0.8 = 6.8 cfs.
19. For Other Return Periods

	2-Year	10-year	25-Year	50-Year
Ratio to 100-Year Peak:	0.22	0.50	0.70	0.90
Q (Cubic feet/second)	1	3	5	6
Tc (minutes {Eqn. 4.5}):	6.5	4.7	4.1	3.7

*A may not exceed 6,400 acres (10 square miles) in size. **$T_{c\,100}$ may not exceed 180 minutes. If $T_{c\,100} \le 5$, set $T_{c\,100} = 5$ minutes.

NOTE: Indicate whether hydrologic computations are for "Future Conditions" or "Existing Conditions" by checking the appropriate box above.

Prepared by: JP Checked by: _____ Company: Psomas Date: 05/27/10

City of Tucson

Hydrologic Data Sheet for Computing 100-year Peak Discharge (Q_{p100})

1. Project Name and Location: Kolb/Sabino Canyon Road Extention
2. Drainage Concentration Point: N3.1
3. *Watershed Area (A) at Drainage Concentration Point: 0.48 acres
4. Length of Hydraulically Longest Watercourse (Lc): 388.0 ft.
5. Length from center of Watershed Area (Lca) along Lc: 194.0 ft.

For (Check One):
- [x] Existing Condtions†
- [ ] Future Conditions†

6. Change in Length Factors - ft / Change in Elevation Factors - ft

a. ΔL_1:	388.0	$(\Delta L_1)^3$:	5.8E+07	ΔH_1:	3.0	$(\Delta L_1)^3/\Delta H_1$:	1.9E+07
b. ΔL_2:		$(\Delta L_2)^3$:		ΔH_2:		$(\Delta L_2)^3/\Delta H_2$:	
c. ΔL_3:		$(\Delta L_3)^3$:		ΔH_3:		$(\Delta L_3)^3\Delta H_3$:	
d. ΔL_4:		$(\Delta L_4)^3$:		ΔH_4:		$(\Delta L_4)^3/\Delta H_4$:	

7. $$G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2} = 4412.4 + ___ + ___ + ___ = 4412.4$$

8. Mean Slope $(S_c) = (L_c/G)^2 =$ (388.0 / 4412.4)^2 = 0.77% ft./ft.

9. Areally reduced 100-year, one-hour rainfall depth ($P_{1,100}$): 3.00 inches.

	Subarea 1	Subarea 2	Subarea 3	Weighted Watershed Parameters
10. Watersheds Type(s) (% of Total Area):	Nat (100%)	Nat (0%)	( )	
11. Basin Factor ($n_{b,100}$):	0.055	0.055		n_{bw100} = 0.055
12. Soil Types, in %:	100% B	100%C		
13. Imperviousnes (%):	30%	0%		I_w = 30.0%
14. Runoff Coefficient (C_{w100}):	0.62	0.71		C_{w100} = 0.62
15. Contrib. Area Factor (F_{Ac}):	1	1		F_{Acw} = 1.00

16. **Time of Concentration (T_{c100}): 6.9 minutes, determined from:

$$T_{c100} = \left(\frac{0.23 n_{bw100}\left(L_c L_{ca}\right)^{0.3}}{\left(S_c P_{1,100} C_{w100}\right)^{0.4}} + 1.31\right)^{1.61} \quad \text{when } 5 \le Tc100 \le 180.$$

17. At T_{c100}, 100-year Rainfall Intensity (i_{100}) = $(4P_{1,100})/(1+0.05T_{c100})$ = 8.9 inches/hour.
18. 100-Year Peak (Q_{p100}) = $(C_{w100})(i_{100})(F_{Acw})A$= 0.62 x 8.90 x 1.0 x 0.5 = 2.6 cfs.
19. For Other Return Periods

	2-Year	10-year	25-Year	50-Year
Ratio to 100-Year Peak:	0.22	0.50	0.70	0.90
Q (Cubic feet/second)	1	1	2	2
Tc (minutes {Eqn. 4.5}):	12.6	9.1	7.9	7.2

*A may not exceed 6,400 acres (10 square miles) in size. **$T_{c\,100}$ may not exceed 180 minutes. If $T_{c\,100} \le 5$, set $T_{c\,100} = 5$ minutes.

NOTE: Indicate whether hydrologic computations are for "Future Conditions" or "Existing Conditions" by checking the appropriate box above.

Prepared by: JP Checked by: _____ Company: Psomas Date: 05/27/10

City of Tucson

Hydrologic Data Sheet for Computing 100-year Peak Discharge (Q_{p100})

1. Project Name and Location: Kolb/Sabino Canyon Road Extention
2. Drainage Concentration Point: N4
3. *Watershed Area (A) at Drainage Concentration Point: 2.96 acres
4. Length of Hydraulically Longest Watercourse (Lc): 943.8 ft.
5. Length from center of Watershed Area (Lca) along Lc: 471.9 ft.

For (Check One):
- [x] Existing Condtions†
- [ ] Future Conditions†

6. Change in Length Factors - ft / Change in Elevation Factors - ft

a. ΔL_1:	943.8	$(\Delta L_1)^3$:	8.4E+08	ΔH_1:	10.5	$(\Delta L_1)^3/\Delta H_1$:	8.0E+07
b. ΔL_2:		$(\Delta L_2)^3$:		ΔH_2:		$(\Delta L_2)^3/\Delta H_2$:	
c. ΔL_3:		$(\Delta L_3)^3$:		ΔH_3:		$(\Delta L_3)^3\Delta H_3$:	
d. ΔL_4:		$(\Delta L_4)^3$:		ΔH_4:		$(\Delta L_4)^3/\Delta H_4$:	

7. $$G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2} = 8948.6 + ___ + ___ + ___ = 8948.6$$

8. Mean Slope $(S_c) = (L_c/G)^2 = (\ 943.8\ /\ 8948.6\ )^2 =$ 1.11% ft./ft.

9. Areally reduced 100-year, one-hour rainfall depth ($P_{1,100}$): 3.00 inches.

	Subarea 1	Subarea 2	Subarea 3	Weighted Watershed Parameters
10. Watersheds Type(s) (% of Total Area):	Nat (72%)	Nat (28%)	( )	
11. Basin Factor ($n_{b,100}$):	0.055	0.055		n_{bw100} = 0.055
12. Soil Types, in %:	100% B	100%C		
13. Imperviousnes (%):	1%	1%		I_w = 1.0%
14. Runoff Coefficient (C_{w100}):	0.62	0.71		C_{w100} = 0.65
15. Contrib. Area Factor (F_{Ao}):	1	1		F_{Acw} = 1.00

16. **Time of Concentration (T_{c100}): 10.1 minutes, determined from:

$$T_{c100} = \left(\frac{0.23 n_{bw100}\left(L_c L_{ca}\right)^{0.3}}{\left(S_c P_{1,100} C_{w100}\right)^{0.4}} + 1.31\right)^{1.61} \quad \text{when } 5 \le Tc100 \le 180.$$

17. At T_{c100}, 100-year Rainfall Intensity (i_{100}) = $(4P_{1,100})/(1+0.05T_{c100})$ = 8.0 inches/hour.
18. 100-Year Peak (Q_{p100}) = $(C_{w100})(i_{100})(F_{Acw})A$= 0.65 x 8.00 x 1.0 x 3.0 = 15.4 cfs.
19. For Other Return Periods

	2-Year	10-year	25-Year	50-Year
Ratio to 100-Year Peak:	0.22	0.50	0.70	0.90
Q (Cubic feet/second)	3	8	11	14
Tc (minutes {Eqn. 4.5}):	18.6	13.4	11.7	10.6

*A may not exceed 6,400 acres (10 square miles) in size. **$T_{c\,100}$ may not exceed 180 minutes. If $T_{c\,100} \le 5$, set $T_{c\,100} = 5$ minutes.

NOTE: Indicate whether hydrologic computations are for "Future Conditions" or "Existing Conditions" by checking the appropriate box above.

Prepared by: JP Checked by: _____ Company: Psomas Date: 05/27/10

City of Tucson

Hydrologic Data Sheet for Computing 100-year Peak Discharge (Q_{p100})

1. Project Name and Location: Kolb/Sabino Canyon Road Extention
2. Drainage Concentration Point: N4.1
3. *Watershed Area (A) at Drainage Concentration Point: 0.23 acres
4. Length of Hydraulically Longest Watercourse (Lc): 197.4 ft.
5. Length from center of Watershed Area (Lca) along Lc: 98.7 ft.

For (Check One):
- [x] Existing Condtions†
- [ ] Future Conditions†

6. Change in Length Factors - ft / Change in Elevation Factors - ft

a. ΔL_1:	197.4	$(\Delta L_1)^3$:	7.7E+06	ΔH_1:	3.0	$(\Delta L_1)^3/\Delta H_1$:	2.6E+06
b. ΔL_2:		$(\Delta L_2)^3$:		ΔH_2:		$(\Delta L_2)^3/\Delta H_2$:	
c. ΔL_3:		$(\Delta L_3)^3$:		ΔH_3:		$(\Delta L_3)^3\Delta H_3$:	
d. ΔL_4:		$(\Delta L_4)^3$:		ΔH_4:		$(\Delta L_4)^3/\Delta H_4$:	

7. $$G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2} = 1600.9 + ___ + ___ + ___ = 1600.9$$

8. Mean Slope $(S_c) = (L_c/G)^2 = ($ 197.4 / 1600.9 $)^2 =$ 1.52% ft./ft.

9. Areally reduced 100-year, one-hour rainfall depth ($P_{1,100}$): 3.00 inches.

	Subarea 1	Subarea 2	Subarea 3	Weighted Watershed Parameters
10. Watersheds Type(s) (% of Total Area):	Nat (100%)	Nat (0%)	( )	
11. Basin Factor ($n_{b,100}$):	0.055	0.055		n_{bw100} = 0.055
12. Soil Types, in %:	100% B	100%C		
13. Imperviousnes (%):	0%	0%		I_w = 0.0%
14. Runoff Coefficient (C_{w100}):	0.62	0.71		C_{w100} = 0.62
15. Contrib. Area Factor (F_{Ac}):	1	1		F_{Acw} = 1.00

16. **Time of Concentration (T_{c100}): 3.9 minutes, determined from:

$$T_{c100} = \left(\frac{0.23 n_{bw100}\left(L_c L_{ca}\right)^{0.3}}{\left(S_c P_{1,100} C_{w100}\right)^{0.4}} + 1.31\right)^{1.61} \quad \text{when } 5 \le Tc100 \le 180.$$

17. At T_{c100}, 100-year Rainfall Intensity (i_{100}) = $(4P_{1,100})/(1+0.05T_{c100})$ = 9.6 inches/hour.
18. 100-Year Peak (Q_{p100}) = $(C_{w100})(i_{100})(F_{Acw})A$= 0.62 x 9.60 x 1.0 x 0.2 = 1.4 cfs.
19. For Other Return Periods

	2-Year	10-year	25-Year	50-Year
Ratio to 100-Year Peak:	0.22	0.50	0.70	0.90
Q (Cubic feet/second)	0	1	1	1
Tc (minutes {Eqn. 4.5}):	7.2	5.1	4.5	4.1

*A may not exceed 6,400 acres (10 square miles) in size. **T_{c100} may not exceed 180 minutes. If $T_{c100} \le 5$, set T_{c100} = 5 minutes.

NOTE: Indicate whether hydrologic computations are for "Future Conditions" or "Existing Conditions" by checking the appropriate box above.

Prepared by: JP Checked by: _____ Company: Psomas Date: 05/27/10

City of Tucson

Hydrologic Data Sheet for Computing 100-year Peak Discharge (Q_{p100})

1. Project Name and Location: Kolb/Sabino Canyon Road Extention
2. Drainage Concentration Point: N4.2
3. *Watershed Area (A) at Drainage Concentration Point: 0.49 acres
4. Length of Hydraulically Longest Watercourse (Lc): 461.1 ft.
5. Length from center of Watershed Area (Lca) along Lc: 230.5 ft.

For (Check One):
- [x] Existing Condtions†
- [ ] Future Conditions†

6. Change in Length Factors - ft / Change in Elevation Factors - ft

a. ΔL_1:	461.1	$(\Delta L_1)^3$:	9.8E+07	ΔH_1:	5.0	$(\Delta L_1)^3/\Delta H_1$:	2.0E+07
b. ΔL_2:		$(\Delta L_2)^3$:		ΔH_2:		$(\Delta L_2)^3/\Delta H_2$:	
c. ΔL_3:		$(\Delta L_3)^3$:		ΔH_3:		$(\Delta L_3)^3\Delta H_3$:	
d. ΔL_4:		$(\Delta L_4)^3$:		ΔH_4:		$(\Delta L_4)^3/\Delta H_4$:	

7. $$G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2} = 4427.6 + ___ + ___ + ___ = \mathbf{4427.6}$$

8. Mean Slope $(S_c) = (L_c/G)^2 = (\ 461.1\ /\ 4427.6\ )^2 =$ 1.08% ft./ft.

9. Areally reduced 100-year, one-hour rainfall depth ($P_{1,100}$): 3.00 inches.

	Subarea 1	Subarea 2	Subarea 3	Weighted Watershed Parameters
10. Watersheds Type(s) (% of Total Area):	Nat (100%)	Nat (0%)	( )	
11. Basin Factor ($n_{b,100}$):	0.048	0.055		n_{bw100} = 0.048
12. Soil Types, in %:	100% B	100%C		
13. Imperviousnes (%):	85%	0%		I_w = 85.0%
14. Runoff Coefficient (C_{w100}):	0.94	0.71		C_{w100} = 0.94
15. Contrib. Area Factor (F_{Ac}):	1	1		F_{Acw} = 1.00

16. **Time of Concentration (T_{c100}): 5.1 minutes, determined from:

$$T_{c100} = \left(\frac{0.23 n_{bw100}\left(L_c L_{ca}\right)^{0.3}}{\left(S_c P_{1,100} C_{w100}\right)^{0.4}} + 1.31\right)^{1.61} \quad \text{when } 5 \le Tc100 \le 180.$$

17. At T_{c100}, 100-year Rainfall Intensity (i_{100}) = $(4P_{1,100})/(1+0.05T_{c100})$ = 9.6 inches/hour.
18. 100-Year Peak (Q_{p100}) = $(C_{w100})(i_{100})(F_{Acw})A$= 0.94 x 9.60 x 1.0 x 0.5 = 4.4 cfs.
19. For Other Return Periods

	2-Year	10-year	25-Year	50-Year
Ratio to 100-Year Peak:	0.22	0.50	0.70	0.90
Q (Cubic feet/second)	1	2	3	4
Tc (minutes {Eqn. 4.5}):	9.3	6.7	5.9	5.3

*A may not exceed 6,400 acres (10 square miles) in size. **$T_{c\,100}$ may not exceed 180 minutes. If $T_{c\,100} \le 5$, set $T_{c\,100} = 5$ minutes.

NOTE: Indicate whether hydrologic computations are for "Future Conditions" or "Existing Conditions" by checking the appropriate box above.

Prepared by: JP Checked by: _____ Company: Psomas Date: 05/27/10

City of Tucson

Hydrologic Data Sheet for Computing 100-year Peak Discharge (Q_{p100})

1. Project Name and Location: Kolb/Sabino Canyon Road Extention
2. Drainage Concentration Point: N5
3. *Watershed Area (A) at Drainage Concentration Point: 3.65 acres
4. Length of Hydraulically Longest Watercourse (Lc): 552.3 ft.
5. Length from center of Watershed Area (Lca) along Lc: 276.2 ft.

For (Check One):
- [x] Existing Condtions†
- [ ] Future Conditions†

6. Change in Length Factors - ft / Change in Elevation Factors - ft

a. ΔL_1:	552.3	$(\Delta L_1)^3$:	1.7E+08	ΔH_1:	9.0	$(\Delta L_1)^3/\Delta H_1$:	1.9E+07
b. ΔL_2:		$(\Delta L_2)^3$:		ΔH_2:		$(\Delta L_2)^3/\Delta H_2$:	
c. ΔL_3:		$(\Delta L_3)^3$:		ΔH_3:		$(\Delta L_3)^3\Delta H_3$:	
d. ΔL_4:		$(\Delta L_4)^3$:		ΔH_4:		$(\Delta L_4)^3/\Delta H_4$:	

7. $G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2}$ = 4327.0 + ____ + ____ + ____ = **4327.0**

8. Mean Slope $(S_c) = (L_c/G)^2 = ($ 552.3 / 4327.0 $)^2 =$ 1.63% ft./ft.

9. Areally reduced 100-year, one-hour rainfall depth ($P_{1,100}$): 3.00 inches.

	Subarea 1	Subarea 2	Subarea 3	Weighted Watershed Parameters
10. Watersheds Type(s) (% of Total Area):	Res (100%)	Res (0%)	( )	
11. Basin Factor ($n_{b,100}$):	0.050	0.050		n_{bw100} = 0.050
12. Soil Types, in %:	100% B	100%C		
13. Imperviousnes (%):	25%	25%		I_w = 25.0%
14. Runoff Coefficient (C_{w100}):	0.69	0.77		C_{w100} = 0.69
15. Contrib. Area Factor (F_{Ac}):	1	1		F_{Acw} = 1.00

16. **Time of Concentration (T_{c100}): 5.6 minutes, determined from:

$$T_{c100} = \left(\frac{0.23 n_{bw100}\left(L_c L_{ca}\right)^{0.3}}{\left(S_c P_{1,100} C_{w100}\right)^{0.4}} + 1.31\right)^{1.61} \quad \text{when } 5 \le Tc100 \le 180.$$

17. At T_{c100}, 100-year Rainfall Intensity (i_{100}) = $(4P_{1,100})/(1+0.05T_{c100})$ = 9.4 inches/hour.
18. 100-Year Peak (Q_{p100}) = $(C_{w100})(i_{100})(F_{Acw})A$= 0.69 x 9.40 x 1.0 x 3.7 = 23.7 cfs.
19. For Other Return Periods

	2-Year	10-year	25-Year	50-Year
Ratio to 100-Year Peak:	0.13	0.41	0.61	0.79
Q (Cubic feet/second)	3	10	14	19
Tc (minutes {Eqn. 4.5}):	12.6	8.0	6.8	6.1

*A may not exceed 6,400 acres (10 square miles) in size. **$T_{c\,100}$ may not exceed 180 minutes. If $T_{c\,100} \le 5$, set $T_{c\,100}$ = 5 minutes.

NOTE: Indicate whether hydrologic computations are for "Future Conditions" or "Existing Conditions" by checking the appropriate box above.

Prepared by: JP Checked by: ____ Company: Psomas Date: 05/27/10

City of Tucson

Hydrologic Data Sheet for Computing 100-year Peak Discharge (Q_{p100})

1. Project Name and Location: Kolb/Sabino Canyon Road Extention
2. Drainage Concentration Point: N5.1
3. *Watershed Area (A) at Drainage Concentration Point: 0.49 acres
4. Length of Hydraulically Longest Watercourse (Lc): 401.0 ft.
5. Length from center of Watershed Area (Lca) along Lc: 200.5 ft.

For (Check One):
- [x] Existing Condtions†
- [ ] Future Conditions†

6. Change in Length Factors - ft / Change in Elevation Factors - ft

a. ΔL_1:	401.0	$(\Delta L_1)^3$:	6.4E+07	ΔH_1:	2.0	$(\Delta L_1)^3/\Delta H_1$:	3.2E+07
b. ΔL_2:		$(\Delta L_2)^3$:		ΔH_2:		$(\Delta L_2)^3/\Delta H_2$:	
c. ΔL_3:		$(\Delta L_3)^3$:		ΔH_3:		$(\Delta L_3)^3\Delta H_3$:	
d. ΔL_4:		$(\Delta L_4)^3$:		ΔH_4:		$(\Delta L_4)^3/\Delta H_4$:	

7. $$G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2} = 5677.2 + ___ + ___ + ___ = 5677.2$$

8. Mean Slope $(S_c) = (L_c/G)^2 = ($ 401.0 / 5677.2 $)^2 =$ 0.50% ft./ft.

9. Areally reduced 100-year, one-hour rainfall depth ($P_{1,100}$): 3.00 inches.

	Subarea 1	Subarea 2	Subarea 3	Weighted Watershed Parameters
10. Watersheds Type(s) (% of Total Area):	Nat (100%)	Nat (0%)	( )	
11. Basin Factor ($n_{b,100}$):	0.055	0.055		n_{bw100} = 0.055
12. Soil Types, in %:	100% B	100%C		
13. Imperviousnes (%):	20%	0%		I_w = 20.0%
14. Runoff Coefficient (C_{w100}):	0.62	0.71		C_{w100} = 0.62
15. Contrib. Area Factor (F_{Ao}):	1	1		$F_{A\,cw}$ = 1.00

16. **Time of Concentration (T_{c100}): 8.4 minutes, determined from:

$$T_{c100} = \left(\frac{0.23 n_{bw100}\left(L_c L_{ca}\right)^{0.3}}{\left(S_c P_{1,100} C_{w100}\right)^{0.4}} + 1.31\right)^{1.61} \quad \text{when } 5 \le Tc100 \le 180.$$

17. At T_{c100}, 100-year Rainfall Intensity (i_{100}) = $(4P_{1,100})/(1+0.05T_{c100})$ = 8.5 inches/hour.
18. 100-Year Peak (Q_{p100}) = $(C_{w100})(i_{100})(F_{Acw})A$= 0.62 x 8.50 x 1.0 x 0.5 = 2.6 cfs.
19. For Other Return Periods

	2-Year	10-year	25-Year	50-Year
Ratio to 100-Year Peak:	0.22	0.50	0.70	0.90
Q (Cubic feet/second)	1	1	2	2
Tc (minutes {Eqn. 4.5}):	15.4	11.1	9.7	8.7

*A may not exceed 6,400 acres (10 square miles) in size. **$T_{c\,100}$ may not exceed 180 minutes. If $T_{c\,100} \le 5$, set $T_{c\,100} = 5$ minutes.

NOTE: Indicate whether hydrologic computations are for "Future Conditions" or "Existing Conditions" by checking the appropriate box above.

Prepared by: JP Checked by: _____ Company: Psomas Date: 05/27/10

City of Tucson

Hydrologic Data Sheet for Computing 100-year Peak Discharge (Q_{p100})

1. Project Name and Location: Kolb/Sabino Canyon Road Extention
2. Drainage Concentration Point: N6
3. *Watershed Area (A) at Drainage Concentration Point: 1.83 acres
4. Length of Hydraulically Longest Watercourse (Lc): 354.6 ft.
5. Length from center of Watershed Area (Lca) along Lc: 177.3 ft.

For (Check One):
- [x] Existing Condtions†
- [ ] Future Conditions†

6. Change in Length Factors - ft / Change in Elevation Factors - ft

a. ΔL_1:	354.6	$(\Delta L_1)^3$:	4.5E+07	ΔH_1:	8.0	$(\Delta L_1)^3/\Delta H_1$:	5.6E+06
b. ΔL_2:		$(\Delta L_2)^3$:		ΔH_2:		$(\Delta L_2)^3/\Delta H_2$:	
c. ΔL_3:		$(\Delta L_3)^3$:		ΔH_3:		$(\Delta L_3)^3\Delta H_3$:	
d. ΔL_4:		$(\Delta L_4)^3$:		ΔH_4:		$(\Delta L_4)^3/\Delta H_4$:	

7. $$G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2} = 2360.9 + ___ + ___ + ___ = \mathbf{2360.9}$$

8. Mean Slope $(S_c) = (L_c/G)^2 =$ (354.6 / 2360.9)^2 = 2.26% ft./ft.

9. Areally reduced 100-year, one-hour rainfall depth ($P_{1,100}$): 3.00 inches.

	Subarea 1	Subarea 2	Subarea 3	Weighted Watershed Parameters
10. Watersheds Type(s) (% of Total Area):	Res (100%)	Res (0%)	( )	
11. Basin Factor ($n_{b,100}$):	0.050	0.050		n_{bw100} = 0.050
12. Soil Types, in %:	100% B	100%C		
13. Imperviousnes (%):	25%	25%		I_w = 25.0%
14. Runoff Coefficient (C_{w100}):	0.69	0.77		C_{w100} = 0.69
15. Contrib. Area Factor (F_{Ac}):	1	1		F_{Acw} = 1.00

16. **Time of Concentration (T_{c100}): 4.1 minutes, determined from:

$$T_{c100} = \left(\frac{0.23 n_{bw100}\left(L_c L_{ca}\right)^{0.3}}{\left(S_c P_{1,100} C_{w100}\right)^{0.4}} + 1.31\right)^{1.61} \quad \text{when } 5 \le Tc100 \le 180.$$

17. At T_{c100}, 100-year Rainfall Intensity (i_{100}) = $(4P_{1,100})/(1+0.05T_{c100})$ = 9.6 inches/hour.
18. 100-Year Peak (Q_{p100}) = $(C_{w100})(i_{100})(F_{Acw})A$= 0.69 x 9.60 x 1.0 x 1.8 = 12.1 cfs.
19. For Other Return Periods

	2-Year	10-year	25-Year	50-Year
Ratio to 100-Year Peak:	0.13	0.41	0.61	0.79
Q (Cubic feet/second)	2	5	7	10
Tc (minutes {Eqn. 4.5}):	9.2	5.8	4.9	4.5

*A may not exceed 6,400 acres (10 square miles) in size. **T_{c100} may not exceed 180 minutes. If $T_{c100} \le 5$, set T_{c100} = 5 minutes.

NOTE: Indicate whether hydrologic computations are for "Future Conditions" or "Existing Conditions" by checking the appropriate box above.

Prepared by: JP Checked by: _____ Company: Psomas Date: 05/27/10

City of Tucson

Hydrologic Data Sheet for Computing 100-year Peak Discharge (Q_{p100})

1. Project Name and Location: Kolb/Sabino Canyon Road Extention
2. Drainage Concentration Point: N7
3. *Watershed Area (A) at Drainage Concentration Point: 0.82 acres
4. Length of Hydraulically Longest Watercourse (Lc): 350.0 ft.
5. Length from center of Watershed Area (Lca) along Lc: 175.0 ft.

For (Check One):
- [x] Existing Condtions†
- [ ] Future Conditions†

6. Change in Length Factors - ft / Change in Elevation Factors - ft

a. ΔL_1:	350.0	$(\Delta L_1)^3$:	4.3E+07	ΔH_1:	5.0	$(\Delta L_1)^3/\Delta H_1$:	8.6E+06
b. ΔL_2:		$(\Delta L_2)^3$:		ΔH_2:		$(\Delta L_2)^3/\Delta H_2$:	
c. ΔL_3:		$(\Delta L_3)^3$:		ΔH_3:		$(\Delta L_3)^3\Delta H_3$:	
d. ΔL_4:		$(\Delta L_4)^3$:		ΔH_4:		$(\Delta L_4)^3/\Delta H_4$:	

7. $G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2}$ = 2928.6 + ____ + ____ + ____ = **2928.6**

8. Mean Slope $(S_c) = (L_c/G)^2 = ($ 350.0 / 2928.6 $)^2 =$ 1.43% ft./ft.

9. Areally reduced 100-year, one-hour rainfall depth ($P_{1,100}$): 3.00 inches.

	Subarea 1	Subarea 2	Subarea 3	Weighted Watershed Parameters
10. Watersheds Type(s) (% of Total Area):	Nat (100%)	Nat (0%)	( )	
11. Basin Factor ($n_{b,100}$):	0.055	0.055		n_{bw100} = 0.055
12. Soil Types, in %:	100% B	100%C		
13. Imperviousnes (%):	5%	5%		I_w = 5.0%
14. Runoff Coefficient (C_{w100}):	0.62	0.71		C_{w100} = 0.62
15. Contrib. Area Factor (F_{Ac}):	1	1		F_{Acw} = 1.00

16. **Time of Concentration (T_{c100}): 5.2 minutes, determined from:

$$T_{c100} = \left(\frac{0.23 n_{bw100}\left(L_c L_{ca}\right)^{0.3}}{\left(S_c P_{1,100} C_{w100}\right)^{0.4}} + 1.31\right)^{1.61} \quad \text{when } 5 \le Tc100 \le 180.$$

17. At T_{c100}, 100-year Rainfall Intensity (i_{100}) = $(4P_{1,100})/(1+0.05T_{c100})$ = 9.5 inches/hour.
18. 100-Year Peak (Q_{p100}) = $(C_{w100})(i_{100})(F_{Acw})A$= 0.62 x 9.50 x 1.0 x 0.8 = 4.8 cfs.
19. For Other Return Periods

	2-Year	10-year	25-Year	50-Year
Ratio to 100-Year Peak:	0.22	0.50	0.70	0.90
Q (Cubic feet/second)	1	2	3	4
Tc (minutes {Eqn. 4.5}):	9.5	6.9	6.0	5.4

*A may not exceed 6,400 acres (10 square miles) in size. **$T_{c\,100}$ may not exceed 180 minutes. If $T_{c\,100} \le 5$, set $T_{c\,100} = 5$ minutes.

NOTE: Indicate whether hydrologic computations are for "Future Conditions" or "Existing Conditions" by checking the appropriate box above.

Prepared by: JP Checked by: ____ Company: Psomas Date: 05/27/10

City of Tucson

Hydrologic Data Sheet for Computing 100-year Peak Discharge (Q_{p100})

1. Project Name and Location: Kolb/Sabino Canyon Road Extention
2. Drainage Concentration Point: N8
3. *Watershed Area (A) at Drainage Concentration Point: 1.07 acres
4. Length of Hydraulically Longest Watercourse (Lc): 472.8 ft.
5. Length from center of Watershed Area (Lca) along Lc: 236.4 ft.

For (Check One):
- [x] Existing Condtions†
- [ ] Future Conditions†

6. Change in Length Factors - ft / Change in Elevation Factors - ft

a. ΔL_1:	472.8	$(\Delta L_1)^3$:	1.1E+08	ΔH_1:	11.0	$(\Delta L_1)^3/\Delta H_1$:	9.6E+06
b. ΔL_2:		$(\Delta L_2)^3$:		ΔH_2:		$(\Delta L_2)^3/\Delta H_2$:	
c. ΔL_3:		$(\Delta L_3)^3$:		ΔH_3:		$(\Delta L_3)^3\Delta H_3$:	
d. ΔL_4:		$(\Delta L_4)^3$:		ΔH_4:		$(\Delta L_4)^3/\Delta H_4$:	

7. $$G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2} = 3099.7 + ___ + ___ + ___ = 3099.7$$

8. Mean Slope $(S_c) = (L_c/G)^2 = ($ 472.8 / 3099.7 $)^2 =$ 2.33% ft./ft.

9. Areally reduced 100-year, one-hour rainfall depth ($P_{1,100}$): 3.00 inches.

	Subarea 1	Subarea 2	Subarea 3	Weighted Watershed Parameters
10. Watersheds Type(s) (% of Total Area):	Com (100%)	Com (0%)	( )	
11. Basin Factor ($n_{b,100}$):	0.048	0.048		n_{bw100} = 0.048
12. Soil Types, in %:	100% B	100%C		
13. Imperviousnes (%):	100%	60%		I_w = 100.0%
14. Runoff Coefficient (C_{w100}):	0.94	0.86		C_{w100} = 0.94
15. Contrib. Area Factor (F_{Ac}):	1	1		F_{Acw} = 1.00

16. **Time of Concentration (T_{c100}): 4.0 minutes, determined from:

$$T_{c100} = \left(\frac{0.23 n_{bw100}\left(L_c L_{ca}\right)^{0.3}}{\left(S_c P_{1,100} C_{w100}\right)^{0.4}} + 1.31\right)^{1.61} \quad \text{when } 5 \le Tc100 \le 180.$$

17. At T_{c100}, 100-year Rainfall Intensity (i_{100}) = $(4P_{1,100})/(1+0.05T_{c100})$ = 9.6 inches/hour.
18. 100-Year Peak (Q_{p100}) = $(C_{w100})(i_{100})(F_{Acw})A$= 0.94 x 9.60 x 1.0 x 1.1 = 9.7 cfs.
19. For Other Return Periods

	2-Year	10-year	25-Year	50-Year
Ratio to 100-Year Peak:	0.22	0.50	0.70	0.90
Q (Cubic feet/second)	2	5	7	9
Tc (minutes {Eqn. 4.5}):	7.4	5.3	4.7	4.2

*A may not exceed 6,400 acres (10 square miles) in size. **$T_{c\,100}$ may not exceed 180 minutes. If $T_{c\,100} \le 5$, set $T_{c\,100} = 5$ minutes.

NOTE: Indicate whether hydrologic computations are for "Future Conditions" or "Existing Conditions" by checking the appropriate box above.

Prepared by: JP Checked by: _____ Company: Psomas Date: 05/27/10

City of Tucson

Hydrologic Data Sheet for Computing 100-year Peak Discharge (Q_{p100})

1. Project Name and Location: Kolb/Sabino Canyon Road Extention
2. Drainage Concentration Point: N8.1
3. *Watershed Area (A) at Drainage Concentration Point: 1.07 acres
4. Length of Hydraulically Longest Watercourse (Lc): 417.5 ft.
5. Length from center of Watershed Area (Lca) along Lc: 208.7 ft.

For (Check One):
- [x] Existing Condtions†
- [ ] Future Conditions†

6. Change in Length Factors - ft / Change in Elevation Factors - ft

a. ΔL_1:	417.5	$(\Delta L_1)^3$:	7.3E+07	ΔH_1:	11.0	$(\Delta L_1)^3/\Delta H_1$:	6.6E+06
b. ΔL_2:		$(\Delta L_2)^3$:		ΔH_2:		$(\Delta L_2)^3/\Delta H_2$:	
c. ΔL_3:		$(\Delta L_3)^3$:		ΔH_3:		$(\Delta L_3)^3\Delta H_3$:	
d. ΔL_4:		$(\Delta L_4)^3$:		ΔH_4:		$(\Delta L_4)^3/\Delta H_4$:	

7. $G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2}$ = 2571.9 + _____ + _____ + _____ = **2571.9**

8. Mean Slope $(S_c) = (L_c/G)^2 = ($ 417.5 / 2571.9 $)^2 =$ 2.63% ft./ft.

9. Areally reduced 100-year, one-hour rainfall depth ($P_{1,100}$): 3.00 inches.

	Subarea 1	Subarea 2	Subarea 3	Weighted Watershed Parameters
10. Watersheds Type(s) (% of Total Area):	Com (100%)	Com (0%)	( )	
11. Basin Factor ($n_{b,100}$):	0.048	0.048		n_{bw100} = 0.048
12. Soil Types, in %:	100% B	100%C		
13. Imperviousnes (%):	100%	60%		I_w = 100.0%
14. Runoff Coefficient (C_{w100}):	0.94	0.86		C_{w100} = 0.94
15. Contrib. Area Factor (F_{Ac}):	1	1		F_{Acw} = 1.00

16. **Time of Concentration (T_{c100}): 3.7 minutes, determined from:

$$T_{c100} = \left(\frac{0.23 n_{bw100}\left(L_c L_{ca}\right)^{0.3}}{\left(S_c P_{1,100} C_{w100}\right)^{0.4}} + 1.31\right)^{1.61} \quad \text{when } 5 \le Tc100 \le 180.$$

17. At T_{c100}, 100-year Rainfall Intensity (i_{100}) = ($4P_{1,100}$)/($1+0.05T_{c100}$) = 9.6 inches/hour.
18. 100-Year Peak (Q_{p100}) = (C_{w100})(i_{100})(F_{Acw})A= 0.94 x 9.60 x 1.0 x 1.1 = 9.7 cfs.
19. For Other Return Periods

	2-Year	10-year	25-Year	50-Year
Ratio to 100-Year Peak:	0.22	0.50	0.70	0.90
Q (Cubic feet/second)	2	5	7	9
Tc (minutes {Eqn. 4.5}):	6.8	4.9	4.3	3.9

*A may not exceed 6,400 acres (10 square miles) in size. **$T_{c\,100}$ may not exceed 180 minutes. If $T_{c\,100} \le 5$, set $T_{c\,100} = 5$ minutes.

NOTE: Indicate whether hydrologic computations are for "Future Conditions" or "Existing Conditions" by checking the appropriate box above.

Prepared by: JP Checked by: _____ Company: Psomas Date: 06/04/10

City of Tucson

Hydrologic Data Sheet for Computing 100-year Peak Discharge (Q_{p100})

1. Project Name and Location: Kolb/Sabino Canyon Road Extention
2. Drainage Concentration Point: N9
3. *Watershed Area (A) at Drainage Concentration Point: 2.06 acres
4. Length of Hydraulically Longest Watercourse (Lc): 607.8 ft.
5. Length from center of Watershed Area (Lca) along Lc: 303.9 ft.

For (Check One):
- [x] Existing Condtions†
- [ ] Future Conditions†

6. Change in Length Factors - ft / Change in Elevation Factors - ft

a. ΔL_1:	607.8	$(\Delta L_1)^3$:	2.2E+08	ΔH_1:	9.0	$(\Delta L_1)^3/\Delta H_1$:	2.5E+07
b. ΔL_2:		$(\Delta L_2)^3$:		ΔH_2:		$(\Delta L_2)^3/\Delta H_2$:	
c. ΔL_3:		$(\Delta L_3)^3$:		ΔH_3:		$(\Delta L_3)^3\Delta H_3$:	
d. ΔL_4:		$(\Delta L_4)^3$:		ΔH_4:		$(\Delta L_4)^3/\Delta H_4$:	

7. $G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2}$ = 4995.3 + ____ + ____ + ____ = **4995.3**

8. Mean Slope $(S_c) = (L_c/G)^2 = ($ 607.8 / 4995.3 $)^2 =$ 1.48% ft./ft.

9. Areally reduced 100-year, one-hour rainfall depth ($P_{1,100}$): 3.00 inches.

	Subarea 1	Subarea 2	Subarea 3	Weighted Watershed Parameters
10. Watersheds Type(s) (% of Total Area):	Res (100%)	Res (0%)	( )	
11. Basin Factor ($n_{b,100}$):	0.052	0.048		n_{bw100} = 0.052
12. Soil Types, in %:	100% B	100%C		
13. Imperviousnes (%):	45%	60%		I_w = 45.0%
14. Runoff Coefficient (C_{w100}):	0.73	0.86		C_{w100} = 0.73
15. Contrib. Area Factor (F_{Ao}):	1	1		F_{Acw} = 1.00

16. **Time of Concentration (T_{c100}): 6.2 minutes, determined from:

$$T_{c100} = \left(\frac{0.23 n_{bw100}\left(L_c L_{ca}\right)^{0.3}}{\left(S_c P_{1,100} C_{w100}\right)^{0.4}} + 1.31\right)^{1.61} \quad \text{when } 5 \le Tc100 \le 180.$$

17. At T_{c100}, 100-year Rainfall Intensity (i_{100}) = $(4P_{1,100})/(1+0.05T_{c100})$ = 9.2 inches/hour.
18. 100-Year Peak (Q_{p100}) = $(C_{w100})(i_{100})(F_{Acw})A$= 0.73 x 9.20 x 1.0 x 2.1 = 13.8 cfs.
19. For Other Return Periods

	2-Year	10-year	25-Year	50-Year
Ratio to 100-Year Peak:	0.22	0.50	0.70	0.90
Q (Cubic feet/second)	3	7	10	12
Tc (minutes {Eqn. 4.5}):	11.3	8.2	7.1	6.5

*A may not exceed 6,400 acres (10 square miles) in size. **T_{c100} may not exceed 180 minutes. If $T_{c100} \le 5$, set T_{c100} = 5 minutes.

NOTE: Indicate whether hydrologic computations are for "Fnture Conditions" or "Existing Conditions" by checking the appropriate box above.

Prepared by: JP Checked by: ____ Company: Psomas Date: 05/27/10

City of Tucson

Hydrologic Data Sheet for Computing 100-year Peak Discharge (Q_{p100})

1. Project Name and Location: Kolb/Sabino Canyon Road Extention
2. Drainage Concentration Point: N10
3. *Watershed Area (A) at Drainage Concentration Point: 1.35 acres
4. Length of Hydraulically Longest Watercourse (Lc): 730.0 ft.
5. Length from center of Watershed Area (Lca) along Lc: 365.0 ft.

For (Check One):
- [x] Existing Condtions†
- [ ] Future Conditions†

6. Change in Length Factors - ft / Change in Elevation Factors - ft

a. ΔL_1:	730.0	$(\Delta L_1)^3$:	3.9E+08	ΔH_1:	9.0	$(\Delta L_1)^3/\Delta H_1$:	4.3E+07
b. ΔL_2:		$(\Delta L_2)^3$:		ΔH_2:		$(\Delta L_2)^3/\Delta H_2$:	
c. ΔL_3:		$(\Delta L_3)^3$:		ΔH_3:		$(\Delta L_3)^3\Delta H_3$:	
d. ΔL_4:		$(\Delta L_4)^3$:		ΔH_4:		$(\Delta L_4)^3/\Delta H_4$:	

7. $$G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2} = 6574.4 + ___ + ___ + ___ = 6574.4$$

8. Mean Slope $(S_c) = (L_c/G)^2 =$ (730.0 / 6574.4)^2 = 1.23% ft./ft.

9. Areally reduced 100-year, one-hour rainfall depth ($P_{1,100}$): 3.00 inches.

	Subarea 1	Subarea 2	Subarea 3	Weighted Watershed Parameters
10. Watersheds Type(s) (% of Total Area):	Road (100%)	Road (0%)	( )	
11. Basin Factor ($n_{b,100}$):	0.048	0.048		n_{bw100} = 0.048
12. Soil Types, in %:	100% B	100%C		
13. Imperviousnes (%):	90%	90%		I_w = 90.0%
14. Runoff Coefficient (C_{w100}):	0.92	0.93		C_{w100} = 0.92
15. Contrib. Area Factor (F_{Ac}):	1	1		$F_{A\,cw}$ = 1.00

16. **Time of Concentration (T_{c100}): 6.2 minutes, determined from:

$$T_{c100} = \left(\frac{0.23 n_{bw100}\left(L_c L_{ca}\right)^{0.3}}{\left(S_c P_{1,100} C_{w100}\right)^{0.4}} + 1.31\right)^{1.61} \quad \text{when } 5 \le Tc100 \le 180.$$

17. At T_{c100}, 100-year Rainfall Intensity (i_{100}) = $(4P_{1,100})/(1+0.05T_{c100})$ = 9.1 inches/hour.
18. 100-Year Peak (Q_{p100}) = $(C_{w100})(i_{100})(F_{Acw})A$= 0.92 x 9.10 x 1.0 x 1.4 = 11.3 cfs.
19. For Other Return Periods

	2-Year	10-year	25-Year	50-Year
Ratio to 100-Year Peak:	0.22	0.50	0.70	0.90
Q (Cubic feet/second)	2	6	8	10
Tc (minutes {Eqn. 4.5}):	11.5	8.2	7.2	6.5

*A may not exceed 6,400 acres (10 square miles) in size. **$T_{c\,100}$ may not exceed 180 minutes. If $T_{c\,100} \le 5$, set $T_{c\,100} = 5$ minutes.

NOTE: Indicate whether hydrologic computations are for "Future Conditions" or "Existing Conditions" by checking the appropriate box above.

Prepared by: JP Checked by: _____ Company: Psomas Date: 06/02/10

City of Tucson

Hydrologic Data Sheet for Computing 100-year Peak Discharge (Q_{p100})

1. Project Name and Location: Kolb/Sabino Canyon Road Extention
2. Drainage Concentration Point: N11
3. *Watershed Area (A) at Drainage Concentration Point: 1.03 acres
4. Length of Hydraulically Longest Watercourse (Lc): 371.6 ft.
5. Length from center of Watershed Area (Lca) along Lc: 185.8 ft.

For (Check One):
- [x] Existing Condtions†
- [ ] Future Conditions†

6. Change in Length Factors - ft / Change in Elevation Factors - ft

a. ΔL_1:	371.6	$(\Delta L_1)^3$:	5.1E+07	ΔH_1: 6.0	$(\Delta L_1)^3/\Delta H_1$:	8.6E+06
b. ΔL_2:		$(\Delta L_2)^3$:		ΔH_2:	$(\Delta L_2)^3/\Delta H_2$:	
c. ΔL_3:		$(\Delta L_3)^3$:		ΔH_3:	$(\Delta L_3)^3\Delta H_3$:	
d. ΔL_4:		$(\Delta L_4)^3$:		ΔH_4:	$(\Delta L_4)^3/\Delta H_4$:	

7. $$G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2} = 2924.6 + ___ + ___ + ___ = 2924.6$$

8. Mean Slope $(S_c) = (L_c/G)^2 =$ (371.6 / 2924.6)^2 = 1.61% ft./ft.

9. Areally reduced 100-year, one-hour rainfall depth ($P_{1,100}$): 3.00 inches.

	Subarea 1	Subarea 2	Subarea 3	Weighted Watersbed Parameters
10. Watersheds Type(s) (% of Total Area):	Road (50%)	Soil B (50%)	( )	
11. Basin Factor ($n_{b,100}$):	0.048	0.048		n_{bw100} = 0.048
12. Soil Types, in %:	100% B	100%C		
13. Imperviousnes (%):	90%	90%		I_w = 90.0%
14. Runoff Coefficient (C_{w100}):	0.92	0.93		C_{w100} = 0.93
15. Contrib. Area Factor (F_{Ac}):	1	1		F_{Acw} = 1.00

16. **Time of Concentration (T_{c100}): 4.1 minutes, determined from:

$$T_{c100} = \left(\frac{0.23 n_{bw100}\left(L_c L_{ca}\right)^{0.3}}{\left(S_c P_{1,100} C_{w100}\right)^{0.4}} + 1.31\right)^{1.61} \quad \text{when } 5 \le Tc100 \le 180.$$

17. At T_{c100}, 100-year Rainfall Intensity (i_{100}) = $(4P_{1,100})/(1+0.05T_{c100})$ = 9.6 inches/hour.
18. 100-Year Peak (Q_{p100}) = $(C_{w100})(i_{100})(F_{Acw})A$= 0.93 x 9.60 x 1.0 x 1.0 = 9.2 cfs.
19. For Other Return Periods

	2-Year	10-year	25-Year	50-Year
Ratio to 100-Year Peak:	0.22	0.50	0.70	0.90
Q (Cubic feet/second)	2	5	6	8
Tc (minutes {Eqn. 4.5}):	7.5	5.4	4.7	4.2

*A may not exceed 6,400 acres (10 square miles) in size. **$T_{c\,100}$ may not exceed 180 minutes. If $T_{c\,100} \le 5$, set $T_{c\,100} = 5$ minutes.

NOTE: Indicate whetber hydrologic computations are for "Future Conditions" or "Existing Conditions" by cbecking the appropriate box above.

Prepared by: JP Checked by: _____ Company: Psomas Date: 06/01/10

City of Tucson

Hydrologic Data Sheet for Computing 100-year Peak Discharge (Q_{p100})

1. Project Name and Location: Kolb/Sabino Canyon Road Extention
2. Drainage Concentration Point: N12
3. *Watershed Area (A) at Drainage Concentration Point: 1.3 acres
4. Length of Hydraulically Longest Watercourse (Lc): 481.3 ft.
5. Length from center of Watershed Area (Lca) along Lc: 240.7 ft.

For (Check One):
- [x] Existing Condtions†
- [ ] Future Conditions†

6. Change in Length Factors - ft / Change in Elevation Factors - ft

a. ΔL_1:	481.3	$(\Delta L_1)^3$:	1.1E+08	ΔH_1:	6.5	$(\Delta L_1)^3/\Delta H_1$:	1.7E+07
b. ΔL_2:		$(\Delta L_2)^3$:		ΔH_2:		$(\Delta L_2)^3/\Delta H_2$:	
c. ΔL_3:		$(\Delta L_3)^3$:		ΔH_3:		$(\Delta L_3)^3\Delta H_3$:	
d. ΔL_4:		$(\Delta L_4)^3$:		ΔH_4:		$(\Delta L_4)^3/\Delta H_4$:	

7. $$G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2} = 4141.6 + ___ + ___ + ___ = \mathbf{4141.6}$$

8. Mean Slope $(S_c) = (L_c/G)^2 =$ (481.3 / 4141.6)^2 = 1.35% ft./ft.

9. Areally reduced 100-year, one-hour rainfall depth ($P_{1,100}$): 3.00 inches.

	Subarea 1	Subarea 2	Subarea 3	Weighted Watershed Parameters
10. Watersheds Type(s) (% of Total Area):	Road (50%)	Soil B (50%)	( )	
11. Basin Factor ($n_{b,100}$):	0.048	0.048		n_{bw100} = 0.048
12. Soil Types, in %:	100% B	100%C		
13. Imperviousnes (%):	90%	90%		I_w = 90.0%
14. Runoff Coefficient (C_{w100}):	0.92	0.93		C_{w100} = 0.93
15. Contrib. Area Factor (F_{Ac}):	1	1		F_{Acw} = 1.00

16. **Time of Concentration (T_{c100}): 4.9 minutes, determined from:

$$T_{c100} = \left(\frac{0.23 n_{bw100}\left(L_c L_{ca}\right)^{0.3}}{\left(S_c P_{1,100} C_{w100}\right)^{0.4}} + 1.31\right)^{1.61} \quad \text{when } 5 \le Tc100 \le 180.$$

17. At T_{c100}, 100-year Rainfall Intensity $(i_{100}) = (4P_{1,100})/(1+0.05T_{c100})$ = 9.6 inches/hour.
18. 100-Year Peak $(Q_{p100}) = (C_{w100})(i_{100})(F_{Acw})A$= 0.93 x 9.60 x 1.0 x 1.3 = 11.6 cfs.
19. For Other Return Periods

	2-Year	10-year	25-Year	50-Year
Ratio to 100-Year Peak:	0.22	0.50	0.70	0.90
Q (Cubic feet/second)	3	6	8	10
Tc (minutes {Eqn. 4.5}):	8.9	6.4	5.6	5.1

*A may not exceed 6,400 acres (10 square miles) in size. **$T_{c\,100}$ may not exceed 180 minutes. If $T_{c\,100} \le 5$, set $T_{c\,100} = 5$ minutes.

NOTE: Indicate whether hydrologic computations are for "Future Conditions" or "Existing Conditions" by checking the appropriate box above.

Prepared by: JP Checked by: _____ Company: Psomas Date: 06/01/10

City of Tucson

Hydrologic Data Sheet for Computing 100-year Peak Discharge (Q_{p100})

1. Project Name and Location: Kolb/Sabino Canyon Road Extention
2. Drainage Concentration Point: N13
3. *Watershed Area (A) at Drainage Concentration Point: 1.66 acres
4. Length of Hydraulically Longest Watercourse (Lc): 1291.7 ft.
5. Length from center of Watershed Area (Lca) along Lc: 645.8 ft.

For (Check One):
- [x] Existing Condtions†
- [ ] Future Conditions†

6. Change in Length Factors - ft / Change in Elevation Factors - ft

a. ΔL_1:	1291.7	$(\Delta L_1)^3$:	2.2E+09	ΔH_1:	8.0	$(\Delta L_1)^3/\Delta H_1$:	2.7E+08
b. ΔL_2:		$(\Delta L_2)^3$:		ΔH_2:		$(\Delta L_2)^3/\Delta H_2$:	
c. ΔL_3:		$(\Delta L_3)^3$:		ΔH_3:		$(\Delta L_3)^3\Delta H_3$:	
d. ΔL_4:		$(\Delta L_4)^3$:		ΔH_4:		$(\Delta L_4)^3/\Delta H_4$:	

7. $$G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2} = 16413.2 + ___ + ___ + ___ = \mathbf{16413.2}$$

8. Mean Slope $(S_c) = (L_c/G)^2 =$ (1291.7 / 16413.2)^2 = 0.62% ft./ft.

9. Areally reduced 100-year, one-hour rainfall depth ($P_{1,100}$): 3.00 inches.

	Subarea 1	Subarea 2	Subarea 3	Weighted Watershed Parameters
10. Watersheds Type(s) (% of Total Area):	Road (100%)	Soil B (0%)	( )	
11. Basin Factor ($n_{b,100}$):	0.048	0.048		n_{bw100} = 0.048
12. Soil Types, in %:	100% B	100%C		
13. Imperviousnes (%):	100%	90%		I_w = 100.0%
14. Runoff Coefficient (C_{w100}):	0.92	0.93		C_{w100} = 0.92
15. Contrib. Area Factor (F_{Ac}):	1	1		F_{Acw} = 1.00

16. **Time of Concentration (T_{c100}): 12.0 minutes, determined from:

$$T_{c100} = \left(\frac{0.23 n_{bw100}\left(L_c L_{ca}\right)^{0.3}}{\left(S_c P_{1,100} C_{w100}\right)^{0.4}} + 1.31\right)^{1.61}$$ when $5 \le Tc100 \le 180$.

17. At T_{c100}, 100-year Rainfall Intensity (i_{100}) = $(4P_{1,100})/(1+0.05T_{c100})$ = 7.5 inches/hour.
18. 100-Year Peak (Q_{p100}) = $(C_{w100})(i_{100})(F_{Acw})A$= 0.92 x 7.50 x 1.0 x 1.7 = 11.5 cfs.
19. For Other Return Periods

	2-Year	10-year	25-Year	50-Year
Ratio to 100-Year Peak:	0.22	0.50	0.70	0.90
Q (Cubic feet/second)	3	6	8	10
Tc (minutes {Eqn. 4.5}):	21.9	15.8	13.8	12.5

*A may not exceed 6,400 acres (10 square miles) in size. **$T_{c\,100}$ may not exceed 180 minutes. If $T_{c\,100} \le 5$, set $T_{c\,100} = 5$ minutes.

NOTE: Indicate whether hydrologic computations are for "Future Conditions" or "Existing Conditions" by checking the appropriate box above.

Prepared by: JP Checked by: _____ Company: Psomas Date: 12/14/10

DEVELOPED CONDITIONS

City of Tucson

Hydrologic Data Sheet for Computing 100-year Peak Discharge (Q_{p100})

1. Project Name and Location: Kolb/Sabino Canyon Road Extention
2. Drainage Concentration Point: OS1
3. *Watershed Area (A) at Drainage Concentration Point: 9.59 acres
4. Length of Hydraulically Longest Watercourse (Lc): 1338.9 ft.
5. Length from center of Watershed Area (Lca) along Lc: 669.4 ft.

For (Check One):
- ☐ Existing Condtions†
- ☑ Future Conditions†

6. Change in Length Factors - ft / Change in Elevation Factors - ft

a. ΔL_1:	1338.9	$(\Delta L_1)^3$:	2.4E+09	ΔH_1:	14.0	$(\Delta L_1)^3/\Delta H_1$:	1.7E+08
b. ΔL_2:		$(\Delta L_2)^3$:		ΔH_2:		$(\Delta L_2)^3/\Delta H_2$:	
c. ΔL_3:		$(\Delta L_3)^3$:		ΔH_3:		$(\Delta L_3)^3\Delta H_3$:	
d. ΔL_4:		$(\Delta L_4)^3$:		ΔH_4:		$(\Delta L_4)^3/\Delta H_4$:	

7. $G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2}$ = 13092.8 + ___ + ___ + ___ = **13092.8**

8. Mean Slope $(S_c) = (L_c/G)^2 = (\ 1338.9\ /\ 13092.8\ )^2 =$ 1.05% ft./ft.

9. Areally reduced 100-year, one-hour rainfall depth ($P_{1,100}$): 3.00 inches.

	Subarea 1	Subarea 2	Subarea 3	Weighted Watershed Parameters
10. Watersheds Type(s) (% of Total Area):	Nat (40%)	Nat (60%)	( )	
11. Basin Factor ($n_{b,100}$):	0.048	0.048		n_{bw100} = 0.048
12. Soil Types, in %:	100% B	100%C		
13. Imperviousnes (%):	60%	60%		I_w = 60.0%
14. Runoff Coefficient (C_{w100}):	0.82	0.86		C_{w100} = 0.84
15. Contrib. Area Factor (F_{Ao}):	0.8	0.8		F_{Acw} = 0.80

16. **Time of Concentration (T_{c100}): 10.0 minutes, determined from:

$$T_{c100} = \left(\frac{0.23 n_{bw100}\left(L_c L_{ca}\right)^{0.3}}{\left(S_c P_{1,100} C_{w100}\right)^{0.4}} + 1.31\right)^{1.61} \quad \text{when } 5 \le Tc100 \le 180.$$

17. At T_{c100}, 100-year Rainfall Intensity (i_{100}) = $(4P_{1,100})/(1+0.05T_{c100})$ = 8.0 inches/hour.
18. 100-Year Peak (Q_{p100}) = $(C_{w100})(i_{100})(F_{Acw})A$= 0.84 x 8.00 x 0.8 x 9.6 = 51.6 cfs.
19. For Other Return Periods

	2-Year	10-year	25-Year	50-Year
Ratio to 100-Year Peak:	0.22	0.50	0.70	0.90
Q (Cubic feet/second)	11	26	36	46
Tc (minutes {Eqn. 4.5}):	18.4	13.3	11.6	10.5

*A may not exceed 6,400 acres (10 square miles) in size. **$T_{c\,100}$ may not exceed 180 minutes. If $T_{c\,100} \le 5$, set $T_{c\,100}$ = 5 minutes.

NOTE: Indicate whether hydrologic computations are for "Future Conditions" or "Existing Conditions" by checking the appropriate box above.

Prepared by: JP Checked by: ___ Company: Psomas Date: 05/27/10

City of Tucson

Hydrologic Data Sheet for Computing 100-year Peak Discharge (Q_{p100})

1. Project Name and Location: Kolb/Sabino Canyon Road Extention
2. Drainage Concentration Point: OS2
3. *Watershed Area (A) at Drainage Concentration Point: 12.22 acres
4. Length of Hydraulically Longest Watercourse (Lc): 1970.5 ft.
5. Length from center of Watershed Area (Lca) along Lc: 985.3 ft.

For (Check One):
- ☐ Existing Condtions†
- ☑ Future Conditions†

6. Change in Length Factors - ft / Change in Elevation Factors - ft

a. ΔL_1:	1970.5	$(\Delta L_1)^3$:	7.7E+09	ΔH_1:	20.5	$(\Delta L_1)^3/\Delta H_1$:	3.7E+08
b. ΔL_2:		$(\Delta L_2)^3$:		ΔH_2:		$(\Delta L_2)^3/\Delta H_2$:	
c. ΔL_3:		$(\Delta L_3)^3$:		ΔH_3:		$(\Delta L_3)^3\Delta H_3$:	
d. ΔL_4:		$(\Delta L_4)^3$:		ΔH_4:		$(\Delta L_4)^3/\Delta H_4$:	

7. $$G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2} = 19319.3 + ___ + ___ + ___ = \mathbf{19319.3}$$

8. Mean Slope $(S_c) = (L_c/G)^2 = ($ 1970.5 / 19319.3 $)^2 =$ 1.04% ft./ft.

9. Areally reduced 100-year, one-hour rainfall depth ($P_{1,100}$): 3.00 inches.

	Subarea 1	Subarea 2	Subarea 3	Weighted Watershed Parameters
10. Watersheds Type(s) (% of Total Area):	Nat (27%)	Nat (73%)	( )	
11. Basin Factor ($n_{b,100}$):	0.052	0.052		n_{bw100} = 0.052
12. Soil Types, in %:	100% B	100%C		
13. Imperviousnes (%):	15%	15%		I_w = 15.0%
14. Runoff Coefficient (C_{w100}):	0.65	0.74		C_{w100} = 0.72
15. Contrib. Area Factor (F_{Ac}):	0.9	0.9		$F_{A\,cw}$ = 0.90

16. **Time of Concentration (T_{c100}): 15.7 minutes, determined from:

$$T_{c100} = \left(\frac{0.23 n_{bw100}\left(L_c L_{ca}\right)^{0.3}}{\left(S_c P_{1,100} C_{w100}\right)^{0.4}} + 1.31\right)^{1.61} \quad \text{when } 5 \le Tc100 \le 180.$$

17. At T_{c100}, 100-year Rainfall Intensity $(i_{100}) = (4P_{1,100})/(1+0.05T_{c100})$ = 6.7 inches/hour.
18. 100-Year Peak $(Q_{p100}) = (C_{w100})(i_{100})(F_{Acw})A$= 0.72 x 6.70 x 0.9 x 12.2 = 53.1 cfs.
19. For Other Return Periods

	2-Year	10-year	25-Year	50-Year
Ratio to 100-Year Peak:	0.13	0.41	0.61	0.79
Q (Cubic feet/second)	7	22	32	42
Tc (minutes {Eqn. 4.5}):	35.4	22.4	19.1	17.2

*A may not exceed 6,400 acres (10 square miles) in size. **$T_{c\,100}$ may not exceed 180 minutes. If $T_{c\,100} \le 5$, set $T_{c\,100} = 5$ minutes.

NOTE: Indicate whether hydrologic computations are for "Future Conditions" or "Existing Conditions" by checking the appropriate box above.

Prepared by: JP Checked by: _____ Company: Psomas Date: 05/27/10

City of Tucson

Hydrologic Data Sheet for Computing 100-year Peak Discharge (Q_{p100})

1. Project Name and Location: Kolb/Sabino Canyon Road Extention
2. Drainage Concentration Point: OS3
3. *Watershed Area (A) at Drainage Concentration Point: 13.23 acres
4. Length of Hydraulically Longest Watercourse (Lc): 1626.3 ft.
5. Length from center of Watershed Area (Lca) along Lc: 813.1 ft.

For (Check One):
- ☐ Existing Condtions†
- ☑ Future Conditions†

6. Change in Length Factors - ft / Change in Elevation Factors - ft

a. ΔL_1:	1626.3	$(\Delta L_1)^3$:	4.3E+09	ΔH_1: 16.0	$(\Delta L_1)^3/\Delta H_1$:	2.7E+08
b. ΔL_2:		$(\Delta L_2)^3$:		ΔH_2:	$(\Delta L_2)^3/\Delta H_2$:	
c. ΔL_3:		$(\Delta L_3)^3$:		ΔH_3:	$(\Delta L_3)^3\Delta H_3$:	
d. ΔL_4:		$(\Delta L_4)^3$:		ΔH_4:	$(\Delta L_4)^3/\Delta H_4$:	

7. $$G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2} = 16395.4 + ___ + ___ + ___ = \mathbf{16395.4}$$

8. Mean Slope $(S_c) = (L_c/G)^2 = (\ 1626.3\ /\ 16395.4\ )^2 =$ 0.98% ft./ft.

9. Areally reduced 100-year, one-hour rainfall depth ($P_{1,100}$): 3.00 inches.

	Subarea 1	Subarea 2	Subarea 3	Weighted Watershed Parameters
10. Watersheds Type(s) (% of Total Area):	Nat (82%)	Nat (18%)	( )	
11. Basin Factor ($n_{b,100}$):	0.052	0.052		n_{bw100} = 0.052
12. Soil Types, in %:	100% B	100%C		
13. Imperviousnes (%):	15%	15%		I_w = 15.0%
14. Runoff Coefficient (C_{w100}):	0.65	0.74		C_{w100} = 0.67
15. Contrib. Area Factor (F_{Ao}):	0.9	0.9		F_{Acw} = 0.90

16. **Time of Concentration (T_{c100}): 14.5 minutes, determined from:

$$T_{c100} = \left(\frac{0.23 n_{bw100}\left(L_c L_{ca}\right)^{0.3}}{\left(S_c P_{1,100} C_{w100}\right)^{0.4}} + 1.31\right)^{1.61} \quad \text{when } 5 \le Tc100 \le 180.$$

17. At T_{c100}, 100-year Rainfall Intensity $(i_{100}) = (4P_{1,100})/(1+0.05T_{c100})$ = 7.0 inches/hour.
18. 100-Year Peak $(Q_{p100}) = (C_{w100})(i_{100})(F_{Acw})A$= 0.67 x 7.00 x 0.9 x 13.2 = 55.8 cfs.
19. For Other Return Periods

	2-Year	10-year	25-Year	50-Year
Ratio to 100-Year Peak:	0.13	0.41	0.61	0.79
Q (Cubic feet/second)	7	23	34	44
Tc (minutes {Eqn. 4.5}):	32.8	20.7	17.6	15.9

*A may not exceed 6,400 acres (10 square miles) in size. **$T_{c\,100}$ may not exceed 180 minutes. If $T_{c\,100} \le 5$, set $T_{c\,100} = 5$ minutes.

NOTE: Indicate whether hydrologic computations are for "Future Conditions" or "Existing Conditions" by checking the appropriate box above.

Prepared by: JP Checked by: _____ Company: Psomas Date: 05/27/10

City of Tucson

Hydrologic Data Sheet for Computing 100-year Peak Discharge (Q_{p100})

1. Project Name and Location: Kolb/Sabino Canyon Road Extention
2. Drainage Concentration Point: N1
3. *Watershed Area (A) at Drainage Concentration Point: 1.12 acres
4. Length of Hydraulically Longest Watercourse (Lc): 433.0 ft.
5. Length from center of Watershed Area (Lca) along Lc: 216.5 ft.

For (Check One):
- ☐ Existing Condtions†
- ☑ Future Conditions†

6. Change in Length Factors - ft / Change in Elevation Factors - ft

a. ΔL_1:	433.0	$(\Delta L_1)^3$:	8.1E+07	ΔH_1:	9.0	$(\Delta L_1)^3/\Delta H_1$:	9.0E+06
b. ΔL_2:		$(\Delta L_2)^3$:		ΔH_2:		$(\Delta L_2)^3/\Delta H_2$:	
c. ΔL_3:		$(\Delta L_3)^3$:		ΔH_3:		$(\Delta L_3)^3\Delta H_3$:	
d. ΔL_4:		$(\Delta L_4)^3$:		ΔH_4:		$(\Delta L_4)^3/\Delta H_4$:	

7. $$G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2} = 3003.4 + ___ + ___ + ___ = 3003.4$$

8. Mean Slope $(S_c) = (L_c/G)^2 = (\ 433.0\ /\ 3003.4\ )^2 =$ 2.08% ft./ft.

9. Areally reduced 100-year, one-hour rainfall depth ($P_{1,100}$): 3.00 inches.

	Subarea 1	Subarea 2	Subarea 3	Weighted Watershed Parameters		
10. Watersheds Type(s) (% of Total Area):	Nat (100%)	Nat (0%)	( )			
11. Basin Factor ($n_{b,100}$):	0.055	0.055		n_{bw100}	=	0.055
12. Soil Types, in %:	100% B	100%C				
13. Imperviousnes (%):	5%	5%		I_w	=	5.0%
14. Runoff Coefficient (C_{w100}):	0.62	0.71		C_{w100}	=	0.62
15. Contrib. Area Factor (F_{Ao}):	1	1		F_{Acw}	=	1.00

16. **Time of Concentration (T_{c100}): 5.1 minutes, determined from:

$$T_{c100} = \left(\frac{0.23 n_{bw100}\left(L_c L_{ca}\right)^{0.3}}{\left(S_c P_{1,100} C_{w100}\right)^{0.4}} + 1.31\right)^{1.61} \quad \text{when } 5 \le Tc100 \le 180.$$

17. At T_{c100}, 100-year Rainfall Intensity (i_{100}) = $(4P_{1,100})/(1+0.05T_{c100})$ = 9.6 inches/hour.
18. 100-Year Peak (Q_{p100}) = $(C_{w100})(i_{100})(F_{Acw})A$= 0.62 x 9.60 x 1.0 x 1.1 = 6.7 cfs.
19. For Other Return Periods

	2-Year	10-year	25-Year	50-Year
Ratio to 100-Year Peak:	0.22	0.50	0.70	0.90
Q (Cubic feet/second)	1	3	5	6
Tc (minutes {Eqn. 4.5}):	9.3	6.7	5.9	5.3

*A may not exceed 6,400 acres (10 square miles) in size. **$T_{c\,100}$ may not exceed 180 minutes. If $T_{c\,100} \le 5$, set $T_{c\,100} = 5$ minutes.

NOTE: Indicate whether hydrologic computations are for "Future Conditions" or "Existing Conditions" by checking the appropriate box above.

Prepared by: JP Checked by: _____ Company: Psomas Date: 05/27/10

City of Tucson

Hydrologic Data Sheet for Computing 100-year Peak Discharge (Q_{p100})

1. Project Name and Location: Kolb/Sabino Canyon Road Extention
2. Drainage Concentration Point: N2
3. *Watershed Area (A) at Drainage Concentration Point: 0.88 acres
4. Length of Hydraulically Longest Watercourse (Lc): 404.4 ft.
5. Length from center of Watershed Area (Lca) along Lc: 202.2 ft.

For (Check One):
- ☐ Existing Condtions†
- ☑ Future Conditions†

6. Change in Length Factors - ft / Change in Elevation Factors - ft

a. ΔL_1:	404.4	$(\Delta L_1)^3$:	6.6E+07	ΔH_1:	4.0	$(\Delta L_1)^3/\Delta H_1$:	1.7E+07
b. ΔL_2:		$(\Delta L_2)^3$:		ΔH_2:		$(\Delta L_2)^3/\Delta H_2$:	
c. ΔL_3:		$(\Delta L_3)^3$:		ΔH_3:		$(\Delta L_3)^3\Delta H_3$:	
d. ΔL_4:		$(\Delta L_4)^3$:		ΔH_4:		$(\Delta L_4)^3/\Delta H_4$:	

7. $G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2}$ = 4065.4 + ____ + ____ + ____ = **4065.4**

8. Mean Slope $(S_c) = (L_c/G)^2 = ($ 404.4 / 4065.4 $)^2 =$ 0.99% ft./ft.

9. Areally reduced 100-year, one-hour rainfall depth ($P_{1,100}$): 3.00 inches.

	Subarea 1	Subarea 2	Subarea 3	Weighted Watershed Parameters
10. Watersheds Type(s) (% of Total Area):	Road (100%)	Road (0%)	( )	
11. Basin Factor ($n_{b,100}$):	0.048	0.048		n_{bw100} = 0.048
12. Soil Types, in %:	100% B	100%C		
13. Imperviousnes (%):	90%	90%		I_w = 90.0%
14. Runoff Coefficient (C_{w100}):	0.92	0.93		C_{w100} = 0.92
15. Contrib. Area Factor (F_{Ac}):	1	1		F_{Acw} = 1.00

16. **Time of Concentration (T_{c100}): 4.9 minutes, determined from:

$$T_{c100} = \left(\frac{0.23 n_{bw100}\left(L_c L_{ca}\right)^{0.3}}{\left(S_c P_{1,100} C_{w100}\right)^{0.4}} + 1.31\right)^{1.61} \quad \text{when } 5 \le Tc100 \le 180.$$

17. At T_{c100}, 100-year Rainfall Intensity (i_{100}) = ($4P_{1,100}$)/($1+0.05T_{c100}$) = 9.6 inches/hour.
18. 100-Year Peak (Q_{p100}) = (C_{w100})(i_{100})(F_{Acw})A= 0.92 x 9.60 x 1.0 x 0.9 = 7.8 cfs.
19. For Other Return Periods

	2-Year	10-year	25-Year	50-Year
Ratio to 100-Year Peak:	0.22	0.50	0.70	0.90
Q (Cubic feet/second)	2	4	5	7
Tc (minutes {Eqn. 4.5}):	9.1	6.5	5.7	5.2

*A may not exceed 6,400 acres (10 square miles) in size. **$T_{c\,100}$ may not exceed 180 minutes. If $T_{c\,100} \le 5$, set $T_{c\,100} = 5$ minutes.

NOTE: Indicate whether hydrologic computations are for "Future Conditions" or "Existing Conditions" by checking the appropriate box above.

Prepared by: JP Checked by: ____ Company: Psomas Date: 12/14/10

City of Tucson

Hydrologic Data Sheet for Computing 100-year Peak Discharge (Q_{p100})

1. Project Name and Location: Kolb/Sabino Canyon Road Extention
2. Drainage Concentration Point: N3
3. *Watershed Area (A) at Drainage Concentration Point: 0.77 acres
4. Length of Hydraulically Longest Watercourse (Lc): 232.6 ft.
5. Length from center of Watershed Area (Lca) along Lc: 116.3 ft.

For (Check One):
- ☐ Existing Condtions†
- ☑ Future Conditions†

6. Change in Length Factors - ft / Change in Elevation Factors - ft

a. ΔL_1:	232.6	$(\Delta L_1)^3$:	1.3E+07	ΔH_1:	3.0	$(\Delta L_1)^3/\Delta H_1$:	4.2E+06
b. ΔL_2:		$(\Delta L_2)^3$:		ΔH_2:		$(\Delta L_2)^3/\Delta H_2$:	
c. ΔL_3:		$(\Delta L_3)^3$:		ΔH_3:		$(\Delta L_3)^3\Delta H_3$:	
d. ΔL_4:		$(\Delta L_4)^3$:		ΔH_4:		$(\Delta L_4)^3/\Delta H_4$:	

7. $$G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2} = 2048.0 + ___ + ___ + ___ = \mathbf{2048.0}$$

8. Mean Slope $(S_c) = (L_c/G)^2 =$ (232.6 / 2048.0)^2 = 1.29% ft./ft.

9. Areally reduced 100-year, one-hour rainfall depth ($P_{1,100}$): 3.00 inches.

	Subarea 1	Subarea 2	Subarea 3	Weighted Watershed Parameters
10. Watersheds Type(s) (% of Total Area):	Road (100%)	Road (0%)	( )	
11. Basin Factor ($n_{b,100}$):	0.048	0.048		n_{bw100} = 0.048
12. Soil Types, in %:	100% B	100%C		
13. Imperviousnes (%):	90%	90%		I_w = 90.0%
14. Runoff Coefficient (C_{w100}):	0.92	0.93		C_{w100} = 0.92
15. Contrib. Area Factor (F_{Ac}):	1	1		F_{Acw} = 1.00

16. **Time of Concentration (T_{c100}): 3.6 minutes, determined from:

$$T_{c100} = \left(\frac{0.23 n_{bw100}\left(L_c L_{ca}\right)^{0.3}}{\left(S_c P_{1,100} C_{w100}\right)^{0.4}} + 1.31\right)^{1.61} \quad \text{when } 5 \le Tc100 \le 180.$$

17. At T_{c100}, 100-year Rainfall Intensity (i_{100}) = $(4P_{1,100})/(1+0.05T_{c100})$ = 9.6 inches/hour.
18. 100-Year Peak (Q_{p100}) = $(C_{w100})(i_{100})(F_{Acw})A$= 0.92 x 9.60 x 1.0 x 0.8 = 6.8 cfs.
19. For Other Return Periods

	2-Year	10-year	25-Year	50-Year
Ratio to 100-Year Peak:	0.22	0.50	0.70	0.90
Q (Cubic feet/second)	1	3	5	6
Tc (minutes {Eqn. 4.5}):	6.5	4.7	4.1	3.7

*A may not exceed 6,400 acres (10 square miles) in size. **$T_{c\,100}$ may not exceed 180 minutes. If $T_{c\,100} \le 5$, set $T_{c\,100} = 5$ minutes.

NOTE: Indicate whether hydrologic computations are for "Future Conditions" or "Existing Conditions" by checking the appropriate box above.

Prepared by: JP Checked by: _____ Company: Psomas Date: 05/27/10

City of Tucson

Hydrologic Data Sheet for Computing 100-year Peak Discharge (Q_{p100})

1. Project Name and Location: Kolb/Sabino Canyon Road Extention
2. Drainage Concentration Point: N3.1
3. *Watershed Area (A) at Drainage Concentration Point: 0.48 acres
4. Length of Hydraulically Longest Watercourse (Lc): 388.0 ft.
5. Length from center of Watershed Area (Lca) along Lc: 194.0 ft.

For (Check One):
- ☐ Existing Condtions†
- ☑ Future Conditions†

6. Change in Length Factors - ft / Change in Elevation Factors - ft

a. ΔL_1:	388.0	$(\Delta L_1)^3$:	5.8E+07	ΔH_1:	3.0	$(\Delta L_1)^3/\Delta H_1$:	1.9E+07
b. ΔL_2:		$(\Delta L_2)^3$:		ΔH_2:		$(\Delta L_2)^3/\Delta H_2$:	
c. ΔL_3:		$(\Delta L_3)^3$:		ΔH_3:		$(\Delta L_3)^3\Delta H_3$:	
d. ΔL_4:		$(\Delta L_4)^3$:		ΔH_4:		$(\Delta L_4)^3/\Delta H_4$:	

7. $$G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2} = 4412.4 + ___ + ___ + ___ = \mathbf{4412.4}$$

8. Mean Slope $(S_c) = (L_c/G)^2 = (\ 388.0\ /\ 4412.4\ )^2 =$ 0.77% ft./ft.

9. Areally reduced 100-year, one-hour rainfall depth ($P_{1,100}$): 3.00 inches.

	Subarea 1	Subarea 2	Subarea 3	Weighted Watershed Parameters
10. Watersheds Type(s) (% of Total Area):	Nat (100%)	Nat (0%)	( )	
11. Basin Factor ($n_{b,100}$):	0.048	0.055		n_{bw100} = 0.048
12. Soil Types, in %:	100% B	100%C		
13. Imperviousnes (%):	100%	0%		I_w = 100.0%
14. Runoff Coefficient (C_{w100}):	0.94	0.71		C_{w100} = 0.94
15. Contrib. Area Factor (F_{Ao}):	1	1		F_{Acw} = 1.00

16. **Time of Concentration (T_{c100}): 5.2 minutes, determined from:

$$T_{c100} = \left(\frac{0.23 n_{bw100}\left(L_c L_{ca}\right)^{0.3}}{\left(S_c P_{1,100} C_{w100}\right)^{0.4}} + 1.31\right)^{1.61} \quad \text{when } 5 \le Tc100 \le 180.$$

17. At T_{c100}, 100-year Rainfall Intensity (i_{100}) = $(4P_{1,100})/(1+0.05T_{c100})$ = 9.5 inches/hour.
18. 100-Year Peak (Q_{p100}) = $(C_{w100})(i_{100})(F_{Acw})A$= 0.94 x 9.50 x 1.0 x 0.5 = 4.3 cfs.
19. For Other Return Periods

	2-Year	10-year	25-Year	50-Year
Ratio to 100-Year Peak:	0.22	0.50	0.70	0.90
Q (Cubic feet/second)	1	2	3	4
Tc (minutes {Eqn. 4.5}):	9.6	6.9	6.0	5.4

*A may not exceed 6,400 acres (10 square miles) in size. **$T_{c\,100}$ may not exceed 180 minutes. If $T_{c\,100} \le 5$, set $T_{c\,100} = 5$ minutes.

NOTE: Indicate whether hydrologic computations are for "Future Conditions" or "Existing Conditions" by checking the appropriate box above.

Prepared by: JP Checked by: _____ Company: Psomas Date: 05/27/10

City of Tucson

Hydrologic Data Sheet for Computing 100-year Peak Discharge (Q_{p100})

1. Project Name and Location: Kolb/Sabino Canyon Road Extention
2. Drainage Concentration Point: N4
3. *Watershed Area (A) at Drainage Concentration Point: 2.96 acres
4. Length of Hydraulically Longest Watercourse (Lc): 943.8 ft.
5. Length from center of Watershed Area (Lca) along Lc: 471.9 ft.

For (Check One):
- ☐ Existing Condtions†
- ☑ Future Conditions†

6. Change in Length Factors - ft / Change in Elevation Factors - ft

a. ΔL_1:	943.8	$(\Delta L_1)^3$:	8.4E+08	ΔH_1:	10.5	$(\Delta L_1)^3/\Delta H_1$:	8.0E+07
b. ΔL_2:		$(\Delta L_2)^3$:		ΔH_2:		$(\Delta L_2)^3/\Delta H_2$:	
c. ΔL_3:		$(\Delta L_3)^3$:		ΔH_3:		$(\Delta L_3)^3\Delta H_3$:	
d. ΔL_4:		$(\Delta L_4)^3$:		ΔH_4:		$(\Delta L_4)^3/\Delta H_4$:	

7. $G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2}$ = 8948.6 + ____ + ____ + ____ = 8948.6

8. Mean Slope $(S_c) = (L_c/G)^2 = ($ 943.8 / 8948.6 $)^2 =$ 1.11% ft./ft.

9. Areally reduced 100-year, one-hour rainfall depth ($P_{1,100}$): 3.00 inches.

	Subarea 1	Subarea 2	Subarea 3	Weighted Watershed Parameters
10. Watersheds Type(s) (% of Total Area):	Nat (72%)	Nat (28%)	( )	
11. Basin Factor ($n_{b,100}$):	0.055	0.055		n_{bw100} = 0.055
12. Soil Types, in %:	100% B	100%C		
13. Imperviousnes (%):	1%	1%		I_w = 1.0%
14. Runoff Coefficient (C_{w100}):	0.62	0.71		C_{w100} = 0.65
15. Contrib. Area Factor (F_{Ac}):	1	1		F_{Acw} = 1.00

16. **Time of Concentration (T_{c100}): 10.1 minutes, determined from:

$$T_{c100} = \left(\frac{0.23 n_{bw100}\left(L_c L_{ca}\right)^{0.3}}{\left(S_c P_{1,100} C_{w100}\right)^{0.4}} + 1.31\right)^{1.61} \quad \text{when } 5 \le Tc100 \le 180.$$

17. At T_{c100}, 100-year Rainfall Intensity (i_{100}) = $(4P_{1,100})/(1+0.05T_{c100})$ = 8.0 inches/hour.
18. 100-Year Peak (Q_{p100}) = $(C_{w100})(i_{100})(F_{Acw})A$= 0.65 x 8.00 x 1.0 x 3.0 = 15.4 cfs.
19. For Other Return Periods

	2-Year	10-year	25-Year	50-Year
Ratio to 100-Year Peak:	0.22	0.50	0.70	0.90
Q (Cubic feet/second)	3	8	11	14
Tc (minutes {Eqn. 4.5}):	18.6	13.4	11.7	10.6

*A may not exceed 6,400 acres (10 square miles) in size. **$T_{c\,100}$ may not exceed 180 minutes. If $T_{c\,100} \le 5$, set $T_{c\,100} = 5$ minutes.

NOTE: Indicate whether hydrologic computations are for "Future Conditions" or "Existing Conditions" by checking the appropriate box above.

Prepared by: JP Checked by: ____ Company: Psomas Date: 05/27/10

City of Tucson

Hydrologic Data Sheet for Computing 100-year Peak Discharge (Q_{p100})

1. Project Name and Location: Kolb/Sabino Canyon Road Extention
2. Drainage Concentration Point: N4.1
3. *Watershed Area (A) at Drainage Concentration Point: 0.63 acres
4. Length of Hydraulically Longest Watercourse (Lc): 558.7 ft.
5. Length from center of Watershed Area (Lca) along Lc: 279.3 ft.

For (Check One):
- ☐ Existing Condtions†
- ☑ Future Conditions†

6. Change in Length Factors - ft / Change in Elevation Factors - ft

a. ΔL_1:	558.7	$(\Delta L_1)^3$:	1.7E+08	ΔH_1:	5.5	$(\Delta L_1)^3/\Delta H_1$:	3.2E+07
b. ΔL_2:		$(\Delta L_2)^3$:		ΔH_2:		$(\Delta L_2)^3/\Delta H_2$:	
c. ΔL_3:		$(\Delta L_3)^3$:		ΔH_3:		$(\Delta L_3)^3\Delta H_3$:	
d. ΔL_4:		$(\Delta L_4)^3$:		ΔH_4:		$(\Delta L_4)^3/\Delta H_4$:	

7. $G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2}$ = 5630.4 + ____ + ____ + ____ = **5630.4**

8. Mean Slope $(S_c) = (L_c/G)^2 = ($ 558.7 / 5630.4 $)^2 =$ 0.98% ft./ft.

9. Areally reduced 100-year, one-hour rainfall depth ($P_{1,100}$): 3.00 inches.

	Subarea 1	Subarea 2	Subarea 3	Weighted Watershed Parameters
10. Watersheds Type(s) (% of Total Area):	Nat (100%)	Nat (0%)	( )	
11. Basin Factor ($n_{b,100}$):	0.048	0.055		n_{bw100} = 0.048
12. Soil Types, in %:	100% B	100%C		
13. Imperviousnes (%):	100%	0%		I_w = 100.0%
14. Runoff Coefficient (C_{w100}):	0.94	0.71		C_{w100} = 0.94
15. Contrib. Area Factor (F_{Ac}):	1	1		F_{Acw} = 1.00

16. **Time of Concentration (T_{c100}): 5.8 minutes, determined from:

$$T_{c100} = \left(\frac{0.23 n_{bw100}\left(L_c L_{ca}\right)^{0.3}}{\left(S_c P_{1,100} C_{w100}\right)^{0.4}} + 1.31\right)^{1.61} \quad \text{when } 5 \le Tc100 \le 180.$$

17. At T_{c100}, 100-year Rainfall Intensity (i_{100}) = ($4P_{1,100}$)/($1+0.05T_{c100}$) = 9.3 inches/hour.
18. 100-Year Peak (Q_{p100}) = (C_{w100})(i_{100})(F_{Acw})A= 0.94 x 9.30 x 1.0 x 0.6 = 5.5 cfs.
19. For Other Return Periods

	2-Year	10-year	25-Year	50-Year
Ratio to 100-Year Peak:	0.22	0.50	0.70	0.90
Q (Cubic feet/second)	1	3	4	5
Tc (minutes {Eqn. 4.5}):	10.6	7.7	6.7	6.1

*A may not exceed 6,400 acres (10 square miles) in size. **$T_{c\,100}$ may not exceed 180 minutes. If $T_{c\,100} \le 5$, set $T_{c\,100} = 5$ minutes.

NOTE: Indicate whether hydrologic computations are for "Future Conditions" or "Existing Conditions" by checking the appropriate box above.

Prepared by: JP Checked by: ____ Company: Psomas Date: 12/14/10

City of Tucson

Hydrologic Data Sheet for Computing 100-year Peak Discharge (Q_{p100})

1. Project Name and Location: Kolb/Sabino Canyon Road Extention
2. Drainage Concentration Point: N5
3. *Watershed Area (A) at Drainage Concentration Point: 3.65 acres
4. Length of Hydraulically Longest Watercourse (Lc): 552.3 ft.
5. Length from center of Watershed Area (Lca) along Lc: 276.2 ft.

For (Check One):
- ☐ Existing Condtions†
- ☑ Future Conditions†

6. Change in Length Factors - ft / Change in Elevation Factors - ft

a. ΔL_1:	552.3	$(\Delta L_1)^3$:	1.7E+08	ΔH_1:	9.0	$(\Delta L_1)^3/\Delta H_1$:	1.9E+07
b. ΔL_2:		$(\Delta L_2)^3$:		ΔH_2:		$(\Delta L_2)^3/\Delta H_2$:	
c. ΔL_3:		$(\Delta L_3)^3$:		ΔH_3:		$(\Delta L_3)^3\Delta H_3$:	
d. ΔL_4:		$(\Delta L_4)^3$:		ΔH_4:		$(\Delta L_4)^3/\Delta H_4$:	

7. $G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2}$ = 4327.0 + ____ + ____ + ____ = **4327.0**

8. Mean Slope $(S_c) = (L_c/G)^2 = ($ 552.3 / 4327.0 $)^2 =$ 1.63% ft./ft.

9. Areally reduced 100-year, one-hour rainfall depth ($P_{1,100}$): 3.00 inches.

	Subarea 1	Subarea 2	Subarea 3	Weighted Watershed Parameters
10. Watersheds Type(s) (% of Total Area):	Res (100%)	Res (0%)	( )	
11. Basin Factor ($n_{b,100}$):	0.048	0.048		n_{bw100} = 0.048
12. Soil Types, in %:	100% B	100%C		
13. Imperviousnes (%):	35%	35%		I_w = 35.0%
14. Runoff Coefficient (C_{w100}):	0.73	0.79		C_{w100} = 0.73
15. Contrib. Area Factor (F_{Ac}):	1	1		F_{Acw} = 1.00

16. **Time of Concentration (T_{c100}): 5.3 minutes, determined from:

$$T_{c100} = \left(\frac{0.23 n_{bw100}\left(L_c L_{ca}\right)^{0.3}}{\left(S_c P_{1,100} C_{w100}\right)^{0.4}} + 1.31\right)^{1.61} \quad \text{when } 5 \le Tc100 \le 180.$$

17. At T_{c100}, 100-year Rainfall Intensity (i_{100}) = $(4P_{1,100})/(1+0.05T_{c100})$ = 9.5 inches/hour.
18. 100-Year Peak (Q_{p100}) = $(C_{w100})(i_{100})(F_{Acw})A$= 0.73 x 9.50 x 1.0 x 3.7 = 25.3 cfs.
19. For Other Return Periods

	2-Year	10-year	25-Year	50-Year
Ratio to 100-Year Peak:	0.13	0.41	0.61	0.79
Q (Cubic feet/second)	3	10	15	20
Tc (minutes {Eqn. 4.5}):	12.0	7.6	6.4	5.8

*A may not exceed 6,400 acres (10 square miles) in size. **$T_{c\,100}$ may not exceed 180 minutes. If $T_{c\,100} \le 5$, set $T_{c\,100} = 5$ minutes.

NOTE: Indicate whether hydrologic computations are for "Future Conditions" or "Existing Conditions" by checking the appropriate box above.

Prepared by: JP Checked by: ____ Company: Psomas Date: 05/27/10

City of Tucson

Hydrologic Data Sheet for Computing 100-year Peak Discharge (Q_{p100})

1. Project Name and Location: Kolb/Sabino Canyon Road Extention
2. Drainage Concentration Point: N5.1
3. *Watershed Area (A) at Drainage Concentration Point: 0.49 acres
4. Length of Hydraulically Longest Watercourse (Lc): 401.0 ft.
5. Length from center of Watershed Area (Lca) along Lc: 200.5 ft.

For (Check One):
☐ Existing Condtions†
☑ Future Conditions†

6. Change in Length Factors - ft / Change in Elevation Factors - ft

a. ΔL_1:	401.0	$(\Delta L_1)^3$:	6.4E+07	ΔH_1:	2.0	$(\Delta L_1)^3/\Delta H_1$:	3.2E+07
b. ΔL_2:		$(\Delta L_2)^3$:		ΔH_2:		$(\Delta L_2)^3/\Delta H_2$:	
c. ΔL_3:		$(\Delta L_3)^3$:		ΔH_3:		$(\Delta L_3)^3\Delta H_3$:	
d. ΔL_4:		$(\Delta L_4)^3$:		ΔH_4:		$(\Delta L_4)^3/\Delta H_4$:	

7. $$G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2} = 5677.2 + ___ + ___ + ___ = 5677.2$$

8. Mean Slope $(S_c) = (L_c/G)^2 = (\ 401.0\ /\ 5677.2\ )^2 =$ 0.50% ft./ft.

9. Areally reduced 100-year, one-hour rainfall depth ($P_{1,100}$): 3.00 inches.

	Subarea 1	Subarea 2	Subarea 3	Weighted Watershed Parameters
10. Watersheds Type(s) (% of Total Area):	Nat (100%)	Nat (0%)	( )	
11. Basin Factor ($n_{b,100}$):	0.048	0.055		n_{bw100} = 0.048
12. Soil Types, in %:	100% B	100%C		
13. Imperviousnes (%):	100%	0%		I_w = 100.0%
14. Runoff Coefficient (C_{w100}):	0.94	0.71		C_{w100} = 0.94
15. Contrib. Area Factor (F_{Ac}):	1	1		F_{Acw} = 1.00

16. **Time of Concentration (T_{c100}): 6.2 minutes, determined from:

$$T_{c100} = \left(\frac{0.23 n_{bw100}\left(L_c L_{ca}\right)^{0.3}}{\left(S_c P_{1,100} C_{w100}\right)^{0.4}} + 1.31\right)^{1.61} \quad \text{when } 5 \le Tc100 \le 180.$$

17. At T_{c100}, 100-year Rainfall Intensity (i_{100}) = $(4P_{1,100})/(1+0.05T_{c100})$ = 9.2 inches/hour.
18. 100-Year Peak (Q_{p100}) = $(C_{w100})(i_{100})(F_{Acw})A$= 0.94 x 9.20 x 1.0 x 0.5 = 4.2 cfs.
19. For Other Return Periods

	2-Year	10-year	25-Year	50-Year
Ratio to 100-Year Peak:	0.22	0.50	0.70	0.90
Q (Cubic feet/second)	1	2	3	4
Tc (minutes {Eqn. 4.5}):	11.4	8.2	7.2	6.5

*A may not exceed 6,400 acres (10 square miles) in size. **T_{c100} may not exceed 180 minutes. If $T_{c100} \le 5$, set T_{c100} = 5 minutes.

NOTE: Indicate whether hydrologic computations are for "Future Conditions" or "Existing Conditions" by checking the appropriate box above.

Prepared by: JP Checked by: _____ Company: Psomas Date: 05/27/10

City of Tucson

Hydrologic Data Sheet for Computing 100-year Peak Discharge (Q_{p100})

1. Project Name and Location: Kolb/Sabino Canyon Road Extention
2. Drainage Concentration Point: N6
3. *Watershed Area (A) at Drainage Concentration Point: 1.53 acres
4. Length of Hydraulically Longest Watercourse (Lc): 354.6 ft.
5. Length from center of Watershed Area (Lca) along Lc: 177.3 ft.

For (Check One):
- ☐ Existing Condtions†
- ☑ Future Conditions†

6. Change in Length Factors - ft / Change in Elevation Factors - ft

a. ΔL_1:	354.6	$(\Delta L_1)^3$:	4.5E+07	ΔH_1:	8.0	$(\Delta L_1)^3/\Delta H_1$:	5.6E+06
b. ΔL_2:		$(\Delta L_2)^3$:		ΔH_2:		$(\Delta L_2)^3/\Delta H_2$:	
c. ΔL_3:		$(\Delta L_3)^3$:		ΔH_3:		$(\Delta L_3)^3\Delta H_3$:	
d. ΔL_4:		$(\Delta L_4)^3$:		ΔH_4:		$(\Delta L_4)^3/\Delta H_4$:	

7. $$G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2} = 2360.9 + ___ + ___ + ___ = \mathbf{2360.9}$$

8. Mean Slope $(S_c) = (L_c/G)^2 = ($ 354.6 / 2360.9 $)^2 =$ 2.26% ft./ft.

9. Areally reduced 100-year, one-hour rainfall depth ($P_{1,100}$): 3.00 inches.

	Subarea 1	Subarea 2	Subarea 3	Weighted Watershed Parameters
10. Watersheds Type(s) (% of Total Area):	Res (100%)	Res (0%)	( )	
11. Basin Factor ($n_{b,100}$):	0.048	0.048		n_{bw100} = 0.048
12. Soil Types, in %:	100% B	100%C		
13. Imperviousnes (%):	35%	35%		I_w = 35.0%
14. Runoff Coefficient (C_{w100}):	0.73	0.79		C_{w100} = 0.73
15. Contrib. Area Factor (F_{Ac}):	1	1		F_{Acw} = 1.00

16. **Time of Concentration (T_{c100}): 3.9 minutes, determined from:

$$T_{c100} = \left(\frac{0.23 n_{bw100}\left(L_c L_{ca}\right)^{0.3}}{\left(S_c P_{1,100} C_{w100}\right)^{0.4}} + 1.31\right)^{1.61} \quad \text{when } 5 \le Tc100 \le 180.$$

17. At T_{c100}, 100-year Rainfall Intensity $(i_{100}) = (4P_{1,100})/(1+0.05T_{c100})$ = 9.6 inches/hour.
18. 100-Year Peak $(Q_{p100}) = (C_{w100})(i_{100})(F_{Acw})A$= 0.73 x 9.60 x 1.0 x 1.5 = 10.7 cfs.
19. For Other Return Periods

	2-Year	10-year	25-Year	50-Year
Ratio to 100-Year Peak:	0.13	0.41	0.61	0.79
Q (Cubic feet/second)	1	4	7	8
Tc (minutes {Eqn. 4.5}):	8.8	5.5	4.7	4.3

*A may not exceed 6,400 acres (10 square miles) in size. **$T_{c\,100}$ may not exceed 180 minutes. If $T_{c\,100} \le 5$, set $T_{c\,100} = 5$ minutes.

NOTE: Indicate whether hydrologic computations are for "Future Conditions" or "Existing Conditions" by checking the appropriate box above.

Prepared by: JP Checked by: _____ Company: Psomas Date: 12/14/10

City of Tucson

Hydrologic Data Sheet for Computing 100-year Peak Discharge (Q_{p100})

1. Project Name and Location: Kolb/Sabino Canyon Road Extention
2. Drainage Concentration Point: N6.1
3. *Watershed Area (A) at Drainage Concentration Point: 0.22 acres
4. Length of Hydraulically Longest Watercourse (Lc): 244.0 ft.
5. Length from center of Watershed Area (Lca) along Lc: 122.0 ft.

For (Check One):
- ☐ Existing Condtions†
- ☑ Future Conditions†

6. Change in Length Factors - ft / Change in Elevation Factors - ft

a. ΔL_1:	244.0	$(\Delta L_1)^3$:	1.5E+07	ΔH_1:	2.0	$(\Delta L_1)^3/\Delta H_1$:	7.3E+06
b. ΔL_2:		$(\Delta L_2)^3$:		ΔH_2:		$(\Delta L_2)^3/\Delta H_2$:	
c. ΔL_3:		$(\Delta L_3)^3$:		ΔH_3:		$(\Delta L_3)^3\Delta H_3$:	
d. ΔL_4:		$(\Delta L_4)^3$:		ΔH_4:		$(\Delta L_4)^3/\Delta H_4$:	

7. $$G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2} = 2695.1 + ___ + ___ + ___ = \mathbf{2695.1}$$

8. Mean Slope $(S_c) = (L_c/G)^2 = ($ 244.0 / 2695.1 $)^2 =$ 0.82% ft./ft.

9. Areally reduced 100-year, one-hour rainfall depth ($P_{1,100}$): 3.00 inches.

	Subarea 1	Subarea 2	Subarea 3	Weighted Watershed Parameters
10. Watersheds Type(s) (% of Total Area):	Pav (100%)	Res (0%)	( )	
11. Basin Factor ($n_{b,100}$):	0.048	0.048		n_{bw100} = 0.048
12. Soil Types, in %:	100% B	100%C		
13. Imperviousnes (%):	100%	100%		I_w = 100.0%
14. Runoff Coefficient (C_{w100}):	0.94	0.79		C_{w100} = 0.94
15. Contrib. Area Factor (F_{Ac}):	1	1		F_{Acw} = 1.00

16. **Time of Concentration (T_{c100}): 4.1 minutes, determined from:

$$T_{c100} = \left(\frac{0.23 n_{bw100}\left(L_c L_{ca}\right)^{0.3}}{\left(S_c P_{1,100} C_{w100}\right)^{0.4}} + 1.31\right)^{1.61} \quad \text{when } 5 \le Tc100 \le 180.$$

17. At T_{c100}, 100-year Rainfall Intensity $(i_{100}) = (4P_{1,100})/(1+0.05T_{c100})$ = 9.6 inches/hour.
18. 100-Year Peak $(Q_{p100}) = (C_{w100})(i_{100})(F_{Acw})A$= 0.94 x 9.60 x 1.0 x 0.2 = 2.0 cfs.
19. For Other Return Periods

	2-Year	10-year	25-Year	50-Year
Ratio to 100-Year Peak:	0.13	0.41	0.61	0.79
Q (Cubic feet/second)	0	1	1	2
Tc (minutes {Eqn. 4.5}):	9.3	5.9	5.0	4.5

*A may not exceed 6,400 acres (10 square miles) in size. **$T_{c\,100}$ may not exceed 180 minutes. If $T_{c\,100} \le 5$, set $T_{c\,100} = 5$ minutes.

NOTE: Indicate whether hydrologic computations are for "Future Conditions" or "Existing Conditions" by checking the appropriate box above.

Prepared by: JP Checked by: _____ Company: Psomas Date: 12/20/10

City of Tucson

Hydrologic Data Sheet for Computing 100-year Peak Discharge (Q_{p100})

1. Project Name and Location: Kolb/Sabino Canyon Road Extention
2. Drainage Concentration Point: N7
3. *Watershed Area (A) at Drainage Concentration Point: 0.82 acres
4. Length of Hydraulically Longest Watercourse (Lc): 350.0 ft.
5. Length from center of Watershed Area (Lca) along Lc: 175.0 ft.

For (Check One):
- ☐ Existing Condtions†
- ☑ Future Conditions†

6. Change in Length Factors - ft / Change in Elevation Factors - ft

a. ΔL_1:	350.0	$(\Delta L_1)^3$:	4.3E+07	ΔH_1:	5.0	$(\Delta L_1)^3/\Delta H_1$:	8.6E+06
b. ΔL_2:		$(\Delta L_2)^3$:		ΔH_2:		$(\Delta L_2)^3/\Delta H_2$:	
c. ΔL_3:		$(\Delta L_3)^3$:		ΔH_3:		$(\Delta L_3)^3\Delta H_3$:	
d. ΔL_4:		$(\Delta L_4)^3$:		ΔH_4:		$(\Delta L_4)^3/\Delta H_4$:	

7. $$G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2} = \underline{2928.6} + ___ + ___ + ___ = \underline{2928.6}$$

8. Mean Slope $(S_c) = (L_c/G)^2 = (\ 350.0\ /\ 2928.6\ )^2 =$ 1.43% ft./ft.

9. Areally reduced 100-year, one-hour rainfall depth ($P_{1,100}$): 3.00 inches.

	Subarea 1	Subarea 2	Subarea 3	Weighted Watershed Parameters
10. Watersheds Type(s) (% of Total Area):	Road (100%)	Road (0%)	( )	
11. Basin Factor ($n_{b,100}$):	0.048	0.048		n_{bw100} = 0.048
12. Soil Types, in %:	100% B	100%C		
13. Imperviousnes (%):	60%	60%		I_w = 60.0%
14. Runoff Coefficient (C_{w100}):	0.82	0.86		C_{w100} = 0.82
15. Contrib. Area Factor (F_{Ac}):	1	1		F_{Acw} = 1.00

16. **Time of Concentration (T_{c100}): 4.3 minutes, determined from:

$$T_{c100} = \left(\frac{0.23 n_{bw100}\left(L_c L_{ca}\right)^{0.3}}{\left(S_c P_{1,100} C_{w100}\right)^{0.4}} + 1.31\right)^{1.61} \quad \text{when } 5 \le Tc100 \le 180.$$

17. At T_{c100}, 100-year Rainfall Intensity (i_{100}) = $(4P_{1,100})/(1+0.05T_{c100})$ = 9.6 inches/hour.
18. 100-Year Peak (Q_{p100}) = $(C_{w100})(i_{100})(F_{Acw})A$= 0.82 x 9.60 x 1.0 x 0.8 = 6.5 cfs.
19. For Other Return Periods

	2-Year	10-year	25-Year	50-Year
Ratio to 100-Year Peak:	0.22	0.50	0.70	0.90
Q (Cubic feet/second)	1	3	5	6
Tc (minutes {Eqn. 4.5}):	7.8	5.6	4.9	4.4

*A may not exceed 6,400 acres (10 square miles) in size. **T_{c100} may not exceed 180 minutes. If $T_{c100} \le 5$, set T_{c100} = 5 minutes.

NOTE: Indicate whether hydrologic computations are for "Future Conditions" or "Existing Conditions" by checking the appropriate box above.

Prepared by: JP Checked by: _____ Company: Psomas Date: 05/27/10

City of Tucson

Hydrologic Data Sheet for Computing 100-year Peak Discharge (Q_{p100})

1. Project Name and Location: Kolb/Sabino Canyon Road Extention
2. Drainage Concentration Point: N8
3. *Watershed Area (A) at Drainage Concentration Point: 1.07 acres
4. Length of Hydraulically Longest Watercourse (Lc): 472.8 ft.
5. Length from center of Watershed Area (Lca) along Lc: 236.4 ft.

For (Check One):
- ☐ Existing Condtions†
- ☑ Future Conditions†

6. Change in Length Factors - ft / Change in Elevation Factors - ft

a. ΔL_1:	472.8	$(\Delta L_1)^3$:	1.1E+08	ΔH_1:	11.0	$(\Delta L_1)^3/\Delta H_1$:	9.6E+06
b. ΔL_2:		$(\Delta L_2)^3$:		ΔH_2:		$(\Delta L_2)^3/\Delta H_2$:	
c. ΔL_3:		$(\Delta L_3)^3$:		ΔH_3:		$(\Delta L_3)^3\Delta H_3$:	
d. ΔL_4:		$(\Delta L_4)^3$:		ΔH_4:		$(\Delta L_4)^3/\Delta H_4$:	

7. $$G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2} = 3099.7 + ___ + ___ + ___ = 3099.7$$

8. Mean Slope $(S_c) = (L_c/G)^2 = ($ 472.8 / 3099.7 $)^2 =$ 2.33% ft./ft.

9. Areally reduced 100-year, one-hour rainfall depth ($P_{1,100}$): 3.00 inches.

	Subarea 1	Subarea 2	Subarea 3	Weighted Watershed Parameters
10. Watersheds Type(s) (% of Total Area):	Com (100%)	Com (0%)	( )	
11. Basin Factor ($n_{b,100}$):	0.048	0.048		n_{bw100} = 0.048
12. Soil Types, in %:	100% B	100%C		
13. Imperviousnes (%):	100%	60%		I_w = 100.0%
14. Runoff Coefficient (C_{w100}):	0.94	0.86		C_{w100} = 0.94
15. Contrib. Area Factor (F_{Ao}):	1	1		F_{Acw} = 1.00

16. **Time of Concentration (T_{c100}): 4.0 minutes, determined from:

$$T_{c100} = \left(\frac{0.23 n_{bw100}\left(L_c L_{ca}\right)^{0.3}}{\left(S_c P_{1,100} C_{w100}\right)^{0.4}} + 1.31\right)^{1.61} \quad \text{when } 5 \le Tc100 \le 180.$$

17. At T_{c100}, 100-year Rainfall Intensity (i_{100}) = $(4P_{1,100})/(1+0.05T_{c100})$ = 9.6 inches/hour.
18. 100-Year Peak (Q_{p100}) = $(C_{w100})(i_{100})(F_{Acw})A$= 0.94 x 9.60 x 1.0 x 1.1 = 9.7 cfs.
19. For Other Return Periods

	2-Year	10-year	25-Year	50-Year
Ratio to 100-Year Peak:	0.22	0.50	0.70	0.90
Q (Cubic feet/second)	2	5	7	9
Tc (minutes {Eqn. 4.5}):	7.4	5.3	4.7	4.2

*A may not exceed 6,400 acres (10 square miles) in size. **$T_{c\,100}$ may not exceed 180 minutes. If $T_{c\,100} \le 5$, set $T_{c\,100} = 5$ minutes.

NOTE: Indicate whether hydrologic computations are for "Future Conditions" or "Existing Conditions" by checking the appropriate box above.

Prepared by: JP Checked by: _____ Company: Psomas Date: 05/27/10

City of Tucson

Hydrologic Data Sheet for Computing 100-year Peak Discharge (Q_{p100})

1. Project Name and Location: Kolb/Sabino Canyon Road Extention
2. Drainage Concentration Point: N8.1
3. *Watershed Area (A) at Drainage Concentration Point: 1.07 acres
4. Length of Hydraulically Longest Watercourse (Lc): 417.5 ft.
5. Length from center of Watershed Area (Lca) along Lc: 208.7 ft.

For (Check One):
- ☐ Existing Condtions†
- ☑ Future Conditions†

6. Change in Length Factors - ft / Change in Elevation Factors - ft

a. ΔL_1:	417.5	$(\Delta L_1)^3$:	7.3E+07	ΔH_1:	11.0	$(\Delta L_1)^3/\Delta H_1$:	6.6E+06
b. ΔL_2:		$(\Delta L_2)^3$:		ΔH_2:		$(\Delta L_2)^3/\Delta H_2$:	
c. ΔL_3:		$(\Delta L_3)^3$:		ΔH_3:		$(\Delta L_3)^3\Delta H_3$:	
d. ΔL_4:		$(\Delta L_4)^3$:		ΔH_4:		$(\Delta L_4)^3/\Delta H_4$:	

7. $$G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2} = 2571.9 + ___ + ___ + ___ = \mathbf{2571.9}$$

8. Mean Slope $(S_c) = (L_c/G)^2 = ($ 417.5 / 2571.9 $)^2 =$ 2.63% ft./ft.

9. Areally reduced 100-year, one-hour rainfall depth ($P_{1,100}$): 3.00 inches.

	Subarea 1	Subarea 2	Subarea 3	Weighted Watershed Parameters
10. Watersheds Type(s) (% of Total Area):	Com (100%)	Com (0%)	( )	
11. Basin Factor ($n_{b,100}$):	0.048	0.048		n_{bw100} = 0.048
12. Soil Types, in %:	100% B	100%C		
13. Imperviousnes (%):	100%	60%		I_w = 100.0%
14. Runoff Coefficient (C_{w100}):	0.94	0.86		C_{w100} = 0.94
15. Contrib. Area Factor (F_{Ac}):	1	1		F_{Acw} = 1.00

16. **Time of Concentration (T_{c100}): 3.7 minutes, determined from:

$$T_{c100} = \left(\frac{0.23 n_{bw100}\left(L_c L_{ca}\right)^{0.3}}{\left(S_c P_{1,100} C_{w100}\right)^{0.4}} + 1.31\right)^{1.61} \quad \text{when } 5 \le Tc100 \le 180.$$

17. At T_{c100}, 100-year Rainfall Intensity $(i_{100}) = (4P_{1,100})/(1+0.05T_{c100})$ = 9.6 inches/hour.
18. 100-Year Peak $(Q_{p100}) = (C_{w100})(i_{100})(F_{Acw})A$= 0.94 x 9.60 x 1.0 x 1.1 = 9.7 cfs.
19. For Other Return Periods

	2-Year	10-year	25-Year	50-Year
Ratio to 100-Year Peak:	0.22	0.50	0.70	0.90
Q (Cubic feet/second)	2	5	7	9
Tc (minutes {Eqn. 4.5}):	6.8	4.9	4.3	3.9

*A may not exceed 6,400 acres (10 square miles) in size. **$T_{c\,100}$ may not exceed 180 minutes. If $T_{c\,100} \le 5$, set $T_{c\,100} = 5$ minutes.

NOTE: Indicate whether hydrologic computations are for "Future Conditions" or "Existing Conditions" by checking the appropriate box above.

Prepared by: JP Checked by: _____ Company: Psomas Date: 06/04/10

City of Tucson

Hydrologic Data Sheet for Computing 100-year Peak Discharge (Q_{p100})

1. Project Name and Location: Kolb/Sabino Canyon Road Extention
2. Drainage Concentration Point: N9
3. *Watershed Area (A) at Drainage Concentration Point: 2.06 acres
4. Length of Hydraulically Longest Watercourse (Lc): 607.8 ft.
5. Length from center of Watershed Area (Lca) along Lc: 303.9 ft.

For (Check One):
- ☐ Existing Condtions†
- ☑ Future Conditions†

6. Change in Length Factors - ft / Change in Elevation Factors - ft

a. ΔL_1:	607.8	$(\Delta L_1)^3$:	2.2E+08	ΔH_1:	9.0	$(\Delta L_1)^3/\Delta H_1$:	2.5E+07
b. ΔL_2:		$(\Delta L_2)^3$:		ΔH_2:		$(\Delta L_2)^3/\Delta H_2$:	
c. ΔL_3:		$(\Delta L_3)^3$:		ΔH_3:		$(\Delta L_3)^3\Delta H_3$:	
d. ΔL_4:		$(\Delta L_4)^3$:		ΔH_4:		$(\Delta L_4)^3/\Delta H_4$:	

7. $$G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2} = 4995.3 + ___ + ___ + ___ = 4995.3$$

8. Mean Slope $(S_c) = (L_c/G)^2 = ($ 607.8 / 4995.3 $)^2 =$ 1.48% ft./ft.

9. Areally reduced 100-year, one-hour rainfall depth ($P_{1,100}$): 3.00 inches.

	Subarea 1	Subarea 2	Subarea 3	Weighted Watershed Parameters
10. Watersheds Type(s) (% of Total Area):	Res (100%)	Res (0%)	( )	
11. Basin Factor ($n_{b,100}$):	0.052	0.048		n_{bw100} = 0.052
12. Soil Types, in %:	100% B	100%C		
13. Impervionsnes (%):	45%	60%		I_w = 45.0%
14. Runoff Coefficient (C_{w100}):	0.73	0.86		C_{w100} = 0.73
15. Contrib. Area Factor (F_{Ac}):	1	1		F_{Acw} = 1.00

16. **Time of Concentration (T_{c100}): 6.2 minutes, determined from:

$$T_{c100} = \left(\frac{0.23 n_{bw100}\left(L_c L_{ca}\right)^{0.3}}{\left(S_c P_{1,100} C_{w100}\right)^{0.4}} + 1.31\right)^{1.61} \quad \text{when } 5 \le Tc100 \le 180.$$

17. At T_{c100}, 100-year Rainfall Intensity (i_{100}) = $(4P_{1,100})/(1+0.05T_{c100})$ = 9.2 inches/hour.
18. 100-Year Peak (Q_{p100}) = $(C_{w100})(i_{100})(F_{Acw})A$= 0.73 x 9.20 x 1.0 x 2.1 = 13.8 cfs.
19. For Other Return Periods

	2-Year	10-year	25-Year	50-Year
Ratio to 100-Year Peak:	0.22	0.50	0.70	0.90
Q (Cubic feet/second)	3	7	10	12
Tc (minutes {Eqn. 4.5}):	11.3	8.2	7.1	6.5

*A may not exceed 6,400 acres (10 square miles) in size. **$T_{c\,100}$ may not exceed 180 minutes. If $T_{c\,100} \le 5$, set $T_{c\,100} = 5$ minutes.

NOTE: Indicate whether hydrologic computations are for "Future Conditions" or "Existing Conditions" by checking the appropriate box above.

Prepared by: JP Checked by: _____ Company: Psomas Date: 05/27/10

City of Tucson

Hydrologic Data Sheet for Computing 100-year Peak Discharge (Q_{p100})

1. Project Name and Location: Kolb/Sabino Canyon Road Extention
2. Drainage Concentration Point: N10
3. *Watershed Area (A) at Drainage Concentration Point: 1.65 acres
4. Length of Hydraulically Longest Watercourse (Lc): 730.0 ft.
5. Length from center of Watershed Area (Lca) along Lc: 365.0 ft.

For (Check One):
- [ ] Existing Condtions†
- [x] Future Conditions†

6. Change in Length Factors - ft / Change in Elevation Factors - ft

a. ΔL_1:	730.0	$(\Delta L_1)^3$:	3.9E+08	ΔH_1:	9.0	$(\Delta L_1)^3/\Delta H_1$:	4.3E+07
b. ΔL_2:		$(\Delta L_2)^3$:		ΔH_2:		$(\Delta L_2)^3/\Delta H_2$:	
c. ΔL_3:		$(\Delta L_3)^3$:		ΔH_3:		$(\Delta L_3)^3\Delta H_3$:	
d. ΔL_4:		$(\Delta L_4)^3$:		ΔH_4:		$(\Delta L_4)^3/\Delta H_4$:	

7. $$G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2} = 6574.4 + ___ + ___ + ___ = 6574.4$$

8. Mean Slope $(S_c) = (L_c/G)^2 =$ (730.0 / 6574.4)^2 = 1.23% ft./ft.

9. Areally reduced 100-year, one-hour rainfall depth ($P_{1,100}$): 3.00 inches.

	Subarea 1	Subarea 2	Subarea 3	Weighted Watershed Parameters
10. Watersheds Type(s) (% of Total Area):	Road (100%)	Road (0%)	( )	
11. Basin Factor ($n_{b,100}$):	0.048	0.048		n_{bw100} = 0.048
12. Soil Types, in %:	100% B	100%C		
13. Imperviousnes (%):	90%	90%		I_w = 90.0%
14. Runoff Coefficient (C_{w100}):	0.92	0.93		C_{w100} = 0.92
15. Contrib. Area Factor (F_{Ac}):	1	1		F_{Acw} = 1.00

16. **Time of Concentration (T_{c100}): 6.2 minutes, determined from:

$$T_{c100} = \left(\frac{0.23 n_{bw100}\left(L_c L_{ca}\right)^{0.3}}{\left(S_c P_{1,100} C_{w100}\right)^{0.4}} + 1.31\right)^{1.61} \quad \text{when } 5 \le Tc100 \le 180.$$

17. At T_{c100}, 100-year Rainfall Intensity (i_{100}) = $(4P_{1,100})/(1+0.05T_{c100})$ = 9.1 inches/hour.
18. 100-Year Peak (Q_{p100}) = $(C_{w100})(i_{100})(F_{Acw})A$= 0.92 x 9.10 x 1.0 x 1.7 = 13.8 cfs.
19. For Other Return Periods

	2-Year	10-year	25-Year	50-Year
Ratio to 100-Year Peak:	0.22	0.50	0.70	0.90
Q (Cubic feet/second)	3	7	10	12
Tc (minutes {Eqn. 4.5}):	11.5	8.2	7.2	6.5

*A may not exceed 6,400 acres (10 square miles) in size. **$T_{c\,100}$ may not exceed 180 minutes. If $T_{c\,100} \le 5$, set $T_{c\,100} = 5$ minutes.

NOTE: Indicate whether hydrologic computations are for "Future Conditions" or "Existing Conditions" by checking the appropriate box above.

Prepared by: JP Checked by: _____ Company: Psomas Date: 06/02/10

City of Tucson

Hydrologic Data Sheet for Computing 100-year Peak Discharge (Q_{p100})

1. Project Name and Location: Kolb/Sabino Canyon Road Extention
2. Drainage Concentration Point: N11
3. *Watershed Area (A) at Drainage Concentration Point: 1.03 acres
4. Length of Hydraulically Longest Watercourse (Lc): 371.6 ft.
5. Length from center of Watershed Area (Lca) along Lc: 185.8 ft.

For (Check One):
- ☐ Existing Condtions†
- ☑ Future Conditions†

6. Change in Length Factors - ft / Change in Elevation Factors - ft

a. ΔL_1:	371.6	$(\Delta L_1)^3$:	5.1E+07	ΔH_1:	6.0	$(\Delta L_1)^3/\Delta H_1$: 8.6E+06
b. ΔL_2:		$(\Delta L_2)^3$:		ΔH_2:		$(\Delta L_2)^3/\Delta H_2$:
c. ΔL_3:		$(\Delta L_3)^3$:		ΔH_3:		$(\Delta L_3)^3 \Delta H_3$:
d. ΔL_4:		$(\Delta L_4)^3$:		ΔH_4:		$(\Delta L_4)^3/\Delta H_4$:

7. $G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2}$ = 2924.6 + ____ + ____ + ____ = **2924.6**

8. Mean Slope $(S_c) = (L_c/G)^2 =$ (371.6 / 2924.6)^2 = 1.61% ft./ft.

9. Areally reduced 100-year, one-hour rainfall depth ($P_{1,100}$): 3.00 inches.

	Subarea 1	Subarea 2	Subarea 3	Weighted Watershed Parameters
10. Watersheds Type(s) (% of Total Area):	Road (50%)	Soil B (50%)	( )	
11. Basin Factor ($n_{b,100}$):	0.048	0.048		n_{bw100} = 0.048
12. Soil Types, in %:	100% B	100%C		
13. Imperviousnes (%):	90%	90%		I_w = 90.0%
14. Runoff Coefficient (C_{w100}):	0.92	0.93		C_{w100} = 0.93
15. Contrib. Area Factor (F_{Ac}):	1	1		F_{Acw} = 1.00

16. **Time of Concentration (T_{c100}): 4.1 minutes, determined from:

$$T_{c100} = \left(\frac{0.23 n_{bw100}\left(L_c L_{ca}\right)^{0.3}}{\left(S_c P_{1,100} C_{w100}\right)^{0.4}} + 1.31\right)^{1.61} \quad \text{when } 5 \le Tc100 \le 180.$$

17. At T_{c100}, 100-year Rainfall Intensity $(i_{100}) = (4P_{1,100})/(1+0.05T_{c100})$ = 9.6 inches/hour.
18. 100-Year Peak $(Q_{p100}) = (C_{w100})(i_{100})(F_{Acw})A$= 0.93 x 9.60 x 1.0 x 1.0 = 9.2 cfs.
19. For Other Return Periods

	2-Year	10-year	25-Year	50-Year
Ratio to 100-Year Peak:	0.22	0.50	0.70	0.90
Q (Cubic feet/second)	2	5	6	8
Tc (minutes {Eqn. 4.5}):	7.5	5.4	4.7	4.2

*A may not exceed 6,400 acres (10 square miles) in size. **$T_{c\,100}$ may not exceed 180 minutes. If $T_{c\,100} \le 5$, set $T_{c\,100} = 5$ minutes.

NOTE: Indicate whether hydrologic computations are for "Future Conditions" or "Existing Conditions" by checking the appropriate box above.

Prepared by: JP Checked by: ____ Company: Psomas Date: 06/01/10

City of Tucson

Hydrologic Data Sheet for Computing 100-year Peak Discharge (Q_{p100})

1. Project Name and Location: Kolb/Sabino Canyon Road Extention
2. Drainage Concentration Point: N12
3. *Watershed Area (A) at Drainage Concentration Point: 1.3 acres
4. Length of Hydraulically Longest Watercourse (Lc): 481.3 ft.
5. Length from center of Watershed Area (Lca) along Lc: 240.7 ft.

For (Check One):
- [ ] Existing Condtions†
- [x] Future Conditions†

6. Change in Length Factors - ft / Change in Elevation Factors - ft

a. ΔL_1:	481.3	$(\Delta L_1)^3$:	1.1E+08	ΔH_1: 6.5	$(\Delta L_1)^3/\Delta H_1$:	1.7E+07
b. ΔL_2:		$(\Delta L_2)^3$:		ΔH_2:	$(\Delta L_2)^3/\Delta H_2$:	
c. ΔL_3:		$(\Delta L_3)^3$:		ΔH_3:	$(\Delta L_3)^3\Delta H_3$:	
d. ΔL_4:		$(\Delta L_4)^3$:		ΔH_4:	$(\Delta L_4)^3/\Delta H_4$:	

7. $$G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2} = 4141.6 + ___ + ___ + ___ = \mathbf{4141.6}$$

8. Mean Slope $(S_c) = (L_c/G)^2 =$ (481.3 / 4141.6)^2 = 1.35% ft./ft.

9. Areally reduced 100-year, one-hour rainfall depth ($P_{1,100}$): 3.00 inches.

	Subarea 1	Subarea 2	Subarea 3	Weighted Watershed Parameters
10. Watersheds Type(s) (% of Total Area):	Road (50%)	Soil B (50%)	( )	
11. Basin Factor ($n_{b,100}$):	0.048	0.048		n_{bw100} = 0.048
12. Soil Types, in %:	100% B	100%C		
13. Imperviousnes (%):	90%	90%		I_w = 90.0%
14. Runoff Coefficient (C_{w100}):	0.92	0.93		C_{w100} = 0.93
15. Contrib. Area Factor (F_{Ac}):	1	1		F_{Acw} = 1.00

16. **Time of Concentration (T_{c100}): 4.9 minutes, determined from:

$$T_{c100} = \left(\frac{0.23 n_{bw100}\left(L_c L_{ca}\right)^{0.3}}{\left(S_c P_{1,100} C_{w100}\right)^{0.4}} + 1.31\right)^{1.61} \quad \text{when } 5 \le Tc100 \le 180.$$

17. At T_{c100}, 100-year Rainfall Intensity (i_{100}) = $(4P_{1,100})/(1+0.05T_{c100})$ = 9.6 inches/hour.
18. 100-Year Peak (Q_{p100}) = $(C_{w100})(i_{100})(F_{Acw})A$= 0.93 x 9.60 x 1.0 x 1.3 = 11.6 cfs.
19. For Other Return Periods

	2-Year	10-year	25-Year	50-Year
Ratio to 100-Year Peak:	0.22	0.50	0.70	0.90
Q (Cubic feet/second)	3	6	8	10
Tc (minutes {Eqn. 4.5}):	8.9	6.4	5.6	5.1

*A may not exceed 6,400 acres (10 square miles) in size. **$T_{c\,100}$ may not exceed 180 minutes. If $T_{c\,100} \le 5$, set $T_{c\,100} = 5$ minutes.

NOTE: Indicate whether hydrologic computations are for "Future Conditions" or "Existing Conditions" by checking the appropriate box above.

Prepared by: JP Checked by: _____ Company: Psomas Date: 06/01/10

City of Tucson

Hydrologic Data Sheet for Computing 100-year Peak Discharge (Q_{p100})

1. Project Name and Location: Kolb/Sabino Canyon Road Extention
2. Drainage Concentration Point: N13
3. *Watershed Area (A) at Drainage Concentration Point: 1.66 acres
4. Length of Hydraulically Longest Watercourse (Lc): 1291.7 ft.
5. Length from center of Watershed Area (Lca) along Lc: 645.8 ft.

For (Check One):
- ☐ Existing Condtions†
- ☑ Future Conditions†

6. Change in Length Factors - ft / Change in Elevation Factors - ft

a. ΔL_1:	1291.7	$(\Delta L_1)^3$:	2.2E+09	ΔH_1:	8.0	$(\Delta L_1)^3/\Delta H_1$:	2.7E+08
b. ΔL_2:		$(\Delta L_2)^3$:		ΔH_2:		$(\Delta L_2)^3/\Delta H_2$:	
c. ΔL_3:		$(\Delta L_3)^3$:		ΔH_3:		$(\Delta L_3)^3\Delta H_3$:	
d. ΔL_4:		$(\Delta L_4)^3$:		ΔH_4:		$(\Delta L_4)^3/\Delta H_4$:	

7. $G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2}$ = 16413.2 + ____ + ____ + ____ = **16413.2**

8. Mean Slope $(S_c) = (L_c/G)^2 =$ (1291.7 / 16413.2)^2 = 0.62% ft./ft.

9. Areally reduced 100-year, one-hour rainfall depth ($P_{1,100}$): 3.00 inches.

	Subarea 1	Subarea 2	Subarea 3	Weighted Watershed Parameters
10. Watersheds Type(s) (% of Total Area):	Road (100%)	Soil B (0%)	( )	
11. Basin Factor ($n_{b,100}$):	0.048	0.048		n_{bw100} = 0.048
12. Soil Types, in %:	100% B	100%C		
13. Imperviousnes (%):	100%	90%		I_w = 100.0%
14. Runoff Coefficient (C_{w100}):	0.92	0.93		C_{w100} = 0.92
15. Contrib. Area Factor (F_{Ac}):	1	1		F_{Acw} = 1.00

16. **Time of Concentration (T_{c100}): 12.0 minutes, determined from:

$$T_{c100} = \left(\frac{0.23 n_{bw100}\left(L_c L_{ca}\right)^{0.3}}{\left(S_c P_{1,100} C_{w100}\right)^{0.4}} + 1.31\right)^{1.61}$$

when $5 \le Tc100 \le 180$.

17. At T_{c100}, 100-year Rainfall Intensity (i_{100}) = $(4P_{1,100})/(1+0.05T_{c100})$ = 7.5 inches/hour.
18. 100-Year Peak (Q_{p100}) = $(C_{w100})(i_{100})(F_{Acw})A$= 0.92 x 7.50 x 1.0 x 1.7 = 11.5 cfs.
19. For Other Return Periods

	2-Year	10-year	25-Year	50-Year
Ratio to 100-Year Peak:	0.22	0.50	0.70	0.90
Q (Cubic feet/second)	3	6	8	10
Tc (minutes {Eqn. 4.5}):	21.9	15.8	13.8	12.5

*A may not exceed 6,400 acres (10 square miles) in size. **$T_{c\,100}$ may not exceed 180 minutes. If $T_{c\,100} \le 5$, set $T_{c\,100} = 5$ minutes.

NOTE: Indicate whether hydrologic computations are for "Future Conditions" or "Existing Conditions" by checking the appropriate box above.

Prepared by: JP Checked by: ____ Company: Psomas Date: 12/14/10

APPENDIX 2

EXISTING HYDRAULIC STRUCTURES

EXISTING STORMDRAIN
SABINO CANYON ROAD

Culvert Calculator Report
Existing Inlet

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	2,527.00	ft	Headwater Depth/Height	1.63	
Computed Headwater Eleva	2,526.33	ft	Discharge	166.00	cfs
Inlet Control HW Elev.	2,526.32	ft	Tailwater Elevation	2,522.79	ft
Outlet Control HW Elev.	2,526.33	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	2,519.00	ft	Downstream Invert	2,517.13	ft
Length	140.00	ft	Constructed Slope	0.013357	ft/ft

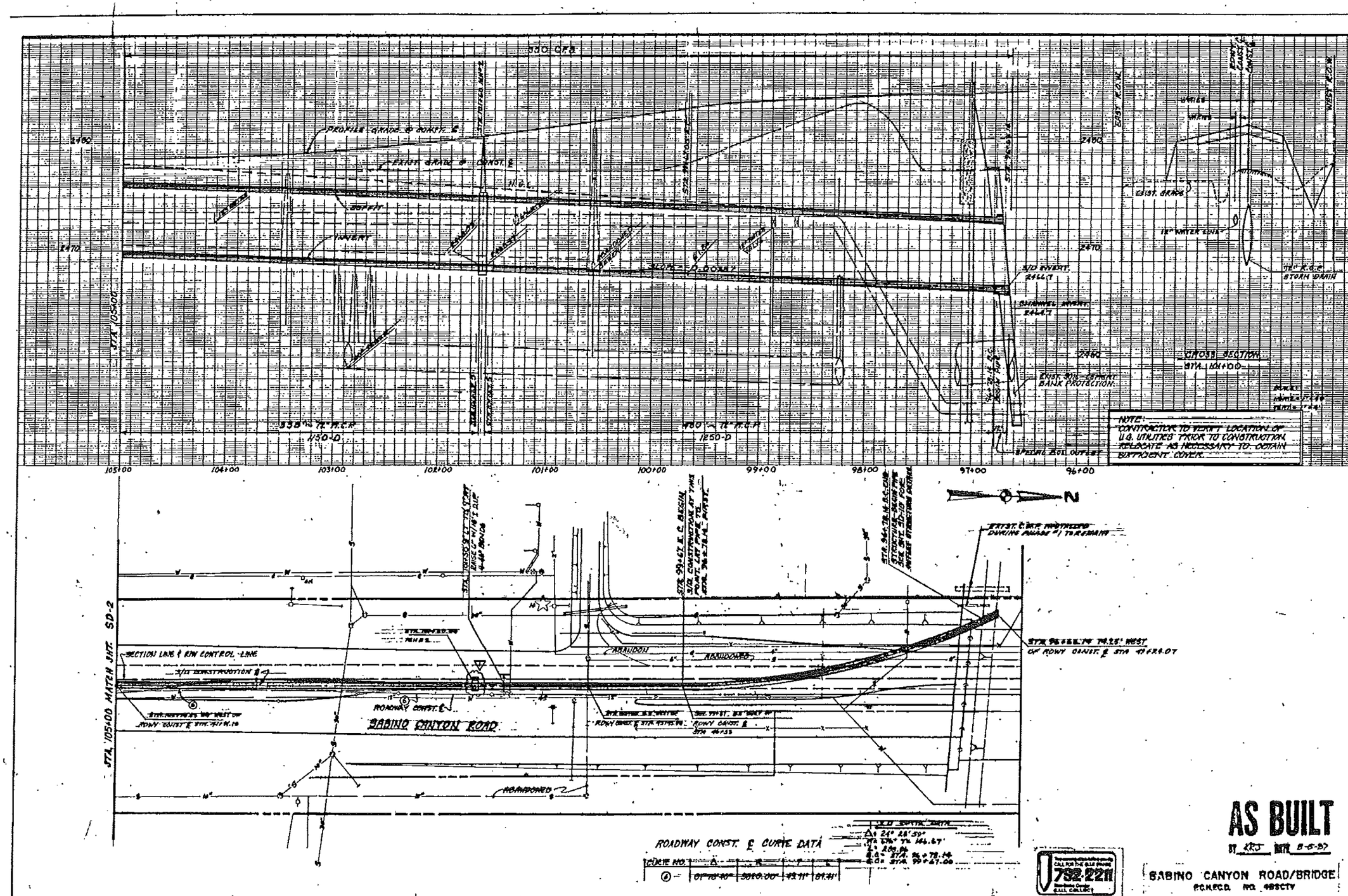
Hydraulic Profile					
Profile	PressureProfile		Depth, Downstream	5.66	ft
Slope Type	N/A		Normal Depth	2.86	ft
Flow Regime	N/A		Critical Depth	3.76	ft
Velocity Downstream	10.44	ft/s	Critical Slope	0.006897	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	4.50	ft
Section Size	54 inch		Rise	4.50	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	2,526.33	ft	Upstream Velocity Head	1.69	ft
Ke	0.50		Entrance Loss	0.85	ft

Inlet Control Properties					
Inlet Control HW Elev.	2,526.32	ft	Flow Control	Submerged	
Inlet Type	Square edge w/headwall		Area Full	15.9	ft²
K	0.00980		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	1	
C	0.03980		Equation Form	1	
Y	0.67000				

6M SD1-SD6



AS BUILT
BY KRJ DATE 8-5-87

SABINO CANYON ROAD/BRIDGE
F.C.H.E.C.D. NO. 48SCTV

PIMA COUNTY DEPARTMENT OF TRANSPORTATION AND FLOOD CONTROL DISTRICT

C.H. HUCKELBERRY R.L.S., P.E. DIRECTOR

NO.	REVISION	DESIGN DIV./SECT. ENGR.	DATE
1	As Built		

		DATE
	JOB NO.	
DESIGNED	JIM HUBBARD	4/15
DRAWN	ILLA KERSENCSKI	4/15
CHECKED	TOM HUSSEY	4/15
PROJ. ENGR.	DONIT E. SMITH	4/15

ANDERSON ENGINEERING CORP.
1155 E. TUCSON BLVD., TUCSON, ARIZ. ZIP CODE 85716 PH. 602-792-3636

HENNINGSON, DURHAM & RICHARDSON INC.
100 W. CLARKSON AVE., TUCSON, ARIZ. ZIP CODE 85013 PH. 602-294-0773

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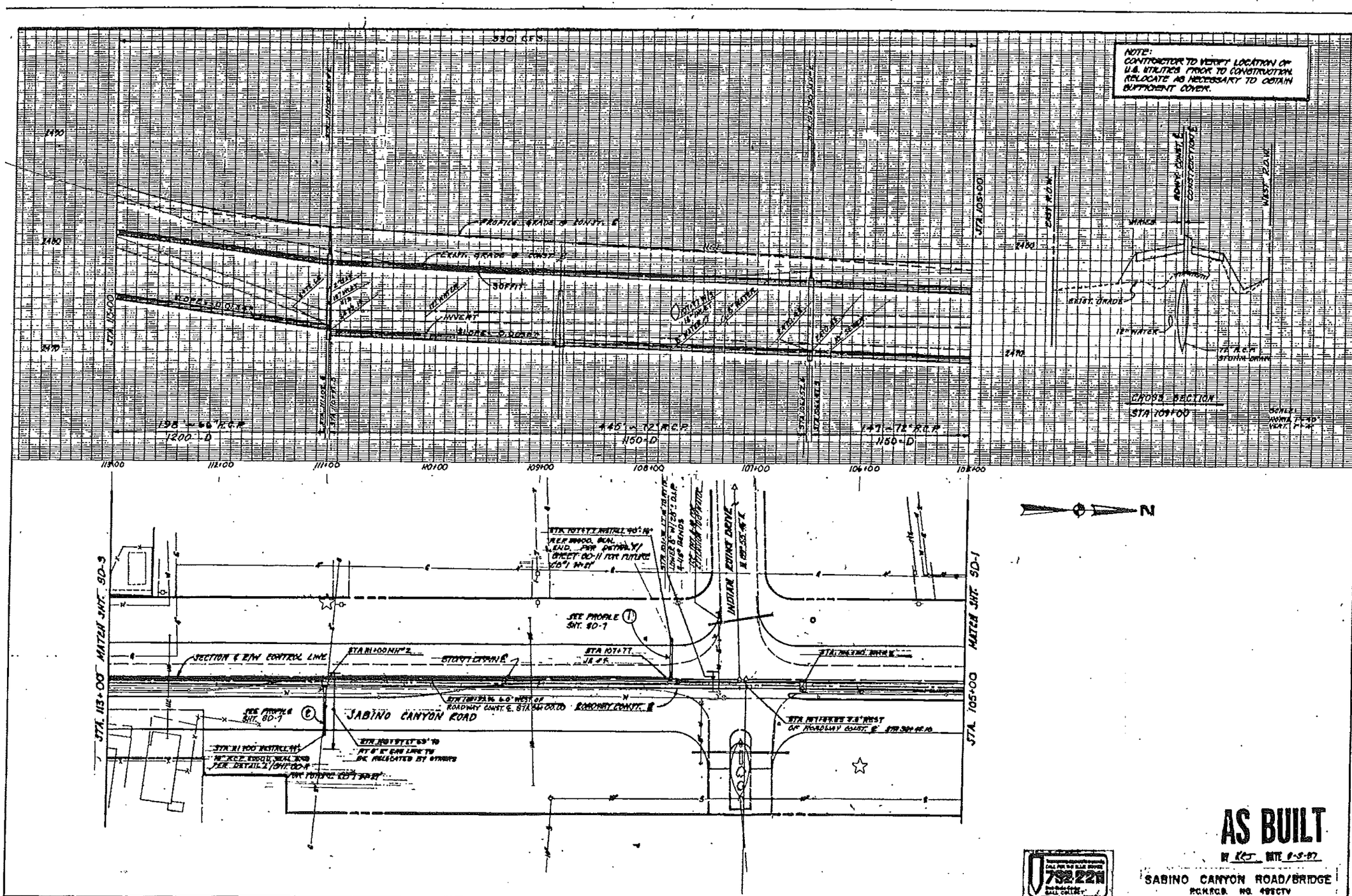

AS BUILT

BY KRT DATE 8-5-87

SABINO CANYON ROAD/BRIDGE

P.C.H.R.C.B. NO. 495CTV

SCALES	HORZ. 1" = 40'
	VERT. 1" = 4'

SHEET SD2 OF SD11

PIMA COUNTY DEPARTMENT OF TRANSPORTATION AND FLOOD CONTROL DISTRICT

C.H. HUCKELBERRY R.L.S., P.E. DIRECTOR

NO.	REVISION DESCRIPTION	DIV/SECT ENGR.	DATE

DESIGN INFO.		DATE
DESIGNED	JAN HERNANDEZ	4/86
DRAWN	J.L.A. RODRIGUEZ	4/86
CHECKED	TOM HIGGEY	4/86
PROJ. ENGR.	DANIEL E. SANDERS	4/86

ANDERSON ENGINEERING CORP.
188 S. TUCSON BLVD., TUCSON, ARIZ.
ZIP CODE 85716 PH. 602-792-3535

HENNINGSON, DURHAM & RICHARDSON INC.
100 W. CLARENDON AVE., PHOENIX, ARIZ.
ZIP CODE 85013 PH. 602-264-0731

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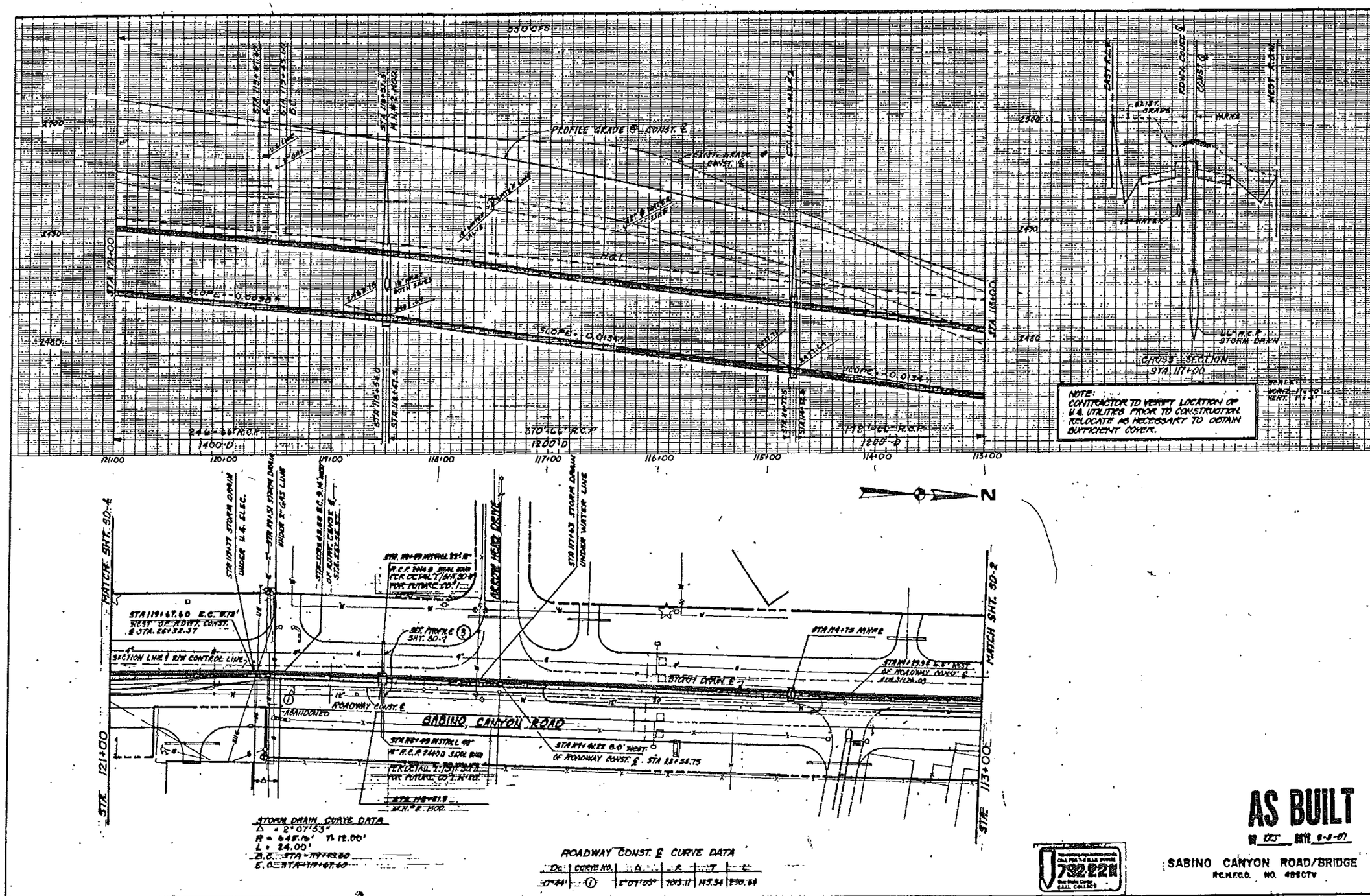

AS BUILT

BY DCT DATE 8-8-07

SABINO CANYON ROAD/BRIDGE
R.C.H.F.C.D. NO. 486CTV

792221

SCALES: HORZ. 1" = 40' VERT. 1" = 4'

SHEET SD3 OF SD11

PIMA COUNTY DEPARTMENT OF TRANSPORTATION AND FLOOD CONTROL DISTRICT

C.H. HUCKELBERRY R.L.S., P.E. DIRECTOR

NO.	REVISION	DESCRIPTION	DWG/SECT ENGR.	DATE

		DATE
DESIGNED	JIM HUGHES	4/01
DRAWN	ILLA KORONSKI	5/04
CHECKED	TOM HIGLEY	4/03
PROJ. ENGR.	EDWIN E. SMITH	4/01

ANDERSON ENGINEERING CORP.
100 S. TUCSON BLVD., TUCSON, ARIZ.
P.O. BOX 27218 PH. 602-792-3434

HENNINKSON, DURHAM & RICHARDSON INC.
100 W. CLARENDON AVE., PHOENIX, ARIZ.
P.O. BOX 35013 PH. 602-264-0731

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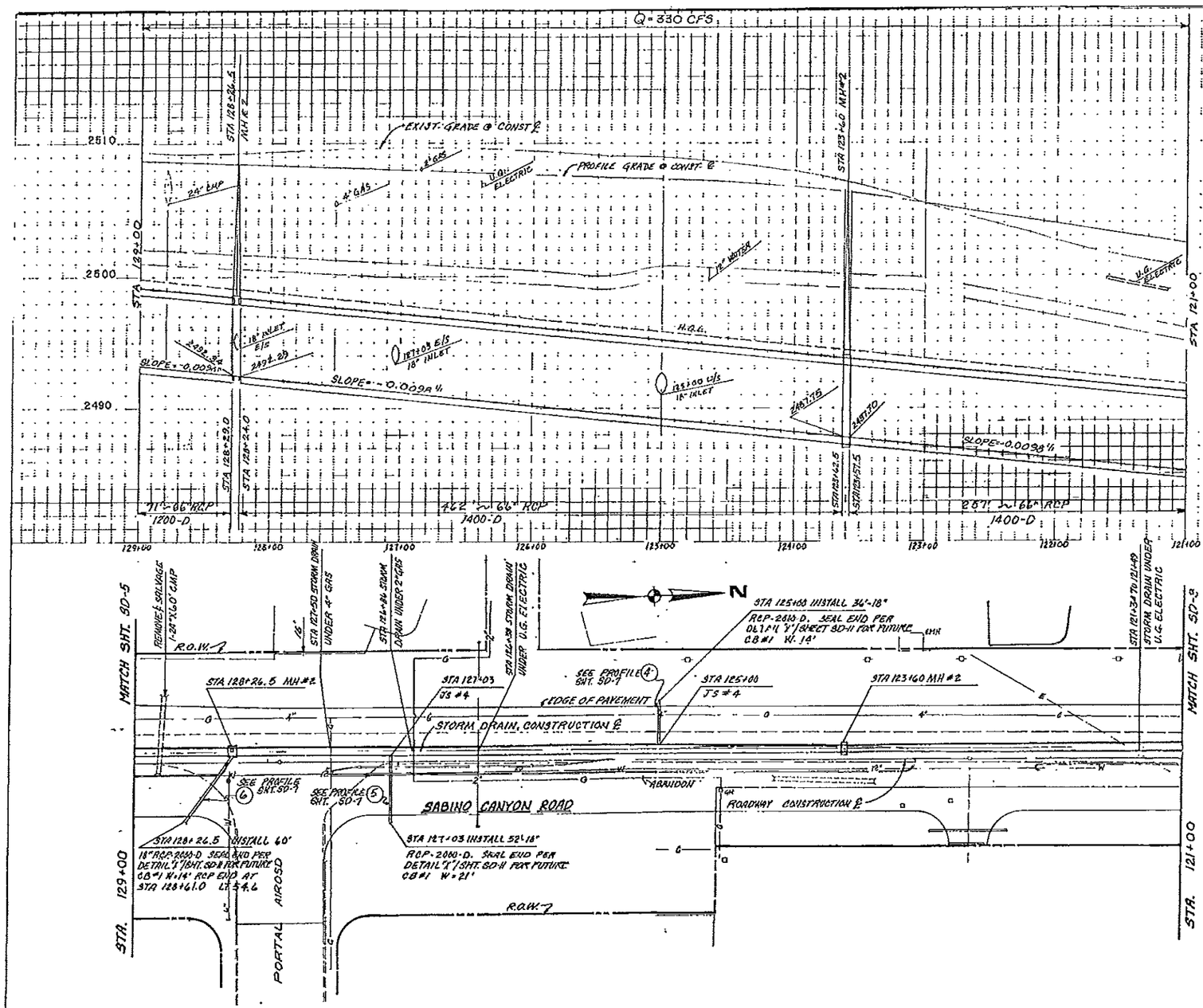
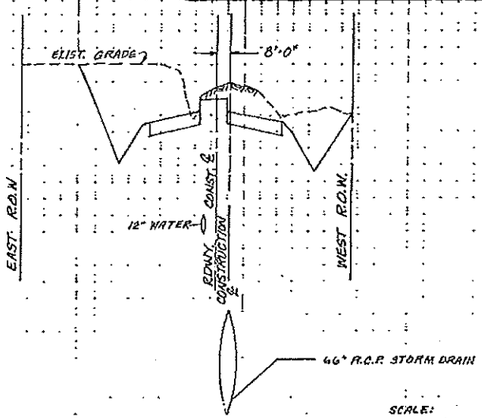


NOTE:
CONTRACTOR TO VERIFY LOCATION OF U.G. UTILITIES PRIOR TO CONSTRUCTION. RELOCATE AS NECESSARY TO OBTAIN SUFFICIENT COVER.



CROSS SECTION
STA 123+00

SCALE:
HORIZ. 1" = 40'
VERT. 1" = 4'

AS BUILT
BY KKJ DATE 8-5-87

SABINO CANYON ROAD/BRIDGE
P.C.H.E.C.D. NO. 4BSCTV

SCALES HORZ. 1" = 40' VERT. 1" = 4'

SHEET SD4 OF SD11

PIMA COUNTY DEPARTMENT OF TRANSPORTATION AND FLOOD CONTROL DISTRICT

C H HUCKELBERRY R.L.S., P.E. DIRECTOR

NO.	REVISION DESCRIPTION	DIV/SECT ENGR	DATE

	HDR INC.	DATE
J.D.	JIM HUBBARD	4/83
KN	ILLA KRAMOSKI	4/85
	TOM HICKEY	4/84
	EDWIN E. SMITH	4/85

ANDERSON ENGINEERING CORP.
1198 S. TUCSON BLVD., TUCSON, ARIZ. ZIP CODE 85713 PH. 602-792-0636

HENNINGSON, DURHAM & RICHARDSON INC.
100 W. CLARKSON AVE. PHOENIX, ARIZ. ZIP CODE 85013 PH. 602-264-0731

Call for the Blue Stakes 792-2211 Blue Stake Center CALL COLLECT

4bsctv_p2_ssd004

NOTE:
CONTRACTOR TO VERIFY LOCATION OF U.G. UTILITIES PRIOR TO CONSTRUCTION RELOCATE AS NECESSARY TO OBTAIN SUFFICIENT COVER.

222 CFS

330 CFS

454' - 54" R.C.P.
1300-D

433' - 66" R.C.P.
1200-D

SLOPE = -0.0085 ft

SLOPE = -0.0098 ft

PROFILE GRADE @ CONST. ℄

EXIST. GRADE @ CONSTRUCTION ℄

H.G.L.

STA 137+01.72 E.C.

STA 136+00.86 P.R.C.

STA 135+00 B.C.

STA 135+34 MH #4

STA 138+00

STA 129+00

2520

2510

2500

138+00 137+00 136+00 135+00 134+00 133+00 132+00 131+00 130+00 129+00

EAST R.O.W.

WEST R.O.W.

ROADWAY CONST. ℄

CONSTRUCTION ℄

EXIST. GRADE

12" WATER

54" R.C.P. STORM DRAIN

CROSS SECTION
STA 134+00

SCALES:
HORIZ. 1" = 40'
VERT. 1" = 4'

STA 0+18.25 TO 0+45.25
10'-24"ø R.C. BOX
WITH T.S. NO. 1 GRAT 31106

CONST. MODIFIED ADOT CATCH BASIN FOR C-15.09

ACOMA ST.

STA 131+98.5 S/D UNDER 6" WATER LINE

N

133+34 MH #4
A=30°00'00" B=56" C=12'-3"
D=54" G=66" E=12'-5½"
L=14'-0" EL.G=2497.85
EL.R=2497.97

MATCH SHT. SD-6

MATCH SHT. SD-4

STA. 138+00

STA. 129+00

R.O.W.

EDGE OF PAVEMENT

R.O.W. CONTROL LINE & SECTION LINE

SABINO CANYON ROAD

STA 135+00.00 B.C.

STA 136+00.86 P.R.C.

STA 136+00.86 14.19' WEST OF ROWY CONST. ℄ STA 9+99.80

STA 135+00.00 21.73 WEST OF ROWY CONST. ℄ STA 11+00.00

STA 133+34 M.H. #4 = STA. 0+00 LATERAL

STA 131+71 JS #4

SEE PROFILE SHT. SD-7

STA 137+01.72 E.C.

STA 137+01.72 6.31' WEST OF ROWY CONST. ℄ STA 8+99.60

STA 0+95.5 JS #4

SEE PROFILE SHT. SD-8

STA 1+18.51 E.C., 12.42' EAST OF ROWY CONST. ℄ STA. 11+99.21

SEE PROFILE SHT. SD-7

STA 0+24.26 B.C.

EDGE OF PAVEMENT

STA 0+95.5 INSTALL 1T-18" R.C.P. 2000-D
SEAL END PER DETAIL "A"/SHT. SD-11 FOR FUTURE CB #1 W=21'

INSTALL A DOT DROP INLET STD C-14.03/100. SEE SHT. SD-9

R.O.W.

CATCH BASIN DATA

(A) MOD. ADOT C-15.09 CATCH BASIN WITH TWO GRATES. H=33" 56'-18" R.C.P. 2000-D APRON SHALL BE 2" Rd. - 3/8" MIX.

ROADWAY CONST. ℄ CURVE DATA

CURVE NO.	Δ	R	T	L
1	2°21'13"	11854.50	243.51	486.94

STORM DRAIN CURVE DATA
Δ=11° 23'55"
R=50.00' T=50.60'
L=100.86'
B.C. STA 135+00.00
P.R.C. STA 136+00.86
E.C. STA 137+01.72

STORM DRAIN CURVE DATA
Δ=60° 00'00"
R=90.00' T=51.96'
L=94.25'
B.C. STA. 0+24.26
E.C. STA 1+18.51

LATERAL PROFILE
SEE SHEET SD-8

AS BUILT
BY KEJ DATE 8-5-87

CALL FOR THE BLUE STAKES
792.2211
Blue Stake Cards CALL COLLECT

SABINO CANYON ROAD/BRIDGE
R.C.H.E.C.O. NO. 4BSCTV

SCALES HORIZ. 1" = 40' VERT. 1" = 4'

SHEET SD-5 OF SD11

PIMA COUNTY DEPARTMENT OF TRANSPORTATION AND FLOOD CONTROL DISTRICT

NO.	REVISION	DATE
1	AS BUILT	

DIV/SECT ENGR
H.E. Gowdeau
DATE

ANDERSON ENGINEERING CORP.
198 S. TUCSON BLVD., TUCSON, ARIZ.
PH. 602-792-3636
ZIP CODE 85716

HENNINGSSON, DURHAM & RICHARDSON INC.
100 W. CLARENDON AVE. PHOENIX, ARIZ.
PH. 602-264-0731
ZIP CODE 85013

C.H. HUCKELBERRY R.L.S., P.E. DIRECTOR

		DATE
J.D.	JIM HUBBARD	4/85
	ILLA KORONSKI	4/85
	TOM HICKEY	4/85
	EDWIN E. SMITH	4/85

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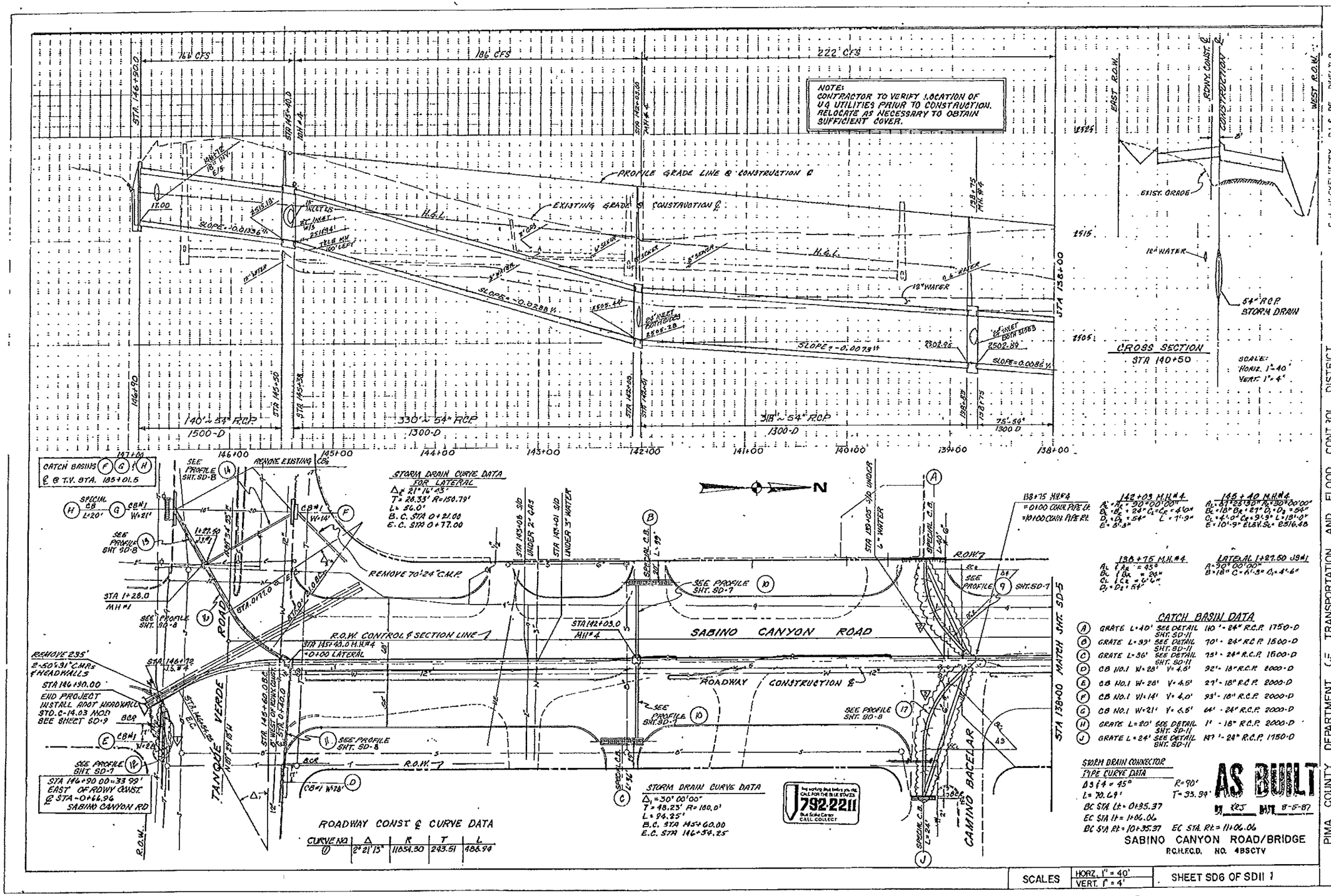

Ubectv_p2 _ 55/006

EXISTING STORMDRAIN HYDRAULIC MODEL RESULTS

Storm Sewer Summary Report

Line No.	Line ID	Flow rate (cfs)	Line size (in)	Line shape	Line length (ft)	Invert EL Dn (ft)	Invert EL Up (ft)	Line slope (%)	HGL down (ft)	HGL up (ft)	Minor loss (ft)	HGL Junct (ft)	Dns line No.	Junction Type
1		330.0	72	Cir	480.000	2466.70	2468.52	0.379	2472.70*	2475.62*	0.32	2475.93	End	Manhole
2		330.0	72	Cir	487.000	2468.52	2470.37	0.380	2475.93*	2478.89*	0.32	2479.21	1	Manhole
3		330.0	72	Cir	445.000	2470.45	2472.14	0.380	2479.21*	2481.91*	0.32	2482.23	2	Manhole
4		330.0	66	Cir	370.000	2472.68	2477.64	1.341	2482.23*	2485.80*	0.45	2486.25	3	Manhole
5		330.0	66	Cir	370.000	2477.71	2482.67	1.341	2486.25*	2489.83*	0.45	2490.28	4	Manhole
6		330.0	66	Cir	503.000	2482.75	2487.70	0.984	2490.28*	2495.14*	0.45	2495.58	5	Manhole
7		330.0	66	Cir	462.000	2487.75	2492.29	0.983	2495.58*	2500.05*	0.45	2500.50	6	Manhole
8		330.0	66	Cir	504.000	2492.34	2497.30	0.984	2500.50*	2505.37*	0.45	2505.82	7	Manhole
9		222.0	54	Cir	529.000	2498.41	2502.89	0.847	2505.82*	2512.56*	0.45	2513.01	8	Manhole
10		222.0	54	Cir	318.000	2502.95	2505.28	0.733	2513.01*	2517.07*	0.45	2517.52	9	Manhole
11		186.0	54	Cir	330.000	2505.44	2514.94	2.879	2517.52*	2520.48*	0.32	2520.79	10	Manhole
12		166.0	54	Cir	140.000	2515.13	2517.00	1.336	2520.79*	2521.79*	1.69	2523.49	11	OpenHeadwall

Project File: Existing System.stm

Number of lines: 12

Run Date: 06-07-2010

NOTES: Known Qs only ; *Surcharged (HGL above crown).

MyReport

Line No.	Area Dn (sqft)	Area Up (sqft)	Byp Ln No	Coeff C1 (C)	Coeff C2 (C)	Coeff C3 (C)	Capac Full (cfs)		Crit Depth (ft)	Cross Sl, Sw (ft/ft)	Cross Sl, Sx (ft/ft)	Curb Len (ft)	Defl Ang (Deg)	Depth Dn (ft)	Depth Up (ft)	DnStm Ln No	Drng Area (ac)	Easting X (ft)	EGL Dn (ft)	EGL Up (ft)	Energy Loss (ft)	
1	28.27	28.27	n/a	0.20	0.50	0.90	260.83		4.84	....	....	....	0.000	6.00	6.00	Outfall	0.00	480.00	2474.82	2477.73	2.914	
2	28.27	28.27	1	0.20	0.50	0.90	261.07		4.84	....	....	....	0.000	6.00	6.00	1	0.00	967.00	2478.05	2481.01	2.957	
3	28.27	28.27	2	0.20	0.50	0.90	261.03		4.84	....	....	....	0.000	6.00	6.00	2	0.00	1412.00	2481.33	2484.03	2.702	
4	23.75	23.76	3	0.20	0.50	0.90	388.86		4.94	....	....	....	0.000	5.50	5.50	3	0.00	1782.00	2485.23	2488.80	3.573	
5	23.75	23.76	4	0.20	0.50	0.90	388.86		4.94	....	....	....	0.000	5.50	5.50	4	0.00	2152.00	2489.25	2492.83	3.573	
6	23.75	23.76	5	0.20	0.50	0.90	333.17		4.94	....	....	....	0.000	5.50	5.50	5	0.00	2655.00	2493.28	2498.13	4.857	
7	23.75	23.76	6	0.20	0.50	0.90	332.93		4.94	....	....	....	0.000	5.50	5.50	6	0.00	3117.00	2498.59	2503.05	4.461	
8	23.75	23.76	7	0.20	0.50	0.90	333.18		4.94	....	....	....	0.000	5.50	5.50	7	0.00	3621.00	2503.50	2508.37	4.867	
9	15.90	15.90	8	0.20	0.50	0.90	180.98		4.17	....	....	....	0.000	4.50	4.50	8	0.00	4150.00	2508.85	2515.59	6.743	
10	15.90	15.90	9	0.20	0.50	0.90	168.34		4.17	....	....	....	0.000	4.50	4.50	9	0.00	4468.00	2516.04	2520.10	4.053	
11	15.90	15.90	10	0.20	0.50	0.90	333.68		3.94	....	....	....	0.000	4.50	4.50	10	0.00	4798.00	2519.65	2522.60	2.953	
12	15.90	15.90	11	0.20	0.50	0.90	227.30		3.70	....	....	....	0.000	4.50	4.50	11	0.00	4938.00	2522.49	2523.49	0.998	

Project File: Existing System.stm | Number of lines: 12 | Date: 06-07-2010

NOTES: ** Critical depth

MyReport

Flow Rate (cfs)	Sf Ave (%)	Sf Dn (%)	Grate Area (sqft)	Grate Len (ft)	Grate Width (ft)	Gnd/Rim El Dn (ft)	Gnd/Rim El Up (ft)	Gutter Depth (ft)	Gutter Slope (ft/ft)	Gutter Spread (ft)	Gutter Width (ft)	HGL Dn (ft)	HGL Up (ft)	HGL Jnct (ft)	HGL Jmp Dn (ft)	HGL Jmp Up (ft)	Incr CxA	Incr Q (cfs)	Inlet Depth (ft)	Inlet Eff (%)
330.00	0.607	0.607	....	....	....	2484.50	2480.50	....	....	....	....	2472.70	2475.62	2475.93	....	....	0.00	330.00	....	....
330.00	0.607	0.607	....	....	....	2480.50	2479.00	....	....	....	....	2475.93	2478.89	2479.21	....	....	0.00	330.00	....	....
330.00	0.607	0.607	....	....	....	2479.00	2482.00	....	....	....	....	2479.21	2481.91	2482.23	....	....	0.00	330.00	....	....
330.00	0.966	0.966	....	....	....	2482.00	2491.00	....	....	....	....	2482.23	2485.80	2486.25	....	....	0.00	330.00	....	....
330.00	0.966	0.966	....	....	....	2491.00	2498.50	....	....	....	....	2486.25	2489.83	2490.28	....	....	0.00	330.00	....	....
330.00	0.966	0.966	....	....	....	2498.50	2506.50	....	....	....	....	2490.28	2495.14	2495.58	....	....	0.00	330.00	....	....
330.00	0.966	0.966	....	....	....	2506.50	2508.50	....	....	....	....	2495.58	2500.05	2500.50	....	....	0.00	330.00	....	....
330.00	0.966	0.966	....	....	....	2508.50	2511.50	....	....	....	....	2500.50	2505.37	2505.82	....	....	0.00	330.00	....	....
222.00	1.275	1.275	....	....	....	2511.50	2517.00	....	....	....	....	2505.82	2512.56	2513.01	....	....	0.00	222.00	....	....
222.00	1.275	1.275	....	....	....	2517.00	2519.00	....	....	....	....	2513.01	2517.07	2517.52	....	....	0.00	222.00	....	....
186.00	0.895	0.895	....	....	....	2519.00	2523.00	....	....	....	....	2517.52	2520.48	2520.79	....	....	0.00	186.00	....	....
166.00	0.713	0.713	....	....	....	2523.00	2522.50	....	....	....	....	2520.79	2521.79	2523.49	....	....	0.00	166.00	....	100

Project File: Existing System.stm | Number of lines: 12 | Date: 06-07-2010

NOTES: ** Critical depth

MyReport

Inlet ID	Inlet Loc	Inlet Spread (ft)	Inlet Time (min)	i Sys (in/hr)	i Inlet (in/hr)	Invert Dn (ft)	Invert Up (ft)	Jump Loc (ft)	Jump Len (ft)	Vel Hd Jmp Dn (ft)	Vel Hd Jmp Up (ft)	J-Loss Coeff	Junct Type	Known Q (cfs)	Cost RCP ($)	Cost CMP ($)	Cost PVC ($)	Line ID	Line Length (ft)	Line Size (in)
	On Grade	....	0.0	0.00	0.00	2466.70	2468.52	....	....	0.00	0.00	0.15	MH	330.00	59,940	53,946	50,949		480.000	72
	On Grade	....	0.0	0.00	0.00	2468.52	2470.37	....	....	0.00	0.00	0.15	MH	330.00	49,280	44,352	41,888		487.000	72
	On Grade	....	0.0	0.00	0.00	2470.45	2472.14	....	....	0.00	0.00	0.15	MH	330.00	42,415	38,174	36,053		445.000	72
	On Grade	....	0.0	0.00	0.00	2472.68	2477.64	....	....	0.00	0.00	0.15	MH	330.00	37,790	34,011	32,122		370.000	66
	On Grade	....	0.0	0.00	0.00	2477.71	2482.67	....	....	0.00	0.00	0.15	MH	330.00	43,540	39,186	37,009		370.000	66
	On Grade	....	0.0	0.00	0.00	2482.75	2487.70	....	....	0.00	0.00	0.15	MH	330.00	66,500	59,850	56,525		503.000	66
	On Grade	....	0.0	0.00	0.00	2487.75	2492.29	....	....	0.00	0.00	0.15	MH	330.00	61,600	55,440	52,360		462.000	66
	On Grade	....	0.0	0.00	0.00	2492.34	2497.30	....	....	0.00	0.00	0.15	MH	330.00	61,060	54,954	51,901		504.000	66
	On Grade	....	0.0	0.00	0.00	2498.41	2502.89	....	....	0.00	0.00	0.15	MH	222.00	53,645	48,281	45,598		529.000	54
	On Grade	....	0.0	0.00	0.00	2502.95	2505.28	....	....	0.00	0.00	0.15	MH	222.00	32,440	29,196	27,574		318.000	54
	On Grade	....	0.0	0.00	0.00	2505.44	2514.94	....	....	0.00	0.00	0.15	MH	186.00	29,610	26,649	25,169		330.000	54
	Sag	....	0.0	0.00	0.00	2515.13	2517.00	....	....	0.00	0.00	1.00	Hdwall	166.00	9,500	8,550	8,075		140.000	54

Project File: Existing System.stm | Number of lines: 12 | Date: 06-07-2010

NOTES: Known Qs only. ; ** Critical depth

MyReport

Line Slope (%)	Line Type	Local Depr (in)	n-val Gutter	n-val Pipe	Minor Loss (ft)	Northing Y (ft)	Pipe Travel (min)	Q Byp (cfs)	Q Capt (cfs)	Q Carry (cfs)	Line Rise (in)	Runoff Coeff (C)	Line Span (in)	Area A1 (ac)	Area A2 (ac)	Area A3 (ac)	Tc (min)	Throat Ht (in)	Total Area (ac)	Total CxA	Total Runoff (cfs)	Vel Ave (ft/s)	Vel Dn (ft/s)
0.38	Cir	....	....	0.013	0.32	0.00	2.67	....	....	....	72	0.00	72	0.00	0.00	0.00	24.8	....	0.00	0.00	0.00	11.67	11.67
0.38	Cir	....	....	0.013	0.32	0.00	2.71	....	....	....	72	0.00	72	0.00	0.00	0.00	22.1	....	0.00	0.00	0.00	11.67	11.67
0.38	Cir	....	....	0.013	0.32	0.00	2.47	....	....	....	72	0.00	72	0.00	0.00	0.00	19.6	....	0.00	0.00	0.00	11.67	11.67
1.34	Cir	....	....	0.013	0.45	0.00	2.06	....	....	....	66	0.00	66	0.00	0.00	0.00	17.5	....	0.00	0.00	0.00	13.89	13.89
1.34	Cir	....	....	0.013	0.45	0.00	2.06	....	....	....	66	0.00	66	0.00	0.00	0.00	15.5	....	0.00	0.00	0.00	13.89	13.89
0.98	Cir	....	....	0.013	0.45	0.00	2.79	....	....	....	66	0.00	66	0.00	0.00	0.00	12.7	....	0.00	0.00	0.00	13.89	13.89
0.98	Cir	....	....	0.013	0.45	0.00	2.57	....	....	....	66	0.00	66	0.00	0.00	0.00	10.1	....	0.00	0.00	0.00	13.89	13.89
0.98	Cir	....	....	0.013	0.45	0.00	2.80	....	....	....	66	0.00	66	0.00	0.00	0.00	7.3	....	0.00	0.00	0.00	13.89	13.89
0.85	Cir	....	....	0.013	0.45	0.00	2.94	....	....	....	54	0.00	54	0.00	0.00	0.00	4.4	....	0.00	0.00	0.00	13.96	13.96
0.73	Cir	....	....	0.013	0.45	0.00	1.77	....	....	....	54	0.00	54	0.00	0.00	0.00	2.6	....	0.00	0.00	0.00	13.96	13.96
2.88	Cir	....	....	0.013	0.32	0.00	1.83	....	....	....	54	0.00	54	0.00	0.00	0.00	0.8	....	0.00	0.00	0.00	11.70	11.70
1.34	Cir	....	....	0.013	1.69	0.00	0.78	0.00	166.00	0.00	54	0.00	54	0.00	0.00	0.00	0.0	....	0.00	0.00	0.00	10.44	10.44

Project File: Existing System.stm | Number of lines: 12 | Date: 06-07-2010

NOTES: ** Critical depth

MyReport

Vel Hd Dn (ft)	Vel Hd Up (ft)	Vel Up (ft/s)	Cover Dn (ft)	Cover Up (ft)	Storage (cft)
2.12	2.12	11.67	11.80	5.98	13569.00
2.12	2.12	11.67	5.98	2.63	13766.88
2.12	2.12	11.67	2.55	3.86	12579.60
3.00	3.00	13.89	3.82	7.86	8788.84
3.00	3.00	13.89	7.79	10.33	8788.84
3.00	3.00	13.89	10.25	13.30	11948.07
3.00	3.00	13.89	13.25	10.71	10974.17
3.00	3.00	13.89	10.66	8.70	11971.82
3.03	3.03	13.96	8.59	9.61	8411.72
3.03	3.03	13.96	9.55	9.22	5056.57
2.13	2.13	11.69	9.06	3.56	5247.39
1.69	1.69	10.44	3.37	1.00	2226.17

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NOTES: ** Critical depth

Hydraflow HGL Computation Procedure

General Procedure: Hydraflow computes the HGL using the Bernoulli energy equation. Manning's equation is used to determine energy losses due to pipe friction. In a standard step, iterative procedure, Hydraflow assumes upstream HGLs until the energy equation balances. If the energy equation cannot balance, supercritical flow exists and critical depth is temporarily assumed at the upstream end. A supercritical flow Profile is then computed using the same procedure in a downstream direction using momentum principles.

Col. 1 The line number being computed. Calculations begin at Line 1 and proceed upstream.

Col. 2 The line size. In the case of non-circular pipes, the line rise is printed above the span.

Col. 3 Total flow rate in the line.

Col. 4 The elevation of the downstream invert.

Col. 5 Elevation of the hydraulic grade line at the downstream end. This is computed as the upstream HGL + Minor loss of this line's downstream line.

Col. 6 The downstream depth of flow inside the pipe (HGL - Invert elevation) but not greater than the line size.

Col. 7 Cross-sectional area of the flow at the downstream end.

Col. 8 The velocity of the flow at the downstream end, (Col. 3 / Col. 7).

Col. 9 Velocity head (Velocity squared / 2g).

Col. 10 The elevation of the energy grade line at the downstream end, HGL + Velocity head, (Col. 5 + Col. 9).

Col. 11 The friction slope at the downstream end (the S or Slope term in Manning's equation).

Col. 12 The line length.

Col. 13 The elevation of the upstream invert.

Col. 14 Elevation of the hydraulic grade line at the upstream end.

Col. 15 The upstream depth of flow inside the pipe (HGL - Invert elevation) but not greater than the line size.

Col. 16 Cross-sectional area of the flow at the upstream end.

Col. 17 The velocity of the flow at the upstream end, (Col. 3 / Col. 16).

Col. 18 Velocity head (Velocity squared / 2g).

Col. 19 The elevation of the energy grade line at the upstream end, HGL + Velocity head, (Col. 14 + Col. 18) .

Col. 20 The friction slope at the upstream end (the S or Slope term in Manning's equation).

Col. 21 The average of the downstream and upstream friction slopes.

Col. 22 Energy loss. Average Sf/100 x Line Length (Col. 21/100 x Col. 12). Equals (EGL upstream - EGL downstream) +/- tolerance.

Col. 23 The junction loss coefficient (K).

Col. 24 Minor loss. (Col. 23 x Col. 18). Is added to upstream HGL and used as the starting HGL for the next upstream line(s).

Hydraulic Grade Line Computations

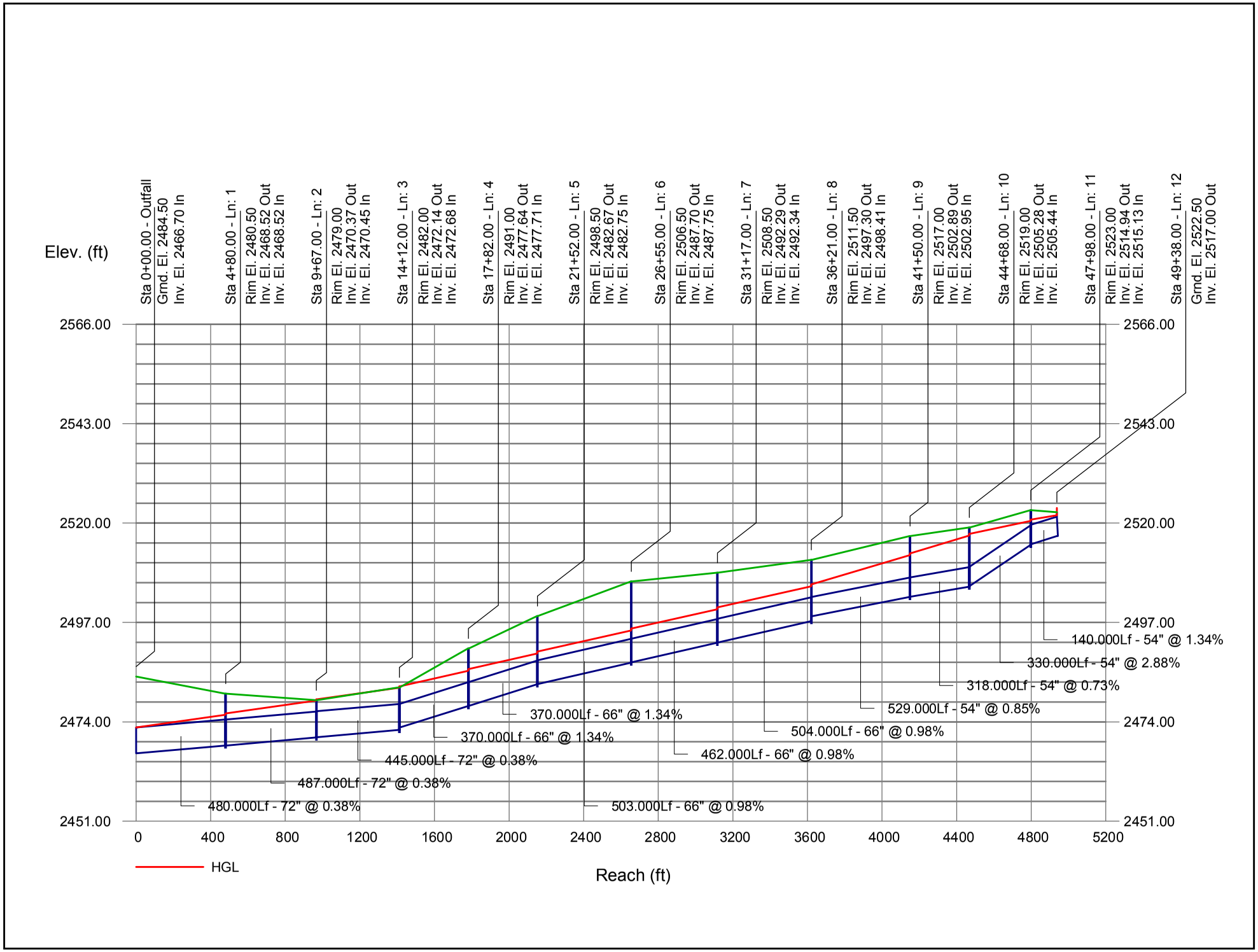
Line	Size	Q	Downstream								Len	Upstream								Check		JL coeff	Minor loss
	(in)	(cfs)	Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	(ft)	Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	Ave Sf (%)	Enrgy loss (ft)	(K)	(ft)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
1	72	330.0	2466.70	2472.70	6.00	28.27	11.67	2.12	2474.82	0.607	480.000	2468.52	2475.62	6.00	28.27	11.67	2.12	2477.73	0.607	0.607	2.914	0.15	0.32
2	72	330.0	2468.52	2475.93	6.00	28.27	11.67	2.12	2478.05	0.607	487.000	2470.37	2478.89	6.00	28.27	11.67	2.12	2481.01	0.607	0.607	2.957	0.15	0.32
3	72	330.0	2470.45	2479.21	6.00	28.27	11.67	2.12	2481.33	0.607	445.000	2472.14	2481.91	6.00	28.27	11.67	2.12	2484.03	0.607	0.607	2.702	0.15	0.32
4	66	330.0	2472.68	2482.23	5.50	23.75	13.89	3.00	2485.23	0.966	370.000	2477.64	2485.80	5.50	23.76	13.89	3.00	2488.80	0.965	0.966	3.573	0.15	0.45
5	66	330.0	2477.71	2486.25	5.50	23.75	13.89	3.00	2489.25	0.966	370.000	2482.67	2489.83	5.50	23.76	13.89	3.00	2492.83	0.965	0.966	3.573	0.15	0.45
6	66	330.0	2482.75	2490.28	5.50	23.75	13.89	3.00	2493.28	0.966	503.000	2487.70	2495.14	5.50	23.76	13.89	3.00	2498.13	0.965	0.966	4.857	0.15	0.45
7	66	330.0	2487.75	2495.58	5.50	23.75	13.89	3.00	2498.59	0.966	462.000	2492.29	2500.05	5.50	23.76	13.89	3.00	2503.05	0.965	0.966	4.461	0.15	0.45
8	66	330.0	2492.34	2500.50	5.50	23.75	13.89	3.00	2503.50	0.966	504.000	2497.30	2505.37	5.50	23.76	13.89	3.00	2508.37	0.965	0.966	4.867	0.15	0.45
9	54	222.0	2498.41	2505.82	4.50	15.90	13.96	3.03	2508.85	1.275	529.000	2502.89	2512.56	4.50	15.90	13.96	3.03	2515.59	1.274	1.275	6.743	0.15	0.45
10	54	222.0	2502.95	2513.01	4.50	15.90	13.96	3.03	2516.04	1.275	318.000	2505.28	2517.07	4.50	15.90	13.96	3.03	2520.10	1.274	1.275	4.053	0.15	0.45
11	54	186.0	2505.44	2517.52	4.50	15.90	11.70	2.13	2519.65	0.895	330.000	2514.94	2520.48	4.50	15.90	11.69	2.13	2522.60	0.895	0.895	2.953	0.15	0.32
12	54	166.0	2515.13	2520.79	4.50	15.90	10.44	1.69	2522.49	0.713	140.000	2517.00	2521.79	4.50	15.90	10.44	1.69	2523.49	0.713	0.713	0.998	1.00	1.69

Project File: Existing System.stm | Number of lines: 12 | Run Date: 06-07-2010

; c = cir e = ellip b = box

Storm Sewer Profile

Proj. file: Existing System.stm



Hydraflow Storm Sewers Extension

APPENDIX 3

CHANNEL DESIGN

PSOMAS

Project Name: Sabino Canyon/Tanque Verde Intersection
Project Number # : 7TUS070901 Made by jco Date 06/02/10
Reference: SMDDFPM Checked By _____ Date _____

Calculation of Channel Parameters

General Equations:

1) Minimum Channel Freeboard

$$FB = 1/6\left[Y + \frac{V^2}{2g}\right] \qquad \text{Eq 8.4}$$

Where
FB = Freeboard (ft)
Y = Depth of Flow (ft)
V = average velocity of flow, (fps)
g = Acceleration due to gravity = 32.2 ft/sec^2

2) Minimum Channel Radius

$$R_c = 3T \qquad \text{Froude Number <0.86}$$

Where
R_c = Minimum Radius of Curvature Centerline (ft)
T = Channel Topwidth at Watersurface (ft)

$$R_c = \frac{4Y^2T}{gY} \qquad \text{Froude Number >0.86} \qquad \text{Eq 8.12}$$

Where
R_c = Minimum Radius of Curvature Centerline (ft)
T = Channel Topwidth at Watersurface (ft)
V = Average velocity of flow, (fps)
Y = Hydraulic Depth of Flow (ft)
D = Minimum Channel Depth (ft)
TW = Minimum Channel Topwidth (ft)

Channel	Q (cfs)	Y (ft)	V (fps)	**FB (ft)**	Froude Number	T (ft)	**Rc (ft)**	D (fl)	TW (ft)
2	13	0.89	4.10	**0.19**	1.08	7.14	**16.75**	1.08	8.7
3	29	1.21	5.00	**0.27**	1.13	9.64	**24.74**	1.48	11.8
4	14	1.00	3.50	**0.20**	0.87	8.02	**12.20**	1.20	9.6

```
                    HEC-RAS Version 4.0.0 March 2008
                      U.S. Army Corps 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: proposed conditions
Project File : proposedconditions.prj
Run Date and Time: 12/14/2010 8:58:38 AM

Project in English units

PLAN DATA

Plan Title: Current model
Plan File : t:\7TUS070901\HYDRO\DRAINAGE\CALCS\Hydraulics\Channels\NorthProject\RAS-export from rivercad\proposedconditions.P01

Geometry Title: Base Conditions Geometry
Geometry File : t:\7TUS070901\HYDRO\DRAINAGE\CALCS\Hydraulics\Channels\NorthProject\RAS-export from rivercad\proposedconditions.G01

Flow Title : 0 Flow Profiles
Flow File : t:\7TUS070901\HYDRO\DRAINAGE\CALCS\Hydraulics\Channels\NorthProject\RAS-export from rivercad\proposedconditions.F01

Plan Summary Information:
Number of: Cross Sections = 20 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

FLOW DATA

Flow Title: 0 Flow Profiles
Flow File : t:\7TUS070901\HYDRO\DRAINAGE\CALCS\Hydraulics\Channels\NorthProject\RAS-export from rivercad\proposedconditions.F01

Flow Data (cfs)

River	Reach	RS	PF 1
River #1	Reach #1	6100	62
River #1	Reach #1	5800	115
River #1	Reach #1	5400	131
River #1	Reach #1	5150	189

Boundary Conditions

River	Reach	Profile	Upstream	Downstream
River #1	Reach #1	PF 1		Normal S = 0.007

GEOMETRY DATA

Geometry Title: Base Conditions Geometry
Geometry File : t:\7TUS070901\HYDRO\DRAINAGE\CALCS\Hydraulics\Channels\NorthProject\RAS-export from rivercad\proposedconditions.G01

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 6100

INPUT
Description:
Station Elevation Data num= 63

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
1002.7	2535.16	1003	2535.17	1003	2535.18	1003.12	2535.67	1003.14	2535.67
1003.62	2535.67	1003.73	2535.66	1009.12	2535.38	1009.13	2535.38	1009.14	2535.37
1009.63	2535.37	1009.75	2534.88	1009.79	2534.88	1040.03	2534.28	1040.83	2534.26
1040.95	2534.75	1041.44	2534.75	1044.73	2534.81	1044.73	2534.83	1044.74	2534.83
1044.83	2534.83	1050.68	2534.95	1051.65	2534.96	1051.8	2534.97	1057.12	2533.64
1057.15	2533.64	1057.27	2533.61	1058.6	2533.63	1058.66	2533.63	1059.07	2533.62
1059.11	2533.62	1059.12	2533.62	1059.44	2533.61	1059.5	2533.61	1059.86	2533.63
1059.98	2533.64	1068.47	2533.53	1069.25	2533.53	1069.84	2533.52	1070.42	2533.51
1079.79	2533.21	1080.79	2533.18	1080.84	2533.18	1080.89	2533.18	1093.45	2533.06
1093.77	2533.05	1098.12	2533.22	1105.75	2533.5	1106.25	2533.54	1112.61	2533.92
1113.91	2533.96	1118.16	2533.6	1122.79	2533.33	1124.24	2533.3	1125.83	2533.15
1127.42	2533.23	1139.69	2533.63	1151.23	2533.66	1164.78	2533.69	1175.54	2533.72
1192.78	2533.74	1204.86	2533.82	1214.94	2533.89				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
1002.7	.03	1051.65	.03	1124.24	.03

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
1051.65	1124.24		50	50	50 .1	.3

Ineffective Flow num= 2

Sta L	Sta R	Elev	Permanent
1002.7	1051.65	2534.96	T
1113.91	1214.94	2533.96	T

CROSS SECTION OUTPUT Profile #PF 1

E.G. Elev (ft)	2533.90	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.13	Wt. n-Val.		0.030	
W.S. Elev (ft)	2533.77	Reach Len. (ft)	50.00	50.00	50.00
Crit W.S. (ft)		Flow Area (sq ft)		21.84	
E.G. Slope (ft/ft)	0.010863	Area (sq ft)		24.08	10.15
Q Total (cfs)	62.00	Flow (cfs)		62.00	
Top Width (ft)	134.66	Top Width (ft)		61.59	73.07
Vel Total (ft/s)	2.84	Avg. Vel. (ft/s)		2.84	
Max Chl Dpth (ft)	0.72	Hydr. Depth (ft)		0.41	
Conv. Total (cfs)	594.9	Conv. (cfs)		594.9	

Length Wtd. (ft)	50.00	Wetted Per. (ft)		53.55	
Min Ch El (ft)	2533.05	Shear (lb/sq ft)		0.28	
Alpha	1.00	Stream Power (lb/ft s)		0.79	
Frctn Loss (ft)	0.51	Cum Volume (acre-ft)	0.39	0.75	0.10
C & E Loss (ft)	0.00	Cum SA (acres)	0.48	1.07	0.36

Warning: Divided flow computed for this cross-section.

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 6050

INPUT
Description:
Station Elevation Data num= 43

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
1003	2534.65	1003.13	2535.15	1003.63	2535.15	1009.38	2534.88	1009.5	2534.88
1009.88	2534.88	1010	2534.38	1011.05	2534.36	1014.73	2534.29	1015.98	2534.26
1039.96	2533.78	1040	2533.78	1040.13	2534.28	1040.63	2534.28	1044	2534.35
1050	2534.47	1051	2534.49	1056.22	2533.19	1057.36	2532.9	1059.71	2532.94
1065.85	2533.14	1072.3	2532.9	1075.54	2532.84	1086.88	2532.75	1088.09	2532.72
1094.86	2532.72	1103.3	2532.7	1106.86	2532.85	1115.04	2533.38	1119.31	2533.59
1121.25	2533.79	1125.03	2533.97	1125.32	2533.98	1131.87	2533.15	1132.48	2533.06
1146.57	2533.01	1159.95	2533.16	1162.37	2533.17	1164.94	2533.17	1188.56	2533.15
1205.22	2533.31	1212.82	2533.36	1223.13	2533.38				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
1003	.03	1051	.03	1125.32	.03

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
1051	1125.32	50	50	50	.1	.3

Ineffective Flow num= 2

Sta L	Sta R	Elev	Permanent
1003	1050	2534.47	T
1123.32	1223.13	2533.98	T

CROSS SECTION OUTPUT Profile #PF 1

E.G. Elev (ft)	2533.39	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.11	Wt. n-Val.		0.030	
W.S. Elev (ft)	2533.28	Reach Len. (ft)	50.00	50.00	50.00
Crit W.S. (ft)		Flow Area (sq ft)		23.32	
E.G. Slope (ft/ft)	0.009628	Area (sq ft)		23.32	10.17
Q Total (cfs)	62.00	Flow (cfs)		62.00	
Top Width (ft)	128.25	Top Width (ft)		57.55	70.71
Vel Total (ft/s)	2.66	Avg. Vel. (ft/s)		2.66	
Max Chl Dpth (ft)	0.58	Hydr. Depth (ft)		0.41	
Conv. Total (cfs)	631.9	Conv. (cfs)		631.9	
Length Wtd. (ft)	50.00	Wetted Per. (ft)		57.62	
Min Ch El (ft)	2532.70	Shear (lb/sq ft)		0.24	
Alpha	1.00	Stream Power (lb/ft s)		0.65	
Frctn Loss (ft)	0.65	Cum Volume (acre-ft)	0.39	0.72	0.09
C & E Loss (ft)	0.01	Cum SA (acres)	0.48	1.00	0.27

Warning: Divided flow computed for this cross-section.

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 6000

INPUT
Description:
Station Elevation Data num= 39

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
1003	2534.11	1003.13	2534.61	1003.63	2534.61	1009.38	2534.35	1009.88	2534.35
1010	2533.85	1040	2533.25	1040.13	2533.75	1040.63	2533.75	1044	2533.82
1050	2533.94	1050.96	2533.96	1051	2533.96	1056.34	2532.62	1057.01	2532.46
1060.84	2532.44	1068.69	2532.37	1071.9	2532.35	1074.21	2532.25	1080.72	2532.24
1089.07	2532.13	1101.39	2532.02	1106.07	2532	1108.11	2532.05	1122.62	2533.85
1124.02	2534.06	1125.44	2534.1	1128.5	2534.13	1138.89	2532.39	1139.75	2532.25
1140.01	2532.25	1143.17	2532.27	1166.78	2532.45	1169.56	2532.44	1170.51	2532.42
1173.96	2532.37	1190.17	2532.25	1196.61	2532.45	1207.11	2532.94		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
1003	.03	1050.96	.03	1128.5	.03

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
1050.96	1128.5	50	50	50	.1	.3

Ineffective Flow num= 2

Sta L	Sta R	Elev	Permanent
1003	1050	2533.94	T
1128.5	1207.11	2534.13	T

CROSS SECTION OUTPUT Profile #PF 1

E.G. Elev (ft)	2532.73	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.17	Wt. n-Val.		0.030	
W.S. Elev (ft)	2532.56	Reach Len. (ft)	50.00	50.00	50.00
Crit W.S. (ft)	2532.56	Flow Area (sq ft)		18.82	
E.G. Slope (ft/ft)	0.018803	Area (sq ft)		18.82	12.64
Q Total (cfs)	62.00	Flow (cfs)		62.00	
Top Width (ft)	116.75	Top Width (ft)		55.64	61.12
Vel Total (ft/s)	3.29	Avg. Vel. (ft/s)		3.29	
Max Chl Dpth (ft)	0.56	Hydr. Depth (ft)		0.34	
Conv. Total (cfs)	452.1	Conv. (cfs)		452.1	
Length Wtd. (ft)	50.00	Wetted Per. (ft)		55.69	
Min Ch El (ft)	2532.00	Shear (lb/sq ft)		0.40	
Alpha	1.00	Stream Power (lb/ft s)		1.31	
Frctn Loss (ft)	0.36	Cum Volume (acre-ft)	0.39	0.70	0.08
C & E Loss (ft)	0.03	Cum SA (acres)	0.48	0.94	0.20

Warning: The energy equation could not be balanced within the specified number of iterations. The program used critical depth for the water surface and continued on with the calculations.
Warning: Divided flow computed for this cross-section.
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.
Warning: During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The program defaulted to critical depth.

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 5950

INPUT
Description:
Station Elevation Data num= 43

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
1003	2533.59	1003.12	2534.09	1003.62	2534.09	1005.86	2533.99	1007	2533.94
1009.37	2533.83	1009.87	2533.83	1010	2533.33	1040	2532.73	1040.12	2533.23
1040.62	2533.23	1041.76	2533.25	1044	2533.3	1044.68	2533.31	1045.51	2533.33
1050	2533.42	1051	2533.44	1055.34	2532.35	1057.93	2531.7	1068.74	2531.67
1070.89	2531.61	1074.27	2531.55	1078.82	2531.44	1091.3	2531.11	1106.69	2531.29
1106.97	2531.3	1107.1	2531.3	1117.55	2531.73	1125.45	2533.51	1126.88	2533.85
1128.38	2533.89	1131.09	2533.94	1141.6	2532.24	1143.59	2531.88	1144.17	2531.83
1147.53	2531.79	1163.56	2531.59	1171.68	2531.97	1175.47	2532.14	1176.69	2532.21
1178.2	2532.29	1193.26	2532.64	1217.89	2533.25				

Manning's n Values num= 3

```
     Sta   n Val     Sta   n Val     Sta   n Val
    1003     .03    1050     .03 1128.38     .03

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
          1050 1128.38               50      50      50             .1       .3
Ineffective Flow     num=       2
   Sta L   Sta R    Elev  Permanent
    1003    1050 2533.42       T
 1131.09 1217.89 2533.94       T

CROSS SECTION OUTPUT  Profile #PF 1

  E.G. Elev (ft)           2532.01    Element                   Left OB    Channel   Right OB
  Vel Head (ft)               0.06    Wt. n-Val.                           0.030
  W.S. Elev (ft)           2531.95    Reach Len. (ft)            50.00     50.00      50.00
  Crit W.S. (ft)                      Flow Area (sq ft)                    31.69
  E.G. Slope (ft/ft)      0.003787    Area (sq ft)                         31.69       6.01
  Q Total (cfs)              62.00    Flow (cfs)                           62.00
  Top Width (ft)             89.55    Top Width (ft)                       61.57      27.98
  Vel Total (ft/s)            1.96    Avg. Vel. (ft/s)                      1.96
  Max Chl Dpth (ft)           0.84    Hydr. Depth (ft)                      0.51
  Conv. Total (cfs)          1007.5    Conv. (cfs)                        1007.5
  Length Wtd. (ft)           50.00    Wetted Per. (ft)                     61.64
  Min Ch El (ft)           2531.11    Shear (lb/sq ft)                      0.12
  Alpha                       1.00    Stream Power (lb/ft s)                0.24
  Frctn Loss (ft)             0.12    Cum Volume (acre-ft)        0.39      0.67       0.07
  C & E Loss (ft)             0.00    Cum SA (acres)              0.48      0.87       0.15


Warning: Divided flow computed for this cross-section.
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.

CROSS SECTION


RIVER: River #1
REACH: Reach #1           RS: 5900

INPUT
Description:
Station Elevation Data    num=      29
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
    1003 2533.07 1003.12 2533.57 1003.62 2533.57 1009.37 2533.31 1009.87 2533.31
    1010 2532.81    1040 2532.21 1040.12 2532.71 1040.62 2532.71    1044 2532.78
    1050  2532.9    1051 2532.92 1058.54 2531.03 1065.98 2530.71 1070.52 2530.71
 1073.93 2530.71 1085.15 2530.71 1091.15 2532.73 1122.16 2533.32 1124.99 2533.02
 1129.39 2533.04  1134.1 2531.88 1136.24 2531.59 1140.68 2531.22 1147.78 2531.43
 1155.25 2531.64 1169.66 2532.17 1179.89 2532.53 1183.62 2532.63

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
    1003     .03    1051     .03 1122.16     .03

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
          1051 1122.16               50      50      50             .1       .3
Ineffective Flow     num=       2
   Sta L   Sta R    Elev  Permanent
    1003    1051 2532.92       T
 1122.16 1183.62 2533.32       T

CROSS SECTION OUTPUT  Profile #PF 1

  E.G. Elev (ft)           2531.89    Element                   Left OB    Channel   Right OB
  Vel Head (ft)               0.06    Wt. n-Val.                           0.030
  W.S. Elev (ft)           2531.83    Reach Len. (ft)            50.00     50.00      50.00
  Crit W.S. (ft)                      Flow Area (sq ft)                    31.60
  E.G. Slope (ft/ft)      0.001688    Area (sq ft)                         31.60       8.26
  Q Total (cfs)              62.00    Flow (cfs)                           62.00
  Top Width (ft)             58.89    Top Width (ft)                       33.10      25.79
```

Vel Total (ft/s)	1.96	Avg. Vel. (ft/s)		1.96	
Max Chl Dpth (ft)	1.12	Hydr. Depth (ft)		0.95	
Conv. Total (cfs)	1509.1	Conv. (cfs)		1509.1	
Length Wtd. (ft)	50.00	Wetted Per. (ft)		33.38	
Min Ch El (ft)	2530.71	Shear (lb/sq ft)		0.10	
Alpha	1.00	Stream Power (lb/ft s)		0.20	
Frctn Loss (ft)	0.04	Cum Volume (acre-ft)	0.39	0.63	0.06
C & E Loss (ft)	0.01	Cum SA (acres)	0.48	0.82	0.12

Warning: Divided flow computed for this cross-section.
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.

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 5850

INPUT
Description:
Station Elevation Data num= 79

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
1003.38	2532.79	1004.52	2532.79	1009.37	2532.79	1009.87	2532.79	1010	2532.29
1040	2531.69	1040.02	2531.69	1040.15	2532.19	1040.65	2532.19	1043.83	2532.23
1046.64	2532.31	1046.65	2532.31	1047.65	2532.33	1050.53	2532.37	1051.46	2532.39
1055.17	2530.45	1058.86	2530.53	1058.87	2530.56	1058.89	2530.56	1059.15	2530.56
1059.19	2530.56	1059.6	2530.65	1066.08	2530.6	1066.48	2530.47	1074.79	2530.37
1077.48	2530.4	1086.55	2530.43	1089.99	2530.42	1091.18	2530.43	1093.51	2530.78
1097.84	2531.43	1100.99	2532.2	1105.07	2533.11	1107.71	2533.35	1112.73	2532.92
1119.6	2531.3	1123.71	2530.77	1124.46	2530.73	1129.92	2531.05	1140.21	2531.27
1153.37	2531.81	1153.93	2531.83	1154.56	2531.85	1155.29	2531.87	1156.1	2531.89
1156.49	2531.9	1157.43	2531.93	1157.87	2531.94	1158	2532.16	1158.16	2532.44
1158.36	2532.43	1158.84	2532.4	1159.14	2532.38	1159.36	2532.37	1160.7	2532.32
1162.14	2532.33	1164.88	2532.33	1166.82	2532.33	1169.19	2532.39	1170.54	2532.48
1170.72	2532.48	1170.92	2532.5	1171.18	2532.51	1171.57	2532.55	1171.81	2532.57
1171.99	2532.27	1172.11	2532.07	1172.25	2532.08	1172.55	2532.09	1172.88	2532.1
1173.11	2532.11	1173.28	2532.12	1173.38	2532.13	1178.01	2532.16	1179	2532.18
1179.91	2532.2	1201.4	2532.72	1213.62	2532.88	1224.81	2533.08		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
1003.38	.03	1051.46	.03	1112.73	.03

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
1051.46	1112.73	50	50	50	.1	.3

Ineffective Flow num= 2

Sta L	Sta R	Elev	Permanent
1003.38	1051.46	2532.39	T
1107.71	1224.81	2533.35	T

CROSS SECTION OUTPUT Profile #PF 1

E.G. Elev (ft)	2531.84	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.02	Wt. n-Val.		0.030	
W.S. Elev (ft)	2531.82	Reach Len. (ft)	50.00	50.00	50.00
Crit W.S. (ft)		Flow Area (sq ft)		56.77	
E.G. Slope (ft/ft)	0.000382	Area (sq ft)	0.42	56.77	20.12
Q Total (cfs)	62.00	Flow (cfs)		62.00	
Top Width (ft)	89.61	Top Width (ft)	6.51	46.88	36.22
Vel Total (ft/s)	1.09	Avg. Vel. (ft/s)		1.09	
Max Chl Dpth (ft)	1.45	Hydr. Depth (ft)		1.21	
Conv. Total (cfs)	3171.2	Conv. (cfs)		3171.2	
Length Wtd. (ft)	50.00	Wetted Per. (ft)		47.39	
Min Ch El (ft)	2530.37	Shear (lb/sq ft)		0.03	
Alpha	1.00	Stream Power (lb/ft s)		0.03	
Frctn Loss (ft)	0.09	Cum Volume (acre-ft)	0.39	0.58	0.04
C & E Loss (ft)	0.04	Cum SA (acres)	0.48	0.77	0.08

Warning: Divided flow computed for this cross-section.
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.

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 5800

INPUT
Description:
Station Elevation Data num= 55

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
1000	2531.97	1003.56	2532.42	1007.01	2532.2	1007.4	2532.2	1007.5	2531.82
1016.74	2531.63	1040	2531.17	1042	2531.04	1056.59	2531.33	1058.24	2531.36
1089.06	2531.98	1089.18	2532.48	1089.68	2532.48	1095.68	2532.6	1096.68	2532.62
1106.01	2530.29	1106.03	2530.26	1106.12	2530.26	1106.54	2530.26	1106.95	2530.26
1108.68	2530.26	1108.91	2530.26	1111	2530.26	1113	2530.26	1115.45	2530.26
1118.1	2530.26	1118.8	2530.26	1119.21	2530.26	1119.39	2530.26	1123.67	2530.26
1125.37	2530.26	1127.8	2533.49	1129.31	2533.31	1133.1	2532.78	1135.03	2532.44
1136.82	2532.17	1140.72	2532.07	1143.36	2532.16	1144.66	2532.13	1149.14	2532.24
1155.82	2532.08	1157.38	2531.98	1160.39	2531.71	1169.66	2531.68	1172.43	2531.77
1174.8	2531.74	1185.87	2531.88	1186.37	2531.89	1201.14	2531.92	1201.21	2531.92
1201.42	2531.92	1201.6	2531.92	1217.78	2532.13	1217.79	2532.13	1217.86	2532.13

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
1000	.03	1096.68	.03	1111	.03

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
1096.68	1111	50	50	50	.1	.3

Ineffective Flow num= 2

Sta L	Sta R	Elev	Permanent
1000	1095.68	2532.6	T
1127.8	1217.86	2533.49	T

CROSS SECTION OUTPUT Profile #PF 1

E.G. Elev (ft)	2531.71	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.45	Wt. n-Val.		0.030	0.030
W.S. Elev (ft)	2531.25	Reach Len. (ft)	50.00	50.00	50.00
Crit W.S. (ft)	2531.25	Flow Area (sq ft)		6.82	14.65
E.G. Slope (ft/ft)	0.013860	Area (sq ft)	1.63	6.82	14.65
Q Total (cfs)	115.00	Flow (cfs)		33.09	81.91
Top Width (ft)	40.97	Top Width (ft)	17.01	8.85	15.12
Vel Total (ft/s)	5.36	Avg. Vel. (ft/s)		4.85	5.59
Max Chl Dpth (ft)	0.99	Hydr. Depth (ft)		0.77	0.97
Conv. Total (cfs)	976.8	Conv. (cfs)		281.1	695.8
Length Wtd. (ft)	50.00	Wetted Per. (ft)		8.98	15.61
Min Ch El (ft)	2530.26	Shear (lb/sq ft)		0.66	0.81
Alpha	1.01	Stream Power (lb/ft s)		3.19	4.54
Frctn Loss (ft)	0.60	Cum Volume (acre-ft)	0.39	0.54	0.02
C & E Loss (ft)	0.05	Cum SA (acres)	0.46	0.74	0.05

Warning: The energy equation could not be balanced within the specified number of iterations. The program used critical depth for the water surface and continued on with the calculations.
Warning: Divided flow computed for this cross-section.
Warning: During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The program defaulted to critical depth.

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 5750

INPUT
Description:
Station Elevation Data num= 37

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
1004	2531.53	1004.12	2532.03	1004.62	2532.03	1004.92	2532.01	1006.99	2531.89
1009.37	2531.75	1009.87	2531.75	1010	2531.25	1040	2530.65	1042	2530.52
1054.25	2530.77	1062.38	2530.93	1078.81	2531.26	1078.93	2531.76	1079.43	2531.76
1085.43	2531.88	1086.43	2531.9	1095.23	2529.7	1095.69	2529.58	1095.8	2529.55
1097.45	2529.68	1097.98	2529.71	1101.93	2529.75	1109.15	2529.83	1115.03	2529.99
1127.09	2530.29	1136.47	2530.54	1148.06	2530.68	1151.4	2530.76	1158.35	2530.9
1168.5	2531.09	1169.72	2531.13	1179.85	2531.17	1192.92	2531.3	1199.51	2531.34
1205.87	2531.44	1218.97	2531.62						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
1004	.03	1086.43	.03	1115.03	.03

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
1086.43	1115.03		50	50	50	.1	.3

Ineffective Flow num= 1

Sta L	Sta R	Elev	Permanent
1004	1085.43	2531.88	T

CROSS SECTION OUTPUT Profile #PF 1

E.G. Elev (ft)	2530.97	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.27	Wt. n-Val.		0.030	0.030
W.S. Elev (ft)	2530.70	Reach Len. (ft)	50.00	50.00	50.00
Crit W.S. (ft)	2530.70	Flow Area (sq ft)		19.99	10.49
E.G. Slope (ft/ft)	0.010625	Area (sq ft)	1.09	19.99	10.49
Q Total (cfs)	115.00	Flow (cfs)		90.48	24.52
Top Width (ft)	71.05	Top Width (ft)	13.37	23.80	33.89
Vel Total (ft/s)	3.77	Avg. Vel. (ft/s)		4.53	2.34
Max Chl Dpth (ft)	1.15	Hydr. Depth (ft)		0.84	0.31
Conv. Total (cfs)	1115.7	Conv. (cfs)		877.8	237.8
Length Wtd. (ft)	50.00	Wetted Per. (ft)		23.95	33.89
Min Ch El (ft)	2529.55	Shear (lb/sq ft)		0.55	0.21
Alpha	1.21	Stream Power (lb/ft s)		2.51	0.48
Frctn Loss (ft)	0.59	Cum Volume (acre-ft)	0.39	0.53	0.01
C & E Loss (ft)	0.00	Cum SA (acres)	0.44	0.72	0.02

Warning: The energy equation could not be balanced within the specified number of iterations. The program used critical depth for the water surface and continued on with the calculations.
Warning: Divided flow computed for this cross-section.
Warning: During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The program defaulted to critical depth.

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 5700

INPUT
Description:
Station Elevation Data num= 44

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
1004	2531.01	1004.12	2531.51	1004.62	2531.51	1007.64	2531.3	1008.57	2531.23
1009.07	2531.23	1009.2	2530.73	1009.86	2530.72	1040	2530.13	1042	2530
1046.3	2530.09	1047.88	2530.12	1063.02	2530.42	1064.03	2530.44	1064.16	2530.94
1064.66	2530.94	1065.41	2530.96	1070.66	2531.06	1071.66	2531.08	1072.62	2530.84
1072.93	2530.76	1074.71	2530.32	1078.42	2529.39	1079.76	2529.06	1079.76	2529.05
1082.88	2529.01	1087.71	2528.96	1093.6	2529.09	1099.99	2529.18	1104.99	2529.23
1109.95	2529.27	1116.29	2529.46	1123.18	2529.69	1126.83	2529.86	1138.41	2530.26
1156.62	2530.44	1159.44	2530.43	1173.75	2530.58	1174.47	2530.59	1174.97	2530.6
1188.47	2530.73	1195.1	2530.81	1207.09	2530.94	1224.37	2531.21		

Manning's n Values num= 3

```
     Sta   n Val     Sta   n Val     Sta   n Val
    1004     .03 1071.66     .03 1123.18     .03

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
       1071.66 1123.18               50      50      50              .1       .3
Ineffective Flow     num=       1
   Sta L   Sta R    Elev  Permanent
    1004 1070.66 2531.06       T

CROSS SECTION OUTPUT  Profile #PF 1

  E.G. Elev (ft)           2530.10    Element                   Left OB    Channel   Right OB
  Vel Head (ft)               0.25    Wt. n-Val.                            0.030      0.030
  W.S. Elev (ft)           2529.85    Reach Len. (ft)            50.00      50.00      50.00
  Crit W.S. (ft)           2529.81    Flow Area (sq ft)                     28.35       0.26
  E.G. Slope (ft/ft)      0.012986    Area (sq ft)                          28.35       0.26
  Q Total (cfs)             115.00    Flow (cfs)                           114.74       0.26
  Top Width (ft)             49.89    Top Width (ft)                        46.57       3.32
  Vel Total (ft/s)            4.02    Avg. Vel. (ft/s)                       4.05       1.02
  Max Chl Dpth (ft)           0.88    Hydr. Depth (ft)                       0.61       0.08
  Conv. Total (cfs)         1009.2    Conv. (cfs)                          1006.9        2.3
  Length Wtd. (ft)           50.00    Wetted Per. (ft)                      46.69       3.32
  Min Ch El (ft)           2528.96    Shear (lb/sq ft)                       0.49       0.06
  Alpha                       1.01    Stream Power (lb/ft s)                 1.99       0.06
  Frctn Loss (ft)             0.65    Cum Volume (acre-ft)        0.39       0.50       0.00
  C & E Loss (ft)             0.01    Cum SA (acres)              0.44       0.68       0.00


CROSS SECTION


RIVER: River #1
REACH: Reach #1           RS: 5650

INPUT
Description:
Station Elevation Data    num=      44
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
    1000 2530.41 1012.71 2530.16 1014.72 2530.12 1028.83 2529.83 1030.95 2529.79
 1036.99 2529.67    1040 2529.61 1040.78 2529.63 1049.07 2529.79 1049.19 2530.29
 1049.69 2530.29 1055.69 2530.41 1056.69 2530.43  1056.7 2530.43  1059.1 2529.83
    1060  2529.6 1063.72 2528.68 1063.88 2528.67 1070.34 2528.39 1072.13 2528.42
 1078.43 2528.42 1080.57 2528.43  1081.5 2528.46 1087.49 2528.73 1091.43 2528.71
 1101.41 2528.59 1111.51    2529 1113.58 2529.06 1118.56 2529.17 1131.69 2529.46
 1135.25 2529.63 1139.34 2529.75 1144.55 2529.93  1154.9  2530.1  1163.3 2530.26
 1172.59 2530.32 1179.44  2530.4 1183.66 2530.48 1185.03  2530.5  1187.2 2530.49
 1202.21 2530.63 1208.67 2530.75 1221.45 2530.76 1222.67 2530.77

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
    1000     .03 1056.69     .03 1131.69     .03

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
       1056.69 1131.69               50      50      50              .1       .3
Ineffective Flow     num=       1
   Sta L   Sta R    Elev  Permanent
    1000 1055.69 2530.41       T

CROSS SECTION OUTPUT  Profile #PF 1

  E.G. Elev (ft)           2529.44    Element                   Left OB    Channel   Right OB
  Vel Head (ft)               0.21    Wt. n-Val.                            0.030
  W.S. Elev (ft)           2529.23    Reach Len. (ft)            50.00      50.00      50.00
  Crit W.S. (ft)           2529.19    Flow Area (sq ft)                     31.49
  E.G. Slope (ft/ft)      0.012842    Area (sq ft)                          31.49
  Q Total (cfs)             115.00    Flow (cfs)                           115.00
  Top Width (ft)             59.93    Top Width (ft)                        59.93
  Vel Total (ft/s)            3.65    Avg. Vel. (ft/s)                       3.65
  Max Chl Dpth (ft)           0.84    Hydr. Depth (ft)                       0.53
  Conv. Total (cfs)         1014.8    Conv. (cfs)                          1014.8
```

Length Wtd. (ft)	50.00	Wetted Per. (ft)		60.02
Min Ch El (ft)	2528.39	Shear (lb/sq ft)		0.42
Alpha	1.00	Stream Power (lb/ft s)		1.54
Frctn Loss (ft)	0.50	Cum Volume (acre-ft)	0.39	0.47
C & E Loss (ft)	0.02	Cum SA (acres)	0.44	0.62

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 5600

INPUT
Description:
Station Elevation Data num= 60

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
1000	2529.89	1040	2529.09	1040.12	2529.59	1040.62	2529.59	1044	2529.66
1050	2529.78	1051	2529.8	1058.18	2528	1058.98	2527.8	1059.36	2527.76
1061.18	2527.91	1061.2	2527.9	1061.26	2527.89	1061.44	2527.87	1062.72	2527.74
1065.47	2527.47	1066.71	2527.61	1070.8	2527.84	1074.13	2528.26	1077.13	2528.29
1078.33	2528.3	1082.39	2528.18	1087.14	2528.14	1097.17	2528.23	1100.53	2528.24
1102.39	2528.28	1109.78	2528.48	1121.64	2528.8	1122.31	2528.81	1133.69	2529.57
1134.52	2529.62	1149.16	2530.71	1151.05	2530.83	1158.25	2531.21	1165.63	2531.67
1166.95	2531.74	1168.31	2531.81	1171.19	2532.07	1173.48	2532.28	1173.55	2532.13
1173.73	2531.78	1174.91	2531.78	1178.27	2531.78	1183.68	2531.79	1185.38	2531.8
1186.23	2531.8	1186.78	2531.8	1189.87	2531.77	1194.47	2531.8	1195.32	2531.82
1196.56	2531.86	1201.31	2532	1203.12	2532.05	1205.15	2532.1	1206.96	2532.1
1209.43	2532.16	1212.31	2532.23	1215.44	2532.29	1215.96	2532.3	1218.94	2532.35

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
1000	.03	1050	.03	1134.52	.03

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
1050	1134.52	50	50	50	.1	.3

Ineffective Flow num= 1

Sta L	Sta R	Elev	Permanent
1000	1050	2529.78	T

CROSS SECTION OUTPUT Profile #PF 1

			Left OB	Channel	Right OB
E.G. Elev (ft)	2528.93	Element			
Vel Head (ft)	0.14	Wt. n-Val.		0.030	
W.S. Elev (ft)	2528.78	Reach Len. (ft)	50.00	50.00	50.00
Crit W.S. (ft)	2528.64	Flow Area (sq ft)		37.93	
E.G. Slope (ft/ft)	0.007877	Area (sq ft)		37.93	
Q Total (cfs)	115.00	Flow (cfs)		115.00	
Top Width (ft)	66.01	Top Width (ft)		66.01	
Vel Total (ft/s)	3.03	Avg. Vel. (ft/s)		3.03	
Max Chl Dpth (ft)	1.31	Hydr. Depth (ft)		0.57	
Conv. Total (cfs)	1295.8	Conv. (cfs)		1295.8	
Length Wtd. (ft)	50.00	Wetted Per. (ft)		66.21	
Min Ch El (ft)	2527.47	Shear (lb/sq ft)		0.28	
Alpha	1.00	Stream Power (lb/ft s)		0.85	
Frctn Loss (ft)	0.56	Cum Volume (acre-ft)	0.39	0.43	
C & E Loss (ft)	0.01	Cum SA (acres)	0.44	0.55	

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.

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 5550

INPUT
Description:

Station Elevation Data num= 54

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
1000	2529.37	1010.43	2529.16	1013.65	2529.1	1023.68	2528.9	1024.29	2528.88
1040	2528.57	1040.12	2529.07	1040.62	2529.07	1044	2529.14	1049.62	2529.25
1050	2529.26	1051	2529.28	1051.03	2529.27	1056.77	2527.84	1056.97	2527.81
1057.96	2527.82	1058.5	2527.82	1060.42	2527.73	1067.02	2527.43	1070.13	2527.45
1075.29	2527.44	1076.72	2527.46	1078.6	2527.59	1085.2	2527.66	1086.58	2527.68
1090.62	2527.61	1097.06	2527.5	1099.38	2527.46	1101.74	2527.55	1108.82	2527.85
1113.02	2527.99	1117.45	2528.09	1123.84	2528.48	1125.25	2528.59	1127.45	2528.88
1130.72	2529.26	1133.17	2529.59	1136.3	2530.02	1142.91	2530.84	1151.72	2531.5
1157.15	2531.9	1167.78	2531.57	1169.96	2531.52	1180.96	2531.53	1181.53	2531.53
1182.15	2531.54	1188.65	2531.89	1190.15	2531.92	1197.33	2532.06	1203.62	2532.16
1206.59	2532.21	1209.72	2532.28	1217.63	2532.5	1223.12	2532.62		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
1000	.03	1051.03	.03	1142.91	.03

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
1051.03	1142.91	50	50	50	.1	.3

Ineffective Flow num= 1

Sta L	Sta R	Elev	Permanent
1000	1051.03	2529.27	T

Left Levee Station= 1076.25 Elevation= 2527.45

CROSS SECTION OUTPUT Profile #PF 1

E.G. Elev (ft)	2528.36	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.24	Wt. n-Val.		0.030	
W.S. Elev (ft)	2528.13	Reach Len. (ft)	50.00	50.00	50.00
Crit W.S. (ft)	2528.13	Flow Area (sq ft)		29.46	
E.G. Slope (ft/ft)	0.016911	Area (sq ft)		29.46	
Q Total (cfs)	115.00	Flow (cfs)		115.00	
Top Width (ft)	62.40	Top Width (ft)		62.40	
Vel Total (ft/s)	3.90	Avg. Vel. (ft/s)		3.90	
Max Chl Dpth (ft)	0.70	Hydr. Depth (ft)		0.47	
Conv. Total (cfs)	884.3	Conv. (cfs)		884.3	
Length Wtd. (ft)	50.00	Wetted Per. (ft)		62.47	
Min Ch El (ft)	2527.43	Shear (lb/sq ft)		0.50	
Alpha	1.00	Stream Power (lb/ft s)		1.94	
Frctn Loss (ft)	0.30	Cum Volume (acre-ft)	0.39	0.39	
C & E Loss (ft)	0.05	Cum SA (acres)	0.44	0.47	

Warning: The energy equation could not be balanced within the specified number of iterations. The program used critical depth for the water surface and continued on with the calculations.
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.
Warning: Critical depth could not be determined within the specified number of iterations. The program used the iteration with the lowest energy.
Warning: During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The program defaulted to critical depth.

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 5500

INPUT
Description:
Station Elevation Data num= 66

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
1001.11	2528.65	1001.5	2528.65	1010	2528.65	1016.41	2528.52	1017.04	2528.51
1041.51	2528.02	1041.64	2528.52	1042.14	2528.52	1045.51	2528.59	1051.51	2528.71
1052.51	2528.73	1053.71	2529.13	1055.71	2529.13	1055.8	2529.1	1060.89	2527.42
1061.72	2527.14	1062.35	2526.94	1062.36	2526.94	1064.86	2526.8	1065.48	2526.84
1069.67	2527.1	1070.45	2527.17	1071.9	2527.14	1078.63	2526.93	1084.44	2526.96
1085.33	2526.97	1085.91	2526.96	1089.46	2526.91	1096.57	2526.85	1099.4	2526.94

```
 1105.39  2527.2 1110.86 2527.34 1114.57 2527.42 1117.42 2527.57 1119.34 2527.75
 1124.48 2528.08 1127.11 2528.61 1129.63 2529.14 1131.43 2529.42 1133.59 2529.98
 1135.19 2530.17 1139.08 2530.69 1145.73 2530.91 1158.25  2531.4 1175.78 2531.39
 1180.84 2531.37 1182.24 2531.38 1183.37 2531.41 1185.79  2531.4 1185.99 2531.41
 1186.13 2531.41 1187.35 2531.44 1190.47 2531.51 1194.12 2531.59 1194.56 2531.62
 1196.55 2531.75 1197.14 2531.77 1199.71 2531.69 1201.08  2531.7 1204.45  2531.9
 1208.81 2532.18 1209.73  2532.3 1213.18  2532.6 1218.16 2532.85 1221.24 2532.89
 1223.54 2532.94

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
 1001.11     .03  1055.8     .03 1145.73     .03

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
        1055.8 1145.73               50      50      50              .1       .3
Ineffective Flow     num=       1
   Sta L   Sta R    Elev  Permanent
 1001.11 1053.71 2529.13       T

CROSS SECTION OUTPUT  Profile #PF 1

  E.G. Elev (ft)           2528.00    Element                   Left OB    Channel   Right OB
  Vel Head (ft)               0.08    Wt. n-Val.                            0.030
  W.S. Elev (ft)           2527.92    Reach Len. (ft)            50.00      50.00      50.00
  Crit W.S. (ft)                      Flow Area (sq ft)                     49.71
  E.G. Slope (ft/ft)      0.002976    Area (sq ft)                          49.71
  Q Total (cfs)             115.00    Flow (cfs)                           115.00
  Top Width (ft)             62.56    Top Width (ft)                        62.56
  Vel Total (ft/s)            2.31    Avg. Vel. (ft/s)                       2.31
  Max Chl Dpth (ft)           1.12    Hydr. Depth (ft)                       0.79
  Conv. Total (cfs)         2107.9    Conv. (cfs)                          2107.9
  Length Wtd. (ft)           50.00    Wetted Per. (ft)                      62.77
  Min Ch El (ft)           2526.80    Shear (lb/sq ft)                       0.15
  Alpha                       1.00    Stream Power (lb/ft s)                 0.34
  Frctn Loss (ft)             0.15    Cum Volume (acre-ft)        0.39       0.34
  C & E Loss (ft)             0.00    Cum SA (acres)              0.44       0.40


CROSS SECTION


RIVER: River #1
REACH: Reach #1           RS: 5450

INPUT
Description:
Station Elevation Data    num=      60
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
 1006.81 2528.05    1010 2528.03 1010.12 2528.03 1011.23 2528.01 1013.88 2527.95
 1026.32 2527.71  1027.1 2527.69 1044.84 2527.33 1044.97 2527.83 1045.47 2527.83
 1045.89 2527.84 1048.09 2527.89 1048.84  2527.9 1054.84 2528.02 1055.84 2528.04
 1057.04 2528.44 1059.04 2528.44 1059.13 2528.41 1062.68 2527.24 1064.26 2526.72
 1065.78 2526.71 1066.39 2526.66  1066.6 2526.66 1066.95  2526.6 1067.74 2526.61
  1068.3 2526.67 1071.68  2526.8 1075.24 2526.87 1077.83 2526.89 1079.11 2526.86
 1086.29 2526.73 1089.96 2526.77 1090.89 2526.78 1091.09 2526.78 1092.45 2526.79
 1101.89 2526.83 1104.44 2526.93 1115.98 2527.38 1118.44 2527.59 1122.02  2527.9
 1132.28 2530.98 1134.93 2531.76 1135.39 2531.74 1138.48 2531.57 1148.15  2531.4
 1158.42 2531.31 1162.94 2531.26 1170.02  2531.1 1175.67 2531.18 1197.92 2531.42
 1200.98 2531.57 1201.11 2531.98  1202.4 2531.86 1203.58 2531.91 1207.65 2532.12
 1211.75 2532.32 1213.39 2532.43 1217.17 2532.57 1220.72 2532.74 1224.67 2532.94

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
 1006.81     .03 1059.13     .03 1148.15     .03

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
       1059.13 1148.15               50      50      50              .1       .3
Ineffective Flow     num=       1
   Sta L   Sta R    Elev  Permanent
 1006.81 1059.04 2528.44       T
```

CROSS SECTION OUTPUT Profile #PF 1

E.G. Elev (ft)	2527.85	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.09	Wt. n-Val.		0.030	
W.S. Elev (ft)	2527.76	Reach Len. (ft)	50.00	50.00	50.00
Crit W.S. (ft)		Flow Area (sq ft)		48.51	
E.G. Slope (ft/ft)	0.003012	Area (sq ft)	4.63	48.51	
Q Total (cfs)	115.00	Flow (cfs)		115.00	
Top Width (ft)	80.72	Top Width (ft)	21.38	59.34	
Vel Total (ft/s)	2.37	Avg. Vel. (ft/s)		2.37	
Max Chl Dpth (ft)	1.16	Hydr. Depth (ft)		0.82	
Conv. Total (cfs)	2095.4	Conv. (cfs)		2095.4	
Length Wtd. (ft)	50.00	Wetted Per. (ft)		59.55	
Min Ch El (ft)	2526.60	Shear (lb/sq ft)		0.15	
Alpha	1.00	Stream Power (lb/ft s)		0.36	
Frctn Loss (ft)	0.29	Cum Volume (acre-ft)	0.38	0.29	
C & E Loss (ft)	0.02	Cum SA (acres)	0.42	0.33	

Warning: Divided flow computed for this cross-section.
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.

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 5400

INPUT
Description:
Station Elevation Data num= 81

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
1008.71	2527.76	1009.21	2527.76	1009.34	2527.26	1045.44	2526.54	1046.01	2526.53
1048.17	2526.49	1048.3	2526.99	1048.8	2526.99	1052.17	2527.06	1058.17	2527.18
1059.17	2527.2	1061.87	2528.1	1063.87	2528.1	1063.96	2528.07	1064.37	2527.93
1066.4	2527.26	1068.29	2526.63	1069.14	2526.34	1069.74	2526.13	1070.28	2526.2
1070.68	2526.22	1071.07	2526.24	1071.79	2526.27	1072.39	2527.74	1072.97	2527.03
1074.15	2526.81	1077.47	2526.65	1079.24	2526.56	1080.36	2526.62	1084.45	2526.59
1085.08	2526.61	1089.32	2526.63	1094.84	2526.41	1100.98	2526.56	1101.21	2526.57
1101.28	2526.59	1101.33	2526.59	1103.82	2526.5	1104.2	2526.5	1105.1	2526.42
1105.82	2526.44	1107.34	2526.34	1108.44	2526.69	1109.04	2526.73	1111.78	2526.88
1112	2527.08	1115.63	2527.31	1117.13	2527.38	1117.89	2527.45	1120.31	2527.62
1126.59	2528.26	1129.81	2528.42	1130.64	2528.47	1134.74	2529.98	1136.78	2530.47
1137.63	2530.68	1138.93	2530.81	1139.7	2530.88	1139.8	2530.62	1143.39	2530.87
1153.85	2531.45	1156.75	2531.49	1157.57	2531.5	1157.74	2531.5	1157.86	2531.22
1161.9	2531.22	1169.38	2530.73	1179.06	2530.65	1182.05	2530.63	1182.16	2530.91
1182.25	2531.13	1182.42	2531.13	1182.58	2531.13	1184.99	2531.15	1189.91	2531.21
1191.58	2531.23	1191.74	2531.12	1196.82	2530.9	1202.77	2530.99	1210.68	2531.43
1222.11	2531.19								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
1008.71	.03	1064.37	.03	1143.39	.03

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
1064.37	1143.39	50	50	50	.1	.3

Ineffective Flow num= 1

Sta L	Sta R	Elev	Permanent
1008.71	1063.87	2528.1	T

CROSS SECTION OUTPUT Profile #PF 1

E.G. Elev (ft)	2527.55	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.27	Wt. n-Val.		0.030	
W.S. Elev (ft)	2527.28	Reach Len. (ft)	50.00	50.00	50.00
Crit W.S. (ft)	2527.23	Flow Area (sq ft)		31.62	
E.G. Slope (ft/ft)	0.012699	Area (sq ft)	17.99	31.62	
Q Total (cfs)	131.00	Flow (cfs)		131.00	

Top Width (ft)	98.35	Top Width (ft)	50.08	48.27
Vel Total (ft/s)	4.14	Avg. Vel. (ft/s)		4.14
Max Chl Dpth (ft)	1.15	Hydr. Depth (ft)		0.66
Conv. Total (cfs)	1162.5	Conv. (cfs)		1162.5
Length Wtd. (ft)	50.00	Wetted Per. (ft)		49.46
Min Ch El (ft)	2526.13	Shear (lb/sq ft)		0.51
Alpha	1.00	Stream Power (lb/ft s)		2.10
Frctn Loss (ft)	0.38	Cum Volume (acre-ft)	0.37	0.24
C & E Loss (ft)	0.04	Cum SA (acres)	0.38	0.27

Warning: Divided flow computed for this cross-section.
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.

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 5350

INPUT
Description:
Station Elevation Data num= 74

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
1000.48	2527	1000.98	2527	1001.1	2526.5	1035.22	2525.82	1035.29	2525.81
1041.95	2525.68	1042.85	2525.66	1051.5	2525.49	1051.63	2525.99	1052.13	2525.99
1053.65	2526.02	1055.5	2526.06	1060.21	2526.15	1061.5	2526.18	1062.5	2526.2
1065.2	2527.1	1067.2	2527.1	1067.29	2527.07	1070.08	2526.15	1071.99	2526.08
1072.28	2526.08	1072.34	2526.1	1072.45	2526.11	1072.48	2526.11	1072.51	2526.11
1072.97	2526.14	1073.45	2526.11	1073.83	2526.09	1074.3	2526.06	1074.59	2526.05
1075.16	2526.04	1075.98	2525.97	1076.94	2525.9	1083.88	2525.91	1084	2525.91
1084.15	2525.91	1084.22	2525.91	1085.41	2525.96	1092.62	2526.23	1093.75	2526.22
1095.42	2526.21	1106.31	2526.15	1112.3	2526.34	1120.97	2526.53	1130.28	2528.32
1131.28	2528.53	1131.68	2528.66	1135.73	2530.38	1139.29	2530.39	1140.19	2530.42
1142.61	2530.44	1151.98	2530.62	1153.64	2530.67	1155.49	2530.76	1156.74	2530.78
1158.42	2530.64	1164.39	2530.65	1176.34	2529.91	1177.94	2529.94	1185.87	2530.68
1186.16	2530.4	1191.19	2530.38	1196.08	2530.6	1199.7	2530.7	1201.41	2530.67
1203.28	2530.65	1215.21	2530.62	1216.32	2530.6	1216.51	2531.07	1216.52	2531.1
1217.27	2531.1	1222.54	2531.09	1222.56	2531.03	1222.74	2530.59		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
1000.48	.03	1075.98	.03	1140.19	.03

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
1075.98	1140.19	50	50	50	.1	.3

Ineffective Flow num= 1

Sta L	Sta R	Elev	Permanent
1000.48	1065.2	2527.1	T

CROSS SECTION OUTPUT Profile #PF 1

E.G. Elev (ft)	2527.13	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.14	Wt. n-Val.	0.030	0.030	
W.S. Elev (ft)	2526.99	Reach Len. (ft)	50.00	50.00	50.00
Crit W.S. (ft)		Flow Area (sq ft)	6.39	37.31	
E.G. Slope (ft/ft)	0.005100	Area (sq ft)	67.27	37.31	
Q Total (cfs)	131.00	Flow (cfs)	18.55	112.45	
Top Width (ft)	119.69	Top Width (ft)	72.32	47.37	
Vel Total (ft/s)	3.00	Avg. Vel. (ft/s)	2.90	3.01	
Max Chl Dpth (ft)	1.50	Hydr. Depth (ft)	0.76	0.79	
Conv. Total (cfs)	1834.4	Conv. (cfs)	259.7	1574.7	
Length Wtd. (ft)	50.00	Wetted Per. (ft)	8.59	47.43	
Min Ch El (ft)	2525.90	Shear (lb/sq ft)	0.24	0.25	
Alpha	1.00	Stream Power (lb/ft s)	0.69	0.75	
Frctn Loss (ft)	0.32	Cum Volume (acre-ft)	0.32	0.20	
C & E Loss (ft)	0.01	Cum SA (acres)	0.31	0.21	

Warning: Divided flow computed for this cross-section.

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 5300

INPUT
Description:
Station Elevation Data num= 54

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
1000	2526.03	1054	2524.95	1054.13	2525.45	1054.63	2525.45	1058	2525.52
1064	2525.64	1065	2525.66	1068.6	2526.86	1070.6	2526.86	1070.69	2526.83
1074.8	2525.47	1074.87	2525.46	1074.92	2525.45	1075.98	2525.48	1076.87	2525.5
1086.46	2525.6	1092.39	2525.66	1096.86	2525.72	1101.98	2525.77	1110.63	2526.11
1112.25	2526.19	1116.02	2527.11	1118.84	2527.69	1124.99	2529.84	1125.58	2530.05
1126.42	2530.09	1129.71	2530.28	1130.88	2530.33	1137.95	2528.79	1139.55	2528.45
1145.28	2527.23	1146.18	2527.03	1147.37	2527.06	1151.08	2527.15	1163.48	2527.32
1178.17	2527.62	1178.64	2527.63	1179.37	2527.65	1190.65	2527.99	1192.68	2528.05
1194.07	2528.08	1199.66	2528.41	1200.22	2528.43	1203.86	2528.57	1204.22	2528.57
1204.27	2528.57	1208.47	2528.66	1209.25	2528.68	1213.41	2528.76	1214.35	2528.8
1217.08	2528.9	1219.28	2528.97	1221.04	2529.01	1223.13	2529.13		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
1000	.03	1070.6	.03	1129.71	.03

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
1070.6	1129.71	50	50	50	.1	.3

Ineffective Flow num= 1

Sta L	Sta R	Elev	Permanent
1000	1068.6	2526.86	T

CROSS SECTION OUTPUT Profile #PF 1

			Left OB	Channel	Right OB
E.G. Elev (ft)	2526.80	Element			
Vel Head (ft)	0.23	Wt. n-Val.		0.030	
W.S. Elev (ft)	2526.57	Reach Len. (ft)	50.00	50.00	50.00
Crit W.S. (ft)		Flow Area (sq ft)		34.11	
E.G. Slope (ft/ft)	0.008083	Area (sq ft)	70.94	34.11	
Q Total (cfs)	131.00	Flow (cfs)		131.00	
Top Width (ft)	110.08	Top Width (ft)	67.74	42.34	
Vel Total (ft/s)	3.84	Avg. Vel. (ft/s)		3.84	
Max Chl Dpth (ft)	1.62	Hydr. Depth (ft)		0.81	
Conv. Total (cfs)	1457.1	Conv. (cfs)		1457.1	
Length Wtd. (ft)	50.00	Wetted Per. (ft)		42.58	
Min Ch El (ft)	2525.45	Shear (lb/sq ft)		0.40	
Alpha	1.00	Stream Power (lb/ft s)		1.55	
Frctn Loss (ft)	0.27	Cum Volume (acre-ft)	0.24	0.16	
C & E Loss (ft)	0.02	Cum SA (acres)	0.23	0.16	

Warning: Divided flow computed for this cross-section.
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.

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 5250

INPUT
Description:
Station Elevation Data num= 56

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
1000	2525.68	1018.69	2525.3	1020.99	2525.26	1035.66	2524.96	1036.05	2524.96
1045.63	2524.76	1046.92	2524.74	1054	2524.6	1054.12	2525.1	1054.62	2525.1

```
    1058 2525.16    1064 2525.28    1065  2525.3  1068.6  2526.5  1070.6  2526.5
 1070.69 2526.47 1072.76 2525.79 1075.03 2525.04 1075.24 2524.98 1075.31 2524.97
 1075.58 2524.92 1076.39 2524.98  1076.6 2525.07 1076.66 2525.05  1076.7 2525.05
 1082.69 2525.08 1090.45 2525.08 1093.54 2525.13 1098.78  2525.2 1104.06 2525.53
 1111.55 2526.04 1114.77 2526.76  1116.6  2527.2 1124.99 2529.92 1125.93 2530.21
 1126.01 2530.23 1126.25 2530.26  1127.1 2530.28 1132.67 2530.44 1137.92 2529.06
  1140.4 2528.39 1143.51 2527.68 1146.02 2527.13 1149.99  2527.2 1158.99 2527.31
 1167.33 2527.47 1173.81 2527.57 1176.71 2527.65 1204.16 2528.11 1204.38 2528.12
 1205.11 2528.14 1206.61 2528.22 1208.25 2528.27 1213.45 2528.25 1214.21 2528.27
 1224.44 2528.53

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
    1000     .03  1070.6     .03  1127.1     .03

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
        1070.6  1127.1               50      50      50              .1       .3
Ineffective Flow     num=       1
   Sta L   Sta R    Elev  Permanent
    1000  1068.6  2526.5       T

CROSS SECTION OUTPUT  Profile #PF 1

  E.G. Elev (ft)           2526.51    Element                   Left OB    Channel   Right OB
  Vel Head (ft)               0.15    Wt. n-Val.                           0.030
  W.S. Elev (ft)           2526.36    Reach Len. (ft)            50.00      50.00      50.00
  Crit W.S. (ft)                      Flow Area (sq ft)                     42.67
  E.G. Slope (ft/ft)      0.003796    Area (sq ft)               80.76      42.67
  Q Total (cfs)             131.00    Flow (cfs)                           131.00
  Top Width (ft)            110.16    Top Width (ft)             68.19      41.97
  Vel Total (ft/s)            3.07    Avg. Vel. (ft/s)                      3.07
  Max Chl Dpth (ft)           1.76    Hydr. Depth (ft)                      1.02
  Conv. Total (cfs)         2126.2    Conv. (cfs)                          2126.2
  Length Wtd. (ft)           50.00    Wetted Per. (ft)                     42.29
  Min Ch El (ft)           2524.92    Shear (lb/sq ft)                      0.24
  Alpha                       1.00    Stream Power (lb/ft s)                0.73
  Frctn Loss (ft)             0.13    Cum Volume (acre-ft)        0.16      0.12
  C & E Loss (ft)             0.02    Cum SA (acres)              0.16      0.11


Warning: Divided flow computed for this cross-section.
Warning: The cross-section end points had to be extended vertically for the computed water surface.

CROSS SECTION


RIVER: River #1
REACH: Reach #1           RS: 5200

INPUT
Description:
Station Elevation Data    num=      44
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
    1000 2525.63    1054 2524.55 1054.12 2525.05 1054.62 2525.05    1058 2525.12
    1064 2525.24    1065 2525.26  1068.6 2526.46  1070.6 2526.46 1070.69 2526.43
 1076.42 2524.54 1076.61 2524.54 1078.94 2524.55 1086.66 2524.64 1089.39 2524.71
 1090.26 2524.74  1091.6  2524.8 1096.35 2525.05 1101.47 2525.15 1106.17 2525.25
 1109.06 2525.44 1113.89 2525.75 1116.89 2525.95 1117.98 2526.02 1123.96 2527.34
 1125.07 2527.59 1131.48 2529.63 1133.97 2530.42  1138.2  2530.7 1138.75 2530.73
 1144.47 2529.25 1147.79 2528.44 1153.22 2527.33 1154.31 2527.11 1155.28 2526.93
 1160.32 2526.91 1177.08 2527.17 1182.34 2527.24 1186.56 2527.35 1201.25 2527.66
 1208.74 2527.86 1214.97 2528.11 1223.26 2528.35  1223.9 2528.37

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
    1000     .03  1070.6     .03  1138.2     .03

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
        1070.6  1138.2               50      50      50              .1       .3
Ineffective Flow     num=       1
```

Sta L	Sta R	Elev	Permanent
1000	1068.6	2526.46	T

CROSS SECTION OUTPUT Profile #PF 1

E.G. Elev (ft)	2526.36	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.09	Wt. n-Val.		0.030	
W.S. Elev (ft)	2526.27	Reach Len. (ft)	50.00	50.00	50.00
Crit W.S. (ft)		Flow Area (sq ft)		54.44	
E.G. Slope (ft/ft)	0.002010	Area (sq ft)	77.41	54.44	
Q Total (cfs)	131.00	Flow (cfs)		131.00	
Top Width (ft)	115.94	Top Width (ft)	68.02	47.92	
Vel Total (ft/s)	2.41	Avg. Vel. (ft/s)		2.41	
Max Chl Dpth (ft)	1.73	Hydr. Depth (ft)		1.14	
Conv. Total (cfs)	2922.1	Conv. (cfs)		2922.1	
Length Wtd. (ft)	50.00	Wetted Per. (ft)		48.26	
Min Ch El (ft)	2524.54	Shear (lb/sq ft)		0.14	
Alpha	1.00	Stream Power (lb/ft s)		0.34	
Frctn Loss (ft)	0.19	Cum Volume (acre-ft)	0.07	0.06	
C & E Loss (ft)	0.01	Cum SA (acres)	0.08	0.06	

Warning: Divided flow computed for this cross-section.
Warning: The cross-section end points had to be extended vertically for the computed water surface.

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 5150

INPUT
Description:
Station Elevation Data num= 74

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
1000	2525.91	1003.61	2525.84	1027.39	2525.36	1028.54	2525.34	1034.08	2525.23
1034.2	2525.22	1054	2524.83	1054.13	2525.33	1054.63	2525.33	1058	2525.4
1059.04	2525.42	1059.61	2525.43	1064	2525.52	1065	2525.54	1068.6	2526.74
1070.6	2526.74	1070.69	2526.71	1077.73	2524.38	1077.79	2524.37	1078.03	2524.4
1078.25	2524.39	1089.57	2524.65	1091.38	2524.69	1092.6	2524.72	1104.43	2525.05
1107.03	2525.15	1111.33	2525.31	1113.64	2525.38	1115.61	2525.4	1116.18	2525.41
1119.43	2525.46	1121.96	2525.49	1126.59	2525.56	1127.25	2525.57	1128.22	2525.61
1134.1	2526.03	1137.23	2526.17	1139	2526.45	1142.5	2526.92	1145.67	2527.36
1147.21	2527.56	1151.25	2528.1	1154.2	2528.92	1158.47	2529.64	1159.63	2529.86
1161.07	2530.06	1164.68	2530.2	1165.21	2530.23	1167.93	2530.33	1169.2	2530.36
1170.67	2530.4	1172.59	2530.45	1174.23	2530.48	1175.76	2530.55	1179.99	2530.6
1181.08	2530.61	1185.32	2530.65	1186.07	2530.66	1190.3	2530.69	1191.02	2530.69
1194.86	2530.73	1195.72	2530.73	1200.34	2530.76	1201.48	2530.75	1204.87	2530.76
1205.87	2530.77	1209.91	2530.7	1210.57	2530.7	1214.03	2530.7	1214.57	2530.7
1217.57	2530.72	1218.28	2530.72	1222.23	2530.78	1225.03	2530.79		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
1000	.03	1070.6	.03	1142.5	.03

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
1070.6	1142.5	50	50	50	.1	.3

Ineffective Flow num= 1

Sta L	Sta R	Elev	Permanent
1000	1068.6	2526.74	T

CROSS SECTION OUTPUT Profile #PF 1

E.G. Elev (ft)	2526.15	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.21	Wt. n-Val.		0.030	
W.S. Elev (ft)	2525.94	Reach Len. (ft)			
Crit W.S. (ft)	2525.74	Flow Area (sq ft)		50.92	
E.G. Slope (ft/ft)	0.007006	Area (sq ft)	36.70	50.92	
Q Total (cfs)	189.00	Flow (cfs)		189.00	
Top Width (ft)	126.02	Top Width (ft)	66.20	59.82	

Vel Total (ft/s)	3.71	Avg. Vel. (ft/s)	3.71
Max Chl Dpth (ft)	1.57	Hydr. Depth (ft)	0.85
Conv. Total (cfs)	2257.9	Conv. (cfs)	2257.9
Length Wtd. (ft)		Wetted Per. (ft)	60.10
Min Ch El (ft)	2524.37	Shear (lb/sq ft)	0.37
Alpha	1.00	Stream Power (lb/ft s)	1.38
Frctn Loss (ft)		Cum Volume (acre-ft)	
C & E Loss (ft)		Cum SA (acres)	

Warning: Divided flow computed for this cross-section.

SUMMARY OF MANNING'S N VALUES

River:River #1

Reach	River Sta.	n1	n2	n3
Reach #1	6100	.03	.03	.03
Reach #1	6050	.03	.03	.03
Reach #1	6000	.03	.03	.03
Reach #1	5950	.03	.03	.03
Reach #1	5900	.03	.03	.03
Reach #1	5850	.03	.03	.03
Reach #1	5800	.03	.03	.03
Reach #1	5750	.03	.03	.03
Reach #1	5700	.03	.03	.03
Reach #1	5650	.03	.03	.03
Reach #1	5600	.03	.03	.03
Reach #1	5550	.03	.03	.03
Reach #1	5500	.03	.03	.03
Reach #1	5450	.03	.03	.03
Reach #1	5400	.03	.03	.03
Reach #1	5350	.03	.03	.03
Reach #1	5300	.03	.03	.03
Reach #1	5250	.03	.03	.03
Reach #1	5200	.03	.03	.03
Reach #1	5150	.03	.03	.03

SUMMARY OF REACH LENGTHS

River: River #1

Reach	River Sta.	Left	Channel	Right
Reach #1	6100	50	50	50
Reach #1	6050	50	50	50
Reach #1	6000	50	50	50
Reach #1	5950	50	50	50
Reach #1	5900	50	50	50
Reach #1	5850	50	50	50
Reach #1	5800	50	50	50
Reach #1	5750	50	50	50
Reach #1	5700	50	50	50
Reach #1	5650	50	50	50
Reach #1	5600	50	50	50
Reach #1	5550	50	50	50
Reach #1	5500	50	50	50
Reach #1	5450	50	50	50
Reach #1	5400	50	50	50
Reach #1	5350	50	50	50
Reach #1	5300	50	50	50
Reach #1	5250	50	50	50
Reach #1	5200	50	50	50
Reach #1	5150	50	50	50

SUMMARY OF CONTRACTION AND EXPANSION COEFFICIENTS
River: River #1

Reach	River Sta.	Contr.	Expan.
Reach #1	6100	.1	.3
Reach #1	6050	.1	.3
Reach #1	6000	.1	.3
Reach #1	5950	.1	.3
Reach #1	5900	.1	.3
Reach #1	5850	.1	.3
Reach #1	5800	.1	.3
Reach #1	5750	.1	.3
Reach #1	5700	.1	.3
Reach #1	5650	.1	.3
Reach #1	5600	.1	.3
Reach #1	5550	.1	.3
Reach #1	5500	.1	.3
Reach #1	5450	.1	.3
Reach #1	5400	.1	.3
Reach #1	5350	.1	.3
Reach #1	5300	.1	.3
Reach #1	5250	.1	.3
Reach #1	5200	.1	.3
Reach #1	5150	.1	.3

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	6100	PF 1	62.00	2533.05	2533.77		2533.90	0.010863	2.84	21.84	134.66	0.78
Reach #1	6050	PF 1	62.00	2532.70	2533.28		2533.39	0.009628	2.66	23.32	128.25	0.74
Reach #1	6000	PF 1	62.00	2532.00	2532.56	2532.56	2532.73	0.018803	3.29	18.82	116.75	1.00
Reach #1	5950	PF 1	62.00	2531.11	2531.95		2532.01	0.003787	1.96	31.69	89.55	0.48
Reach #1	5900	PF 1	62.00	2530.71	2531.83		2531.89	0.001688	1.96	31.60	58.89	0.35
Reach #1	5850	PF 1	62.00	2530.37	2531.82		2531.84	0.000382	1.09	56.77	89.61	0.17
Reach #1	5800	PF 1	115.00	2530.26	2531.25	2531.25	2531.71	0.013860	4.85	21.47	40.97	0.97
Reach #1	5750	PF 1	115.00	2529.55	2530.70	2530.70	2530.97	0.010625	4.53	30.49	71.05	0.87
Reach #1	5700	PF 1	115.00	2528.96	2529.85	2529.81	2530.10	0.012986	4.05	28.61	49.89	0.91
Reach #1	5650	PF 1	115.00	2528.39	2529.23	2529.19	2529.44	0.012842	3.65	31.49	59.93	0.89
Reach #1	5600	PF 1	115.00	2527.47	2528.78	2528.64	2528.93	0.007877	3.03	37.93	66.01	0.70
Reach #1	5550	PF 1	115.00	2527.43	2528.13	2528.13	2528.36	0.016911	3.90	29.46	62.40	1.00
Reach #1	5500	PF 1	115.00	2526.80	2527.92		2528.00	0.002976	2.31	49.71	62.56	0.46
Reach #1	5450	PF 1	115.00	2526.60	2527.76		2527.85	0.003012	2.37	48.51	80.72	0.46
Reach #1	5400	PF 1	131.00	2526.13	2527.28	2527.23	2527.55					

```
0.012699       4.14       31.62       98.35           0.90
  Reach #1      5350          PF 1       131.00     2525.90     2526.99                 2527.13
0.005100       3.01       43.69      119.69           0.60
  Reach #1      5300          PF 1       131.00     2525.45     2526.57                 2526.80
0.008083       3.84       34.11      110.08           0.75
  Reach #1      5250          PF 1       131.00     2524.92     2526.36                 2526.51
0.003796       3.07       42.67      110.16           0.54
  Reach #1      5200          PF 1       131.00     2524.54     2526.27                 2526.36
0.002010       2.41       54.44      115.94           0.40
  Reach #1      5150          PF 1       189.00     2524.37     2525.94     2525.74     2526.15
0.007006       3.71       50.92      126.02           0.71
```

Profile Output Table - Standard Table 2

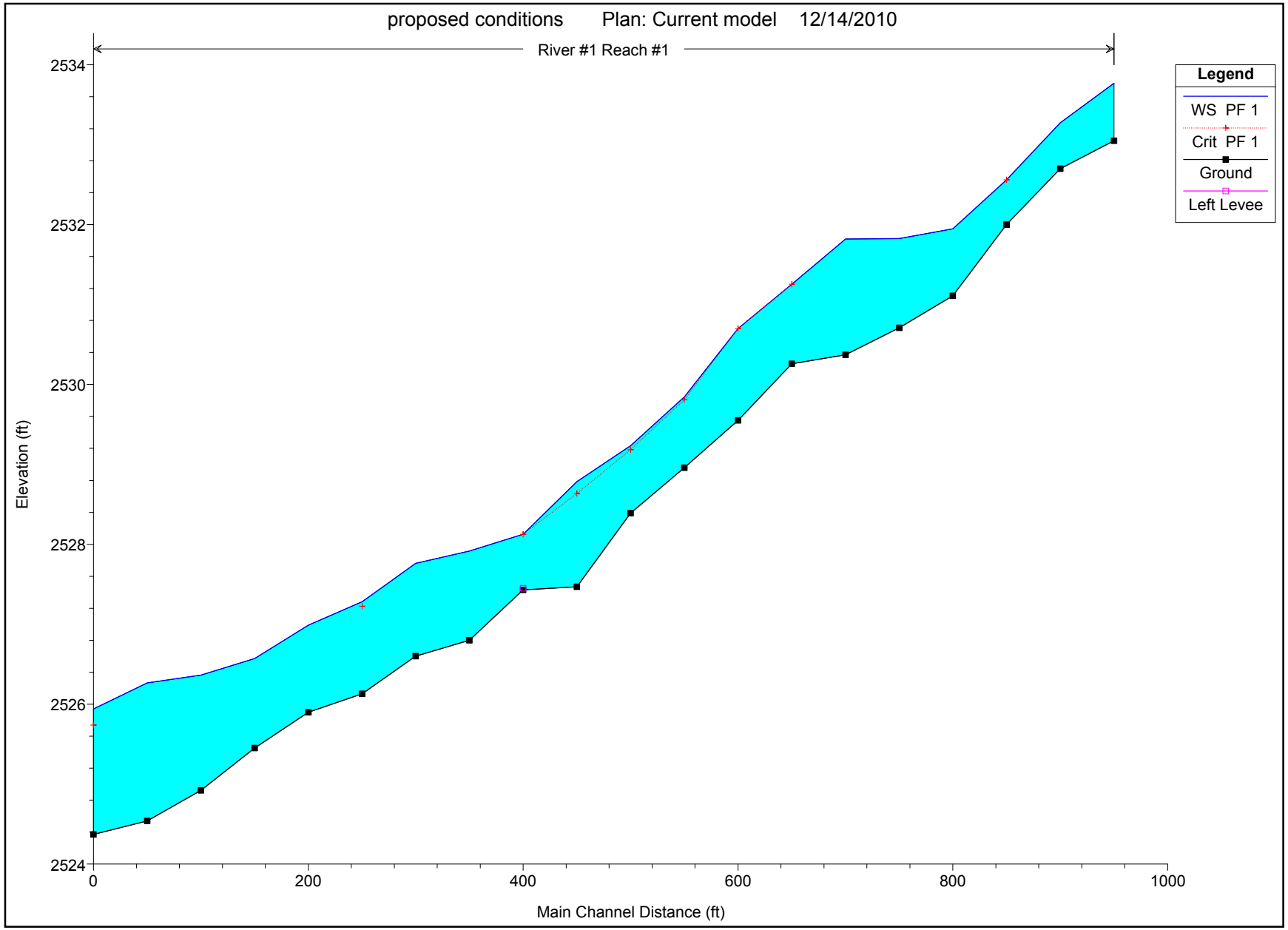
```
  Reach         River Sta     Profile   E.G. Elev   W.S. Elev   Vel Head   Frctn Loss   C & E Loss   Q
Left   Q Channel   Q Right   Top Width
                                            (ft)        (ft)       (ft)         (ft)         (ft)
(cfs)       (cfs)     (cfs)        (ft)


  Reach #1      6100          PF 1        2533.90     2533.77       0.13         0.51         0.00
       62.00                134.66
  Reach #1      6050          PF 1        2533.39     2533.28       0.11         0.65         0.01
       62.00                128.25
  Reach #1      6000          PF 1        2532.73     2532.56       0.17         0.36         0.03
       62.00                116.75
  Reach #1      5950          PF 1        2532.01     2531.95       0.06         0.12         0.00
       62.00                 89.55
  Reach #1      5900          PF 1        2531.89     2531.83       0.06         0.04         0.01
       62.00                 58.89
  Reach #1      5850          PF 1        2531.84     2531.82       0.02         0.09         0.04
       62.00                 89.61
  Reach #1      5800          PF 1        2531.71     2531.25       0.45         0.60         0.05
       33.09     81.91       40.97
  Reach #1      5750          PF 1        2530.97     2530.70       0.27         0.59         0.00
       90.48     24.52       71.05
  Reach #1      5700          PF 1        2530.10     2529.85       0.25         0.65         0.01
      114.74      0.26       49.89
  Reach #1      5650          PF 1        2529.44     2529.23       0.21         0.50         0.02
      115.00                 59.93
  Reach #1      5600          PF 1        2528.93     2528.78       0.14         0.56         0.01
      115.00                 66.01
  Reach #1      5550          PF 1        2528.36     2528.13       0.24         0.30         0.05
      115.00                 62.40
  Reach #1      5500          PF 1        2528.00     2527.92       0.08         0.15         0.00
      115.00                 62.56
  Reach #1      5450          PF 1        2527.85     2527.76       0.09         0.29         0.02
      115.00                 80.72
  Reach #1      5400          PF 1        2527.55     2527.28       0.27         0.38         0.04
      131.00                 98.35
  Reach #1      5350          PF 1        2527.13     2526.99       0.14         0.32         0.01
18.55      112.45                119.69
  Reach #1      5300          PF 1        2526.80     2526.57       0.23         0.27         0.02
      131.00                110.08
  Reach #1      5250          PF 1        2526.51     2526.36       0.15         0.13         0.02
      131.00                110.16
  Reach #1      5200          PF 1        2526.36     2526.27       0.09         0.19         0.01
      131.00                115.94
  Reach #1      5150          PF 1        2526.15     2525.94       0.21
      189.00                126.02
```

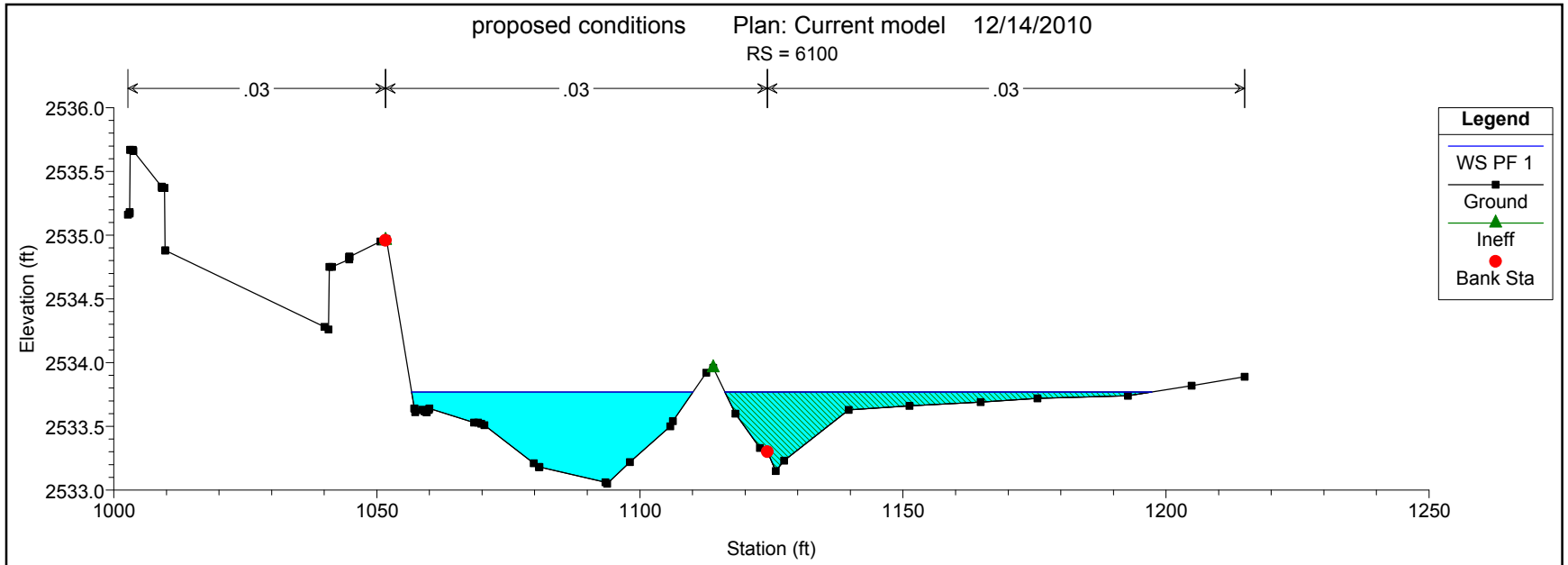
ERRORS WARNINGS AND NOTES

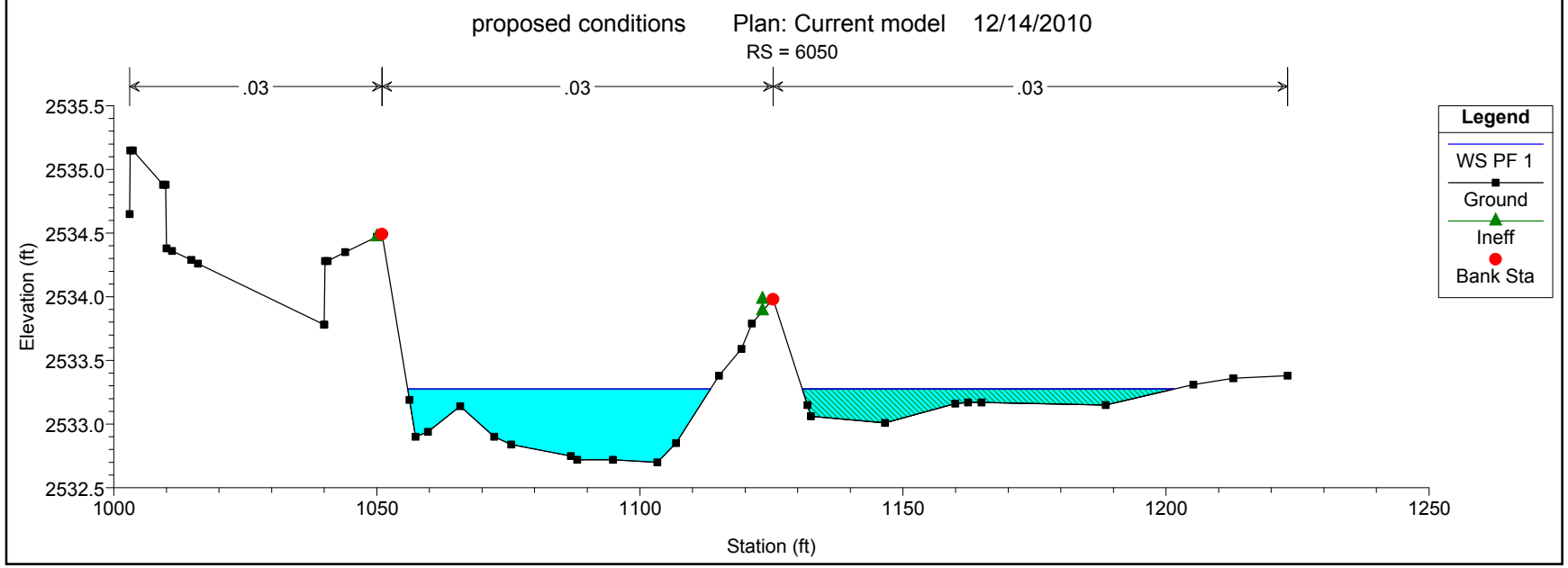
Errors Warnings and Notes for Plan : Current mode

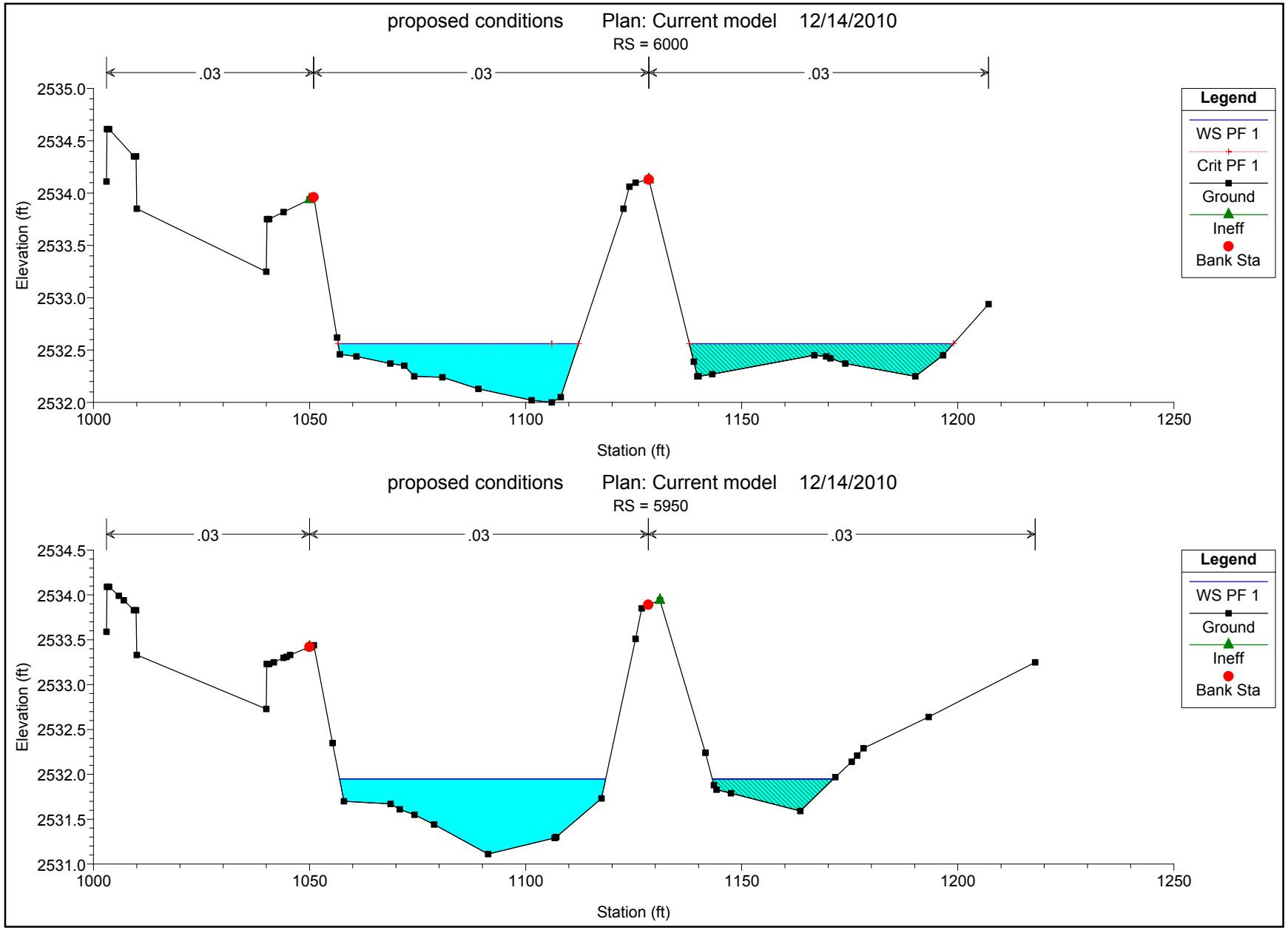
River: River #1 Reach: Reach #1 RS: 6100 Profile: PF 1
Warning:Divided flow computed for this cross-section.
River: River #1 Reach: Reach #1 RS: 6050 Profile: PF 1
Warning:Divided flow computed for this cross-section.
River: River #1 Reach: Reach #1 RS: 6000 Profile: PF 1
Warning:The energy equation could not be balanced within the specified number of iterations. The program used critical depth
for the water surface and continued on with the calculations.
Warning:Divided flow computed for this cross-section.
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.
Warning:During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated
water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The
program defaulted to critical depth.
River: River #1 Reach: Reach #1 RS: 5950 Profile: PF 1
Warning:Divided flow computed for this cross-section.
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: 5900 Profile: PF 1
Warning:Divided flow computed for this cross-section.
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: 5850 Profile: PF 1
Warning:Divided flow computed for this cross-section.
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: 5800 Profile: PF 1
Warning:The energy equation could not be balanced within the specified number of iterations. The program used critical depth
for the water surface and continued on with the calculations.
Warning:Divided flow computed for this cross-section.
Warning:During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated
water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The
program defaulted to critical depth.
River: River #1 Reach: Reach #1 RS: 5750 Profile: PF 1
Warning:The energy equation could not be balanced within the specified number of iterations. The program used critical depth
for the water surface and continued on with the calculations.
Warning:Divided flow computed for this cross-section.
Warning:During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated
water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The
program defaulted to critical depth.
River: River #1 Reach: Reach #1 RS: 5600 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: 5550 Profile: PF 1
Warning:The energy equation could not be balanced within the specified number of iterations. The program used critical depth
for the water surface and continued on with the calculations.
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.
Warning:Critical depth could not be determined within the specified number of iterations. The program used the iteration
with the lowest energy.
Warning:During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated
water surface came back below critical depth. This indicates that there is not a valid

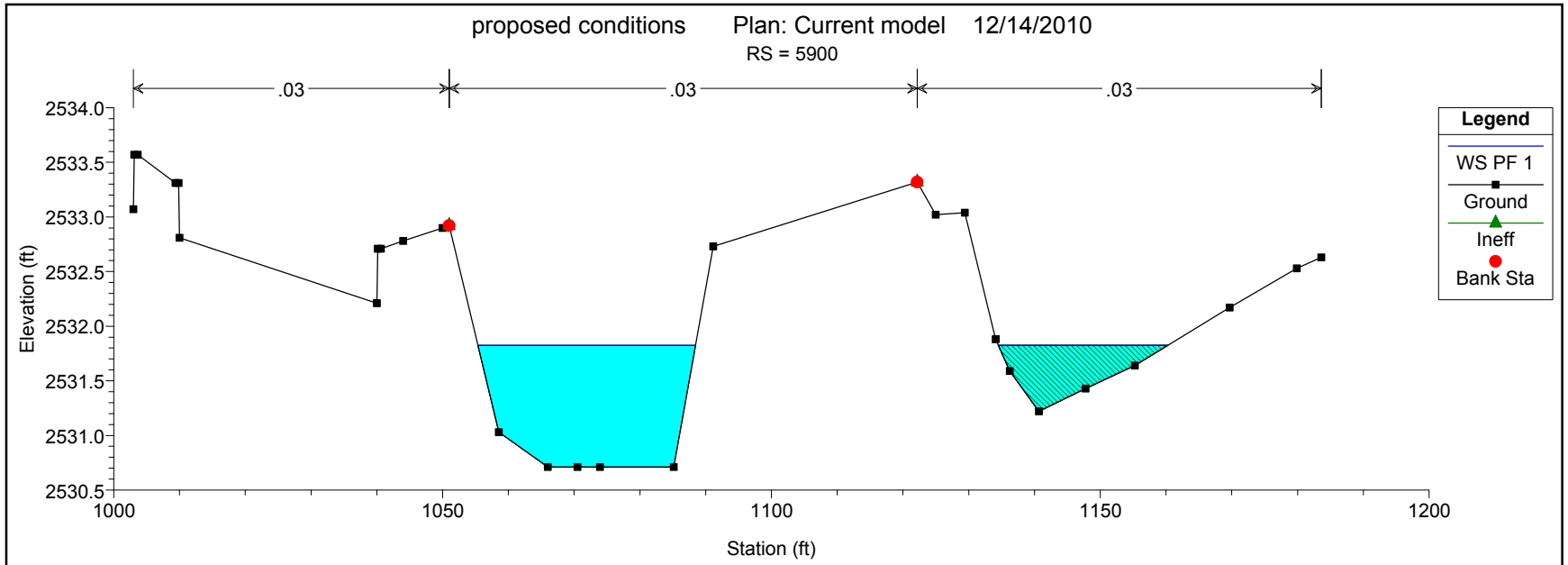
subcritical answer. The
program defaulted to critical depth.
River: River #1 Reach: Reach #1 RS: 5450 Profile: PF 1
Warning:Divided flow computed for this cross-section.
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: River #1 Reach: Reach #1 RS: 5400 Profile: PF 1
Warning:Divided flow computed for this cross-section.
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: 5350 Profile: PF 1
Warning:Divided flow computed for this cross-section.
River: River #1 Reach: Reach #1 RS: 5300 Profile: PF 1
Warning:Divided flow computed for this cross-section.
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: 5250 Profile: PF 1
Warning:Divided flow computed for this cross-section.
Warning:The cross-section end points had to be extended vertically for the computed water surface.
River: River #1 Reach: Reach #1 RS: 5200 Profile: PF 1
Warning:Divided flow computed for this cross-section.
Warning:The cross-section end points had to be extended vertically for the computed water surface.
River: River #1 Reach: Reach #1 RS: 5150 Profile: PF 1
Warning:Divided flow computed for this cross-section.

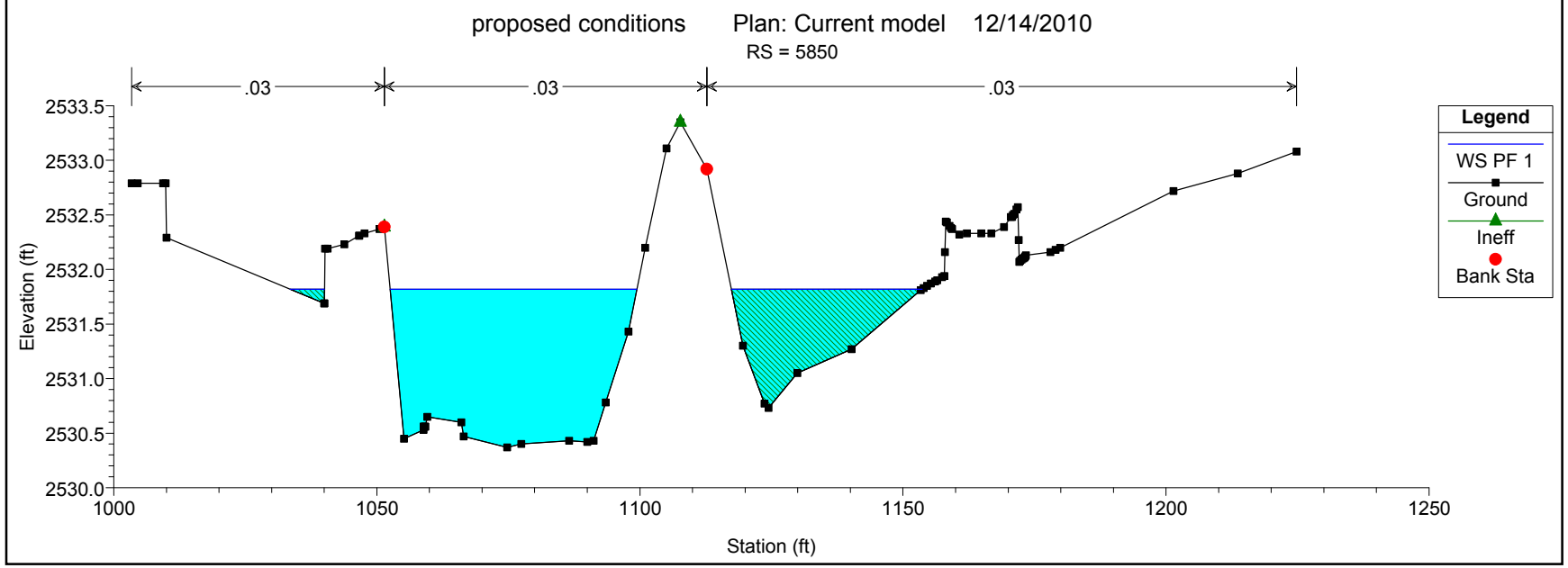

proposed conditions Plan: Current model 12/14/2010
River #1 Reach #1
Legend
WS PF 1
Crit PF 1
Ground
Left Levee
Elevation (ft)
2534
2532
2530
2528
2526
2524
0
200
400
600
800
1000
Main Channel Distance (ft)

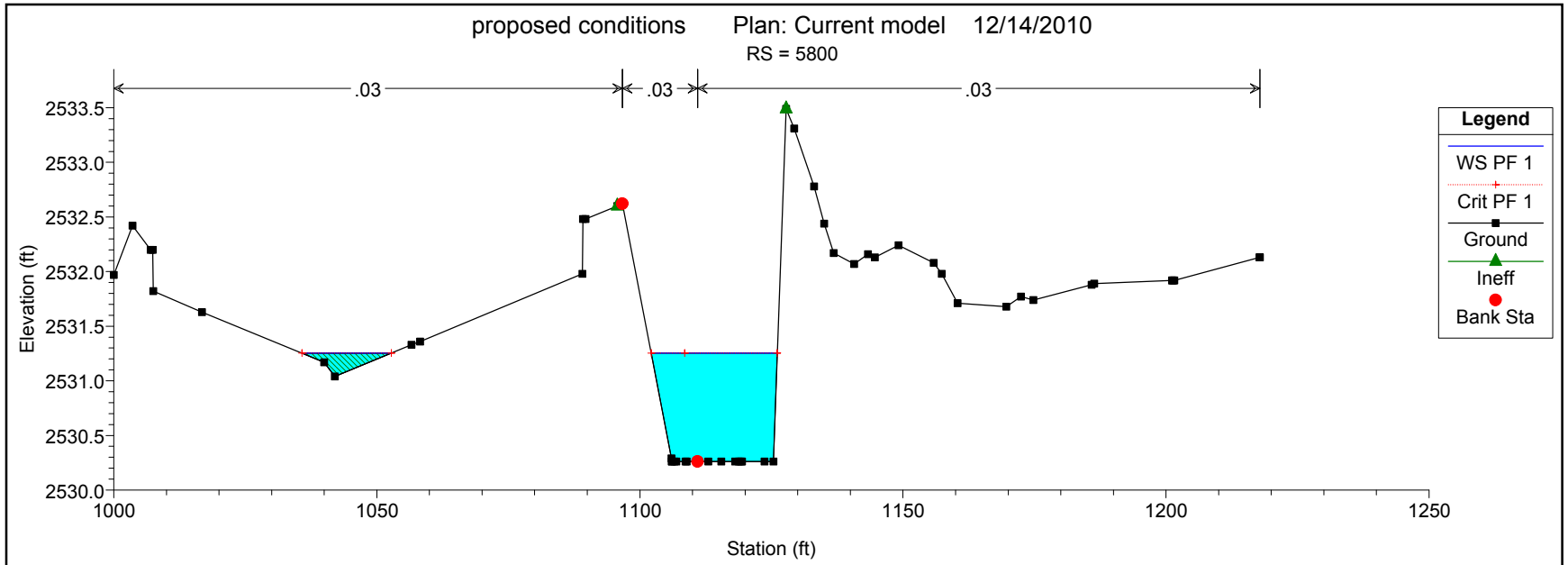

proposed conditions Plan: Current model 12/14/2010
RS = 6100
.03
.03
.03
Elevation (ft)
2536.0
2535.5
2535.0
2534.5
2534.0
2533.5
2533.0
1000
1050
1100
1150
1200
1250
Station (ft)
Legend
WS PF 1
Ground
Ineff
Bank Sta

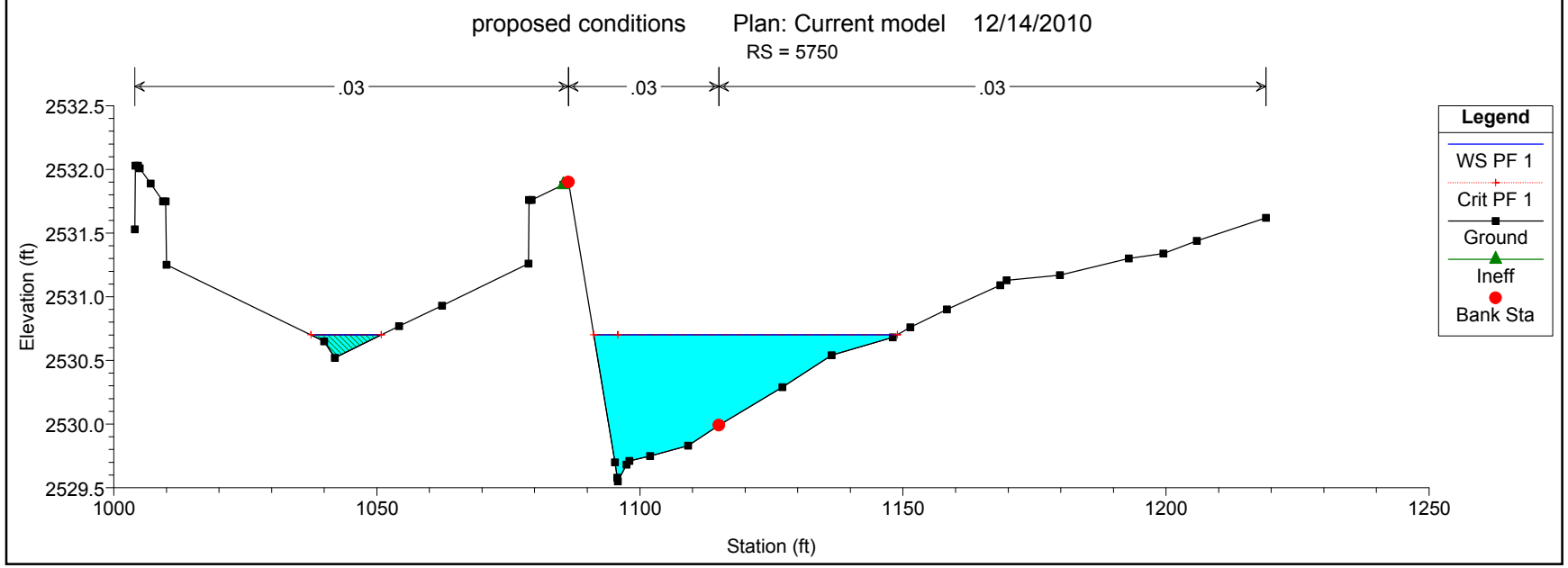

proposed conditions Plan: Current model 12/14/2010
RS = 6050
.03
.03
.03
Elevation (ft)
2535.5
2535.0
2534.5
2534.0
2533.5
2533.0
2532.5
1000
1050
1100
1150
1200
1250
Station (ft)
Legend
WS PF 1
Ground
Ineff
Bank Sta

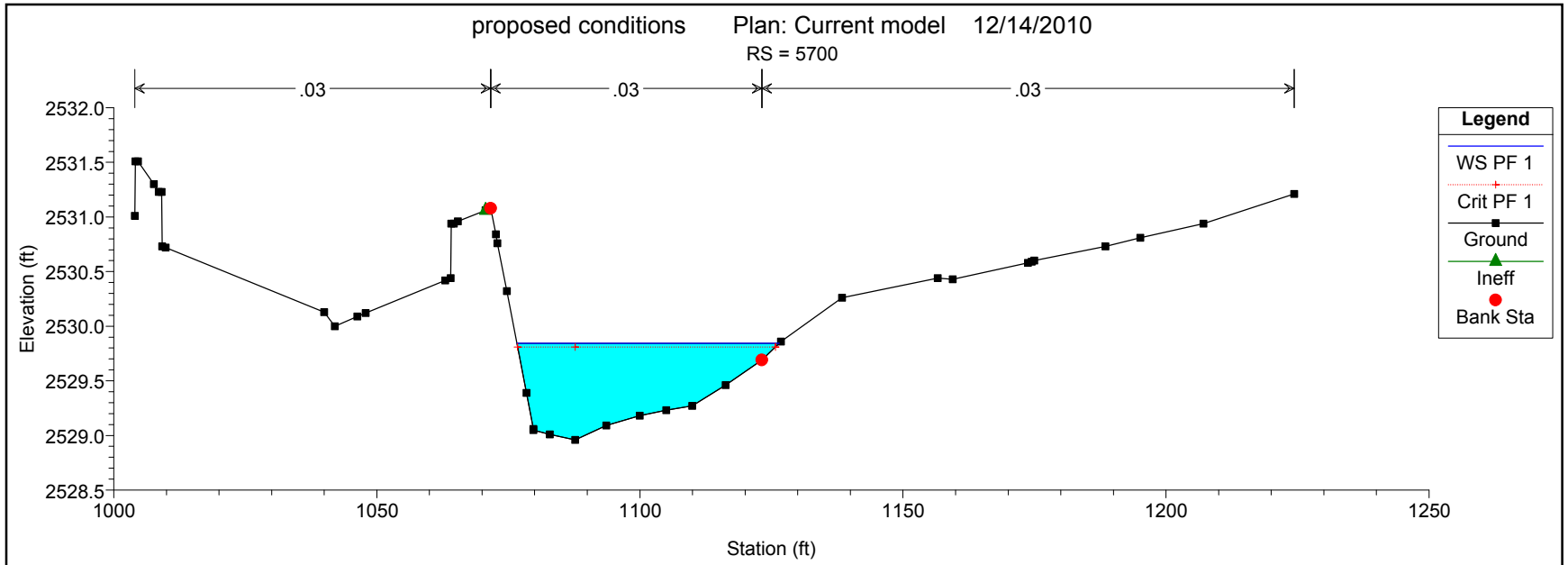

proposed conditions Plan: Current model 12/14/2010
RS = 6000
.03
.03
.03
Elevation (ft)
2535.0
2534.5
2534.0
2533.5
2533.0
2532.5
2532.0
1000
1050
1100
1150
1200
1250
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Ineff
Bank Sta
proposed conditions Plan: Current model 12/14/2010
RS = 5950
.03
.03
.03
Elevation (ft)
2534.5
2534.0
2533.5
2533.0
2532.5
2532.0
2531.5
2531.0
1000
1050
1100
1150
1200
1250
Station (ft)
Legend
WS PF 1
Ground
Ineff
Bank Sta

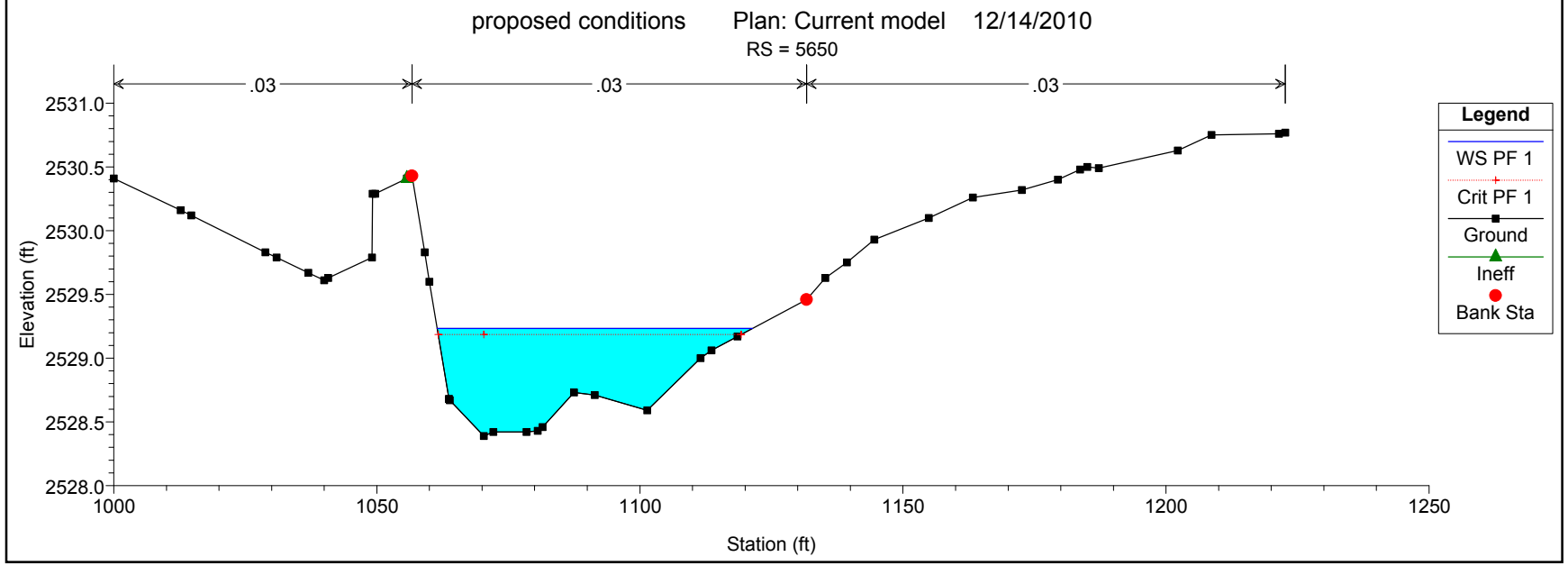

proposed conditions Plan: Current model 12/14/2010
RS = 5900
.03
.03
.03
Elevation (ft)
2534.0
2533.5
2533.0
2532.5
2532.0
2531.5
2531.0
2530.5
1000
1050
1100
1150
1200
Station (ft)
Legend
WS PF 1
Ground
Ineff
Bank Sta

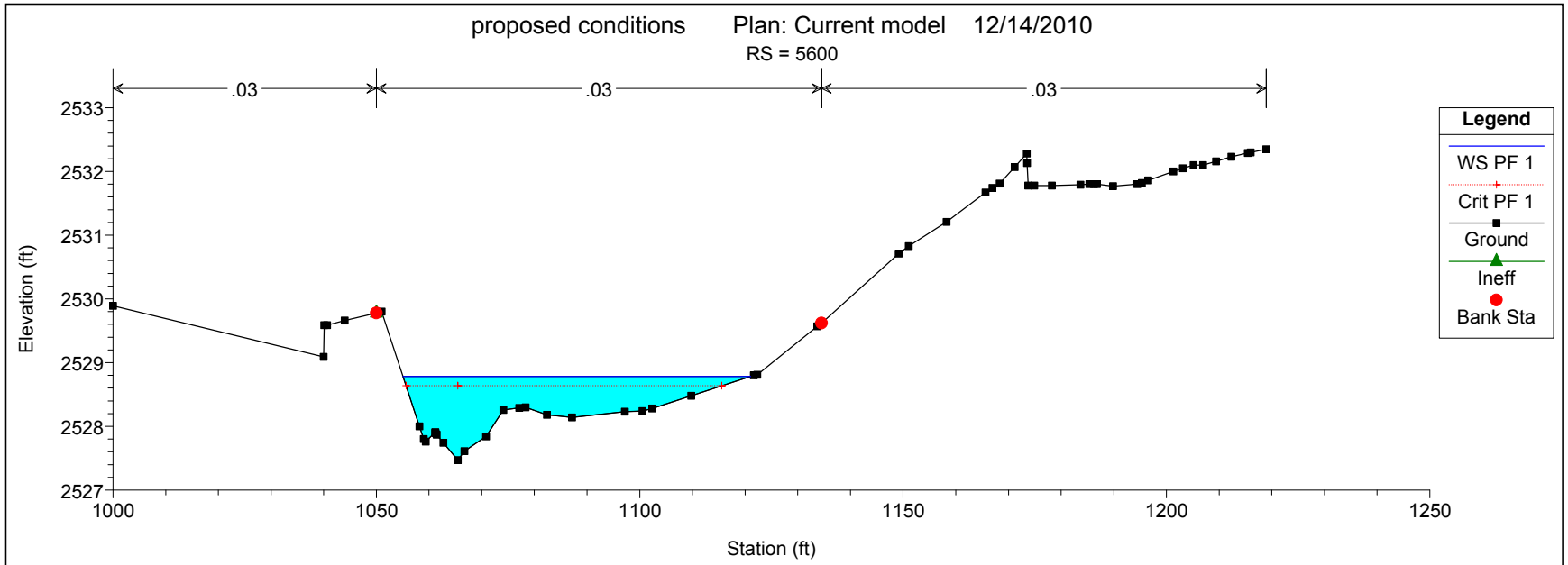

proposed conditions Plan: Current model 12/14/2010
RS = 5850
.03
.03
.03
Elevation (ft)
2533.5
2533.0
2532.5
2532.0
2531.5
2531.0
2530.5
2530.0
1000
1050
1100
1150
1200
1250
Station (ft)
Legend
WS PF 1
Ground
Ineff
Bank Sta

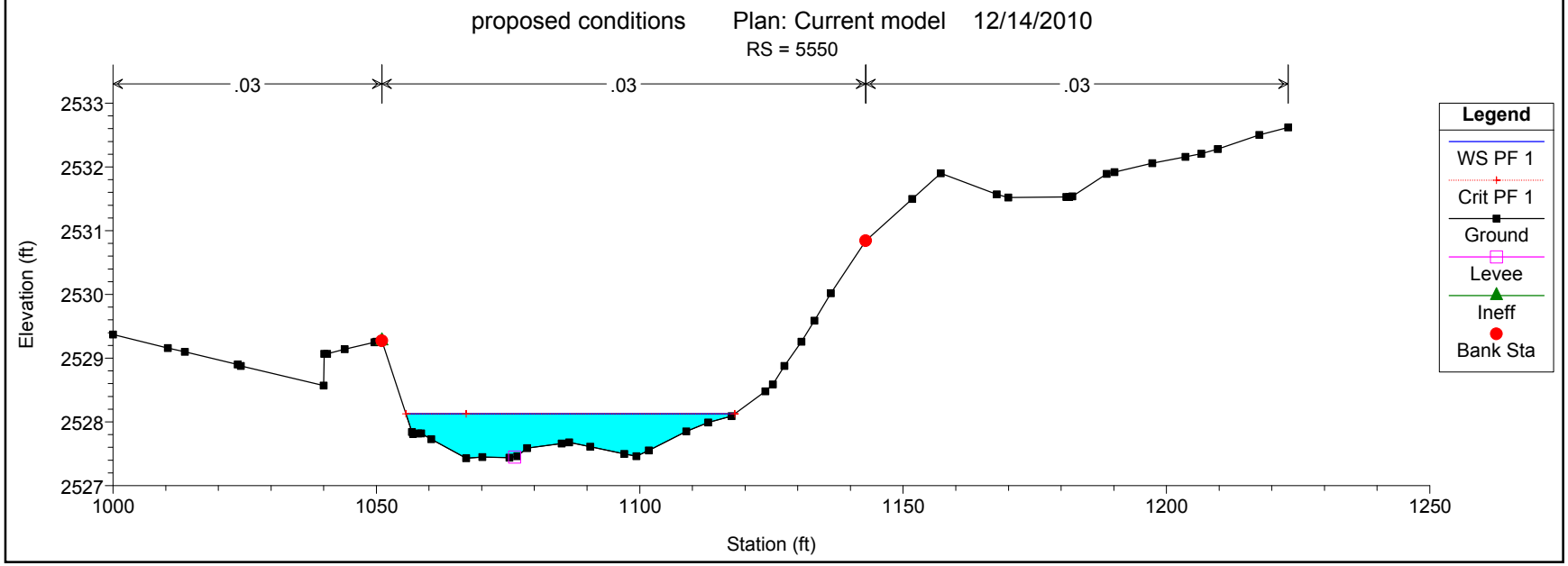

proposed conditions Plan: Current model 12/14/2010
RS = 5800
.03
.03
.03
Elevation (ft)
2533.5
2533.0
2532.5
2532.0
2531.5
2531.0
2530.5
2530.0
1000
1050
1100
1150
1200
1250
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Ineff
Bank Sta


proposed conditions Plan: Current model 12/14/2010
RS = 5750
.03
.03
.03
Elevation (ft)
2532.5
2532.0
2531.5
2531.0
2530.5
2530.0
2529.5
1000
1050
1100
1150
1200
1250
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Ineff
Bank Sta


proposed conditions Plan: Current model 12/14/2010
RS = 5700
.03
.03
.03
Elevation (ft)
2532.0
2531.5
2531.0
2530.5
2530.0
2529.5
2529.0
2528.5
1000
1050
1100
1150
1200
1250
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Ineff
Bank Sta


proposed conditions Plan: Current model 12/14/2010
RS = 5650
.03
.03
.03
Elevation (ft)
2531.0
2530.5
2530.0
2529.5
2529.0
2528.5
2528.0
1000
1050
1100
1150
1200
1250
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Ineff
Bank Sta


proposed conditions Plan: Current model 12/14/2010
RS = 5600
.03
.03
.03
Elevation (ft)
2533
2532
2531
2530
2529
2528
2527
1000
1050
1100
1150
1200
1250
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Ineff
Bank Sta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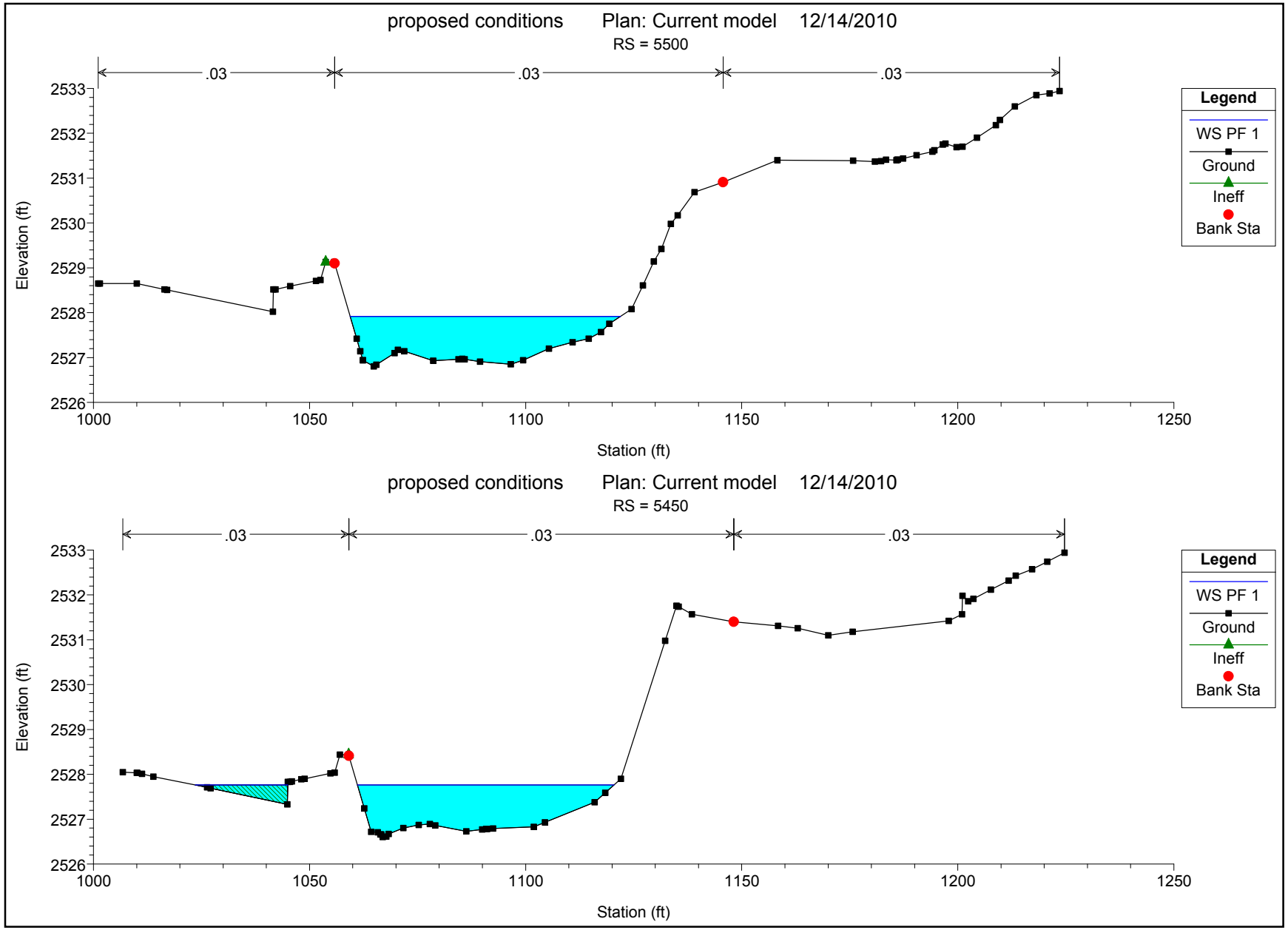
RS = 5550
.03
.03
.03
Elevation (ft)
2533
2532
2531
2530
2529
2528
2527
1000
1050
1100
1150
1200
1250
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Levee
Ineff
Bank Sta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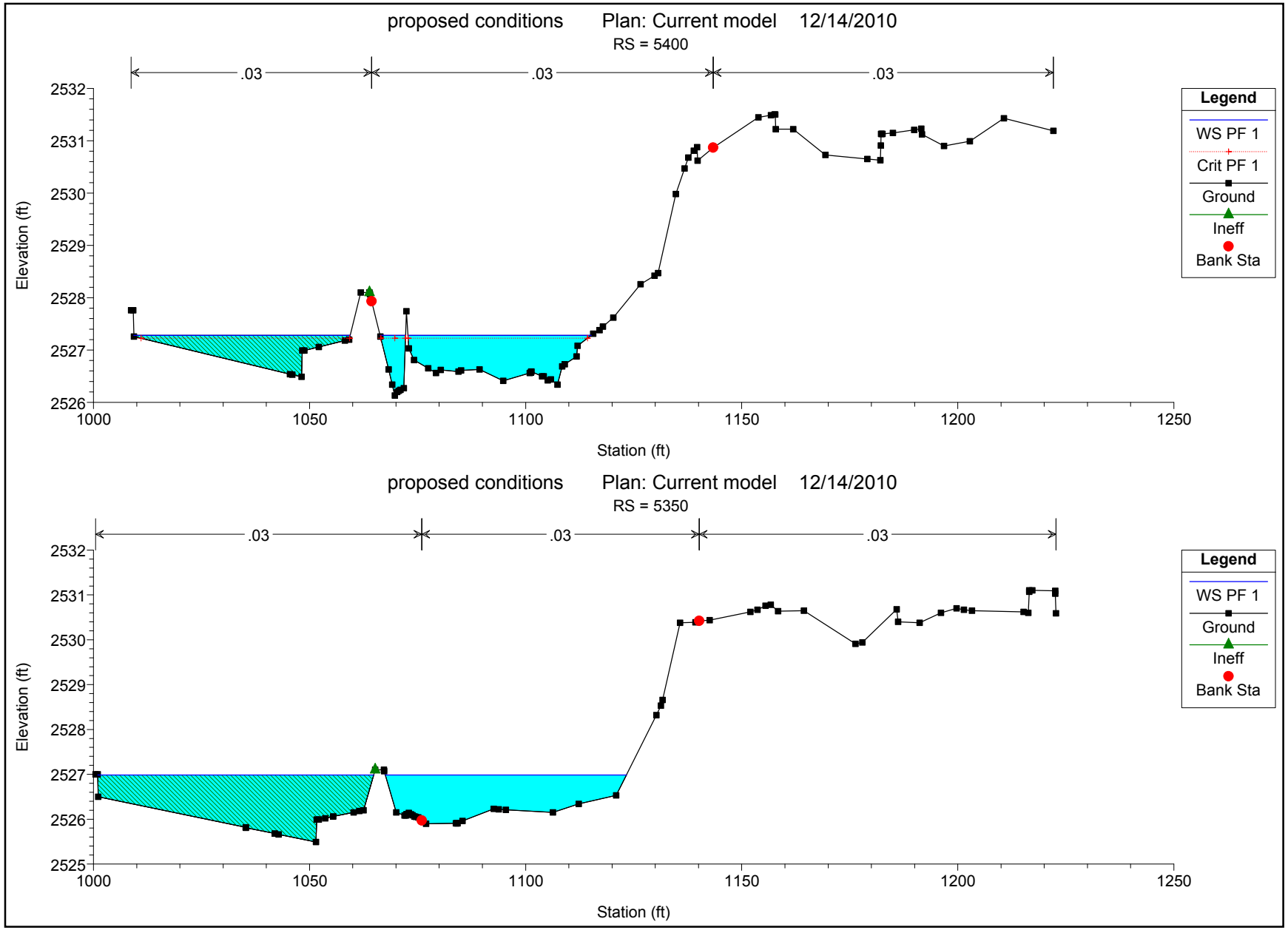
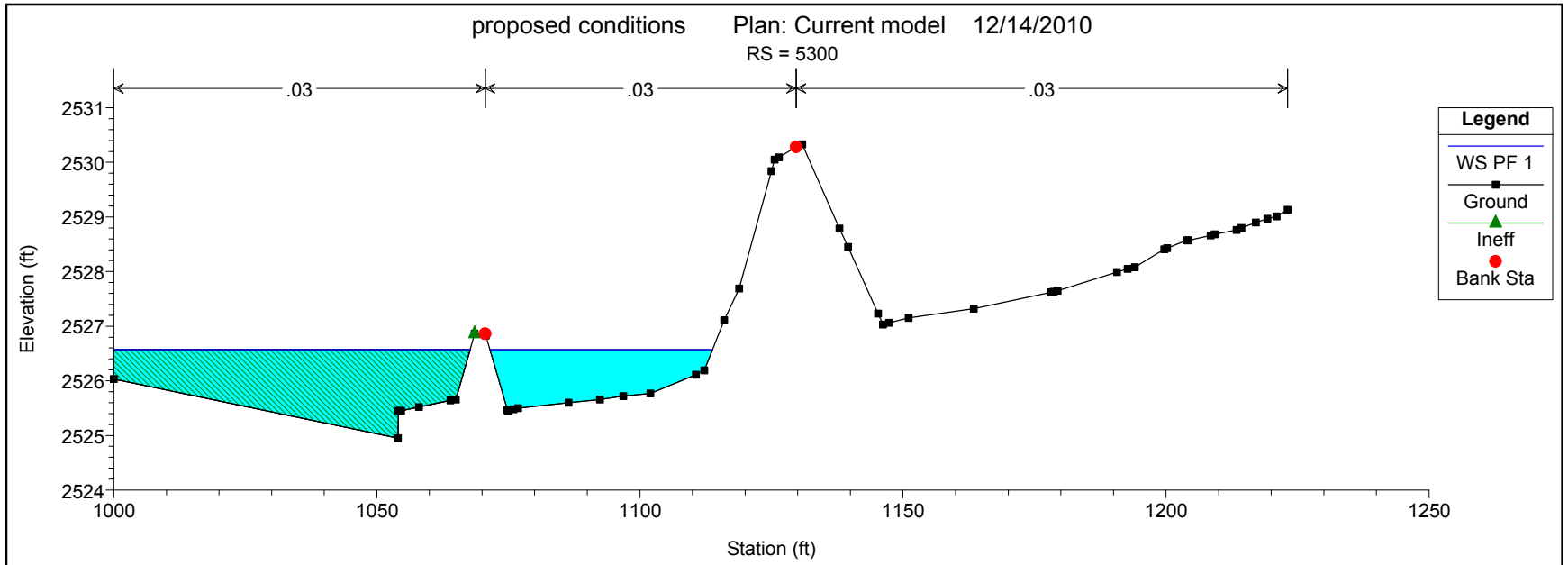
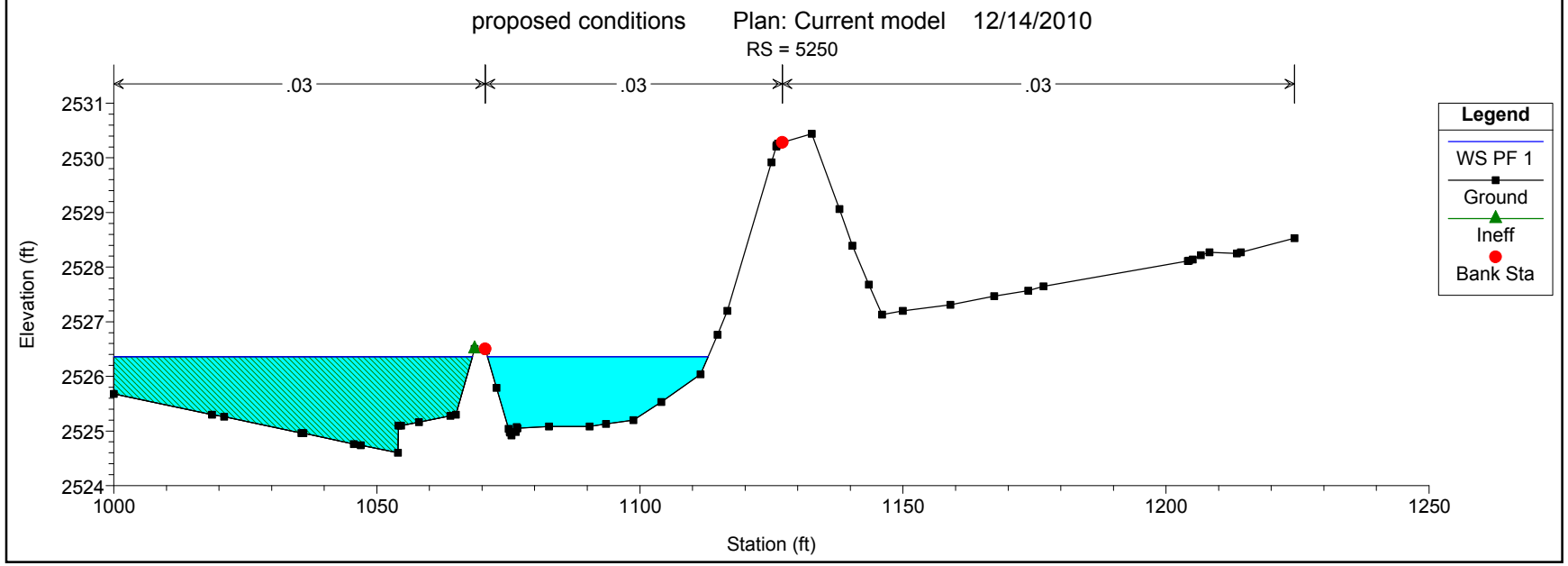
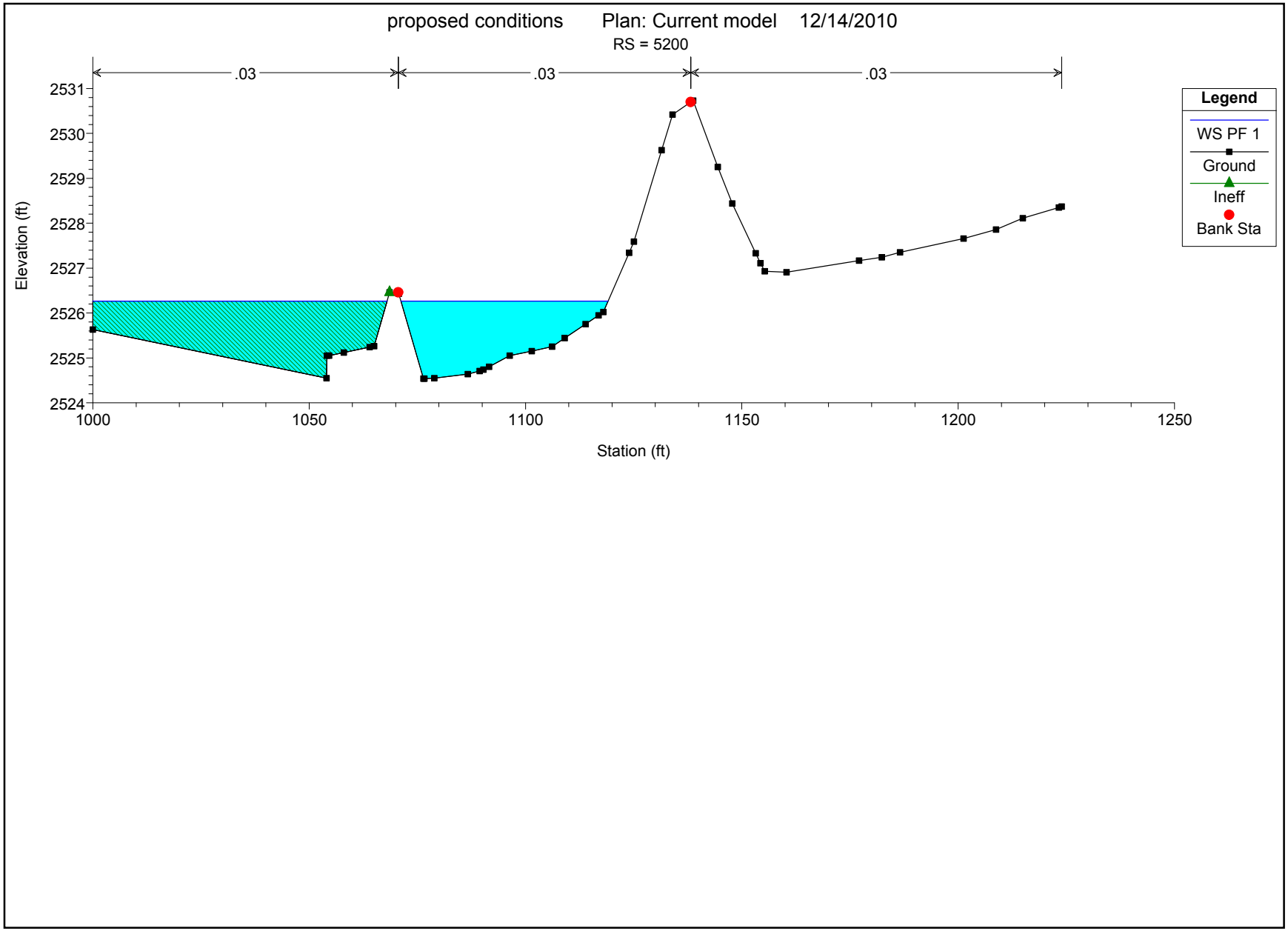
RS = 5500
.03
.03
.03
Elevation (ft)
2533
2532
2531
2530
2529
2528
2527
2526
1000
1050
1100
1150
1200
1250
Station (ft)
Legend
WS PF 1
Ground
Ineff
Bank Sta
proposed conditions Plan: Current model 12/14/2010
RS = 5450
.03
.03
.03
Elevation (ft)
2533
2532
2531
2530
2529
2528
2527
2526
1000
1050
1100
1150
1200
1250
Station (ft)
Legend
WS PF 1
Ground
Ineff
Bank Sta


proposed conditions Plan: Current model 12/14/2010
RS = 5400
.03
.03
.03
Elevation (ft)
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Ineff
Bank Sta
proposed conditions Plan: Current model 12/14/2010
RS = 5350
.03
.03
.03
Elevation (ft)
Station (ft)
Legend
WS PF 1
Ground
Ineff
Bank Sta


proposed conditions Plan: Current model 12/14/2010
RS = 5300
.03
.03
.03
Elevation (ft)
2531
2530
2529
2528
2527
2526
2525
2524
1000
1050
1100
1150
1200
1250
Station (ft)
Legend
WS PF 1
Ground
Ineff
Bank Sta


proposed conditions Plan: Current model 12/14/2010
RS = 5250
.03
.03
.03
Elevation (ft)
2531
2530
2529
2528
2527
2526
2525
2524
1000
1050
1100
1150
1200
1250
Station (ft)
Legend
WS PF 1
Ground
Ineff
Bank Sta


proposed conditions
Plan: Current model
12/14/2010
RS = 5200
.03
.03
.03
Elevation (ft)
2531
2530
2529
2528
2527
2526
2525
2524
1000
1050
1100
1150
1200
1250
Station (ft)
Legend
WS PF 1
Ground
Ineff
Bank Sta

APPENDIX 4

INLET DESIGN

FHWA Urban Drainage Design Program, HY-22
Drainage of Highway Pavements

Inlets on Sag
Date: 12/15/2010

Project No. :
Project Name.:
Computed by :

Inlets on Sag: Curb-Opening Inlet

Roadway and Discharge Data

	Cross Slope	Composite/Dep
Sx	Pavement Cross Slope (ft/ft)	0.0200
Sw	Gutter Cross Slope (ft/ft)	0.0793
n	Manning's Coefficient	0.016
W	Gutter Width (ft)	1.71
a	Gutter Depression (inch)	1.00

Inlet Interception

	Inlet Type *Sag*	Curb-Opening
T	Width of Spread (ft)	9.29
L	Curb-Opening Length (ft)	16.00
H	Curb-Opening Height (in)	6.00
d_curb	Depth at Curb (ft)	0.371
Qi	Intercepted Flow (cfs)	3.850

CB3

FHWA Urban Drainage Design Program, HY-22
Drainage of Highway Pavements

Inlets on Sag
Date: 12/15/2010

Project No. :
Project Name.:
Computed by :

Inlets on Sag: Curb-Opening Inlet

Roadway and Discharge Data

	Cross Slope	Composite/Dep
Sx	Pavement Cross Slope (ft/ft)	0.0200
Sw	Gutter Cross Slope (ft/ft)	0.0793
n	Manning's Coefficient	0.016
W	Gutter Width (ft)	1.71
a	Gutter Depression (inch)	1.00

Inlet Interception

	Inlet Type *Sag*	Curb-Opening
T	Width of Spread (ft)	6.00
L	Curb-Opening Length (ft)	24.00
H	Curb-Opening Height (in)	6.00
d_curb	Depth at Curb (ft)	0.305
Qi	Intercepted Flow (cfs)	3.000

CB3.1

FHWA Urban Drainage Design Program, HY-22
Drainage of Highway Pavements

Inlets on Grade
Date: 05/06/2010

Project No. :
Project Name.: KOLB ROAD
Computed by :

Inlets on Grade: Curb Opening Inlet CP N3.1

Roadway and Discharge Data

			Composite
	Cross Slope		
S	Longitudinal Slope	(ft/ft)	0.0100
Sx	Pavement Cross Slope	(ft/ft)	0.0200
Sw	Gutter Cross Slope	(ft/ft)	0.0793
n	Manning's Coefficient		0.016
W	Gutter Width (ft)		1.71
a	Gutter Depression (inch)		0.00
Q	Discharge (cfs)		2.000
T	Width of Spread (ft)		8.51

Gutter Flow

Eo	Gutter Flow Ratio	0.573
d	Depth of Flow (ft)	0.27
V	Average Velocity (ft/sec)	2.47

Inlet Interception

	Inlet Type	Curb-Opening
LT	Length for 100% Inteception (ft)	13.89
L	Curb-Opening Length (ft)	12.89
e	Inlet Efficiency	1.000
Qi	Intercepted Flow (cfs)	2.000
Qb	By-pass Flow (cfs)	0.000

CB4.1

FHWA Urban Drainage Design Program, HY-22
Drainage of Highway Pavements

Inlets on Grade
Date: 12/15/2010

Project No. :
Project Name.:
Computed by :

Inlets on Grade: Curb Opening Inlet

Roadway and Discharge Data

			Composite
	Cross Slope		
S	Longitudinal Slope	(ft/ft)	0.0100
Sx	Pavement Cross Slope	(ft/ft)	0.0200
Sw	Gutter Cross Slope	(ft/ft)	0.0793
n	Manning's Coefficient		0.016
W	Gutter Width	(ft)	1.71
a	Gutter Depression	(inch)	1.00
Q	Discharge	(cfs)	3.000
T	Width of Spread	(ft)	10.17

Gutter Flow

Eo	Gutter Flow Ratio		0.490
d	Depth of Flow	(ft)	0.30
V	Average Velocity	(ft/sec)	2.68

Inlet Interception

	Inlet Type		Curb-Opening
LT	Length for 100% Inteception	(ft)	13.75
L	Curb-Opening Length	(ft)	12.75
e	Inlet Efficiency		1.000
Qi	Intercepted Flow	(cfs)	3.000
Qb	By-pass Flow	(cfs)	0.000

SC5.1

FHWA Urban Drainage Design Program, HY-22
Drainage of Highway Pavements

Inlets on Grade
Date: 05/05/2010

Project No. :
Project Name.: KOLB ROAD
Computed by :

Inlets on Grade: Curb Opening Inlet CP N5.1

Roadway and Discharge Data

			Composite
	Cross Slope		
S	Longitudinal Slope	(ft/ft)	0.0100
Sx	Pavement Cross Slope	(ft/ft)	0.0200
Sw	Gutter Cross Slope	(ft/ft)	0.0793
n	Manning's Coefficient		0.016
W	Gutter Width (ft)		1.71
a	Gutter Depression (inch)		0.00
Q	Discharge (cfs)		2.000
T	Width of Spread (ft)		8.51

Gutter Flow

Eo	Gutter Flow Ratio	0.573
d	Depth of Flow (ft)	0.27
V	Average Velocity (ft/sec)	2.47

Inlet Interception

	Inlet Type	Curb-Opening
LT	Length for 100% Inteception (ft)	13.89
L	Curb-Opening Length (ft)	12.89
e	Inlet Efficiency	1.000
Qi	Intercepted Flow (cfs)	2.000
Qb	By-pass Flow (cfs)	0.000

SC6.1

FHWA Urban Drainage Design Program, HY-22
Drainage of Highway Pavements

Inlets on Grade
Date: 12/15/2010

Project No. :
Project Name.:
Computed by :

Inlets on Grade: Curb Opening Inlet

Roadway and Discharge Data

			Composite
	Cross Slope		
S	Longitudinal Slope	(ft/ft)	0.0137
Sx	Pavement Cross Slope	(ft/ft)	0.0200
Sw	Gutter Cross Slope	(ft/ft)	0.0793
n	Manning's Coefficient		0.016
W	Gutter Width	(ft)	1.71
a	Gutter Depression	(inch)	1.00
Q	Discharge	(cfs)	2.000
T	Width of Spread	(ft)	7.92

Gutter Flow

Eo	Gutter Flow Ratio	0.608
d	Depth of Flow (ft)	0.26
V	Average Velocity (ft/sec)	2.80

Inlet Interception

	Inlet Type	Curb-Opening
LT	Length for 100% Inteception (ft)	11.57
L	Curb-Opening Length (ft)	11.15
e	Inlet Efficiency	1.000
Qi	Intercepted Flow (cfs)	2.000
Qb	By-pass Flow (cfs)	0.000

CB13

FHWA Urban Drainage Design Program, HY-22
Drainage of Highway Pavements

Inlets on Grade
Date: 09/16/2010

Project No. :
Project Name.:
Computed by :

Inlets on Grade: Curb Opening Inlet

Roadway and Discharge Data

	Cross Slope	Composite
S	Longitudinal Slope (ft/ft)	0.0050
Sx	Pavement Cross Slope (ft/ft)	0.0200
Sw	Gutter Cross Slope (ft/ft)	0.0793
n	Manning's Coefficient	0.016
W	Gutter Width (ft)	1.71
a	Gutter Depression (inch)	1.00
Q	Discharge (cfs)	6.000
T	Width of Spread (ft)	15.60

Gutter Flow

Eo	Gutter Flow Ratio	0.322
d	Depth of Flow (ft)	0.41
V	Average Velocity (ft/sec)	2.38

Inlet Interception

	Inlet Type	Curb-Opening
LT	Length for 100% Inteception (ft)	17.73
L	Curb-Opening Length (ft)	16.73
e	Inlet Efficiency	0.994
Qi	Intercepted Flow (cfs)	5.966
Qb	By-pass Flow (cfs)	0.034

PSOMAS

Project Name: Kolb Road
Project Number # : 7TUS070901 Made by CLR Date 5/5/10
Reference: COT SMDDFM Checked By Date

GRATED INLET DESIGN

General Equations

Wier

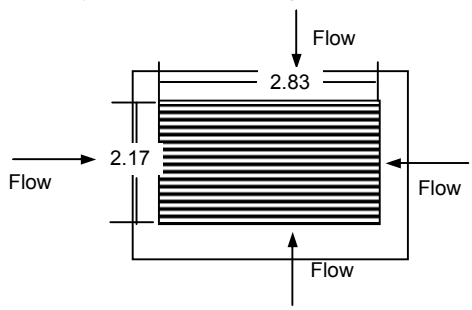
$$Q = C_s L H^{3/2}$$

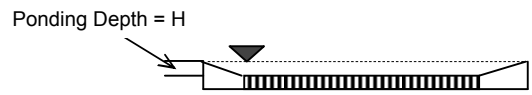
where
- L = Length of Opening (ft)
- C_D = Weir Coefficient
- H = Height of Opening (ft)
- Q = 100-year Peak Discharge (cfs)

Orifice

$$Q = C_s A H^{1/2}$$

where
- A = Effective Area
- Cs = Orifice Coefficient
- H = Depth of ponding
- Q = 100-year Peak Discharge (cfs)





For PC/COT EF-1Type Grate
Effective Area = 4.66 ft^2/Grate (Per PC/COT SD-311)
Effective Horizontal Opening = 2.83 f Perimeter = 2.83(2) + 2.17(2) = 10 feet
Clogging factor = 25%

Solution

For Concentration Point N5 (CB9)

Weir

Q_{DES} = 25.3 cfs
C_D = 3
H = 1.1 ft
L = 7 ft
L_{CLOG} = 15

One grate provides 10-feet of opening
USE 2 GRATES

Orifice

Q_{DES} = 25.3 cfs
C_D = 5.35
H = 1.1
A = 4.5
A_{CLOG} = 9.0

One grate provides 4.7 ft^2 of opening
USE 2 GRATES

2-grates governs

Project Number # : 7TUS070901 Made by CLR Date 5/5/10
Reference: COT SMDDFM Checked By Date

GRATED INLET DESIGN

General Equations

Wier

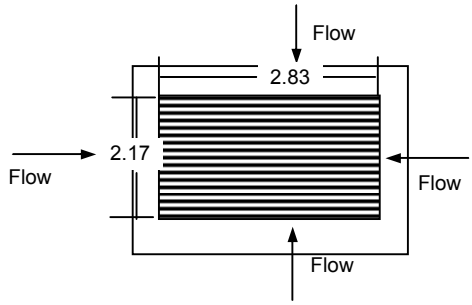
$$Q = C_s L H^{3/2}$$

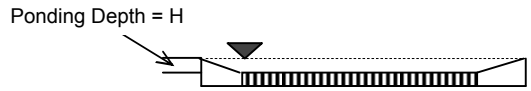
where
- L = Length of Opening (ft)
- C_D = Weir Coefficient
- H = Height of Opening (ft)
- Q = 100-year Peak Discharge (cfs)

Orifice

$$Q = C_s A H^{1/2}$$

where
- A = Effective Area
- Cs = Orifice Coefficient
- H = Depth of ponding
- Q = 100-year Peak Discharge (cfs)





For PC/COT EF-1Type Grate
Effective Area = 4.66 ft^2/Grate (Per PC/COT SD-311)
Effective Horizontal Opening = 2.83 f Perimeter = 2.83(2) + 2.17(2) = 10 feet
Clogging factor = 25%

Solution

For Concentration Point N6 (CB10)

Weir
- Q_{DES} = 12.8 cfs
- C_D = 3
- H = 1.1 ft
- **L = 4 ft**
- **L_{CLOG} = 7**

One grate provides 10-feet of opening
USE 1 GRATE

Orifice
- Q_{DES} = 12.8 cfs
- C_D = 5.35
- H = 1.1
- **A = 2.3**
- **A_{CLOG} = 4.6**

One grate provides 4.7 ft^2 of opening
USE 1 GRATE

2-grate governs

Solution

For Catch Basin N9 (CB8)

Weir
- Q_{DES} = 16.6 cfs
- C_D = 3
- H = 0.75 ft
- **L = 9 ft**
- **L_{CLOG} = 17**

One grate provides 10-feet of opening
USE 2 GRATES

Orifice
- Q_{DES} = 16.6 cfs
- C_D = 5.35
- H = 0.75
- **A = 3.6**
- **A_{CLOG} = 7.2**

One grate provides 4.7 ft^2 of opening
USE 2 GRATE

2-grates governs

FHWA Urban Drainage Design Program, HY-22
Drainage of Highway Pavements

Inlets on Grade
Date: 06/02/2010

Project No. :
Project Name.:
Computed by :

Inlets on Grade: Gutter Flow Parameters

Roadway and Discharge Data

	Cross Slope		Composite
S	Longitudinal Slope	(ft/ft)	0.0100
Sx	Pavement Cross Slope	(ft/ft)	0.0200
Sw	Gutter Cross Slope	(ft/ft)	0.0793
n	Manning's Coefficient		0.016
W	Gutter Width (ft)		1.71
a	Gutter Depression (inch)		1.00
Q	Discharge (cfs)		12.000
T	Width of Spread (ft)		17.89

Gutter Flow

Eo	Gutter Flow Ratio	0.280
d	Depth of Flow (ft)	0.46
V	Average Velocity (ft/sec)	3.65

FHWA Urban Drainage Design Program, HY-22
Drainage of Highway Pavements

Inlets on Grade
Date: 06/02/2010

Project No. :
Project Name.:
Computed by :

Inlets on Grade: Gutter Flow Parameters

Roadway and Discharge Data

	Cross Slope		Composite
S	Longitudinal Slope	(ft/ft)	0.0100
Sx	Pavement Cross Slope	(ft/ft)	0.0200
Sw	Gutter Cross Slope	(ft/ft)	0.0793
n	Manning's Coefficient		0.016
W	Gutter Width (ft)		1.71
a	Gutter Depression (inch)		1.00
Q	Discharge (cfs)		14.000
T	Width of Spread (ft)		19.00

Gutter Flow

Eo	Gutter Flow Ratio	0.263
d	Depth of Flow (ft)	0.48
V	Average Velocity (ft/sec)	3.79

Worksheet for N8

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.016	
Channel Slope	0.06000	ft/ft
Bottom Width	34.70	ft
Discharge	10.00	ft^3/s

Results

Normal Depth	0.07	ft
Flow Area	2.53	ft^2
Wetted Perimeter	34.85	ft
Hydraulic Radius	0.07	ft
Top Width	34.70	ft
Critical Depth	0.14	ft
Critical Slope	0.00731	ft/ft
Velocity	3.95	ft/s
Velocity Head	0.24	ft
Specific Energy	0.32	ft
Froude Number	2.58	
Flow Type	Supercritical	

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	0.07	ft
Critical Depth	0.14	ft
Channel Slope	0.06000	ft/ft
Critical Slope	0.00731	ft/ft

Worksheet for N8.1

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.016	
Channel Slope	0.05720	ft/ft
Bottom Width	34.70	ft
Discharge	10.00	ft^3/s

Results

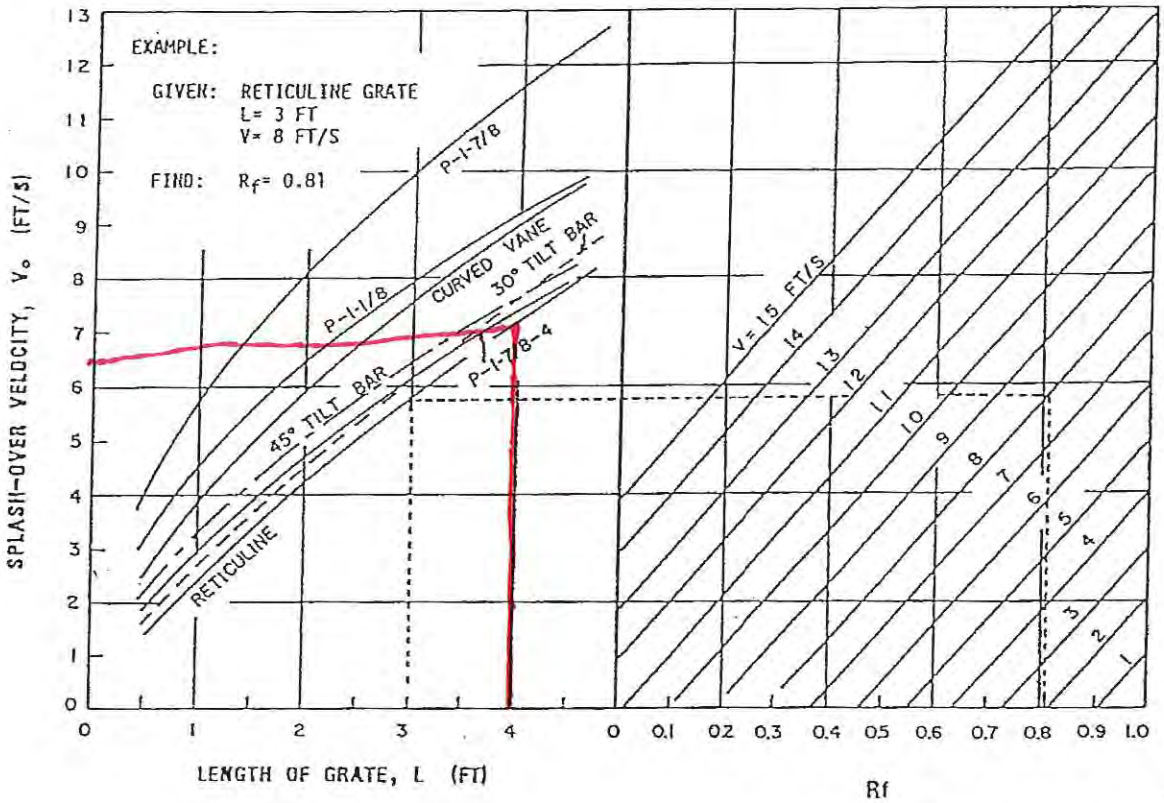
Normal Depth	0.07	ft
Flow Area	2.57	ft^2
Wetted Perimeter	34.85	ft
Hydraulic Radius	0.07	ft
Top Width	34.70	ft
Critical Depth	0.14	ft
Critical Slope	0.00731	ft/ft
Velocity	3.90	ft/s
Velocity Head	0.24	ft
Specific Energy	0.31	ft
Froude Number	2.53	
Flow Type	Supercritical	

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	0.07	ft
Critical Depth	0.14	ft
Channel Slope	0.05720	ft/ft
Critical Slope	0.00731	ft/ft



$$Q_{fi} = R_f \, Q_f$$

FIGURE 10.5
FRONTAL-FLOW INTERCEPTION EFFICIENCY FOR GRATE INLETS

PAVEMENT SPREAD CHECK
FOR
VERTICAL CURB

CB2

FHWA Urban Drainage Design Program, HY-22
Drainage of Highway Pavements

Inlets on Sag
Date: 02/15/2011

Project No. :
Project Name.:
Computed by :

Inlets on Sag: Curb-Opening Inlet

Roadway and Discharge Data

	Cross Slope	Uniform
Sx	Pavement Cross Slope (ft/ft)	0.0200
Sw	Gutter Cross Slope (ft/ft)	0.0200
n	Manning's Coefficient	0.016
W	Gutter Width (ft)	2.00
a	Gutter Depression (inch)	0.00

Inlet Interception

	Inlet Type *Sag*	Curb-Opening
T	Width of Spread (ft)	9.29
L	Curb-Opening Length (ft)	16.00
H	Curb-Opening Height (in)	6.00
d_curb	Depth at Curb (ft)	0.186
Qi	Intercepted Flow (cfs)	3.850

CB3

FHWA Urban Drainage Design Program, HY-22
Drainage of Highway Pavements

Inlets on Sag
Date: 02/15/2011

Project No. :
Project Name.:
Computed by :

Inlets on Sag: Curb-Opening Inlet

Roadway and Discharge Data

	Cross Slope	Uniform
Sx	Pavement Cross Slope (ft/ft)	0.0200
Sw	Gutter Cross Slope (ft/ft)	0.0200
n	Manning's Coefficient	0.016
W	Gutter Width (ft)	2.00
a	Gutter Depression (inch)	0.00

Inlet Interception

	Inlet Type *Sag*	Curb-Opening
T	Width of Spread (ft)	6.00
L	Curb-Opening Length (ft)	24.00
H	Curb-Opening Height (in)	6.00
d_curb	Depth at Curb (ft)	0.120
Qi	Intercepted Flow (cfs)	3.000

CB5

FHWA Urban Drainage Design Program, HY-22
Drainage of Highway Pavements

Inlets on Grade
Date: 02/15/2011

Project No. :
Project Name.:
Computed by :

Inlets on Grade: Gutter Flow Parameters

Roadway and Discharge Data

	Cross Slope		Uniform
S	Longitudinal Slope	(ft/ft)	0.0100
Sx	Pavement Cross Slope	(ft/ft)	0.0200
Sw	Gutter Cross Slope	(ft/ft)	0.0200
n	Manning's Coefficient		0.016
W	Gutter Width (ft)		2.00
a	Gutter Depression (inch)		0.00
Q	Discharge (cfs)		2.000
T	Width of Spread (ft)		9.35

Gutter Flow

Eo	Gutter Flow Ratio	0.474
d	Depth of Flow (ft)	0.19
V	Average Velocity (ft/sec)	2.29

CB7

FHWA Urban Drainage Design Program, HY-22
Drainage of Highway Pavements

Inlets on Grade
Date: 02/15/2011

Project No. :
Project Name.:
Computed by :

Inlets on Grade: Gutter Flow Parameters

Roadway and Discharge Data

	Cross Slope		Uniform
S	Longitudinal Slope	(ft/ft)	0.0100
Sx	Pavement Cross Slope	(ft/ft)	0.0200
Sw	Gutter Cross Slope	(ft/ft)	0.0200
n	Manning's Coefficient		0.016
W	Gutter Width (ft)		2.00
a	Gutter Depression (inch)		0.00
Q	Discharge (cfs)		3.000
T	Width of Spread (ft)		10.89

Gutter Flow

Eo	Gutter Flow Ratio	0.418
d	Depth of Flow (ft)	0.22
V	Average Velocity (ft/sec)	2.53

CP N10 Dev

FHWA Urban Drainage Design Program, HY-22
Drainage of Highway Pavements

Inlets on Grade
Date: 02/15/2011

Project No. :
Project Name.:
Computed by :

Inlets on Grade: Gutter Flow Parameters

Roadway and Discharge Data

	Cross Slope	Uniform
S	Longitudinal Slope (ft/ft)	0.0100
Sx	Pavement Cross Slope (ft/ft)	0.0200
Sw	Gutter Cross Slope (ft/ft)	0.0200
n	Manning's Coefficient	0.016
W	Gutter Width (ft)	2.00
a	Gutter Depression (inch)	0.00
Q	Discharge (cfs)	14.000
T	Width of Spread (ft)	19.39

Gutter Flow

Eo	Gutter Flow Ratio	0.252
d	Depth of Flow (ft)	0.39
V	Average Velocity (ft/sec)	3.72

CPN13

FHWA Urban Drainage Design Program, HY-22
Drainage of Highway Pavements

Inlets on Grade
Date: 02/15/2011

Project No. :
Project Name.:
Computed by :

Inlets on Grade: Gutter Flow Parameters

Roadway and Discharge Data

	Cross Slope		Uniform
S	Longitudinal Slope	(ft/ft)	0.0050
Sx	Pavement Cross Slope	(ft/ft)	0.0200
Sw	Gutter Cross Slope	(ft/ft)	0.0200
n	Manning's Coefficient		0.016
W	Gutter Width (ft)		2.00
a	Gutter Depression (inch)		0.00
Q	Discharge (cfs)		14.000
T	Width of Spread (ft)		22.08

Gutter Flow

Eo	Gutter Flow Ratio	0.224
d	Depth of Flow (ft)	0.44
V	Average Velocity (ft/sec)	2.87

FHWA Urban Drainage Design Program, HY-22
Drainage of Highway Pavements

Inlets on Grade
Date: 02/15/2011

Project No. :
Project Name.:
Computed by :

Inlets on Grade: Gutter Flow Parameters

Roadway and Discharge Data

	Cross Slope	Uniform
S	Longitudinal Slope (ft/ft)	0.0100
Sx	Pavement Cross Slope (ft/ft)	0.0200
Sw	Gutter Cross Slope (ft/ft)	0.0200
n	Manning's Coefficient	0.016
W	Gutter Width (ft)	2.00
a	Gutter Depression (inch)	0.00
Q	Discharge (cfs)	2.000
T	Width of Spread (ft)	9.35

Gutter Flow

Eo	Gutter Flow Ratio	0.474
d	Depth of Flow (ft)	0.19
V	Average Velocity (ft/sec)	2.29

FHWA Urban Drainage Design Program, HY-22
Drainage of Highway Pavements

Inlets on Grade
Date: 02/15/2011

Project No. :
Project Name.:
Computed by :

Inlets on Grade: Gutter Flow Parameters

Roadway and Discharge Data

	Cross Slope	Uniform
S	Longitudinal Slope (ft/ft)	0.0137
Sx	Pavement Cross Slope (ft/ft)	0.0200
Sw	Gutter Cross Slope (ft/ft)	0.0200
n	Manning's Coefficient	0.016
W	Gutter Width (ft)	2.00
a	Gutter Depression (inch)	0.00
Q	Discharge (cfs)	2.000
T	Width of Spread (ft)	8.82

Gutter Flow

Eo	Gutter Flow Ratio	0.496
d	Depth of Flow (ft)	0.18
V	Average Velocity (ft/sec)	2.57

STORMDRAIN DESIGN

Hydraflow HGL Computation Procedure

General Procedure: Hydraflow computes the HGL using the Bernoulli energy equation. Manning's equation is used to determine energy losses due to pipe friction. In a standard step, iterative procedure, Hydraflow assumes upstream HGLs until the energy equation balances. If the energy equation cannot balance, supercritical flow exists and critical depth is temporarily assumed at the upstream end. A supercritical flow Profile is then computed using the same procedure in a downstream direction using momentum principles.

Col. 1 The line number being computed. Calculations begin at Line 1 and proceed upstream.

Col. 2 The line size. In the case of non-circular pipes, the line rise is printed above the span.

Col. 3 Total flow rate in the line.

Col. 4 The elevation of the downstream invert.

Col. 5 Elevation of the hydraulic grade line at the downstream end. This is computed as the upstream HGL + Minor loss of this line's downstream line.

Col. 6 The downstream depth of flow inside the pipe (HGL - Invert elevation) but not greater than the line size.

Col. 7 Cross-sectional area of the flow at the downstream end.

Col. 8 The velocity of the flow at the downstream end, (Col. 3 / Col. 7).

Col. 9 Velocity head (Velocity squared / 2g).

Col. 10 The elevation of the energy grade line at the downstream end, HGL + Velocity head, (Col. 5 + Col. 9).

Col. 11 The friction slope at the downstream end (the S or Slope term in Manning's equation).

Col. 12 The line length.

Col. 13 The elevation of the upstream invert.

Col. 14 Elevation of the hydraulic grade line at the upstream end.

Col. 15 The upstream depth of flow inside the pipe (HGL - Invert elevation) but not greater than the line size.

Col. 16 Cross-sectional area of the flow at the upstream end.

Col. 17 The velocity of the flow at the upstream end, (Col. 3 / Col. 16).

Col. 18 Velocity head (Velocity squared / 2g).

Col. 19 The elevation of the energy grade line at the upstream end, HGL + Velocity head, (Col. 14 + Col. 18) .

Col. 20 The friction slope at the upstream end (the S or Slope term in Manning's equation).

Col. 21 The average of the downstream and upstream friction slopes.

Col. 22 Energy loss. Average Sf/100 x Line Length (Col. 21/100 x Col. 12). Equals (EGL upstream - EGL downstream) +/- tolerance.

Col. 23 The junction loss coefficient (K).

Col. 24 Minor loss. (Col. 23 x Col. 18). Is added to upstream HGL and used as the starting HGL for the next upstream line(s).

Storm Sewer Summary Report

Line No.	Line ID	Flow rate (cfs)	Line size (in)	Line shape	Line length (ft)	Invert EL Dn (ft)	Invert EL Up (ft)	Line slope (%)	HGL down (ft)	HGL up (ft)	Minor loss (ft)	HGL Junct (ft)	Dns line No.	Junction Type
1		330.0	72	Cir	480.000	2468.89	2470.71	0.379	2474.89*	2477.81*	0.32	2478.12	End	Manhole
2		330.0	72	Cir	487.000	2470.71	2472.56	0.380	2478.12*	2481.08*	0.32	2481.40	1	Manhole
3		330.0	72	Cir	445.000	2472.64	2474.33	0.380	2481.40*	2484.10*	0.32	2484.42	2	Manhole
4		330.0	66	Cir	370.000	2474.87	2479.83	1.341	2484.42*	2487.99*	0.45	2488.44	3	Manhole
5		330.0	66	Cir	370.000	2479.90	2484.86	1.341	2488.44*	2492.02*	0.45	2492.47	4	Manhole
6		330.0	66	Cir	503.000	2484.94	2489.87	0.980	2492.47*	2497.32*	0.45	2497.77	5	Manhole
7		330.0	66	Cir	462.000	2489.94	2494.47	0.981	2497.77*	2502.24*	0.45	2502.69	6	Manhole
8		330.0	66	Cir	504.000	2494.53	2499.47	0.980	2502.69*	2507.56*	0.45	2508.01	7	Manhole
9		222.0	54	Cir	529.000	2500.60	2505.10	0.851	2508.01*	2514.75*	0.45	2515.20	8	Manhole
10		222.0	54	Cir	318.000	2505.14	2507.46	0.730	2515.20*	2519.26*	0.45	2519.71	9	Manhole
11		186.0	54	Cir	330.000	2507.63	2517.13	2.879	2519.71*	2522.67*	0.32	2522.98	10	Manhole
12		166.0	54	Cir	43.410	2517.32	2517.90	1.336	2522.98*	2523.29*	0.03	2523.33	11	Generic
13	N1	166.0	54	Cir	165.240	2518.10	2518.78	0.411	2523.33*	2524.51*	0.85	2525.35	12	Grate
14	2	87.60	54	Cir	26.860	2518.88	2518.97	0.335	2525.35*	2525.41*	0.24	2525.64	13	Manhole
15	3	80.30	54	Cir	102.880	2519.07	2519.42	0.340	2525.64*	2525.81*	0.20	2526.01	14	Manhole
16	4	70.60	54	Cir	102.880	2519.52	2519.83	0.301	2526.01*	2526.15*	0.15	2526.30	15	Manhole
17	5	68.45	48	Cir	64.880	2520.33	2520.52	0.293	2526.30*	2526.45*	0.23	2526.68	16	Manhole
18	5(2)	68.45	42	Cir	76.650	2521.02	2521.40	0.496	2526.68*	2527.03*	0.39	2527.43	17	Manhole
19	6	58.75	36	Cir	85.580	2521.90	2522.33	0.503	2527.43*	2528.09*	0.54	2528.63	18	Manhole
20	7	42.20	36	Cir	219.420	2522.43	2523.53	0.501	2528.63*	2529.51*	0.08	2529.59	19	Generic
21	8	12.70	24	Cir	204.920	2524.53	2526.58	1.000	2529.59*	2530.24*	0.25	2530.49	20	Manhole
22	8(2)	12.70	24	Cir	202.630	2526.68	2528.71	1.002	2530.49*	2531.13*	0.25	2531.38	21	OpenHeadwall
23	N2	7.30	24	Cir	9.080	2519.07	2519.16	0.989	2525.64*	2525.65*	0.08	2525.74	14	Curb-Horiz
24	10	3.40	24	Cir	123.690	2519.36	2519.98	0.501	2525.74*	2525.76*	0.02	2525.78	23	Curb-Horiz

Project File: Revised 1-6-10.stm | Number of lines: 30 | Run Date: 02-15-2011

NOTES: Known Qs only ; *Surcharged (HGL above crown).

Storm Sewer Summary Report

Line No.	Line ID	Flow rate (cfs)	Line size (in)	Line shape	Line length (ft)	Invert EL Dn (ft)	Invert EL Up (ft)	Line slope (%)	HGL down (ft)	HGL up (ft)	Minor loss (ft)	HGL Junct (ft)	Dns line No.	Junction Type
25	11	9.70	30	Cir	163.590	2519.52	2520.34	0.501	2526.01*	2526.10*	0.03	2526.13	15	Grate
26	12	2.15	24	Cir	134.980	2519.93	2521.28	1.000	2526.30*	2526.31*	0.00	2526.31	16	Curb-Horiz
27	26	9.70	24	Cir	80.900	2521.50	2522.31	1.001	2527.43*	2527.57*	0.02	2527.60	18	Grate
28	27	2.75	24	Cir	50.910	2522.43	2522.94	1.002	2528.63*	2528.64*	0.01	2528.64	19	Curb-Horiz
29	17	13.80	24	Cir	56.910	2522.43	2523.00	1.002	2528.63*	2528.84*	0.15	2528.99	19	Grate
30		5.75	24	Cir	69.050	2520.90	2521.59	1.000	2523.33	2523.36	0.00	2523.36	12	Grate

Project File: Revised 1-6-10.stm | Number of lines: 30 | Run Date: 02-15-2011

NOTES: Known Qs only ; *Surcharged (HGL above crown).

MyReport

Line No.	Line ID	Flow Rate (cfs)	Capac Full (cfs)	Incr Q (cfs)	Line Size (in)	Line Length (ft)	Line Slope (%)	HGL Dn (ft)	HGL Up (ft)	Vel Ave (ft/s)	J-Loss Coeff
1		330.00	260.83	330.00	72	480.000	0.38	2474.89	2477.81	11.67	0.15
2		330.00	261.07	330.00	72	487.000	0.38	2478.12	2481.08	11.67	0.15
3		330.00	261.05	330.00	72	445.000	0.38	2481.40	2484.10	11.67	0.15
4		330.00	388.86	330.00	66	370.000	1.34	2484.42	2487.99	13.89	0.15
5		330.00	388.87	330.00	66	370.000	1.34	2488.44	2492.02	13.89	0.15
6		330.00	332.50	330.00	66	503.000	0.98	2492.47	2497.32	13.89	0.15
7		330.00	332.57	330.00	66	462.000	0.98	2497.77	2502.24	13.89	0.15
8		330.00	332.50	330.00	66	504.000	0.98	2502.69	2507.56	13.89	0.15
9		222.00	181.38	222.00	54	529.000	0.85	2508.01	2514.75	13.96	0.15
10		222.00	167.98	222.00	54	318.000	0.73	2515.20	2519.26	13.96	0.15
11		186.00	333.68	186.00	54	330.000	2.88	2519.71	2522.67	11.70	0.15
12		166.00	227.29	166.00	54	43.410	1.34	2522.98	2523.29	10.44	0.02
13	N1	166.00	126.15	166.00	54	165.240	0.41	2523.33	2524.51	10.44	0.50
14	2	87.60	113.89	87.60	54	26.860	0.34	2525.35	2525.41	5.51	0.50
15	3	80.30	114.68	80.30	54	102.880	0.34	2525.64	2525.81	5.05	0.50
16	4	70.60	107.96	70.60	54	102.880	0.30	2526.01	2526.15	4.44	0.50
17	5	68.45	77.72	68.45	48	64.880	0.29	2526.30	2526.45	5.45	0.50
18	5(2)	68.45	70.83	68.45	42	76.650	0.50	2526.68	2527.03	7.12	0.50
19	6	58.75	47.28	58.75	36	85.580	0.50	2527.43	2528.09	8.31	0.50
20	7	42.20	47.22	42.20	36	219.420	0.50	2528.63	2529.51	5.97	0.15
21	8	12.70	22.62	12.70	24	204.920	1.00	2529.59	2530.24	4.04	1.00
22	8(2)	12.70	22.64	12.70	24	202.630	1.00	2530.49	2531.13	4.04	1.00
23	N2	7.30	22.50	7.30	24	9.080	0.99	2525.64	2525.65	2.32	1.00

Project File: Revised 1-6-10.stm | Number of lines: 30 | Date: 02-15-2011

NOTES: ** Critical depth

MyReport

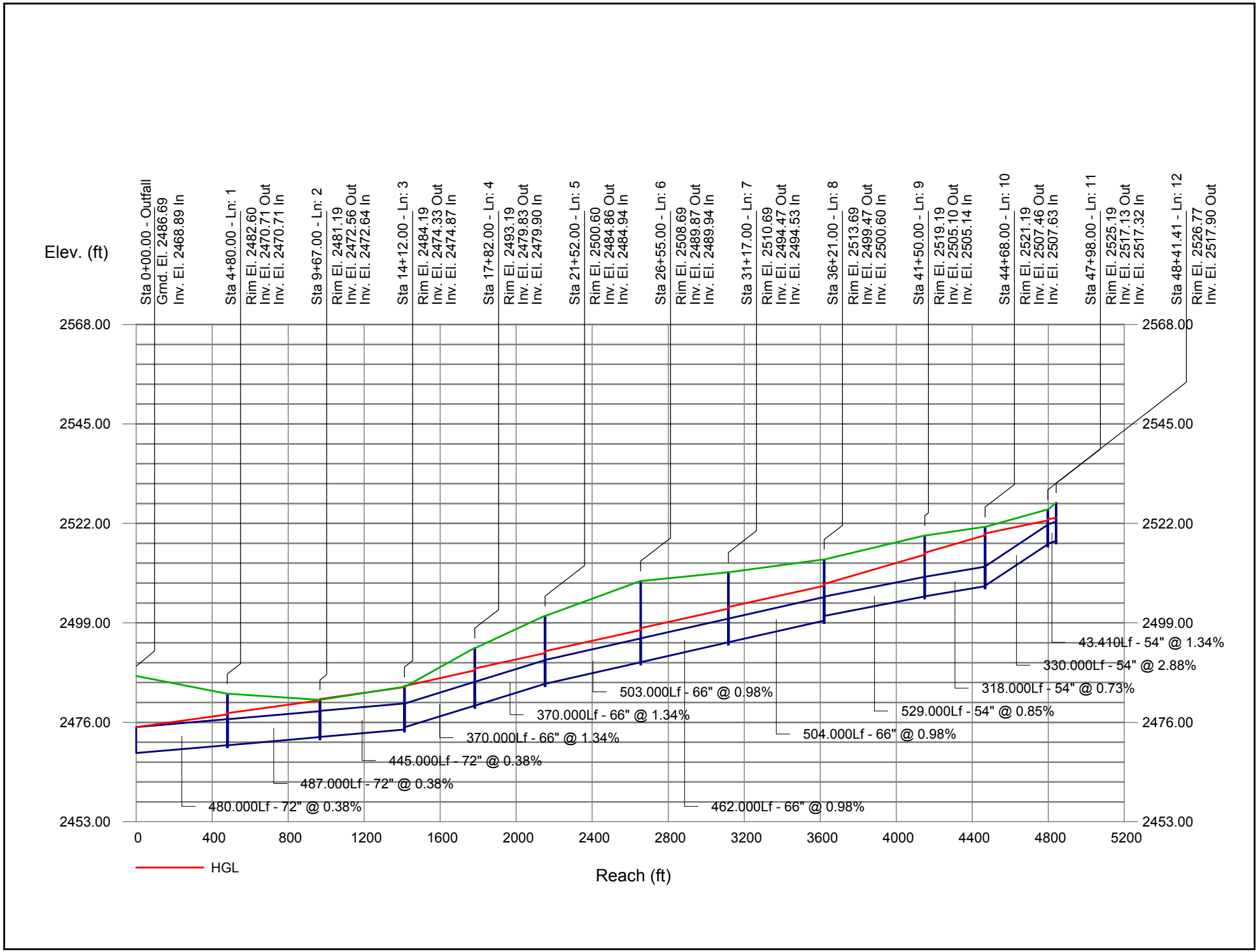
Line No.	Line ID	Flow Rate (cfs)	Capac Full (cfs)	Incr Q (cfs)	Line Size (in)	Line Length (ft)	Line Slope (%)	HGL Dn (ft)	HGL Up (ft)	Vel Ave (ft/s)	J-Loss Coeff
24	10	3.40	16.01	3.40	24	123.690	0.50	2525.74	2525.76	1.08	1.00
25	11	9.70	29.04	9.70	30	163.590	0.50	2526.01	2526.10	1.98	0.50
26	12	2.15	22.62	2.15	24	134.980	1.00	2526.30	2526.31	0.68	0.50
27	26	9.70	22.63	9.70	24	80.900	1.00	2527.43	2527.57	3.09	0.15
28	27	2.75	22.64	2.75	24	50.910	1.00	2528.63	2528.64	0.88	0.50
29	17	13.80	22.64	13.80	24	56.910	1.00	2528.63	2528.84	4.39	0.50
30		5.75	22.61	5.75	24	69.050	1.00	2523.33	2523.36	1.89	0.00

Project File: Revised 1-6-10.stm | Number of lines: 30 | Date: 02-15-2011

NOTES: ** Critical depth

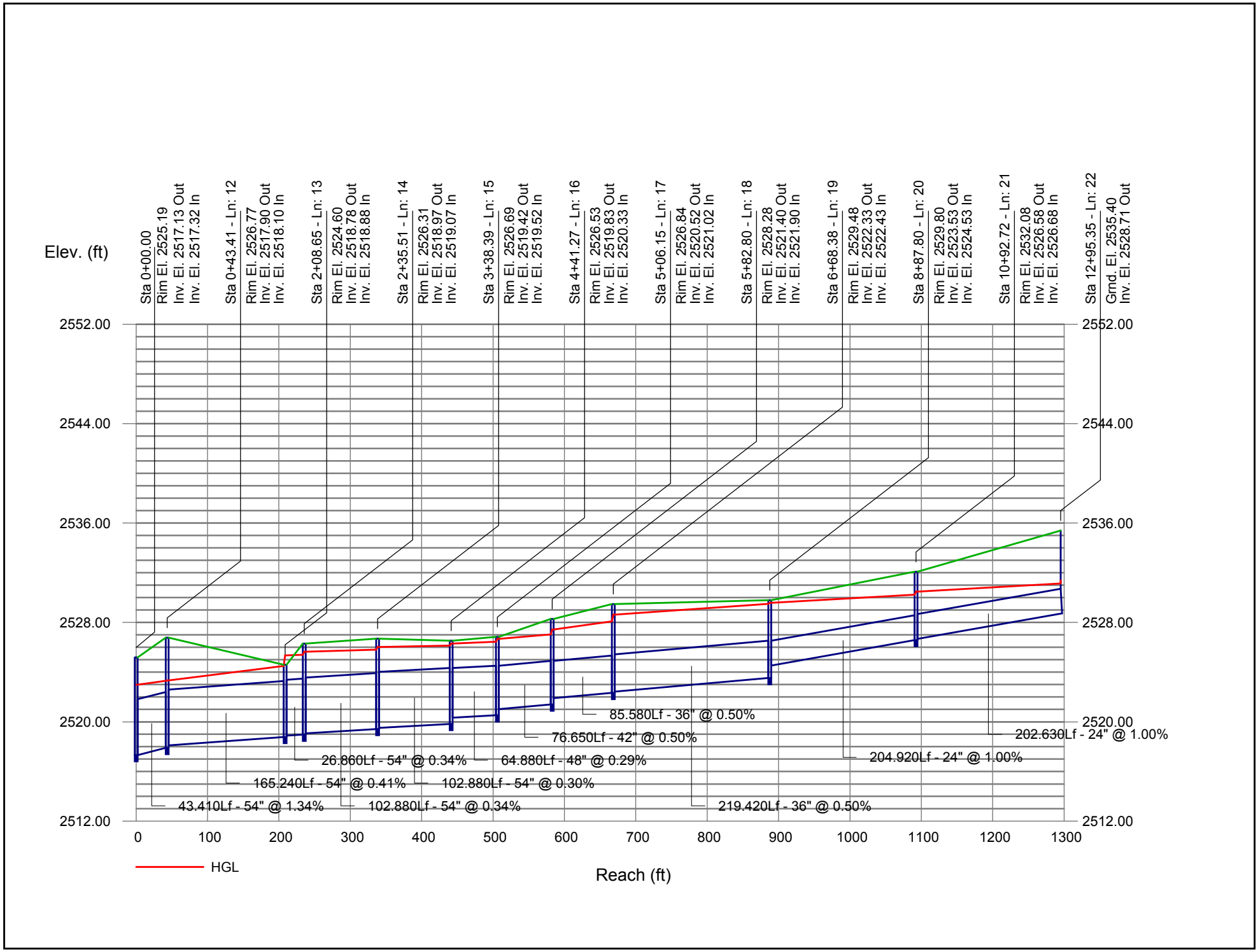
Storm Sewer Profile

Proj. file: Revised 1-6-10.stm



Storm Sewer Profile

Proj. file: Revised 1-6-10.stm



APPENDIX 5

Crestline Dip

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.016	
Channel Slope	0.01000	ft/ft
Constructed Depth	0.40	ft
Constructed Top Width	60.00	ft
Discharge	63.00	ft^3/s

Results

Normal Depth	0.40	ft
Flow Area	16.25	ft^2
Wetted Perimeter	60.27	ft
Hydraulic Radius	0.27	ft
Top Width	60.26	ft
Critical Depth	0.46	ft
Critical Slope	0.00577	ft/ft
Velocity	3.88	ft/s
Velocity Head	0.23	ft
Specific Energy	0.64	ft
Froude Number	1.32	
Flow Type	Supercritical	

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	0.40	ft
Critical Depth	0.46	ft
Channel Slope	0.01000	ft/ft
Critical Slope	0.00577	ft/ft

Crestline Dip section

DISCHARGE	CULVERT WIDTH	HEIGHT	TAILWATER DEPTH	DURATION
63.00CFS	60.00FT	0.40FT	0.20FT	5.00MIN

MAX SCOUR LGT	MAX SCOUR DEPTH	MAX SCOUR WIDTH	SCOUR VOLUME
5.5FT	0.6FT	2.7FT	1.2FT3

MAX DEPTH OCCURS 2.2 FT DOWNSTREAM OF THE CULVERT OUTLET

SCOUR PROFILE		SCOUR X-SECT AT LOC MAX DEPTH	
LENGTH	DEPTH	DIST FROM CL	DEPTH
0.0	0.00	0.0	0.59
0.6	0.19	0.1	0.58
1.1	0.44	0.3	0.54
1.7	0.56	0.4	0.46
2.2	0.59	0.5	0.30
2.8	0.57	0.7	0.14
3.3	0.51	0.8	0.05
3.9	0.42	0.9	0.02
4.4	0.30	1.1	0.01
5.0	0.15	1.2	0.01
5.5	0.00	1.3	0.00

STONE DIAM(D50) REQUIRED TO PREVENT SCOUR UNDER ALL TAILWATER CONDITION
==> 1.27 INCHES ON A HORIZONTAL BLANKET 2D50 THICK.

LENGTH OF HORIZONTAL STONE PROTECTION BLANKET REQUIRED TO PREVENT SCOUR
UNDER ALL TAILWATER CONDITIONS = 5.0FT

THE RIPRAP BLANKET SHOULD BE 3 CULVERT DIAMETERS WID E AT THE CULVERT AND
SHOULD BE FLARED 1(NORMAL TO THE CULVE RT CL) ON 2(PARALLEL TO THE CULVERT
CENTERLINE AND HAVE A THICKNESS EQUAL TO 2D50.

IF THE COMPUTED STONE SIZE (D50) IS NOT REALISTIC, IT CAN BE REDUCED
BY 38 AND 59 PERCENT IF PREFORMED SCOUR HOLES 0.5 OR 1.0 CULVERT DIAMETER
DEEP, RESPECTIVELY, ARE USED. THE BOTTOM OF THE SCOUR HOLE SHOULD BE
3 CULVERT DIAMETER LONG AND 2 CULVERT DIAMETERS WIDE AND SHOULD
BEGIN 1.5 AND 3.0 CULVERT DIAMETERS DOWNSTREAM FROM THE CULVERT EXIT
PORTAL FOR SCOUR HOLE DEPTH OF 0.5 AND 1.0 CULVERT DIAMETERS, RESPECTIVELY.
IT SHOULD HAVE 1V TO 3H SIDE SLOPES IN ALL DIRECTIONS AND HAVE A RIP
RAP THICKNESS EQUAL TO 2D50.

SCUPPER AT N5-1

DISCHARGE	CULVERT WIDTH	HEIGHT	TAILWATER DEPTH	DURATION
4.00CFS	16.00FT	0.50FT	0.25FT	5.00MIN

MAX SCOUR LGT	MAX SCOUR DEPTH	MAX SCOUR WIDTH	SCOUR VOLUME
2.0FT	0.4FT	0.7FT	0.1FT3

MAX DEPTH OCCURS 0.8 FT DOWNSTREAM OF THE CULVERT OUTLET

SCOUR PROFILE		SCOUR X-SECT AT LOC MAX DEPTH	
LENGTH	DEPTH	DIST FROM CL	DEPTH
0.0	0.00	0.0	0.38
0.2	0.12	0.0	0.37
0.4	0.29	0.1	0.35
0.6	0.36	0.1	0.30
0.8	0.38	0.1	0.19
1.0	0.37	0.2	0.09
1.2	0.33	0.2	0.03
1.4	0.27	0.2	0.02
1.6	0.19	0.3	0.01
1.8	0.10	0.3	0.00
2.0	0.00	0.3	0.00

STONE DIAM(D50) REQUIRED TO PREVENT SCOUR UNDER ALL TAILWATER CONDITION
==> 0.15 INCHES ON A HORIZONTAL BLANKET 2D50 THICK.

LENGTH OF HORIZONTAL STONE PROTECTION BLANKET REQUIRED TO PREVENT SCOUR
UNDER ALL TAILWATER CONDITIONS = 1.1FT

THE RIPRAP BLANKET SHOULD BE 3 CULVERT DIAMETERS WID E AT THE CULVERT AND
SHOULD BE FLARED 1(NORMAL TO THE CULVE RT CL) ON 2(PARALLEL TO THE CULVERT
CENTERLINE AND HAVE A THICKNESS EQUAL TO 2D50.

IF THE COMPUTED STONE SIZE (D50) IS NOT REALISTIC, IT CAN BE REDUCED
BY 38 AND 59 PERCENT IF PREFORMED SCOUR HOLES 0.5 OR 1.0 CULVERT DIAMETER
DEEP, RESPECTIVELY, ARE USED. THE BOTTOM OF THE SCOUR HOLE SHOULD BE
3 CULVERT DIAMETER LONG AND 2 CULVERT DIAMETERS WIDE AND SHOULD
BEGIN 1.5 AND 3.0 CULVERT DIAMETERS DOWNSTREAM FROM THE CULVERT EXIT
PORTAL FOR SCOUR HOLE DEPTH OF 0.5 AND 1.0 CULVERT DIAMETERS, RESPECTIVELY.
IT SHOULD HAVE 1V TO 3H SIDE SLOPES IN ALL DIRECTIONS AND HAVE A RIP
RAP THICKNESS EQUAL TO 2D50.

SCUPPER AT N6-1

DISCHARGE	CULVERT WIDTH	HEIGHT	TAILWATER DEPTH	DURATION
4.00CFS	16.00FT	0.50FT	0.25FT	5.00MIN

MAX SCOUR LGT	MAX SCOUR DEPTH	MAX SCOUR WIDTH	SCOUR VOLUME
2.0FT	0.4FT	0.7FT	0.1FT3

MAX DEPTH OCCURS 0.8 FT DOWNSTREAM OF THE CULVERT OUTLET

SCOUR PROFILE		SCOUR X-SECT AT LOC MAX DEPTH	
LENGTH	DEPTH	DIST FROM CL	DEPTH
0.0	0.00	0.0	0.38
0.2	0.12	0.0	0.37
0.4	0.29	0.1	0.35
0.6	0.36	0.1	0.30
0.8	0.38	0.1	0.19
1.0	0.37	0.2	0.09
1.2	0.33	0.2	0.03
1.4	0.27	0.2	0.02
1.6	0.19	0.3	0.01
1.8	0.10	0.3	0.00
2.0	0.00	0.3	0.00

STONE DIAM(D50) REQUIRED TO PREVENT SCOUR UNDER ALL TAILWATER CONDITION
==> 0.15 INCHES ON A HORIZONTAL BLANKET 2D50 THICK.

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