FINAL DRAINAGE REPORT
REPORT
FOR
HOUGHTON ROAD
IRVINGTON ROAD TO VALENCIA ROAD

February 19, 2010

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ARIZONA U.S.A.
Expires 9/30/2011

FINAL DRAINAGE REPORT
FOR
HOUGHTON ROAD
IRVINGTON ROAD TO VALENCIA ROAD

Location:
This project is located within
Township 14 South, Range 15 East, Sections 35, and 36
And Township 15 South, Range 15 East, Sections 01, 02, 11, 12, 13, and 14;
Within the City of Tucson
Pima County, Arizona

Prepared for:
City of Tucson
Department of Transportation
201 N. Stone Avenue
Tucson, AZ 85701

February 19, 2010

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1.0 INTRODUCTION

This Drainage Report addresses a three-mile segment of the Houghton Corridor, from north of Irvington Road to north of Valencia Road and improvements along side streets. This roadway segment is located in Township 14, Range 15, Sections 35 and 36 and Township 15, Range 15, Sections 1, 2, 11, 12, 13 and 14. Houghton Road is currently a two-lane roadway and will be widened to a six-lane roadway with depressed vegetated medians, turn lanes, bike, pedestrian, and bus facilities. The roadway improvements will include curb at all signalized intersections, a main storm drain system that begins at Seven Generations Way and discharges into the Pantano Wash north of Irvington Road and various smaller storm drain systems. The Houghton Corridor will serve as a cross town corridor as well as serve existing and prospective residential and commercial developments in the area. Figure 1, Location Map shows the project extents.

Within this segment of the Houghton Corridor, the roadway crosses the Attebury Wash, the Mesquite Ranch Wash, an unnamed wash just south of Poorman Road and numerous smaller watercourses. Flow currently crosses the road as sheet flow or through existing culverts. Several existing channels convey flow parallel to the road before discharging through culverts to the west. Flow across Houghton Road throughout the project generally originates from the southeast and flows to the northwest. Existing channels and culverts will be modified, removed or replaced to accommodate the roadway design and minimize impact on the existing drainage patterns.

2.0 OBJECTIVES

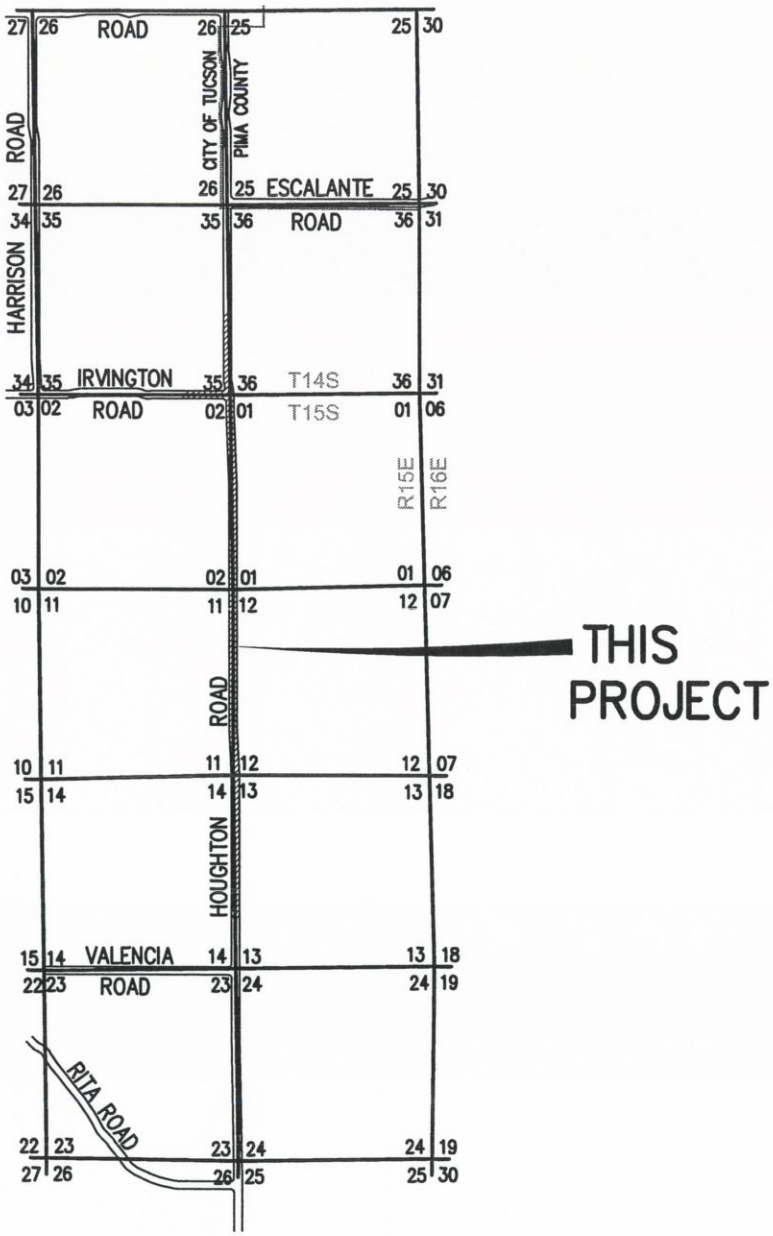
The intent of this report is to provide a drainage design which conveys stormwater runoff safely and efficiently through the project limits.

The following tasks were completed as part of the drainage report preparation for Houghton Road:

- Peak discharges for both onsite and offsite watersheds were determined. Onsite discharges were calculated using City of Tucson (COT) methodology. Offsite watershed peak discharges were extracted from existing approved reports and from Tucson Stormwater Management Study (TSMS) nodes.
- Drainage structures including catch basins, transverse grates, channels, culverts, stormdrain and erosion protection were located and sized for the safe and efficient conveyance of runoff.
- Regulatory floodplains ($Q \geq 100$ cfs) and FEMA Floodplains were evaluated.

The remainder of this report describes the assumptions made and reasoning used to design the drainage scheme and summarizes the results of the hydrologic and hydraulic calculations used as part of this design. Figures and calculations are provided as technical support.

SCALE: 1" = 1 Mile



LOCATION MAP

Sections 35 and 36 of Township 14 South, Range 15 East
Sections 01, 02, 11, 12, 13 and 14 of Township 15 South, Range 15 East
City of Tucson, Pima County, Arizona

3.0 EXISTING CONDITIONS

3.1 Hydrologic Analysis

Under existing conditions, discharges concentrated at Houghton Road are generated to the east from both undeveloped land and from various subdivisions. The offsite peak discharges used in this report were obtained from three sources; existing approved subdivision drainage reports, TSMS nodes, and one discharge was taken from the approved Houghton Road Design Concept Report (DCR). Table 1 provides a summary of the offsite discharges utilized in the drainage analysis.

Table 1: Summary of Hydrologic Analysis (Offsite Existing Conditions)

C.P.	Q_{100} (cfs)	SOURCE
1	4	Civano Block 1, Ph. 2 & 3, Fig. 1 **(CP D43a)**
2	26	Civano Block 1, Ph. 2 & 3, Fig. 1 **(CP D43)**
3	20	Civano Block 1, Ph. 2 & 3, Fig. 3, pg 3 of 3 **(CP D42)**
4	12	Civano Block 1, Ph. 2 & 3, Fig. 3, pg 3 of 3 **(CP D109)**
5	9	Civano Block 1, Ph. 2 & 3, Fig. 3, pg 3 of 3 **(CP D106)**
6	9	Civano Block 1, Ph. 2 & 3, Fig. 3, pg 3 of 3 **(CP D102)**
7	37	Civano Villas, Fig. 5 **(CP D1)**
8	40	Civano Villas, Fig. 5 **(CP D5)**
9	23.5	Watershed CH12
10	756	Mesquite Ranch Wash, TSMS Node UN-N0010
11	45	Civano 2, Fig 3B **(CP10REV)**
12**	109	**Psomas Tech Memo Civano Block II, Houghton Road Channel Revision
13**	104	**Psomas Tech Memo Civano Block II, Houghton Road Channel Revision
14**	99	**Psomas Tech Memo Civano Block II, Houghton Road Channel Revision
15**	90	**Psomas Tech Memo Civano Block II, Houghton Road Channel Revision
16**	86	**Psomas Tech Memo Civano Block II, Houghton Road Channel Revision
17	6.4	Mesquite Ranch, Fig. 5 **(CP C12)**
18	83.1	Mesquite Ranch, Fig. 5 **(CP P2)**
19	0.7	Mesquite Ranch, Fig. 5 **(CP A9)**
20	50.2	Mesquite Ranch, Fig. 5 **(CP C5)**
21	31.6	Mesquite Ranch, Fig. 5 **(CP C10)**
22	763	Houghton Road DCR **(CP12) The watershed area has been adjusted**
24*	1623	Attebury Wash, Reach 40 between TSMS Node UG-N0040 & UG-N0050
25*		

* Discharge is split between two culverts per the Flo2D analysis

** Discharges are cumulative along the channel per the referenced memo

NOTE: C.P. numbers correspond to keynotes on Figure 3

3.2 Existing Drainage Structures

Along Houghton Road, the existing drainage structures consist of culverts, channels and swales. Defined channels are located along the east side of the road adjacent to the developed portions of land that convey flow parallel to Houghton Road. Culverts are located at some of the existing driveways and cross streets to convey flow to the north between channel segments. There are also culverts under Houghton Road that convey flow to the west. In general, swales are located parallel to Houghton adjacent to the undeveloped parcels of land. There is one cross drainage culvert along Irvington Road that conveys flow from the south to the north. As part of this project, all of the existing culverts along Houghton Road will be removed and replaced such that drainage patterns remain similar to existing conditions. The culvert on Irvington Road will be extended. The proposed culvert locations and analysis will be discussed in Section 4.3, Cross Drainage.

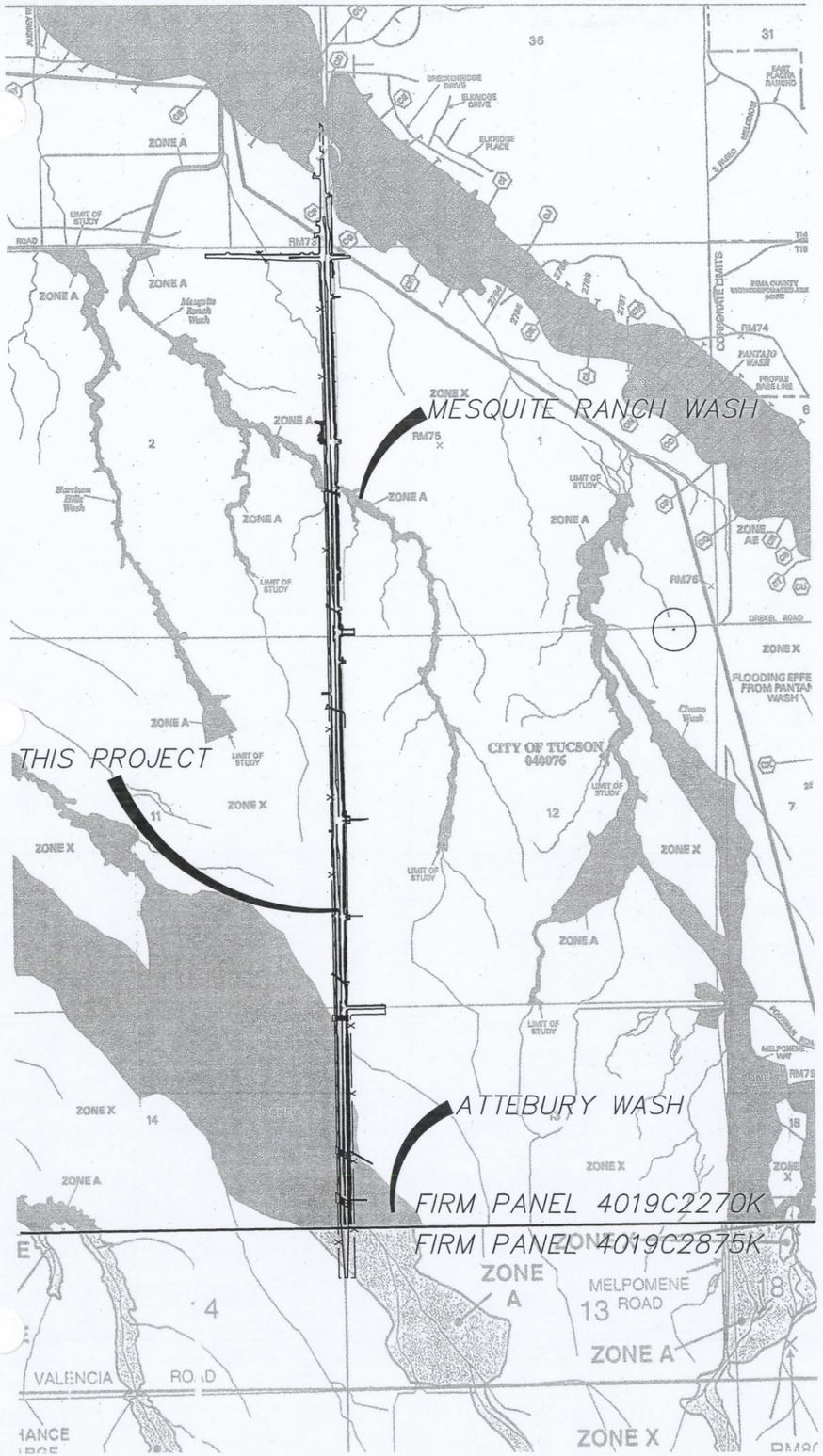
3.3 Existing Floodplains

Two regulatory Federal Emergency Management Agency (FEMA) floodplains are located within the project limits. Both floodplains are designated as Zone A with the remainder of the project located within Zone X (unshaded). FIRM Panel 04019C2875K, Effective Date January 06, 2006 and FIRM Panel 04019C2270K, Effective Date January 06, 2006 were utilized to determine where the floodplains were located. Per the FIRM Panel legend, Zone X (unshaded) denotes areas outside of the 500-year floodplain and Zone A denotes Special Flood Hazard Areas Inundated by the 100-year flood (1% annual chance) where base flood elevations have not been determined. The floodplains are associated with the Mesquite Ranch Wash and Attebury Wash. The existing FEMA floodplain limits are depicted on Figure 3, FEMA FIRM Panel.

Mesquite Ranch Wash is located south of Seven Generations Way and is a defined channel that conveys flow under Houghton Road through an existing 10' x 8' concrete box culvert. The culvert is going to be replaced with 2-10' x 6' concrete box culverts that have the ability to convey more flow than the existing culvert. Since the discharge is contained within the existing channel and the replacement culvert has more capacity than the existing, there will not be an increase in water surface elevation and the floodplain limits will not be negatively

impacted. For those reasons it is not anticipated that a Conditional Letter of Map Revision (CLOMR) and Letter of Map revision (LOMR) are required.

The Attebury Wash is located south of Mesquite Ranch Wash and north of Valencia Road. The flow within the Attebury Wash is shallow sheet flow as it crosses over Houghton Road during the 100-year storm event. The existing floodplain crosses approximately 2400 feet of Houghton road. The proposed improvements for this project will concentrate flow at two locations and thus have an impact on the flow depths within the floodplain. The extents of the floodplain remain essentially the same. Since the floodplain is currently mapped as a Zone A and the extents have not been increased, a CLOMR/LOMR is not necessary. The improvements and effects on the floodplain will be further discussed in Section 4.4, State Land Improvements. A technical memorandum was prepared for the State Land Department detailing the proposed improvements and impacts to their property, which includes the Attebury Wash Floodplain. This memorandum, including exhibits that show floodplain limits, depths and changes to depths due to improvements can be found in Appendix D.



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.

UNDEVELOPED COASTAL BARRIERS

Identified 1983 | Identified 1990 | Otherwise Protected Areas

Coastal barrier areas are normally located within or adjacent to Special Flood Hazard Areas.

Floodplain Boundary

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 BFEs, 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 120 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

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL:

Refer to the FLOOD INSURANCE RATE MAP EFFECTIVE DATE shown on this map to determine when actuarial rates apply to structures in zones where elevations or depths have been established.

To determine if flood insurance is available, contact an insurance agent or call the National Flood Insurance Program at (800) 638-6620.

NATIONAL FLOOD INSURANCE PROGRAM

FIRM
FLOOD INSURANCE RATE MAP

PIMA COUNTY,
ARIZONA
AND INCORPORATED AREAS

PANEL 2875 OF 4700

(SEE MAP INDEX FOR PANELS NOT PRINTED)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
PIMA COUNTY, UNINCORPORATED AREAS	040073	2875	K

REVISED TO
REFLECT LOMR
DATED JAN 27 2006

MAP NUMBER
04019C2875 K

EFFECTIVE DATE:
FEBRUARY 8, 1999

Federal Emergency Management Agency

LEGEND

SPECIAL FLOOD HAZARD AREAS SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD EVENT

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water surface elevation of the 1% annual chance 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 AR Area of special flood hazard formerly protected from the 1% annual chance flood event by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood event.

ZONE A99 Area to be protected from 1% annual chance flood event by a Federal flood protection system under construction; no base flood elevations determined.

ZONE V Coastal flood zone with velocity hazard (wave action); no base flood elevations determined.

ZONE VE Coastal flood zone with velocity hazard (wave action); base flood elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X Areas determined to be outside the 0.2% annual chance floodplain.

ZONE D Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

Floodplain boundary

Floodway boundary

Zone D boundary

CBRS and OPA boundary

Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or velocities.

~~~513~~~ Base Flood Elevation line and value; elevation in 1*

(EL 987) Base Flood Elevation value where uniform within zone; elevation in 1*

*Referenced to the National Geodetic Vertical Datum of 1929

(A)———(A) Cross Section Line

(23)- - - - - -(23) Transect Line

97°07'30", 32°22'30" Geographic coordinates referenced to the North American Datum of 1927 (NAD 27)

4276000M 1000-meter Universal Transverse Mercator grid values, zone 12

600000 FT 5000-foot grid ticks

DX5510 × Bench mark (see explanation in Notes to Users section of this FIRM panel).

• M1.5 River Mile

MAP REPOSITORY
Refer to Repository Listing on Index Map

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

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at (800) 638-6620.

MAP SCALE 1" = 1000'

500 0 1000 2000 FEET

300 0 300 600 METERS

NFIP

PANEL 2270K

FIRM
FLOOD INSURANCE RATE MAP

PIMA COUNTY,
ARIZONA
AND INCORPORATED AREAS

PANEL 2270 OF 4700

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
PIMA COUNTY, UNINCORPORATED AREAS	040073	2270	K
TUCSON, CITY OF	040076	2270	K

REVISED TO
REFLECT LOMR
DATED JAN 27 2006

Notice to User: The Map Number shown below should be used when placing map orders; the Community Number shown above should be used on insurance applications for the subject community.

MAP NUMBER
04019C2270K

EFFECTIVE DATE:
FEBRUARY 8, 1999

FIGURE 2: FEMA FIRM MAP

90%
PRELIMINARY
NOT FOR
CONSTRUCTION

PSOMAS
800 E. Wetmore Road, Suite 110
Tucson, AZ 85719
(520) 292-2300 (520) 292-1290 fax
www.psomas.com

NO.	DATE	REVISION	BY	CHKD.	APPR.

DEPARTMENT OF TRANSPORTATION/ENGINEERING DIVISION
HOUGHTON ROAD
IRVINGTON RD TO VALENCIA RD

1 OF 1

CITY OF TUCSON

DRWN. BY CLR	08/09	REF.	SCALE: 1"=40'
DSGN. BY JO	08/09		N/A
CHKD. BY	01/10	PLAN NO. I-2007-001	

3.4 Existing Conditions Hydraulic Analysis

An existing conditions Flo-2D analysis was produced for the Attebury Wash. Flo2D was chosen due to the shallow sheet flow conditions within this wash that HEC-RAS cannot appropriately model. The model extends from Valencia Road to roughly 1000 feet downstream of Houghton Road. The model was created using Pima Associations of Governments (PAG) Digital Elevation Model (DEM) data and grid cell elevations interpolated on a 20 foot grid. The Manning's roughness values were set globally at 0.04 and a Shallow Flow N-Value of 0.10 was used. The Floodplain Limiting Froude No. was set at 0.99. The inflow hydrograph within the Flo-2D model was extracted from the TSMS HEC-1 model for the Attebury Wash watershed provided by the City of Tucson from the Q_{100} TSMS model and was used for the existing FEMA floodplain mapping at the Attebury Wash. The hydrograph used was from Reach 40 within the model, which is the routing reach located between TSMS Nodes UG-N0040 (upstream of Houghton Road) and UG-N0050 (downstream of Houghton Road). This hydrograph was evenly distributed across multiple cells at the downstream end of the culvert crossing at Valencia Road. Overlaying the existing FEMA floodplain limits on the results from the Flo-2D analysis shows essentially the same floodplain limits. Figure 1 of the State Land Memorandum included in Appendix D depicts the floodplain limits produced by the Flo2D analysis as compared to the effective FEMA floodplain.

A second Flo2D model was created for an unnamed wash just south of Poorman Road. This wash has a peak discharge of 763 cfs and is also conveyed across Houghton Road as sheet flow. The same model parameters were used in this model as were used in the Attebury Wash model. The hydrograph for this peak discharge was generated using the computer program PC Hydro, which utilizes the Pima County modified rational method to determine peak discharges. The floodplain resulting from this analysis is depicted on Figure 3 of the technical memorandum prepared for the State Land Department which can be found in Appendix D.

4.0 DEVELOPED CONDITIONS

4.1 Hydrologic Analysis

The developed conditions hydrologic analysis was performed using COT methodology. Watersheds were delineated using project topography where available, PAG DEM data and the design drawings. Basin factors and flood event ratios were determined based on proposed conditions per the guidelines in the Standards Manual for Drainage Design and Floodplain Management (SMDDFM). The 10-year storm peak discharge was estimated as 50% of the 100-year storm event for all watersheds using Table 4.5 of the SMDDFM based on watershed type. Soil types were determined from soil surveys available through the Natural Resources Conservation Service (NRCS). Areas, watercourse lengths, slopes and impervious percentages were determined based on the design.

Watershed delineation along the roadway was constrained by the need to meet spread criteria along segments of the roadway that have curb. In roadway segments without curb, watersheds were only delineated if they were going to contribute to a roadside channel or ditch. Seven offsite watersheds where peak discharges were not available from existing sources were required to be delineated under proposed conditions due to the need to size roadside channels, driveway culvert crossings and stormdrain. These five watersheds are ST13, ST14, CH7, CH8 and CH10. Watershed ST13 is the Quikmart parking lot and contributes to the proposed stormdrain in Houghton Road. ST14 was delineated at the southeast corner of Irvington Road and Houghton Road to determine the peak flow to contribute to the stormdrain system. CH7 was delineated in order to size a roadside channel between Mesquite Ranch Wash and Drexel Road, and CH8 was delineated to size a driveway culvert crossing and roadside channel. CH10 was delineated for a small swale at the northeast corner of the intersection of Houghton Road and Irvington Road that surrounds a utility pole. CH11 was delineated to size a driveway culvert along the east side of Houghton Road north of Irvington Road. CH12 was delineated to determine the amount of flow contributing to the stormdrain mainline from the Civano Nursery.

Watersheds are labeled with designations such as PV1, CH1 and ST1. In general, watersheds with a PV label are along roadway segments that have curb. With the exception of ST13 and ST14, watersheds with an ST label are along roadway segments without curb. Watersheds with a CH designation are located outside of the pavement. Along the Civano subdivision, (CH2-CH6), the watersheds delineated include all the area from the edge of pavement to the middle of the adjacent lots. It was necessary to include the rear half of the lots since there are wall openings provided at each lot for drainage.

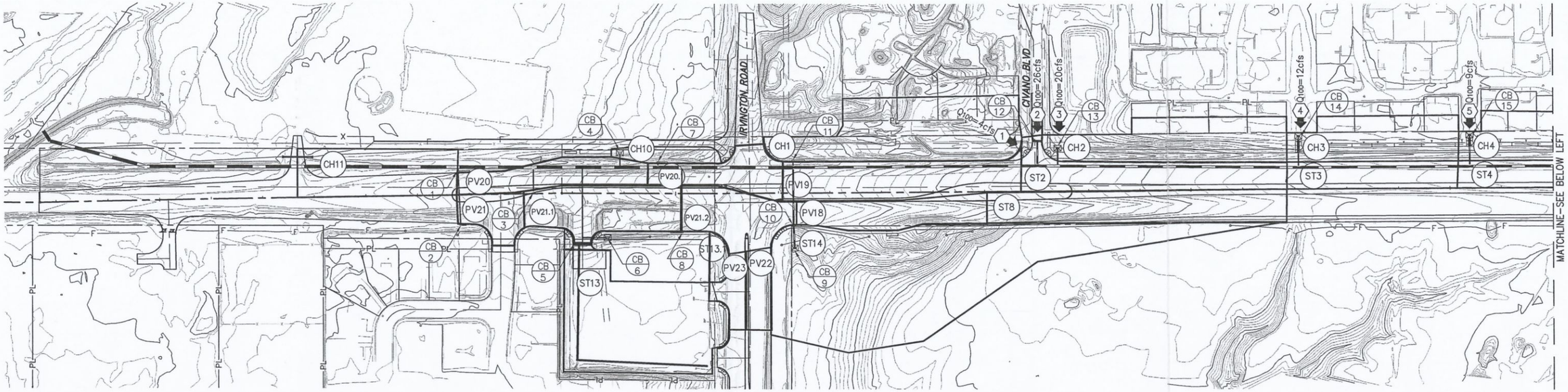
Table 2, Developed Conditions Hydrologic Analysis, provides a summary of the parameters and peak discharges associated with the analysis. Figure 3, Developed Conditions Watershed Map, shows the watershed delineations. Calculation sheets are provided in Appendix A.

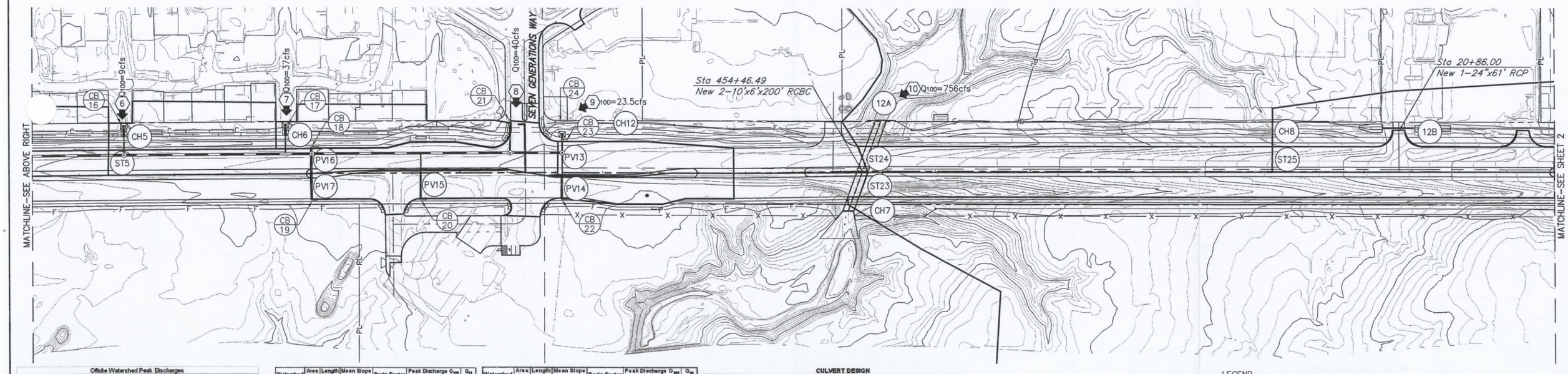
Table 2: Summary of Hydrologic Analysis (Developed Conditions)

Watershed	Area	Length	Mean Slope	Basin Factor	Peak Discharge Q_{100}	Q_{10}
	(ac)	(ft)	(%)		(cfs)	(cfs)
PV1	0.52	411	1.90	0.052	4.7	2.4
PV1.1	1.27	714	1.09	0.052	10.7	5.4
PV2	1.18	566	1.90	0.052	10.8	5.4
PV2.1	0.26	178	0.70	0.052	2.4	1.2
PV3	0.55	233	1.90	0.052	5.0	2.5
PV3.1	0.21	178	0.70	0.052	1.9	1.0
PV4	0.54	370	0.80	0.052	4.9	2.5
PV5	0.72	720	0.83	0.052	5.9	3.0
PV6	1.02	773	0.80	0.052	8.2	4.1
PV7	0.84	433	1.00	0.052	7.6	3.8
PV8	0.92	627	0.70	0.052	7.6	3.8
PV8.1	0.70	268	0.75	0.052	6.4	3.2
PV9	1.56	1061	0.86	0.052	12.0	6.0
PV10	0.48	372	0.75	0.052	4.3	2.2
PV11	0.32	249	3.50	0.052	2.9	1.5
PV11.1	0.59	354	3.50	0.052	5.4	2.7
PV12	0.34	248	3.50	0.052	3.1	1.6
PV12.1	1.10	744	0.75	0.052	8.9	4.5
PV13	0.57	370	0.50	0.052	4.9	2.5
PV14	0.46	362	0.50	0.052	4.0	2.0
PV15	0.45	294	0.50	0.052	4.0	2.0
PV16	0.73	517	0.50	0.052	6.0	3.0
PV17	0.35	230	0.50	0.052	3.2	1.6
PV18	0.47	369	3.20	0.052	4.3	2.2
PV19	0.77	462	3.20	0.052	7.0	3.5
PV20	0.37	369	3.90	0.052	3.4	1.7
PV20.1	0.37	261	5.10	0.052	3.4	1.7
PV21	1.32	656	3.90	0.052	12.0	6.0
PV21.1	0.50	230	3.90	0.052	4.6	2.3
PV21.2	0.35	174	3.90	0.052	3.2	1.6
PV22	0.17	157	0.50	0.052	1.6	0.8
PV23	0.16	151	0.50	0.052	1.5	0.8
PV26	0.16	198	1.44	0.052	1.5	0.8

Table 2(continued): Summary of Hydrologic Analysis (Developed Conditions)

Watershed	Area	Length	Mean Slope	Basin Factor	Peak Discharge Q_{100}	Q_{10}
	(ac)	(ft)	(%)		(cfs)	(cfs)
ST2	0.71	474	2.11	0.052	6.3	3.2
ST3	0.40	308	0.97	0.052	3.5	1.8
ST4	0.42	322	0.62	0.052	3.6	1.8
ST5	0.51	328	0.61	0.052	4.4	2.2
ST8	0.74	466	1.93	0.052	6.5	3.3
ST13	1.952	516	0.39	0.052	11.7	5.9
ST13.1	.53	260	0.77	0.052	4.2	2.1
ST14	2.60	786	3.05	0.052	15.0	7.5
ST15	1.84	1129	0.89	0.052	13.5	6.8
ST17	0.67	504	0.85	0.052	5.6	2.8
ST23	1.76	1422	1.76	0.052	13.6	6.8
ST24	1.06	844	1.42	0.052	8.7	4.4
ST25	0.79	581	2.24	0.052	7.0	3.5
ST30	0.68	621	0.64	0.052	5.4	2.7
CH1	1.14	464	3.45	0.042	7.2	3.6
CH2	0.81	446	3.81	0.042	5.1	2.6
CH3	0.63	312	2.56	0.042	4.0	2.0
CH4	0.71	322	1.55	0.042	4.5	2.3
CH5	0.76	328	1.22	0.042	4.8	2.4
CH6	0.82	474	0.63	0.042	5.0	2.5
CH7	23.27	2343	2.22	0.052	105.3	52.7
CH8	2.41	932	0.54	0.052	10.8	5.4
CH9	0.93	300	1.33	0.052	5.5	2.8
CH10	0.14	180	0.56	0.052	0.8	0.4
CH11	0.65	290	2.63	0.052	4.8	2.4
CH12	5.03	750	0.40	0.052	23.5	11.8





Offsite Watershed Peak Discharges

ID	Q_{100} (cfs)	SOURCE
1	4	Civano Block 1, Ph. 2 & 3, Fig. 1 (CP D43a)
2	26	Civano Block 1, Ph. 2 & 3, Fig. 1 (CP D43)
3	20	Civano Block 1, Ph. 2 & 3, Fig. 3, pg 3 of 3 (CP D42)
4	12	Civano Block 1, Ph. 2 & 3, Fig. 3, pg 3 of 3 (CP D100)
5	9	Civano Block 1, Ph. 2 & 3, Fig. 3, pg 3 of 3 (CP D106)
6	9	Civano Block 1, Ph. 2 & 3, Fig. 3, pg 3 of 3 (CP D102)
7	37	Civano Villas, Fig. 5 (CP D1)
8	40	Civano Villas, Fig. 5 (CP D5)
9	23.5	Watershed CH12
10	756	Mesquite Ranch Wash, TSMS Node UN-N0010
11	45	Civano 2, Fig 3B (CP 10REV)
12**	109	**Psomas Tech Memo Civano Block II, Houghton Road Channel Revision
13**	104	**Psomas Tech Memo Civano Block II, Houghton Road Channel Revision
14**	99	**Psomas Tech Memo Civano Block II, Houghton Road Channel Revision
15**	90	**Psomas Tech Memo Civano Block II, Houghton Road Channel Revision
16**	[illegible]	**Psomas Tech Memo Civano Block II, Houghton Road Channel Revision
17	[illegible]	Mesquite Ranch, Fig. 5 (CP C12)
18	[illegible]	Mesquite Ranch, Fig. 5 (CP P2)
19	[illegible]	Mesquite Ranch, Fig. 5 (CP A9)
20	50.2	Mesquite Ranch, Fig. 5 (CP C9)
21	31.6	Mesquite Ranch, Fig. 5 (CP C10)
22	776	Houghton Road DCR (CP 12)
23	75	Mesquite Ranch, Fig. 5 (CP OS1)
24*	1623	Atterbury Wash, Reach 40 between TSMS Node UG-N0040 & UG-N0050
25*		

* Discharge is split between two culverts per the Flo2D analysis
** Discharges are cumulative along the channel per the memo
NOTE: ID numbers correspond to keynotes on Figure 4

Watershed	Area (ac)	Length (ft)	Mean Slope (%)	Basin Factor	Peak Discharge Q_{200} (cfs)	Q_{50} (cfs)
PV1	0.52	411	1.90	0.052	4.7	2.4
PV1.1	1.27	714	1.09	0.052	10.7	5.4
PV2	1.18	566	1.90	0.052	10.8	5.4
PV2.1	0.26	178	0.70	0.052	2.4	1.2
PV3	0.55	233	1.90	0.052	5.0	2.5
PV3.1	0.21	176	0.70	0.052	1.9	1.0
PV4	0.54	370	0.80	0.052	4.9	2.5
PV5	0.72	720	0.83	0.052	5.9	3.0
PV6	1.02	773	0.80	0.052	8.2	4.1
PV7	0.84	433	1.00	0.052	7.6	3.8
PV8	0.92	627	0.70	0.052	7.6	3.8
PV8.1	0.70	268	0.75	0.052	6.4	3.2
PV9	1.56	1061	0.86	0.052	12.0	6.0
PV10	0.46	372	0.75	0.052	4.3	2.2
PV11	0.32	249	3.50	0.052	2.9	1.5
PV11.1	0.59	354	3.50	0.052	5.4	2.7
PV12	0.34	248	3.50	0.052	3.1	1.6
PV12.1	1.10	744	0.75	0.052	8.9	4.5
PV13	0.57	370	0.50	0.052	4.9	2.5
PV14	0.46	362	0.50	0.052	4.0	2.0
PV15	0.45	294	0.50	0.052	4.0	2.0
PV16	0.73	517	0.50	0.052	6.0	3.0
PV17	0.35	230	0.50	0.052	3.2	1.6
PV18	0.47	369	3.20	0.052	4.3	2.2
PV19	0.77	462	3.20	0.052	7.0	3.5
PV20	0.37	369	3.90	0.052	3.4	1.7
PV20.1	0.37	261	5.10	0.052	3.4	1.7
PV21	1.32	656	3.90	0.052	12.0	6.0
PV21.1	0.50	230	3.90	0.052	4.6	2.3
PV21.2	0.35	174	3.90	0.052	3.2	1.6
PV22	0.17	157	0.50	0.052	1.6	0.8
PV23	0.16	151	0.50	0.052	1.5	0.8
PV26	0.16	198	1.44	0.052	1.5	0.8

Watershed	Area (ac)	Length (ft)	Mean Slope (%)	Basin Factor	Peak Discharge Q_{200} (cfs)	Q_{50} (cfs)
ST2	0.71	474	2.11	0.052	6.3	3.2
ST3	0.40	308	0.97	0.052	3.5	1.8
ST4	0.42	322	0.62	0.052	3.6	1.8
ST5	0.51	328	0.61	0.052	4.4	2.2
ST8	0.74	466	1.93	0.052	6.5	3.3
ST13	1.52	516	0.39	0.052	11.7	5.9
ST13.1	0.53	260	0.77	0.052	4.2	2.1
ST14	2.60	786	3.05	0.052	15.0	7.5
ST15	1.84	1129	0.89	0.052	13.5	6.8
ST17	0.87	504	0.85	0.052	5.6	2.8
ST23	1.76	1422	1.76	0.052	13.6	6.8
ST24	1.06	844	1.42	0.052	8.7	4.4
ST25	0.79	561	2.24	0.052	7.0	3.5
ST30	0.68	621	0.64	0.052	5.4	2.7
CH1	1.14	464	3.45	0.042	7.2	3.6
CH2	0.81	446	3.81	0.042	5.1	2.6
CH3	0.63	312	2.56	0.042	4.0	2.0
CH4	0.71	322	1.55	0.042	4.5	2.3
CH5	0.76	328	1.22	0.042	4.8	2.4
CH6	0.82	474	0.63	0.042	5.0	2.5
CH7	23.27	2343	2.22	0.052	105.3	52.7
CH8	2.41	932	0.54	0.052	10.8	5.4
CH9	0.93	300	1.33	0.052	5.5	2.8
CH10	0.14	190	0.58	0.052	0.8	0.4
CH11	0.65	290	2.63	0.052	4.8	2.4
CH12	5.08	750	0.40	0.052	23.5	11.8

CULVERT DESIGN

Culvert ID	CP	Culvert	Station	Length (ft)	Invert Elevation (ft) DS	Invert Elevation (ft) US	Slope (%)	HW_{100} (ft)	HW_{100} (ft)	Velocity (fps)	Q_{100} (cfs)
D01	12A	2-10'x6' RCBC	454+46.49	204	2832.49	2833.92	0.70	6.20	2840.12	13.47	756
D02	12B	1-24" RCP	20+92	61	2858.73	2859.34	1.00	2.25	2861.59	7.50	14
D03	13A	3-24" RCP	471+02.43	196	2871.05	2877.52	3.30	2.77	2880.29	12.83	57
D04	13B	3-24" RCP	21+07.01	118	2878.51	2879.10	0.50	2.81	2881.91	7.19	57
D05	13C	3-24" RCP	21+05.01	53	2882.62	2882.88	0.49	2.53	2885.41	6.79	51
D06	14	3-36" RCP	485+00.41	195	2885.53	2888.45	1.50	3.74	2892.19	12.08	152
D07	15A	3-30" RCP	21+12.00	131	2895.02	2897.18	1.65	3.92	2901.10	11.41	111
D08	15B	3-24" RCP	21+05.00	104	2908.20	2908.82	0.60	2.89	2911.71	7.33	59
D09	16	3-30" RCP	522+86.63	251	2909.33	2912.59	1.30	2.19	2914.78	8.67	49
D10	17	6-10x4' RCBC	528+20.00	174	2914.74	2915.79	0.60	3.00	2918.79	9.28	763
D11	18A	6-10x4' RCBC	547+26.31	196	2928.93	2930.30	0.70	2.50	2932.80	8.87	580
D12	18B	6-12x4' RCBC	553+98.93	188	2932.61	2933.55	0.50	3.24	2936.79	9.26	1051
D13	19	3-48"	11+39.85	34	2792.91	2793.59	2.00	4.88	2798.27	9.21	264
D13*	19	3-48" RCP	11+39.85	102	2792.11	2792.91	0.78	4.82	2797.73	10.69	264

* Existing culvert to be extended upstream. This is of the existing culvert to determine outlet velocity

100 0 50 100 150 200

LEGEND

- (PV1) ONSITE CONCENTRATION POINT
- (2) OFFSITE CONCENTRATION POINT
- Q100=37cfs 100–YEAR DISCHARGE
- (CB 4) CATCH BASIN ID
- WATERSHED BOUNDARY

Two working days before you dig, CALL FOR THE BLUE STAKES
1-800-STAKE-IT
Blue Stake Center CALL COLLECT

FIGURE 3: DEVELOPED CONDITIONS MAP

90% PRELIMINARY NOT FOR CONSTRUCTION

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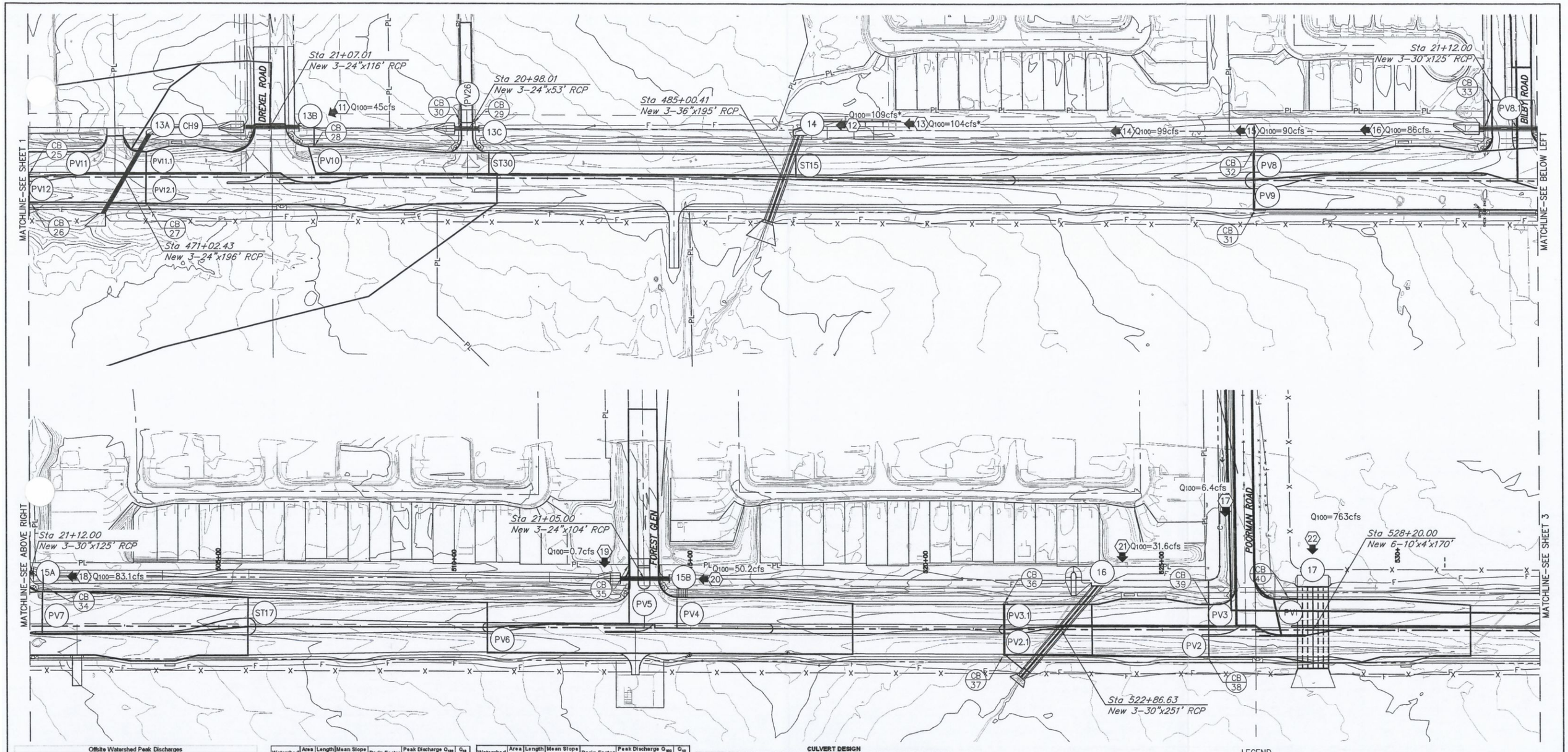
NO.	DATE	REVISION	BY	CHKD	APPR

DEPARTMENT OF TRANSPORTATION/ENGINEERING DIVISION
HOUGHTON ROAD
IRVINGTON RD TO VALENCIA RD

1 OF 3

CITY OF TUCSON

DRWN. BY CLR	08/09	REF.	SCALE:
DSGN. BY JO	08/09		
CHKD. BY MFD	02/10	PLAN NO. I–2007–001	



Offsite Watershed Peak Discharges		
ID	Q_{100} (cfs)	SOURCE
1	4	Civano Block 1, Ph. 2 & 3, Fig. 1 (CP D43a)
2	26	Civano Block 1, Ph. 2 & 3, Fig. 1 (CP D43)
3	20	Civano Block 1, Ph. 2 & 3, Fig. 3, pg 3 of 3 (CP D42)
4	12	Civano Block 1, Ph. 2 & 3, Fig. 3, pg 3 of 3 (CP D109)
5	9	Civano Block 1, Ph. 2 & 3, Fig. 3, pg 3 of 3 (CP D106)
6	9	Civano Block 1, Ph. 2 & 3, Fig. 3, pg 3 of 3 (CP D102)
7	37	Civano Villas, Fig. 5 (CP D1)
8	40	Civano Villas, Fig. 5 (CP D5)
9	23.5	Watershed CH12
10	756	Mesquite Ranch Wash, TSMS Node UN-N0010
11	45	Civano 2, Fig 3B (CP10REV)
12**	109	**Psomas Tech Memo Civano Block II, Houghton Road Channel Revision
13**	104	**Psomas Tech Memo Civano Block II, Houghton Road Channel Revision
14**	99	**Psomas Tech Memo Civano Block II, Houghton Road Channel Revision
15**	90	**Psomas Tech Memo Civano Block II, Houghton Road Channel Revision
16**	[illegible]	**Psomas Tech Memo Civano Block II, Houghton Road Channel Revision
17	[illegible]	Mesquite Ranch, Fig. 5 (CP C12)
18	[illegible]	Mesquite Ranch, Fig. 5 (CP P2)
19	[illegible]	Mesquite Ranch, Fig. 5 (CP A9)
20	50.2	Mesquite Ranch, Fig. 5 (CP C5)
21	31.6	Mesquite Ranch, Fig. 5 (CP C10)
22	776	Houghton Road DCR (CP L2)
23	75	Mesquite Ranch, Fig. 5 (CP C61)
24*	1623	Atterbury Wash, Reach 40 between TSMS Node UG-N0040 & UG-N0050
25*		

* Discharge is split between two culverts per the Flo2D analysis

** Discharges are cumulative along the channel per the memo

NOTE: ID numbers correspond to keynotes on Figure 4

Watershed	Area (ac)	Length (ft)	Mean Slope (%)	Basin Factor	Peak Discharge Q_{100} (cfs)	Q_{10} (cfs)
PV1	0.52	411	1.90	0.052	4.7	2.4
PV1.1	1.27	714	1.09	0.052	10.7	5.4
PV2	1.18	566	1.90	0.052	10.8	5.4
PV2.1	0.26	178	0.70	0.052	2.4	1.2
PV3	0.55	233	1.90	0.052	5.0	2.5
PV3.1	0.21	178	0.70	0.052	1.9	1.0
PV4	0.54	370	0.80	0.052	4.9	2.5
PV5	0.72	720	0.83	0.052	5.9	3.0
PV6	1.02	773	0.80	0.052	8.2	4.1
PV7	0.84	433	1.00	0.052	7.6	3.8
PV8	0.92	627	0.70	0.052	7.6	3.8
PV8.1	0.70	268	0.75	0.052	6.4	3.2
PV9	1.56	1061	0.86	0.052	12.0	6.0
PV10	0.46	372	0.75	0.052	4.3	2.2
PV11	0.32	249	3.50	0.052	2.9	1.5
PV11.1	0.59	354	3.50	0.052	5.4	2.7
PV12	0.34	248	3.50	0.052	3.1	1.6
PV12.1	1.10	744	0.75	0.052	8.9	4.5
PV13	0.57	370	0.50	0.052	4.9	2.5
PV14	0.46	362	0.50	0.052	4.0	2.0
PV15	0.45	294	0.50	0.052	4.0	2.0
PV16	0.73	517	0.50	0.052	6.0	3.0
PV17	0.35	230	0.50	0.052	3.2	1.6
PV18	0.47	369	3.20	0.052	4.3	2.2
PV19	0.77	462	3.20	0.052	7.0	3.5
PV20	0.37	389	3.90	0.052	3.4	1.7
PV20.1	0.37	261	5.10	0.052	3.4	1.7
PV21	1.32	656	3.90	0.052	12.0	6.0
PV21.1	0.50	230	3.90	0.052	4.6	2.3
PV21.2	0.35	174	3.90	0.052	3.2	1.6
PV22	0.17	157	0.50	0.052	1.6	0.8
PV23	0.16	151	0.50	0.052	1.5	0.8
PV26	0.16	198	1.44	0.052	1.5	0.8

Watershed	Area (ac)	Length (ft)	Mean Slope (%)	Basin Factor	Peak Discharge Q_{100} (cfs)	Q_{10} (cfs)
ST2	0.71	474	2.11	0.052	6.3	3.2
ST3	0.40	308	0.97	0.052	3.5	1.8
ST4	0.42	322	0.62	0.052	3.6	1.8
ST5	0.51	328	0.61	0.052	4.4	2.2
ST6	0.74	466	1.93	0.052	6.5	3.3
ST13	1.52	516	0.39	0.052	11.7	5.9
ST13.1	0.53	260	0.77	0.052	4.2	2.1
ST14	2.60	786	3.05	0.052	15.0	7.5
ST15	1.84	1129	0.89	0.052	13.5	6.8
ST17	0.67	504	0.85	0.052	5.6	2.8
ST23	1.76	1422	1.76	0.052	13.6	6.8
ST24	1.06	844	1.42	0.052	8.7	4.4
ST25	0.79	581	2.24	0.052	7.0	3.5
ST30	0.68	621	0.64	0.052	5.4	2.7
CH1	1.14	464	3.45	0.042	7.2	3.6
CH2	0.81	446	3.81	0.042	5.1	2.6
CH3	0.63	312	2.56	0.042	4.0	2.0
CH4	0.71	322	1.55	0.042	4.5	2.3
CH5	0.76	328	1.22	0.042	4.8	2.4
CH6	0.82	474	0.63	0.042	5.0	2.5
CH7	23.27	2343	2.22	0.052	105.3	52.7
CH8	2.41	932	0.54	0.052	10.8	5.4
CH9	0.93	300	1.33	0.052	5.5	2.8
CH10	0.14	180	0.58	0.052	0.8	0.4
CH11	0.65	290	2.63	0.052	4.8	2.4
CH12	5.03	750	0.40	0.052	23.5	11.8

CULVERT DESIGN

Culvert ID	CP	Culvert	Station	Length (ft)	Invert Elevation (ft) DS	Invert Elevation (ft) US	Slope (%)	HW_{100} (ft)	HW_{10} (ft)	Velocity (fps)	Q_{100} (cfs)
D01	12A	2-10'x6' RCBC	454+46.49	204	2832.49	2833.92	0.70	6.20	2840.12	13.47	756
D02	12B	1-24" RCP	20+92	61	2858.73	2859.34	1.00	2.25	2861.59	7.50	14
D03	13A	3-24" RCP	471+02.43	196	2871.05	2877.52	3.30	2.77	2880.29	12.63	57
D04	13B	3-24" RCP	21+07.01	118	2878.51	2879.10	0.50	2.81	2881.91	7.19	57
D05	13C	3-24" RCP	21+05.01	53	2882.62	2882.88	0.49	2.53	2885.41	6.79	51
D06	14	3-36" RCP	485+00.41	195	2885.53	2888.45	1.50	3.74	2892.19	12.08	152
D07	15A	3-30" RCP	21+12.00	131	2895.02	2897.18	1.65	3.92	2901.10	11.41	111
D08	15B	3-24" RCP	21+05.00	104	2908.20	2908.82	0.60	2.89	2911.71	7.33	59
D09	16	3-30" RCP	522+86.63	251	2909.33	2912.59	1.30	2.19	2914.78	8.67	49
D10	17	6-10'x4' RCBC	528+20.00	174	2914.74	2915.79	0.60	3.00	2918.79	9.28	763
D11	18A	6-10'x4' RCBC	547+26.31	196	2928.93	2930.30	0.70	2.50	2932.80	8.87	580
D12	18B	6-12'x4' RCBC	553+98.93	188	2932.61	2933.55	0.50	3.24	2936.79	9.26	1031
D13	19	3-48"	11+39.65	34	2792.91	2793.59	2.00	4.68	2798.27	9.21	264
D13*	19	3-48" RCP	11+39.65	102	2792.11	2792.91	0.78	4.82	2797.73	10.69	264

* Existing culvert to be extended upstream. This is of the existing culvert to determine outlet velocity

LEGEND

- (PV1) ONSITE CONCENTRATION POINT
- (2) OFFSITE CONCENTRATION POINT
- Q_{100}=37cfs 100-YEAR DISCHARGE
- (CB 4) CATCH BASIN ID
- WATERSHED BOUNDARY

100 0 50 100 150 200

Two working days before you dig, CALL FOR THE BLUE STAKES
1-800-STAKE-IT
Blue Stake Center CALL COLLECT

FIGURE 4: DEVELOPED CONDITIONS MAP

90% PRELIMINARY NOT FOR CONSTRUCTION

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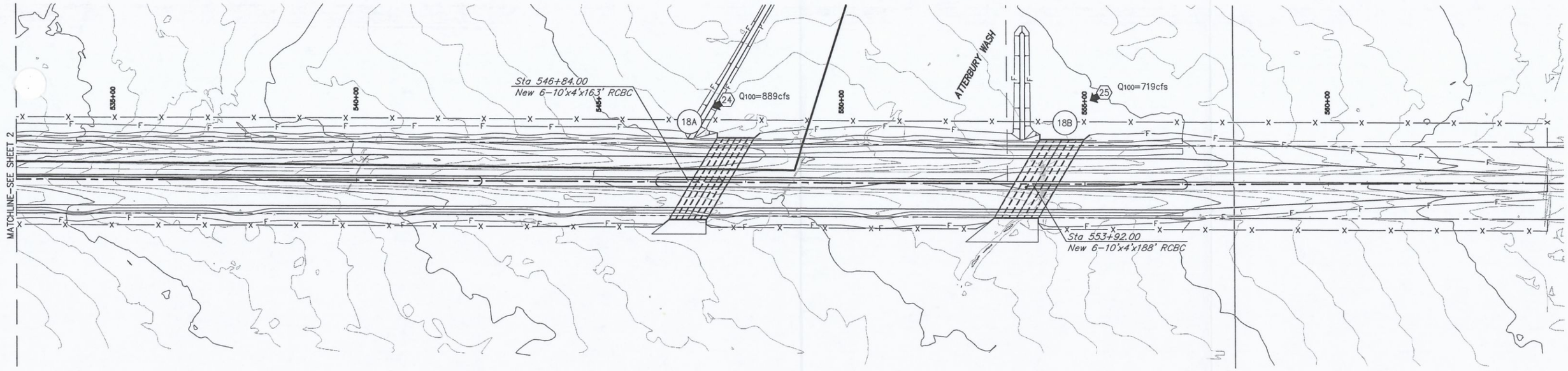
NO.	DATE	REVISION	BY	CHKD.	APPR.

DEPARTMENT OF TRANSPORTATION/ENGINEERING DIVISION
HOUGHTON ROAD
IRVINGTON RD TO VALENCIA RD

2 OF 3

CITY OF TUCSON

DRWN. BY CLR	06/09	REF.	SCALE: 1"=100'
DSGN. BY JO	06/09		
CHKD. BY MED	02/10	PLAN NO. I-2007-001	



Offsite Watershed Peak Discharges		
ID	Q_{100} (cfs)	SOURCE
[illegible]	[illegible]	Civano Block 1, Ph. 2 & 3, Fig. 1 (CP D43a)
[illegible]	[illegible]	Civano Block 1, Ph. 2 & 3, Fig. 1 (CP D43)
[illegible]	20	Civano Block 1, Ph. 2 & 3, Fig. 3, pg 3 of 3 (CP D42)
4	12	Civano Block 1, Ph. 2 & 3, Fig. 3, pg 3 of 3 (CP D109)
5	9	Civano Block 1, Ph. 2 & 3, Fig. 3, pg 3 of 3 (CP D106)
6	9	Civano Block 1, Ph. 2 & 3, Fig. 3, pg 3 of 3 (CP D102)
7	37	Civano Villas, Fig. 5 (CP D1)
8	40	Civano Villas, Fig. 5 (CP D5)
9	23.5	Watershed CH12
10	756	Mesquite Ranch Wash, TSMS Node UN-N0010
11	45	Civano 2, Fig 3B (CP10REV)
12**	109	**Psomas Tech Memo Civano Block II, Houghton Road Channel Revision
13**	104	**Psomas Tech Memo Civano Block II, Houghton Road Channel Revision
14**	99	**Psomas Tech Memo Civano Block II, Houghton Road Channel Revision
15**	90	**Psomas Tech Memo Civano Block II, Houghton Road Channel Revision
16**	86	**Psomas Tech Memo Civano Block II, Houghton Road Channel Revision
17	6.4	Mesquite Ranch, Fig. 5 (CP C12)
18	83.1	Mesquite Ranch, Fig. 5 (CP P2)
19	0.7	Mesquite Ranch, Fig. 5 (CP A9)
20	50.2	Mesquite Ranch, Fig. 5 (CP C5)
21	31.6	Mesquite Ranch, Fig. 5 (CP C10)
22	776	Houghton Road DCR (CP12)
23	75	Mesquite Ranch, Fig. 5 (CP OS1)
24*	1623	Atterbury Wash, Reach 40 between TSMS Node UG-N0040 & UG-N0050
25*		

* Discharge is split between two culverts per the Flo2D analysis

** Discharges are cumulative along the channel per the memo

NOTE: ID numbers correspond to keynotes on Figure 4

Watershed	Area (ac)	Length (ft)	Mean Slope (%)	Basin Factor	Peak Discharge Q_{100} (cfs)	Q_{10} (cfs)
PV1	0.52	411	1.90	0.052	4.7	2.4
PV1.1	1.27	714	1.09	0.052	10.7	5.4
PV2	1.18	586	1.90	0.052	10.8	5.4
PV2.1	0.26	178	0.70	0.052	2.4	1.2
PV3	0.55	233	1.90	0.052	5.0	2.5
PV3.1	0.21	178	0.70	0.052	1.9	1.0
PV4	0.54	370	0.80	0.052	4.9	2.5
PV5	0.72	720	0.83	0.052	5.9	3.0
PV6	1.02	773	0.80	0.052	8.2	4.1
PV7	0.84	433	1.00	0.052	7.6	3.8
PV8	0.92	627	0.70	0.052	7.6	3.8
PV8.1	0.70	268	0.75	0.052	6.4	3.2
PV9	1.56	1061	0.86	0.052	12.0	6.0
PV10	0.48	372	0.75	0.052	4.3	2.2
PV11	0.32	249	3.50	0.052	2.9	1.5
PV11.1	0.59	354	3.50	0.052	5.4	2.7
PV12	0.34	248	3.50	0.052	3.1	1.6
PV12.1	1.10	744	0.75	0.052	8.9	4.5
PV13	0.57	370	0.50	0.052	4.9	2.5
PV14	0.46	362	0.50	0.052	4.0	2.0
PV15	0.45	294	0.50	0.052	4.0	2.0
PV16	0.73	517	0.50	0.052	6.0	3.0
PV17	0.35	230	0.50	0.052	3.2	1.6
PV18	0.47	369	3.20	0.052	4.3	2.2
PV19	0.77	462	3.20	0.052	7.0	3.5
PV20	0.37	369	3.90	0.052	3.4	1.7
PV20.1	0.37	261	5.10	0.052	3.4	1.7
PV21	1.32	656	3.90	0.052	12.0	6.0
PV21.1	0.50	230	3.90	0.052	4.6	2.3
PV21.2	0.35	174	3.90	0.052	3.2	1.6
PV22	0.17	157	0.50	0.052	1.6	0.8
PV23	0.16	151	0.50	0.052	1.5	0.8
PV26	0.16	198	1.44	0.052	1.5	0.8

Watershed	Area (ac)	Length (ft)	Mean Slope (%)	Basin Factor	Peak Discharge Q_{100} (cfs)	Q_{10} (cfs)
ST2	0.71	474	2.11	0.052	6.3	3.2
ST3	0.40	308	0.97	0.052	3.5	1.8
ST4	0.42	322	0.82	0.052	3.6	1.8
ST5	0.51	328	0.61	0.052	4.4	2.2
ST8	0.74	466	1.93	0.052	6.5	3.3
ST13	1.52	616	0.39	0.052	11.7	5.9
ST13.1	0.53	260	0.77	0.052	4.2	2.1
ST14	2.80	786	3.05	0.052	15.0	7.5
ST15	1.84	1129	0.89	0.052	13.5	6.8
ST17	0.67	504	0.95	0.052	5.6	2.8
ST23	1.76	1422	1.76	0.052	13.6	6.8
ST24	1.06	844	1.42	0.052	8.7	4.4
ST25	0.79	581	2.24	0.052	7.0	3.5
ST30	0.68	621	0.84	0.052	5.4	2.7
CH1	1.14	464	3.45	0.042	7.2	3.6
CH2	0.81	446	3.81	0.042	5.1	2.6
CH3	0.63	312	2.68	0.042	4.0	2.0
CH4	0.71	322	1.55	0.042	4.5	2.3
CH5	0.76	328	1.22	0.042	4.8	2.4
CH6	0.82	474	0.63	0.042	5.0	2.5
CH7	23.27	2343	2.22	0.052	105.3	52.7
CH8	2.41	932	0.54	0.052	10.8	5.4
CH9	0.93	300	1.33	0.052	5.5	2.8
CH10	0.14	180	0.56	0.052	0.8	0.4
CH11	0.85	290	2.63	0.052	4.8	2.4
CH12	5.03	750	0.40	0.052	23.5	11.8

CULVERT DESIGN

Culvert ID	CP	Culvert	Station	Length (ft)	Invert Elevation (ft) DS	Invert Elevation (ft) US	Slope (%)	HW_{100} (ft)	HW_{100} (ft)	Velocity (fps)	Q_{100} (cfs)
D01	12A	2-10'x6' RCBC	454+46.49	204	2832.49	2833.92	0.70	6.20	2840.12	13.47	756
D02	12B	1-24" RCP	20+92	61	2858.73	2859.34	1.00	2.25	2861.59	7.50	14
D03	13A	3-24" RCP	471+02.43	196	2871.05	2877.53	3.30	2.77	2880.29	12.83	57
D04	13B	3-24" RCP	21+07.01	118	2878.51	2879.10	0.50	2.81	2881.91	7.19	57
D05	13C	3-24" RCP	21+05.01	53	2882.62	2882.88	0.49	2.53	2885.41	6.79	51
D06	14	3-36" RCP	485+00.41	195	2885.53	2888.45	1.50	3.74	2892.19	12.08	152
D07	15A	3-30" RCP	21+12.00	131	2895.02	2897.18	1.65	3.92	2901.10	11.41	111
D08	15B	3-24" RCP	21+05.00	104	2908.30	2908.82	0.60	2.89	2911.71	7.33	59
D09	16	3-30" RCP	522+86.63	251	2909.33	2912.59	1.30	2.19	2914.78	8.67	49
D10	17	6-10'x4' RCBC	528+20.00	174	2914.74	2915.79	0.60	3.00	2918.79	9.28	763
D11	18A	6-10'x4' RCBC	547+26.31	196	2928.93	2930.30	0.70	2.50	2932.80	8.87	580
D12	18B	6-12'x4' RCBC	553+98.93	188	2932.61	2933.55	0.50	3.24	2936.79	9.26	1031
D13	19	3-48"	11+39.65	34	2792.91	2793.59	2.00	4.68	2798.27	9.21	264
D13*	19	3-48" RCP	11+39.65	102	2792.11	2792.91	0.78	4.82	2797.73	10.69	264

* Existing culvert to be extended upstream. This is of the existing culvert to determine outlet velocity

LEGEND

- (PV1) ONSITE CONCENTRATION POINT
- (2) OFFSITE CONCENTRATION POINT
- Q100=37cfs 100–YEAR DISCHARGE
- (CB 4) CATCH BASIN ID
- WATERSHED BOUNDARY

Two working days before you dig, CALL FOR THE BLUE STAKES
1-800-STAKE-IT
Blue Stake Center CALL COLLECT

FIGURE 4: DEVELOPED CONDITIONS MAP

100 0 50 100 150 200

NO.	DATE	REVISION	BY	CHKD.	APPR.

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HOUGHTON ROAD
IRVINGTON RD TO VALENCIA RD

3 OF 3

CITY OF TUCSON

DRWN. BY CLR	06/09	REF.	SCALE: 1"=100'
DSGN. BY JO	06/09		
CHKD. BY MED	02/10	PLAN NO. I–2007–001	

4.2 Pavement Drainage

The typical section for Houghton Road is a crowned section with three travel lanes in both directions of travel, depressed medians and turn lanes. The road is uncurbed for much of the project, with curb only at signalized intersections and driveway turn outs. A six-inch cut ditch is provided along the roadway to collect initial runoff, however is not intended as a method of conveyance. Once the cut ditch is overtopped, the flow will be conveyed in roadside channels or continue downstream along its natural course.

The depressed median will be used for water harvesting and contribute to the desert parkway theme for the corridor. The stormwater that falls within the median will act as a supplemental source of water for the median landscaping. Houghton Road between Valencia and Irvington sloped from the south to the north. For this reason it will be necessary to provide intermittent landscaped berms so that large quantities of runoff do not accumulate and cause the median to act as a channel. The landscaped berms will allow water to pond behind them to provide the water harvesting. The landscape plans provide detail as to where the landscaped berms are located.

Pavement drainage is allowed to flow off the road in uncurbed segments. On the east side of the road it will be collected in roadside ditches and conveyed to the nearest cross drainage structure. On the west side of the road, flow will either be collected and conveyed to the nearest cross drainage channel or allowed to flow out of the right-of-way as shallow sheet flow. North of Seven Generations Way, curbed segments of road will have catch basins or transverse grates that discharge into the proposed stormdrain mainline and ultimately discharge into the Pantano Wash. South of Seven Generations the curbed segments of roadway will have catch basins or scuppers to convey flow into the proposed stormdrain which discharges into cross culverts and roadside channels. Transverse grates will be provided at two locations within the project to collect offsite runoff. The two locations are at the driveway to the Quikmart at the northwest corner of Irvington and Houghton Roads and on Civano Boulevard near its intersection with Houghton Road.

The Pima County Roadway Design Manual states that a 10-year design storm is to be used for non-depressed roadways. For a 6-lane roadway, 20 feet of pavement must be kept clear during this event. The typical roadway width in each direction is 43 feet between the median and the curb with a 2% cross slope, allowing for a maximum spread of 23 feet within the roadway before overtopping the curb. A typical roadway segment can be seen on Figure 4, Typical Section. Catch basin lengths were designed for 100% capture of the 10-year storm event since the purpose of the openings is to prevent flow from entering an intersection or flowing around the end of a curbed segment causing erosion. In order to provide a factor of safety against possible clogging, catch basin lengths were designed with the assumption that 20% of upstream flow would bypass the previous catch basin and contribute to the peak discharge. The parameters used to calculate the curb opening length, such as gutter width and slope and inlet depression, were based on PC/COT Standard Detail 209 for the curb and Standard Detail 308 for the catch basin inlets. The results of the inlet design and the spread are summarized in Table 3a, Summary of Pavement Drainage Design. Table 3b summarizes the watersheds that contribute flow to each catch basin. Catch basin locations are shown on Figure 4, Developed Conditions Watershed Map, as well as in the storm drain design sheets included in Appendix F. Calculation sheets are provided in Appendix F.

Table 3a: Summary of Pavement Drainage Design

Catch Basin #	Station	Watershed Concentration Point	Wing Length	Min. Required Length	Q_{10}	Width of Spread
			(ft)	(ft)	(cfs)	(ft)
1	415+78.94	PV20	20	23.33	4.5	9.0
2	415+82.08	PV21	8	14.96	2.1	6.8
3	417+25.45	PV21.1	20	21.57	3.2	11.9
4	418+91.95	CH10 (Area Grate)	N/A	N/A	0.8*	N/A
5	418+18.98	ST13 (Transverse Grate at Quikmart)	N/A	N/A	11.7*	N/A
6	418+70.39	ST13.1 (Area Grate)	4	N/A	7.4*	45.0
7	419+65.56	PV20.1	16	16.84	2.6	7.0
8	420+12.04	PV21.2	20	23.58	3.7	12.6
9	422+30.33	ST14 (Area Grate)	N/A	N/A	15*	N/A
10	422+28.74	PV18	12	14.49	2.2	6.7
11	422+28.74	PV19	20	19.32	3.5	8.4
12	427+03.16	1&2 (Transverse Grate on Civano Blvd.)	N/A	N/A	30*	N/A
13	427+42.15	3 (Area Grate to Collect Offsite Flow)	N/A	N/A	25*	N/A
14	432+08.02	4 (Area Grate to Collect Offsite Flow)	N/A	N/A	16*	N/A
15	435+39.02	5 (Area Grate to Collect Offsite Flow)	N/A	N/A	14*	N/A
16	438+94.67	6 (Area Grate to Collect Offsite Flow)	N/A	N/A	14*	N/A
17	442+33.29	7 (Area Grate to Collect Offsite Flow)	N/A	N/A	37*	N/A
18	442+88.56	PV16	12	13.21	3.6	12.7
19	442+88.56	PV17	8	9.95	2.2	10.4
20	445+18.30	PV15	8	10.64	2.5	10.9
21	447+7.64	8	N/A	N/A	40*	N/A
22	448+14.22	PV14	8	9.33	2.0	9.9
23	448+14.22	PV13	8	10.52	2.5	10.8
24	447+99.53	CH12 (Area Grate to Collect Offsite Flow)	N/A	N/A	23.5*	N/A
25	469+01.73	PV11	20	23.10	4.6	9.3
26	469+01.73	PV12	16	16.75	2.7	7.3
27	471+50.11	PV12.1	20	22.71	4.5	9.2
28	475+04.87	PV10	16	15.98	4.3	12.6
29	478+41.19	PV26	20		0.75*	
30	478+17.20	PV26	4		0.75*	
31	495+01.58	PV9	20	19.11	6.0	14.6
32	495+01.58	PV8	16	16.68	4.8	13.3
33	500+05.38	PV8.1	8		6.4*	
34	501+28.79	PV7	4	15.82	3.8	11.2
35	513+72.33	PV5	12	14.58	3.6	11.5
36	521+68.25	PV3.1	4	6.46	1.0	6.5
37	521+67.25	PV2.1	4	6.46	1.0	6.5
38	525+99.62	PV2	8	7.58	5.4	18.2
39	525+99.62	PV3	12	7.58	3.1	12.5
40	527+67.63	PV1	12	13.65	2.4	7.9

NOTE: Catch basin length (3.58 ft) not included in the wing length

NOTE: Area/Transverse grates located outside of pavement and have no spread requirement

NOTE: ST13 is located in the Quikmart parking lot and has no spread requirement

*Q_{100}

Table 3b: Summary of Contributing Watersheds

Drainage Structure	Contributing Watersheds
CB1	PV20, PV20.1
CB2	PV21, PV21.1
CB3	PV21.1, PV21.2*
CB4	CH10
CB5	ST13
CB6	ST13.1
CB7	PV20.1, PV19
CB8	PV21.2, PV22*, PV23*, PV18*
CB9	ST14
CB10	PV18
CB11	PV19,CH1
CB12	(1), (2)
CB13	(3), CH2, ST2
CB14	(4), CH3, ST3
CB15	(5), CH4, ST4
CB16	(6), CH5, ST5
CB17	(7), CH6
CB18	PV16, PV13*
CB19	PV17, PV15*
CB20	PV15, PV14.1
CB21	-8
CB22	PV14
CB23	PV13
CB24	CH12
CB25	PV11, PV10*, PV11.1*
CB26	PV12, PV12.1*
CB27	PV12.1
CB28	PV10
CB29	PV26
CB30	PV26
CB31	PV9
CB32	PV8, PV7*
CB33	PV8.1
CB34	PV7
CB35	PV5
CB36	PV3.1
CB37	PV2.1
CB38	PV2
CB39	PV3, PV1*
CB40	PV1

* Denotes bypass flow from this watershed
NOTE: Watersheds in parentheses are from offsite sources

4.3 Cross Drainage

As previously stated, all of the existing cross drainage structures along Houghton Road are going to be removed and replaced with new cross drainage structures that are capable of conveying the 100-year storm event under Houghton Road. The culvert crossing under Irvington Road is going to be extended on the upstream side. The proposed culvert crossings for this project were analyzed using the CulvertMaster® v3.0 computer program developed by Haestad Methods, Inc. The program methodology is based on the Federal Highway Administration's Hydraulic Design Series Number 5 nomographs.

Culvert crossings were generally placed at or near locations of existing crossings and aligned in the same direction. Additional culverts are located throughout the project where the roadway design warrants them. Design constraints that resulting in additional culvert crossings include the following:

- Available Right-of-Way
- Maintaining existing vegetation
- Utility conflicts

In the segment along the Civano subdivision, between Civano Boulevard and Seven Generations Way, the desire to maintain existing vegetation limited the available space to create a channel. Under existing conditions this flow is in a roadside swale that discharges through culverts under Civano Boulevard on its course to the Pantano Wash. North of Civano Boulevard, there is a lack of right-of-way to construct a new channel to convey this flow to the Pantano Wash. Now this flow will be collected at its outlet from the Civano subdivision and discharged into a stormdrain system, eliminating the need for the culvert under Civano Boulevard and any downstream channel.

Another critical design constraint that impacted the culvert crossings under Houghton Road along the entire project reach is the 12" gas line that runs parallel to Houghton Road along the east side. Southwest Gas requires a minimum separation between the culvert invert and the top of the gas line of 18 inches, which limits the amount of drop at the culvert inlets that can be acquired to allow for additional ponding depths. It is also restrictive on the size of culverts and the channel depths that convey flow to the culverts. For several of these reasons,

Poorman Road was raised to allow for an adequate ponding depth that did not require an excessive amount of smaller culverts to be used, and to prevent the flow from entering the channel to the north of it, which no longer has adequate capacity to convey flow from south the roadway. Further discussion of the wash crossing just south of Poorman Road can be found in the technical memorandum to the State Land Department in Appendix D.

One cross culvert location that does not exist currently has been added south of the Millennium Energy Building at Concentration Point 13A, due to a lack of Right-of-Way resulting in the inability to convey flow to the north. The flow will now be discharged under Houghton Road to the west.

Another location of a new culvert is at the Attebury Wash crossing. Under existing conditions, there is one undersized culvert crossing, with the vast majority of the flow crossing over the top of the roadway during the 100-year storm event. As part of this design and to prevent flow overtopping the roadway, two crossings are proposed. Further discussion of the Attebury Wash improvements can be found in Section 4.4, State Land Improvements.

The ponding depth at each culvert crossing was reviewed to ensure that flow is below the edge of pavement and that the ponded water does not spill into adjacent watersheds. Table 4, Summary of Proposed Culverts, summarizes the results of the hydraulic analysis. Culvert calculation sheets and plan and profile sheets are provided in Appendix C.

Table 4: Summary of Proposed Culverts

Culvert ID	CP	Culvert	Station	Length	Invert Elevation (ft)		Slope	HW_{100} Depth	HW_{100}	Velocity	Q_{100}
				(ft)	DS	US	(%)	(ft)	(ft)	(fps)	(cfs)
D01	12A	2-10'x6' RCBC	454+46.49	204	2832.49	2833.92	0.70	6.20	2840.12	13.47	756
D02	12B	1-24" RCP	20+92	61	2858.73	2859.34	1.00	2.25	2861.59	7.50	14
D03	13A	3-24" RCP	471+02.43	196	2871.05	2877.52	3.30	2.77	2880.29	12.83	57
D04	13B	3-24" RCP	21+07.01	118	2878.51	2879.10	0.50	2.81	2881.91	7.19	57
D05	13C	3-24" RCP	21+05.01	53	2882.62	2882.88	0.50	2.53	2885.41	6.79	51
D06	14	3-36" RCP	485+00.41	195	2885.53	2888.45	1.50	3.74	2892.19	12.08	152
D07	15A	3-30" RCP	21+12.00	131	2895.02	2897.18	1.65	3.92	2901.10	11.41	111
D08	15B	3-24" RCP	21+05.00	104	2908.20	2908.82	0.60	2.89	2911.71	7.33	59
D09	16	3-30" RCP	522+86.63	251	2909.33	2912.59	1.30	2.19	2914.78	8.67	49
D10	17	6-10'x4' RCBC	528+20.00	174	2914.74	2915.79	0.60	3.00	2918.79	9.28	763
D11	18A	6-10'x4' RCBC	547+26.31	196	2928.93	2930.30	0.70	2.50	2932.80	8.87	580
D12	18B	6-12'x4' RCBC	553+98.93	188	2932.61	2933.55	0.50	3.24	2936.79	9.26	1031
D13	19	3-48"	11+39.65	34	2792.91	2793.59	2.00	4.68	2798.27	9.21	264
D13*	19	3-48" RCP	11+39.65	102	2792.11	2792.91	0.78	4.82	2797.73	10.69	264

* Existing culvert to be extended upstream. This is of the existing culvert to determine outlet velocity

4.4 State Land Improvements

The State Land Department owns the parcel of land along the west side of Houghton Road between Irvington Road and Valencia Road and the parcel along the east side of the Houghton road between Poorman Road and Valencia Road. Between Poorman Road and Valencia Road, there are two washes crossing Houghton Road as shallow sheet flow. The southernmost crossing is the Attebury Wash, and the northernmost crossing is unnamed.

The Attebury Wash crosses Houghton Road between Poorman Road and Valencia Road. Flow within this wash is shallow sheet flow and is not appropriately modeled with a 1-dimensional program such as HEC-RAS. For this reason, Psomas has modeled the floodplain with Flo2D, a 2-dimensional modeling program that uses a grid system and to analyze flow distribution and also account for routing within the floodplain. A model for both the existing conditions and the selected design alternative was created to analyze the changes to the floodplain.

The existing conditions model was set up using PAG DEM data and a 20 foot grid system. The inflow hydrograph was obtained from the TSMS HEC-1 model that was used as part of the FEMA mapping effort by the City for the Attebury Wash. The results from this analysis were mapped and the FEMA floodplain limits overlaid to compare the differences. The limits were essentially the same.

Psomas considered and analyzed several alternatives and provided the City with these three alternatives to choose from for the design. The alternatives were as follows:

- Alternative 1: Eight culvert crossings with 5 HERCP pipes and berms at each.
- Alternative 2: Two culvert crossings with 6-10x4 RCBC culverts and berms at each.
- Alternative 3: One crossing and a constructed channel along the wash between Valencia Road and Houghton Road.

Other alternatives that were considered and determined to be unreasonable or not feasible and not presented as design alternatives were as follows:

- Multiple crossings and allow flow to still cross over the road
- A low bridge spanning the entire length of the floodplain.

Design Alternative 2 was chosen by the City to proceed with design. Alternative 1 was not chosen because it has a large construction cost associated with it, as well as not being appropriate when future development of the adjacent land is considered. If the land is developed in the future, it would be likely that a channel would be constructed and one concentration point would be selected. If this were to happen, the 40 culverts associated with Alternative 1 end up serving no purpose. Alternative 3 was not chosen as it would create unnecessary environmental impacts to the Attebury Wash as well as possibly impacting the project schedule due to required coordination with the State Land Department. It would also pose design constraints on future development. Design Alternative 2 was an appropriate choice because it minimized environmental impacts and concentrates flow at two locations that better facilitate future development.

Concentrating flow at two locations in an area which under existing conditions has a 2400 foot wide shallow floodplain will require 3-3.5 feet of headwater to build at the culverts' entrances in order to convey the 100-year peak discharge through the culverts. The existing topography does not allow this and would cause the discharge to flow to the north and into another watershed. For this reason, berms are proposed that will allow headwater to build without flowing into adjacent watersheds. Maintaining the flow in its current watershed is also necessary to minimize changes to the floodplain, which is federally regulated.

Ponding against the roadway and discharging downstream at two locations will result in increased water surface elevations and will impact the distribution of flow on the downstream property. Though the water surface elevations are increased due to ponding, the floodplain limits remain essentially unchanged, and are maintained within the FEMA floodplain limits.

The proposed condition was modeled using a modified version of the existing conditions Flo-2D model. The model parameters used were identical in both models. The roadway and the berms were modeled as levees, ensuring that water ponding against them did not have an opportunity to flow over them and into an adjacent cell. The culverts were modeled by inserting stage versus discharge data into the program's hydraulic structures function. This method does not allow for routing within the pipes, however this effect is not necessary due to their short length. Water surface elevations produced as a result of this model were used to determine the necessary berm heights. The berms will have a 10 foot top width and 4:1 side slopes per ADOT Standard Drawing C-3.10 Type A. Model results show the velocities against the berms range between 1 and 4 feet per second and thus should not need to be protected with riprap as long as the berms are vegetated. The city may opt to add riprap along the front face of the berms as a precautionary measure to minimize the potential maintenance. Figure 2, of the technical memorandum submitted to the State Land department and found in Appendix D, shows the depths of flow under proposed conditions. An additional figure provided as addenda to the technical memorandum and also provided in Appendix D shows the change in flow depths between existing and proposed conditions. Appendix D also contains the culvert rating tables used within the model, as well as the HEC-1 output from which the inflow hydrograph was obtained and a CD containing the Flo2D models. It should be noted that the peak discharges for each of the two

culvert crossing do not match exactly the peak discharge within the HEC-1 model and is due to the floodplain routing within the model.

The unnamed wash crossing just south of Poorman Road was modeled in the same manner as the Attebury Wash using Flo2D. The proposed design raises the roadway profile along Poorman Road so that the ponding required to convey the entire 100-year peak discharge under Houghton Road through the proposed culverts does not overtop the road. In this model, the cell elevations were raised along the roadway to match the proposed profile. Figures 3 and 4 of the technical memorandum submitted to the State Land Department show the flow depths for the existing and proposed conditions models, respectively. An additional figure submitted as addenda to the memorandum shows the increases in flow depth due to the proposed improvements. These three figures can be found in Appendix D.

4.5 Channel Design

Channel design was governed by the same constraints as the culvert design which is discussed in Section 4.3. Along the Civano subdivision, the offsite flows will be discharged into the new stormdrain, leaving just the local drainage from the roadway and the Right-of-Way to be conveyed in a channel. The typical section along this area from the edge of pavement to the east, slopes down at 2%, consisting of a six-inch cut ditch with 6:1 side slopes, two paths, and a 1 foot ditch with 6:1 side slopes closest to the roadway and varying side slopes to match existing grade. Figure 4, Typical Section, illustrates this cross section. The cut-ditch is provided to capture initial roadway runoff and is not meant as a method of conveyance. The 1 foot ditch will convey 10-year peak discharges from the pavement and within the Right-of-Way to the grate inlets that capture offsite flows. During larger events, the entire right of way will be utilized to convey flow. Capacity calculation sheets have been provided in Appendix E that illustrate the capacity of the1 foot v-ditch and of the typical roadway cross section within the Right-of-Way. For the remainder of the project, channels were formed by excavation at the toe of the fill slope, or by cutting into the ground where fill is not required. These channels have varying side slopes and depths that can be seen on the Typical Sheets within the roadway plan set. Channels are primarily only required along developed parcels of land, with flow being allowed to flow naturally in undeveloped land against the fill of the roadway. HEC-RAS models have been created for the v-ditches to verify

capacity. The cross sections were cut perpendicularly to the roadway centerline every fifty feet on even station intervals (e.g. 420+00, 420+50). The cross sections are labeled in the models to match the station at which they were cut (e.g. 420, 420.5). The channels are to be unlined, except where the velocity exceeds 5 feet per second per city guidelines. The manning's n-value used was 0.025 for the channels and 0.035 for the overbanks in the unlined conditions. A value of 0.035 was used for the lined channel segments. Separate HEC-RAS models were created for each segment of channel between driveway culverts and cross culverts. The headwater elevations from the result of the culvert analyses were used as the downstream starting boundary condition for the models. The result of this analysis shows that the 100-year peak discharge is either contained within the channel or between the roadway and the adjacent lots, with the water surface elevation below the edge of pavement and below the lot elevations. The HEC-RAS output as well as a CD containing the model can be found in Appendix E.

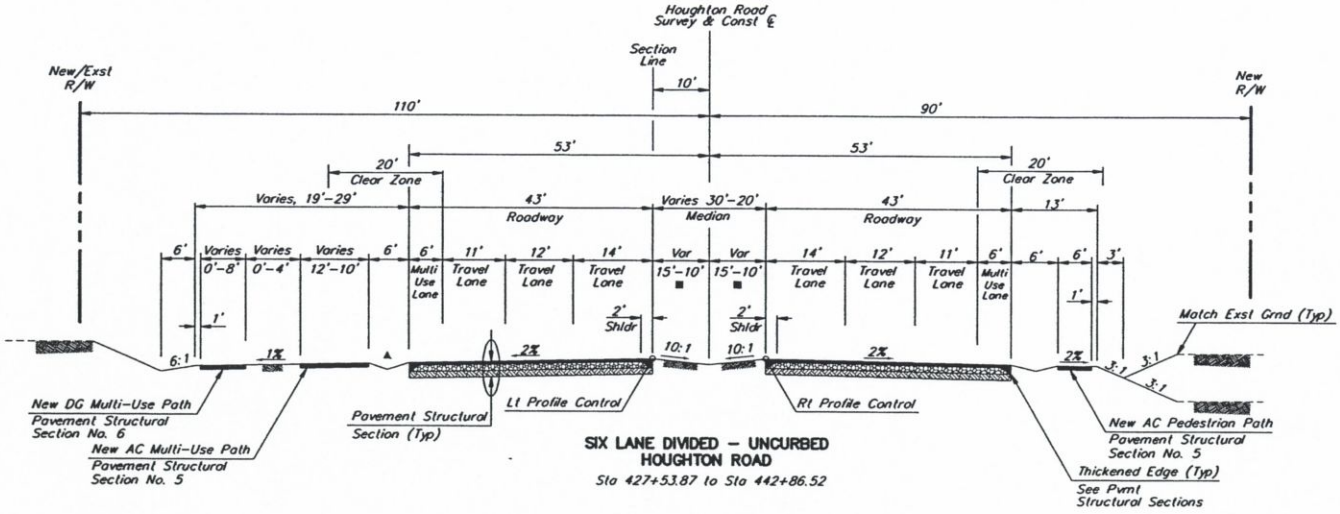

FIGURE 4: TYPICAL SECTION

4.6 Stormdrain Design

Currently, there is no existing storm drain along Houghton Road within the project limits. The addition of cub along portions of the project, and the lack of available space to construct a channel resulted in the need for stormdrain. The proposed system will include a mainline that will begin upstream of Seven Generations Way and extend downstream, discharging into the Pantano Wash east of the roadway. The mainline consists of 72 inch and 54 inch RCP with multiple laterals that are 18, 24 or 30 inches in diameter. South of Seven Generations Way, there are multiple small systems that collect only pavement drainage and consist of only 1 or 2 pipes per system, discharging into roadside channels on the east, into proposed culverts, or to the undeveloped land to the west. City of Tucson guidelines only require stormdrain to be designed to convey the 10-year storm event, however, in this case, the main storm drain system has been designed to convey the 100-year storm event for offsite flow, and the 10-year storm event for runoff generated on the pavement. The ability to convey the 100-year offsite discharge is necessary since the widened roadway prevents construction of an adequate channel and the flow is carried in a channel under existing conditions.

The stormdrain systems were analyzed using utilizing Hydraflow® software by Intelisolve. This program allows input of the discharges, lengths, inverts, sizes, roughness values, and junction loss coefficients and then determines the hydraulic grade line. Junction loss coefficients have a significant impact on the hydraulic grade line. Values for junction losses were obtained from table that references the book Design and Construction of Urban Stormwater Management Systems (1992) by the Water Environment Federation and American Society of Engineers. A copy of this table has been provided in Appendix F as well as the hydraulic grade line computational steps.

The main system collects offsite flow from the west and east sides of Houghton and pavement drainage along Houghton Road from north of Irvington Road to Seven Generations Way. The east side of Houghton Road between Seven Generations Way and Civano Boulevard is primarily uncurbed. Stormwater runoff within this area is intercepted by area grates that also intercept offsite flow. Transverse grates are utilized in Civano Boulevard and at the Houghton Road entrance to Quikmart to collect their respective offsite peak discharges.

These grates were designed by using the COT equation for orifice flow and weir flow over a grate with a 50% clogging factor to determine the necessary required open area. This area was then used in conjunction with Ohio Grates manufacturer's percentage open area to determine the grates size. This was done by dividing the required open area by the percent open area provided by Ohio Grates for the W-30-2 grate to get a total area of grate that would be required. The total area was then divided by the width of the roadway to calculate the length of the culvert required. The Civano Boulevard grate had a required length calculated at less than 1 foot for 6 inches of ponding. The design of the grate will be set at 2 feet, providing a larger factor of safety for clogging. The grate at the Quikmart entrance was sized using Figure 10.5 from the SMDDFM with a grate length of 3 ft and a velocity of 8.84 fps that was determined using a normal depth calculation for the cross section of the driveway. This resulted in an efficiency of approximately 75%. Area grates (EF-1) were sized at the concentration points along the Civano subdivision to collect this offsite flow. These grates were sized based on the COT equations. Calculation sheets for the grate sizing are provided in Appendix B. The grate sizes are shown on the Stormdrain Plans included in Appendix F.

The remaining storm drain systems, located south of Seven Generations Way are only provided where curb is located. These systems are provided to maintain the spread criteria as well as to prevent flow from going down driveways and side streets and to prevent flow from passing around the curb at the end of curb segments.

Tables 5a and 5b summarize the results of the hydraulic analysis. Calculation sheets and Stormdrain Plans can be found in Appendix F. The stormdrain plans illustrate the hydraulic grade line to show that surging does not occur at the manholes and inlets.

Table 5a: Summary of Main Storm Drain System

Hydraflow Line Number	Pipe #	Discharge	Diameter	Length	Slope	Downstream Velocity	Downstream HGL
		(cfs)	(in)	(ft)	(%)	(fps)	
1	1	293.30	72	19.80	0.40	10.38	2770.93
2	2	293.30	72	183.78	0.41	10.38	2772.68
3	3	293.30	72	391.94	0.43	10.38	2774.08
4	4-1	293.30	72	201.56	2.04	10.38	2776.22
5	15	2.95	18	4.68	1.07	5.23	2777.45
6	14	1.25	18	99.78	0.40	1.19	2777.83
7	4-2	290.35	72	140.00	2.04	12.60	2777.01
8	5-1	288.05	72	91.02	3.87	13.50	2779.85
9	5-2	269.05	72	72.09	3.87	11.78	2783.65
10	5-3	268.05	72	69.45	3.89	12.16	2786.29
11	6-1	266.35	72	43.00	2.35	13.09	2788.98
12	6-2	263.20	72	212.30	2.36	12.01	2790.27
13	7	232.10	54	466.00	3.23	23.71	2795.40
14	8-1	202.10	54	36.56	2.43	13.75	2812.01
15	8-2	173.85	54	461.37	2.44	11.51	2813.04
16	9	156.35	54	320.00	0.58	10.70	2824.43
17	10	141.05	54	347.10	0.69	9.38	2826.73
18	11-1	125.05	54	335.30	0.37	8.53	2829.30
19	11-2	83.05	54	50.59	0.38	5.38	2830.82
20	12-1	78.45	54	228.37	0.30	5.38	2831.00
21	12-2	76.45	54	181.00	0.30	5.60	2831.41

NOTE: Pipes that are split (eg: 4-1 and 4-2) are both Pipe 4 as shown on the Stormdrain Plans

Table 5a (continued): Summary of Main Storm Drain System

Hydraflow Line Number	Pipe #	Discharge	Diameter	Length	Slope	Downstream Velocity	Downstream HGL
		(cfs)	(in)	(ft)	(%)	(fps)	
22	13	36.45	54	100.71	1.64	3.09	2831.78
25	16	2.30	18	40.77	1.01	4.76	2779.87
44	17	1.00	18	23.50	1.02	3.77	2786.73
39	18	19.00	18	146.15	1.00	10.75	2784.58
42	19	4.20	18	45.35	0.99	2.38	2790.27
26	20	1.70	18	3.98	1.01	4.38	2789.16
27	21	3.15	18	121.14	1.00	5.19	2790.97
43	22	18.25	30	41.82	0.45	4.65	2796.74
40	23	20.40	30	107.51	0.50	6.41	2795.87
28	24	10.70	18	7.50	1.06	6.99	2796.54
29	25	30.00	30	43.05	11.66	6.13	2812.01
30	26	28.25	24	31.27	0.99	8.99	2813.46
31	27	17.50	18	56.13	1.00	9.90	2824.39
32	28	15.30	24	56.13	1.00	4.87	2826.73
33	29	16.00	24	56.13	1.00	7.05	2828.50
34	30	42.00	24	57.90	1.00	13.37	2830.82
35	31	3.00	18	7.53	1.06	1.70	2831.00
41	32	1.60	18	91.47	1.00	0.91	2831.00
36	33	2.00	18	93.25	1.00	2.95	2831.41
37	34	40.00	30	54.01	1.00	9.52	2832.21
38	35	2.00	18	91.50	1.01	4.58	2833.34
23	36	34.45	30	20.50	1.03	9.46	2833.64
24	37	32.00	30	10.45	0.96	6.52	2834.76

NOTE: Pipes that are split (eg: 4-1 and 4-2) are both Pipe 4 as shown on the Stormdrain Plans

Table 5b: Summary of Remaining Storm Drain Systems

Hydraflow Line Number	Pipe #	Discharge	Diameter	Length	Slope	Downstream Velocity	Downstream HGL
		(cfs)	(in)	(ft)	(%)	(fps)	
2	38	4.58	18	60.00	0.40	2.6	2868.7
1	39	7.24	18	26.75	0.41	4.1	2868.47
3	40	4.45	18	73.85	1.30	2.5	2873.6
4	41	4.30	18	37.65	0.29	2.4	2880.8
6	42	1.50	18	25.00	0.40	0.85	2884.4
5	43	2.25	18	7.72	0.39	1.3	2884.4
9	44	6.00	14 X 23	123.00	0.30	3.42	2897.59
8	45	9.80	14 X 23	52.50	0.31	5.58	2896.38
16	46	6.40	18	40.79	0.39	3.62	2897.45
7	47	3.80	18	32.98	1.00	2.15	2900.6
10	48	5.90	18	18.57	0.38	3.34	2910.03
12	49	1.45	18	107.00	2.00	1.68	2912.09
11	50	3.73	18	46.17	1.99	2.11	2911.93
14	51	5.40	18	111.00	1.00	3.87	2916.13
13	52	8.37	18	47.42	2.00	4.74	2915.58
15	53	2.35	12	18.53	1.03	2.99	2918.18

4.7 Erosion Protection

Erosion protection will be provided at all culvert outlets. Two types of erosion protection will be utilized; rock riprap splashpads and rock riprap pre-formed scour holes. Cross culvert splash pads were designed using HEC-14 guidelines and methodology. Splashpads at the outlets of driveway crossings were designed using West Consultant's Splashpad program based on HEC-11 methodology since the outlet flow is contained within side channels. The designed lengths splashpads may be longer than the minimum required per the calculation sheets due to the culvert outlet velocities to ensure adequate protection. The preformed scour hole at Irvington Road was designed per Equation 10.1 from HEC-14. Table 6 summarizes the splashpad and scour hole design for the culverts. Calculation sheets are provided in Appendix G.

Table 6: Summary of Splash Pad Analysis

Concentration Point	Culvert	Station	Min.D_{50}	Min. Thickness	Min. Width *	Min. Length	Culvert Outlet Velocity	Q_{100}
			(in)	(ft)	(ft)	(ft)	(fps)	(cfs)
12A	2-10'x6' RCBC	454+46.49	18	3.0	21	61	13.47	756
12B	1-24" RCP	20+92	9	1.5	6	23	7.50	14
13A	3-24" RCP	471+02.43	9	1.5	15	21	12.83	57
13B	3-24" RCP	21+07.01	9	1.5	10	27	7.19	57
13C	3-24" RCP	21+05.01	6	1.0	12	18	6.79	51
14	3-36" RCP	485+00.41	12	2.0	27	39	12.08	152
15A	3-30" RCP	21+12.00	6	1.0	10	29	11.41	111
15B	3-24" RCP	21+05.00	6	1.0	8	21	7.33	59
16	3-30" RCP	522+86.63	6	1.0	21	10	8.67	49
17	6-10'x4' RCBC	528+20.00	9 ***	1.5	65	36	9.28	763
18A	6-10'x4' RCBC	547+26.31	9 ***	1.5	65	29	8.87	580
18B	6-12'x4' RCBC	553+98.93	9 ***	1.5	77	43	9.26	1031
19	3-48" RCP	11+39.65	1	2.0	**	**	10.69	264

*At culvert outlet, to be flared 3:1 through length

**Preformed Scourhole (3:1 sideslopes)

*** D50 and thickness upsized due to culvert outlet velocities during design

4.8 Stormwater Harvesting Design

The City of Tucson requested that water harvesting be incorporated in this project. Water harvesting will occur in the depressed medians of the roadway and along the 1 foot v-ditch adjacent to the Civano subdivision. In the depressed median, landscaped berms will be provided at to create ponding behind them. In the 1 foot v-ditch, the grate inlets will be raised 6 inches to provide ponding in the ditch upstream of them. The groundwater harvesting will be utilized to support the landscaping and is part of the desert parkway this project aims to accomplish.

4.9 404 Compliance Statement

A Jurisdictional Delineation has been prepared by Logan Simpson Associates and approved by the U.S. Army Corps of Engineers. The two FEMA floodplains have 404 delineations associated with them. The roadway design will minimize disturbance to any potential 404 washes.

Compliance with WASH Ordinance and Riparian Habitat requirements will be addressed by the project Environmental Consultant, Logan Simpson. Environmental compliance reports prepared by them have been submitted to the City of Tucson under separate cover.

5.0 CONCLUSION

Houghton Road is going to be widened to three lanes in each direction between approximately Irvington Road and Valencia Road. Improvements to side streets and driveways, and the construction of drainage structures will be necessary as part of this project. It is also the intent of the City to create a "desert parkway" along this corridor. .

Existing drainage structures along Houghton Road consist only of culverts, of which the cross culverts are all undersized for the 100-year storm event. All existing cross culverts along Houghton road will be replaced and new cross culverts added. Existing driveway culverts will be replaced and new ones added as well. Along Irvington Road, the one cross drainage structure will be extended. Storm drain systems will be installed to collect pavement drainage along curbed sections of roadway and to collect offsite flow where there are design constraints that do not allow for roadside conveyance.

Two FEMA floodplains exist within the project limits. The washes associated with these floodplains are the Mesquite Ranch Wash and the Attebury Wash. The Mesquite Ranch Wash is contained within an incised channel and there are no expected significant impacts to this floodplain. The Attebury Wash floodplain is wide and shallow. The extents of the floodplain will not be affected, however the flow depths will be increased due to ponding at the culverts.

The desert parkway aspect of this project will be accomplished by keeping the majority of the roadway uncurbed, providing water harvesting in the median and along the Civano subdivision, maintaining much of the existing vegetation and by having paths along the roadway for the majority of the project length.

The methods discussed in this report for the design of drainage structures were done in accordance with COT standards and to maintain existing flow pattern as much as possible.

6.0 REFERENCES

1) Pima County Storm Drain Design, Guidelines and Standard Plans. March 23, 1981.

2) Pima County Department of Transportation and Flood Control District; Hydrology Manual for Engineering Design and Floodplain Management within Pima County, Arizona, September 1979.

3) Standards Manual for Drainage Design and Floodplain Management in Tucson, Arizona. December 1989. Revised July 1998.

4) HEC 14: Hydraulic Design of Energy Dissipators for Culverts and Channels. FHWA July 2006.

5) HEC-11: Design of Riprap Revetment. FHWA March 1989.

6) Design and Construction of Urban Stormwater management Systems. Water Environment Federation 1992.

HYDROLOGIC CALCULATIONS

City of Tucson

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

1. Project Name and Location: Houghton
2. Drainage Concentration Point: PV1
3. *Watershed Area (A) at Drainage Concentration Point: 0.52 acres
4. Length of Hydraulically Longest Watercourse (Lc): 411.0 ft.
5. Length from center of Watershed Area (Lca) along Lc: 205.5 ft.

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

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

a. ΔL_1:	205.5	$(\Delta L_1)^3$:	8.7E+06	ΔH_1:	3.9	$(\Delta L_1)^3/\Delta H_1$:	2.2E+06
b. ΔL_2:	205.5	$(\Delta L_2)^3$:	8.7E+06	ΔH_2:	3.9	$(\Delta L_2)^3/\Delta H_2$:	2.2E+06
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. $G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2}$ = 1491.7 + 1491.7 + ____ + ____ = **2983.4**

8. Mean Slope $(S_c) = (L_c/G)^2 = ($ 411.0 / 2983.4 $)^2 =$ 1.90% 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 (0%)	Urb (100%)	( )	
11. Basin Factor ($n_{b,100}$):	0.055	0.048		n_{bw100} = 0.052
12. Soil Types, in %:	100% B	100%B		
13. Imperviousnes (%):	0%	100%		I_w = 100.0%
14. Runoff Coefficient (C_{w100}):	0.62	0.95		C_{w100} = 0.95
15. Contrib. Area Factor (F_{Ac}):	1	1		F_{Acw} = 1.00

16. **Time of Concentration (T_{c100}): 4.2 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 $(i_{100}) = (4P_{1,100})/(1+0.05T_{c100})$ = 9.6 inches/hour.
18. 100-Year Peak $(Q_{p100}) = (C_{w100})(i_{100})(F_{Acw})A$= 0.95 x 9.60 x 1.0 x 0.5 = 4.7 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	2	3	4
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. **$T_{c\,100}$ 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: jco Checked by: ____ Company: Psomas Date: 02/09/10

City of Tucson

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

1. Project Name and Location: Houghton
2. Drainage Concentration Point: PV1
3. *Watershed Area (A) at Drainage Concentration Point: 1.27 acres
4. Length of Hydraulically Longest Watercourse (Lc): 714.0 ft.
5. Length from center of Watershed Area (Lca) along Lc: 357.0 ft.

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

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

a. ΔL_1:	357.0	$(\Delta L_1)^3$:	4.5E+07	ΔH_1:	3.9	$(\Delta L_1)^3/\Delta H_1$:	1.2E+07
b. ΔL_2:	357.0	$(\Delta L_2)^3$:	4.5E+07	ΔH_2:	3.9	$(\Delta L_2)^3/\Delta H_2$:	1.2E+07
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. $$G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2} = 3415.6 + 3415.6 + \_\_\_ + \_\_\_ = \mathbf{6831.2}$$

8. Mean Slope $(S_c) = (L_c/G)^2 = ($ 714.0 / 6831.2 $)^2 =$ 1.09% 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 (0%)	Urb (100%)	( )	
11. Basin Factor ($n_{b,100}$):	0.055	0.048		n_{bw100} = 0.052
12. Soil Types, in %:	100% B	100%B		
13. Imperviousnes (%):	0%	100%		I_w = 100.0%
14. Runoff Coefficient (C_{w100}):	0.62	0.95		C_{w100} = 0.95
15. Contrib. Area Factor (F_{Ac}):	1	1		F_{Acw} = 1.00

16. **Time of Concentration (T_{c100}): 6.8 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}) = $(4P_{1,100})/(1+0.05T_{c100})$ = 8.9 inches/hour.
18. 100-Year Peak (Q_{p100}) = $(C_{w100})(i_{100})(F_{Acw})A$= 0.95 x 8.90 x 1.0 x 1.3 = 10.7 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	8	10
Tc (minutes {Eqn. 4.5}):	12.5	9.0	7.9	7.1

*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: jco Checked by: _____ Company: Psomas Date: 02/09/10

City of Tucson

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

1. Project Name and Location: Houghton
2. Drainage Concentration Point: PV2
3. *Watershed Area (A) at Drainage Concentration Point: 1.18 acres
4. Length of Hydraulically Longest Watercourse (Lc): 566.0 ft.
5. Length from center of Watershed Area (Lca) along Lc: 283.0 ft.

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

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

a. ΔL_1:	283.0	$(\Delta L_1)^3$:	2.3E+07	ΔH_1:	5.4	$(\Delta L_1)^3/\Delta H_1$:	4.2E+06
b. ΔL_2:	283.0	$(\Delta L_2)^3$:	2.3E+07	ΔH_2:	5.4	$(\Delta L_2)^3/\Delta H_2$:	4.2E+06
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. $$G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2} = 2052.5 + 2052.5 + \_\_\_ + \_\_\_ = \mathbf{4105.1}$$

8. Mean Slope $(S_c) = (L_c/G)^2 = ($ 566.0 / 4105.1 $)^2 =$ 1.90% 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 (0%)	Urb (100%)	( )	
11. Basin Factor ($n_{b,100}$):	0.055	0.048		n_{bw100} = 0.052
12. Soil Types, in %:	100% B	100%B		
13. Imperviousnes (%):	0%	100%		I_w = 100.0%
14. Runoff Coefficient (C_{w100}):	0.62	0.95		C_{w100} = 0.95
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 $(Q_{p100}) = (C_{w100})(i_{100})(F_{Acw})A$= 0.95 x 9.60 x 1.0 x 1.2 = 10.8 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	5	8	10
Tc (minutes {Eqn. 4.5}):	9.0	6.5	5.7	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: jco Checked by: _____ Company: Psomas Date: 02/09/10

City of Tucson

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

1. Project Name and Location: Houghton
2. Drainage Concentration Point: PV2.1
3. *Watershed Area (A) at Drainage Concentration Point: 0.26 acres
4. Length of Hydraulically Longest Watercourse (Lc): 178.0 ft.
5. Length from center of Watershed Area (Lca) along Lc: 89.0 ft.

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

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

a. ΔL_1:	89.0	$(\Delta L_1)^3$:	7.0E+05	ΔH_1:	0.6	$(\Delta L_1)^3/\Delta H_1$:	1.1E+06
b. ΔL_2:	89.0	$(\Delta L_2)^3$:	7.0E+05	ΔH_2:	0.6	$(\Delta L_2)^3/\Delta H_2$:	1.1E+06
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. $G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2}$ = 1066.3 + 1066.3 + ____ + ____ = **2132.6**

8. Mean Slope $(S_c) = (L_c/G)^2 = ($ 178.0 / 2132.6 $)^2 =$ 0.70% 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 (0%)	Urb (100%)	( )	
11. Basin Factor ($n_{b,100}$):	0.055	0.048		n_{bw100} = 0.052
12. Soil Types, in %:	100% B	100%B		
13. Imperviousnes (%):	0%	100%		I_w = 100.0%
14. Runoff Coefficient (C_{w100}):	0.62	0.95		C_{w100} = 0.95
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}) = $(C_{w100})(i_{100})(F_{Acw})A$= 0.95 x 9.60 x 1.0 x 0.3 = 2.4 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	1	2	2
Tc (minutes {Eqn. 4.5}):	7.2	5.2	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: jco Checked by: ____ Company: Psomas Date: 02/09/10

City of Tucson

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

1. Project Name and Location: Houghton
2. Drainage Concentration Point: PV3
3. *Watershed Area (A) at Drainage Concentration Point: 0.55 acres
4. Length of Hydraulically Longest Watercourse (Lc): 233.0 ft.
5. Length from center of Watershed Area (Lca) along Lc: 116.5 ft.

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

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

a. ΔL_1:	116.5	$(\Delta L_1)^3$:	1.6E+06	ΔH_1:	2.2	$(\Delta L_1)^3/\Delta H_1$:	7.2E+05
b. ΔL_2:	116.5	$(\Delta L_2)^3$:	1.6E+06	ΔH_2:	2.2	$(\Delta L_2)^3/\Delta H_2$:	7.2E+05
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. $G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2}$ = 845.8 + 845.8 + ____ + ____ = **1691.7**

8. Mean Slope $(S_c) = (L_c/G)^2 = ($ 233.0 / 1691.7 $)^2 =$ 1.90% 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 (0%)	Urb (100%)	( )	
11. Basin Factor ($n_{b,100}$):	0.055	0.048		n_{bw100} = 0.052
12. Soil Types, in %:	100% B	100%B		
13. Imperviousnes (%):	0%	100%		I_w = 100.0%
14. Runoff Coefficient (C_{w100}):	0.62	0.95		C_{w100} = 0.95
15. Contrib. Area Factor (F_{Ac}):	1	1		F_{Acw} = 1.00

16. **Time of Concentration (T_{c100}): 3.4 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 $(i_{100}) = (4P_{1,100})/(1+0.05T_{c100})$ = 9.6 inches/hour.
18. 100-Year Peak $(Q_{p100}) = (C_{w100})(i_{100})(F_{Acw})A$= 0.95 x 9.60 x 1.0 x 0.6 = 5.0 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}):	6.2	4.4	3.9	3.5

*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: jco Checked by: ____ Company: Psomas Date: 02/09/10

City of Tucson

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

1. Project Name and Location: Houghton
2. Drainage Concentration Point: PV3.1
3. *Watershed Area (A) at Drainage Concentration Point: 0.21 acres
4. Length of Hydraulically Longest Watercourse (Lc): 178.0 ft.
5. Length from center of Watershed Area (Lca) along Lc: 89.0 ft.

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

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

a. ΔL_1:	89.0	$(\Delta L_1)^3$:	7.0E+05	ΔH_1:	0.6	$(\Delta L_1)^3/\Delta H_1$:	1.1E+06
b. ΔL_2:	89.0	$(\Delta L_2)^3$:	7.0E+05	ΔH_2:	0.6	$(\Delta L_2)^3/\Delta H_2$:	1.1E+06
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. $$G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2} = 1066.3 + 1066.3 + \_\_\_ + \_\_\_ = \mathbf{2132.6}$$

8. Mean Slope $(S_c) = (L_c/G)^2 = ($ 178.0 / 2132.6 $)^2 =$ 0.70% 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 (0%)	Urb (100%)	( )	
11. Basin Factor ($n_{b,100}$):	0.055	0.048		n_{bw100} = 0.052
12. Soil Types, in %:	100% B	100%B		
13. Imperviousnes (%):	0%	100%		I_w = 100.0%
14. Runoff Coefficient (C_{w100}):	0.62	0.95		C_{w100} = 0.95
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 $(Q_{p100}) = (C_{w100})(i_{100})(F_{Acw})A$= 0.95 x 9.60 x 1.0 x 0.2 = 1.9 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	2
Tc (minutes {Eqn. 4.5}):	7.2	5.2	4.5	4.1

*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: jco Checked by: _____ Company: Psomas Date: 02/09/10

City of Tucson

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

1. Project Name and Location: Houghton
2. Drainage Concentration Point: PV4
3. *Watershed Area (A) at Drainage Concentration Point: 0.54 acres
4. Length of Hydraulically Longest Watercourse (Lc): 370.0 ft.
5. Length from center of Watershed Area (Lca) along Lc: 185.0 ft.

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

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

a. ΔL_1:	185.0	$(\Delta L_1)^3$:	6.3E+06	ΔH_1:	1.5	$(\Delta L_1)^3/\Delta H_1$:	4.3E+06
b. ΔL_2:	185.0	$(\Delta L_2)^3$:	6.3E+06	ΔH_2:	1.5	$(\Delta L_2)^3/\Delta H_2$:	4.3E+06
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. $$G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2} = 2068.4 + 2068.4 + \_\_\_ + \_\_\_ = \mathbf{4136.7}$$

8. Mean Slope $(S_c) = (L_c/G)^2 = ($ 370.0 / 4136.7 $)^2 =$ 0.80% 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 (0%)	Urb (100%)	( )	
11. Basin Factor ($n_{b,100}$):	0.055	0.048		n_{bw100} = 0.052
12. Soil Types, in %:	100% B	100%B		
13. Imperviousnes (%):	0%	100%		I_w = 100.0%
14. Runoff Coefficient (C_{w100}):	0.62	0.95		C_{w100} = 0.95
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 $(Q_{p100}) = (C_{w100})(i_{100})(F_{Acw})A$= 0.95 x 9.50 x 1.0 x 0.5 = 4.9 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}):	9.8	7.0	6.1	5.6

*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: jco Checked by: _____ Company: Psomas Date: 02/09/10

City of Tucson

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

1. Project Name and Location: Houghton
2. Drainage Concentration Point: PV5
3. *Watershed Area (A) at Drainage Concentration Point: 1.04 acres
4. Length of Hydraulically Longest Watercourse (Lc): 720.0 ft.
5. Length from center of Watershed Area (Lca) along Lc: 360.0 ft.

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

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

a. ΔL_1:	360.0	$(\Delta L_1)^3$:	4.7E+07	ΔH_1:	3.0	$(\Delta L_1)^3/\Delta H_1$:	1.6E+07
b. ΔL_2:	360.0	$(\Delta L_2)^3$:	4.7E+07	ΔH_2:	3.0	$(\Delta L_2)^3/\Delta H_2$:	1.6E+07
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. $$G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2} = 3943.6 + 3943.6 + \_\_\_ + \_\_\_ = \mathbf{7887.2}$$

8. Mean Slope $(S_c) = (L_c/G)^2 = ($ 720.0 / 7887.2 $)^2 =$ 0.83% 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 (0%)	Urb (100%)	( )	
11. Basin Factor ($n_{b,100}$):	0.055	0.048		n_{bw100} = 0.052
12. Soil Types, in %:	100% B	100%B		
13. Imperviousnes (%):	0%	100%		I_w = 100.0%
14. Runoff Coefficient (C_{w100}):	0.62	0.95		C_{w100} = 0.95
15. Contrib. Area Factor (F_{Ac}):	1	1		F_{Acw} = 1.00

16. **Time of Concentration (T_{c100}): 7.6 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 $(i_{100}) = (4P_{1,100})/(1+0.05T_{c100})$ = 8.7 inches/hour.
18. 100-Year Peak $(Q_{p100}) = (C_{w100})(i_{100})(F_{Acw})A$= 0.95 x 8.70 x 1.0 x 1.0 = 8.6 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)	2	4	6	8
Tc (minutes {Eqn. 4.5}):	14.0	10.1	8.8	8.0

*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: jco Checked by: _____ Company: Psomas Date: 02/09/10

City of Tucson

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

1. Project Name and Location: Houghton
2. Drainage Concentration Point: PV5
3. *Watershed Area (A) at Drainage Concentration Point: 0.716 acres
4. Length of Hydraulically Longest Watercourse (Lc): 720.0 ft.
5. Length from center of Watershed Area (Lca) along Lc: 360.0 ft.

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

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

a. ΔL_1:	360.0	$(\Delta L_1)^3$:	4.7E+07	ΔH_1:	3.0	$(\Delta L_1)^3/\Delta H_1$:	1.6E+07
b. ΔL_2:	360.0	$(\Delta L_2)^3$:	4.7E+07	ΔH_2:	3.0	$(\Delta L_2)^3/\Delta H_2$:	1.6E+07
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. $$G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2} = 3943.6 + 3943.6 + \_\_\_ + \_\_\_ = \mathbf{7887.2}$$

8. Mean Slope $(S_c) = (L_c/G)^2 = (\ 720.0\ /\ 7887.2\ )^2 =$ 0.83% 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 (0%)	Urb (100%)	( )	
11. Basin Factor ($n_{b,100}$):	0.055	0.048		n_{bw100} = 0.052
12. Soil Types, in %:	100% B	100%B		
13. Imperviousnes (%):	0%	100%		I_w = 100.0%
14. Runoff Coefficient (C_{w100}):	0.62	0.95		C_{w100} = 0.95
15. Contrib. Area Factor (F_{Ac}):	1	1		F_{Acw} = 1.00

16. **Time of Concentration (T_{c100}): 7.6 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 $(i_{100}) = (4P_{1,100})/(1+0.05T_{c100})$ = 8.7 inches/hour.
18. 100-Year Peak $(Q_{p100}) = (C_{w100})(i_{100})(F_{Acw})A$= 0.95 x 8.70 x 1.0 x 0.7 = 5.9 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}):	14.0	10.1	8.8	8.0

*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: jco Checked by: _____ Company: Psomas Date: 02/09/10

City of Tucson

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

1. Project Name and Location: Houghton
2. Drainage Concentration Point: PV6
3. *Watershed Area (A) at Drainage Concentration Point: 1.02 acres
4. Length of Hydraulically Longest Watercourse (Lc): 773.0 ft.
5. Length from center of Watershed Area (Lca) along Lc: 386.5 ft.

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

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

a. ΔL_1:	386.5	$(\Delta L_1)^3$:	5.8E+07	ΔH_1:	3.1	$(\Delta L_1)^3/\Delta H_1$:	1.9E+07
b. ΔL_2:	386.5	$(\Delta L_2)^3$:	5.8E+07	ΔH_2:	3.1	$(\Delta L_2)^3/\Delta H_2$:	1.9E+07
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. $$G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2} = 4322.6 + 4322.6 + \_\_\_ + \_\_\_ = \mathbf{8645.2}$$

8. Mean Slope $(S_c) = (L_c/G)^2 = ($ 773.0 / 8645.2 $)^2 =$ 0.80% 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 (0%)	Urb (100%)	( )	
11. Basin Factor ($n_{b,100}$):	0.055	0.048		n_{bw100} = 0.052
12. Soil Types, in %:	100% B	100%B		
13. Imperviousnes (%):	0%	100%		I_w = 100.0%
14. Runoff Coefficient (C_{w100}):	0.62	0.95		C_{w100} = 0.95
15. Contrib. Area Factor (F_{Ac}):	1	1		F_{Acw} = 1.00

16. **Time of Concentration (T_{c100}): 8.1 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 $(i_{100}) = (4P_{1,100})/(1+0.05T_{c100})$ = 8.5 inches/hour.
18. 100-Year Peak $(Q_{p100}) = (C_{w100})(i_{100})(F_{Acw})A$= 0.95 x 8.50 x 1.0 x 1.0 = 8.2 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	4	6	7
Tc (minutes {Eqn. 4.5}):	14.9	10.7	9.4	8.5

*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: jco Checked by: _____ Company: Psomas Date: 02/09/10

City of Tucson

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

1. Project Name and Location: Houghton
2. Drainage Concentration Point: PV7
3. *Watershed Area (A) at Drainage Concentration Point: 0.84 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:	216.5	$(\Delta L_1)^3$:	1.0E+07	ΔH_1:	2.2	$(\Delta L_1)^3/\Delta H_1$:	4.7E+06
b. ΔL_2:	216.5	$(\Delta L_2)^3$:	1.0E+07	ΔH_2:	2.2	$(\Delta L_2)^3/\Delta H_2$:	4.7E+06
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. $$G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2} = 2162.5 + 2162.7 + \_\_\_ + \_\_\_ = \mathbf{4325.2}$$

8. Mean Slope $(S_c) = (L_c/G)^2 = ($ 433.0 / 4325.2 $)^2 =$ 1.00% 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 (0%)	Urb (100%)	( )	
11. Basin Factor ($n_{b,100}$):	0.055	0.048		n_{bw100} = 0.051
12. Soil Types, in %:	100% B	100%B		
13. Imperviousnes (%):	0%	100%		I_w = 100.0%
14. Runoff Coefficient (C_{w100}):	0.62	0.95		C_{w100} = 0.95
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 $(Q_{p100}) = (C_{w100})(i_{100})(F_{Acw})A$= 0.95 x 9.50 x 1.0 x 0.8 = 7.6 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)	2	4	5	7
Tc (minutes {Eqn. 4.5}):	9.8	7.1	6.2	5.6

*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.

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City of Tucson

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

1. Project Name and Location: Houghton
2. Drainage Concentration Point: PV8
3. *Watershed Area (A) at Drainage Concentration Point: 0.92 acres
4. Length of Hydraulically Longest Watercourse (Lc): 627.0 ft.
5. Length from center of Watershed Area (Lca) along Lc: 313.5 ft.

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

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

a. ΔL_1:	313.5	$(\Delta L_1)^3$:	3.1E+07	ΔH_1:	2.2	$(\Delta L_1)^3/\Delta H_1$:	1.4E+07
b. ΔL_2:	313.5	$(\Delta L_2)^3$:	3.1E+07	ΔH_2:	2.2	$(\Delta L_2)^3/\Delta H_2$:	1.4E+07
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. $$G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2} = 3750.9 + 3750.9 + \_\_\_ + \_\_\_ = \mathbf{7501.8}$$

8. Mean Slope $(S_c) = (L_c/G)^2 = ($ 627.0 / 7501.8 $)^2 =$ 0.70% 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 (0%)	Urb (100%)	( )	
11. Basin Factor ($n_{b,100}$):	0.055	0.048		n_{bw100} = 0.052
12. Soil Types, in %:	100% B	100%B		
13. Imperviousnes (%):	0%	100%		I_w = 100.0%
14. Runoff Coefficient (C_{w100}):	0.62	0.95		C_{w100} = 0.95
15. Contrib. Area Factor (F_{Ac}):	1	1		F_{Acw} = 1.00

16. **Time of Concentration (T_{c100}): 7.5 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 $(i_{100}) = (4P_{1,100})/(1+0.05T_{c100})$ = 8.7 inches/hour.
18. 100-Year Peak $(Q_{p100}) = (C_{w100})(i_{100})(F_{Acw})A$= 0.95 x 8.70 x 1.0 x 0.9 = 7.6 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)	2	4	5	7
Tc (minutes {Eqn. 4.5}):	13.8	10.0	8.7	7.9

*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.

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City of Tucson

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

1. Project Name and Location: Houghton
2. Drainage Concentration Point: PV8.1 Bilby
3. *Watershed Area (A) at Drainage Concentration Point: 0.7 acres
4. Length of Hydraulically Longest Watercourse (Lc): 268.0 ft.
5. Length from center of Watershed Area (Lca) along Lc: 134.0 ft.

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

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

a. ΔL_1:	134.0	$(\Delta L_1)^3$:	2.4E+06	ΔH_1:	1.0	$(\Delta L_1)^3/\Delta H_1$:	2.4E+06
b. ΔL_2:	134.0	$(\Delta L_2)^3$:	2.4E+06	ΔH_2:	1.0	$(\Delta L_2)^3/\Delta H_2$:	2.4E+06
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. $$G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2} = 1551.2 + 1551.2 + \_\_\_ + \_\_\_ = \mathbf{3102.3}$$

8. Mean Slope $(S_c) = (L_c/G)^2 = ($ 268.0 / 3102.3 $)^2 =$ 0.75% 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 (0%)	Urb (100%)	( )	
11. Basin Factor ($n_{b,100}$):	0.055	0.048		n_{bw100} = 0.052
12. Soil Types, in %:	100% B	100%B		
13. Imperviousnes (%):	0%	100%		I_w = 100.0%
14. Runoff Coefficient (C_{w100}):	0.62	0.95		C_{w100} = 0.95
15. Contrib. Area Factor (F_{Ac}):	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 $(Q_{p100}) = (C_{w100})(i_{100})(F_{Acw})A$= 0.95 x 9.60 x 1.0 x 0.7 = 6.4 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	3	4	6
Tc (minutes {Eqn. 4.5}):	8.5	6.1	5.4	4.8

*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.

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City of Tucson

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

1. Project Name and Location: Houghton
2. Drainage Concentration Point: PV9
3. *Watershed Area (A) at Drainage Concentration Point: 1.56 acres
4. Length of Hydraulically Longest Watercourse (Lc): 1061.0 ft.
5. Length from center of Watershed Area (Lca) along Lc: 530.5 ft.

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

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

a. ΔL_1:	650.0	$(\Delta L_1)^3$:	2.7E+08	ΔH_1:	6.5	$(\Delta L_1)^3/\Delta H_1$:	4.2E+07
b. ΔL_2:	411.0	$(\Delta L_2)^3$:	6.9E+07	ΔH_2:	2.9	$(\Delta L_2)^3/\Delta H_2$:	2.4E+07
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. $$G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2} = 6500.0 + 4909.8 + \_\_\_ + \_\_\_ = \mathbf{11409.8}$$

8. Mean Slope $(S_c) = (L_c/G)^2 = (\ 1061.0\ /\ 11409.8\ )^2 =$ 0.86% 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 (0%)	Urb (100%)	( )	
11. Basin Factor ($n_{b,100}$):	0.055	0.048		n_{bw100} = 0.052
12. Soil Types, in %:	100% B	100%B		
13. Imperviousnes (%):	0%	100%		I_w = 100.0%
14. Runoff Coefficient (C_{w100}):	0.62	0.95		C_{w100} = 0.95
15. Contrib. Area Factor (F_{Ac}):	1	1		F_{Acw} = 1.00

16. **Time of Concentration (T_{c100}): 9.8 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 $(i_{100}) = (4P_{1,100})/(1+0.05T_{c100})$ = 8.1 inches/hour.
18. 100-Year Peak $(Q_{p100}) = (C_{w100})(i_{100})(F_{Acw})A$= 0.95 x 8.10 x 1.0 x 1.6 = 12.0 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	11
Tc (minutes {Eqn. 4.5}):	17.9	12.9	11.3	10.2

*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.

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City of Tucson

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

1. Project Name and Location: Houghton
2. Drainage Concentration Point: PV10
3. *Watershed Area (A) at Drainage Concentration Point: 0.48 acres
4. Length of Hydraulically Longest Watercourse (Lc): 372.0 ft.
5. Length from center of Watershed Area (Lca) along Lc: 186.0 ft.

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

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

a. ΔL_1:	186.0	$(\Delta L_1)^3$:	6.4E+06	ΔH_1:	1.4	$(\Delta L_1)^3/\Delta H_1$:	4.6E+06
b. ΔL_2:	186.0	$(\Delta L_2)^3$:	6.4E+06	ΔH_2:	1.4	$(\Delta L_2)^3/\Delta H_2$:	4.6E+06
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. $$G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2} = 2143.9 + 2143.9 + \_\_\_ + \_\_\_ = \mathbf{4287.8}$$

8. Mean Slope $(S_c) = (L_c/G)^2 = ($ 372.0 / 4287.8 $)^2 =$ 0.75% 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 (0%)	Urb (100%)	( )	
11. Basin Factor ($n_{b,100}$):	0.055	0.048		n_{bw100} = 0.052
12. Soil Types, in %:	100% B	100%B		
13. Imperviousnes (%):	0%	100%		I_w = 100.0%
14. Runoff Coefficient (C_{w100}):	0.62	0.95		C_{w100} = 0.95
15. Contrib. Area Factor (F_{Ac}):	1	1		F_{Acw} = 1.00

16. **Time of Concentration (T_{c100}): 5.5 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 $(i_{100}) = (4P_{1,100})/(1+0.05T_{c100})$ = 9.4 inches/hour.
18. 100-Year Peak $(Q_{p100}) = (C_{w100})(i_{100})(F_{Acw})A$= 0.95 x 9.40 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}):	10.0	7.2	6.3	5.7

*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.

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City of Tucson

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

1. Project Name and Location: Houghton
2. Drainage Concentration Point: PV11
3. *Watershed Area (A) at Drainage Concentration Point: 0.32 acres
4. Length of Hydraulically Longest Watercourse (Lc): 249.0 ft.
5. Length from center of Watershed Area (Lca) along Lc: 124.5 ft.

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

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

a. ΔL_1:	124.5	$(\Delta L_1)^3$:	1.9E+06	ΔH_1:	4.4	$(\Delta L_1)^3/\Delta H_1$:	4.4E+05
b. ΔL_2:	124.5	$(\Delta L_2)^3$:	1.9E+06	ΔH_2:	4.4	$(\Delta L_2)^3/\Delta H_2$:	4.4E+05
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. $$G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2} = 665.3 + 665.3 + \_\_\_ + \_\_\_ = \mathbf{1330.6}$$

8. Mean Slope $(S_c) = (L_c/G)^2 = ($ 249.0 / 1330.6 $)^2 =$ 3.50% 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 (0%)	Urb (100%)	( )	
11. Basin Factor ($n_{b,100}$):	0.055	0.048		n_{bw100} = 0.052
12. Soil Types, in %:	100% B	100%B		
13. Imperviousnes (%):	0%	100%		I_w = 100.0%
14. Runoff Coefficient (C_{w100}):	0.62	0.95		C_{w100} = 0.95
15. Contrib. Area Factor (F_{Ac}):	1	1		F_{Acw} = 1.00

16. **Time of Concentration (T_{c100}): 3.0 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 $(Q_{p100}) = (C_{w100})(i_{100})(F_{Acw})A =$ 0.95 x 9.60 x 1.0 x 0.3 = 2.9 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	3
Tc (minutes {Eqn. 4.5}):	5.5	3.9	3.4	3.1

*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: jco Checked by: _____ Company: Psomas Date: 02/09/10

City of Tucson

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

1. Project Name and Location: Houghton
2. Drainage Concentration Point: PV11.1
3. *Watershed Area (A) at Drainage Concentration Point: 0.59 acres
4. Length of Hydraulically Longest Watercourse (Lc): 354.0 ft.
5. Length from center of Watershed Area (Lca) along Lc: 177.0 ft.

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

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

a. ΔL_1:	177.0	$(\Delta L_1)^3$:	5.5E+06	ΔH_1:	6.2	$(\Delta L_1)^3/\Delta H_1$:	8.9E+05
b. ΔL_2:	177.0	$(\Delta L_2)^3$:	5.5E+06	ΔH_2:	6.2	$(\Delta L_2)^3/\Delta H_2$:	8.9E+05
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. $$G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2} = 945.7 + 945.7 + \_\_\_ + \_\_\_ = \mathbf{1891.4}$$

8. Mean Slope $(S_c) = (L_c/G)^2 = ($ 354.0 / 1891.4 $)^2 =$ 3.50% 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 (0%)	Urb (100%)	( )	
11. Basin Factor ($n_{b,100}$):	0.055	0.048		n_{bw100} = 0.052
12. Soil Types, in %:	100% B	100%B		
13. Imperviousnes (%):	0%	100%		I_w = 100.0%
14. Runoff Coefficient (C_{w100}):	0.62	0.95		C_{w100} = 0.95
15. Contrib. Area Factor (F_{Ac}):	1	1		F_{Acw} = 1.00

16. **Time of Concentration (T_{c100}): 3.4 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}) = $(4P_{1,100})/(1+0.05T_{c100})$ = 9.6 inches/hour.
18. 100-Year Peak (Q_{p100}) = $(C_{w100})(i_{100})(F_{Acw})A$= 0.95 x 9.60 x 1.0 x 0.6 = 5.4 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	3	4	5
Tc (minutes {Eqn. 4.5}):	6.2	4.5	3.9	3.5

*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: jco Checked by: _____ Company: Psomas Date: 02/09/10

City of Tucson

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

1. Project Name and Location: Houghton
2. Drainage Concentration Point: PV12
3. *Watershed Area (A) at Drainage Concentration Point: 0.34 acres
4. Length of Hydraulically Longest Watercourse (Lc): 248.0 ft.
5. Length from center of Watershed Area (Lca) along Lc: 124.0 ft.

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

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

a. ΔL_1:	124.0	$(\Delta L_1)^3$:	1.9E+06	ΔH_1:	4.3	$(\Delta L_1)^3/\Delta H_1$:	4.4E+05
b. ΔL_2:	124.0	$(\Delta L_2)^3$:	1.9E+06	ΔH_2:	4.3	$(\Delta L_2)^3/\Delta H_2$:	4.4E+05
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. $$G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2} = 662.8 + 662.8 + \_\_\_ + \_\_\_ = \mathbf{1325.6}$$

8. Mean Slope $(S_c) = (L_c/G)^2 = ($ 248.0 / 1325.6 $)^2 =$ 3.50% 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 (0%)	Urb (100%)	( )	
11. Basin Factor ($n_{b,100}$):	0.055	0.048		n_{bw100} = 0.052
12. Soil Types, in %:	100% B	100%B		
13. Imperviousnes (%):	0%	100%		I_w = 100.0%
14. Runoff Coefficient (C_{w100}):	0.62	0.95		C_{w100} = 0.95
15. Contrib. Area Factor (F_{Ac}):	1	1		$F_{A\,cw}$ = 1.00

16. **Time of Concentration (T_{c100}): 3.0 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 $(Q_{p100}) = (C_{w100})(i_{100})(F_{Acw})A$= 0.95 x 9.60 x 1.0 x 0.3 = 3.1 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	2	2	3
Tc (minutes {Eqn. 4.5}):	5.5	3.9	3.4	3.1

*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: jco Checked by: _____ Company: Psomas Date: 02/09/10

City of Tucson

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

1. Project Name and Location: Houghton
2. Drainage Concentration Point: PV12.1
3. *Watershed Area (A) at Drainage Concentration Point: 1.1 acres
4. Length of Hydraulically Longest Watercourse (Lc): 744.0 ft.
5. Length from center of Watershed Area (Lca) along Lc: 372.0 ft.

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

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

a. ΔL_1:	372.0	$(\Delta L_1)^3$:	5.1E+07	ΔH_1:	2.8	$(\Delta L_1)^3/\Delta H_1$:	1.8E+07
b. ΔL_2:	372.0	$(\Delta L_2)^3$:	5.1E+07	ΔH_2:	2.8	$(\Delta L_2)^3/\Delta H_2$:	1.8E+07
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. $$G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2} = 4295.5 + 4295.5 + \_\_\_ + \_\_\_ = \mathbf{8591.0}$$

8. Mean Slope $(S_c) = (L_c/G)^2 = ($ 744.0 / 8591.0 $)^2 =$ 0.75% 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 (0%)	Urb (100%)	( )	
11. Basin Factor ($n_{b,100}$):	0.055	0.048		n_{bw100} = 0.052
12. Soil Types, in %:	100% B	100%B		
13. Imperviousnes (%):	0%	100%		I_w = 100.0%
14. Runoff Coefficient (C_{w100}):	0.62	0.95		C_{w100} = 0.95
15. Contrib. Area Factor (F_{Ac}):	1	1		F_{Acw} = 1.00

16. **Time of Concentration (T_{c100}): 8.1 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 $(i_{100}) = (4P_{1,100})/(1+0.05T_{c100})$ = 8.5 inches/hour.
18. 100-Year Peak $(Q_{p100}) = (C_{w100})(i_{100})(F_{Acw})A$= 0.95 x 8.50 x 1.0 x 1.1 = 8.9 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	6	8
Tc (minutes {Eqn. 4.5}):	14.9	10.7	9.4	8.5

*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: jco Checked by: _____ Company: Psomas Date: 02/09/10

City of Tucson

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

1. Project Name and Location: Houghton
2. Drainage Concentration Point: PV13
3. *Watershed Area (A) at Drainage Concentration Point: 0.57 acres
4. Length of Hydraulically Longest Watercourse (Lc): 370.0 ft.
5. Length from center of Watershed Area (Lca) along Lc: 185.0 ft.

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

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

a. ΔL_1:	185.0	$(\Delta L_1)^3$:	6.3E+06	ΔH_1:	0.9	$(\Delta L_1)^3/\Delta H_1$:	6.8E+06
b. ΔL_2:	185.0	$(\Delta L_2)^3$:	6.3E+06	ΔH_2:	0.9	$(\Delta L_2)^3/\Delta H_2$:	6.8E+06
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. $$G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2} = 2609.3 + 2609.3 + \_\_\_ + \_\_\_ = \mathbf{5218.5}$$

8. Mean Slope $(S_c) = (L_c/G)^2 = ($ 370.0 / 5218.5 $)^2 =$ 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 (0%)	Urb (100%)	( )	
11. Basin Factor ($n_{b,100}$):	0.055	0.048		n_{bw100} = 0.052
12. Soil Types, in %:	100% B	100%B		
13. Imperviousnes (%):	0%	100%		I_w = 100.0%
14. Runoff Coefficient (C_{w100}):	0.62	0.95		C_{w100} = 0.95
15. Contrib. Area Factor (F_{Ac}):	1	1		F_{Acw} = 1.00

16. **Time of Concentration (T_{c100}): 6.3 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 $(i_{100}) = (4P_{1,100})/(1+0.05T_{c100})$ = 9.1 inches/hour.
18. 100-Year Peak $(Q_{p100}) = (C_{w100})(i_{100})(F_{Acw})A$= 0.95 x 9.10 x 1.0 x 0.6 = 4.9 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}):	11.5	8.3	7.3	6.6

*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: jco Checked by: _____ Company: Psomas Date: 02/09/10

City of Tucson

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

1. Project Name and Location: Houghton
2. Drainage Concentration Point: PV14
3. *Watershed Area (A) at Drainage Concentration Point: 0.46 acres
4. Length of Hydraulically Longest Watercourse (Lc): 362.0 ft.
5. Length from center of Watershed Area (Lca) along Lc: 181.0 ft.

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

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

a. ΔL_1:	181.0	$(\Delta L_1)^3$:	5.9E+06	ΔH_1:	0.9	$(\Delta L_1)^3/\Delta H_1$:	6.5E+06
b. ΔL_2:	181.0	$(\Delta L_2)^3$:	5.9E+06	ΔH_2:	0.9	$(\Delta L_2)^3/\Delta H_2$:	6.5E+06
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. $$G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2} = 2552.7 + 2552.7 + \_\_\_ + \_\_\_ = \mathbf{5105.4}$$

8. Mean Slope $(S_c) = (L_c/G)^2 = ($ 362.0 / 5105.4 $)^2 =$ 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 (0%)	Urb (100%)	( )	
11. Basin Factor ($n_{b,100}$):	0.055	0.048		n_{bw100} = 0.052
12. Soil Types, in %:	100% B	100%B		
13. Imperviousnes (%):	0%	100%		I_w = 100.0%
14. Runoff Coefficient (C_{w100}):	0.62	0.95		C_{w100} = 0.95
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 $(Q_{p100}) = (C_{w100})(i_{100})(F_{Acw})A$= 0.95 x 9.20 x 1.0 x 0.5 = 4.0 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. **$T_{c\,100}$ 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: jco Checked by: _____ Company: Psomas Date: 02/09/10

City of Tucson

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

1. Project Name and Location: Houghton
2. Drainage Concentration Point: PV15
3. *Watershed Area (A) at Drainage Concentration Point: 0.45 acres
4. Length of Hydraulically Longest Watercourse (Lc): 294.0 ft.
5. Length from center of Watershed Area (Lca) along Lc: 147.0 ft.

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

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

a. ΔL_1:	147.0	$(\Delta L_1)^3$:	3.2E+06	ΔH_1:	0.7	$(\Delta L_1)^3/\Delta H_1$:	4.3E+06
b. ΔL_2:	147.0	$(\Delta L_2)^3$:	3.2E+06	ΔH_2:	0.7	$(\Delta L_2)^3/\Delta H_2$:	4.3E+06
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. $$G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2} = 2071.9 + 2071.9 + \_\_\_ + \_\_\_ = \mathbf{4143.7}$$

8. Mean Slope $(S_c) = (L_c/G)^2 = ($ 294.0 / 4143.7 $)^2 =$ 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 (0%)	Urb (100%)	( )	
11. Basin Factor ($n_{b,100}$):	0.055	0.048		n_{bw100} = 0.052
12. Soil Types, in %:	100% B	100%B		
13. Imperviousnes (%):	0%	100%		I_w = 100.0%
14. Runoff Coefficient (C_{w100}):	0.62	0.95		C_{w100} = 0.95
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 $(Q_{p100}) = (C_{w100})(i_{100})(F_{Acw})A$= 0.95 x 9.40 x 1.0 x 0.5 = 4.0 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}):	10.2	7.3	6.4	5.8

*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: jco Checked by: _____ Company: Psomas Date: 02/09/10

City of Tucson

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

1. Project Name and Location: Houghton
2. Drainage Concentration Point: PV16
3. *Watershed Area (A) at Drainage Concentration Point: 0.73 acres
4. Length of Hydraulically Longest Watercourse (Lc): 517.0 ft.
5. Length from center of Watershed Area (Lca) along Lc: 258.5 ft.

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

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

a. ΔL_1:	258.5	$(\Delta L_1)^3$:	1.7E+07	ΔH_1:	1.3	$(\Delta L_1)^3/\Delta H_1$:	1.3E+07
b. ΔL_2:	258.5	$(\Delta L_2)^3$:	1.7E+07	ΔH_2:	1.3	$(\Delta L_2)^3/\Delta H_2$:	1.3E+07
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. $$G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2} = 3659.3 + 3659.3 + \_\_\_ + \_\_\_ = \mathbf{7318.6}$$

8. Mean Slope $(S_c) = (L_c/G)^2 = ($ 517.0 / 7318.6 $)^2 =$ 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 (0%)	Urb (100%)	( )	
11. Basin Factor ($n_{b,100}$):	0.055	0.048		n_{bw100} = 0.052
12. Soil Types, in %:	100% B	100%B		
13. Imperviousnes (%):	0%	100%		I_w = 100.0%
14. Runoff Coefficient (C_{w100}):	0.62	0.95		C_{w100} = 0.95
15. Contrib. Area Factor (F_{Ac}):	1	1		F_{Acw} = 1.00

16. **Time of Concentration (T_{c100}): 7.7 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 $(i_{100}) = (4P_{1,100})/(1+0.05T_{c100})$ = 8.7 inches/hour.
18. 100-Year Peak $(Q_{p100}) = (C_{w100})(i_{100})(F_{Acw})A$= 0.95 x 8.70 x 1.0 x 0.7 = 6.0 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}):	14.1	10.1	8.9	8.0

*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: jco Checked by: _____ Company: Psomas Date: 02/09/10

City of Tucson

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

1. Project Name and Location: Houghton
2. Drainage Concentration Point: PV17
3. *Watershed Area (A) at Drainage Concentration Point: 0.35 acres
4. Length of Hydraulically Longest Watercourse (Lc): 230.0 ft.
5. Length from center of Watershed Area (Lca) along Lc: 115.0 ft.

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

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

a. ΔL_1:	115.0	$(\Delta L_1)^3$:	1.5E+06	ΔH_1:	0.6	$(\Delta L_1)^3/\Delta H_1$:	2.6E+06
b. ΔL_2:	115.0	$(\Delta L_2)^3$:	1.5E+06	ΔH_2:	0.6	$(\Delta L_2)^3/\Delta H_2$:	2.6E+06
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. $G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2}$ = 1626.3 + 1626.3 + ____ + ____ = **3252.7**

8. Mean Slope $(S_c) = (L_c/G)^2 = ($ 230.0 / 3252.7 $)^2 =$ 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 (0%)	Urb (100%)	( )	
11. Basin Factor ($n_{b,100}$):	0.055	0.048		n_{bw100} = 0.052
12. Soil Types, in %:	100% B	100%B		
13. Imperviousnes (%):	0%	100%		I_w = 100.0%
14. Runoff Coefficient (C_{w100}):	0.62	0.95		C_{w100} = 0.95
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}) = $(C_{w100})(i_{100})(F_{Acw})A$= 0.95 x 9.60 x 1.0 x 0.4 = 3.2 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	2	3
Tc (minutes {Eqn. 4.5}):	9.0	6.5	5.7	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.

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City of Tucson

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

1. Project Name and Location: Houghton
2. Drainage Concentration Point: PV18
3. *Watershed Area (A) at Drainage Concentration Point: 0.47 acres
4. Length of Hydraulically Longest Watercourse (Lc): 369.0 ft.
5. Length from center of Watershed Area (Lca) along Lc: 184.5 ft.

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

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

a. ΔL_1:	184.5	$(\Delta L_1)^3$:	6.3E+06	ΔH_1:	5.9	$(\Delta L_1)^3/\Delta H_1$:	1.1E+06
b. ΔL_2:	184.5	$(\Delta L_2)^3$:	6.3E+06	ΔH_2:	5.9	$(\Delta L_2)^3/\Delta H_2$:	1.1E+06
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. $$G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2} = 1031.7 + 1031.7 + \_\_\_ + \_\_\_ = \mathbf{2063.5}$$

8. Mean Slope $(S_c) = (L_c/G)^2 = ($ 369.0 / 2063.5 $)^2 =$ 3.20% 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 (0%)	Urb (100%)	( )	
11. Basin Factor ($n_{b,100}$):	0.055	0.048		n_{bw100} = 0.052
12. Soil Types, in %:	100% B	100%B		
13. Imperviousnes (%):	0%	100%		I_w = 100.0%
14. Runoff Coefficient (C_{w100}):	0.62	0.95		C_{w100} = 0.95
15. Contrib. Area Factor (F_{Ac}):	1	1		F_{Acw} = 1.00

16. **Time of Concentration (T_{c100}): 3.5 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 $(i_{100}) = (4P_{1,100})/(1+0.05T_{c100})$ = 9.6 inches/hour.
18. 100-Year Peak $(Q_{p100}) = (C_{w100})(i_{100})(F_{Acw})A$= 0.95 x 9.60 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}):	6.4	4.6	4.0	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.

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City of Tucson

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

1. Project Name and Location: Houghton
2. Drainage Concentration Point: PV19
3. *Watershed Area (A) at Drainage Concentration Point: 0.77 acres
4. Length of Hydraulically Longest Watercourse (Lc): 462.0 ft.
5. Length from center of Watershed Area (Lca) along Lc: 231.0 ft.

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

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

a. ΔL_1:	231.0	$(\Delta L_1)^3$:	1.2E+07	ΔH_1:	7.4	$(\Delta L_1)^3/\Delta H_1$:	1.7E+06
b. ΔL_2:	231.0	$(\Delta L_2)^3$:	1.2E+07	ΔH_2:	7.4	$(\Delta L_2)^3/\Delta H_2$:	1.7E+06
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. $$G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2} = 1291.5 + 1291.5 + \_\_\_ + \_\_\_ = \mathbf{2583.0}$$

8. Mean Slope $(S_c) = (L_c/G)^2 = ($ 462.0 / 2583.0 $)^2 =$ 3.20% 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 (0%)	Urb (100%)	( )	
11. Basin Factor ($n_{b,100}$):	0.055	0.048		n_{bw100} = 0.052
12. Soil Types, in %:	100% B	100%B		
13. Imperviousnes (%):	0%	100%		I_w = 100.0%
14. Runoff Coefficient (C_{w100}):	0.62	0.95		C_{w100} = 0.95
15. Contrib. Area Factor (F_{Ac}):	1	1		F_{Acw} = 1.00

16. **Time of Concentration (T_{c100}): 3.8 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 $(i_{100}) = (4P_{1,100})/(1+0.05T_{c100})$ = 9.6 inches/hour.
18. 100-Year Peak $(Q_{p100}) = (C_{w100})(i_{100})(F_{Acw})A$= 0.95 x 9.60 x 1.0 x 0.8 = 7.0 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	6
Tc (minutes {Eqn. 4.5}):	7.0	5.1	4.4	4.0

*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.

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City of Tucson

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

1. Project Name and Location: Houghton
2. Drainage Concentration Point: PV20
3. *Watershed Area (A) at Drainage Concentration Point: 0.37 acres
4. Length of Hydraulically Longest Watercourse (Lc): 369.0 ft.
5. Length from center of Watershed Area (Lca) along Lc: 184.5 ft.

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

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

a. ΔL_1:	184.5	$(\Delta L_1)^3$:	6.3E+06	ΔH_1:	7.2	$(\Delta L_1)^3/\Delta H_1$:	8.7E+05
b. ΔL_2:	184.5	$(\Delta L_2)^3$:	6.3E+06	ΔH_2:	7.2	$(\Delta L_2)^3/\Delta H_2$:	8.7E+05
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. $G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2}$ = 934.6 + 934.2 + _____ + _____ = **1868.8**

8. Mean Slope $(S_c) = (L_c/G)^2 =$ (369.0 / 1868.8)^2 = 3.90% 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 (0%)	Urb (100%)	( )	
11. Basin Factor ($n_{b,100}$):	0.055	0.048		n_{bw100} = 0.052
12. Soil Types, in %:	100% B	100%B		
13. Imperviousnes (%):	0%	100%		I_w = 100.0%
14. Runoff Coefficient (C_{w100}):	0.62	0.95		C_{w100} = 0.95
15. Contrib. Area Factor (F_{Ac}):	1	1		F_{Acw} = 1.00

16. **Time of Concentration (T_{c100}): 3.3 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}) = $(C_{w100})(i_{100})(F_{Acw})A$= 0.95 x 9.60 x 1.0 x 0.4 = 3.4 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	2	3
Tc (minutes {Eqn. 4.5}):	6.1	4.4	3.8	3.5

*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.

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City of Tucson

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

1. Project Name and Location: Houghton
2. Drainage Concentration Point: PV20.1
3. *Watershed Area (A) at Drainage Concentration Point: 0.37 acres
4. Length of Hydraulically Longest Watercourse (Lc): 261.0 ft.
5. Length from center of Watershed Area (Lca) along Lc: 130.5 ft.

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

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

a. ΔL_1:	130.5	$(\Delta L_1)^3$:	2.2E+06	ΔH_1:	6.7	$(\Delta L_1)^3/\Delta H_1$:	3.3E+05
b. ΔL_2:	130.5	$(\Delta L_2)^3$:	2.2E+06	ΔH_2:	6.7	$(\Delta L_2)^3/\Delta H_2$:	3.3E+05
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. $$G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2} = 578.1 + 578.1 + \_\_\_ + \_\_\_ = \mathbf{1156.2}$$

8. Mean Slope $(S_c) = (L_c/G)^2 = ($ 261.0 / 1156.2 $)^2 =$ 5.10% 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 (0%)	Urb (100%)	( )	
11. Basin Factor ($n_{b,100}$):	0.055	0.048		n_{bw100} = 0.052
12. Soil Types, in %:	100% B	100%B		
13. Imperviousnes (%):	0%	100%		I_w = 100.0%
14. Runoff Coefficient (C_{w100}):	0.62	0.95		C_{w100} = 0.95
15. Contrib. Area Factor (F_{Ac}):	1	1		F_{Acw} = 1.00

16. **Time of Concentration (T_{c100}): 2.8 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 $(i_{100}) = (4P_{1,100})/(1+0.05T_{c100})$ = 9.6 inches/hour.
18. 100-Year Peak $(Q_{p100}) = (C_{w100})(i_{100})(F_{Acw})A$= 0.95 x 9.60 x 1.0 x 0.4 = 3.4 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	2	3
Tc (minutes {Eqn. 4.5}):	5.1	3.7	3.2	2.9

*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: jco Checked by: _____ Company: Psomas Date: 02/09/10

City of Tucson

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

1. Project Name and Location: Houghton
2. Drainage Concentration Point: PV21
3. *Watershed Area (A) at Drainage Concentration Point: 0.27 acres
4. Length of Hydraulically Longest Watercourse (Lc): 159.0 ft.
5. Length from center of Watershed Area (Lca) along Lc: 79.5 ft.

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

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

a. ΔL_1:	79.5	$(\Delta L_1)^3$:	5.0E+05	ΔH_1:	4.4	$(\Delta L_1)^3/\Delta H_1$:	1.2E+05
b. ΔL_2:	79.5	$(\Delta L_2)^3$:	5.0E+05	ΔH_2:	4.4	$(\Delta L_2)^3/\Delta H_2$:	1.2E+05
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. $$G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2} = 339.9 + 339.9 + \_\_\_ + \_\_\_ = 679.7$$

8. Mean Slope $(S_c) = (L_c/G)^2 = ($ 159.0 / 679.7 $)^2 =$ 5.47% 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 (0%)	Urb (100%)	( )	
11. Basin Factor ($n_{b,100}$):	0.055	0.048		n_{bw100} = 0.052
12. Soil Types, in %:	100% B	100%B		
13. Imperviousnes (%):	0%	100%		I_w = 100.0%
14. Runoff Coefficient (C_{w100}):	0.62	0.95		C_{w100} = 0.95
15. Contrib. Area Factor (F_{Ac}):	1	1		F_{Acw} = 1.00

16. **Time of Concentration (T_{c100}): 2.4 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 $(i_{100}) = (4P_{1,100})/(1+0.05T_{c100})$ = 9.6 inches/hour.
18. 100-Year Peak $(Q_{p100}) = (C_{w100})(i_{100})(F_{Acw})A$= 0.95 x 9.60 x 1.0 x 0.3 = 2.5 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	1	2	2
Tc (minutes {Eqn. 4.5}):	4.4	3.2	2.8	2.5

*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: jco Checked by: _____ Company: Psomas Date: 02/09/10

City of Tucson

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

1. Project Name and Location: Houghton
2. Drainage Concentration Point: PV21.1
3. *Watershed Area (A) at Drainage Concentration Point: 0.5 acres
4. Length of Hydraulically Longest Watercourse (Lc): 230.0 ft.
5. Length from center of Watershed Area (Lca) along Lc: 115.0 ft.

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

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

a. ΔL_1:	115.0	$(\Delta L_1)^3$:	1.5E+06	ΔH_1:	4.5	$(\Delta L_1)^3/\Delta H_1$:	3.4E+05
b. ΔL_2:	115.0	$(\Delta L_2)^3$:	1.5E+06	ΔH_2:	4.5	$(\Delta L_2)^3/\Delta H_2$:	3.4E+05
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. $$G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2} = 582.0 + 582.0 + \_\_\_ + \_\_\_ = \mathbf{1164.0}$$

8. Mean Slope $(S_c) = (L_c/G)^2 = ($ 230.0 / 1164.0 $)^2 =$ 3.90% 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 (0%)	Urb (100%)	( )	
11. Basin Factor ($n_{b,100}$):	0.055	0.048		n_{bw100} = 0.052
12. Soil Types, in %:	100% B	100%B		
13. Imperviousnes (%):	0%	100%		I_w = 100.0%
14. Runoff Coefficient (C_{w100}):	0.62	0.95		C_{w100} = 0.95
15. Contrib. Area Factor (F_{Ac}):	1	1		$F_{A\,cw}$ = 1.00

16. **Time of Concentration (T_{c100}): 2.8 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}) = $(4P_{1,100})/(1+0.05T_{c100})$ = 9.6 inches/hour.
18. 100-Year Peak (Q_{p100}) = $(C_{w100})(i_{100})(F_{Acw})A$= 0.95 x 9.60 x 1.0 x 0.5 = 4.6 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	2	3	4
Tc (minutes {Eqn. 4.5}):	5.2	3.8	3.3	3.0

*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: jco Checked by: _____ Company: Psomas Date: 02/09/10

City of Tucson

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

1. Project Name and Location: Houghton
2. Drainage Concentration Point: PV21.2
3. *Watershed Area (A) at Drainage Concentration Point: 0.35 acres
4. Length of Hydraulically Longest Watercourse (Lc): 174.0 ft.
5. Length from center of Watershed Area (Lca) along Lc: 87.0 ft.

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

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

a. ΔL_1:	87.0	$(\Delta L_1)^3$:	6.6E+05	ΔH_1:	3.4	$(\Delta L_1)^3/\Delta H_1$:	1.9E+05
b. ΔL_2:	87.0	$(\Delta L_2)^3$:	6.6E+05	ΔH_2:	3.4	$(\Delta L_2)^3/\Delta H_2$:	1.9E+05
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. $$G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2} = 440.7 + 440.7 + \_\_\_ + \_\_\_ = \mathbf{881.5}$$

8. Mean Slope $(S_c) = (L_c/G)^2 = (\ 174.0\ /\ 881.5\ )^2 =$ 3.90% 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 (0%)	Urb (100%)	( )	
11. Basin Factor ($n_{b,100}$):	0.055	0.048		n_{bw100} = 0.052
12. Soil Types, in %:	100% B	100%B		
13. Imperviousnes (%):	0%	100%		I_w = 100.0%
14. Runoff Coefficient (C_{w100}):	0.62	0.95		C_{w100} = 0.95
15. Contrib. Area Factor (F_{Ac}):	1	1		F_{Acw} = 1.00

16. **Time of Concentration (T_{c100}): 2.6 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 $(Q_{p100}) = (C_{w100})(i_{100})(F_{Acw})A$= 0.95 x 9.60 x 1.0 x 0.4 = 3.2 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	2	3
Tc (minutes {Eqn. 4.5}):	4.8	3.5	3.0	2.7

*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: jco Checked by: _____ Company: Psomas Date: 02/09/10

City of Tucson

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

1. Project Name and Location: Houghton
2. Drainage Concentration Point: PV22
3. *Watershed Area (A) at Drainage Concentration Point: 0.17 acres
4. Length of Hydraulically Longest Watercourse (Lc): 157.0 ft.
5. Length from center of Watershed Area (Lca) along Lc: 78.5 ft.

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

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

a. ΔL_1:	78.5	$(\Delta L_1)^3$:	4.8E+05	ΔH_1:	0.4	$(\Delta L_1)^3/\Delta H_1$:	1.2E+06
b. ΔL_2:	78.5	$(\Delta L_2)^3$:	4.8E+05	ΔH_2:	0.4	$(\Delta L_2)^3/\Delta H_2$:	1.2E+06
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. $$G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2} = 1113.7 + 1113.7 + \_\_\_ + \_\_\_ = \mathbf{2227.4}$$

8. Mean Slope $(S_c) = (L_c/G)^2 = ($ 157.0 / 2227.4 $)^2 =$ 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 (0%)	Urb (100%)	( )	
11. Basin Factor ($n_{b,100}$):	0.055	0.048		n_{bw100} = 0.052
12. Soil Types, in %:	100% B	100%B		
13. Imperviousnes (%):	0%	100%		I_w = 100.0%
14. Runoff Coefficient (C_{w100}):	0.62	0.95		C_{w100} = 0.95
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 $(Q_{p100}) = (C_{w100})(i_{100})(F_{Acw})A$= 0.95 x 9.60 x 1.0 x 0.2 = 1.6 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)	0	1	1	1
Tc (minutes {Eqn. 4.5}):	7.5	5.4	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: jco Checked by: _____ Company: Psomas Date: 02/09/10

City of Tucson

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

1. Project Name and Location: Houghton
2. Drainage Concentration Point: PV23
3. *Watershed Area (A) at Drainage Concentration Point: 0.16 acres
4. Length of Hydraulically Longest Watercourse (Lc): 151.0 ft.
5. Length from center of Watershed Area (Lca) along Lc: 75.5 ft.

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

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

a. ΔL_1:	75.5	$(\Delta L_1)^3$:	4.3E+05	ΔH_1:	0.4	$(\Delta L_1)^3/\Delta H_1$:	1.1E+06
b. ΔL_2:	75.5	$(\Delta L_2)^3$:	4.3E+05	ΔH_2:	0.4	$(\Delta L_2)^3/\Delta H_2$:	1.1E+06
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. $$G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2} = 1064.2 + 1064.2 + \_\_\_ + \_\_\_ = \mathbf{2128.4}$$

8. Mean Slope $(S_c) = (L_c/G)^2 = ($ 151.0 / 2128.4 $)^2 =$ 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 (0%)	Urb (100%)	( )	
11. Basin Factor ($n_{b,100}$):	0.055	0.048		n_{bw100} = 0.052
12. Soil Types, in %:	100% B	100%B		
13. Imperviousnes (%):	0%	100%		I_w = 100.0%
14. Runoff Coefficient (C_{w100}):	0.62	0.95		C_{w100} = 0.95
15. Contrib. Area Factor (F_{Ac}):	1	1		$F_{A\,cw}$ = 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 $(Q_{p100}) = (C_{w100})(i_{100})(F_{Acw})A$= 0.95 x 9.60 x 1.0 x 0.2 = 1.5 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)	0	1	1	1
Tc (minutes {Eqn. 4.5}):	7.4	5.3	4.6	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: jco Checked by: _____ Company: Psomas Date: 02/09/10

City of Tucson

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

1. Project Name and Location: Houghton
2. Drainage Concentration Point: PV26
3. *Watershed Area (A) at Drainage Concentration Point: 0.163 acres
4. Length of Hydraulically Longest Watercourse (Lc): 198.0 ft.
5. Length from center of Watershed Area (Lca) along Lc: 99.0 ft.

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

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

a. ΔL_1:	99.0	$(\Delta L_1)^3$:	9.7E+05	ΔH_1:	1.4	$(\Delta L_1)^3/\Delta H_1$:	6.8E+05
b. ΔL_2:	99.0	$(\Delta L_2)^3$:	9.7E+05	ΔH_2:	1.4	$(\Delta L_2)^3/\Delta H_2$:	6.8E+05
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. $$G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2} = 823.7 + 823.7 + \_\_\_ + \_\_\_ = \mathbf{1647.5}$$

8. Mean Slope $(S_c) = (L_c/G)^2 = ($ 198.0 / 1647.5 $)^2 =$ 1.44% 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 (0%)	Urb (100%)	( )	
11. Basin Factor ($n_{b,100}$):	0.055	0.048		n_{bw100} = 0.052
12. Soil Types, in %:	100% B	100%B		
13. Imperviousnes (%):	0%	100%		I_w = 100.0%
14. Runoff Coefficient (C_{w100}):	0.62	0.95		C_{w100} = 0.95
15. Contrib. Area Factor (F_{Ac}):	1	1		F_{Acw} = 1.00

16. **Time of Concentration (T_{c100}): 3.4 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 $(i_{100}) = (4P_{1,100})/(1+0.05T_{c100})$ = 9.6 inches/hour.
18. 100-Year Peak $(Q_{p100}) = (C_{w100})(i_{100})(F_{Acw})A$= 0.95 x 9.60 x 1.0 x 0.2 = 1.5 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)	0	1	1	1
Tc (minutes {Eqn. 4.5}):	6.2	4.5	3.9	3.5

*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: jco Checked by: _____ Company: Psomas Date: 02/09/10

City of Tucson

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

1. Project Name and Location: Houghton
2. Drainage Concentration Point: ST2
3. *Watershed Area (A) at Drainage Concentration Point: 0.71 acres
4. Length of Hydraulically Longest Watercourse (Lc): 474.0 ft.
5. Length from center of Watershed Area (Lca) along Lc: 237.0 ft.

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

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

a. ΔL_1:	237.0	$(\Delta L_1)^3$:	1.3E+07	ΔH_1:	5.0	$(\Delta L_1)^3/\Delta H_1$:	2.7E+06
b. ΔL_2:	237.0	$(\Delta L_2)^3$:	1.3E+07	ΔH_2:	5.0	$(\Delta L_2)^3/\Delta H_2$:	2.7E+06
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. $$G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2} = 1631.7 + 1631.7 + \_\_\_ + \_\_\_ = \mathbf{3263.4}$$

8. Mean Slope $(S_c) = (L_c/G)^2 = ($ 474.0 / 3263.4 $)^2 =$ 2.11% 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 (0%)	Urb (100%)	( )	
11. Basin Factor ($n_{b,100}$):	0.055	0.048		n_{bw100} = 0.052
12. Soil Types, in %:	100% B	100%B		
13. Imperviousnes (%):	0%	100%		I_w = 100.0%
14. Runoff Coefficient (C_{w100}):	0.62	0.92		C_{w100} = 0.92
15. Contrib. Area Factor (F_{Ac}):	1	1		F_{Acw} = 1.00

16. **Time of Concentration (T_{c100}): 4.4 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 $(i_{100}) = (4P_{1,100})/(1+0.05T_{c100})$ = 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 0.7 = 6.3 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	3	4	6
Tc (minutes {Eqn. 4.5}):	8.1	5.8	5.1	4.6

*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: jco Checked by: _____ Company: Psomas Date: 02/09/10

City of Tucson

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

1. Project Name and Location: Houghton
2. Drainage Concentration Point: ST3
3. *Watershed Area (A) at Drainage Concentration Point: 0.4 acres
4. Length of Hydraulically Longest Watercourse (Lc): 308.0 ft.
5. Length from center of Watershed Area (Lca) along Lc: 154.0 ft.

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

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

a. ΔL_1:	154.0	$(\Delta L_1)^3$:	3.7E+06	ΔH_1:	1.5	$(\Delta L_1)^3/\Delta H_1$:	2.4E+06
b. ΔL_2:	154.0	$(\Delta L_2)^3$:	3.7E+06	ΔH_2:	1.5	$(\Delta L_2)^3/\Delta H_2$:	2.4E+06
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. $$G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2} = 1560.4 + 1560.4 + \_\_\_ + \_\_\_ = \mathbf{3120.8}$$

8. Mean Slope $(S_c) = (L_c/G)^2 = ($ 308.0 / 3120.8 $)^2 =$ 0.97% 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 (0%)	Urb (100%)	( )	
11. Basin Factor ($n_{b,100}$):	0.055	0.048		n_{bw100} = 0.052
12. Soil Types, in %:	100% B	100%B		
13. Imperviousnes (%):	0%	100%		I_w = 100.0%
14. Runoff Coefficient (C_{w100}):	0.62	0.92		C_{w100} = 0.92
15. Contrib. Area Factor (F_{Ac}):	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 $(Q_{p100}) = (C_{w100})(i_{100})(F_{Acw})A$= 0.92 x 9.60 x 1.0 x 0.4 = 3.5 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	2	2	3
Tc (minutes {Eqn. 4.5}):	8.4	6.1	5.3	4.8

*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: jco Checked by: _____ Company: Psomas Date: 02/09/10

City of Tucson

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

1. Project Name and Location: Houghton
2. Drainage Concentration Point: ST4
3. *Watershed Area (A) at Drainage Concentration Point: 0.42 acres
4. Length of Hydraulically Longest Watercourse (Lc): 322.0 ft.
5. Length from center of Watershed Area (Lca) along Lc: 161.0 ft.

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

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

a. ΔL_1:	161.0	$(\Delta L_1)^3$:	4.2E+06	ΔH_1:	1.0	$(\Delta L_1)^3/\Delta H_1$:	4.2E+06
b. ΔL_2:	161.0	$(\Delta L_2)^3$:	4.2E+06	ΔH_2:	1.0	$(\Delta L_2)^3/\Delta H_2$:	4.2E+06
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. $$G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2} = 2042.9 + 2042.9 + \_\_\_ + \_\_\_ = \mathbf{4085.7}$$

8. Mean Slope $(S_c) = (L_c/G)^2 = ($ 322.0 / 4085.7 $)^2 =$ 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):	Nat (0%)	Urb (100%)	( )	
11. Basin Factor ($n_{b,100}$):	0.055	0.048		n_{bw100} = 0.052
12. Soil Types, in %:	100% B	100%B		
13. Imperviousnes (%):	0%	100%		I_w = 100.0%
14. Runoff Coefficient (C_{w100}):	0.62	0.92		C_{w100} = 0.92
15. Contrib. Area Factor (F_{Ac}):	1	1		F_{Acw} = 1.00

16. **Time of Concentration (T_{c100}): 5.5 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}) = $(4P_{1,100})/(1+0.05T_{c100})$ = 9.4 inches/hour.
18. 100-Year Peak (Q_{p100}) = $(C_{w100})(i_{100})(F_{Acw})A$= 0.92 x 9.40 x 1.0 x 0.4 = 3.6 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	2	3	3
Tc (minutes {Eqn. 4.5}):	10.0	7.2	6.3	5.7

*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: jco Checked by: _____ Company: Psomas Date: 02/09/10

City of Tucson

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

1. Project Name and Location: Houghton
2. Drainage Concentration Point: ST5
3. *Watershed Area (A) at Drainage Concentration Point: 0.51 acres
4. Length of Hydraulically Longest Watercourse (Lc): 328.0 ft.
5. Length from center of Watershed Area (Lca) along Lc: 164.0 ft.

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

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

a. ΔL_1:	164.0	$(\Delta L_1)^3$:	4.4E+06	ΔH_1:	1.0	$(\Delta L_1)^3/\Delta H_1$:	4.4E+06
b. ΔL_2:	164.0	$(\Delta L_2)^3$:	4.4E+06	ΔH_2:	1.0	$(\Delta L_2)^3/\Delta H_2$:	4.4E+06
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. $G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2}$ = 2100.2 + 2100.2 + ____ + ____ = **4200.4**

8. Mean Slope $(S_c) = (L_c/G)^2 =$ (328.0 / 4200.4)^2 = 0.61% 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):	Nat (0%)	Urb (100%)	( )	
11. Basin Factor ($n_{b,100}$):	0.055	0.048		n_{bw100} = 0.052
12. Soil Types, in %:	100% B	100%B		
13. Imperviousnes (%):	0%	100%		I_w = 100.0%
14. Runoff Coefficient (C_{w100}):	0.62	0.92		C_{w100} = 0.92
15. Contrib. Area Factor (F_{Ac}):	1	1		F_{Acw} = 1.00

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

$$T_{c100} = \left(\frac{0.23 n_{bw100}\left(L_c L_{ca}\right)^{0.3}}{\left(S_c P_{1,100} C_{w100}\right)^{0.4}} + 1.31\right)^{1.61}$$ 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}) = $(C_{w100})(i_{100})(F_{Acw})A$= 0.92 x 9.40 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}):	10.2	7.3	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: jco Checked by: ____ Company: Psomas Date: 02/09/10

City of Tucson

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

1. Project Name and Location: Houghton
2. Drainage Concentration Point: ST8
3. *Watershed Area (A) at Drainage Concentration Point: 0.74 acres
4. Length of Hydraulically Longest Watercourse (Lc): 466.0 ft.
5. Length from center of Watershed Area (Lca) along Lc: 233.0 ft.

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

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

a. ΔL_1:	233.0	$(\Delta L_1)^3$:	1.3E+07	ΔH_1:	4.5	$(\Delta L_1)^3/\Delta H_1$:	2.8E+06
b. ΔL_2:	233.0	$(\Delta L_2)^3$:	1.3E+07	ΔH_2:	4.5	$(\Delta L_2)^3/\Delta H_2$:	2.8E+06
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. $$G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2} = 1676.6 + 1676.6 + \_\_\_ + \_\_\_ = \mathbf{3353.2}$$

8. Mean Slope $(S_c) = (L_c/G)^2 = ($ 466.0 / 3353.2 $)^2 =$ 1.93% 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 (0%)	Urb (100%)	( )	
11. Basin Factor ($n_{b,100}$):	0.055	0.048		n_{bw100} = 0.052
12. Soil Types, in %:	100% B	100%B		
13. Imperviousnes (%):	0%	100%		I_w = 100.0%
14. Runoff Coefficient (C_{w100}):	0.62	0.92		C_{w100} = 0.92
15. Contrib. Area Factor (F_{Ac}):	1	1		F_{Acw} = 1.00

16. **Time of Concentration (T_{c100}): 4.5 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 $(i_{100}) = (4P_{1,100})/(1+0.05T_{c100})$ = 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 0.7 = 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}):	8.3	6.0	5.2	4.7

*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: jco Checked by: _____ Company: Psomas Date: 02/09/10

City of Tucson

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

1. Project Name and Location: Houghton
2. Drainage Concentration Point: ST13
3. *Watershed Area (A) at Drainage Concentration Point: 1.914 acres
4. Length of Hydraulically Longest Watercourse (Lc): 516.0 ft.
5. Length from center of Watershed Area (Lca) along Lc: 258.0 ft.

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

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

a. ΔL_1:	258.0	$(\Delta L_1)^3$:	1.7E+07	ΔH_1:	1.0	$(\Delta L_1)^3/\Delta H_1$:	1.7E+07
b. ΔL_2:	258.0	$(\Delta L_2)^3$:	1.7E+07	ΔH_2:	1.0	$(\Delta L_2)^3/\Delta H_2$:	1.7E+07
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. $$G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2} = 4144.1 + 4144.1 + \_\_\_ + \_\_\_ = \mathbf{8288.2}$$

8. Mean Slope $(S_c) = (L_c/G)^2 = ($ 516.0 / 8288.2 $)^2 =$ 0.39% 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 (0%)	Urb (100%)	( )	
11. Basin Factor ($n_{b,100}$):	0.055	0.048		n_{bw100} = 0.052
12. Soil Types, in %:	100% B	100%B		
13. Imperviousnes (%):	0%	100%		I_w = 100.0%
14. Runoff Coefficient (C_{w100}):	0.62	0.92		C_{w100} = 0.92
15. Contrib. Area Factor (F_{Ac}):	1	1		F_{Acw} = 1.00

16. **Time of Concentration (T_{c100}): 8.6 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 $(i_{100}) = (4P_{1,100})/(1+0.05T_{c100})$ = 8.4 inches/hour.
18. 100-Year Peak $(Q_{p100}) = (C_{w100})(i_{100})(F_{Acw})A$= 0.92 x 8.40 x 1.0 x 1.9 = 14.8 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	13
Tc (minutes {Eqn. 4.5}):	15.8	11.4	10.0	9.0

*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: jco Checked by: _____ Company: Psomas Date: 02/09/10

City of Tucson

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

1. Project Name and Location: Houghton
2. Drainage Concentration Point: ST13
3. *Watershed Area (A) at Drainage Concentration Point: 0.53 acres
4. Length of Hydraulically Longest Watercourse (Lc): 260.0 ft.
5. Length from center of Watershed Area (Lca) along Lc: 130.0 ft.

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

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

a. ΔL_1:	130.0	$(\Delta L_1)^3$:	2.2E+06	ΔH_1:	1.0	$(\Delta L_1)^3/\Delta H_1$:	2.2E+06
b. ΔL_2:	130.0	$(\Delta L_2)^3$:	2.2E+06	ΔH_2:	1.0	$(\Delta L_2)^3/\Delta H_2$:	2.2E+06
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. $$G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2} = 1482.2 + 1482.2 + \_\_\_ + \_\_\_ = \mathbf{2964.5}$$

8. Mean Slope $(S_c) = (L_c/G)^2 = ($ 260.0 / 2964.5 $)^2 =$ 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 (30%)	Urb (70%)	( )			
11. Basin Factor ($n_{b,100}$):	0.055	0.048		n_{bw100}	=	0.052
12. Soil Types, in %:	100% B	100%B				
13. Imperviousnes (%):	0%	100%		I_w	=	70.0%
14. Runoff Coefficient (C_{w100}):	0.62	0.92		C_{w100}	=	0.83
15. Contrib. Area Factor (F_{Ac}):	1	1		F_{Acw}	=	1.00

16. **Time of Concentration (T_{c100}): 4.7 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}) = $(C_{w100})(i_{100})(F_{Acw})A$= 0.83 x 9.60 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}):	8.7	6.2	5.5	4.9

*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: jco Checked by: _____ Company: Psomas Date: 02/19/10

City of Tucson

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

1. Project Name and Location: Houghton
2. Drainage Concentration Point: ST14
3. *Watershed Area (A) at Drainage Concentration Point: 2.6 acres
4. Length of Hydraulically Longest Watercourse (Lc): 786.0 ft.
5. Length from center of Watershed Area (Lca) along Lc: 393.0 ft.

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

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

a. ΔL_1:	393.0	$(\Delta L_1)^3$:	6.1E+07	ΔH_1:	12.0	$(\Delta L_1)^3/\Delta H_1$:	5.1E+06
b. ΔL_2:	393.0	$(\Delta L_2)^3$:	6.1E+07	ΔH_2:	12.0	$(\Delta L_2)^3/\Delta H_2$:	5.1E+06
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. $$G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2} = 2249.0 + 2249.0 + \_\_\_ + \_\_\_ = \mathbf{4498.1}$$

8. Mean Slope $(S_c) = (L_c/G)^2 = ($ 786.0 / 4498.1 $)^2 =$ 3.05% 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 (100%)	Urb (0%)	( )	
11. Basin Factor ($n_{b,100}$):	0.055	0.048		n_{bw100} = 0.052
12. Soil Types, in %:	100% B	100%B		
13. Imperviousnes (%):	0%	100%		I_w = 0.0%
14. Runoff Coefficient (C_{w100}):	0.62	0.92		C_{w100} = 0.62
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 $(Q_{p100}) = (C_{w100})(i_{100})(F_{Acw})A$= 0.62 x 9.30 x 1.0 x 2.6 = 15.0 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	13
Tc (minutes {Eqn. 4.5}):	10.5	7.6	6.6	6.0

*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: jco Checked by: _____ Company: Psomas Date: 02/09/10

City of Tucson

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

1. Project Name and Location: Houghton
2. Drainage Concentration Point: ST15
3. *Watershed Area (A) at Drainage Concentration Point: 1.84 acres
4. Length of Hydraulically Longest Watercourse (Lc): 1129.0 ft.
5. Length from center of Watershed Area (Lca) along Lc: 564.5 ft.

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

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

a. ΔL_1:	564.5	$(\Delta L_1)^3$:	1.8E+08	ΔH_1:	5.0	$(\Delta L_1)^3/\Delta H_1$:	3.6E+07
b. ΔL_2:	564.5	$(\Delta L_2)^3$:	1.8E+08	ΔH_2:	5.0	$(\Delta L_2)^3/\Delta H_2$:	3.6E+07
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. $G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2}$ = 5998.1 + 5998.1 + _____ + _____ = **11996.1**

8. Mean Slope $(S_c) = (L_c/G)^2 =$ (1129.0 / 11996.1)^2 = 0.89% 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 (0%)	Urb (100%)	( )	
11. Basin Factor ($n_{b,100}$):	0.055	0.048		n_{bw100} = 0.052
12. Soil Types, in %:	100% B	100%B		
13. Imperviousnes (%):	0%	100%		I_w = 100.0%
14. Runoff Coefficient (C_{w100}):	0.62	0.92		C_{w100} = 0.92
15. Contrib. Area Factor (F_{Ac}):	1	1		F_{Acw} = 1.00

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}) = $(C_{w100})(i_{100})(F_{Acw})A$= 0.92 x 8.00 x 1.0 x 1.8 = 13.5 cfs.
19. For Other Return Periods

	2-Year	10-year	25-Year	50-Year
Ratio to 100-Year Peak:	0.10	0.37	0.53	0.77
Q (Cubic feet/second)	1	5	7	10
Tc (minutes {Eqn. 4.5}):	25.2	15.0	12.9	11.2

*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: jco Checked by: _____ Company: Psomas Date: 02/09/10

City of Tucson

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

1. Project Name and Location: Houghton
2. Drainage Concentration Point: ST17
3. *Watershed Area (A) at Drainage Concentration Point: 0.67 acres
4. Length of Hydraulically Longest Watercourse (Lc): 504.0 ft.
5. Length from center of Watershed Area (Lca) along Lc: 252.0 ft.

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

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

a. ΔL_1:	252.0	$(\Delta L_1)^3$:	1.6E+07	ΔH_1:	2.1	$(\Delta L_1)^3/\Delta H_1$:	7.5E+06
b. ΔL_2:	252.0	$(\Delta L_2)^3$:	1.6E+07	ΔH_2:	2.1	$(\Delta L_2)^3/\Delta H_2$:	7.5E+06
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. $$G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2} = 2734.6 + 2734.6 + \_\_\_ + \_\_\_ = \mathbf{5469.2}$$

8. Mean Slope $(S_c) = (L_c/G)^2 = ($ 504.0 / 5469.2 $)^2 =$ 0.85% 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 (0%)	Urb (100%)	( )	
11. Basin Factor ($n_{b,100}$):	0.055	0.048		n_{bw100} = 0.052
12. Soil Types, in %:	100% B	100%B		
13. Imperviousnes (%):	0%	100%		I_w = 100.0%
14. Runoff Coefficient (C_{w100}):	0.62	0.92		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 0.7 = 5.6 cfs.
19. For Other Return Periods

	2-Year	10-year	25-Year	50-Year
Ratio to 100-Year Peak:	0.10	0.37	0.53	0.77
Q (Cubic feet/second)	1	2	3	4
Tc (minutes {Eqn. 4.5}):	15.7	9.3	8.0	6.9

*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: jco Checked by: _____ Company: Psomas Date: 02/09/10

City of Tucson

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

1. Project Name and Location: Houghton
2. Drainage Concentration Point: ST23
3. *Watershed Area (A) at Drainage Concentration Point: 1.76 acres
4. Length of Hydraulically Longest Watercourse (Lc): 1422.0 ft.
5. Length from center of Watershed Area (Lca) along Lc: 711.0 ft.

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

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

a. ΔL_1:	711.0	$(\Delta L_1)^3$:	3.6E+08	ΔH_1:	12.5	$(\Delta L_1)^3/\Delta H_1$:	2.9E+07
b. ΔL_2:	711.0	$(\Delta L_2)^3$:	3.6E+08	ΔH_2:	12.5	$(\Delta L_2)^3/\Delta H_2$:	2.9E+07
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. $$G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2} = 5362.3 + 5362.3 + \_\_\_ + \_\_\_ = \mathbf{10724.6}$$

8. Mean Slope $(S_c) = (L_c/G)^2 =$ (1422.0 / 10724.6)^2 = 1.76% 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 (0%)	Urb (100%)	( )	
11. Basin Factor ($n_{b,100}$):	0.055	0.048		n_{bw100} = 0.052
12. Soil Types, in %:	100% B	100%B		
13. Imperviousnes (%):	0%	100%		I_w = 100.0%
14. Runoff Coefficient (C_{w100}):	0.62	0.92		C_{w100} = 0.92
15. Contrib. Area Factor (F_{Ac}):	1	1		F_{Acw} = 1.00

16. **Time of Concentration (T_{c100}): 8.7 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 $(i_{100}) = (4P_{1,100})/(1+0.05T_{c100})$ = 8.4 inches/hour.
18. 100-Year Peak $(Q_{p100}) = (C_{w100})(i_{100})(F_{Acw})A$= 0.92 x 8.40 x 1.0 x 1.8 = 13.6 cfs.
19. For Other Return Periods

	2-Year	10-year	25-Year	50-Year
Ratio to 100-Year Peak:	0.10	0.37	0.53	0.77
Q (Cubic feet/second)	1	5	7	10
Tc (minutes {Eqn. 4.5}):	21.8	12.9	11.2	9.6

*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: jco Checked by: _____ Company: Psomas Date: 02/09/10

City of Tucson

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

1. Project Name and Location: Houghton
2. Drainage Concentration Point: ST24
3. *Watershed Area (A) at Drainage Concentration Point: 1.06 acres
4. Length of Hydraulically Longest Watercourse (Lc): 844.0 ft.
5. Length from center of Watershed Area (Lca) along Lc: 422.0 ft.

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

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

a. ΔL_1:	422.0	$(\Delta L_1)^3$:	7.5E+07	ΔH_1:	6.0	$(\Delta L_1)^3/\Delta H_1$:	1.3E+07
b. ΔL_2:	422.0	$(\Delta L_2)^3$:	7.5E+07	ΔH_2:	6.0	$(\Delta L_2)^3/\Delta H_2$:	1.3E+07
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. $$G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2} = 3539.1 + 3539.1 + \_\_\_ + \_\_\_ = \mathbf{7078.2}$$

8. Mean Slope $(S_c) = (L_c/G)^2 = ($ 844.0 / 7078.2 $)^2 =$ 1.42% 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):	Nat (0%)	Urb (100%)	( )	Weighted Watershed Parameters	
11. Basin Factor ($n_{b,100}$):	0.055	0.048		n_{bw100} =	0.052
12. Soil Types, in %:	100% B	100%B			
13. Imperviousnes (%):	0%	100%		I_w =	100.0%
14. Runoff Coefficient (C_{w100}):	0.62	0.92		C_{w100} =	0.92
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 $(Q_{p100}) = (C_{w100})(i_{100})(F_{Acw})A$= 0.92 x 8.90 x 1.0 x 1.1 = 8.7 cfs.
19. For Other Return Periods

	2-Year	10-year	25-Year	50-Year
Ratio to 100-Year Peak:	0.10	0.37	0.53	0.77
Q (Cubic feet/second)	1	3	5	7
Tc (minutes {Eqn. 4.5}):	17.3	10.2	8.9	7.6

*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: jco Checked by: _____ Company: Psomas Date: 02/09/10

City of Tucson

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

1. Project Name and Location: Houghton
2. Drainage Concentration Point: ST25
3. *Watershed Area (A) at Drainage Concentration Point: 0.79 acres
4. Length of Hydraulically Longest Watercourse (Lc): 581.0 ft.
5. Length from center of Watershed Area (Lca) along Lc: 290.5 ft.

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

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

a. ΔL_1:	290.5	$(\Delta L_1)^3$:	2.5E+07	ΔH_1:	6.5	$(\Delta L_1)^3/\Delta H_1$:	3.8E+06
b. ΔL_2:	290.5	$(\Delta L_2)^3$:	2.5E+07	ΔH_2:	6.5	$(\Delta L_2)^3/\Delta H_2$:	3.8E+06
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. $$G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2} = 1942.1 + 1942.1 + \_\_\_ + \_\_\_ = \mathbf{3884.1}$$

8. Mean Slope $(S_c) = (L_c/G)^2 =$ (581.0 / 3884.1)^2 = 2.24% 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 (0%)	Urb (100%)	( )	
11. Basin Factor ($n_{b,100}$):	0.055	0.048		n_{bw100} = 0.052
12. Soil Types, in %:	100% B	100%B		
13. Imperviousnes (%):	0%	100%		I_w = 100.0%
14. Runoff Coefficient (C_{w100}):	0.62	0.92		C_{w100} = 0.92
15. Contrib. Area Factor (F_{Ac}):	1	1		F_{Acw} = 1.00

16. **Time of Concentration (T_{c100}): 4.8 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 $(i_{100}) = (4P_{1,100})/(1+0.05T_{c100})$ = 9.6 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 = 7.0 cfs.
19. For Other Return Periods

	2-Year	10-year	25-Year	50-Year
Ratio to 100-Year Peak:	0.10	0.37	0.53	0.77
Q (Cubic feet/second)	1	3	4	5
Tc (minutes {Eqn. 4.5}):	12.0	7.1	6.2	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: jco Checked by: _____ Company: Psomas Date: 02/09/10

City of Tucson

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

1. Project Name and Location: Houghton
2. Drainage Concentration Point: ST30
3. *Watershed Area (A) at Drainage Concentration Point: 0.68 acres
4. Length of Hydraulically Longest Watercourse (Lc): 621.0 ft.
5. Length from center of Watershed Area (Lca) along Lc: 310.5 ft.

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

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

a. ΔL_1:	310.5	$(\Delta L_1)^3$:	3.0E+07	ΔH_1:	2.0	$(\Delta L_1)^3/\Delta H_1$:	1.5E+07
b. ΔL_2:	310.5	$(\Delta L_2)^3$:	3.0E+07	ΔH_2:	2.0	$(\Delta L_2)^3/\Delta H_2$:	1.5E+07
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. $$G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2} = 3868.8 + 3868.8 + \_\_\_ + \_\_\_ = \mathbf{7737.6}$$

8. Mean Slope $(S_c) = (L_c/G)^2 = ($ 621.0 / 7737.6 $)^2 =$ 0.64% 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 (0%)	Urb (100%)	( )	
11. Basin Factor ($n_{b,100}$):	0.055	0.048		n_{bw100} = 0.052
12. Soil Types, in %:	100% B	100%B		
13. Imperviousnes (%):	0%	100%		I_w = 100.0%
14. Runoff Coefficient (C_{w100}):	0.62	0.92		C_{w100} = 0.92
15. Contrib. Area Factor (F_{Ac}):	1	1		$F_{A\,cw}$ = 1.00

16. **Time of Concentration (T_{c100}): 7.9 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 $(i_{100}) = (4P_{1,100})/(1+0.05T_{c100})$ = 8.6 inches/hour.
18. 100-Year Peak $(Q_{p100}) = (C_{w100})(i_{100})(F_{Acw})A$= 0.92 x 8.60 x 1.0 x 0.7 = 5.4 cfs.
19. For Other Return Periods

	2-Year	10-year	25-Year	50-Year
Ratio to 100-Year Peak:	0.10	0.37	0.53	0.77
Q (Cubic feet/second)	1	2	3	4
Tc (minutes {Eqn. 4.5}):	19.7	11.7	10.1	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: jco Checked by: _____ Company: Psomas Date: 02/09/10

OFFSITE DRAINAGE

City of Tucson

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

1. Project Name and Location: Houghton
2. Drainage Concentration Point: CH1
3. *Watershed Area (A) at Drainage Concentration Point: 1.14 acres
4. Length of Hydraulically Longest Watercourse (Lc): 464.0 ft.
5. Length from center of Watershed Area (Lca) along Lc: 232.0 ft.

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

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

a. ΔL_1:	232.0	$(\Delta L_1)^3$:	1.2E+07	ΔH_1:	8.0	$(\Delta L_1)^3/\Delta H_1$:	1.6E+06
b. ΔL_2:	232.0	$(\Delta L_2)^3$:	1.2E+07	ΔH_2:	8.0	$(\Delta L_2)^3/\Delta H_2$:	1.6E+06
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. $$G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2} = 1249.4 + 1249.4 + \_\_\_ + \_\_\_ = \mathbf{2498.7}$$

8. Mean Slope $(S_c) = (L_c/G)^2 = ($ 464.0 / 2498.7 $)^2 =$ 3.45% 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 (0%)	Urb (100%)	( )	
11. Basin Factor ($n_{b,100}$):	0.055	0.028		n_{bw100} = 0.042
12. Soil Types, in %:	100% B	100%B		
13. Imperviousnes (%):	0%	40%		I_w = 40.0%
14. Runoff Coefficient (C_{w100}):	0.62	0.82		C_{w100} = 0.82
15. Contrib. Area Factor (F_{Ac}):	1	0.8		F_{Acw} = 0.80

16. **Time of Concentration (T_{c100}): 3.4 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}) = $(4P_{1,100})/(1+0.05T_{c100})$ = 9.6 inches/hour.
18. 100-Year Peak (Q_{p100}) = $(C_{w100})(i_{100})(F_{Acw})A$= 0.82 x 9.60 x 0.8 x 1.1 = 7.2 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	4	5	6
Tc (minutes {Eqn. 4.5}):	6.2	4.5	3.9	3.5

*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: jco Checked by: _____ Company: Psomas Date: 02/09/10

City of Tucson

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

1. Project Name and Location: Houghton
2. Drainage Concentration Point: CH2
3. *Watershed Area (A) at Drainage Concentration Point: 0.81 acres
4. Length of Hydraulically Longest Watercourse (Lc): 446.0 ft.
5. Length from center of Watershed Area (Lca) along Lc: 223.0 ft.

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

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

a. ΔL_1:	223.0	$(\Delta L_1)^3$:	1.1E+07	ΔH_1:	8.5	$(\Delta L_1)^3/\Delta H_1$:	1.3E+06
b. ΔL_2:	223.0	$(\Delta L_2)^3$:	1.1E+07	ΔH_2:	8.5	$(\Delta L_2)^3/\Delta H_2$:	1.3E+06
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. $$G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2} = 1142.2 + 1142.2 + \_\_\_ + \_\_\_ = \mathbf{2284.4}$$

8. Mean Slope $(S_c) = (L_c/G)^2 = ($ 446.0 / 2284.4 $)^2 =$ 3.81% 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 (0%)	Urb (100%)	( )	
11. Basin Factor ($n_{b,100}$):	0.055	0.028		n_{bw100} = 0.042
12. Soil Types, in %:	100% B	100%B		
13. Imperviousnes (%):	0%	40%		I_w = 40.0%
14. Runoff Coefficient (C_{w100}):	0.62	0.82		C_{w100} = 0.82
15. Contrib. Area Factor (F_{Ac}):	1	0.8		F_{Acw} = 0.80

16. **Time of Concentration (T_{c100}): 3.3 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 0.8 x 0.8 = 5.1 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	5
Tc (minutes {Eqn. 4.5}):	6.0	4.3	3.8	3.4

*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: jco Checked by: _____ Company: Psomas Date: 02/09/10

City of Tucson

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

1. Project Name and Location: Houghton
2. Drainage Concentration Point: CH3
3. *Watershed Area (A) at Drainage Concentration Point: 0.63 acres
4. Length of Hydraulically Longest Watercourse (Lc): 312.0 ft.
5. Length from center of Watershed Area (Lca) along Lc: 156.0 ft.

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

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

a. ΔL_1:	156.0	$(\Delta L_1)^3$:	3.8E+06	ΔH_1:	4.0	$(\Delta L_1)^3/\Delta H_1$:	9.5E+05
b. ΔL_2:	156.0	$(\Delta L_2)^3$:	3.8E+06	ΔH_2:	4.0	$(\Delta L_2)^3/\Delta H_2$:	9.5E+05
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. $G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2}$ = 974.2 + 974.2 + ____ + ____ = **1948.4**

8. Mean Slope $(S_c) = (L_c/G)^2 = ($ 312.0 / 1948.4 $)^2 =$ 2.56% 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 (0%)	Urb (100%)	( )	
11. Basin Factor ($n_{b,100}$):	0.055	0.028		n_{bw100} = 0.042
12. Soil Types, in %:	100% B	100%B		
13. Imperviousnes (%):	0%	40%		I_w = 40.0%
14. Runoff Coefficient (C_{w100}):	0.62	0.82		C_{w100} = 0.82
15. Contrib. Area Factor (F_{Ac}):	1	0.8		F_{Acw} = 0.80

16. **Time of Concentration (T_{c100}): 3.2 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}) = $(4P_{1,100})/(1+0.05T_{c100})$ = 9.6 inches/hour.
18. 100-Year Peak (Q_{p100}) = $(C_{w100})(i_{100})(F_{Acw})A$= 0.82 x 9.60 x 0.8 x 0.6 = 4.0 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}):	5.8	4.2	3.6	3.3

*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: jco Checked by: ____ Company: Psomas Date: 02/09/10

City of Tucson

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

1. Project Name and Location: Houghton
2. Drainage Concentration Point: CH4
3. *Watershed Area (A) at Drainage Concentration Point: 0.71 acres
4. Length of Hydraulically Longest Watercourse (Lc): 322.0 ft.
5. Length from center of Watershed Area (Lca) along Lc: 161.0 ft.

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

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

a. ΔL_1:	161.0	$(\Delta L_1)^3$:	4.2E+06	ΔH_1:	2.5	$(\Delta L_1)^3/\Delta H_1$:	1.7E+06
b. ΔL_2:	161.0	$(\Delta L_2)^3$:	4.2E+06	ΔH_2:	2.5	$(\Delta L_2)^3/\Delta H_2$:	1.7E+06
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. $$G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2} = 1292.0 + 1292.0 + \_\_\_ + \_\_\_ = \mathbf{2584.0}$$

8. Mean Slope $(S_c) = (L_c/G)^2 = ($ 322.0 / 2584.0 $)^2 =$ 1.55% 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 (0%)	Urb (100%)	( )	
11. Basin Factor ($n_{b,100}$):	0.055	0.028		n_{bw100} = 0.042
12. Soil Types, in %:	100% B	100%B		
13. Imperviousnes (%):	0%	40%		I_w = 40.0%
14. Runoff Coefficient (C_{w100}):	0.62	0.82		C_{w100} = 0.82
15. Contrib. Area Factor (F_{Ac}):	1	0.8		F_{Acw} = 0.80

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 $(Q_{p100}) = (C_{w100})(i_{100})(F_{Acw})A$= 0.82 x 9.60 x 0.8 x 0.7 = 4.5 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	2	3	4
Tc (minutes {Eqn. 4.5}):	6.6	4.8	4.2	3.8

*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: jco Checked by: _____ Company: Psomas Date: 02/09/10

City of Tucson

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

1. Project Name and Location: Houghton
2. Drainage Concentration Point: CH5
3. *Watershed Area (A) at Drainage Concentration Point: 0.76 acres
4. Length of Hydraulically Longest Watercourse (Lc): 328.0 ft.
5. Length from center of Watershed Area (Lca) along Lc: 164.0 ft.

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

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

a. ΔL_1:	164.0	$(\Delta L_1)^3$:	4.4E+06	ΔH_1:	2.0	$(\Delta L_1)^3/\Delta H_1$:	2.2E+06
b. ΔL_2:	164.0	$(\Delta L_2)^3$:	4.4E+06	ΔH_2:	2.0	$(\Delta L_2)^3/\Delta H_2$:	2.2E+06
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. $G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2}$ = 1485.1 + 1485.1 + _____ + _____ = **2970.2**

8. Mean Slope $(S_c) = (L_c/G)^2 = ($ 328.0 / 2970.2 $)^2 =$ 1.22% 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 (0%)	Urb (100%)	( )	
11. Basin Factor ($n_{b,100}$):	0.055	0.028		n_{bw100} = 0.042
12. Soil Types, in %:	100% B	100%B		
13. Imperviousnes (%):	0%	40%		I_w = 40.0%
14. Runoff Coefficient (C_{w100}):	0.62	0.82		C_{w100} = 0.82
15. Contrib. Area Factor (F_{Ac}):	1	0.8		F_{Acw} = 0.80

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 $(Q_{p100}) = (C_{w100})(i_{100})(F_{Acw})A$= 0.82 x 9.60 x 0.8 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}):	7.1	5.1	4.5	4.1

*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: jco Checked by: _____ Company: Psomas Date: 02/09/10

City of Tucson

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

1. Project Name and Location: Houghton
2. Drainage Concentration Point: CH6
3. *Watershed Area (A) at Drainage Concentration Point: 0.82 acres
4. Length of Hydraulically Longest Watercourse (Lc): 474.0 ft.
5. Length from center of Watershed Area (Lca) along Lc: 237.0 ft.

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

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

a. ΔL_1:	237.0	$(\Delta L_1)^3$:	1.3E+07	ΔH_1:	1.5	$(\Delta L_1)^3/\Delta H_1$:	8.9E+06
b. ΔL_2:	237.0	$(\Delta L_2)^3$:	1.3E+07	ΔH_2:	1.5	$(\Delta L_2)^3/\Delta H_2$:	8.9E+06
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. $$G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2} = 2979.0 + 2979.0 + \_\_\_ + \_\_\_ = \mathbf{5958.1}$$

8. Mean Slope $(S_c) = (L_c/G)^2 = ($ 474.0 / 5958.1 $)^2 =$ 0.63% 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):	Nat (0%)	Urb (100%)	( )	
11. Basin Factor ($n_{b,100}$):	0.055	0.028		n_{bw100} = 0.042
12. Soil Types, in %:	100% B	100%B		
13. Imperviousnes (%):	0%	40%		I_w = 40.0%
14. Runoff Coefficient (C_{w100}):	0.62	0.82		C_{w100} = 0.82
15. Contrib. Area Factor (F_{Ac}):	1	0.8		F_{Acw} = 0.80

16. **Time of Concentration (T_{c100}): 5.7 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 $(i_{100}) = (4P_{1,100})/(1+0.05T_{c100})$ = 9.3 inches/hour.
18. 100-Year Peak $(Q_{p100}) = (C_{w100})(i_{100})(F_{Acw})A$= 0.82 x 9.30 x 0.8 x 0.8 = 5.0 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}):	10.5	7.6	6.6	6.0

*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: jco Checked by: _____ Company: Psomas Date: 02/09/10

City of Tucson

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

1. Project Name and Location: Houghton
2. Drainage Concentration Point: CH7
3. *Watershed Area (A) at Drainage Concentration Point: 23.27 acres
4. Length of Hydraulically Longest Watercourse (Lc): 2343.0 ft.
5. Length from center of Watershed Area (Lca) along Lc: 1171.5 ft.

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

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

a. ΔL_1:	1171.5	$(\Delta L_1)^3$:	1.6E+09	ΔH_1:	26.0	$(\Delta L_1)^3/\Delta H_1$:	6.2E+07
b. ΔL_2:	1171.5	$(\Delta L_2)^3$:	1.6E+09	ΔH_2:	26.0	$(\Delta L_2)^3/\Delta H_2$:	6.2E+07
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. $$G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2} = 7863.7 + 7863.7 + \_\_\_ + \_\_\_ = \mathbf{15727.4}$$

8. Mean Slope $(S_c) = (L_c/G)^2 = ($ 2343.0 / 15727.4 $)^2 =$ 2.22% 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%)	Urb (0%)	( )	
11. Basin Factor ($n_{b,100}$):	0.055	0.048		n_{bw100} = 0.052
12. Soil Types, in %:	100% B	100%B		
13. Imperviousnes (%):	0%	100%		I_w = 0.0%
14. Runoff Coefficient (C_{w100}):	0.62	0.92		C_{w100} = 0.62
15. Contrib. Area Factor (F_{Ac}):	1	1		F_{Acw} = 1.00

16. **Time of Concentration (T_{c100}): 13.0 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 $(i_{100}) = (4P_{1,100})/(1+0.05T_{c100})$ = 7.3 inches/hour.
18. 100-Year Peak $(Q_{p100}) = (C_{w100})(i_{100})(F_{Acw})A$= 0.62 x 7.30 x 1.0 x 23.3 = 105.3 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)	23	53	74	95
Tc (minutes {Eqn. 4.5}):	23.9	17.2	15.1	13.6

*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.

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City of Tucson

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

1. Project Name and Location: Houghton
2. Drainage Concentration Point: CH8
3. *Watershed Area (A) at Drainage Concentration Point: 2.41 acres
4. Length of Hydraulically Longest Watercourse (Lc): 932.0 ft.
5. Length from center of Watershed Area (Lca) along Lc: 466.0 ft.

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

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

a. ΔL_1:	466.0	$(\Delta L_1)^3$:	1.0E+08	ΔH_1:	2.5	$(\Delta L_1)^3/\Delta H_1$:	4.0E+07
b. ΔL_2:	466.0	$(\Delta L_2)^3$:	1.0E+08	ΔH_2:	2.5	$(\Delta L_2)^3/\Delta H_2$:	4.0E+07
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. $$G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2} = 6362.2 + 6362.2 + \_\_\_ + \_\_\_ = \mathbf{12724.4}$$

8. Mean Slope $(S_c) = (L_c/G)^2 = (\ 932.0\ /\ 12724.4\ )^2 =$ 0.54% 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%)	Urb (0%)	( )	
11. Basin Factor ($n_{b,100}$):	0.055	0.048		n_{bw100} = 0.052
12. Soil Types, in %:	100% B	100%B		
13. Imperviousnes (%):	5%	100%		I_w = 5.0%
14. Runoff Coefficient (C_{w100}):	0.62	0.92		C_{w100} = 0.62
15. Contrib. Area Factor (F_{Ac}):	1	1		F_{Acw} = 1.00

16. **Time of Concentration (T_{c100}): 13.3 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 $(i_{100}) = (4P_{1,100})/(1+0.05T_{c100})$ = 7.2 inches/hour.
18. 100-Year Peak $(Q_{p100}) = (C_{w100})(i_{100})(F_{Acw})A$= 0.62 x 7.20 x 1.0 x 2.4 = 10.8 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	5	8	10
Tc (minutes {Eqn. 4.5}):	24.3	17.5	15.3	13.9

*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: jco Checked by: _____ Company: Psomas Date: 02/09/10

City of Tucson

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

1. Project Name and Location: Houghton
2. Drainage Concentration Point: CH9
3. *Watershed Area (A) at Drainage Concentration Point: 0.93 acres
4. Length of Hydraulically Longest Watercourse (Lc): 300.0 ft.
5. Length from center of Watershed Area (Lca) along Lc: 150.0 ft.

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

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

a. ΔL_1:	150.0	$(\Delta L_1)^3$:	3.4E+06	ΔH_1:	2.0	$(\Delta L_1)^3/\Delta H_1$:	1.7E+06
b. ΔL_2:	150.0	$(\Delta L_2)^3$:	3.4E+06	ΔH_2:	2.0	$(\Delta L_2)^3/\Delta H_2$:	1.7E+06
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. $$G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2} = 1299.0 + 1299.0 + \_\_\_ + \_\_\_ = \mathbf{2598.1}$$

8. Mean Slope $(S_c) = (L_c/G)^2 = ($ 300.0 / 2598.1 $)^2 =$ 1.33% 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):	Nat (100%)	Urb (0%)	( )	
11. Basin Factor ($n_{b,100}$):	0.055	0.048		n_{bw100} = 0.052
12. Soil Types, in %:	100% B	100%B		
13. Imperviousnes (%):	5%	100%		I_w = 5.0%
14. Runoff Coefficient (C_{w100}):	0.62	0.92		C_{w100} = 0.62
15. Contrib. Area Factor (F_{Ac}):	1	1		F_{Acw} = 1.00

16. **Time of Concentration (T_{c100}): 4.7 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}) = $(C_{w100})(i_{100})(F_{Acw})A$= 0.62 x 9.60 x 1.0 x 0.9 = 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}):	8.6	6.2	5.4	4.9

*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: jco Checked by: _____ Company: Psomas Date: 02/09/10

City of Tucson

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

1. Project Name and Location: Houghton
2. Drainage Concentration Point: CH10(nursery)
3. *Watershed Area (A) at Drainage Concentration Point: 5.03 acres
4. Length of Hydraulically Longest Watercourse (Lc): 750.0 ft.
5. Length from center of Watershed Area (Lca) along Lc: 375.0 ft.

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

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

a. ΔL_1:	375.0	$(\Delta L_1)^3$:	5.3E+07	ΔH_1:	1.5	$(\Delta L_1)^3/\Delta H_1$:	3.5E+07
b. ΔL_2:	375.0	$(\Delta L_2)^3$:	5.3E+07	ΔH_2:	1.5	$(\Delta L_2)^3/\Delta H_2$:	3.5E+07
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. $$G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2} = 5929.3 + 5929.3 + \_\_\_ + \_\_\_ = \mathbf{11858.5}$$

8. Mean Slope $(S_c) = (L_c/G)^2 = (\ 750.0\ /\ 11858.5\ )^2 =$ 0.40% 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%)	Urb (0%)	( )	
11. Basin Factor ($n_{b,100}$):	0.055	0.048		n_{bw100} = 0.052
12. Soil Types, in %:	100% B	100%B		
13. Imperviousnes (%):	90%	10%		I_w = 90.0%
14. Runoff Coefficient (C_{w100}):	0.62	0.92		C_{w100} = 0.62
15. Contrib. Area Factor (F_{Ac}):	1	1		F_{Acw} = 1.00

16. **Time of Concentration (T_{c100}): 13.1 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}) = $(4P_{1,100})/(1+0.05T_{c100})$ = 7.3 inches/hour.
18. 100-Year Peak (Q_{p100}) = $(C_{w100})(i_{100})(F_{Acw})A$= 0.62 x 7.30 x 1.0 x 5.0 = 22.8 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)	5	11	16	20
Tc (minutes {Eqn. 4.5}):	24.0	17.3	15.1	13.6

*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: jco Checked by: _____ Company: Psomas Date: 02/09/10

City of Tucson

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

1. Project Name and Location: Houghton
2. Drainage Concentration Point: CH11
3. *Watershed Area (A) at Drainage Concentration Point: 0.65 acres
4. Length of Hydraulically Longest Watercourse (Lc): 290.0 ft.
5. Length from center of Watershed Area (Lca) along Lc: 145.0 ft.

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

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

a. ΔL_1:	145.0	$(\Delta L_1)^3$:	3.0E+06	ΔH_1:	5.0	$(\Delta L_1)^3/\Delta H_1$:	6.1E+05
b. ΔL_2:	145.0	$(\Delta L_2)^3$:	3.0E+06	ΔH_2:	3.0	$(\Delta L_2)^3/\Delta H_2$:	1.0E+06
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. $$G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2} = 780.8 + 1008.1 + \_\_\_ + \_\_\_ = \mathbf{1788.9}$$

8. Mean Slope $(S_c) = (L_c/G)^2 = ($ 290.0 / 1788.9 $)^2 =$ 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):	Nat (50%)	Urb (50%)	( )	
11. Basin Factor ($n_{b,100}$):	0.055	0.048		n_{bw100} = 0.052
12. Soil Types, in %:	100% B	100%B		
13. Imperviousnes (%):	5%	100%		I_w = 52.5%
14. Runoff Coefficient (C_{w100}):	0.62	0.92		C_{w100} = 0.77
15. Contrib. Area Factor (F_{Ac}):	1	1		F_{Acw} = 1.00

16. **Time of Concentration (T_{c100}): 3.5 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}) = $(4P_{1,100})/(1+0.05T_{c100})$ = 9.6 inches/hour.
18. 100-Year Peak (Q_{p100}) = $(C_{w100})(i_{100})(F_{Acw})A$= 0.77 x 9.60 x 1.0 x 0.7 = 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}):	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: jco Checked by: _____ Company: Psomas Date: 02/19/10

City of Tucson

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

1. Project Name and Location: Houghton
2. Drainage Concentration Point: CH12(Civano Nursery)
3. *Watershed Area (A) at Drainage Concentration Point: 5.03 acres
4. Length of Hydraulically Longest Watercourse (Lc): 750.0 ft.
5. Length from center of Watershed Area (Lca) along Lc: 375.0 ft.

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

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

a. ΔL_1:	375.0	$(\Delta L_1)^3$:	5.3E+07	ΔH_1:	1.5	$(\Delta L_1)^3/\Delta H_1$:	3.5E+07
b. ΔL_2:	375.0	$(\Delta L_2)^3$:	5.3E+07	ΔH_2:	1.5	$(\Delta L_2)^3/\Delta H_2$:	3.5E+07
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. $G = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} + \left(\frac{\Delta L_4^3}{\Delta H_4}\right)^{1/2}$ = 5929.3 + 5929.3 + _____ + _____ = **11858.5**

8. Mean Slope $(S_c) = (L_c/G)^2 = ($ 750.0 / 11858.5 $)^2 =$ 0.40% 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 (95%)	Urb (5%)	( )	
11. Basin Factor ($n_{b,100}$):	0.055	0.048		n_{bw100} = 0.052
12. Soil Types, in %:	100% B	100%B		
13. Imperviousnes (%):	90%	10%		I_w = 86.0%
14. Runoff Coefficient (C_{w100}):	0.62	0.92		C_{w100} = 0.64
15. Contrib. Area Factor (F_{Ac}):	1	1		F_{Acw} = 1.00

16. **Time of Concentration (T_{c100}): 12.9 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 $(i_{100}) = (4P_{1,100})/(1+0.05T_{c100})$ = 7.3 inches/hour.
18. 100-Year Peak $(Q_{p100}) = (C_{w100})(i_{100})(F_{Acw})A$= 0.64 x 7.30 x 1.0 x 5.0 = 23.5 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)	5	12	16	21
Tc (minutes {Eqn. 4.5}):	23.7	17.1	14.9	13.5

*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.

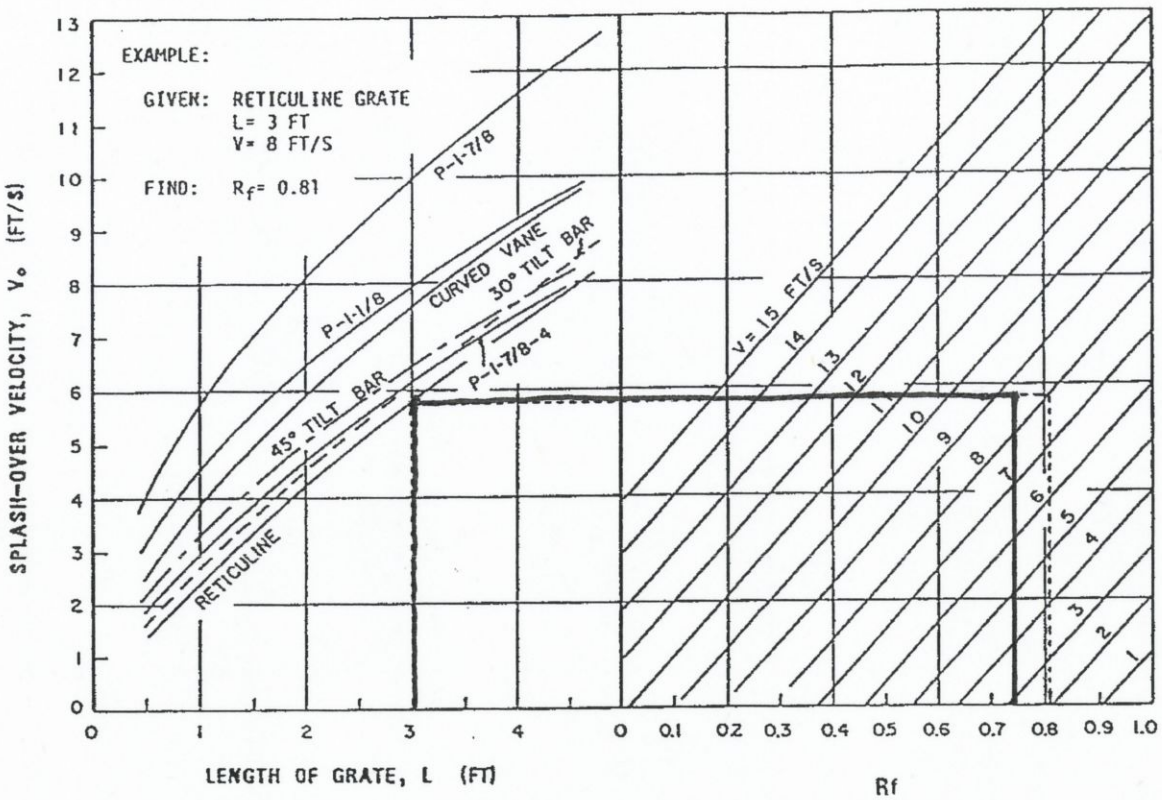
NOTE: Indicate whether hydrologic computations are for "Future Conditions" or "Existing Conditions" by checking the appropriate box above.

Prepared by: jco Checked by: _____ Company: Psomas Date: 02/19/10

PAVEMENT DRAINAGE

INLET CALCULATIONS

GRATE INLETS



$$\boxed{Q_{fi} = R_f \, Q_f}$$

L=3 ft

V=8.84 ft/s

FIGURE 10.5
FRONTAL-FLOW INTERCEPTION EFFICIENCY FOR GRATE INLETS

Quikmart Transverse Grate

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.10000	ft/ft
Discharge	11.70	ft^3/s

Section Definitions

Station (ft)	Elevation (ft)
1+00	100.00
1+00	99.50
1+36	101.12
1+36	101.62

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(1+00, 100.00)	(1+36, 101.62)	0.016

Options

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results

Normal Depth	0.35	ft
Elevation Range	99.50 to 101.62 ft	
Flow Area	1.32	ft^2
Wetted Perimeter	8.02	ft
Hydraulic Radius	0.16	ft
Top Width	7.67	ft
Normal Depth	0.35	ft
Critical Depth	0.59	ft
Critical Slope	0.00597	ft/ft

Quikmart Transverse Grate

Results

Velocity	8.84	ft/s
Velocity Head	1.21	ft
Specific Energy	1.56	ft
Froude Number	3.75	
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	0.35	ft
Critical Depth	0.59	ft
Channel Slope	0.10000	ft/ft
Critical Slope	0.00597	ft/ft

PSOMAS

Project Name: Houghton Road Improvements
Project Number # : 7TED009904 Made by MED Date 7/2/09
Reference: COT SMDDFM Checked By _____ Date _____

GRATED INLET DESIGN

General Equations

Wier

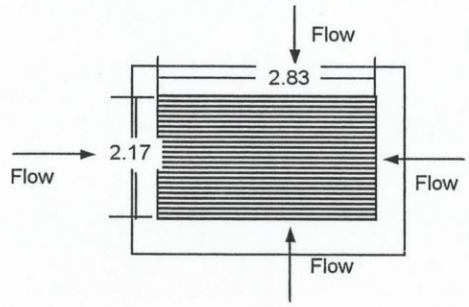
$$Q = C_s L H^{3/2}$$

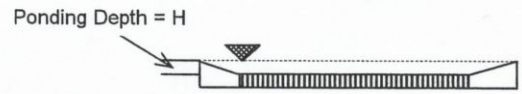
where
- L = Length of Opening (ft)
- C_D = Weir Coefficient
- H = Height of Opening (ft)
- Q = 100-year Peak Discharge (cfs)

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 ft Perimeter = 2.83(2) + 2.17(2) = 10 feet
Clogging factor = 25%

Solution

For Catch Basin CB13

Weir
- Q_{DES} = 25 cfs
- C_D = 3
- H = 0.75 ft
- **L = 13 ft**
- **L_{CLOG} = 16**

One grate provides 10-feet of opening
USE 2 GRATES

Orifice
- Q_{DES} = 25 cfs
- C_D = 5.35
- H = 0.75
- **A = 5.4**
- **A_{CLOG} = 6.7**

One grate provides 4.7 ft^2 of opening
USE 2 GRATES

2-grates governs

Solution

For Catch Basin CB14

Weir
- Q_{DES} = 16 cfs
- C_D = 3
- H = 0.75 ft
- **L = 8 ft**
- **L_{CLOG} = 10**

One grate provides 10-feet of opening
USE 1 GRATE

Orifice
- Q_{DES} = 16 cfs
- C_D = 5.35
- H = 0.75
- **A = 3.5**
- **A_{CLOG} = 4.3**

One grate provides 4.7 ft^2 of opening
USE 1 GRATES

2-grates governs

Project Number # : 7TED009904 Made by MED Date 7/2/09
Reference: COT SMDDFM Checked By _____ Date _____

GRATED INLET DESIGN

General Equations

Wier

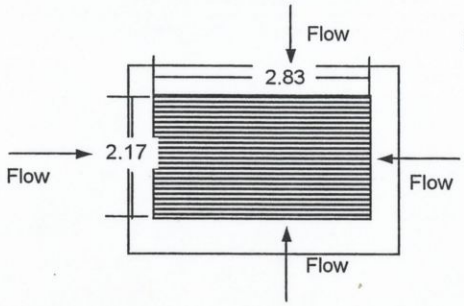
$$Q = C_s L H^{3/2}$$

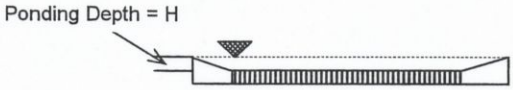
where
- L = Length of Opening (ft)
- C_D = Weir Coefficient
- H = Height of Opening (ft)
- Q = 100-year Peak Discharge (cfs)

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 ft Perimeter = 2.83(2) + 2.17(2) = 10 feet
Clogging factor = 25%

Solution

For Catch Basin CB15

Weir
- Q_{DES} = 14 cfs
- C_D = 3
- H = 0.75 ft
- **L = 7 ft**
- **L_{CLOG} = 9**

One grate provides 10-feet of opening
USE 1 GRATE

Orifice
- Q_{DES} = 14 cfs
- C_D = 5.35
- H = 0.75
- **A = 3.0**
- **A_{CLOG} = 3.8**

One grate provides 4.7 ft^2 of opening
USE 1 GRATES

1-grates governs

Solution

For Catch Basin CB16

Weir
- Q_{DES} = 14 cfs
- C_D = 3
- H = 0.75 ft
- **L = 7 ft**
- **L_{CLOG} = 9**

One grate provides 10-feet of opening
USE 1 GRATE

Orifice
- Q_{DES} = 14 cfs
- C_D = 5.35
- H = 0.75
- **A = 3.0**
- **A_{CLOG} = 3.8**

One grate provides 4.7 ft^2 of opening
USE 1 GRATES

1-grates governs

Project Number # : 7TED009904 Made by MED Date 7/2/09
Reference: COT SMDDFM Checked By _____ Date _____

GRATED INLET DESIGN

General Equations

Wier

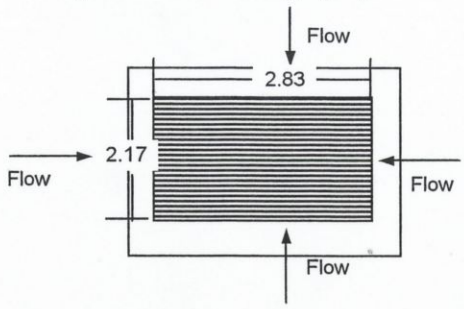
$$Q = C_s L H^{3/2}$$

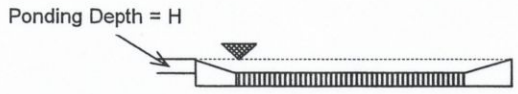
where
- L = Length of Opening (ft)
- C_D = Weir Coefficient
- H = Height of Opening (ft)
- Q = 100-year Peak Discharge (cfs)

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 ft Perimeter = 2.83(2) + 2.17(2) = 10 feet
Clogging factor = 25%

Solution

For Catch Basin CB17

Weir
- Q_{DES} = 37 cfs
- C_D = 3
- H = 0.75 ft
- **L = 19 ft**
- **L_{CLOG} = 24**

One grate provides 10-feet of opening
USE 3 GRATES

Orifice
- Q_{DES} = 37 cfs
- C_D = 5.35
- H = 0.75
- **A = 8.0**
- **A_{CLOG} = 10.0**

One grate provides 4.7 ft^2 of opening
USE 3 GRATES

3-grates governs

Solution

For Catch Basin CB12 (Civano Blvd)

Weir
- Q_{DES} = 30 cfs
- C_D = 3
- H = 0.5 ft
- **L = 28 ft**
- **L_{CLOG} = 42**

One grate provides 10-feet of opening
USE 5 GRATES

Orifice
- Q_{DES} = 30 cfs
- C_D = 5.35
- H = 0.5
- **A = 7.9**
- **A_{CLOG} = 11.9**

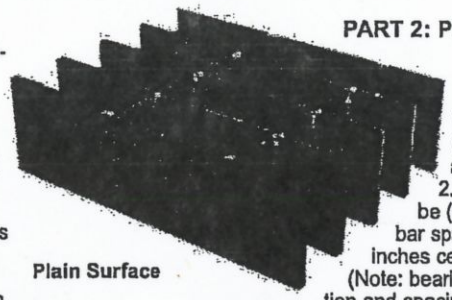
One grate provides 4.7 ft^2 of opening
USE 3 GRATES

HEAVY DUTY WELDED STEEL

W SERIES

PRODUCT SPECIFICATION GUIDE

How to Specify:
The information below provides a specification format for architecturaland engineering specification sections that, when applied, will be consistent with the Three-Part Section Format for Construction Specifications Canada (CSC) and the Technical Documents Committee of Construction Specifications Institute (CSI) for specifications serving the con-struction industry. These specifications are intended for use as a guide spec for architects and engineers, and may need to be altered or modified to fit the specific conditions of the application in question.



Plain Surface

PART 1: GENERAL...

1.1 Scope
The contractor shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install grating, stair treads and frames.

1.2 Quality Assurance
A.1. Comply with applicable provisions and recommendations of the following: NAAMM Metal Bar Grating Manual designated ANSI/NAAMM MBG 531 (Aluminum and Light Duty Steel and Stainless Steel Grating) and MBG 532 (Heavy Duty Steel Grating).
2. Heavy Duty Steel: ASTM A36 for hot rolled structural steel bars. ASTM A510 for carbon steel wire rods and coarse round wire.

B.1. Take field measurements prior to preparation of shop drawings and fabrication where required, to ensure proper fitting of the work.

1.3 Submittals
A. The contractor shall submit for approval shop drawings for the fabrication and erection of all work. Include plans, elevations, and details of sections and connections. Show type and location of all fasteners.
B. The contractor shall submit the manufacturer's specifications, load tables, anchor details and standard installation details.

Serrated Surface

PART 2: PRODUCT...

1. Grating: Heavy Duty Welded Steel W Series by Ohio Gratings, Inc., or approved equal.
2. Bearing Bars: To be (size) rectangular bar spaced (as specified) inches center-to-center. (Note: bearing bar size selection and spacing must be coordinated with the load and span conditions.)
3. Cross Bars: To be (size) spaced 4" center-to-center and welded at right angles to bearing bars with one fillet at each bearing bar/cross bar intersection. (Note: 2" cross bar spacing may be specified for maximum lateral stability.)
4. Surface: Plain. (Note: a serrated surface may be specified for maximum skid resistance.)
5. Loading: (Shall be specified by the architect /engi-neer in terms of uniform load/sq. ft., concentrated load/ft.of grating width, or by AASHTO wheel load designation. Loading, bearing bar size, bearing bar spacing and span conditions must be coordinated.)
6. Finish: (Galvanized or manufacturer's standard black paint at the discretion of the architect /engineer.)
7. Fabrication and Tolerances: in accordance with the NAAMM Metal Bar Grating Manual.

PART 3: EXECUTION...

3.1 Installation
A. Prior to grating installation, contractor shall inspect supports for correct size, layout and alignment. Any inconsistencies between contract drawings and supporting structure deemed detrimental to grating placement shall be reported in writing to the architect or owner's agent prior to grating placement.

B. Install grating in accordance with shop drawings and standard installation clearances as recommended by the NAAMM Metal Bar Grating Manual.

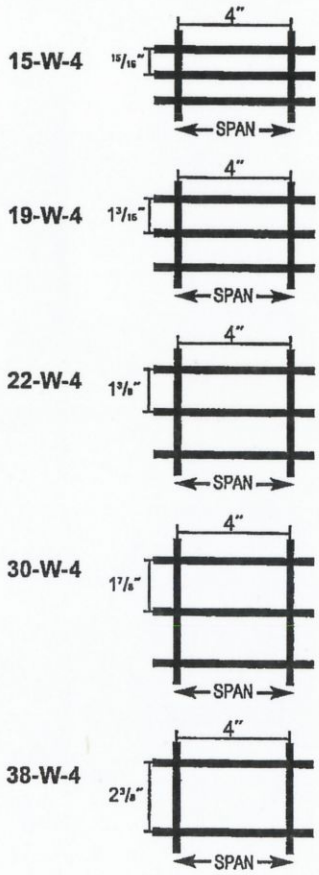
C. Cutting, Fitting and Placement.
1. Perform all cutting and fitting required for installation. Grating shall be placed such that cross bars align.
2. Wherever grating is pierced by pipes, ducts and structural members, cut openings neatly and accurately to size and weld a rectangular band bar of the same height and material as bearing bars.
3. Cutouts for circular obstructions are to be at least 2" larger in diameter than the obstruction. Cutouts for all piping 4" or less shall be made in the field.
4. All rectangular cutouts are to be made to the next bearing bar beyond the penetration with a clearance not to exceed bearing bar spacing.
5. Utilize standard panel widths wherever possible.

3.2 Grating Attachment
Use anchorage devices (saddle clips) (grating clamps) (plank clips) (plank lugs) (countersunk lands) (Z clips) or (anchor blocks) and fasteners to secure grating to supporting members or prepared openings.

Grating Profiles Available...

W Series - Heavy Duty Welded Steel

All profiles shown below are also available with 2" cross bar centers. Product numbers would be **15-W-2, 19-W-2, 22-W-2, 30-W-2 and 38-W-2**



30 SPACE

Load Tables

Maximum Safe Concentrated Load*, Lbs. - Clear Span

Bar Size Inches	1'-0"	1'-6"	2'-0"	2'-6"	3'-0"	3'-6"	4'-0"	4'-6"	5'-0"	5'-6"	6'-0"	7'-0"	8'-0"
1 x 1/4	1780	1187	890	712	593	509							
1 x 3/8	2667	1778	1333	1067	889	762							
1-1/4 x 1/4	2780	1853	1390	1112	927	794	695						
1-1/4 x 3/8	4167	2778	2083	1667	1389	1190	1042						
1-1/2 x 1/4	4000	2667	2000	1600	1333	1143	1000	889					
1-1/2 x 5/16	5000	3333	2500	2000	1667	1429	1250	1111					
1-1/2 x 3/8	6000	4000	3000	2400	2000	1714	1500	1333					
1-3/4 x 1/4	5447	3631	2723	2179	1816	1556	1362	1210	1089				
1-3/4 x 3/8	8167	5444	4083	3267	2722	2333	2042	1815	1633				
2 x 1/4	7113	4742	3557	2845	2371	2032	1778	1581	1423				
2 x 5/16	8887	5924	4443	3555	2962	2539	2222	1975	1777				
2 x 3/8	10667	7111	5333	4267	3556	3048	2667	2370	2133				
2-1/4 x 1/4	9000	6000	4500	3600	3000	2571	2250	2000	1800	1636			
2-1/4 x 3/8	13500	9000	6750	5400	4500	3857	3375	3000	2700	2455			
2-1/2 x 1/4	11113	7409	5557	4445	3704	3175	2778	2470	2223	2021	1852		
2-1/2 x 5/16	13887	9258	6943	5555	4629	3968	3472	3086	2777	2525	2314		
2-1/2 x 3/8	16667	11111	8333	6667	5556	4762	4167	3704	3333	3030	2778		
3 x 1/4	16000	10667	8000	6400	5333	4571	4000	3556	3200	2909	2667		
3 x 5/16	20000	13333	10000	8000	6667	5714	5000	4444	4000	3636	3333		
3 x 3/8	24000	16000	12000	9600	8000	6857	6000	5333	4800	4364	4000		
3 x 1/2	32000	21333	16000	12800	10667	9143	8000	7111	6400	5818	5333		
3-1/2 x 1/4	21780	14520	10890	8712	7260	6223	5445	4840	4356	3960	3630	3111	
3-1/2 x 3/8	32667	21778	16333	13067	10889	9333	8167	7259	6533	5939	5444	4667	
3-1/2 x 1/2	43553	29036	21777	17421	14518	12444	10888	9679	8711	7919	7259	6222	
4 x 1/4	28447	18964	14223	11379	9482	8128	7112	6321	5689	5172	4741	4064	
4 x 5/16	35553	23702	17777	14221	11851	10158	8888	7904	7111	6464	5926	5079	
4 x 3/8	42667	28444	21333	17067	14222	12190	10667	9481	8533	7758	7111	6095	
4 x 1/2	56887	37924	28443	22755	18962	16253	14222	12641	11377	10343	9481	8127	
4-1/2 x 1/4	36000	24000	18000	14400	12000	10286	9000	8000	7200	6545	6000	5143	4500
4-1/2 x 3/8	54000	36000	27000	21600	18000	15429	13500	12000	10800	9818	9000	7714	6750
4-1/2 x 1/2		48000	36000	28800	24000	20571	18000	16000	14400	13091	12000	10286	9000
5 x 1/4		29631	22223	17779	14816	12699	11112	9877	8889	8081	7408	6350	5556
5 x 5/16		37036	27777	22221	18518	15872	13888	12345	11111	10101	9259	7936	6944
5 x 3/8		44444	33333	26667	22222	19048	16667	14815	13333	12121	11111	9524	8333
5 x 1/2		59258	44443	35555	29629	25396	22222	19753	17777	16161	14814	12698	11111
5-1/2 x 1/4		35853	26890	21512	17927	15366	13445	11951	10756	9778	8963	7683	6723
5-1/2 x 3/8		53778	40333	32267	26889	23048	20167	17926	16133	14667	13444	11524	10083
5-1/2 x 1/2			53777	43021	35851	30730	26888	23901	21511	19555	17926	15365	13444
6 x 1/4			32000	25600	21333	18286	16000	14222	12800	11636	10667	9143	8000
6 x 5/16			40000	32000	26667	22857	20000	17778	16000	14545	13333	11429	10000
6 x 3/8			48000	38400	32000	27429	24000	21333	19200	17455	16000	13714	12000
6 x 1/2				51200	42667	36571	32000	28444	25600	23273	21333	18286	16000

% OPEN AREA*					
		BEARING BAR THICKNESS			
BB Size	CB Ctrs	1/4"	5/16"	3/8"	1/2"
thru 2-1/2"	4" cc	79%	76%	73%	
	2" cc	72%	70%	67%	
3" - 6"	4" cc	82%	78%	75%	69%
	2" cc	77%	74%	71%	65%

Loads are theoretical and are based on a unit stress of 20,000 psi.

*Based on 6.4 bars / ft. of grating width. Bearing bars 1-7/8" c.c.

Note: When serrated grating is specified, the depth of grating required for a specific load will be 1/4" greater than that shown in these tables.

30-W-4 / 30-W-2 Panel Width Chart (in.)

Dimensions Are Out-to-Out of Bearing Bars

No. of Bars	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1/4" Bars	2 1/8	4	5 7/8	7 3/4	9 5/8	11 1/2	13 3/8	15 1/4	17 1/8	19	20 7/8	22 3/4	24 5/8	26 1/2	28 3/8
7/16" Bars	2 3/16	4 1/16	5 15/16	7 13/16	9 11/16	11 9/16	13 7/16	15 5/16	17 3/16	19 1/16	20 15/16	22 13/16	24 11/16	26 9/16	28 7/16
3/8" Bars	2 1/4	4 1/8	6	7 7/8	9 3/4	11 5/8	13 1/2	15 3/8	17 1/4	19 1/8	21	22 7/8	24 3/4	26 5/8	28 1/2
1/2" Bars	2 3/8	4 3/4	6 1/8	8	9 7/8	11 3/4	13 5/8	15 1/2	17 3/8	19 1/4	21 1/8	23	24 7/8	26 3/4	28 5/8

No. of Bars	17	18	19	20
1/4" Bars	30 1/4	32 1/8	34	35 7/8
7/16" Bars	30 7/16	32 9/16	34 7/16	36 15/16
3/8" Bars	30 3/8	32 1/4	34 1/8	36
1/2" Bars	30 1/2	32 3/8	34 1/4	36 1/8

CURB OPENING LENGTH CALCULATIONS

PV1

FHWA Urban Drainage Design Program, HY-22
Drainage of Highway Pavements

Inlets on Grade
Date: 06/22/2009

Project No. :
Project Name.:
Computed by :

Inlets on Grade: Curb Opening Inlet

Roadway and Discharge Data

	Cross Slope	Composite
S	Longitudinal Slope (ft/ft)	0.0190
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)	2.350
T	Width of Spread (ft)	7.91

Gutter Flow

Eo	Gutter Flow Ratio	0.609
d	Depth of Flow (ft)	0.26
V	Average Velocity (ft/sec)	3.30

Inlet Interception

	Inlet Type	Curb-Opening
LT	Length for 100% Inteception (ft)	13.65
L	Curb-Opening Length (ft)	12.65
e	Inlet Efficiency	1.000
Qi	Intercepted Flow (cfs)	2.350
Qb	By-pass Flow (cfs)	0.000

PV2

FHWA Urban Drainage Design Program, HY-22
Drainage of Highway Pavements

Inlets on Sag
Date: 06/22/2009

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)	18.23
L	Curb-Opening Length (ft)	7.58
H	Curb-Opening Height (in)	6.00
d_curb	Depth at Curb (ft)	0.549
Qi	Intercepted Flow (cfs)	5.400

PV2-1

FHWA Urban Drainage Design Program, HY-22
Drainage of Highway Pavements

Inlets on Grade
Date: 06/22/2009

Project No. :
Project Name.:
Computed by :

Inlets on Grade: Curb Opening Inlet

Roadway and Discharge Data

	Cross Slope	Composite
S	Longitudinal Slope (ft/ft)	0.0070
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)	0.950
T	Width of Spread (ft)	6.51

Gutter Flow

Eo	Gutter Flow Ratio	0.705
d	Depth of Flow (ft)	0.23
V	Average Velocity (ft/sec)	1.86

Inlet Interception

	Inlet Type	Curb-Opening
LT	Length for 100% Inteception (ft)	6.46
L	Curb-Opening Length (ft)	6.04
e	Inlet Efficiency	1.000
Qi	Intercepted Flow (cfs)	0.950
Qb	By-pass Flow (cfs)	0.000

PV-3
0.59 BYPASS FROM PV1 INCLUDED IN DISCHARGE

FHWA Urban Drainage Design Program, HY-22
Drainage of Highway Pavements

Inlets on Sag
Date: 06/22/2009

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)	12.53
L	Curb-Opening Length (ft)	7.58
H	Curb-Opening Height (in)	6.00
d_curb	Depth at Curb (ft)	0.435
Qi	Intercepted Flow (cfs)	3.080

FHWA Urban Drainage Design Program, HY-22
Drainage of Highway Pavements

Inlets on Grade
Date: 06/22/2009

Project No. :
Project Name.:
Computed by :

Inlets on Grade: Curb Opening Inlet

Roadway and Discharge Data

	Cross Slope	Composite
S	Longitudinal Slope (ft/ft)	0.0070
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)	0.950
T	Width of Spread (ft)	6.51

Gutter Flow

Eo	Gutter Flow Ratio	0.705
d	Depth of Flow (ft)	0.23
V	Average Velocity (ft/sec)	1.86

Inlet Interception

	Inlet Type	Curb-Opening
LT	Length for 100% Inteception (ft)	6.46
L	Curb-Opening Length (ft)	6.04
e	Inlet Efficiency	1.000
Qi	Intercepted Flow (cfs)	0.950
Qb	By-pass Flow (cfs)	0.000

PV4

FHWA Urban Drainage Design Program, HY-22
Drainage of Highway Pavements

Inlets on Grade
Date: 06/22/2009

Project No. :
Project Name.:
Computed by :

Inlets on Grade: Curb Opening Inlet

Roadway and Discharge Data

	Cross Slope	Composite
S	Longitudinal Slope (ft/ft)	0.0080
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)	4.750
T	Width of Spread (ft)	12.92

Gutter Flow

Eo	Gutter Flow Ratio	0.390
d	Depth of Flow (ft)	0.36
V	Average Velocity (ft/sec)	2.71

Inlet Interception

	Inlet Type	Curb-Opening
LT	Length for 100% Inteception (ft)	17.18
L	Curb-Opening Length (ft)	16.18
e	Inlet Efficiency	1.000
Qi	Intercepted Flow (cfs)	4.750
Qb	By-pass Flow (cfs)	0.000

PV5
1.19CFS BYPASS INCLUDED FROM PV4

FHWA Urban Drainage Design Program, HY-22
Drainage of Highway Pavements

Inlets on Grade
Date: 06/22/2009

Project No. :
Project Name.:
Computed by :

Inlets on Grade: Curb Opening Inlet

Roadway and Discharge Data

	Cross Slope	Composite
S	Longitudinal Slope (ft/ft)	0.0080
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)	3.590
T	Width of Spread (ft)	11.50

Gutter Flow

Eo	Gutter Flow Ratio	0.436
d	Depth of Flow (ft)	0.33
V	Average Velocity (ft/sec)	2.55

Inlet Interception

	Inlet Type	Curb-Opening
LT	Length for 100% Inteception (ft)	14.58
L	Curb-Opening Length (ft)	13.58
e	Inlet Efficiency	1.000
Qi	Intercepted Flow (cfs)	3.590
Qb	By-pass Flow (cfs)	0.000

PV6

FHWA Urban Drainage Design Program, HY-22
Drainage of Highway Pavements

Inlets on Grade
Date: 06/22/2009

Project No. :
Project Name.:
Computed by :

Inlets on Grade: Curb Opening Inlet

Roadway and Discharge Data

	Cross Slope	Composite
S	Longitudinal Slope (ft/ft)	0.0080
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)	4.100
T	Width of Spread (ft)	12.16

Gutter Flow

Eo	Gutter Flow Ratio	0.413
d	Depth of Flow (ft)	0.34
V	Average Velocity (ft/sec)	2.62

Inlet Interception

	Inlet Type	Curb-Opening
LT	Length for 100% Inteception (ft)	15.76
L	Curb-Opening Length (ft)	14.76
e	Inlet Efficiency	1.000
Qi	Intercepted Flow (cfs)	4.100
Qb	By-pass Flow (cfs)	0.000

PV7

FHWA Urban Drainage Design Program, HY-22
Drainage of Highway Pavements
Inlets on Grade
Date: 06/22/2009

Project No. :
Project Name.:
Computed by :

Inlets on Grade: Curb Opening Inlet

Roadway and Discharge Data

	Cross Slope		Composite
S	Longitudinal Slope	(ft/ft)	0.0100
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)		3.800
T	Width of Spread (ft)		11.24

Gutter Flow

Eo	Gutter Flow Ratio	0.446
d	Depth of Flow (ft)	0.33
V	Average Velocity (ft/sec)	2.81

Inlet Interception

	Inlet Type	Curb-Opening
LT	Length for 100% Inteception (ft)	15.82
L	Curb-Opening Length (ft)	14.82
e	Inlet Efficiency	1.000
Qi	Intercepted Flow (cfs)	3.800
Qb	By-pass Flow (cfs)	0.000

PV8
0.95CFS BYPASS INCLUDED FROM PV7

FHWA Urban Drainage Design Program, HY-22
Drainage of Highway Pavements

Inlets on Grade
Date: 06/22/2009

Project No. :
Project Name.:
Computed by :

Inlets on Grade: Curb Opening Inlet

Roadway and Discharge Data

	Cross Slope	Composite
S	Longitudinal Slope (ft/ft)	0.0070
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)	4.750
T	Width of Spread (ft)	13.27

Gutter Flow

Eo	Gutter Flow Ratio	0.379
d	Depth of Flow (ft)	0.37
V	Average Velocity (ft/sec)	2.57

Inlet Interception

	Inlet Type	Curb-Opening
LT	Length for 100% Inteception (ft)	16.68
L	Curb-Opening Length (ft)	15.68
e	Inlet Efficiency	1.000
Qi	Intercepted Flow (cfs)	4.750
Qb	By-pass Flow (cfs)	0.000

PV9

FHWA Urban Drainage Design Program, HY-22
Drainage of Highway Pavements

Inlets on Grade
Date: 06/22/2009

Project No. :
Project Name.:
Computed by :

Inlets on Grade: Curb Opening Inlet

Roadway and Discharge Data

	Cross Slope	Composite
S	Longitudinal Slope (ft/ft)	0.0070
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)	14.59

Gutter Flow

Eo	Gutter Flow Ratio	0.345
d	Depth of Flow (ft)	0.39
V	Average Velocity (ft/sec)	2.71

Inlet Interception

	Inlet Type	Curb-Opening
LT	Length for 100% Inteception (ft)	19.11
L	Curb-Opening Length (ft)	18.11
e	Inlet Efficiency	1.000
Qi	Intercepted Flow (cfs)	6.000
Qb	By-pass Flow (cfs)	0.000

PV10

FHWA Urban Drainage Design Program, HY-22
Drainage of Highway Pavements

Inlets on Grade
Date: 06/22/2009

Project No. :
Project Name.:
Computed by :

Inlets on Grade: Curb Opening Inlet

Roadway and Discharge Data

	Cross Slope	Composite
S	Longitudinal Slope (ft/ft)	0.0075
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)	4.300
T	Width of Spread (ft)	12.56

Gutter Flow

Eo	Gutter Flow Ratio	0.400
d	Depth of Flow (ft)	0.35
V	Average Velocity (ft/sec)	2.58

Inlet Interception

	Inlet Type	Curb-Opening
LT	Length for 100% Inteception (ft)	15.98
L	Curb-Opening Length (ft)	14.98
e	Inlet Efficiency	1.000
Qi	Intercepted Flow (cfs)	4.300
Qb	By-pass Flow (cfs)	0.000

PV11
Bypass PV10 = .43cfs
PV11.1=2.7 cfs
PV 11 = 1.45

FHWA Urban Drainage Design Program, HY-22
Drainage of Highway Pavements

Inlets on Grade
Date: 07/23/2009

Project No. :
Project Name.:
Computed by :

Inlets on Grade: Curb Opening Inlet

Roadway and Discharge Data

	Cross Slope		Composite
S	Longitudinal Slope	(ft/ft)	0.0350
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)		4.580
T	Width of Spread (ft)		9.31

Gutter Flow

Eo	Gutter Flow Ratio	0.530
d	Depth of Flow (ft)	0.29
V	Average Velocity (ft/sec)	4.80

Inlet Interception

	Inlet Type		Curb-Opening
LT	Length for 100% Inteception	(ft)	23.10
L	Curb-Opening Length (ft)		22.10
e	Inlet Efficiency		1.000
Qi	Intercepted Flow (cfs)		4.580
Qb	By-pass Flow (cfs)		0.000

PV12
1.11 BYPASS FROM PV 12.1

FHWA Urban Drainage Design Program, HY-22
Drainage of Highway Pavements

Inlets on Grade
Date: 06/30/2009

Project No. :
Project Name.:
Computed by :

Inlets on Grade: Curb Opening Inlet

Roadway and Discharge Data

	Cross Slope	Composite
S	Longitudinal Slope (ft/ft)	0.0350
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)	2.660
T	Width of Spread (ft)	7.27

Gutter Flow

Eo	Gutter Flow Ratio	0.651
d	Depth of Flow (ft)	0.25
V	Average Velocity (ft/sec)	4.33

Inlet Interception

	Inlet Type	Curb-Opening
LT	Length for 100% Inteception (ft)	16.75
L	Curb-Opening Length (ft)	15.75
e	Inlet Efficiency	1.000
Qi	Intercepted Flow (cfs)	2.660
Qb	By-pass Flow (cfs)	0.000

PV12.1

FHWA Urban Drainage Design Program, HY-22
Drainage of Highway Pavements

Inlets on Grade
Date: 06/30/2009

Project No. :
Project Name.:
Computed by :

Inlets on Grade: Curb Opening Inlet

Roadway and Discharge Data

	Cross Slope	Composite
S	Longitudinal Slope (ft/ft)	0.0350
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)	4.450
T	Width of Spread (ft)	9.20

Gutter Flow

Eo	Gutter Flow Ratio	0.536
d	Depth of Flow (ft)	0.29
V	Average Velocity (ft/sec)	4.77

Inlet Interception

	Inlet Type	Curb-Opening
LT	Length for 100% Inteception (ft)	22.71
L	Curb-Opening Length (ft)	21.71
e	Inlet Efficiency	1.000
Qi	Intercepted Flow (cfs)	4.450
Qb	By-pass Flow (cfs)	0.000

PV13

FHWA Urban Drainage Design Program, HY-22
Drainage of Highway Pavements

Inlets on Grade
Date: 06/22/2009

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)	2.450
T	Width of Spread (ft)	10.82

Gutter Flow

Eo	Gutter Flow Ratio	0.462
d	Depth of Flow (ft)	0.32
V	Average Velocity (ft/sec)	1.95

Inlet Interception

	Inlet Type	Curb-Opening
LT	Length for 100% Inteception (ft)	10.52
L	Curb-Opening Length (ft)	10.10
e	Inlet Efficiency	1.000
Qi	Intercepted Flow (cfs)	2.450
Qb	By-pass Flow (cfs)	0.000

PV14

FHWA Urban Drainage Design Program, HY-22
Drainage of Highway Pavements

Inlets on Grade
Date: 06/22/2009

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)	2.000
T	Width of Spread (ft)	9.92

Gutter Flow

Eo	Gutter Flow Ratio	0.501
d	Depth of Flow (ft)	0.30
V	Average Velocity (ft/sec)	1.87

Inlet Interception

	Inlet Type	Curb-Opening
LT	Length for 100% Inteception (ft)	9.33
L	Curb-Opening Length (ft)	8.91
e	Inlet Efficiency	1.000
Qi	Intercepted Flow (cfs)	2.000
Qb	By-pass Flow (cfs)	0.000

0.50 CFS BYPASS INCLUDED FROM PV14

FHWA Urban Drainage Design Program, HY-22
Drainage of Highway Pavements

Inlets on Grade
Date: 06/22/2009

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)		2.500
T	Width of Spread (ft)		10.91

Gutter Flow

Eo	Gutter Flow Ratio	0.459
d	Depth of Flow (ft)	0.32
V	Average Velocity (ft/sec)	1.96

Inlet Interception

	Inlet Type	Curb-Opening
LT	Length for 100% Inteception (ft)	10.64
L	Curb-Opening Length (ft)	10.22
e	Inlet Efficiency	1.000
Qi	Intercepted Flow (cfs)	2.500
Qb	By-pass Flow (cfs)	0.000

PV16
.61CFS BYPASS INCLUDED FROM PV13

FHWA Urban Drainage Design Program, HY-22
Drainage of Highway Pavements

Inlets on Grade
Date: 06/22/2009

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)	3.610
T	Width of Spread (ft)	12.71

Gutter Flow

Eo	Gutter Flow Ratio	0.396
d	Depth of Flow (ft)	0.36
V	Average Velocity (ft/sec)	2.12

Inlet Interception

	Inlet Type	Curb-Opening
LT	Length for 100% Inteception (ft)	13.21
L	Curb-Opening Length (ft)	12.21
e	Inlet Efficiency	1.000
Qi	Intercepted Flow (cfs)	3.610
Qb	By-pass Flow (cfs)	0.000

PV17
0.63CFS BYPASS INCLUDED FROM PV15

FHWA Urban Drainage Design Program, HY-22
Drainage of Highway Pavements

Inlets on Grade
Date: 06/22/2009

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)	2.230
T	Width of Spread (ft)	10.39

Gutter Flow

Eo	Gutter Flow Ratio	0.480
d	Depth of Flow (ft)	0.31
V	Average Velocity (ft/sec)	1.91

Inlet Interception

	Inlet Type	Curb-Opening
LT	Length for 100% Inteception (ft)	9.95
L	Curb-Opening Length (ft)	9.53
e	Inlet Efficiency	1.000
Qi	Intercepted Flow (cfs)	2.230
Qb	By-pass Flow (cfs)	0.000

PV18

FHWA Urban Drainage Design Program, HY-22
Drainage of Highway Pavements

Inlets on Grade
Date: 06/22/2009

Project No. :
Project Name.:
Computed by :

Inlets on Grade: Curb Opening Inlet

Roadway and Discharge Data

	Cross Slope	Composite
S	Longitudinal Slope (ft/ft)	0.0320
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)	2.150
T	Width of Spread (ft)	6.70

Gutter Flow

Eo	Gutter Flow Ratio	0.691
d	Depth of Flow (ft)	0.24
V	Average Velocity (ft/sec)	4.02

Inlet Interception

	Inlet Type	Curb-Opening
LT	Length for 100% Inteception (ft)	14.49
L	Curb-Opening Length (ft)	13.49
e	Inlet Efficiency	1.000
Qi	Intercepted Flow (cfs)	2.150
Qb	By-pass Flow (cfs)	0.000

PV19

FHWA Urban Drainage Design Program, HY-22
Drainage of Highway Pavements

Inlets on Grade
Date: 06/22/2009

Project No. :
Project Name.:
Computed by :

Inlets on Grade: Curb Opening Inlet

Roadway and Discharge Data

	Cross Slope	Composite
S	Longitudinal Slope (ft/ft)	0.0320
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)	3.500
T	Width of Spread (ft)	8.43

Gutter Flow

Eo	Gutter Flow Ratio	0.578
d	Depth of Flow (ft)	0.27
V	Average Velocity (ft/sec)	4.39

Inlet Interception

	Inlet Type	Curb-Opening
LT	Length for 100% Inteception (ft)	19.32
L	Curb-Opening Length (ft)	18.32
e	Inlet Efficiency	1.000
Qi	Intercepted Flow (cfs)	3.500
Qb	By-pass Flow (cfs)	0.000

PV20
2.58 cfs from PV20.1 (this includes bypass from PV19)

FHWA Urban Drainage Design Program, HY-22
Drainage of Highway Pavements

Inlets on Grade
Date: 07/28/2009

Project No. :
Project Name.:
Computed by :

Inlets on Grade: Curb Opening Inlet

Roadway and Discharge Data

	Cross Slope		Composite
S	Longitudinal Slope	(ft/ft)	0.0390
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)		4.480
T	Width of Spread (ft)		9.00

Gutter Flow

Eo	Gutter Flow Ratio	0.546
d	Depth of Flow (ft)	0.28
V	Average Velocity (ft/sec)	4.99

Inlet Interception

	Inlet Type		Curb-Opening
LT	Length for 100% Inteception	(ft)	23.33
L	Curb-Opening Length (ft)		22.33
e	Inlet Efficiency		1.000
Qi	Intercepted Flow (cfs)		4.480
Qb	By-pass Flow (cfs)		0.000

PV20.1
0.88CFS BYPASS FROM PV19

FHWA Urban Drainage Design Program, HY-22
Drainage of Highway Pavements

Inlets on Grade
Date: 06/30/2009

Project No. :
Project Name.:
Computed by :

Inlets on Grade: Curb Opening Inlet

Roadway and Discharge Data

	Cross Slope	Composite
S	Longitudinal Slope (ft/ft)	0.0390
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)	2.580
T	Width of Spread (ft)	6.98

Gutter Flow

Eo	Gutter Flow Ratio	0.671
d	Depth of Flow (ft)	0.24
V	Average Velocity (ft/sec)	4.50

Inlet Interception

	Inlet Type	Curb-Opening
LT	Length for 100% Inteception (ft)	16.84
L	Curb-Opening Length (ft)	15.84
e	Inlet Efficiency	1.000
Qi	Intercepted Flow (cfs)	2.580
Qb	By-pass Flow (cfs)	0.000

PV21
.81CFS BYPASS FROM PV21-1

CROSS SLOPE TAKE AT UPSTREAM END OF CATCH BASIN TO BE CONSERVATIVE

FHWA Urban Drainage Design Program, HY-22
Drainage of Highway Pavements

Inlets on Grade
Date: 07/02/2009

Project No. :
Project Name.:
Computed by :

Inlets on Grade: Curb Opening Inlet

Roadway and Discharge Data

	Cross Slope	Composite
S	Longitudinal Slope (ft/ft)	0.0390
Sx	Pavement Cross Slope (ft/ft)	0.0174
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)	2.050
T	Width of Spread (ft)	6.75

Gutter Flow

Eo	Gutter Flow Ratio	0.709
d	Depth of Flow (ft)	0.22
V	Average Velocity (ft/sec)	4.21

Inlet Interception

	Inlet Type	Curb-Opening
LT	Length for 100% Inteception (ft)	14.96
L	Curb-Opening Length (ft)	13.96
e	Inlet Efficiency	1.000
Qi	Intercepted Flow (cfs)	2.050
Qb	By-pass Flow (cfs)	0.000

PV21-1
0.92FS BYPASS FROM PV21-2

FHWA Urban Drainage Design Program, HY-22
Drainage of Highway Pavements

Inlets on Grade
Date: 07/02/2009

Project No. :
Project Name.:
Computed by :

Inlets on Grade: Curb Opening Inlet

Roadway and Discharge Data

	Cross Slope	Composite
S	Longitudinal Slope (ft/ft)	0.0390
Sx	Pavement Cross Slope (ft/ft)	0.0100
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)	3.220
T	Width of Spread (ft)	11.85

Gutter Flow

Eo	Gutter Flow Ratio	0.521
d	Depth of Flow (ft)	0.24
V	Average Velocity (ft/sec)	4.01

Inlet Interception

	Inlet Type	Curb-Opening
LT	Length for 100% Inteception (ft)	21.57
L	Curb-Opening Length (ft)	20.57
e	Inlet Efficiency	1.000
Qi	Intercepted Flow (cfs)	3.220
Qb	By-pass Flow (cfs)	0.000

PV21.2
0.8CFS FROM OV22
0.75CFS FROM PV23
0.54CFS BYPASS FROM PV18

FHWA Urban Drainage Design Program, HY-22
Drainage of Highway Pavements

Inlets on Grade
Date: 07/02/2009

Project No. :
Project Name.:
Computed by :

Inlets on Grade: Curb Opening Inlet

Roadway and Discharge Data

	Cross Slope	Composite
S	Longitudinal Slope (ft/ft)	0.0390
Sx	Pavement Cross Slope (ft/ft)	0.0100
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)	3.690
T	Width of Spread (ft)	12.64

Gutter Flow

Eo	Gutter Flow Ratio	0.489
d	Depth of Flow (ft)	0.24
V	Average Velocity (ft/sec)	4.10

Inlet Interception

	Inlet Type	Curb-Opening
LT	Length for 100% Inteception (ft)	23.58
L	Curb-Opening Length (ft)	22.58
e	Inlet Efficiency	1.000
Qi	Intercepted Flow (cfs)	3.690
Qb	By-pass Flow (cfs)	0.000

FHWA Urban Drainage Design Program, HY-22
Drainage of Highway Pavements

Inlets on Grade
Date: 06/22/2009

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)	0.800
T	Width of Spread (ft)	6.50

Gutter Flow

Eo	Gutter Flow Ratio	0.706
d	Depth of Flow (ft)	0.23
V	Average Velocity (ft/sec)	1.57

Inlet Interception

	Inlet Type	Curb-Opening
LT	Length for 100% Inteception (ft)	5.43
L	Curb-Opening Length (ft)	5.27
e	Inlet Efficiency	1.000
Qi	Intercepted Flow (cfs)	0.800
Qb	By-pass Flow (cfs)	0.000

PV23

FHWA Urban Drainage Design Program, HY-22
Drainage of Highway Pavements

Inlets on Grade
Date: 06/22/2009

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)	0.750
T	Width of Spread (ft)	6.26

Gutter Flow

Eo	Gutter Flow Ratio	0.724
d	Depth of Flow (ft)	0.23
V	Average Velocity (ft/sec)	1.57

Inlet Interception

	Inlet Type	Curb-Opening
LT	Length for 100% Inteception (ft)	5.22
L	Curb-Opening Length (ft)	5.06
e	Inlet Efficiency	1.000
Qi	Intercepted Flow (cfs)	0.750
Qb	By-pass Flow (cfs)	0.000

PV24

FHWA Urban Drainage Design Program, HY-22
Drainage of Highway Pavements

Inlets on Grade
Date: 06/22/2009

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)	3.050
T	Width of Spread (ft)	11.85

Gutter Flow

Eo	Gutter Flow Ratio	0.424
d	Depth of Flow (ft)	0.34
V	Average Velocity (ft/sec)	2.04

Inlet Interception

	Inlet Type	Curb-Opening
LT	Length for 100% Inteception (ft)	11.97
L	Curb-Opening Length (ft)	11.54
e	Inlet Efficiency	1.000
Qi	Intercepted Flow (cfs)	3.050
Qb	By-pass Flow (cfs)	0.000

PV25
0.76CFS BYPASS INCLUDED FROM PV24

FHWA Urban Drainage Design Program, HY-22
Drainage of Highway Pavements

Inlets on Grade
Date: 06/22/2009

Project No. :
Project Name.:
Computed by :

Inlets on Grade: Curb Opening Inlet

Roadway and Discharge Data

	Cross Slope	Composite
S	Longitudinal Slope (ft/ft)	0.0080
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)	3.160
T	Width of Spread (ft)	10.90

Gutter Flow

Eo	Gutter Flow Ratio	0.459
d	Depth of Flow (ft)	0.32
V	Average Velocity (ft/sec)	2.48

Inlet Interception

	Inlet Type	Curb-Opening
LT	Length for 100% Inteception (ft)	13.52
L	Curb-Opening Length (ft)	12.52
e	Inlet Efficiency	1.000
Qi	Intercepted Flow (cfs)	3.160
Qb	By-pass Flow (cfs)	0.000

CULVERT CALCULATIONS

Culvert Design Report
D01_CP12A_454+46.49

Peak Discharge Method: User-Specified

Design Discharge	756.00 cfs	Check Discharge	0.00 cfs

Grades Model: Inverts

Invert Upstream	2,833.92 ft	Invert Downstream	2,832.49 ft
Length	204.00 ft	Slope	0.007010 ft/ft
Drop	1.43 ft		

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater

Tailwater Elevation	0.00 ft

Name	Description	Discharge	HW Elev.	Velocity
x Trial-1	2-10 x 6 ft Box	756.00 cfs	2,840.12 ft	13.47 ft/s

Culvert Design Report
D01_CP12A_454+46.49

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	ft	Storm Event	Design	
Computed Headwater Elevation	2,840.12	ft	Discharge	756.00	cfs
Headwater Depth/Height	1.03		Tailwater Elevation	0.00	ft
Inlet Control HW Elev.	2,839.61	ft	Control Type	Entrance Control	
Outlet Control HW Elev.	2,840.12	ft			

Grades					
Upstream Invert	2,833.92	ft	Downstream Invert	2,832.49	ft
Length	204.00	ft	Constructed Slope	0.007010	ft/ft

Hydraulic Profile					
Profile	S2		Depth, Downstream	2.81	ft
Slope Type	Steep		Normal Depth	2.71	ft
Flow Regime	Supercritical		Critical Depth	3.54	ft
Velocity Downstream	13.47	ft/s	Critical Slope	0.003299	ft/ft

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	10.00	ft
Section Size	10 x 6 ft		Rise	6.00	ft
Number Sections	2				

Outlet Control Properties					
Outlet Control HW Elev.	2,840.12	ft	Upstream Velocity Head	1.77	ft
Ke	0.50		Entrance Loss	0.89	ft

Inlet Control Properties					
Inlet Control HW Elev.	2,839.61	ft	Flow Control	N/A	
Inlet Type	30 to 75° wingwall flares		Area Full	120.0	ft²
K	0.02600		HDS 5 Chart	8	
M	1.00000		HDS 5 Scale	1	
C	0.03470		Equation Form	1	
Y	0.86000				

Culvert Design Report
D02_CP12B_20+86.00

Peak Discharge Method: User-Specified			
Design Discharge	14.00 cfs	Check Discharge	0.00 cfs

Grades Model: Inverts			
Invert Upstream	2,859.34 ft	Invert Downstream	2,858.73 ft
Length	61.00 ft	Slope	0.010000 ft/ft
Drop	0.61 ft		

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	0.00 ft

Name	Description	Discharge	HW Elev.	Velocity
x Trial-1	1-24 inch Circular	14.00 cfs	2,861.59 ft	7.50 ft/s

Culvert Design Report
D02_CP12B_20+86.00

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	ft	Storm Event	Design	
Computed Headwater Elevation	2,861.59	ft	Discharge	14.00	cfs
Headwater Depth/Height	1.12		Tailwater Elevation	0.00	ft
Inlet Control HW Elev.	2,861.47	ft	Control Type	Entrance Control	
Outlet Control HW Elev.	2,861.59	ft			

Grades					
Upstream Invert	2,859.34	ft	Downstream Invert	2,858.73	ft
Length	61.00	ft	Constructed Slope	0.010000	ft/ft

Hydraulic Profile					
Profile	S2		Depth, Downstream	1.15	ft
Slope Type	Steep		Normal Depth	1.14	ft
Flow Regime	Supercritical		Critical Depth	1.35	ft
Velocity Downstream	7.50	ft/s	Critical Slope	0.006053	ft/ft

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

Outlet Control Properties					
Outlet Control HW Elev.	2,861.59	ft	Upstream Velocity Head	0.60	ft
Ke	0.50		Entrance Loss	0.30	ft

Inlet Control Properties					
Inlet Control HW Elev.	2,861.47	ft	Flow Control	N/A	
Inlet Type	Square edge w/headwall		Area Full	3.1	ft^2
K	0.00980		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	1	
C	0.03980		Equation Form	1	
Y	0.67000				

Culvert Design Report
D03_CP13A_471+02.43

Peak Discharge Method: User-Specified			
Design Discharge	57.00 cfs	Check Discharge	0.00 cfs

Grades Model: Inverts			
Invert Upstream	2,877.52 ft	Invert Downstream	2,871.05 ft
Length	196.00 ft	Slope	0.033010 ft/ft
Drop	6.47 ft		

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	0.00 ft

Name	Description	Discharge	HW Elev.	Velocity
x Trial-1	3-24 inch Circular	57.00 cfs	2,880.29 ft	12.83 ft/s

Culvert Design Report
D03_CP13A_471+02.43

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	ft	Storm Event	Design	
Computed Headwater Elevation	2,880.29	ft	Discharge	57.00	cfs
Headwater Depth/Height	1.39		Tailwater Elevation	0.00	ft
Inlet Control HW Elev.	2,880.28	ft	Control Type	Entrance Control	
Outlet Control HW Elev.	2,880.29	ft			

Grades					
Upstream Invert	2,877.52	ft	Downstream Invert	2,871.05	ft
Length	196.00	ft	Constructed Slope	0.033010	ft/ft

Hydraulic Profile					
Profile	S2		Depth, Downstream	0.96	ft
Slope Type	Steep		Normal Depth	0.96	ft
Flow Regime	Supercritical		Critical Depth	1.57	ft
Velocity Downstream	12.83	ft/s	Critical Slope	0.007688	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	2.00	ft
Section Size	24 inch		Rise	2.00	ft
Number Sections	3				

Outlet Control Properties					
Outlet Control HW Elev.	2,880.29	ft	Upstream Velocity Head	0.80	ft
Ke	0.50		Entrance Loss	0.40	ft

Inlet Control Properties					
Inlet Control HW Elev.	2,880.28	ft	Flow Control	N/A	
Inlet Type	Square edge w/headwall		Area Full	9.4	ft^2
K	0.00980		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	1	
C	0.03980		Equation Form	1	
Y	0.67000				

Culvert Design Report
D04_CP13B_21+07.01

Peak Discharge Method: User-Specified			
Design Discharge	57.00 cfs	Check Discharge	0.00 cfs

Grades Model: Inverts			
Invert Upstream	2,879.10 ft	Invert Downstream	2,878.51 ft
Length	118.00 ft	Slope	0.005000 ft/ft
Drop	0.59 ft		

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	0.00 ft

Name	Description	Discharge	HW Elev.	Velocity
x Trial-1	3-24 inch Circular	57.00 cfs	2,881.91 ft	7.19 ft/s

Culvert Design Report
D04_CP13B_21+07.01

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	ft	Storm Event	Design	
Computed Headwater Elevation	2,881.91	ft	Discharge	57.00	cfs
Headwater Depth/Height	1.41		Tailwater Elevation	0.00	ft
Inlet Control HW Elev.	2,881.89	ft	Control Type	Outlet Control	
Outlet Control HW Elev.	2,881.91	ft			

Grades					
Upstream Invert	2,879.10	ft	Downstream Invert	2,878.51	ft
Length	118.00	ft	Constructed Slope	0.005000	ft/ft

Hydraulic Profile					
Profile	M2		Depth, Downstream	1.57	ft
Slope Type	Mild		Normal Depth	N/A	ft
Flow Regime	Subcritical		Critical Depth	1.57	ft
Velocity Downstream	7.19	ft/s	Critical Slope	0.007688	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	2.00	ft
Section Size	24 inch		Rise	2.00	ft
Number Sections	3				

Outlet Control Properties					
Outlet Control HW Elev.	2,881.91	ft	Upstream Velocity Head	0.58	ft
Ke	0.50		Entrance Loss	0.29	ft

Inlet Control Properties					
Inlet Control HW Elev.	2,881.89	ft	Flow Control	N/A	
Inlet Type	Square edge w/headwall		Area Full	9.4	ft²
K	0.00980		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	1	
C	0.03980		Equation Form	1	
Y	0.67000				

Culvert Design Report
D05_CP13C_20+98.01

Peak Discharge Method: User-Specified			
Design Discharge	51.00 cfs	Check Discharge	0.00 cfs

Grades Model: Inverts			
Invert Upstream	2,882.88 ft	Invert Downstream	2,882.62 ft
Length	53.00 ft	Slope	0.004906 ft/ft
Drop	0.26 ft		

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	2,883.74 ft

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	3-24 inch Circular	51.00 cfs	2,885.41 ft	6.79 ft/s

Culvert Design Report
D05_CP13C_20+98.01

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	ft	Storm Event	Design	
Computed Headwater Elevation	2,885.41	ft	Discharge	51.00	cfs
Headwater Depth/Height	1.26		Tailwater Elevation	2,883.74	ft
Inlet Control HW Elev.	2,885.39	ft	Control Type	Outlet Control	
Outlet Control HW Elev.	2,885.41	ft			

Grades					
Upstream Invert	2,882.88	ft	Downstream Invert	2,882.62	ft
Length	53.00	ft	Constructed Slope	0.004906	ft/ft

Hydraulic Profile					
Profile	M2		Depth, Downstream	1.49	ft
Slope Type	Mild		Normal Depth	1.84	ft
Flow Regime	Subcritical		Critical Depth	1.49	ft
Velocity Downstream	6.79	ft/s	Critical Slope	0.006938	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	2.00	ft
Section Size	24 inch		Rise	2.00	ft
Number Sections	3				

Outlet Control Properties					
Outlet Control HW Elev.	2,885.41	ft	Upstream Velocity Head	0.56	ft
Ke	0.50		Entrance Loss	0.28	ft

Inlet Control Properties					
Inlet Control HW Elev.	2,885.39	ft	Flow Control	N/A	
Inlet Type	Square edge w/headwall		Area Full	9.4	ft^2
K	0.00980		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	1	
C	0.03980		Equation Form	1	
Y	0.67000				

Culvert Design Report
D06_CP14_485+00.41

Peak Discharge Method: User-Specified			
Design Discharge	152.00 cfs	Check Discharge	0.00 cfs

Grades Model: Inverts			
Invert Upstream	2,888.45 ft	Invert Downstream	2,885.53 ft
Length	195.00 ft	Slope	0.014974 ft/ft
Drop	2.92 ft		

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	2,885.94 ft

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	3-36 inch Circular	152.00 cfs	2,892.19 ft	12.08 ft/s

Culvert Design Report
D06_CP14_485+00.41

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	ft	Storm Event	Design	
Computed Headwater Elevation	2,892.19	ft	Discharge	152.00	cfs
Headwater Depth/Height	1.25		Tailwater Elevation	2,885.94	ft
Inlet Control HW Elev.	2,892.19	ft	Control Type	Inlet Control	
Outlet Control HW Elev.	2,892.16	ft			

Grades					
Upstream Invert	2,888.45	ft	Downstream Invert	2,885.53	ft
Length	195.00	ft	Constructed Slope	0.014974	ft/ft

Hydraulic Profile					
Profile	S2		Depth, Downstream	1.72	ft
Slope Type	Steep		Normal Depth	1.71	ft
Flow Regime	Supercritical		Critical Depth	2.32	ft
Velocity Downstream	12.08	ft/s	Critical Slope	0.006502	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	3.00	ft
Section Size	36 inch		Rise	3.00	ft
Number Sections	3				

Outlet Control Properties					
Outlet Control HW Elev.	2,892.16	ft	Upstream Velocity Head	1.16	ft
Ke	0.20		Entrance Loss	0.23	ft

Inlet Control Properties					
Inlet Control HW Elev.	2,892.19	ft	Flow Control	N/A	
Inlet Type	Beveled ring, 45° bevels		Area Full	21.2	ft^2
K	0.00180		HDS 5 Chart	3	
M	2.50000		HDS 5 Scale	A	
C	0.03000		Equation Form	1	
Y	0.74000				

Culvert Design Report
D07_CP15A_21+12.00

Peak Discharge Method: User-Specified			
Design Discharge	111.00 cfs	Check Discharge	0.00 cfs

Grades Model: Inverts			
Invert Upstream	2,897.18 ft	Invert Downstream	2,895.02 ft
Length	131.00 ft	Slope	0.016489 ft/ft
Drop	2.16 ft		

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	0.00 ft

Name	Description	Discharge	HW Elev.	Velocity
x Trial-1	3-30 inch Circular	111.00 cfs	2,901.10 ft	11.41 ft/s

Culvert Design Report
D07_CP15A_21+12.00

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	ft	Storm Event	Design	
Computed Headwater Elevation	2,901.10	ft	Discharge	111.00	cfs
Headwater Depth/Height	1.57		Tailwater Elevation	0.00	ft
Inlet Control HW Elev.	2,901.10	ft	Control Type	Inlet Control	
Outlet Control HW Elev.	2,900.94	ft			

Grades					
Upstream Invert	2,897.18	ft	Downstream Invert	2,895.02	ft
Length	131.00	ft	Constructed Slope	0.016489	ft/ft

Hydraulic Profile					
Profile	S2		Depth, Downstream	1.57	ft
Slope Type	Steep		Normal Depth	1.54	ft
Flow Regime	Supercritical		Critical Depth	2.06	ft
Velocity Downstream	11.41	ft/s	Critical Slope	0.008062	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	2.50	ft
Section Size	30 inch		Rise	2.50	ft
Number Sections	3				

Outlet Control Properties					
Outlet Control HW Elev.	2,900.94	ft	Upstream Velocity Head	1.14	ft
Ke	0.50		Entrance Loss	0.57	ft

Inlet Control Properties					
Inlet Control HW Elev.	2,901.10	ft	Flow Control	N/A	
Inlet Type	Square edge w/headwall		Area Full	14.7	ft²
K	0.00980		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	1	
C	0.03980		Equation Form	1	
Y	0.67000				

Culvert Design Report
D08_CP15B_21+05.00

Peak Discharge Method: User-Specified			
Design Discharge	59.00 cfs	Check Discharge	0.00 cfs

Grades Model: Inverts			
Invert Upstream	2,908.82 ft	Invert Downstream	2,908.20 ft
Length	104.00 ft	Slope	0.005962 ft/ft
Drop	0.62 ft		

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	0.00 ft

Name	Description	Discharge	HW Elev.	Velocity
x Trial-1	3-24 inch Circular	59.00 cfs	2,911.71 ft	7.33 ft/s

Culvert Design Report
D08_CP15B_21+05.00

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	ft	Storm Event	Design	
Computed Headwater Elevation	2,911.71	ft	Discharge	59.00	cfs
Headwater Depth/Height	1.45		Tailwater Elevation	0.00	ft
Inlet Control HW Elev.	2,911.71	ft	Control Type	Inlet Control	
Outlet Control HW Elev.	2,911.65	ft			

Grades					
Upstream Invert	2,908.82	ft	Downstream Invert	2,908.20	ft
Length	104.00	ft	Constructed Slope	0.005962	ft/ft

Hydraulic Profile					
Profile	M2		Depth, Downstream	1.59	ft
Slope Type	Mild		Normal Depth	N/A	ft
Flow Regime	Subcritical		Critical Depth	1.59	ft
Velocity Downstream	7.33	ft/s	Critical Slope	0.007971	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	2.00	ft
Section Size	24 inch		Rise	2.00	ft
Number Sections	3				

Outlet Control Properties					
Outlet Control HW Elev.	2,911.65	ft	Upstream Velocity Head	0.65	ft
Ke	0.50		Entrance Loss	0.32	ft

Inlet Control Properties					
Inlet Control HW Elev.	2,911.71	ft	Flow Control	N/A	
Inlet Type	Square edge w/headwall		Area Full	9.4	ft²
K	0.00980		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	1	
C	0.03980		Equation Form	1	
Y	0.67000				

Culvert Design Report
D09_CP16_522+86.63

Peak Discharge Method: User-Specified			
Design Discharge	49.00 cfs	Check Discharge	0.00 cfs

Grades Model: Inverts			
Invert Upstream	2,912.59 ft	Invert Downstream	2,909.33 ft
Length	251.00 ft	Slope	0.012988 ft/ft
Drop	3.26 ft		

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	0.00 ft

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	3-30 inch Circular	49.00 cfs	2,914.78 ft	8.67 ft/s

Culvert Design Report
D09_CP16_522+86.63

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	ft	Storm Event	Design	
Computed Headwater Elevation	2,914.78	ft	Discharge	49.00	cfs
Headwater Depth/Height	0.88		Tailwater Elevation	0.00	ft
Inlet Control HW Elev.	2,914.60	ft	Control Type	Entrance Control	
Outlet Control HW Elev.	2,914.78	ft			

Grades					
Upstream Invert	2,912.59	ft	Downstream Invert	2,909.33	ft
Length	251.00	ft	Constructed Slope	0.012988	ft/ft

Hydraulic Profile					
Profile	S2		Depth, Downstream	1.02	ft
Slope Type	Steep		Normal Depth	1.02	ft
Flow Regime	Supercritical		Critical Depth	1.37	ft
Velocity Downstream	8.67	ft/s	Critical Slope	0.004724	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	2.50	ft
Section Size	30 inch		Rise	2.50	ft
Number Sections	3				

Outlet Control Properties					
Outlet Control HW Elev.	2,914.78	ft	Upstream Velocity Head	0.55	ft
Ke	0.50		Entrance Loss	0.28	ft

Inlet Control Properties					
Inlet Control HW Elev.	2,914.60	ft	Flow Control	N/A	
Inlet Type	Square edge w/headwall		Area Full	14.7	ft^2
K	0.00980		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	1	
C	0.03980		Equation Form	1	
Y	0.67000				

Culvert Design Report
D10_CP17_528+20.00

Peak Discharge Method: User-Specified			
Design Discharge	763.00 cfs	Check Discharge	0.00 cfs

Grades Model: Inverts			
Invert Upstream	2,915.79 ft	Invert Downstream	2,914.74 ft
Length	174.00 ft	Slope	0.006034 ft/ft
Drop	1.05 ft		

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	0.00 ft

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	6-10 x 4 ft Box	763.00 cfs	2,918.79 ft	9.28 ft/s

Culvert Design Report
D10_CP17_528+20.00

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	ft	Storm Event	Design	
Computed Headwater Elevation	2,918.79	ft	Discharge	763.00	cfs
Headwater Depth/Height	0.75		Tailwater Elevation	0.00	ft
Inlet Control HW Elev.	2,918.51	ft	Control Type	Entrance Control	
Outlet Control HW Elev.	2,918.79	ft			

Grades					
Upstream Invert	2,915.79	ft	Downstream Invert	2,914.74	ft
Length	174.00	ft	Constructed Slope	0.006034	ft/ft

Hydraulic Profile					
Profile	S2		Depth, Downstream	1.37	ft
Slope Type	Steep		Normal Depth	1.37	ft
Flow Regime	Supercritical		Critical Depth	1.71	ft
Velocity Downstream	9.28	ft/s	Critical Slope	0.003048	ft/ft

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	10.00	ft
Section Size	10 x 4 ft		Rise	4.00	ft
Number Sections	6				

Outlet Control Properties					
Outlet Control HW Elev.	2,918.79	ft	Upstream Velocity Head	0.86	ft
Ke	0.50		Entrance Loss	0.43	ft

Inlet Control Properties					
Inlet Control HW Elev.	2,918.51	ft	Flow Control	N/A	
Inlet Type	30 to 75° wingwall flares		Area Full	240.0	ft²
K	0.02600		HDS 5 Chart	8	
M	1.00000		HDS 5 Scale	1	
C	0.03470		Equation Form	1	
Y	0.86000				

Culvert Design Report
D11_CP18A_547+26

Peak Discharge Method: User-Specified			
Design Discharge	580.00 cfs	Check Discharge	0.00 cfs

Grades Model: Inverts			
Invert Upstream	2,930.30 ft	Invert Downstream	2,928.93 ft
Length	196.00 ft	Slope	0.006990 ft/ft
Drop	1.37 ft		

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	0.00 ft

Name	Description	Discharge	HW Elev.	Velocity
x Trial-1	6-10 x 4 ft Box	580.00 cfs	2,932.80 ft	8.87 ft/s

Culvert Design Report
D11_CP18A_547+26

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	ft	Storm Event	Design	
Computed Headwater Elevation	2,932.80	ft	Discharge	580.00	cfs
Headwater Depth/Height	0.62		Tailwater Elevation	0.00	ft
Inlet Control HW Elev.	2,932.55	ft	Control Type	Entrance Control	
Outlet Control HW Elev.	2,932.80	ft			

Grades					
Upstream Invert	2,930.30	ft	Downstream Invert	2,928.93	ft
Length	196.00	ft	Constructed Slope	0.006990	ft/ft

Hydraulic Profile					
Profile	S2		Depth, Downstream	1.09	ft
Slope Type	Steep		Normal Depth	1.09	ft
Flow Regime	Supercritical		Critical Depth	1.43	ft
Velocity Downstream	8.87	ft/s	Critical Slope	0.003057	ft/ft

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	10.00	ft
Section Size	10 x 4 ft		Rise	4.00	ft
Number Sections	6				

Outlet Control Properties					
Outlet Control HW Elev.	2,932.80	ft	Upstream Velocity Head	0.71	ft
Ke	0.50		Entrance Loss	0.36	ft

Inlet Control Properties					
Inlet Control HW Elev.	2,932.55	ft	Flow Control	N/A	
Inlet Type	30 to 75° wingwall flares		Area Full	240.0	ft²
K	0.02600		HDS 5 Chart	8	
M	1.00000		HDS 5 Scale	1	
C	0.03470		Equation Form	1	
Y	0.86000				

Culvert Design Report
D12_CP18B_553+99.00 DESIGN

Peak Discharge Method: User-Specified			
Design Discharge	1,031.00 cfs	Check Discharge	0.00 cfs

Grades Model: Inverts			
Invert Upstream	2,933.55 ft	Invert Downstream	2,932.61 ft
Length	188.00 ft	Slope	0.005000 ft/ft
Drop	0.94 ft		

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	0.00 ft

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	6-12 x 4 ft Box	1,031.00 cfs	2,936.79 ft	9.26 ft/s

Culvert Design Report
D12_CP18B_553+99.00 DESIGN

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	ft	Storm Event	Design	
Computed Headwater Elevation	2,936.79	ft	Discharge	1,031.00	cfs
Headwater Depth/Height	0.81		Tailwater Elevation	0.00	ft
Inlet Control HW Elev.	2,936.51	ft	Control Type	Entrance Control	
Outlet Control HW Elev.	2,936.79	ft			

Grades					
Upstream Invert	2,933.55	ft	Downstream Invert	2,932.61	ft
Length	188.00	ft	Constructed Slope	0.005000	ft/ft

Hydraulic Profile					
Profile	S2		Depth, Downstream	1.55	ft
Slope Type	Steep		Normal Depth	1.54	ft
Flow Regime	Supercritical		Critical Depth	1.85	ft
Velocity Downstream	9.26	ft/s	Critical Slope	0.002870	ft/ft

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	12.00	ft
Section Size	12 x 4 ft		Rise	4.00	ft
Number Sections	6				

Outlet Control Properties					
Outlet Control HW Elev.	2,936.79	ft	Upstream Velocity Head	0.93	ft
Ke	0.50		Entrance Loss	0.46	ft

Inlet Control Properties					
Inlet Control HW Elev.	2,936.51	ft	Flow Control	N/A	
Inlet Type	30 to 75° wingwall flares		Area Full	288.0	ft²
K	0.02600		HDS 5 Chart	8	
M	1.00000		HDS 5 Scale	1	
C	0.03470		Equation Form	1	
Y	0.86000				

Culvert Design Report
D13_CP19_11+39.65-extention

Peak Discharge Method: User-Specified			
Design Discharge	264.00 cfs	Check Discharge	0.00 cfs

Grades Model: Inverts			
Invert Upstream	2,792.91 ft	Invert Downstream	2,793.59 ft
Length	34.00 ft	Slope	-0.020000 ft/ft
Drop	-0.68 ft		

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	0.00 ft

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	3-48 inch Circular	264.00 cfs	2,798.27 ft	9.21 ft/s

Culvert Design Report
D13_CP19_11+39.65-extention

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	ft	Storm Event	Design	
Computed Headwater Elevation	2,798.27	ft	Discharge	264.00	cfs
Headwater Depth/Height	1.34		Tailwater Elevation	0.00	ft
Inlet Control HW Elev.	2,798.27	ft	Control Type	Inlet Control	
Outlet Control HW Elev.	2,798.26	ft			

Grades					
Upstream Invert	2,792.91	ft	Downstream Invert	2,793.59	ft
Length	34.00	ft	Constructed Slope	-0.020000	ft/ft

Hydraulic Profile					
Profile	CompositeA2PressureProfile		Depth, Downstream	2.84	ft
Slope Type	Adverse		Normal Depth	0.00	ft
Flow Regime	Subcritical		Critical Depth	2.84	ft
Velocity Downstream	9.21	ft/s	Critical Slope	0.005144	ft/ft

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

Outlet Control Properties					
Outlet Control HW Elev.	2,798.26	ft	Upstream Velocity Head	0.76	ft
Ke	0.50		Entrance Loss	0.38	ft

Inlet Control Properties					
Inlet Control HW Elev.	2,798.27	ft	Flow Control	Transition	
Inlet Type	Square edge w/headwall		Area Full	37.7	ft²
K	0.00980		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	1	
C	0.03980		Equation Form	1	
Y	0.67000				

Culvert Design Report
D13_CP19_11+39.65

Peak Discharge Method: User-Specified			
Design Discharge	264.00 cfs	Check Discharge	0.00 cfs

Grades Model: Inverts			
Invert Upstream	2,792.91 ft	Invert Downstream	2,792.11 ft
Length	102.00 ft	Slope	0.007843 ft/ft
Drop	0.80 ft		

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	0.00 ft

Name	Description	Discharge	HW Elev.	Velocity
x Trial-1	3-48 inch Circular	264.00 cfs	2,797.73 ft	10.69 ft/s

Culvert Design Report
D13_CP19_11+39.65

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	ft	Storm Event	Design	
Computed Headwater Elevation	2,797.73	ft	Discharge	264.00	cfs
Headwater Depth/Height	1.21		Tailwater Elevation	0.00	ft
Inlet Control HW Elev.	2,797.54	ft	Control Type	Entrance Control	
Outlet Control HW Elev.	2,797.73	ft			

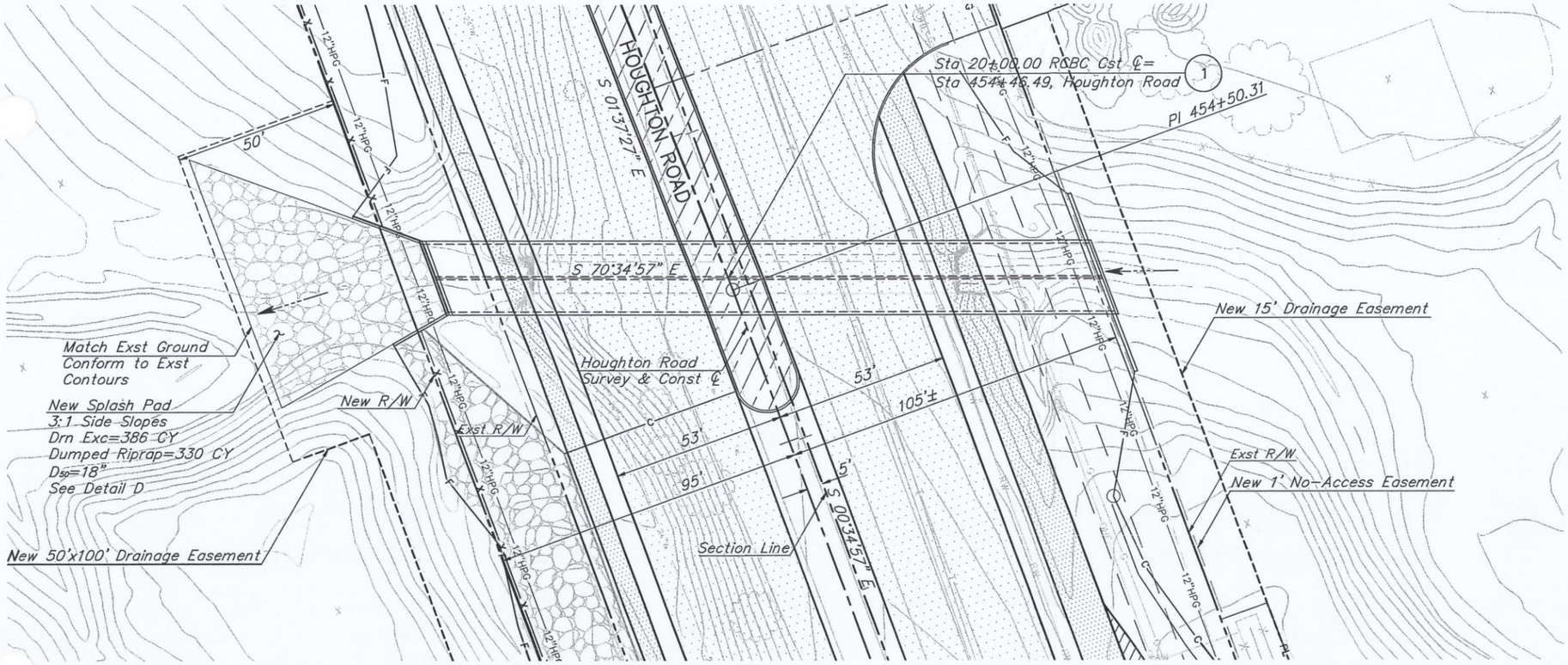
Grades					
Upstream Invert	2,792.91	ft	Downstream Invert	2,792.11	ft
Length	102.00	ft	Constructed Slope	0.007843	ft/ft

Hydraulic Profile					
Profile	S2		Depth, Downstream	2.49	ft
Slope Type	Steep		Normal Depth	2.45	ft
Flow Regime	Supercritical		Critical Depth	2.84	ft
Velocity Downstream	10.69	ft/s	Critical Slope	0.005144	ft/ft

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

Outlet Control Properties					
Outlet Control HW Elev.	2,797.73	ft	Upstream Velocity Head	1.32	ft
Ke	0.50		Entrance Loss	0.66	ft

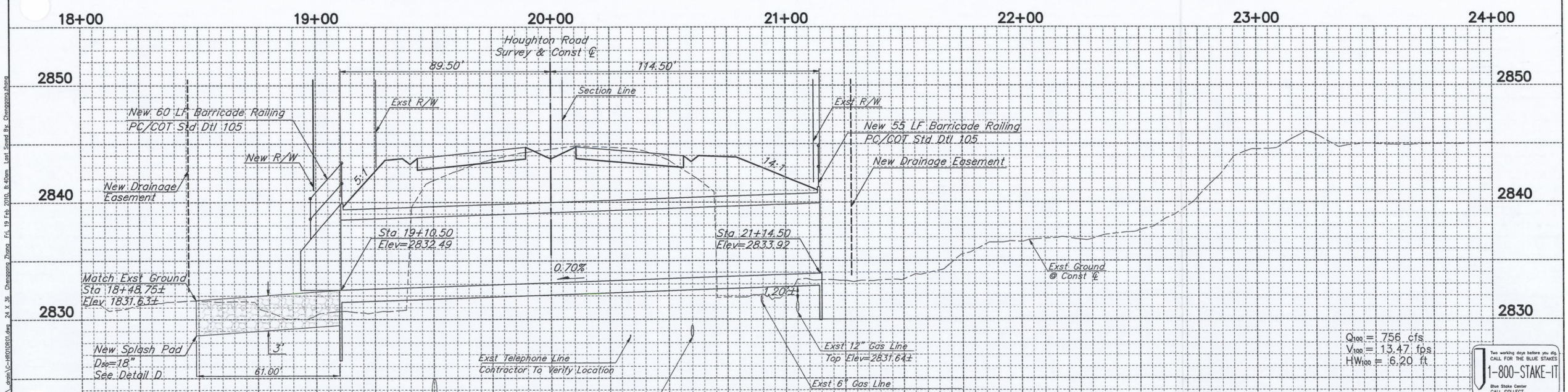
Inlet Control Properties					
Inlet Control HW Elev.	2,797.54	ft	Flow Control	N/A	
Inlet Type	Square edge w/headwall		Area Full	37.7	ft^2
K	0.00980		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	1	
C	0.03980		Equation Form	1	
Y	0.67000				



WARNING
Exst 12" High-Pressure Gas Lines
Lt & Rt
Protect in Place

NOTES:

1. Inlet headwall & wingwall dimensions shall be based on 20° skew, 4:1 side slopes, and ADOT Std Dwg B-04.30. Wingwalls to be constructed at 0° angle and Θ=0°.
2. Outlet headwall & wingwall dimensions shall be based on 20° skew, 4:1 side slopes, and ADOT Std Dwg B-04.10, with the following exception: The angle Θ1 between the outlet headwall and the southern wingwall shall be 80° instead of 90°.
3. Boxes shall be constructed per ADOT Std Dwg B-02.20.



Q_{100} = 756 cfs
V_{100} = 13.47 fps
HW_{100} = 6.20 ft

Two working days before you dig. CALL FOR THE BLUE STAKES
1-800-STAKE-IT
Blue Stake Center CALL COLLECT

Sta 454+46.49
Remove Exst 10'x8' RCBC
New 2-10'x6'x204' RCBC
Skew 20° Rt

NO.	DATE	REVISION	BY	CHKD.	APPR.

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HOUGHTON ROAD
IRVINGTON RD TO VALENCIA RD
Drainage Plan & Profile

CITY OF TUCSON

DRWN. BY CZ	2/10	REF.	SCALE: 1"=20' 1"=4'
DSGN. BY DAD	2/10		
CHKD. BY BB, AA, CZ	2/10	PLAN NO. I-2007-001	

DR01 OF DR13

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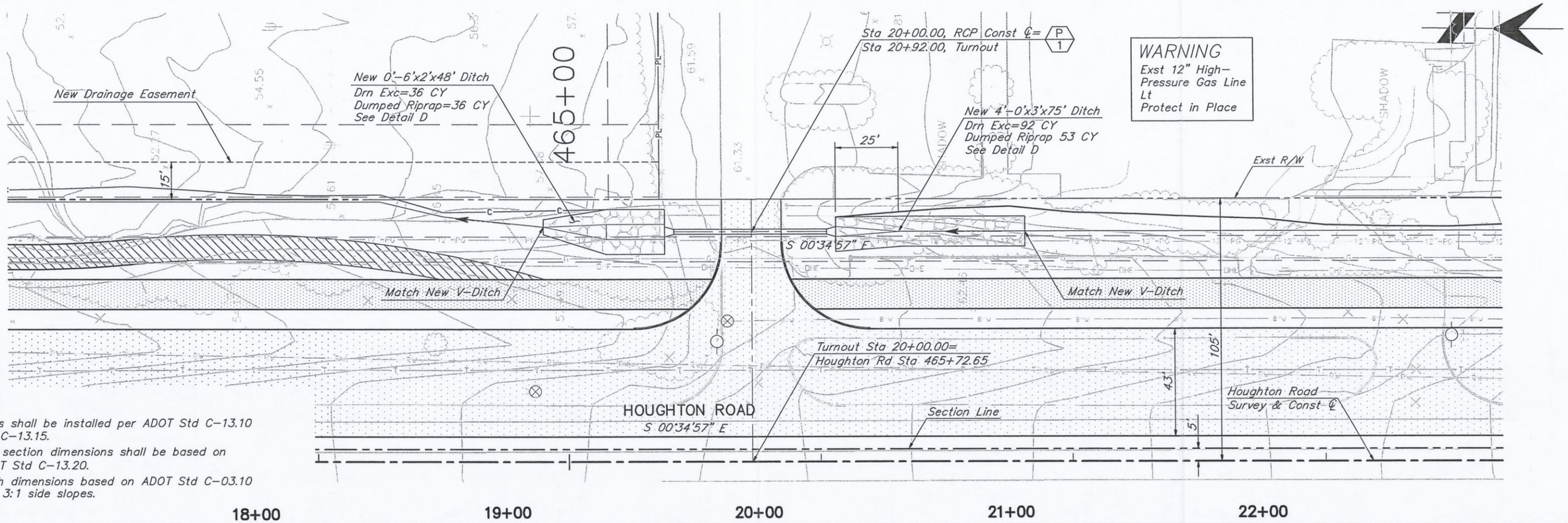

NOTES:

1. Pipes shall be installed per ADOT Std C-13.10 and C-13.15.
2. End section dimensions shall be based on ADOT Std C-13.20.
3. Ditch dimensions based on ADOT Std C-03.10 with 3:1 side slopes.

Sta 20+92.00
New 1-24"x61' RCP
Skew 0°

NO.	DATE	REVISION	BY	CHKD.	APPR.

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CITY OF TUCSON

DRWN. BY CZ	2/10	REF.	SCALE: 1"=20' 1"=4'
DSGN. BY CZ	2/10		
CHKD. BY BB, AA, CZ	2/10	PLAN NO. I-2007-001	

DR02 OF DR13

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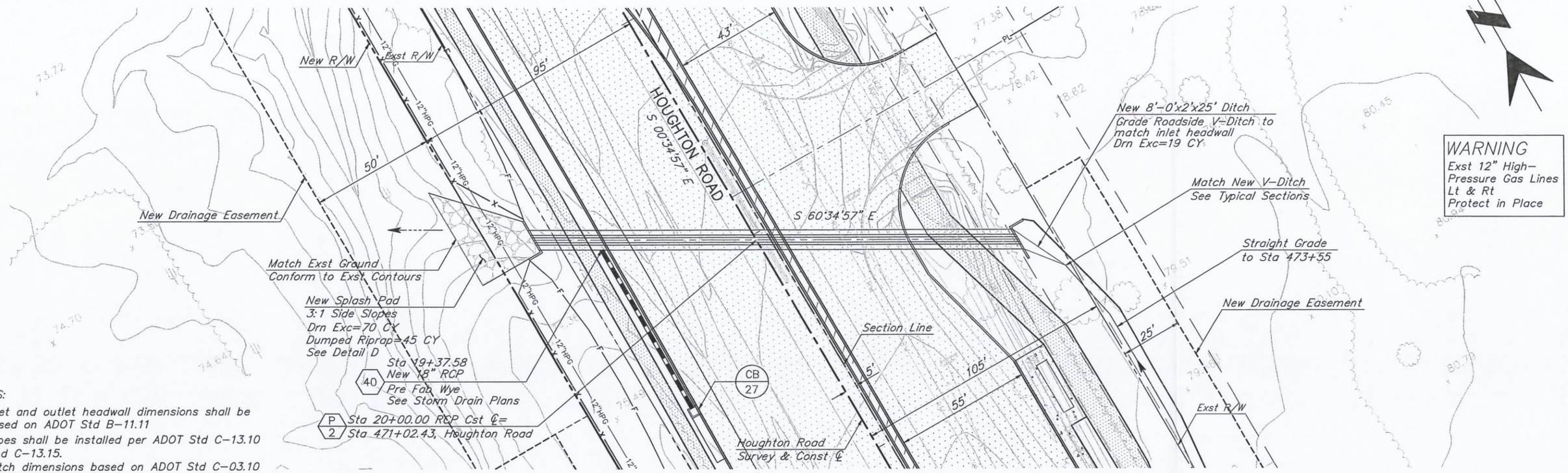
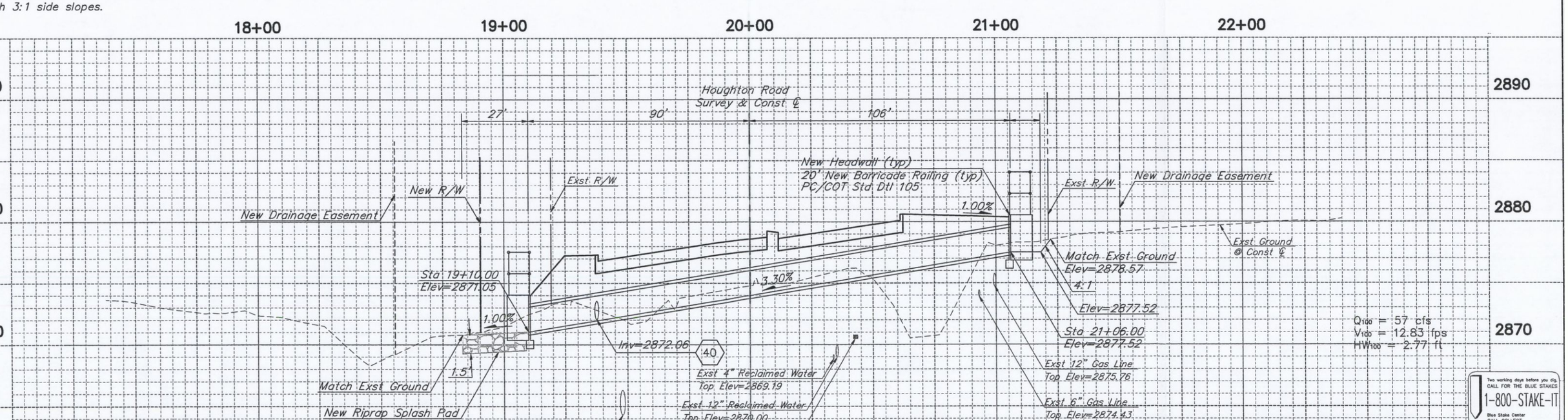
Two working days before you dig. CALL FOR THE BLUE STAKES
1-800-STAKE-IT
Blue Stake Center CALL COLLECT

:\7TED069904\PUBLIC_WORKS\Sheets_drain\C-HR01DR02.dwg 24 X 36 Chenggang Zhang Fri, 19 Feb 2010, 8:41am Last Saved By: Chenggang.zhang



NOTES:

1. Inlet and outlet headwall dimensions shall be based on ADOT Std B-11.11
2. Pipes shall be installed per ADOT Std C-13.10 and C-13.15.
3. Ditch dimensions based on ADOT Std C-03.10 with 3:1 side slopes.



Two working days before you dig.
CALL FOR THE BLUE STAKES
1-800-STAKE-IT
Blue Stake Center
CALL COLLECT

Sta 471+02.43
New 3-24"x196' RCP
Skew 30° Rt

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Drainage Plan & Profile

CITY OF TUCSON

DRWN. BY CZ	2/10	REF. ____ SCALE: 1"=20' / 1"=4'
DSGN. BY CZ	2/10	
CHKD. BY BB, AA, CZ	2/10	PLAN NO. I-2007-001

DR03 OF DR13

98 OF 304

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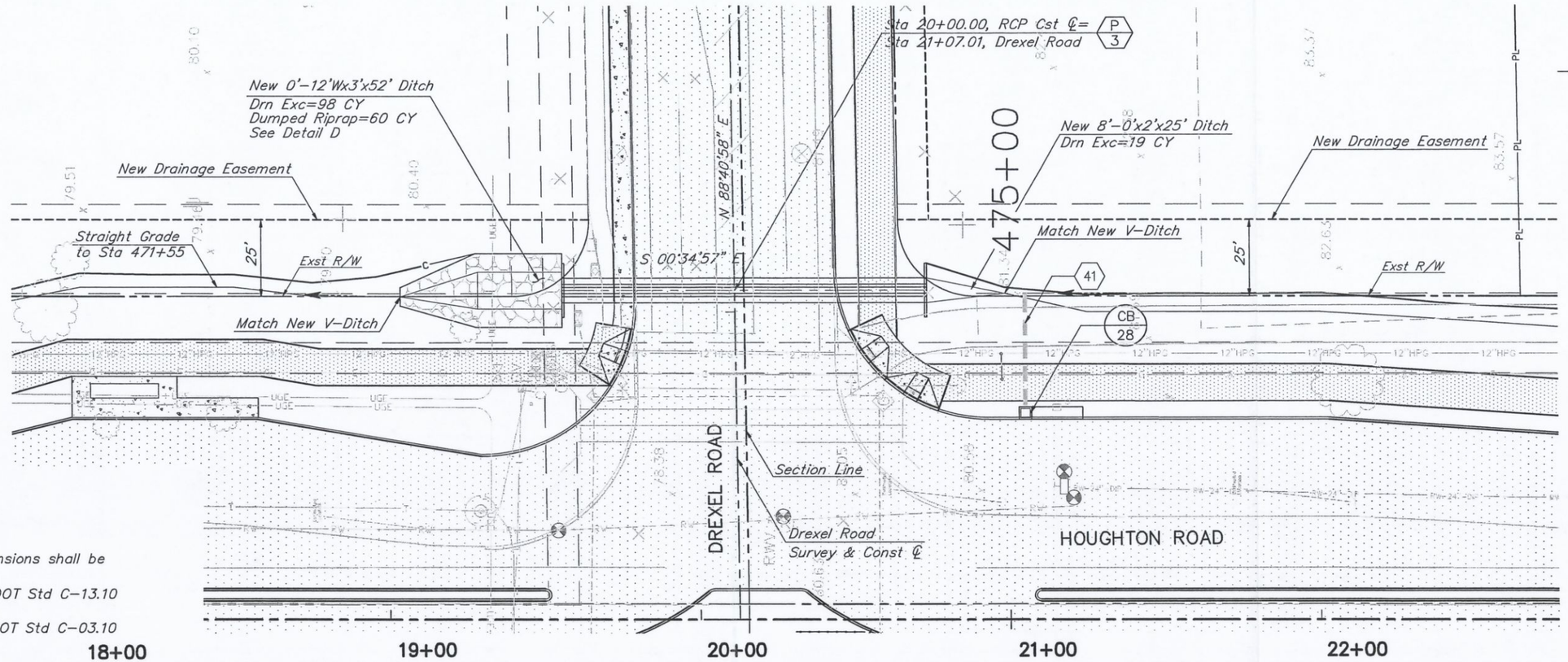
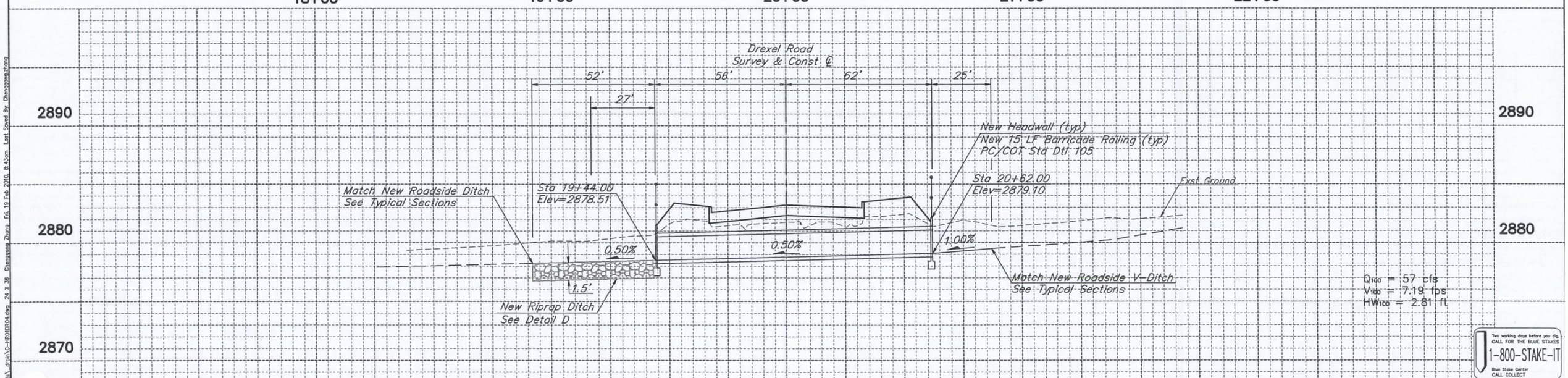


WARNING
Exst 12" High-Pressure Gas Line Lt
Protect in Place

NOTES:

1. Inlet and outlet headwall dimensions shall be based on ADOT Std B-11.11
2. Pipes shall be installed per ADOT Std C-13.10 and C-13.15.
3. Ditch dimensions based on ADOT Std C-03.10 with 3:1 side slopes.



Q_{100} = 57 cfs
V_{100} = 7.19 fps
HW_{100} = 2.81 ft

Two working days before you dig. CALL FOR THE BLUE STAKES
1-800-STAKE-IT
Blue Stake Center CALL COLLECT

Sta 21+07.01
New 3-24"x118' RCP
Skew 0°

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Drainage Plan & Profile

CITY OF TUCSON

DRWN. BY CZ	2/10	REF.	SCALE: 1"=20' 1"=4'
DSGN. BY CZ	2/10		
CHKD. BY BB, AA, CZ	2/10	PLAN NO. I-2007-001	

DR04 OF DR13

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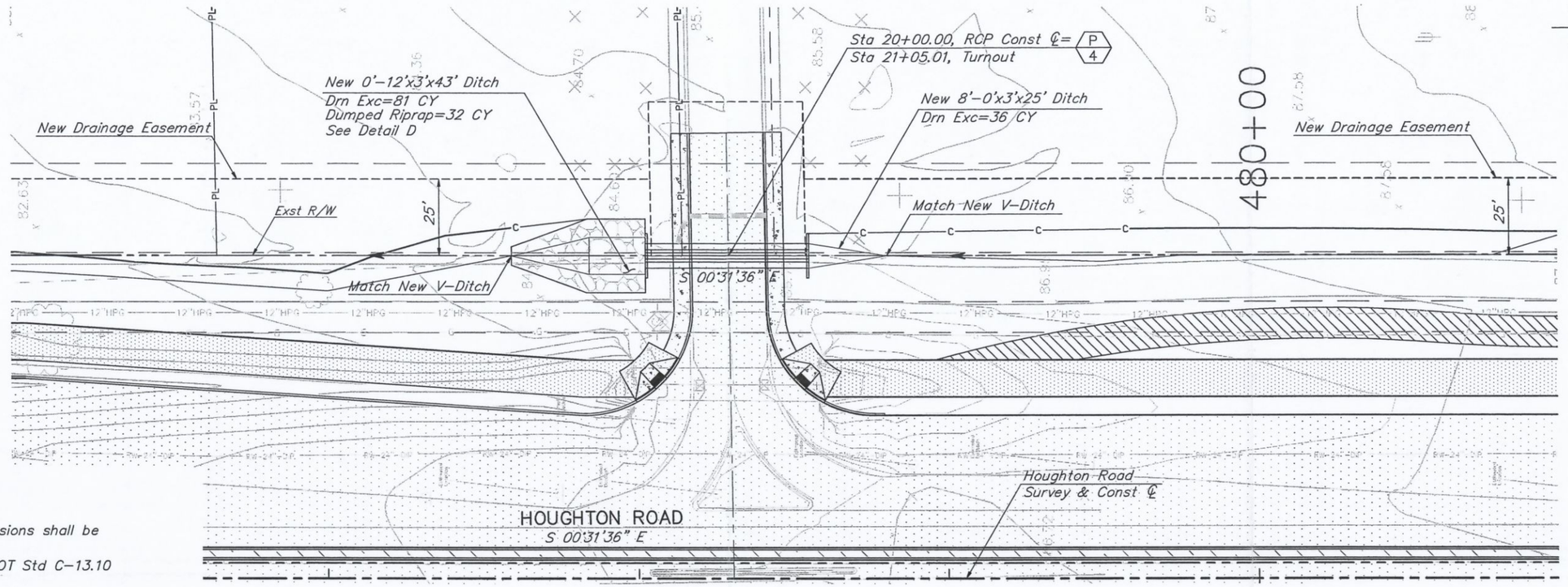
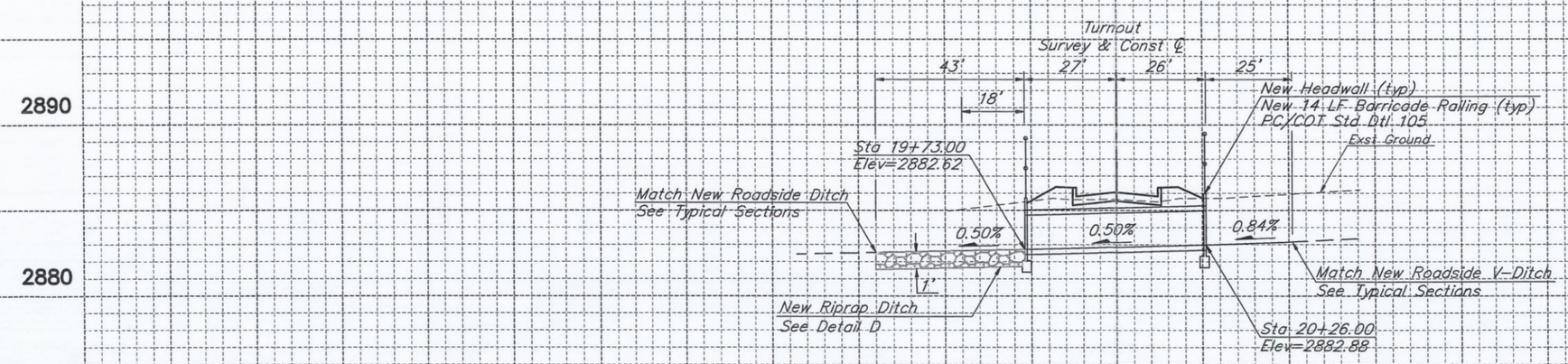
I:\7TED069904\PUBLIC_WORKS\Sheets_drain\C-HR01DR04.dwg 24 X 36 Chenggang Zhang Fri, 19 Feb 2010, 8:43am Last Saved By: Chenggang.zhang



WARNING
Exst 12" High-Pressure Gas Line Lt
Protect in Place

NOTES:

1. Inlet and outlet headwall dimensions shall be based on ADOT Std B-11.11
2. Pipes shall be installed per ADOT Std C-13.10 and C-13.15.
3. Ditch dimensions based on ADOT Std C-03.10 with 3:1 side slopes.



Q_{100} = 51 cfs
V_{100} = 6.79 fps
HW_{100} = 2.53 ft

Two working days before you dig. CALL FOR THE BLUE STAKES
1-800-STAKE-IT
Blue Stake Center CALL COLLECT

Sta 21+05.01
New 3-24"x53' RCP
Skew 0°

NO.	DATE	REVISION	BY	CHKD.	APPR.

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IRVINGTON RD TO VALENCIA RD
Drainage Plan & Profile

CITY OF TUCSON

DRWN. BY CZ	2/10	REF.	SCALE: 1"=20' 1"=4'
DSGN. BY CZ	2/10		
CHKD. BY BB, AA, CZ	2/10	PLAN NO. I-2007-001	

DR05 OF DR13

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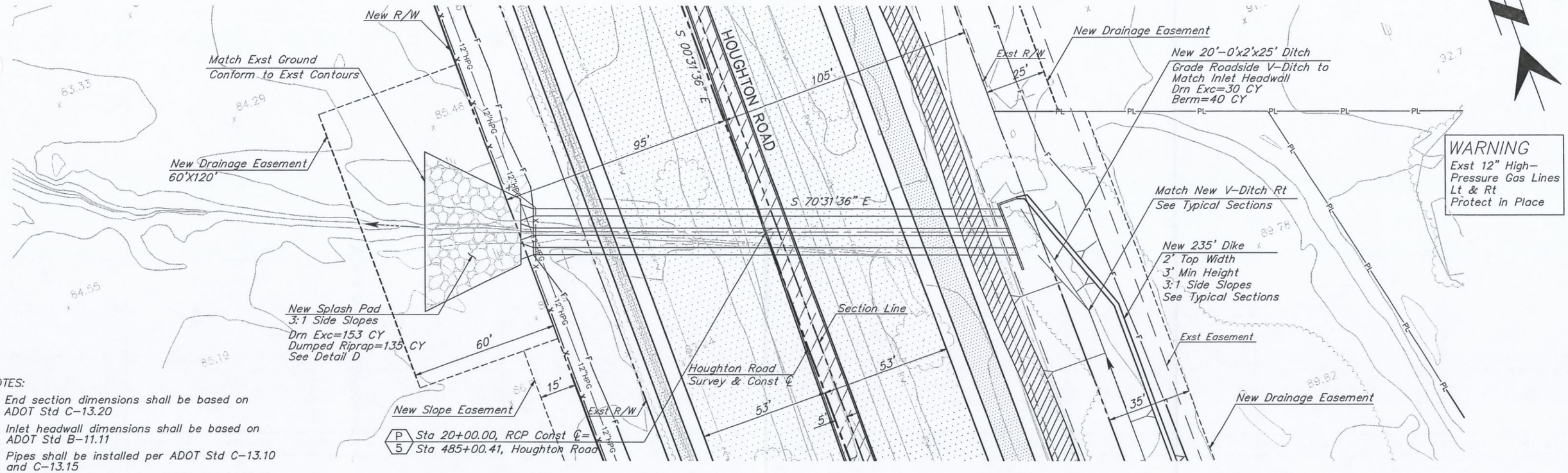
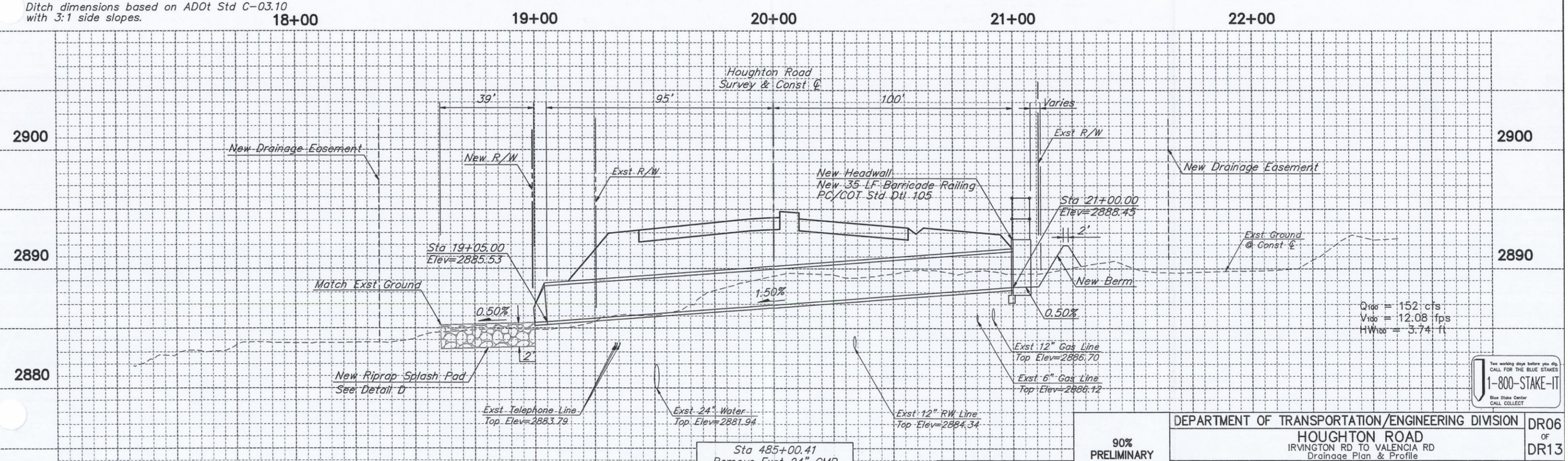


NOTES:

1. End section dimensions shall be based on ADOT Std C-13.20
2. Inlet headwall dimensions shall be based on ADOT Std B-11.11
3. Pipes shall be installed per ADOT Std C-13.10 and C-13.15
   Ditch dimensions based on ADOt Std C-03.10 with 3:1 side slopes.



Two working days before you dig. CALL FOR THE BLUE STAKES
1-800-STAKE-IT
Blue Stake Center CALL COLLECT

Sta 485+00.41
Remove Exst 24" CMP
New 3-36"x195' RCP
Skew 20° Rt

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Drainage Plan & Profile

CITY OF TUCSON

DRWN. BY CZ	2/10	REF.	SCALE: 1"=20' 1"=4'
DSGN. BY CZ	2/10		
CHKD. BY BB, AA, CZ	2/10	PLAN NO. I-2007-001	

DR06 OF DR13

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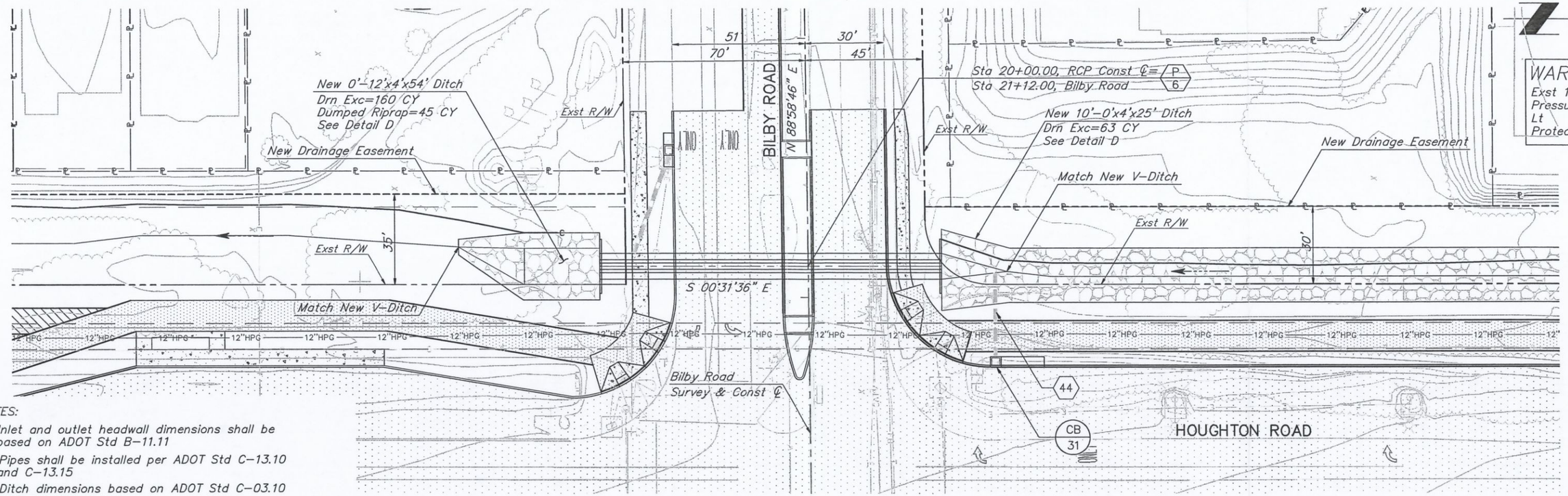
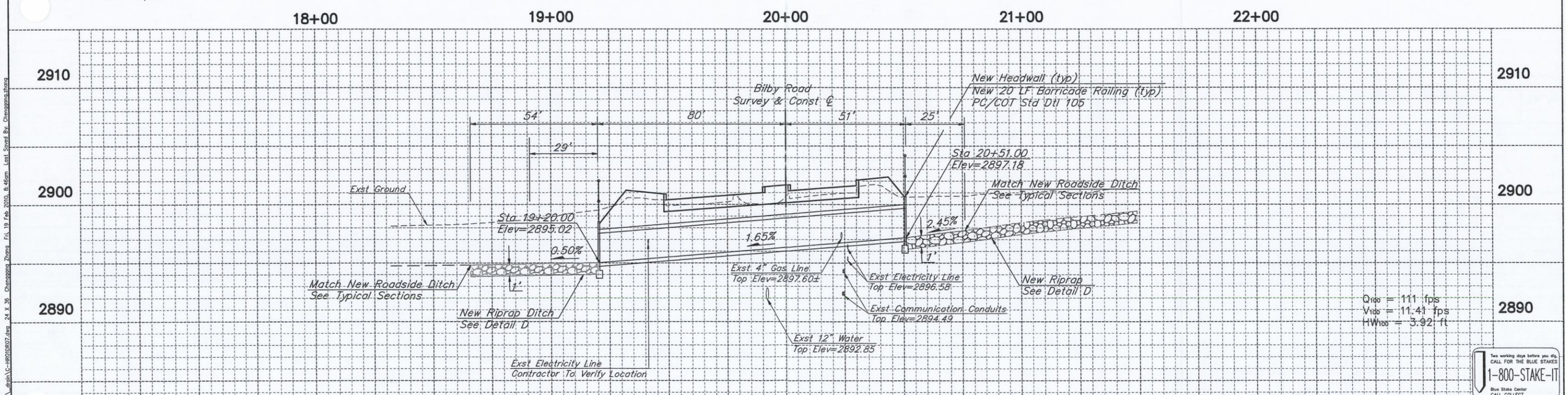
T:\7TED069904\PUBLIC_WORKS\Sheets_drain\C-HR01DR06.dwg 24 X 36 Chenggong Zhang Fri, 19 Feb 2010, 8:45am Last Saved By: Chenggong.zhang



NOTES:

1. Inlet and outlet headwall dimensions shall be based on ADOT Std B-11.11
2. Pipes shall be installed per ADOT Std C-13.10 and C-13.15
3. Ditch dimensions based on ADOT Std C-03.10 with 3:1 side slopes.



Two working days before you dig, CALL FOR THE BLUE STAKES
1-800-STAKE-IT
Blue Stake Center
CALL COLLECT

Sta 21+12.00, Bilby Rd
New 3-30"x131' RCP
Skew 0°

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Drainage Plan & Profile

CITY OF TUCSON

DRWN. BY CZ	2/10	REF.	SCALE: 1"=20' 1"=4'
DSGN. BY CZ	2/10		
CHKD. BY BB, AA, CZ	2/10	PLAN NO. I-2007-001	

DR07 OF DR13

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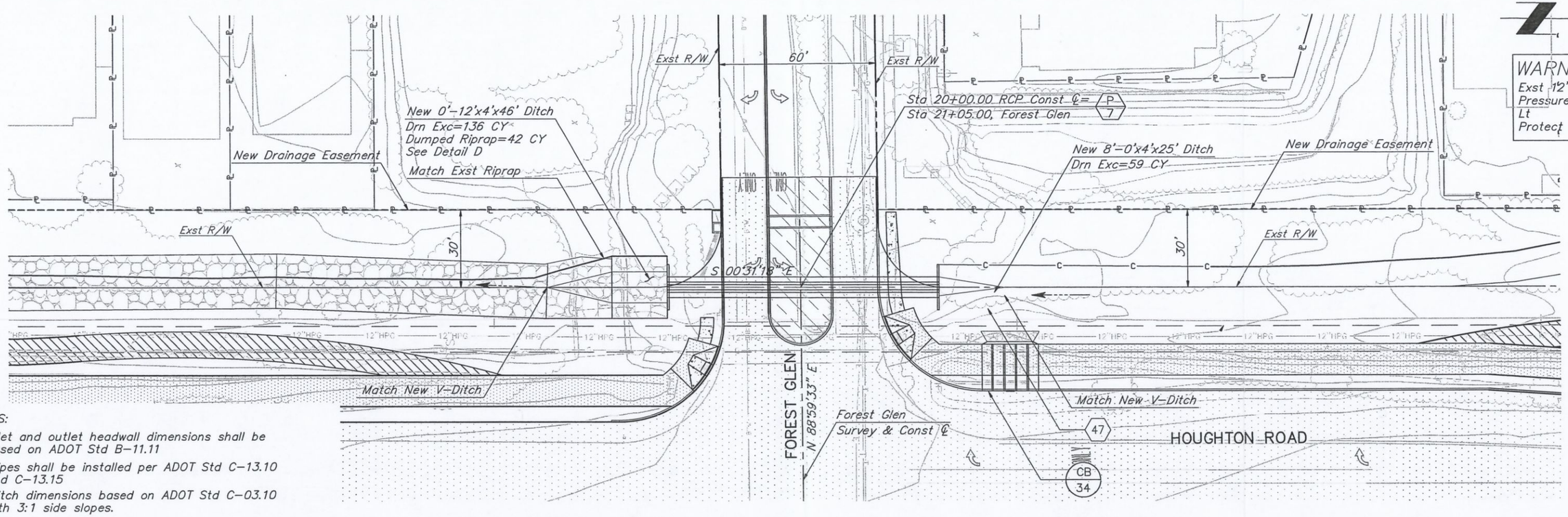
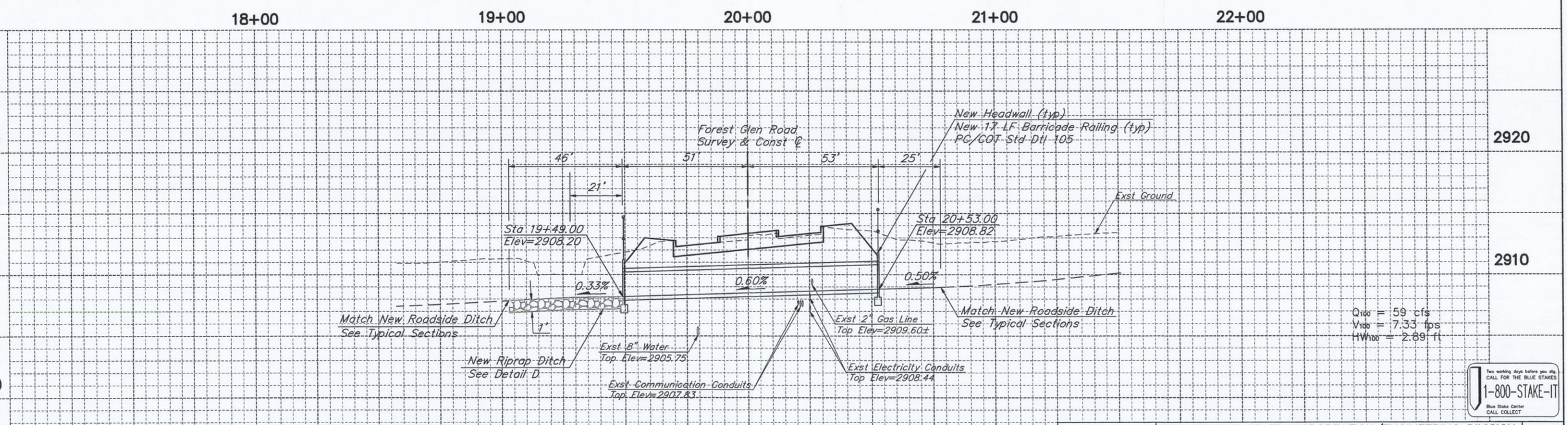


NOTES:

1. Inlet and outlet headwall dimensions shall be based on ADOT Std B-11.11
2. Pipes shall be installed per ADOT Std C-13.10 and C-13.15
3. Ditch dimensions based on ADOT Std C-03.10 with 3:1 side slopes.



Two working days before you dig, CALL FOR THE BLUE STAKES
1-800-STAKE-IT
Blue Stake Center
CALL COLLECT

Sta 21+05.00, Forest Glen
New 3-24"x104' RCP
Skew 0°

NO.	DATE	REVISION	BY	CHKD.	APPR.

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HOUGHTON ROAD
IRVINGTON RD TO VALENCIA RD
Drainage Plan & Profile

CITY OF TUCSON

DRWN. BY CZ	2/10	REF.
DSGN. BY CZ	2/10	SCALE: 1"=20' 1"=4'
CHKD. BY BB, AA, CZ	2/10	PLAN NO. I-2007-001

DR08 OF DR13

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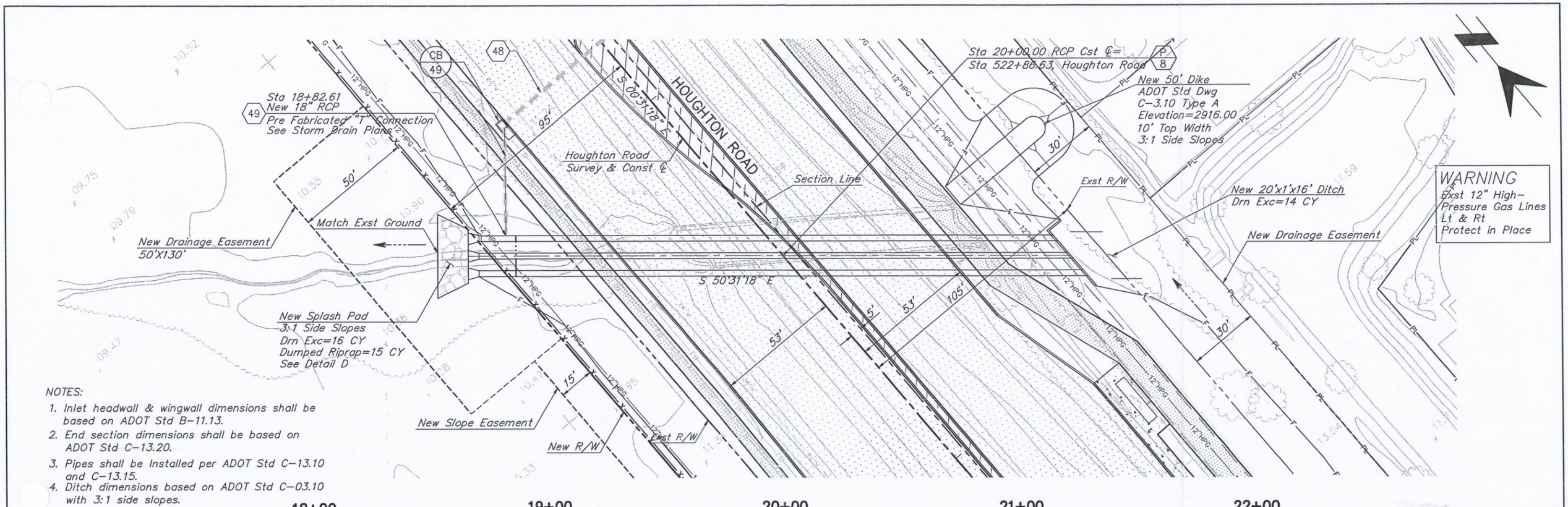
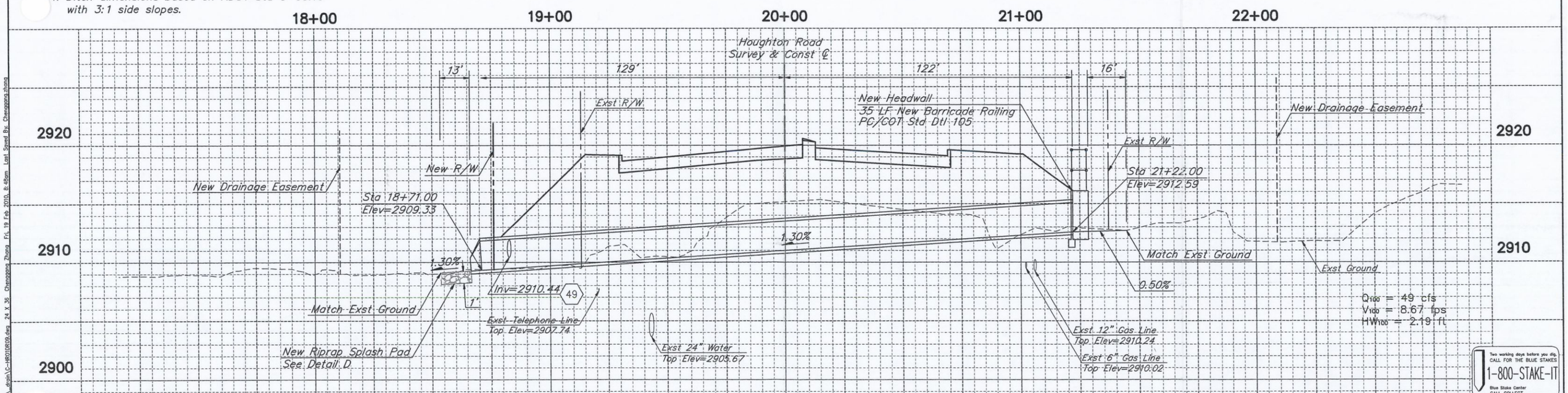
T:\7TED069904\PUBLIC_WORKS\Sheets_drain\C-HR01DR08.dwg 24 X 36 Chenggang Zhang Fri, 19 Feb 2010, 8:47am Last Saved By: Chenggang.zhang



NOTES:

1. Inlet headwall & wingwall dimensions shall be based on ADOT Std B-11.13.
2. End section dimensions shall be based on ADOT Std C-13.20.
3. Pipes shall be Installed per ADOT Std C-13.10 and C-13.15.
4. Ditch dimensions based on ADOT Std C-03.10 with 3:1 side slopes.



Two working days before you dig. CALL FOR THE BLUE STAKES
1-800-STAKE-IT
Blue Stake Center
CALL COLLECT

Sta 522+86.63
Remove Exst 2-24" CMP
New 3-30"x251' RCP
Skew 40° Rt

NO.	DATE	REVISION	BY	CHKD.	APPR.

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IRVINGTON RD TO VALENCIA RD
Drainage Plan & Profile

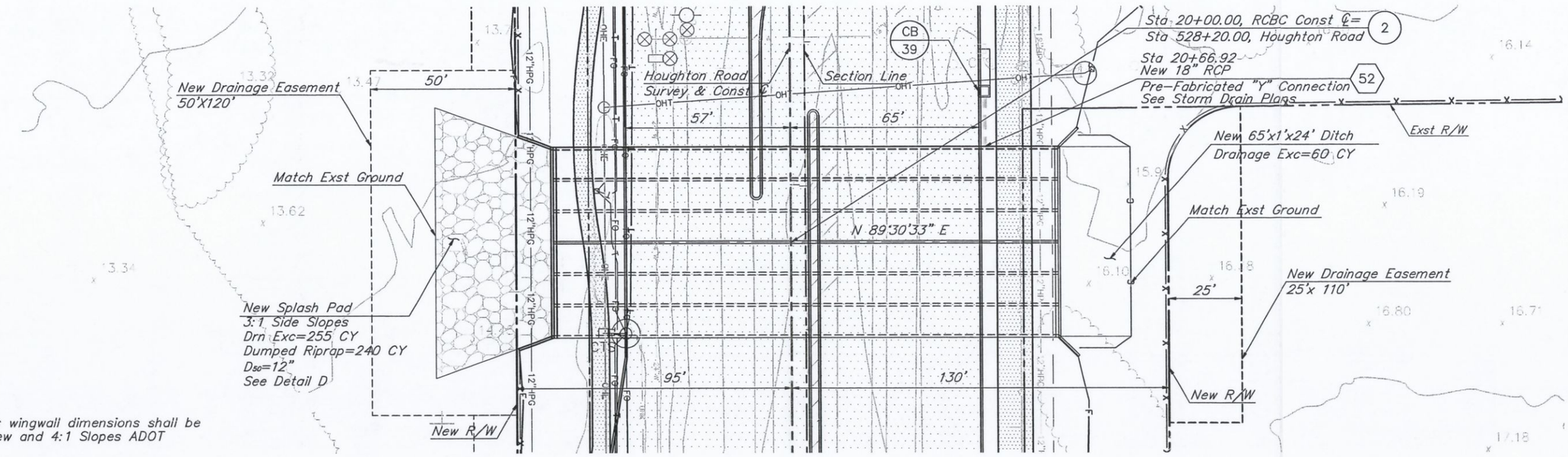
CITY OF TUCSON

DRWN. BY CZ	2/10	REF.	SCALE: 1"=20' 1"=4'
DSGN. BY CZ	2/10		
CHKD. BY BB, AA, CZ	2/10	PLAN NO. I-2007-001	

DR09 OF DR13

104 OF 304

I:\7TED069904\PUBLIC_WORKS\Sheets_drain\C-HR01DR09.dwg 24 X 36 Chenggang Zhang Fri, 19 Feb 2010, 8:48am Last Saved By: Chenggang.zhang

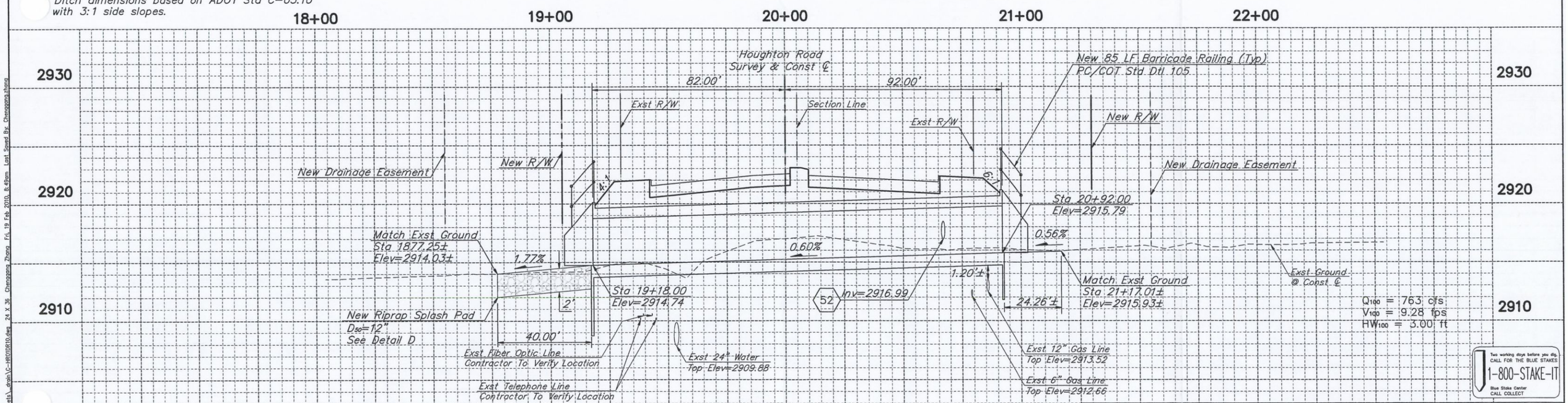


WARNING
Exst 12" High-Pressure Gas Lines
Lt & Rt
Protect in Place

NOTES:

1. Inlet headwall & wingwall dimensions shall be based on 0° Skew and 4:1 Slopes ADOT Std B-04.30.
2. Outlet headwall & wingwall dimensions shall be based on 0° Skew and 4:1 Slopes ADOT Std B-04.10.
3. RCBC shall be constructed per ADOT Std B-02.60

Ditch dimensions based on ADOT Std C-03.10 with 3:1 side slopes.



Two working days before you dig, CALL FOR THE BLUE STAKES
1-800-STAKE-IT
Blue Stake Center
CALL COLLECT

Sta 528+20.00
New 6-10'x4'x174' RCBC
Skew 0°

NO.	DATE	REVISION	BY	CHKD.	APPR.

PSOMAS
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90% PRELIMINARY NOT FOR CONSTRUCTION

DEPARTMENT OF TRANSPORTATION/ENGINEERING DIVISION
HOUGHTON ROAD
IRVINGTON RD TO VALENCIA RD
Drainage Plan & Profile

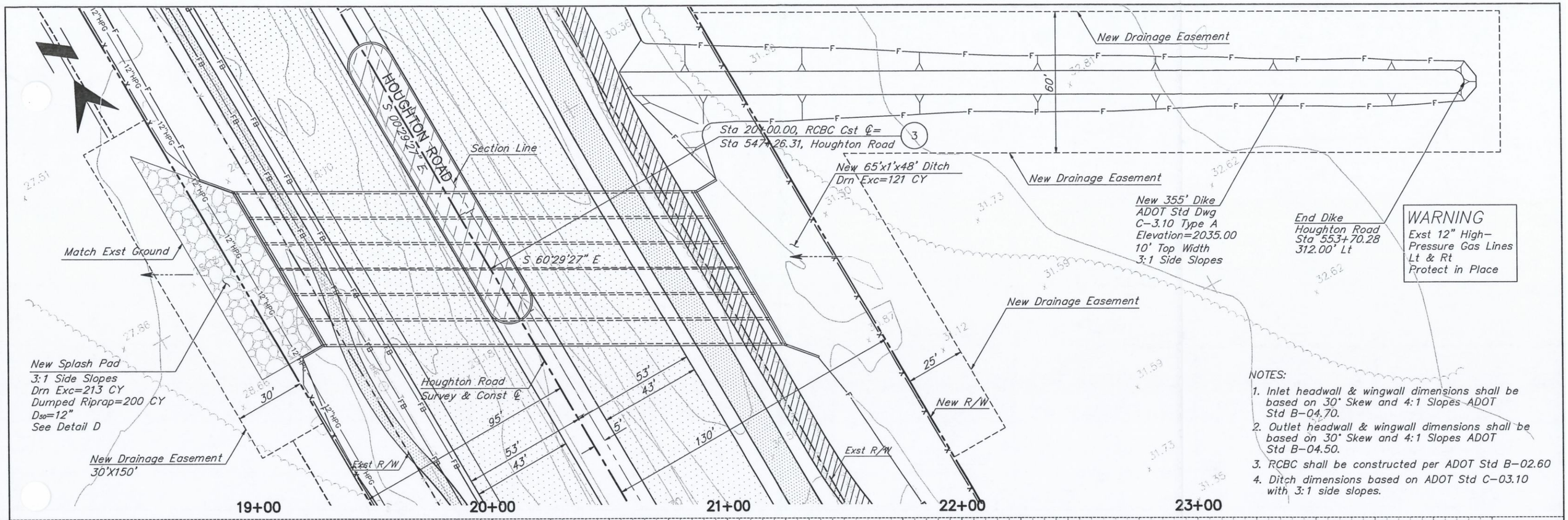
CITY OF TUCSON

DRWN. BY CZ	2/10	REF.	SCALE: 1"=20' 1"=4'
DSGN. BY CZ	2/10		
CHKD. BY BB, AA, CZ	2/10	PLAN NO. I-2007-001	

DR10 OF DR13

105 OF 304

F:\7TED069904\PUBLIC_WORKS\Sheets_drain\C-HR01DR10.dwg 24 X 36 Chenggang Zhang Fri, 19 Feb 2010, 8:49am Last Saved By: Chenggang.zhang



NOTES:

1. Inlet headwall & wingwall dimensions shall be based on 30° Skew and 4:1 Slopes ADOT Std B-04.70.
2. Outlet headwall & wingwall dimensions shall be based on 30° Skew and 4:1 Slopes ADOT Std B-04.50.
3. RCBC shall be constructed per ADOT Std B-02.60
4. Ditch dimensions based on ADOT Std C-03.10 with 3:1 side slopes.

Sta 547+26.31
New 6-10'x4'x196' RCBC
Skew 30° Rt

NO.	DATE	REVISION	BY	CHKD.	APPR.

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Drainage Plan & Profile

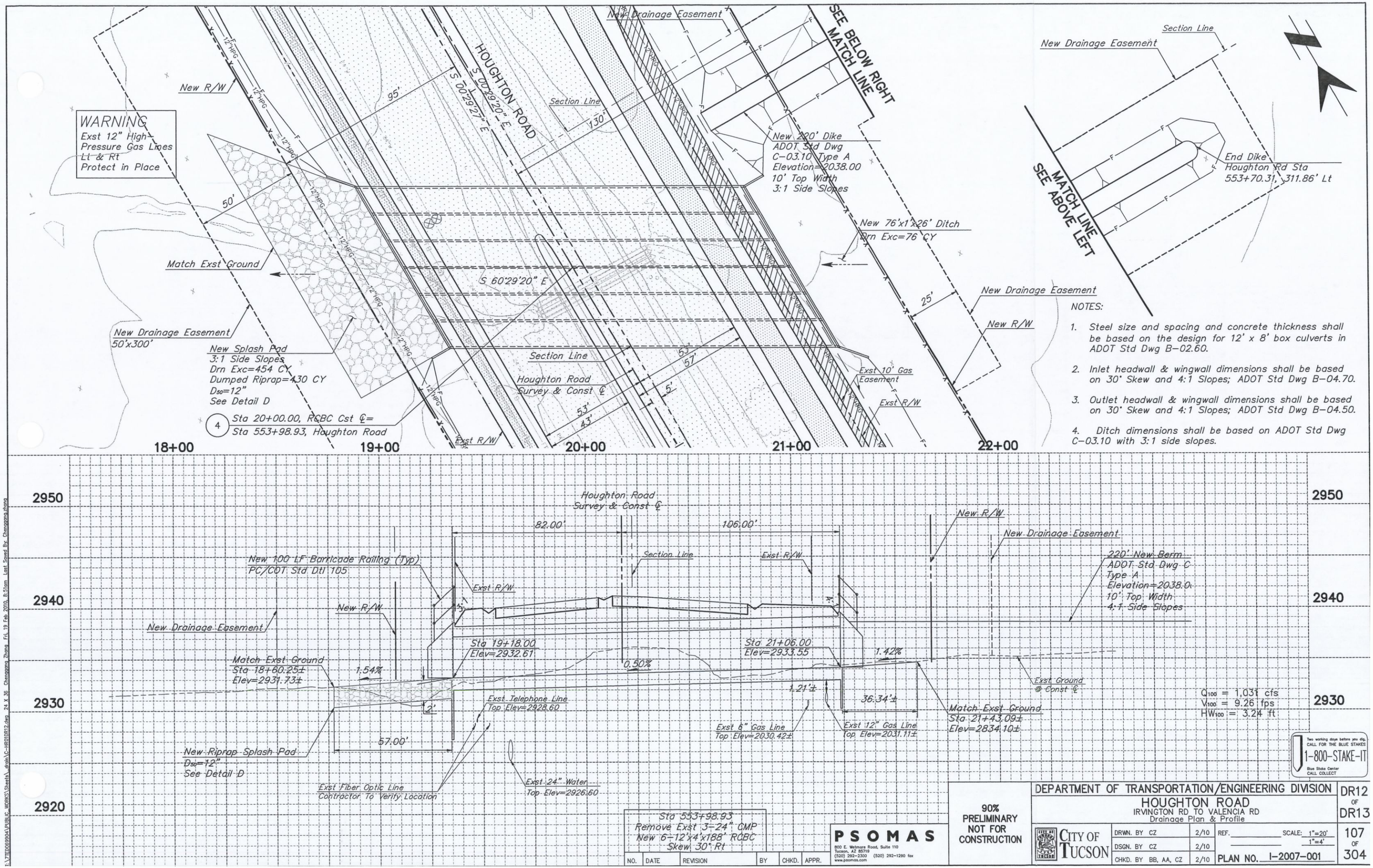
CITY OF TUCSON

DRWN. BY CZ	2/10	REF. ____ SCALE: 1"=20' 1"=4'
DSGN. BY DAD	2/10	
CHKD. BY BB, AA, CZ	2/10	PLAN NO. I-2007-001

DR11 OF DR13

106 OF 304

T:\TEDD6990A\PUBLIC_WORKS\Sheets_drain\C-HR010811.dwg 24 X 36 Changqing Zhang Fri, 19 Feb 2010, 8:50am Last Saved By: Changqing.zhang



NOTES:

1. Steel size and spacing and concrete thickness shall be based on the design for 12' x 8' box culverts in ADOT Std Dwg B-02.60.
2. Inlet headwall & wingwall dimensions shall be based on 30° Skew and 4:1 Slopes; ADOT Std Dwg B-04.70.
3. Outlet headwall & wingwall dimensions shall be based on 30° Skew and 4:1 Slopes; ADOT Std Dwg B-04.50.
4. Ditch dimensions shall be based on ADOT Std Dwg C-03.10 with 3:1 side slopes.

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Blue Stake Center CALL COLLECT

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Drainage Plan & Profile

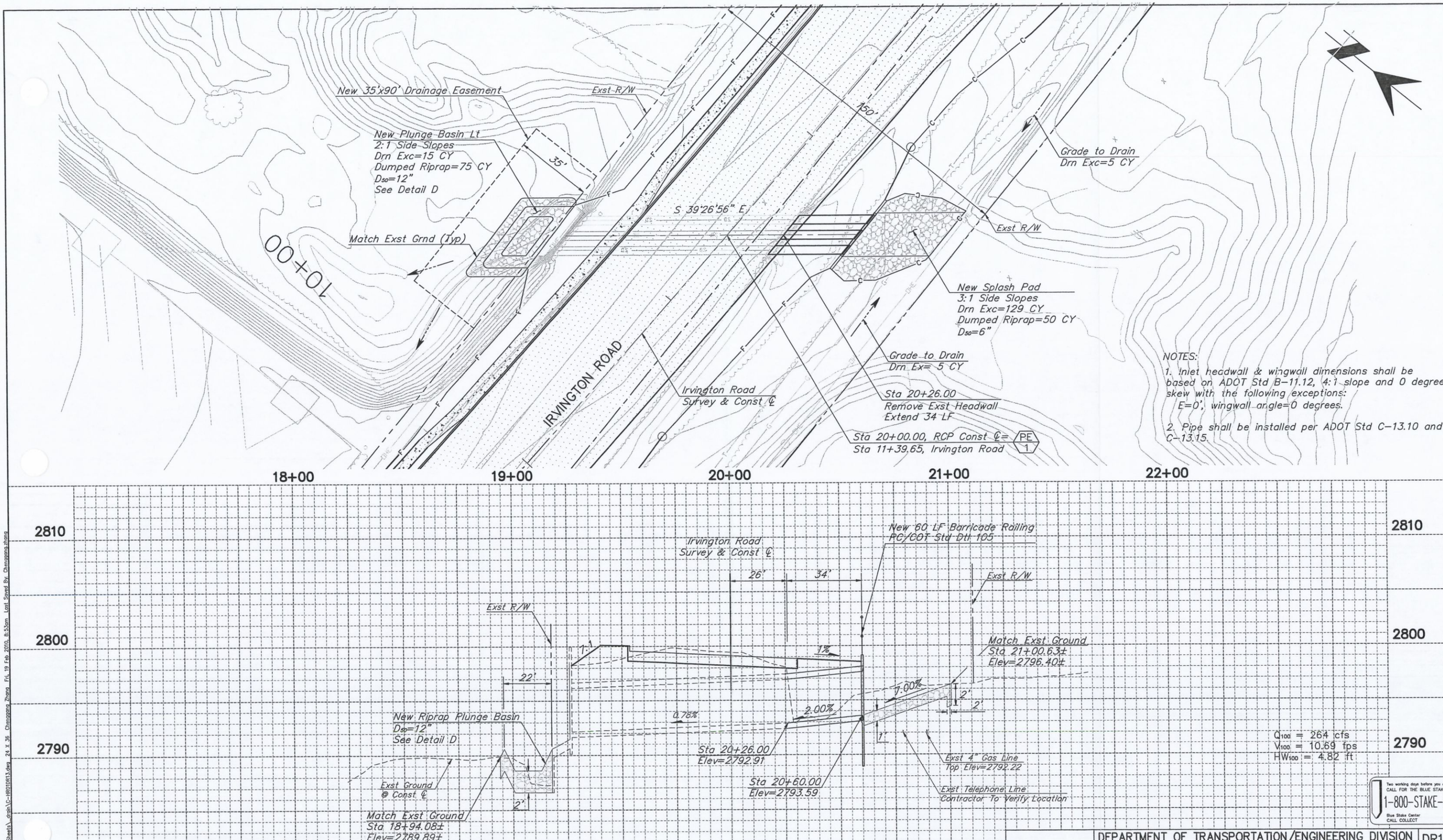
CITY OF TUCSON

DRWN. BY CZ	2/10	REF.	SCALE: 1"=20' 1"=4'
DSGN. BY CZ	2/10		
CHKD. BY BB, AA, CZ	2/10	PLAN NO. I-2007-001	

DR12 OF DR13

107 OF 304

I:\7TED069904\PUBLIC_WORKS\Sheets_drain\C-HR01DR12.dwg 24 X 36 Chenggang Zhang Fri, 19 Feb 2010, 8:51am Last Saved By: Chenggang.zhang



NOTES:

1. Inlet headwall & wingwall dimensions shall be based on ADOT Std B-11.12, 4:1 slope and 0 degree skew with the following exceptions:
   E=0', wingwall angle=0 degrees.
2. Pipe shall be installed per ADOT Std C-13.10 and C-13.15.

Sta 11+39.65
Exst 3-48" RCP
Extend 34' Right
Skew 41° Lt

NO.	DATE	REVISION	BY	CHKD.	APPR.

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DEPARTMENT OF TRANSPORTATION/ENGINEERING DIVISION

HOUGHTON ROAD
IRVINGTON RD TO VALENCIA RD
Drainage Plan & Profile

CITY OF TUCSON

DRWN. BY CZ	2/10	REF.	SCALE: 1"=20' 1"=4'
DSGN. BY CZ	2/10		
CHKD. BY BB, AA, CZ	2/10	PLAN NO. I-2007-001	

DR13 OF DR13

108 OF 304

Two working days before you dig. CALL FOR THE BLUE STAKES
1-800-STAKE-IT
Blue Stake Center CALL COLLECT

\7TED069904\PUBLIC_WORKS\Sheets_drain\C-HR01DR13.dwg 24 X 36 Chenggang Zhang Fri, 19 Feb 2010, 8:53am Last Saved By: Chenggang.zhang

STATE LAND MEMORANDUM/
FLO-2D ANALYSIS

MEMORANDUM

To: Arizona State Land Department

Attn: Alex Kuchansky, Water Resource Specialist IV

From: Mike Daly, P.E.

Date: October 29, 2009

Subject: Houghton Road Improvements at the Attebury Wash and Poorman Road

---

Introduction

Improvement plans are currently being prepared for the widening of Houghton Road from approximately Irvington Road and Valencia Road in the City of Tucson, AZ. Within this segment of roadway there are two significant wash crossings on State Land which will be impacted by the project: the Attebury Wash and an unnamed wash located just south of Poorman Road. Both washes cross Houghton Road and flow across State Land both immediately upstream and downstream of the roadway. The impacted properties are State Land Parcel 141010110 (upstream) and Parcel 141010120 (downstream). Hydraulic analyses were performed for both the existing and proposed conditions for each wash crossing, and the results are presented within this memorandum showing the impacts to State Land.

Existing Conditions

Under existing conditions, the Attebury wash is a FEMA Floodplain (Zone A) that crosses Houghton Road between Poorman Road and Valencia Road in Sections 13 and 14 of Township 15 South, Range 15 East. The 100-year storm event peak discharge within this wash is 1629 cfs. Along the east side of the roadway, there are shallow swales that convey low flows at two locations through culverts under Houghton Road to the west. The northernmost location has 1-24" CMP and the southernmost location has 3-24" CMPs. Psomas prepared an existing conditions hydraulic analysis using the Flo-2D software application to analyze the shallow sheet flow that characterizes the wash at this crossing. Results from this analysis are presented on Figure 1, Existing Conditions Analysis. The results show that the floodplain is approximately 1200 feet wide perpendicular to the direction of flow at the roadway crossing with depths generally between 0.50 feet and 1.50 feet immediately upstream and downstream of the roadway.

The unnamed wash crossing just south of Poorman Road is considered a regulatory floodplain by the City of Tucson, with a peak discharge of 763 cfs. A Flo-2D analysis was performed for this crossing as the floodplain associated with this wash is also characterized by shallow sheet flow. Results of this analysis are present on Figure 3 – Existing Conditions Analysis. The floodplain top width at Houghton Road is approximately 750 feet wide. There is currently 1-24" CMP used to convey low flows under the road The remainder of the flow overtops Houghton Road to the

west and also Poorman Road before entering the roadside channel that flows to the north. Depths within this wash are generally between 0.50 feet and 1.50 feet immediately upstream and downstream of Houghton Road.

Proposed Improvements and Impacts

At the Atterbury wash, the project team is proposing to provide two-culvert crossings at approximately the same locations as the existing culverts. These culverts will be significantly larger in size, and will allow for the conveyance of the 100-year storm event peak discharge of 1629 cfs. At the northernmost crossing, a six cell 10'x4' crossing is being proposed. At the southernmost crossing, a six cell 12'x4' crossing is being proposed. A 12" high pressure gas line is located parallel and along the east side of the roadway and has minimal cover. This gas line poses a significant design constraint due to the amount of cover, which eliminates the ability to significantly drop the invert of the culvert inlets. According to Southwest Gas, relocation of the gas line is not feasible because there are no other primary lines in southeast Tucson. The inability to drop the culvert inlets, and the necessity to build headwater in order to convey the 100-year storm event, results in the need to raise the roadway profile and to construct a berm which extends upstream at each inlet beyond the limits of the road right-of-way. Psomas prepared a hydraulic analysis of the proposed conditions using Flo-2D, incorporating the two culvert crossing locations, the raised roadway and the berms. The results of this analysis are shown on Figure 2, Proposed Conditions Analysis. The proposed berms will allow for the headwater to build to a height that will convey the peak discharge through the culvert crossings. The result is a ponding depth upstream of Houghton Road which will be greater than under existing conditions. At the culvert outlets, flow depths will be greater for a short distance downstream where the flow is allowed to spread out until flow depths similar to existing conditions are reached.

At Poorman Road, the proposed improvements will provide a six cell 10' x 4' box culvert that will be located just south of Poorman Road and will be capable of conveying the 100-year storm event peak discharge under Houghton Road. As was the case at the Attebury Wash crossing, the 12" gas line is a design constraint for this culvert. In order to convey the 100-year peak discharge through the proposed box culverts it will be necessary to build adequate headwater upstream of the inlet. To contain this headwater, Poorman Road will be raised from Houghton Road to the east to the extents of headwater ponding. The flow depths upstream of Houghton Road are greater than that under existing conditions due to this ponding. The flow depths downstream will greater than under existing conditions for a short distance since the flow will be concentrated at the outlet, and no longer allowed to spread out across Houghton Road.

Drainage easements are being proposed that will allow for maintenance of the berms and culverts. The approximate location of the berms and the required easements are shown on the post-development figures. Permission from the State is being requested that will allow the increase in flow depths both upstream and downstream as described above.

Benefits to State Land

Although under developed conditions there would be some impacts to the State Land parcels in the form of higher water surface elevations, the changes to the floodplain limits would be very limited, which means that the amount of land available for development would remain the same. Furthermore, the proposed improvements could be of significant benefit to accommodate future development on those parcels. The City of Tucson has agreed to upsize the southernmost Attebury Wash culvert crossing to accommodate the entire 100-year flow if needed. This is not necessary for the proposed two-crossing alternative, but it is expected that if development were to occur east of Houghton Road, the developer would prefer a single crossing as it would likely be necessary to channelize the Attebury Wash from Houghton Road to Valencia Road to eliminate the existing wide floodplain. The possibility of channelization though this parcel is made feasible by the fact that the Atterbury Wash is contained in a constructed channel upstream of Valencia Road and crosses under it via an existing box culvert.

The unnamed wash culvert crossing just south of Poorman Road is also designed to convey the 100-year storm event peak discharge and could serve as a single crossing for future development efforts. Combined, the two culvert crossings have an estimated cost of approximately $1.5 million that would no longer be required as infrastructure improvements to be paid by the developer of the land. Future changes to the cross-drainage along Houghton Road to accommodate development will be impractical, as City policies call for a five year moratorium on any pavement cuts along new road once completed, during which time the construction of new structures would not be allowed.

Summary and Conclusions

As part of the Houghton Road Improvements, it is proposed that the road profile be raised and the 100-year peak discharge for the Attebury Wash and an unnamed wash be conveyed entirely under the roadway. Under existing conditions, both washes contain shallow sheet flow, have very wide floodplains and the majority of 100-year storm event peak discharge is conveyed over Houghton Road. To facilitate the headwater necessary to convey the flow through culvert crossings at discrete locations and under the roadway, berms will be constructed at each of the Attebury Wash crossings to allow for ponding to occur without spilling over into the adjacent watershed. At the crossing for the unnamed wash, Poorman Road will be raised from its intersection with Houghton Road to the east in order to contain the headwater. At the outlet to each culvert crossing, flow will be allowed to expand back to conditions that are similar to existing conditions. There will be an increase in flow depths downstream until existing conditions are re-established. Upstream, the flow depth increase is only within the area of ponding necessary to build headwater. State Land is being asked to allow the additional depth of flow upstream and downstream. The design of these culvert crossing was done with consideration for future planning efforts. This design will reduce future infrastructure costs by approximately $1.5 million and will provide a single point of crossing for each wash. A formal written agreement from State Land providing permission to increase flow depth on their property is being requested.

EXISTING 1-24" CMP
CULVERT CROSSING

ATTERBURY WASH

EXISTING 3-24" CMP
CULVERT CROSSING

HOUGHTON ROAD

EXST. CONSTRUCTED
CHANNEL

VALENCIA ROAD

EXISTING FEMA
FLOODPLAIN LIMITS
(ZONE A)

100-YEAR FLOW DEPTH (0.01'-0.5')
100-YEAR FLOW DEPTH (0.5'-1.0')
100-YEAR FLOW DEPTH (1.0'-1.5')
100-YEAR FLOW DEPTH (1.5'-2.0')
100-YEAR FLOW DEPTH (>2.0')

300 0 150 300 450 600

FIGURE 1: EXISTING CONDITIONS ANALYSIS

NO.	DATE	REVISION	BY	CHKD.	APPR.

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www.psomas.com

DEPARTMENT OF TRANSPORTATION/ENGINEERING DIVISION
HOUGHTON ROAD
ATTERBURY WASH CROSSING

CITY OF TUCSON

DRWN. BY CLR	10/09	REF.	SCALE: 1"=300'
DSGN. BY JO	10/09		N/A
CHKD. BY	10/09	PLAN NO.	

EXISTING FEMA FLOODPLAIN LIMITS (ZONE A)

BERM

PROPOSED EASEMENT

6-10'x4' RCBC
Q 100 =580CFS

PROPOSED EASEMENT

BERM

ATTERBURY WASH

12" HPG

HOUGHTON ROAD

PROPOSED EASEMENT

6-12'x4' RCBC
Q 100 =1031 CFS

200 0 100 200 300 400

- 100-YEAR FLOW DEPTH (0.01'-0.5')
- 100-YEAR FLOW DEPTH (0.5'-1.0')
- 100-YEAR FLOW DEPTH (1.0'-1.5')
- 100-YEAR FLOW DEPTH (1.5'-2.0')
- 100-YEAR FLOW DEPTH (>2.0')

FIGURE 2: PROPOSED CONDITIONS ANALYSIS

NO.	DATE	REVISION	BY	CHKD.	APPR.

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DEPARTMENT OF TRANSPORTATION/ENGINEERING DIVISION
HOUGHTON ROAD
ATTERBURY WASH CROSSING

CITY OF TUCSON

DRWN. BY CLR	10/09	REF.
DSGN. BY JO	10/09	
CHKD. BY	10/09	PLAN NO.

SCALE: 1"=200'
N/A

EXISTING FLOW DEPTH ≥ 0.01'

POORMAN ROAD

HOUGHTON ROAD

EXISTING 2- 24" CULVERT CROSSING

EXISTING 24" CULVERT CROSSING

200 0 100 200 300 400

- 100-YEAR FLOW DEPTH (0.01'-0.5')
- 100-YEAR FLOW DEPTH (0.5'-1.0')
- 100-YEAR FLOW DEPTH (1.0'-1.5')
- 100-YEAR FLOW DEPTH (1.5'-2.0')
- 100-YEAR FLOW DEPTH (>2.0')

FIGURE 3: EXISTING CONDITIONS ANALYSIS

NO.	DATE	REVISION	BY	CHKD.	APPR.

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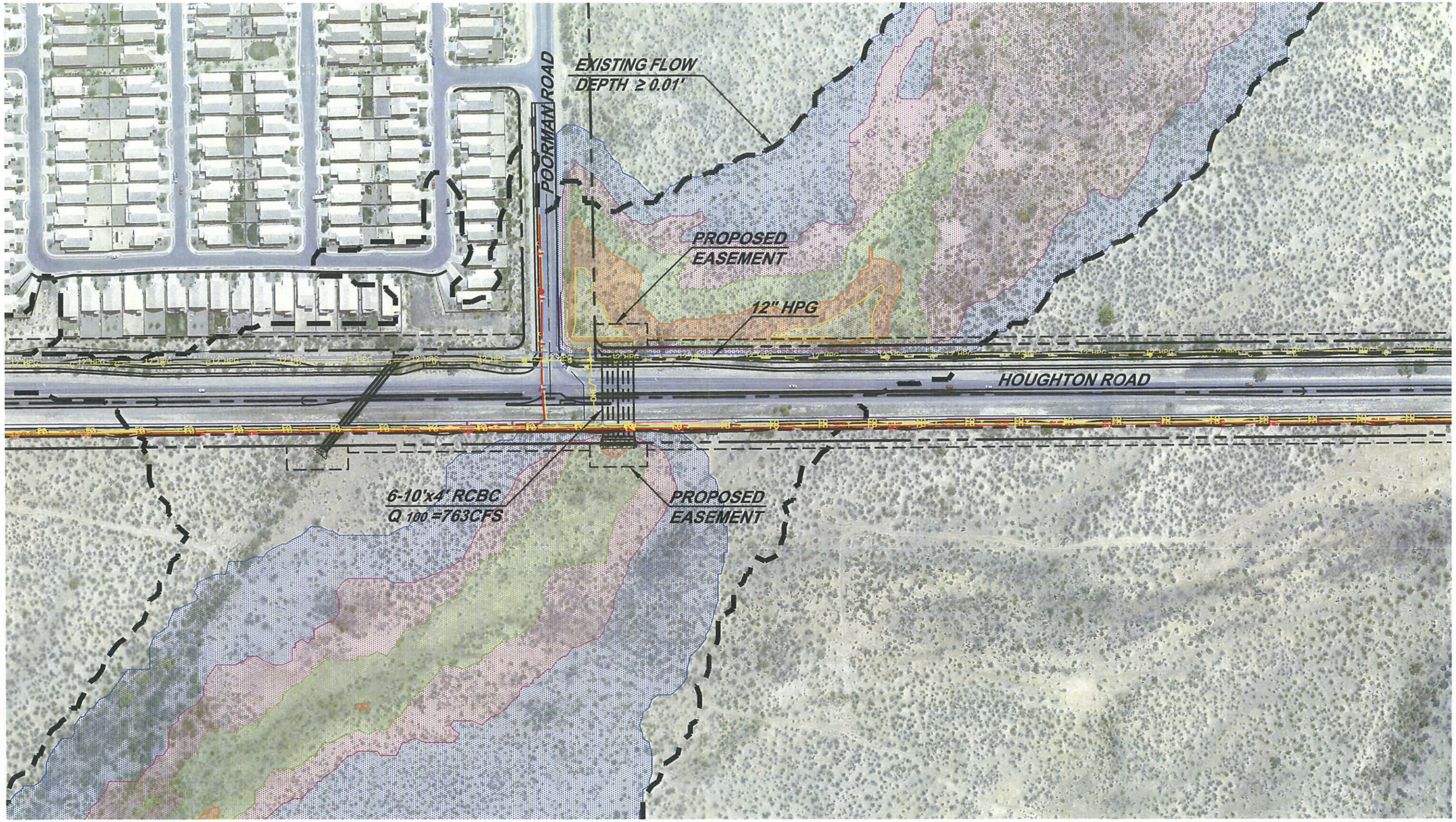
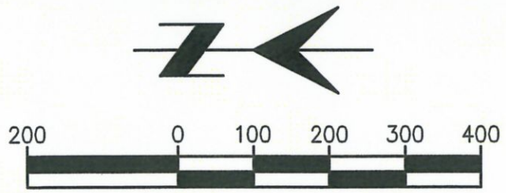
www.psomas.com

DEPARTMENT OF TRANSPORTATION/ENGINEERING DIVISION
HOUGHTON ROAD
POORMAN ROAD

CITY OF TUCSON

DRWN. BY CLR	10/09	REF.	SCALE: 1"=200'
DSGN. BY JO	10/09		N/A
CHKD. BY	10/09	PLAN NO.	





- 100-YEAR FLOW DEPTH (0.01'-0.5')
- 100-YEAR FLOW DEPTH (0.5'-1.0')
- 100-YEAR FLOW DEPTH (1.0'-1.5')
- 100-YEAR FLOW DEPTH (1.5'-2.0')
- 100-YEAR FLOW DEPTH (>2.0')

FIGURE 4: PROPOSED CONDITIONS ANALYSIS

NO.	DATE	REVISION	BY	CHKD.	APPR.

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Tucson, AZ 85705
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www.psomas.com

DEPARTMENT OF TRANSPORTATION/ENGINEERING DIVISION
HOUGHTON ROAD
POORMAN ROAD

CITY OF TUCSON

DRWN. BY CLR	10/09	REF.	SCALE: 1"=200'
DSGN. BY JO	10/09		N/A
CHKD. BY	10/09	PLAN NO.	

EXISTING FEMA FLOODPLAIN LIMITS (ZONE A)

BERM

PROPOSED EASEMENT

PROPOSED EASEMENT

BERM

ATTERBURY WASH

6-10'x4' RCBC
Q 100 =580CFS

12" HPG

BERM

HOUGHTON ROAD

PROPOSED EASEMENT

6-12'x4' RCBC
Q 100 =1031 CFS

200 0 100 200 300 400

- 100-YEAR FLOW DEPTH INCREASE (0.1'-0.3')
- 100-YEAR FLOW DEPTH INCREASE (0.3-0.5')
- 100-YEAR FLOW DEPTH INCREASE (0.5'-1.0')
- 100-YEAR FLOW DEPTH INCREASE (1.0'-2.0')
- 100-YEAR FLOW DEPTH INCREASE (>2.0')

ATTEBURY WASH FLOW DEPTH CHANGE

NO.	DATE	REVISION	BY	CHKD.	APPR.

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800 E. Weimore Road, Suite 110
Tucson, AZ 85718
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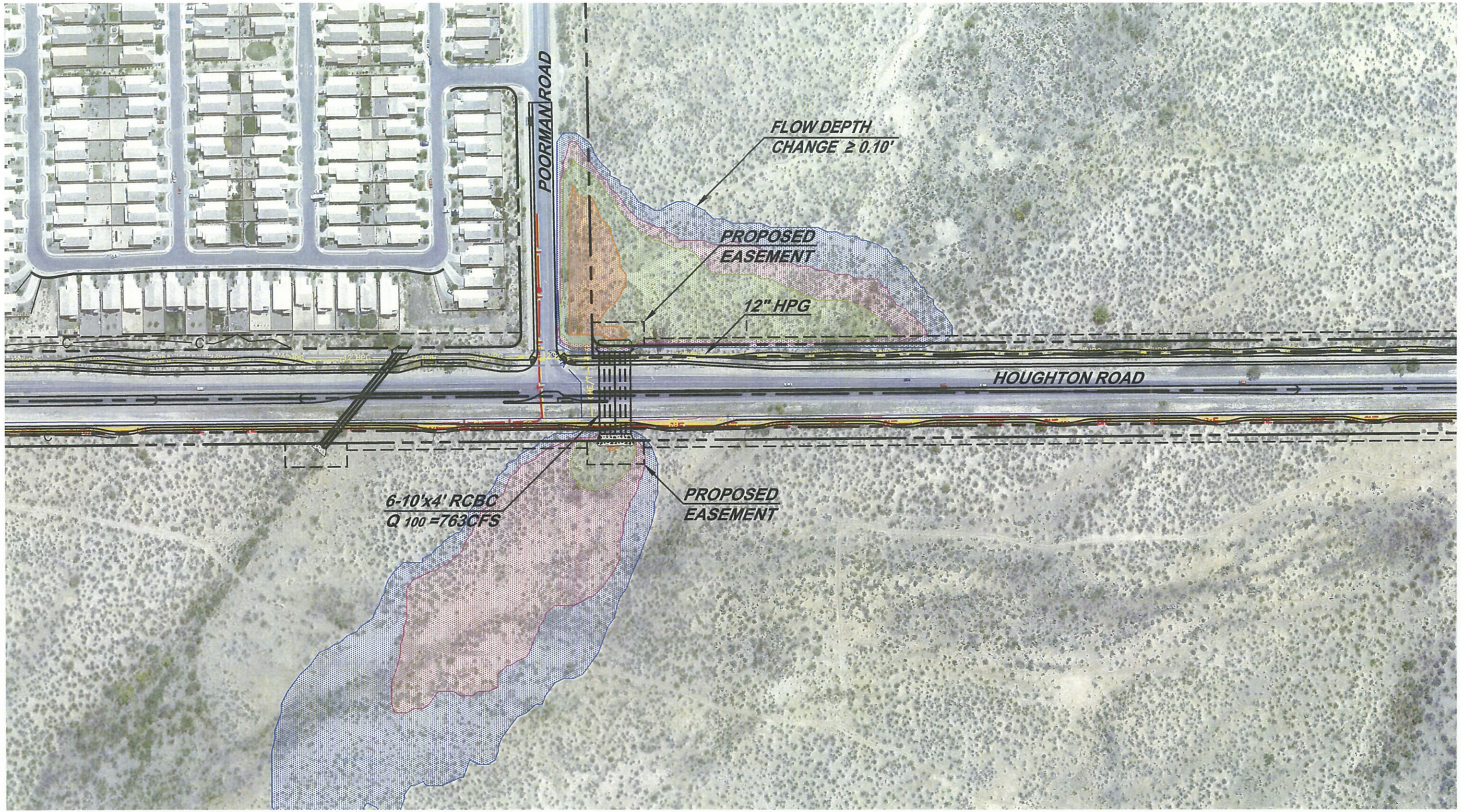
HOUGHTON ROAD
ATTERBURY WASH CROSSING

CITY OF TUCSON

DRWN. BY		REF.	SCALE:
DSGN. BY JO			
CHKD. BY	10/09	PLAN NO.	



100-YEAR FLOW DEPTH INCREASE (0.1'-0.3')
100-YEAR FLOW DEPTH INCREASE (0.3'-0.5')
100-YEAR FLOW DEPTH INCREASE (0.5'-1.0')
100-YEAR FLOW DEPTH INCREASE (1.0'-2.0')
100-YEAR FLOW DEPTH INCREASE (>2.0')

200 0 100 200 300 400

POORMAN RD. CHANGE IN FLOW DEPTH

NO.	DATE	REVISION	BY	CHKD.	APPR.

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DEPARTMENT OF TRANSPORTATION/ENGINEERING DIVISION
HOUGHTON ROAD
POORMAN ROAD

CITY OF TUCSON

DRWN. BY		REF.	SCALE:
DSGN. BY JO			
CHKD. BY	10/09	PLAN NO.	

FLO-2D MODEL
AND
SUPPORTING CALCULATIONS

```
1*****************************************
*                                       *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
*              MAY   1991               *
*            VERSION 4.0.1E             *
*                                       *
*  RUN DATE  07/01/:9  TIME  21:56:06   *
*                                       *
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*****************************************
*                                       *
*    U.S. ARMY CORPS OF ENGINEERS       *
*    HYDROLOGIC ENGINEERING CENTER      *
*          609 SECOND STREET            *
*       DAVIS, CALIFORNIA 95616         *
*           (916) 551-1748              *
*                                       *
*****************************************
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X     X  XXXXXXX   XXXXX          X
X     X  X        X     X        XX
X     X  X        X              X
XXXXXXX  XXXX     X        XXXXX X
X     X  X        X              X
X     X  X        X     X        X
X     X  XXXXXXX   XXXXX         XXX
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THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

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


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

   1          ID      Map: UG0050 (ATTERBURY WASH NEAR S. 1/4 S11, T15, R15)
   2          ID      Scenario: EXIST (EXISTING CONDITIONS)
   3          ID      Storm: T-STORM100 (100-YEAR, 3 HR THUNDER STORM)
   4          ID             Return Period: 100 yrs, Interval: 1 min
   5          ID      Total Watershed Area=   4.99 sq mi
   6          ID      Areal Reduction of Rainfall Applied
   7          ID
   8          ID        ***************** WARNING !! ********************
   9          ID      * THIS IS A COMPUTER GENERATED HEC-1 INPUT FILE *
  10          ID
  11          ID        This file was created by the City of Tucson
  12          ID        Stormwater Planner computer software package.
  13          ID        Neither the City of Tucson nor the consultants
  14          ID        who developed the software warrant the accuracy
  15          ID        of the input data or the results obtained from
  16          ID        the HEC-1 modeling process through the use of such
```

```
 17          ID         data. It is the sole respons    y of the user to
 18          ID         verify the accuracy of the da   contained within
 19          ID         this Stormwater Planner data file.
 20          ID         ************************************************
 21          ID
             *DIAGRAM
 22          IT       1                    400
 23          IO       3

 24          KK   S0010
 25          KM        RUNOFF FROM SUBBASIN S0010
 26          IN       1
 27          PB   3.187
 28          PI  .05691  .06348  .07131  .08064  .09195  .10581  .12309  .14493  .17316.19047
 29          PI   .1581  .13332  .11397  .09852  .08601  .07575  .06723  .06006  .05397.05127
 30          PI  .04878  .04647  .04431  .04227  .04041  .03864  .03699  .03546  .03402.03264
 31          PI  .03138  .03018  .02904  .02796  .02694  .02598  .02505  .02421  .02337.02259
 32          PI  .02187  .02115  .02049  .01983  .01923  .01866  .01809  .01755  .01704.01656
 33          PI  .01611  .01566  .01521  .01482   .0144  .01404  .01368  .01332  .01299.01266
 34          PI  .01236  .01203  .01176  .01146  .01119  .01095  .01068  .01044   .0102.00999
 35          PI  .00978  .00957  .00936  .00915  .00897  .00876  .00858  .00843  .00825.00807
 36          PI  .00792  .00777  .00762  .00747  .00732   .0072  .00705  .00693  .00681.00666
 37          PI  .00654  .00645  .00633  .00621  .00609   .0060  .00588  .00579   .0057.00561
 38          PI  .00552  .00543  .00534  .00525  .00516  .00507  .00501  .00492  .00483.00477
 39          PI  .00471  .00462  .00456   .0045  .00441  .00435  .00429  .00423  .00417.00411
 40          PI  .00405  .00399  .00393   .0039  .00384  .00378  .00372  .00369  .00363.00357
 41          PI  .00354  .00348  .00345  .00339  .00336   .0033  .00327  .00324  .00318.00315
 42          PI  .00312  .00306  .00303   .0030  .00297  .00291  .00288  .00285  .00282.00279
 43          PI  .00276  .00273   .0027  .00267  .00264  .00261  .00258  .00255  .00252.00249
 44          PI  .00246  .00243   .0024  .00237  .00234  .00231  .00231  .00228  .00225.00222
 45          PI  .00219  .00219  .00216  .00213   .0021   .0021  .00207  .00204  .00204.00201
 46          BA   0.784
 47          LS       0      96                   87.41
 48          UK     300    .019      .1       3
 49          UK     300    .019    .204      97
 50          RK    3600    .016     .04   0.375    TRAP       0      50
 51          RK   13000    .009     .04            TRAP      50,     50
```



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

 52          KK   S0015
 53          KM        RUNOFF FROM SUBBASIN S0015
 54          BA   0.401
 55          LS       0      96                   86.96
 56          UK     300     .01      .1       3
 57          UK     300     .01      .2      97
 58          RK     800    .031     .04 0.19375    TRAP       0      50
 59          RK    9000    .012     .04            TRAP      50      50

 60          KK   N0015
```

```
 61          KM       COMBINE SUBBASIN HYDROGRAPHS @      15
 62          HC       2

 63          KK   R0015
 64          KM        ROUTING HYDROGRAPH THROUGH CHANNEL R0015
 65          RS       1    FLOW      -1
 66          RC     .05     .04     .05    2100   .0086
 67          RX       0      60     120     200     300     400     475     550
 68          RY    3050    3049    3048    3048    3048    3048    3049    3050

 69          KK   S0018
 70          KM        RUNOFF FROM SUBBASIN S0018
 71          BA   0.155
 72          LS       0      96                   87.78
 73          UK     300    .033      .1       1
 74          UK     300    .033    .193      99
 75          RK    1600    .019     .04 0.04844    TRAP       0      50
 76          RK    2000    .009     .04            TRAP     220      60

 77          KK   S0020
 78          KM        RUNOFF FROM SUBBASIN S0020
 79          BA   0.923
 80          LS       0      96                   87.61
 81          UK     300     .02      .1       8
 82          UK     300     .02    .203      92
 83          RK    1733    .014     .04 0.28438    TRAP       0      50
 84          RK   16000     .01     .04            TRAP      30      40

 85          KK   N0020
 86          KM       COMBINE SUBBASIN HYDROGRAPHS @ N0020
 87          HC       2

 88          KK   N0020
 89          KM       COMBINE SUBBASIN & CHANNEL HYDROGRAPHS @ N0020
 90          HC       2

 91          KK   R0020
 92          KM        ROUTING HYDROGRAPH THROUGH CHANNEL R0020
 93          RS       1    FLOW      -1
 94          RC     .05     .04     .05    6400   .0066
 95          RX       0      50     410     430     440     450     790     800
 96          RY    3014    3012    3010    3009    3009    3010    3012    3013
```



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

 97          KK   S0025
 98          KM        RUNOFF FROM SUBBASIN S0025
 99          BA   0.368
100          LS       0   89.08
101          UK     300     .05      .2     100
```

```
 02          RK     170      .06      .04 0.10938    T          0       50
103          RK    7000      .01      .04            TR       100       70

104          KK   S0030
105          KM        RUNOFF FROM SUBBASIN S0030
106          BA   0.876
107          LS       0   87.72
108          UK     300      .02       .2      100
109          RK     600      .03      .04 0.01406    TRAP       0       50
110          RK    3067     .011      .04 0.29375    TRAP       0       50
111          RK    6400     .006      .04            TRAP      30       70

112          KK   N0030
113          KM       COMBINE SUBBASIN HYDROGRAPHS @ N0030
114          HC       2

115          KK   N0030
116          KM       COMBINE SUBBASIN & CHANNEL HYDROGRAPHS @ N0030
117          HC       2

118          KK   R0030
119          KM        ROUTING HYDROGRAPH THROUGH CHANNEL R0030
120          RS       1    FLOW      -1
121          RC     .05      .04      .05     3800    .0063
122          RX       0       50      150      170      180      200      380      520
123          RY    2980     2976     2975     2975     2975     2975     2976     2980

124          KK   S0040
125          KM        RUNOFF FROM SUBBASIN S0040
126          BA   0.538
127          LS       0   89.59
128          UK     300      .01       .2      100
129          RK    2400     .006      .04 0.22344    TRAP       0       50
130          RK    3800     .003      .04            TRAP     300       15

131          KK   N0040
132          KM       COMBINE SUBBASIN & CHANNEL HYDROGRAPHS @ N0040
133          HC       2

134          KK   R0040
135          KM        ROUTING HYDROGRAPH THROUGH CHANNEL R0040
136          RS       1    FLOW      -1
137          RC     .05      .04      .05     7600    .0082
138          RX       0       70      150      200      300      350      410      510
139          RY    2926     2924     2923     2923     2923     2923     2924     2926
```



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

140          KK   S0050
141          KM        RUNOFF FROM SUBBASIN S0050
```

```
142          BA   0.863
143          LS       0      96                    88.
144          UK     300     .01      .1      13
145          UK     300     .01      .2      87
146          RK    2100    .009     .04 0.21406    TRAP       0      50
147          RK    7600    .009     .04            TRAP     200      50

148          KK   N0050
149          KM       COMBINE SUBBASIN & CHANNEL HYDROGRAPHS @ N0050
150          HC       2
151          KO       1
152          ZZ
```

1

SCHEMATIC DIAGRAM OF STREAM NETWORK

```
INPUT
 LINE      (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

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

   24       S0010
                .
                .
   52           .       S0015
                .           .
                .           .
   60       N0015............
                V
                V
   63       R0015
                .
                .
   69           .       S0018
                .           .
                .           .
   77           .           .       S0020
                .           .           .
                .           .           .
   85           .       N0020............
                .           .
                .           .
   88       N0020............
                V
                V
   91       R0020
                .
                .
   97           .       S0025
                .           .
                .           .
  104           .           .       S0030
                .           .           .
                .           .           .
```

```
 112          .       N0030............
              .           .
              .           .
 115      N0030............
              V
              V
 118      R0030
              .
              .
 124          .       S0040
              .           .
              .           .
 131      N0040............
              V
              V
 134      R0040
              .
              .
 140          .       S0050
              .           .
              .           .
 148      N0050............
```

```
 (***) RUNOFF ALSO COMPUTED AT THIS LOCATION
1****************************************
 *                                      *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *
 *              MAY   1991              *
 *           VERSION 4.0.1E             *
 *                                      *
 *  RUN DATE  07/01/:9  TIME  21:56:06  *
 *                                      *
 ****************************************
```

```
****************************************
*                                      *
*    U.S. ARMY CORPS OF ENGINEERS      *
*    HYDROLOGIC ENGINEERING CENTER     *
*          609 SECOND STREET           *
*       DAVIS, CALIFORNIA 95616        *
*           (916) 551-1748             *
*                                      *
****************************************
```

Map: UG0050 (ATTERBURY WASH NEAR S. 1/4 S11, T15, R15)
Scenario: EXIST (EXISTING CONDITIONS)
Storm: T-STORM100 (100-YEAR, 3 HR THUNDER STORM)
Return Period: 100 yrs, Interval: 1 min
Total Watershed Area= 4.99 sq mi
Areal Reduction of Rainfall Applied

```
 ***************** WARNING !! ********************
* THIS IS A COMPUTER GENERATED HEC-1 INPUT FILE *
```

This file was created by the City of Tucson
Stormwater Planner computer software package.
Neither the City of Tucson nor the consultants
who developed the software warrant the accuracy

of the input data or the result tained from
the HEC-1 modeling process throu the use of such
data. It is the sole responsibity of the user to
verify the accuracy of the data contained within
this Stormwater Planner data file.
****

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

    IT          HYDROGRAPH TIME DATA
                       NMIN           1  MINUTES IN COMPUTATION INTERVAL
                      IDATE      1    0  STARTING DATE
                      ITIME        0000  STARTING TIME
                         NQ         400  NUMBER OF HYDROGRAPH ORDINATES
                     NDDATE      1    0  ENDING DATE
                     NDTIME        0639  ENDING TIME
                     ICENT          19  CENTURY MARK

                 COMPUTATION INTERVAL    0.02 HOURS
                      TOTAL TIME BASE    6.65 HOURS

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


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


          **************
          *            *
 24 KK    *     S0010  *
          *            *
          **************
                            RUNOFF FROM SUBBASIN S0010

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

             SUBBASIN RUNOFF DATA
```

46 BA SUBBASIN CHARACTERISTICS

TAREA	0.78	SUBBASIN AREA

PRECIPITATION DATA

27 PB

STORM	3.19	BASIN TOTAL PRECIPITATION

28 PI INCREMENTAL PRECIPITATION PATTERN

0.06	0.06	0.07	0.08	0.09	0.11	0.12	0.14	0.17	0.19
0.16	0.13	0.11	0.10	0.09	0.08	0.07	0.06	0.05	0.05
0.05	0.05	0.04	0.04	0.04	0.04	0.04	0.04	0.03	0.03
0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.02	0.02
0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01
0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

47 LS SCS LOSS RATE

STRTL	0.08	INITIAL ABSTRACTION
CRVNBR	96.00	CURVE NUMBER
RTIMP	0.00	PERCENT IMPERVIOUS AREA

LOSS RATE VARIABLES FOR SECOND OVERLAND FLOW ELEMENT

STRTL	0.29	INITIAL ABSTRACTION
CRVNBR	87.41	CURVE NUMBER
RTIMP	0.00	PERCENT IMPERVIOUS AREA

KINEMATIC WAVE

48 UK OVERLAND-FLOW ELEMENT NO. 1

L	300.	OVERLAND FLOW LENGTH
S	0.0190	SLOPE
N	0.100	ROUGHNESS COEFFICIENT
PA	3.0	PERCENT OF SUBBASIN
DXMIN	5	MINIMUM NUMBER OF DX INTERVALS

49 UK OVERLAND-FLOW ELEMENT NO. 2

L	300.	OVERLAND FLOW LENGTH
S	0.0190	SLOPE
N	0.204	ROUGHNESS COEFFICIENT
PA	97.0	PERCENT OF SUBBASIN
DXMIN	5	MINIMUM NUMBER OF DX INTERVALS

```
                KINEMATIC WAVE
 50 RK            COLLECTOR CHANNEL
                        L       3600.  CHANNEL LENGTH
                        S      0.0160  SLOPE
                        N       0.040  CHANNEL ROUGHNESS COEFFICIENT
                       CA        0.38  CONTRIBUTING AREA
                    SHAPE        TRAP  CHANNEL SHAPE
                       WD        0.00  BOTTOM WIDTH OR DIAMETER
                        Z       50.00  SIDE SLOPE
                   NDXMIN           2  MINIMUM NUMBER OF DX INTERVALS
 51 RK            MAIN CHANNEL
                        L      13000.  CHANNEL LENGTH
                        S      0.0090  SLOPE
                        N       0.040  CHANNEL ROUGHNESS COEFFICIENT
                       CA        0.78  CONTRIBUTING AREA
                    SHAPE        TRAP  CHANNEL SHAPE
                       WD       50.00  BOTTOM WIDTH OR DIAMETER
                        Z       50.00  SIDE SLOPE
                   NDXMIN           2  MINIMUM NUMBER OF DX INTERVALS
                   RUPSTQ          NO  ROUTE UPSTREAM HYDROGRAPH
```

***

COMPUTED KINEMATIC PARAMETERS
VARIABLE TIME STEP
(DT SHOWN IS A MINIMUM)

ELEMENT	ALPHA	M	DT (MIN)	DX (FT)	PEAK (CFS)	TIME TO PEAK (MIN)	VOLUME (IN)	MAXIMUM CELERITY (FPS)
PLANE1	2.05	1.67	1.00	50.00	83.50	15.63	2.72	0.72
PLANE2	1.01	1.67	1.00	20.00	1096.64	28.76	1.92	0.32
COLLECTOR1	0.81	1.33	1.00	327.27	1009.28	35.80	1.94	5.44
MAIN	0.50	1.36	1.25	302.33	585.83	83.80	1.92	4.41

CONTINUITY SUMMARY (AC-FT) - INFLOW=0.0000E+00 EXCESS=0.8198E+02 OUTFLOW=0.8024E+02 BASIN STORAGE=0.1314E+01 PERCENT ERROR= 0.5

INTERPOLATED TO SPECIFIED COMPUTATION INTERVAL

MAIN	0.50	1.36	1.00	585.45	84.00	1.92

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

HYDROGRAPH AT STATION S0010

TOTAL RAINFALL = 3.19, TOTAL LOSS = 1.23, TOTAL EXCESS = 1.96

PEAK FLOW	TIME	MAXIMUM AVERAGE FLOW 6-HR	24-HR	72-HR	6.65-HR

```
+   (CFS)       (HR)
                          (CFS)
+     585.      1.40                  161.        146.        146.        146.
                       (INCHES)      1.913       1.919       1.919       1.919
                        (AC-FT)        80.         80.         80.         80.

                        CUMULATIVE AREA =    0.78 SQ MI


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


            **************
            *            *
  52 KK     *     S0015  *
            *            *
            **************
                              RUNOFF FROM SUBBASIN S0015

               SUBBASIN RUNOFF DATA

  54 BA          SUBBASIN CHARACTERISTICS
                      TAREA        0.40  SUBBASIN AREA

                 PRECIPITATION DATA

  27 PB               STORM        3.19  BASIN TOTAL PRECIPITATION

  28 PI            INCREMENTAL PRECIPITATION PATTERN
                     0.06      0.06      0.07      0.08      0.09      0.11      0.12      0.14      0.17      0.19
                     0.16      0.13      0.11      0.10      0.09      0.08      0.07      0.06      0.05      0.05
                     0.05      0.05      0.04      0.04      0.04      0.04      0.04      0.04      0.03      0.03
                     0.03      0.03      0.03      0.03      0.03      0.03      0.03      0.02      0.02      0.02
                     0.02      0.02      0.02      0.02      0.02      0.02      0.02      0.02      0.02      0.02
                     0.02      0.02      0.02      0.01      0.01      0.01      0.01      0.01      0.01      0.01
                     0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01
                     0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01
                     0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01
                     0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01
                     0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.00      0.00      0.00
                     0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
                     0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
                     0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
                     0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
                     0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
                     0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
                     0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00

  55 LS          SCS LOSS RATE
                      STRTL        0.08  INITIAL ABSTRACTION
```

```
                CRVNBR        96.00  CURVE NUMBER
                 RTIMP         0.00  PERCENT IMPERVIOUS AREA

              LOSS RATE VARIABLES FOR SECOND OVERLAND FLOW ELEMENT
                 STRTL         0.30  INITIAL ABSTRACTION
                CRVNBR        86.96  CURVE NUMBER
                 RTIMP         0.00  PERCENT IMPERVIOUS AREA

            KINEMATIC WAVE
56 UK         OVERLAND-FLOW ELEMENT NO. 1
                     L         300.  OVERLAND FLOW LENGTH
                     S       0.0100  SLOPE
                     N        0.100  ROUGHNESS COEFFICIENT
                    PA          3.0  PERCENT OF SUBBASIN
                 DXMIN            5  MINIMUM NUMBER OF DX INTERVALS
57 UK         OVERLAND-FLOW ELEMENT NO. 2
                     L         300.  OVERLAND FLOW LENGTH
                     S       0.0100  SLOPE
                     N        0.200  ROUGHNESS COEFFICIENT
                    PA         97.0  PERCENT OF SUBBASIN
                 DXMIN            5  MINIMUM NUMBER OF DX INTERVALS

            KINEMATIC WAVE
58 RK         COLLECTOR CHANNEL
                     L         800.  CHANNEL LENGTH
                     S       0.0310  SLOPE
                     N        0.040  CHANNEL ROUGHNESS COEFFICIENT
                    CA         0.19  CONTRIBUTING AREA
                 SHAPE         TRAP  CHANNEL SHAPE
                    WD         0.00  BOTTOM WIDTH OR DIAMETER
                     Z        50.00  SIDE SLOPE
                NDXMIN            2  MINIMUM NUMBER OF DX INTERVALS
59 RK         MAIN CHANNEL
                     L        9000.  CHANNEL LENGTH
                     S       0.0120  SLOPE
                     N        0.040  CHANNEL ROUGHNESS COEFFICIENT
                    CA         0.40  CONTRIBUTING AREA
                 SHAPE         TRAP  CHANNEL SHAPE
                    WD        50.00  BOTTOM WIDTH OR DIAMETER
                     Z        50.00  SIDE SLOPE
                NDXMIN            2  MINIMUM NUMBER OF DX INTERVALS
                RUPSTQ           NO  ROUTE UPSTREAM HYDROGRAPH

                                                    ***
                          COMPUTED KINEMATIC PARAMETERS
                               VARIABLE TIME STEP
                             (DT SHOWN IS A MINIMUM)

          ELEMENT    ALPHA       M         DT        DX       PEAK    TIME TO     VOLUME    MAXIMUM
                                                                        PEAK                CELERITY
                                         (MIN)      (FT)     (CFS)     (MIN)       (IN)      (FPS)
```

```
                PLANE1        1.49      1.67      1.00      3[illegible]      37.90     18.28      2.72      0.56
                PLANE2        0.75      1.67      1.00      15[illegible]     484.90     34.54      1.88      0.25
                COLLECTOR1    1.12      1.33      0.83    266.67     495.41     35.64      1.91      6.18
                MAIN          0.58      1.36      1.00    281.25     342.55     64.21      1.89      4.26

CONTINUITY SUMMARY (AC-FT) - INFLOW=0.0000E+00  EXCESS=0.4117E+02 OUTFLOW=0.4047E+02 BASIN STORAGE=0.4724E+00 PERCENT ERROR=   0.6

                                        INTERPOLATED TO SPECIFIED COMPUTATION INTERVAL

                MAIN          0.58      1.36      1.00              342.35     64.00      1.89

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

                    HYDROGRAPH AT STATION    S0015

   TOTAL RAINFALL =    3.19, TOTAL LOSS =    1.26, TOTAL EXCESS =    1.93

 PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR      6.65-HR
+   (CFS)       (HR)
                          (CFS)
+     342.      1.07                  81.         74.         74.          74.
                        (INCHES)    1.886       1.892       1.892        1.892
                         (AC-FT)     40.         40.         40.          40.

                        CUMULATIVE AREA =    0.40 SQ MI


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


            **************
            *            *
  60 KK     *     N0015  *
            *            *
            **************
                          COMBINE SUBBASIN HYDROGRAPHS @ N0015

  62 HC          HYDROGRAPH COMBINATION
                      ICOMP           2  NUMBER OF HYDROGRAPHS TO COMBINE

                                                                  ***

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

                    HYDROGRAPH AT STATION    N0015
```

```
  PEAK FI        TIME                          MAXIMUM AVERAGE FLO
                                        6-HR        24-HR        72-HR        6.65-HR
+   (CFS)        (HR)
                              (CFS)
+     845.       1.33                    243.         220.         220.          220.
                          (INCHES)     1.904        1.910        1.910         1.910
                           (AC-FT)      120.         121.         121.          121.

                          CUMULATIVE AREA =    1.18 SQ MI


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


            **************
            *            *
  63 KK     *     R0015  *
            *            *
            **************
                                ROUTING HYDROGRAPH THROUGH CHANNEL R0015

              HYDROGRAPH ROUTING DATA

  65 RS          STORAGE ROUTING
                       NSTPS           1  NUMBER OF SUBREACHES
                        ITYP        FLOW  TYPE OF INITIAL CONDITION
                      RSVRIC       -1.00  INITIAL CONDITION
                           X        0.00 WORKING R AND D COEFFICIENT

  66 RC          NORMAL DEPTH CHANNEL
                         ANL       0.050  LEFT OVERBANK N-VALUE
                        ANCH       0.040  MAIN CHANNEL N-VALUE
                         ANR       0.050  RIGHT OVERBANK N-VALUE
                       RLNTH       2100.  REACH LENGTH
                         SEL      0.0086  ENERGY SLOPE
                       ELMAX         0.0  MAX. ELEV. FOR STORAGE/OUTFLOW CALCULATION

                                          CROSS-SECTION DATA
                          --- LEFT OVERBANK --- + ------ MAIN CHANNEL ------- + --- RIGHT OVERBANK ---
  68 RY        ELEVATION   3050.00   3049.00   3048.00   3048.00   3048.00   3048.00   3049.00   3050.00
  67 RX        DISTANCE       0.00     60.00    120.00    200.00    300.00    400.00    475.00    550.00

                                                                  ***

                                          COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

           STORAGE       0.00      1.46      2.98      4.59      6.26      8.00      9.82     11.71     13.67     15.70
           OUTFLOW       0.00     22.97     73.86    146.99    240.34    352.85    483.88    633.06    800.14    984.98
         ELEVATION    3048.00   3048.11   3048.21   3048.32   3048.42   3048.53   3048.63   3048.74   3048.84   3048.95
```

STORAGE	17.81	19.98	22.23	24.55	[illegible]5	29.41	31.95	34.56	37.24	39.99
OUTFLOW	1187.52	1407.74	1645.67	1901.37	21[illegible]92	2466.41	2775.96	3103.70	3449.76	3814.29
ELEVATION	3049.05	3049.16	3049.26	3049.37	3049.47	3049.58	3049.68	3049.79	3049.89	3050.00

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HYDROGRAPH AT STATION R0015

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW 6-HR	24-HR	72-HR	6.65-HR
+ (CFS)	(HR)	(CFS)				
+ 819.	1.43		241.	218.	218.	218.
		(INCHES)	1.887	1.891	1.891	1.891
		(AC-FT)	119.	120.	120.	120.

PEAK STORAGE	TIME	MAXIMUM AVERAGE STORAGE 6-HR	24-HR	72-HR	6.65-HR
+ (AC-FT)	(HR)				
14.	1.43	6.	5.	5.	5.

PEAK STAGE	TIME	MAXIMUM AVERAGE STAGE 6-HR	24-HR	72-HR	6.65-HR
+ (FEET)	(HR)				
3048.85	1.43	3048.37	3048.34	3048.34	3048.34

CUMULATIVE AREA = 1.18 SQ MI

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              *            *
   69 KK      *     S0018  *
              *            *
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RUNOFF FROM SUBBASIN S0018

SUBBASIN RUNOFF DATA

71 BA SUBBASIN CHARACTERISTICS
TAREA 0.16 SUBBASIN AREA

PRECIPITATION DATA

27 PB STORM 3.19 BASIN TOTAL PRECIPITATION

28 PI INCREMENTAL PRECIPITATION PATTERN

0.06	0.06	0.07	0.08	0.[illegible]	0.11	0.12	0.14	0.17	0.19
0.16	0.13	0.11	0.10	0.0[illegible]	0.08	0.07	0.06	0.05	0.05
0.05	0.05	0.04	0.04	0.04	0.04	0.04	0.04	0.03	0.03
0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.02	0.02
0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01
0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

```
72 LS        SCS LOSS RATE
                  STRTL        0.08  INITIAL ABSTRACTION
                 CRVNBR       96.00  CURVE NUMBER
                  RTIMP        0.00  PERCENT IMPERVIOUS AREA

               LOSS RATE VARIABLES FOR SECOND OVERLAND FLOW ELEMENT
                  STRTL        0.28  INITIAL ABSTRACTION
                 CRVNBR       87.78  CURVE NUMBER
                  RTIMP        0.00  PERCENT IMPERVIOUS AREA

             KINEMATIC WAVE
73 UK          OVERLAND-FLOW ELEMENT NO. 1
                      L        300.  OVERLAND FLOW LENGTH
                      S      0.0330  SLOPE
                      N       0.100  ROUGHNESS COEFFICIENT
                     PA         1.0  PERCENT OF SUBBASIN
                  DXMIN           5  MINIMUM NUMBER OF DX INTERVALS
74 UK          OVERLAND-FLOW ELEMENT NO. 2
                      L        300.  OVERLAND FLOW LENGTH
                      S      0.0330  SLOPE
                      N       0.193  ROUGHNESS COEFFICIENT
                     PA        99.0  PERCENT OF SUBBASIN
                  DXMIN           5  MINIMUM NUMBER OF DX INTERVALS

             KINEMATIC WAVE
75 RK          COLLECTOR CHANNEL
                      L       1600.  CHANNEL LENGTH
                      S      0.0190  SLOPE
                      N       0.040  CHANNEL ROUGHNESS COEFFICIENT
                     CA        0.05  CONTRIBUTING AREA
                  SHAPE        TRAP  CHANNEL SHAPE
                     WD        0.00  BOTTOM WIDTH OR DIAMETER
                      Z       50.00  SIDE SLOPE
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                NDXMIN          2  MINIMUM NUMBER OF DX IN     ALS
76 RK         MAIN CHANNEL
                  L       2000.  CHANNEL LENGTH
                  S      0.0090  SLOPE
                  N       0.040  CHANNEL ROUGHNESS COEFFICIENT
                 CA        0.16  CONTRIBUTING AREA
              SHAPE        TRAP  CHANNEL SHAPE
                 WD      220.00  BOTTOM WIDTH OR DIAMETER
                  Z       60.00  SIDE SLOPE
              NDXMIN          2  MINIMUM NUMBER OF DX INTERVALS
              RUPSTQ         NO  ROUTE UPSTREAM HYDROGRAPH
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COMPUTED KINEMATIC PARAMETERS
VARIABLE TIME STEP
(DT SHOWN IS A MINIMUM)

ELEMENT	ALPHA	M	DT (MIN)	DX (FT)	PEAK (CFS)	TIME TO PEAK (MIN)	VOLUME (IN)	MAXIMUM CELERITY (FPS)
PLANE1	2.71	1.67	1.00	60.00	5.96	13.87	2.72	0.89
PLANE2	1.40	1.67	1.00	30.00	257.79	24.59	1.96	0.42
COLLECTOR1	0.88	1.33	1.00	228.57	235.06	28.70	1.96	3.66
MAIN	0.26	1.43	1.00	166.67	207.09	37.84	1.96	2.83

CONTINUITY SUMMARY (AC-FT) - INFLOW=0.0000E+00 EXCESS=0.1632E+02 OUTFLOW=0.1617E+02 BASIN STORAGE=0.5898E-01 PERCENT ERROR= 0.6

INTERPOLATED TO SPECIFIED COMPUTATION INTERVAL

MAIN	0.26	1.43	1.00	207.05	38.00	1.96

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

HYDROGRAPH AT STATION S0018

TOTAL RAINFALL = 3.19, TOTAL LOSS = 1.21, TOTAL EXCESS = 1.97

	PEAK FLOW (CFS)	TIME (HR)		MAXIMUM AVERAGE FLOW 6-HR	24-HR	72-HR	6.65-HR
+			(CFS)				
+	207.	0.63		33.	29.	29.	29.
			(INCHES)	1.954	1.956	1.956	1.956
			(AC-FT)	16.	16.	16.	16.

CUMULATIVE AREA = 0.16 SQ MI

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              *            *
77 KK         *     S0020  *
              *            *
              **************
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RUNOFF FROM SUBBASIN S0020

SUBBASIN RUNOFF DATA

79 BA SUBBASIN CHARACTERISTICS

TAREA	0.92	SUBBASIN AREA

PRECIPITATION DATA

27 PB

STORM	3.19	BASIN TOTAL PRECIPITATION

28 PI INCREMENTAL PRECIPITATION PATTERN

0.06	0.06	0.07	0.08	0.09	0.11	0.12	0.14	0.17	0.19
0.16	0.13	0.11	0.10	0.09	0.08	0.07	0.06	0.05	0.05
0.05	0.05	0.04	0.04	0.04	0.04	0.04	0.04	0.03	0.03
0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.02	0.02
0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01
0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

80 LS SCS LOSS RATE

STRTL	0.08	INITIAL ABSTRACTION
CRVNBR	96.00	CURVE NUMBER
RTIMP	0.00	PERCENT IMPERVIOUS AREA

LOSS RATE VARIABLES FOR SECOND OVERLAND FLOW ELEMENT

STRTL	0.28	INITIAL ABSTRACTION
CRVNBR	87.61	CURVE NUMBER
RTIMP	0.00	PERCENT IMPERVIOUS AREA

KINEMATIC WAVE

```
81 UK          OVERLAND-FLOW ELEMENT NO. 1
                       L        300.  OVERLAND FLOW LENGTH
                       S      0.0200  SLOPE
                       N       0.100  ROUGHNESS COEFFICIENT
                      PA         8.0  PERCENT OF SUBBASIN
                   DXMIN           5  MINIMUM NUMBER OF DX INTERVALS
82 UK          OVERLAND-FLOW ELEMENT NO. 2
                       L        300.  OVERLAND FLOW LENGTH
                       S      0.0200  SLOPE
                       N       0.203  ROUGHNESS COEFFICIENT
                      PA        92.0  PERCENT OF SUBBASIN
                   DXMIN           5  MINIMUM NUMBER OF DX INTERVALS

             KINEMATIC WAVE
83 RK          COLLECTOR CHANNEL
                       L       1733.  CHANNEL LENGTH
                       S      0.0140  SLOPE
                       N       0.040  CHANNEL ROUGHNESS COEFFICIENT
                      CA        0.28  CONTRIBUTING AREA
                   SHAPE        TRAP  CHANNEL SHAPE
                      WD        0.00  BOTTOM WIDTH OR DIAMETER
                       Z       50.00  SIDE SLOPE
                 NDXMIN           2  MINIMUM NUMBER OF DX INTERVALS
84 RK          MAIN CHANNEL
                       L      16000.  CHANNEL LENGTH
                       S      0.0100  SLOPE
                       N       0.040  CHANNEL ROUGHNESS COEFFICIENT
                      CA        0.92  CONTRIBUTING AREA
                   SHAPE        TRAP  CHANNEL SHAPE
                      WD       30.00  BOTTOM WIDTH OR DIAMETER
                       Z       40.00  SIDE SLOPE
                 NDXMIN           2  MINIMUM NUMBER OF DX INTERVALS
                 RUPSTQ          NO  ROUTE UPSTREAM HYDROGRAPH
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COMPUTED KINEMATIC PARAMETERS
VARIABLE TIME STEP
(DT SHOWN IS A MINIMUM)

ELEMENT	ALPHA	M	DT (MIN)	DX (FT)	PEAK (CFS)	TIME TO PEAK (MIN)	VOLUME (IN)	MAXIMUM CELERITY (FPS)
PLANE1	2.11	1.67	1.00	50.00	264.33	15.45	2.72	0.74
PLANE2	1.04	1.67	1.00	21.43	1254.07	27.99	1.94	0.33
COLLECTOR1	0.75	1.33	1.00	288.83	1308.09	30.90	2.00	5.02
MAIN	0.61	1.35	1.00	363.64	705.39	81.41	1.98	5.13

CONTINUITY SUMMARY (AC-FT) - INFLOW=0.0000E+00 EXCESS=0.9922E+02 OUTFLOW=0.9735E+02 BASIN STORAGE=0.1319E+01 PERCENT ERROR= 0.6

```
                                    INTERPOLATED TO SPECIF.   COMPUTATION INTERVAL

                 MAIN          0.61      1.35       1.00              704.92     81.00      1.98

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

                        HYDROGRAPH AT STATION    S0020

    TOTAL RAINFALL =    3.19, TOTAL LOSS =    1.17, TOTAL EXCESS =    2.02

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                      6-HR       24-HR       72-HR      6.65-HR
+   (CFS)       (HR)
                          (CFS)
+     705.      1.35                  196.        177.        177.         177.
                        (INCHES)     1.971       1.977       1.977        1.977
                         (AC-FT)      97.         97.         97.          97.

                        CUMULATIVE AREA =    0.92 SQ MI


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


            **************
            *            *
  85 KK     *     N0020  *
            *            *
            **************
                                COMBINE SUBBASIN HYDROGRAPHS @ N0020

  87 HC          HYDROGRAPH COMBINATION
                       ICOMP           2  NUMBER OF HYDROGRAPHS TO COMBINE

                                                                  ***

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

                        HYDROGRAPH AT STATION    N0020

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                      6-HR       24-HR       72-HR      6.65-HR
+   (CFS)       (HR)
                          (CFS)
+     777.      1.33                  228.        207.        207.         207.
                        (INCHES)     1.968       1.974       1.974        1.974
                         (AC-FT)      113.        114.        114.         114.

                        CUMULATIVE AREA =    1.08 SQ MI
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*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

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          *            *
  88 KK   *     N0020  *
          *            *
          **************
                          COMBINE SUBBASIN & CHANNEL HYDROGRAPHS @ N0020

  90 HC          HYDROGRAPH COMBINATION
                       ICOMP           2  NUMBER OF HYDROGRAPHS TO COMBINE

                                                                  ***

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

                       HYDROGRAPH AT STATION    N0020

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                      6-HR       24-HR       72-HR      6.65-HR
+   (CFS)       (HR)
                          (CFS)
+    1585.      1.37                 468.        424.        424.        424.
                        (INCHES)    1.924       1.931       1.931       1.931
                         (AC-FT)     232.        233.        233.        233.

                        CUMULATIVE AREA =    2.26 SQ MI


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

          **************
          *            *
  91 KK   *     R0020  *
          *            *
          **************
                          ROUTING HYDROGRAPH THROUGH CHANNEL R0020

             HYDROGRAPH ROUTING DATA

  93 RS          STORAGE ROUTING
                      NSTPS           1  NUMBER OF SUBREACHES
                       ITYP        FLOW  TYPE OF INITIAL CONDITION
                     RSVRIC       -1.00  INITIAL CONDITION
```

```
                    X        0.00 WORKING R AND D COEFFIC

94 RC        NORMAL DEPTH CHANNEL
                   ANL       0.050  LEFT OVERBANK N-VALUE
                  ANCH       0.040  MAIN CHANNEL N-VALUE
                   ANR       0.050  RIGHT OVERBANK N-VALUE
                 RLNTH       6400.  REACH LENGTH
                   SEL      0.0066  ENERGY SLOPE
                 ELMAX         0.0  MAX. ELEV. FOR STORAGE/OUTFLOW CALCULATION
```

CROSS-SECTION DATA

		--- LEFT OVERBANK ---	+	------ MAIN CHANNEL -------		+	--- RIGHT OVERBANK ---	
96 RY	ELEVATION	3014.00	3012.00	3010.00	3009.00	3009.00	3010.00	3012.00	3013.00
95 RX	DISTANCE	0.00	50.00	410.00	430.00	440.00	450.00	790.00	800.00

***

COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

STORAGE	0.00	0.54	1.38	2.53	4.05	8.10	15.70	26.86	41.59	59.88
OUTFLOW	0.00	3.86	14.55	33.36	63.32	121.58	226.95	397.93	650.25	998.08
ELEVATION	3009.00	3009.26	3009.53	3009.79	3010.05	3010.32	3010.58	3010.84	3011.11	3011.37
STORAGE	81.73	107.14	135.54	164.54	193.91	223.63	253.67	283.97	314.52	345.33
OUTFLOW	1454.53	2031.89	2821.02	3792.69	4886.60	6097.48	7432.06	8879.69	10434.68	12094.50
ELEVATION	3011.63	3011.90	3012.16	3012.42	3012.68	3012.95	3013.21	3013.47	3013.74	3014.00

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

HYDROGRAPH AT STATION R0020

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	6.65-HR
+ (CFS)	(HR)					
		(CFS)				
+ 1095.	1.83		460.	417.	417.	417.
		(INCHES)	1.892	1.897	1.897	1.897
		(AC-FT)	228.	229.	229.	229.

PEAK STORAGE	TIME	MAXIMUM AVERAGE STORAGE			
		6-HR	24-HR	72-HR	6.65-HR
+ (AC-FT)	(HR)				
65.	1.83	29.	26.	26.	26.

PEAK STAGE	TIME	MAXIMUM AVERAGE STAGE			
		6-HR	24-HR	72-HR	6.65-HR
+ (FEET)	(HR)				
3011.42	1.82	3010.79	3010.64	3010.64	3010.64

CUMULATIVE AREA = 2.26 SQ MI

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              *            *
 97 KK        *     S0025  *
              *            *
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RUNOFF FROM SUBBASIN S0025

SUBBASIN RUNOFF DATA

99 BA SUBBASIN CHARACTERISTICS

TAREA	0.37	SUBBASIN AREA

PRECIPITATION DATA

27 PB

STORM	3.19	BASIN TOTAL PRECIPITATION

28 PI INCREMENTAL PRECIPITATION PATTERN

0.06	0.06	0.07	0.08	0.09	0.11	0.12	0.14	0.17	0.19
0.16	0.13	0.11	0.10	0.09	0.08	0.07	0.06	0.05	0.05
0.05	0.05	0.04	0.04	0.04	0.04	0.04	0.04	0.03	0.03
0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.02	0.02
0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01
0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

100 LS SCS LOSS RATE

STRTL	0.25	INITIAL ABSTRACTION
CRVNBR	89.08	CURVE NUMBER
RTIMP	0.00	PERCENT IMPERVIOUS AREA

KINEMATIC WAVE

101 UK OVERLAND-FLOW ELEMENT NO. 1

L	300.	OVERLAND FLOW LENGTH
S	0.0500	SLOPE
N	0.200	ROUGHNESS COEFFICIENT

```
                PA       100.0  PERCENT OF SUBBASIN
             DXMIN           5  MINIMUM NUMBER OF DX IN..RVALS

          KINEMATIC WAVE
102 RK      COLLECTOR CHANNEL
                 L        170.  CHANNEL LENGTH
                 S      0.0600  SLOPE
                 N       0.040  CHANNEL ROUGHNESS COEFFICIENT
                CA        0.11  CONTRIBUTING AREA
             SHAPE        TRAP  CHANNEL SHAPE
                WD        0.00  BOTTOM WIDTH OR DIAMETER
                 Z       50.00  SIDE SLOPE
            NDXMIN           2  MINIMUM NUMBER OF DX INTERVALS
103 RK      MAIN CHANNEL
                 L       7000.  CHANNEL LENGTH
                 S      0.0100  SLOPE
                 N       0.040  CHANNEL ROUGHNESS COEFFICIENT
                CA        0.37  CONTRIBUTING AREA
             SHAPE        TRAP  CHANNEL SHAPE
                WD      100.00  BOTTOM WIDTH OR DIAMETER
                 Z       70.00  SIDE SLOPE
            NDXMIN           2  MINIMUM NUMBER OF DX INTERVALS
            RUPSTQ          NO  ROUTE UPSTREAM HYDROGRAPH

                                                  ***
                        COMPUTED KINEMATIC PARAMETERS
                             VARIABLE TIME STEP
                           (DT SHOWN IS A MINIMUM)

          ELEMENT    ALPHA       M        DT        DX       PEAK    TIME TO     VOLUME    MAXIMUM
                                                                      PEAK                CELERITY
                                         (MIN)      (FT)     (CFS)    (MIN)       (IN)      (FPS)

          PLANE1      1.67      1.67      1.00     37.50    723.08     21.71       2.07      0.50
          COLLECTOR1  1.56      1.33      0.27     56.67    708.95     21.19       2.07      8.14
          MAIN        0.42      1.37      1.00    259.26    400.24     52.99       2.06      3.73

CONTINUITY SUMMARY (AC-FT) - INFLOW=0.0000E+00  EXCESS=0.4075E+02 OUTFLOW=0.4033E+02 BASIN STORAGE=0.2005E+00 PERCENT ERROR=   0.5

                                  INTERPOLATED TO SPECIFIED COMPUTATION INTERVAL

          MAIN        0.42      1.37      1.00              400.21     53.00       2.06

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

                 HYDROGRAPH AT STATION    S0025

  TOTAL RAINFALL =    3.19, TOTAL LOSS =    1.11, TOTAL EXCESS =    2.08
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PEAK FI	TIME		MAXIMUM AVERAGE FLO			
			6-HR	24-HR	72-HR	6.65-HR
+ (CFS)	(HR)					
		(CFS)				
+ 400.	0.88		81.	73.	73.	73.
		(INCHES)	2.051	2.055	2.055	2.055
		(AC-FT)	40.	40.	40.	40.

CUMULATIVE AREA = 0.37 SQ MI

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              **************
              *            *
  104 KK      *     S0030  *
              *            *
              **************
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RUNOFF FROM SUBBASIN S0030

SUBBASIN RUNOFF DATA

106 BA SUBBASIN CHARACTERISTICS

TAREA 0.88 SUBBASIN AREA

PRECIPITATION DATA

27 PB STORM 3.19 BASIN TOTAL PRECIPITATION

28 PI INCREMENTAL PRECIPITATION PATTERN

0.06	0.06	0.07	0.08	0.09	0.11	0.12	0.14	0.17	0.19
0.16	0.13	0.11	0.10	0.09	0.08	0.07	0.06	0.05	0.05
0.05	0.05	0.04	0.04	0.04	0.04	0.04	0.04	0.03	0.03
0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.02	0.02
0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01
0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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107 LS        SCS LOSS RATE
                  STRTL        0.28  INITIAL ABSTRACTION
                 CRVNBR       87.72  CURVE NUMBER
                  RTIMP        0.00  PERCENT IMPERVIOUS AREA

              KINEMATIC WAVE
108 UK          OVERLAND-FLOW ELEMENT NO. 1
                      L        300.  OVERLAND FLOW LENGTH
                      S      0.0200  SLOPE
                      N       0.200  ROUGHNESS COEFFICIENT
                     PA       100.0  PERCENT OF SUBBASIN
                  DXMIN           5  MINIMUM NUMBER OF DX INTERVALS

              KINEMATIC WAVE
109 RK          COLLECTOR CHANNEL
                      L        600.  CHANNEL LENGTH
                      S      0.0300  SLOPE
                      N       0.040  CHANNEL ROUGHNESS COEFFICIENT
                     CA        0.01  CONTRIBUTING AREA
                  SHAPE        TRAP  CHANNEL SHAPE
                     WD        0.00  BOTTOM WIDTH OR DIAMETER
                      Z       50.00  SIDE SLOPE
                 NDXMIN           2  MINIMUM NUMBER OF DX INTERVALS
110 RK          COLLECTOR CHANNEL
                      L       3067.  CHANNEL LENGTH
                      S      0.0110  SLOPE
                      N       0.040  CHANNEL ROUGHNESS COEFFICIENT
                     CA        0.29  CONTRIBUTING AREA
                  SHAPE        TRAP  CHANNEL SHAPE
                     WD        0.00  BOTTOM WIDTH OR DIAMETER
                      Z       50.00  SIDE SLOPE
                 NDXMIN           2  MINIMUM NUMBER OF DX INTERVALS
111 RK          MAIN CHANNEL
                      L       6400.  CHANNEL LENGTH
                      S      0.0060  SLOPE
                      N       0.040  CHANNEL ROUGHNESS COEFFICIENT
                     CA        0.88  CONTRIBUTING AREA
                  SHAPE        TRAP  CHANNEL SHAPE
                     WD       30.00  BOTTOM WIDTH OR DIAMETER
                      Z       70.00  SIDE SLOPE
                 NDXMIN           2  MINIMUM NUMBER OF DX INTERVALS
                 RUPSTQ          NO  ROUTE UPSTREAM HYDROGRAPH

                                                    ***
                          COMPUTED KINEMATIC PARAMETERS
                               VARIABLE TIME STEP
                             (DT SHOWN IS A MINIMUM)

          ELEMENT    ALPHA       M         DT        DX       PEAK    TIME TO     VOLUME    MAXIMUM
                                                                        PEAK                CELERITY
                                          (MIN)      (FT)     (CFS)    (MIN)       (IN)      (FPS)
```

```
                PLANE1        1.05      1.67      1.00     27[illegible]     1313.25     27.71      1.95      0.34
                COLLECTOR1    1.10      1.33      1.00     200[illegible]     1287.82     30.46      1.95      3.28
                COLLECTOR2    0.67      1.33      1.20     278.82    1141.79     37.42      1.95      4.46
                MAIN          0.42      1.34      1.00     246.15     860.59     61.45      1.93      3.92

CONTINUITY SUMMARY (AC-FT) - INFLOW=0.0000E+00  EXCESS=0.9167E+02 OUTFLOW=0.9036E+02 BASIN STORAGE=0.6601E+00 PERCENT ERROR=   0.7

                                        INTERPOLATED TO SPECIFIED COMPUTATION INTERVAL

                MAIN          0.42      1.34      1.00              860.42     62.00      1.93

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

                     HYDROGRAPH AT STATION    S0030

    TOTAL RAINFALL =    3.19, TOTAL LOSS =    1.22, TOTAL EXCESS =    1.96

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                      6-HR       24-HR       72-HR      6.65-HR
+   (CFS)       (HR)
                          (CFS)
+     860.      1.03                  182.        164.        164.         164.
                        (INCHES)     1.931       1.934       1.934        1.934
                         (AC-FT)       90.         90.         90.          90.

                        CUMULATIVE AREA =    0.88 SQ MI


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            *            *
 112 KK     *     N0030  *
            *            *
            **************
                          COMBINE SUBBASIN HYDROGRAPHS @ N0030

 114 HC          HYDROGRAPH COMBINATION
                      ICOMP           2  NUMBER OF HYDROGRAPHS TO COMBINE

                                                                ***

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                     HYDROGRAPH AT STATION    N0030
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  PEAK F/        TIME                          MAXIMUM AVERAGE FLC
                                        6-HR       24-HR       72-H.       6.65-HR
+   (CFS)        (HR)
                              (CFS)
+    1200.       1.00                   263.        238.        238.         238.
                          (INCHES)     1.965       1.970       1.970        1.970
                           (AC-FT)     130.        131.        131.         131.

                          CUMULATIVE AREA =    1.24 SQ MI


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


            **************
            *            *
 115 KK     *     N0030  *
            *            *
            **************
                                COMBINE SUBBASIN & CHANNEL HYDROGRAPHS @ N0030

 117 HC          HYDROGRAPH COMBINATION
                       ICOMP           2  NUMBER OF HYDROGRAPHS TO COMBINE

                                                                  ***

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

                         HYDROGRAPH AT STATION    N0030

  PEAK FLOW      TIME                          MAXIMUM AVERAGE FLOW
                                        6-HR       24-HR       72-HR       6.65-HR
+   (CFS)        (HR)
                              (CFS)
+    1615.       1.52                   721.        654.        654.         654.
                          (INCHES)     1.911       1.923       1.923        1.923
                           (AC-FT)     357.        360.        360.         360.

                          CUMULATIVE AREA =    3.51 SQ MI


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


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            *            *
 118 KK     *     R0030  *
            *            *
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                    ROUTING HYDROGRAPH THROUGH CHANNEL R0030

          HYDROGRAPH ROUTING DATA

120 RS        STORAGE ROUTING
                   NSTPS          1  NUMBER OF SUBREACHES
                    ITYP       FLOW  TYPE OF INITIAL CONDITION
                  RSVRIC      -1.00  INITIAL CONDITION
                       X       0.00 WORKING R AND D COEFFICIENT

121 RC        NORMAL DEPTH CHANNEL
                     ANL      0.050  LEFT OVERBANK N-VALUE
                    ANCH      0.040  MAIN CHANNEL N-VALUE
                     ANR      0.050  RIGHT OVERBANK N-VALUE
                   RLNTH      3800.  REACH LENGTH
                     SEL     0.0063  ENERGY SLOPE
                   ELMAX        0.0  MAX. ELEV. FOR STORAGE/OUTFLOW CALCULATION

                                  CROSS-SECTION DATA
                      --- LEFT OVERBANK --- + ------ MAIN CHANNEL ------- + --- RIGHT OVERBANK ---
123 RY       ELEVATION  2980.00   2976.00   2975.00   2975.00   2975.00   2975.00   2976.00   2980.00
122 RX       DISTANCE      0.00     50.00    150.00    170.00    180.00    200.00    380.00    520.00

                                                    ***

                                  COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

          STORAGE       0.00      1.99      5.68     11.06     18.10     25.88     33.94     42.29     50.93     59.86
          OUTFLOW       0.00     21.91     88.41    210.80    406.31    697.20   1054.21   1473.94   1954.31   2493.99
        ELEVATION    2975.00   2975.26   2975.53   2975.79   2976.05   2976.32   2976.58   2976.84   2977.11   2977.37

          STORAGE      69.07     78.57     88.36     98.43    108.79    119.44    130.37    141.59    153.10    164.90
          OUTFLOW    3092.17   3748.38   4462.41   5234.20   6063.87   6951.63   7897.77   8902.67   9966.75  11090.76
        ELEVATION    2977.63   2977.90   2978.16   2978.42   2978.68   2978.95   2979.21   2979.47   2979.74   2980.00

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

                    HYDROGRAPH AT STATION    R0030

 PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                    6-HR       24-HR       72-HR      6.65-HR
+   (CFS)      (HR)
                          (CFS)
+    1571.     1.77                 710.        643.        643.        643.
                       (INCHES)    1.883       1.888       1.888       1.888
                        (AC-FT)     352.        353.        353.        353.

 PEAK STORAGE  TIME                          MAXIMUM AVERAGE STORAGE
                                    6-HR       24-HR       72-HR      6.65-HR
+  (AC-FT)     (HR)
```

```
    4.        1.77                    24.         22.         22.          22.

 PEAK STAGE    TIME                            MAXIMUM AVERAGE STAGE
                                        6-HR       24-HR       72-HR       6.65-HR
+   (FEET)     (HR)
   2976.90     1.77                 2976.24     2976.13     2976.13      2976.13

                        CUMULATIVE AREA =    3.51 SQ MI


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            *            *
 124 KK     *     S0040  *
            *            *
            **************
                                RUNOFF FROM SUBBASIN S0040

               SUBBASIN RUNOFF DATA

 126 BA          SUBBASIN CHARACTERISTICS
                      TAREA        0.54  SUBBASIN AREA

                 PRECIPITATION DATA

  27 PB                STORM        3.19  BASIN TOTAL PRECIPITATION

  28 PI            INCREMENTAL PRECIPITATION PATTERN
                      0.06      0.06      0.07      0.08      0.09      0.11      0.12      0.14      0.17      0.19
                      0.16      0.13      0.11      0.10      0.09      0.08      0.07      0.06      0.05      0.05
                      0.05      0.05      0.04      0.04      0.04      0.04      0.04      0.04      0.03      0.03
                      0.03      0.03      0.03      0.03      0.03      0.03      0.03      0.02      0.02      0.02
                      0.02      0.02      0.02      0.02      0.02      0.02      0.02      0.02      0.02      0.02
                      0.02      0.02      0.02      0.01      0.01      0.01      0.01      0.01      0.01      0.01
                      0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01
                      0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01
                      0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01
                      0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01
                      0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.00      0.00      0.00
                      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
                      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
                      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
                      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
                      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
                      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
                      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00

 127 LS          SCS LOSS RATE
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                STRTL        0.23  INITIAL ABSTRACTION
               CRVNBR       89.59  CURVE NUMBER
                RTIMP        0.00  PERCENT IMPERVIOUS AREA

            KINEMATIC WAVE
128 UK        OVERLAND-FLOW ELEMENT NO. 1
                    L        300.  OVERLAND FLOW LENGTH
                    S      0.0100  SLOPE
                    N       0.200  ROUGHNESS COEFFICIENT
                   PA       100.0  PERCENT OF SUBBASIN
                DXMIN           5  MINIMUM NUMBER OF DX INTERVALS

            KINEMATIC WAVE
129 RK        COLLECTOR CHANNEL
                    L       2400.  CHANNEL LENGTH
                    S      0.0060  SLOPE
                    N       0.040  CHANNEL ROUGHNESS COEFFICIENT
                   CA        0.22  CONTRIBUTING AREA
                SHAPE        TRAP  CHANNEL SHAPE
                   WD        0.00  BOTTOM WIDTH OR DIAMETER
                    Z       50.00  SIDE SLOPE
               NDXMIN           2  MINIMUM NUMBER OF DX INTERVALS
130 RK        MAIN CHANNEL
                    L       3800.  CHANNEL LENGTH
                    S      0.0030  SLOPE
                    N       0.040  CHANNEL ROUGHNESS COEFFICIENT
                   CA        0.54  CONTRIBUTING AREA
                SHAPE        TRAP  CHANNEL SHAPE
                   WD      300.00  BOTTOM WIDTH OR DIAMETER
                    Z       15.00  SIDE SLOPE
               NDXMIN           2  MINIMUM NUMBER OF DX INTERVALS
               RUPSTQ          NO  ROUTE UPSTREAM HYDROGRAPH

                                                    ***
                         COMPUTED KINEMATIC PARAMETERS
                              VARIABLE TIME STEP
                            (DT SHOWN IS A MINIMUM)

     ELEMENT    ALPHA       M         DT        DX       PEAK    TIME TO     VOLUME    MAXIMUM
                                                                   PEAK                CELERITY
                                   (MIN)      (FT)     (CFS)     (MIN)       (IN)      (FPS)

     PLANE1       0.75      1.67      1.00     16.67    801.27     31.86       2.10      0.27
     COLLECTOR1   0.49      1.33      1.00    200.00    711.65     39.06       2.10      3.32
     MAIN         0.07      1.57      1.00    190.00    577.65     58.75       2.07      3.00

CONTINUITY SUMMARY (AC-FT) - INFLOW=0.0000E+00  EXCESS=0.6084E+02 OUTFLOW=0.5947E+02 BASIN STORAGE=0.9802E+00 PERCENT ERROR=   0.6

                         INTERPOLATED TO SPECIFIED COMPUTATION INTERVAL
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```
                MAIN          0.07      1.57       1.00              577.61     58.00      2.07

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

                        HYDROGRAPH AT STATION    S0040

    TOTAL RAINFALL =    3.19, TOTAL LOSS =    1.07, TOTAL EXCESS =    2.12

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                      6-HR       24-HR       72-HR      6.65-HR
+   (CFS)       (HR)
                          (CFS)
+     578.      0.97                  120.        108.        108.         108.
                        (INCHES)     2.066       2.072       2.072        2.072
                         (AC-FT)      59.         59.         59.          59.

                        CUMULATIVE AREA =    0.54 SQ MI


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


            **************
            *            *
  131 KK    *    N0040   *
            *            *
            **************
                              COMBINE SUBBASIN & CHANNEL HYDROGRAPHS @ N0040

  133 HC          HYDROGRAPH COMBINATION
                       ICOMP           2  NUMBER OF HYDROGRAPHS TO COMBINE

                                                                  ***

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

                        HYDROGRAPH AT STATION    N0040

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                      6-HR       24-HR       72-HR      6.65-HR
+   (CFS)       (HR)
                          (CFS)
+    1817.      1.60                  829.        751.        751.         751.
                        (INCHES)     1.905       1.912       1.912        1.912
                         (AC-FT)      411.        413.        413.         413.

                        CUMULATIVE AREA =    4.05 SQ MI
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*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

          **************
          *            *
134 KK    *     R0040  *
          *            *
          **************
                          ROUTING HYDROGRAPH THROUGH CHANNEL R0040

             HYDROGRAPH ROUTING DATA

136 RS          STORAGE ROUTING
                      NSTPS          1  NUMBER OF SUBREACHES
                       ITYP       FLOW  TYPE OF INITIAL CONDITION
                     RSVRIC      -1.00  INITIAL CONDITION
                          X       0.00 WORKING R AND D COEFFICIENT

137 RC          NORMAL DEPTH CHANNEL
                        ANL      0.050  LEFT OVERBANK N-VALUE
                       ANCH      0.040  MAIN CHANNEL N-VALUE
                        ANR      0.050  RIGHT OVERBANK N-VALUE
                      RLNTH      7600.  REACH LENGTH
                        SEL     0.0082  ENERGY SLOPE
                      ELMAX        0.0  MAX. ELEV. FOR STORAGE/OUTFLOW CALCULATION

                                          CROSS-SECTION DATA
                        --- LEFT OVERBANK --- + ------ MAIN CHANNEL ------- + --- RIGHT OVERBANK ---
139 RY        ELEVATION   2926.00   2924.00   2923.00   2923.00   2923.00   2923.00   2924.00   2926.00
138 RX        DISTANCE       0.00     70.00    150.00    200.00    300.00    350.00    410.00    510.00

                                                   ***

                                          COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

          STORAGE       0.00      5.82     12.24     19.28     26.92     35.18     44.04     53.46     63.26     73.44
          OUTFLOW       0.00     32.01    104.37    210.56    348.84    518.67    720.03    956.28   1225.06   1524.38
        ELEVATION    2923.00   2923.16   2923.32   2923.47   2923.63   2923.79   2923.95   2924.11   2924.26   2924.42

          STORAGE      83.98     94.89    106.18    117.83    129.85    142.24    155.01    168.14    181.64    195.52
          OUTFLOW    1854.06   2214.06   2604.41   3025.23   3476.67   3958.92   4472.21   5016.79   5592.93   6201.34
        ELEVATION    2924.58   2924.74   2924.90   2925.05   2925.21   2925.37   2925.53   2925.69   2925.84   2926.00

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

                      HYDROGRAPH AT STATION    R0040

PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR      6.65-HR
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```
+   (CFS)        (HR)
                          (CFS)
+    1624.       2.13                  796.        718.        718.        718.
                        (INCHES)      1.829       1.829       1.829       1.829
                         (AC-FT)       395.        395.        395.        395.

 PEAK STORAGE   TIME                          MAXIMUM AVERAGE STORAGE
                                        6-HR       24-HR       72-HR      6.65-HR
+  (AC-FT)      (HR)
       77.      2.13                    45.         41.         41.         41.

  PEAK STAGE    TIME                          MAXIMUM AVERAGE STAGE
                                        6-HR       24-HR       72-HR      6.65-HR
+   (FEET)      (HR)
   2924.47      2.12                 2923.94     2923.85     2923.85     2923.85

                        CUMULATIVE AREA =    4.05 SQ MI


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            *            *
 140 KK     *     S0050  *
            *            *
            **************
                              RUNOFF FROM SUBBASIN S0050

               SUBBASIN RUNOFF DATA

 142 BA          SUBBASIN CHARACTERISTICS
                      TAREA        0.86  SUBBASIN AREA

                 PRECIPITATION DATA

  27 PB               STORM        3.19  BASIN TOTAL PRECIPITATION

  28 PI            INCREMENTAL PRECIPITATION PATTERN
                      0.06      0.06      0.07      0.08      0.09      0.11      0.12      0.14      0.17      0.19
                      0.16      0.13      0.11      0.10      0.09      0.08      0.07      0.06      0.05      0.05
                      0.05      0.05      0.04      0.04      0.04      0.04      0.04      0.04      0.03      0.03
                      0.03      0.03      0.03      0.03      0.03      0.03      0.03      0.02      0.02      0.02
                      0.02      0.02      0.02      0.02      0.02      0.02      0.02      0.02      0.02      0.02
                      0.02      0.02      0.02      0.01      0.01      0.01      0.01      0.01      0.01      0.01
                      0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01
                      0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01
                      0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01
                      0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01
                      0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.00      0.00      0.00
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```
          0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
          0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
          0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
          0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
          0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
          0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
          0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00

143 LS    SCS LOSS RATE
               STRTL        0.08  INITIAL ABSTRACTION
              CRVNBR       96.00  CURVE NUMBER
               RTIMP        0.00  PERCENT IMPERVIOUS AREA

            LOSS RATE VARIABLES FOR SECOND OVERLAND FLOW ELEMENT
               STRTL        0.27  INITIAL ABSTRACTION
              CRVNBR       88.27  CURVE NUMBER
               RTIMP        0.00  PERCENT IMPERVIOUS AREA

          KINEMATIC WAVE
144 UK      OVERLAND-FLOW ELEMENT NO. 1
                  L        300.  OVERLAND FLOW LENGTH
                  S      0.0100  SLOPE
                  N       0.100  ROUGHNESS COEFFICIENT
                 PA        13.0  PERCENT OF SUBBASIN
              DXMIN           5  MINIMUM NUMBER OF DX INTERVALS
145 UK      OVERLAND-FLOW ELEMENT NO. 2
                  L        300.  OVERLAND FLOW LENGTH
                  S      0.0100  SLOPE
                  N       0.200  ROUGHNESS COEFFICIENT
                 PA        87.0  PERCENT OF SUBBASIN
              DXMIN           5  MINIMUM NUMBER OF DX INTERVALS

          KINEMATIC WAVE
146 RK      COLLECTOR CHANNEL
                  L       2100.  CHANNEL LENGTH
                  S      0.0090  SLOPE
                  N       0.040  CHANNEL ROUGHNESS COEFFICIENT
                 CA        0.21  CONTRIBUTING AREA
              SHAPE        TRAP  CHANNEL SHAPE
                 WD        0.00  BOTTOM WIDTH OR DIAMETER
                  Z       50.00  SIDE SLOPE
             NDXMIN           2  MINIMUM NUMBER OF DX INTERVALS
147 RK      MAIN CHANNEL
                  L       7600.  CHANNEL LENGTH
                  S      0.0090  SLOPE
                  N       0.040  CHANNEL ROUGHNESS COEFFICIENT
                 CA        0.86  CONTRIBUTING AREA
              SHAPE        TRAP  CHANNEL SHAPE
                 WD      200.00  BOTTOM WIDTH OR DIAMETER
                  Z       50.00  SIDE SLOPE
             NDXMIN           2  MINIMUM NUMBER OF DX INTERVALS
             RUPSTQ          NO  ROUTE UPSTREAM HYDROGRAPH
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COMPUTED KINEMATIC PARAMETERS
VARIABLE TIME STEP
(DT SHOWN IS A MINIMUM)

ELEMENT	ALPHA	M	DT (MIN)	DX (FT)	PEAK (CFS)	TIME TO PEAK (MIN)	VOLUME (IN)	MAXIMUM CELERITY (FPS)
PLANE1	1.49	1.67	1.00	37.50	353.43	18.28	2.72	0.56
PLANE2	0.75	1.67	1.00	15.79	1023.26	33.22	1.99	0.26
COLLECTOR1	0.61	1.33	1.00	233.33	1106.53	37.08	2.08	3.83
MAIN	0.26	1.44	1.25	292.31	862.26	60.30	2.06	4.48

CONTINUITY SUMMARY (AC-FT) - INFLOW=0.0000E+00 EXCESS=0.9677E+02 OUTFLOW=0.9493E+02 BASIN STORAGE=0.1149E+01 PERCENT ERROR= 0.7

INTERPOLATED TO SPECIFIED COMPUTATION INTERVAL

MAIN	0.26	1.44	1.00	861.75	61.00	2.06

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

HYDROGRAPH AT STATION S0050

TOTAL RAINFALL = 3.19, TOTAL LOSS = 1.08, TOTAL EXCESS = 2.10

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW 6-HR	24-HR	72-HR	6.65-HR
+ (CFS)	(HR)					
		(CFS)				
+ 862.	1.02		191.	173.	173.	173.
		(INCHES)	2.057	2.062	2.062	2.062
		(AC-FT)	95.	95.	95.	95.

CUMULATIVE AREA = 0.86 SQ MI

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            **************
            *            *
148 KK      *    N0050   *
            *            *
            **************
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COMBINE SUBBASIN & CHANNEL HYDROGRAPHS @ N0050

151 KO OUTPUT CONTROL VARIABLES

IPRNT	1	PRINT CONTROL
IPLOT	0	PLOT CONTROL
QSCAL	0.	HYDROGRAPH PLOT SCALE

150 HC HYDROGRAPH COMBINATION

ICOMP	2	NUMBER OF HYDROGRAPHS TO COMBINE

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HYDROGRAPH AT STATION N0050
SUM OF 2 HYDROGRAPHS

****

DA	MON	HRMN	ORD	FLOW	*	DA	MON	HRMN	ORD	FLOW	*	DA	MON	HRMN	ORD	FLOW	*	DA	MON	HRMN	ORD	FLOW
1		0000	1	0.	*	1		0140	101	1809.	*	1		0320	201	1203.	*	1		0500	301	485.
1		0001	2	0.	*	1		0141	102	1818.	*	1		0321	202	1193.	*	1		0501	302	480.
1		0002	3	0.	*	1		0142	103	1826.	*	1		0322	203	1183.	*	1		0502	303	476.
1		0003	4	0.	*	1		0143	104	1834.	*	1		0323	204	1173.	*	1		0503	304	471.
1		0004	5	0.	*	1		0144	105	1841.	*	1		0324	205	1163.	*	1		0504	305	467.
1		0005	6	0.	*	1		0145	106	1848.	*	1		0325	206	1153.	*	1		0505	306	463.
1		0006	7	0.	*	1		0146	107	1854.	*	1		0326	207	1143.	*	1		0506	307	459.
1		0007	8	0.	*	1		0147	108	1860.	*	1		0327	208	1133.	*	1		0507	308	454.
1		0008	9	0.	*	1		0148	109	1865.	*	1		0328	209	1123.	*	1		0508	309	450.
1		0009	10	0.	*	1		0149	110	1870.	*	1		0329	210	1113.	*	1		0509	310	446.
1		0010	11	0.	*	1		0150	111	1875.	*	1		0330	211	1103.	*	1		0510	311	442.
1		0011	12	0.	*	1		0151	112	1879.	*	1		0331	212	1093.	*	1		0511	312	438.
1		0012	13	0.	*	1		0152	113	1883.	*	1		0332	213	1084.	*	1		0512	313	434.
1		0013	14	0.	*	1		0153	114	1887.	*	1		0333	214	1074.	*	1		0513	314	430.
1		0014	15	1.	*	1		0154	115	1889.	*	1		0334	215	1064.	*	1		0514	315	426.
1		0015	16	2.	*	1		0155	116	1892.	*	1		0335	216	1055.	*	1		0515	316	422.
1		0016	17	3.	*	1		0156	117	1894.	*	1		0336	217	1045.	*	1		0516	317	418.
1		0017	18	4.	*	1		0157	118	1895.	*	1		0337	218	1036.	*	1		0517	318	414.
1		0018	19	4.	*	1		0158	119	1896.	*	1		0338	219	1027.	*	1		0518	319	410.
1		0019	20	7.	*	1		0159	120	1896.	*	1		0339	220	1019.	*	1		0519	320	406.
1		0020	21	10.	*	1		0200	121	1896.	*	1		0340	221	1010.	*	1		0520	321	402.
1		0021	22	14.	*	1		0201	122	1896.	*	1		0341	222	1001.	*	1		0521	322	399.
1		0022	23	18.	*	1		0202	123	1895.	*	1		0342	223	993.	*	1		0522	323	395.
1		0023	24	26.	*	1		0203	124	1893.	*	1		0343	224	984.	*	1		0523	324	391.
1		0024	25	35.	*	1		0204	125	1891.	*	1		0344	225	976.	*	1		0524	325	387.
1		0025	26	44.	*	1		0205	126	1889.	*	1		0345	226	967.	*	1		0525	326	384.
1		0026	27	57.	*	1		0206	127	1886.	*	1		0346	227	959.	*	1		0526	327	380.
1		0027	28	70.	*	1		0207	128	1883.	*	1		0347	228	950.	*	1		0527	328	376.
1		0028	29	86.	*	1		0208	129	1880.	*	1		0348	229	942.	*	1		0528	329	373.
1		0029	30	102.	*	1		0209	130	1876.	*	1		0349	230	934.	*	1		0529	330	369.
1		0030	31	121.	*	1		0210	131	1871.	*	1		0350	231	926.	*	1		0530	331	366.
1		0031	32	141.	*	1		0211	132	1867.	*	1		0351	232	917.	*	1		0531	332	362.

1	32	33	163.	*	1	0212	133	1862.		1	0352	233	909.	*	1	0532	333	59.
1	33	34	185.	*	1	0213	134	1857.		1	0353	234	901.	*	1	0533	334	56.
1	0034	35	210.	*	1	0214	135	1851.	*	1	0354	235	893.	*	1	0534	335	353.
1	0035	36	236.	*	1	0215	136	1845.	*	1	0355	236	885.	*	1	0535	336	350.
1	0036	37	264.	*	1	0216	137	1839.	*	1	0356	237	877.	*	1	0536	337	347.
1	0037	38	292.	*	1	0217	138	1833.	*	1	0357	238	869.	*	1	0537	338	344.
1	0038	39	322.	*	1	0218	139	1826.	*	1	0358	239	861.	*	1	0538	339	341.
1	0039	40	352.	*	1	0219	140	1819.	*	1	0359	240	853.	*	1	0539	340	338.
1	0040	41	383.	*	1	0220	141	1812.	*	1	0400	241	845.	*	1	0540	341	335.
1	0041	42	416.	*	1	0221	142	1805.	*	1	0401	242	837.	*	1	0541	342	332.
1	0042	43	448.	*	1	0222	143	1797.	*	1	0402	243	829.	*	1	0542	343	329.
1	0043	44	481.	*	1	0223	144	1789.	*	1	0403	244	822.	*	1	0543	344	326.
1	0044	45	513.	*	1	0224	145	1781.	*	1	0404	245	814.	*	1	0544	345	323.
1	0045	46	546.	*	1	0225	146	1772.	*	1	0405	246	806.	*	1	0545	346	321.
1	0046	47	582.	*	1	0226	147	1764.	*	1	0406	247	799.	*	1	0546	347	318.
1	0047	48	619.	*	1	0227	148	1755.	*	1	0407	248	791.	*	1	0547	348	315.
1	0048	49	657.	*	1	0228	149	1746.	*	1	0408	249	784.	*	1	0548	349	312.
1	0049	50	694.	*	1	0229	150	1737.	*	1	0409	250	776.	*	1	0549	350	309.
1	0050	51	732.	*	1	0230	151	1728.	*	1	0410	251	769.	*	1	0550	351	307.
1	0051	52	770.	*	1	0231	152	1718.	*	1	0411	252	762.	*	1	0551	352	304.
1	0052	53	809.	*	1	0232	153	1709.	*	1	0412	253	755.	*	1	0552	353	301.
1	0053	54	852.	*	1	0233	154	1699.	*	1	0413	254	749.	*	1	0553	354	299.
1	0054	55	896.	*	1	0234	155	1689.	*	1	0414	255	742.	*	1	0554	355	296.
1	0055	56	940.	*	1	0235	156	1680.	*	1	0415	256	735.	*	1	0555	356	293.
1	0056	57	984.	*	1	0236	157	1670.	*	1	0416	257	729.	*	1	0556	357	291.
1	0057	58	1027.	*	1	0237	158	1660.	*	1	0417	258	722.	*	1	0557	358	288.
1	0058	59	1071.	*	1	0238	159	1650.	*	1	0418	259	715.	*	1	0558	359	285.
1	0059	60	1112.	*	1	0239	160	1640.	*	1	0419	260	709.	*	1	0559	360	283.
1	0100	61	1146.	*	1	0240	161	1630.	*	1	0420	261	702.	*	1	0600	361	280.
1	0101	62	1176.	*	1	0241	162	1619.	*	1	0421	262	696.	*	1	0601	362	278.
1	0102	63	1201.	*	1	0242	163	1609.	*	1	0422	263	689.	*	1	0602	363	275.
1	0103	64	1225.	*	1	0243	164	1598.	*	1	0423	264	683.	*	1	0603	364	273.
1	0104	65	1248.	*	1	0244	165	1588.	*	1	0424	265	677.	*	1	0604	365	270.
1	0105	66	1268.	*	1	0245	166	1577.	*	1	0425	266	670.	*	1	0605	366	268.
1	0106	67	1287.	*	1	0246	167	1566.	*	1	0426	267	664.	*	1	0606	367	265.
1	0107	68	1306.	*	1	0247	168	1555.	*	1	0427	268	658.	*	1	0607	368	263.
1	0108	69	1324.	*	1	0248	169	1544.	*	1	0428	269	651.	*	1	0608	369	261.
1	0109	70	1344.	*	1	0249	170	1533.	*	1	0429	270	645.	*	1	0609	370	258.
1	0110	71	1363.	*	1	0250	171	1522.	*	1	0430	271	639.	*	1	0610	371	256.
1	0111	72	1381.	*	1	0251	172	1511.	*	1	0431	272	633.	*	1	0611	372	254.
1	0112	73	1399.	*	1	0252	173	1500.	*	1	0432	273	627.	*	1	0612	373	251.
1	0113	74	1416.	*	1	0253	174	1489.	*	1	0433	274	621.	*	1	0613	374	249.
1	0114	75	1433.	*	1	0254	175	1478.	*	1	0434	275	615.	*	1	0614	375	247.
1	0115	76	1452.	*	1	0255	176	1467.	*	1	0435	276	609.	*	1	0615	376	244.
1	0116	77	1471.	*	1	0256	177	1456.	*	1	0436	277	603.	*	1	0616	377	242.
1	0117	78	1488.	*	1	0257	178	1445.	*	1	0437	278	598.	*	1	0617	378	240.
1	0118	79	1505.	*	1	0258	179	1434.	*	1	0438	279	592.	*	1	0618	379	238.
1	0119	80	1522.	*	1	0259	180	1423.	*	1	0439	280	587.	*	1	0619	380	235.
1	0120	81	1538.	*	1	0300	181	1412.	*	1	0440	281	581.	*	1	0620	381	233.
1	0121	82	1553.	*	1	0301	182	1401.	*	1	0441	282	575.	*	1	0621	382	231.
1	0122	83	1570.	*	1	0302	183	1390.	*	1	0442	283	570.	*	1	0622	383	229.
1	0123	84	1587.	*	1	0303	184	1379.	*	1	0443	284	565.	*	1	0623	384	227.

1	24	85	1604.	*	1	0304	185	1368.		1	0444	285	559.	*	1	0624	385	24.
1	.25	86	1620.	*	1	0305	186	1357.		1	0445	286	554.	*	1	0625	386	22.
1	0126	87	1635.	*	1	0306	187	1346.	*	1	0446	287	549.	*	1	0626	387	220.
1	0127	88	1650.	*	1	0307	188	1336.	*	1	0447	288	544.	*	1	0627	388	218.
1	0128	89	1664.	*	1	0308	189	1326.	*	1	0448	289	539.	*	1	0628	389	217.
1	0129	90	1678.	*	1	0309	190	1315.	*	1	0449	290	535.	*	1	0629	390	215.
1	0130	91	1692.	*	1	0310	191	1305.	*	1	0450	291	530.	*	1	0630	391	213.
1	0131	92	1704.	*	1	0311	192	1295.	*	1	0451	292	525.	*	1	0631	392	211.
1	0132	93	1718.	*	1	0312	193	1285.	*	1	0452	293	521.	*	1	0632	393	210.
1	0133	94	1731.	*	1	0313	194	1274.	*	1	0453	294	516.	*	1	0633	394	208.
1	0134	95	1744.	*	1	0314	195	1264.	*	1	0454	295	511.	*	1	0634	395	206.
1	0135	96	1756.	*	1	0315	196	1254.	*	1	0455	296	507.	*	1	0635	396	205.
1	0136	97	1768.	*	1	0316	197	1244.	*	1	0456	297	502.	*	1	0636	397	203.
1	0137	98	1779.	*	1	0317	198	1234.	*	1	0457	298	498.	*	1	0637	398	201.
1	0138	99	1789.	*	1	0318	199	1223.	*	1	0458	299	493.	*	1	0638	399	199.
1	0139	100	1799.	*	1	0319	200	1213.	*	1	0459	300	489.	*	1	0639	400	198.
				*					*					*				

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PEAK FLOW (CFS)	TIME (HR)		MAXIMUM AVERAGE FLOW 6-HR	24-HR	72-HR	6.65-HR
1896.	1.98	(CFS)	981.	891.	891.	891.
		(INCHES)	1.859	1.870	1.870	1.870
		(AC-FT)	487.	490.	490.	490.

CUMULATIVE AREA = 4.91 SQ MI

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RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
HYDROGRAPH AT	S0010	585.	1.40	161.	146.	146.	0.78		
HYDROGRAPH AT	S0015	342.	1.07	81.	74.	74.	0.40		
2 COMBINED AT	N0015	845.	1.33	243.	220.	220.	1.18		
ROUTED TO	R0015	819.	1.43	241.	218.	218.	1.18		
								3048.85	1.43
HYDROGRAPH AT									

+		S0018	207.	0.63	33.	29.	29.	0.16		
	HYDROGRAPH AT									
+		S0020	705.	1.35	196.	177.	177.	0.92		
	2 COMBINED AT									
+		N0020	777.	1.33	228.	207.	207.	1.08		
	2 COMBINED AT									
+		N0020	1585.	1.37	468.	424.	424.	2.26		
	ROUTED TO									
+		R0020	1095.	1.83	460.	417.	417.	2.26		
+									3011.42	1.82
	HYDROGRAPH AT									
+		S0025	400.	0.88	81.	73.	73.	0.37		
	HYDROGRAPH AT									
+		S0030	860.	1.03	182.	164.	164.	0.88		
	2 COMBINED AT									
+		N0030	1200.	1.00	263.	238.	238.	1.24		
	2 COMBINED AT									
+		N0030	1615.	1.52	721.	654.	654.	3.51		
	ROUTED TO									
+		R0030	1571.	1.77	710.	643.	643.	3.51		
+									2976.90	1.77
	HYDROGRAPH AT									
+		S0040	578.	0.97	120.	108.	108.	0.54		
	2 COMBINED AT									
+		N0040	1817.	1.60	829.	751.	751.	4.05		
	ROUTED TO									
+		R0040	1624.	2.13	796.	718.	718.	4.05		
+									2924.47	2.12
	HYDROGRAPH AT									
+		S0050	862.	1.02	191.	173.	173.	0.86		
	2 COMBINED AT									
+		N0050	1896.	1.98	981.	891.	891.	4.91		

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SUMMARY OF KINEMATIC WAVE - MUSKINGUM-CUNGE ROUTING
(FLOW IS DIRECT RUNOFF WITHOUT BASE FLOW)

						INTERPOLATED TO COMPUTATION INTERVAL			
ISTAQ	ELEMENT	DT	PEAK	TIME TO	VOLUME	DT	PEAK	TIME TO	VOLUME

				PEAK				PEAK	
		(MIN)	(CFS)	(MIN)	(IN)	(MIN)	(CFS)	(MIN)	(IN)
S0010	MANE	1.25	585.83	83.80	1.92	1.00	585.45	84.00	1.92

CONTINUITY SUMMARY (AC-FT) - INFLOW=0.0000E+00 EXCESS=0.8198E+02 OUTFLOW=0.8024E+02 BASIN STORAGE=0.1314E+01 PERCENT ERROR= 0.5

S0015	MANE	1.00	342.55	64.21	1.89	1.00	342.35	64.00	1.89

CONTINUITY SUMMARY (AC-FT) - INFLOW=0.0000E+00 EXCESS=0.4117E+02 OUTFLOW=0.4047E+02 BASIN STORAGE=0.4724E+00 PERCENT ERROR= 0.6

S0018	MANE	1.00	207.09	37.84	1.96	1.00	207.05	38.00	1.96

CONTINUITY SUMMARY (AC-FT) - INFLOW=0.0000E+00 EXCESS=0.1632E+02 OUTFLOW=0.1617E+02 BASIN STORAGE=0.5898E-01 PERCENT ERROR= 0.6

S0020	MANE	1.00	705.39	81.41	1.98	1.00	704.92	81.00	1.98

CONTINUITY SUMMARY (AC-FT) - INFLOW=0.0000E+00 EXCESS=0.9922E+02 OUTFLOW=0.9735E+02 BASIN STORAGE=0.1319E+01 PERCENT ERROR= 0.6

S0025	MANE	1.00	400.24	52.99	2.06	1.00	400.21	53.00	2.06

CONTINUITY SUMMARY (AC-FT) - INFLOW=0.0000E+00 EXCESS=0.4075E+02 OUTFLOW=0.4033E+02 BASIN STORAGE=0.2005E+00 PERCENT ERROR= 0.5

S0030	MANE	1.00	860.59	61.45	1.93	1.00	860.42	62.00	1.93

CONTINUITY SUMMARY (AC-FT) - INFLOW=0.0000E+00 EXCESS=0.9167E+02 OUTFLOW=0.9036E+02 BASIN STORAGE=0.6601E+00 PERCENT ERROR= 0.7

S0040	MANE	1.00	577.65	58.75	2.07	1.00	577.61	58.00	2.07

CONTINUITY SUMMARY (AC-FT) - INFLOW=0.0000E+00 EXCESS=0.6084E+02 OUTFLOW=0.5947E+02 BASIN STORAGE=0.9802E+00 PERCENT ERROR= 0.6

S0050	MANE	1.25	862.26	60.30	2.06	1.00	861.75	61.00	2.06

CONTINUITY SUMMARY (AC-FT) - INFLOW=0.0000E+00 EXCESS=0.9677E+02 OUTFLOW=0.9493E+02 BASIN STORAGE=0.1149E+01 PERCENT ERROR= 0.7

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

CAPACITY CALCULATIONS
FOR
CIVANO ROADSIDE DITCHES

Culvert Calculator Report
2-10x4 0.50% K=0.20

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	103.00	ft	Headwater Depth/Height	0.76	
Computed Headwater Elev	103.06	ft	Discharge	300.00	cfs
Inlet Control HW Elev.	103.01	ft	Tailwater Elevation	0.00	ft
Outlet Control HW Elev.	103.06	ft	Control Type	Entrance Control	

Grades					
Upstream Invert	100.00	ft	Downstream Invert	99.50	ft
Length	100.00	ft	Constructed Slope	0.005000	ft/ft

Hydraulic Profile					
Profile	S2		Depth, Downstream	1.65	ft
Slope Type	Steep		Normal Depth	1.62	ft
Flow Regime	Supercritical		Critical Depth	1.91	ft
Velocity Downstream	9.11	ft/s	Critical Slope	0.003056	ft/ft

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	10.00	ft
Section Size	10 x 4 ft		Rise	4.00	ft
Number Sections	2				

Outlet Control Properties					
Outlet Control HW Elev.	103.06	ft	Upstream Velocity Head	0.96	ft
Ke	0.20		Entrance Loss	0.19	ft

Inlet Control Properties					
Inlet Control HW Elev.	103.01	ft	Flow Control	N/A	
Inlet Type	90° headwall w 45° bevels		Area Full	80.0	ft²
K	0.49500		HDS 5 Chart	10	
M	0.66700		HDS 5 Scale	2	
C	0.03140		Equation Form	2	
Y	0.82000				

Rating Table Report
2-10x4 0.50% K=0.20

Range Data:

	Minimum	Maximum	Increment	
Discharge	0.00	500.00	50.00	cfs

Discharge (cfs	HW Elev. (ft)
0.00	100.00
50.00	100.93
100.00	101.47
150.00	101.93
200.00	102.33
250.00	102.71
300.00	103.06
350.00	103.39
400.00	103.71
450.00	104.01
500.00	104.30

Worksheet
Worksheet for Triangular Channel

Project Description	
Worksheet	1' depth 3:1 V-Dil
Flow Element	Triangular Chann
Method	Manning's Formu
Solve For	Discharge

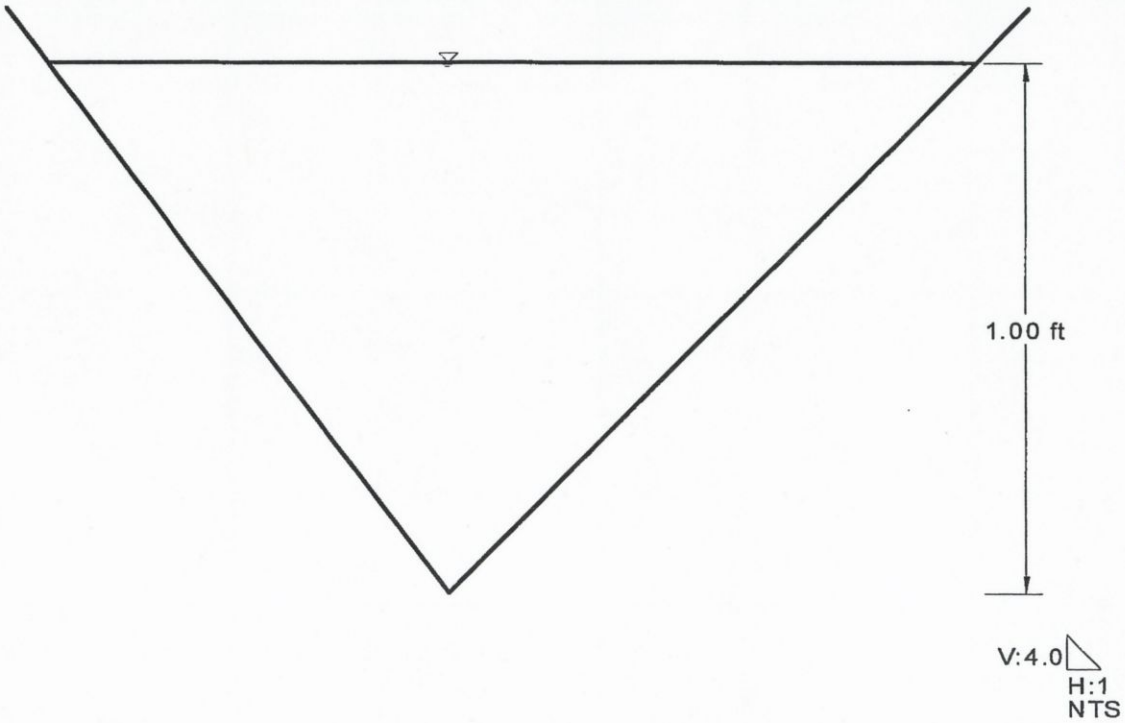
Input Data		
Mannings Coeffic	0.025	
Channel Slope	005000	ft/ft
Depth	1.00	ft
Left Side Slope	3.00	H : V
Right Side Slope	4.00	H : V

Results		
Discharge	9.02	cfs
Flow Area	3.5	ft²
Wetted Perim	7.29	ft
Top Width	7.00	ft
Critical Depth	0.84	ft
Critical Slope	0.012838	ft/ft
Velocity	2.58	ft/s
Velocity Head	0.10	ft
Specific Energ	1.10	ft
Froude Numb	0.64	
Flow Type	Subcritical	

Cross Section
Cross Section for Triangular Channel

Project Description	
Worksheet	1' depth 3:1 V-Dil
Flow Element	Triangular Chann
Method	Manning's Formu
Solve For	Discharge

Section Data		
Mannings Coeffic	0.025	
Channel Slope	005000	ft/ft
Depth	1.00	ft
Left Side Slope	3.00	H : V
Right Side Slope	4.00	H : V
Discharge	9.02	cfs



Worksheet
Worksheet for Irregular Channel

Project Description	
Worksheet	TYPICAL SEC'
Flow Element	Irregular Chan
Method	Manning's Forr
Solve For	Discharge

Input Data		
Channel Slope	005000	ft/ft
Water Surface Elev.	100.00	ft

Options	
Current Roughness Meth	ved Lotter's Method
Open Channel Weighting	ved Lotter's Method
Closed Channel Weightin	Horton's Method

Results		
Mannings Coeffic	0.025	
Elevation Range	.40 to 100.00	
Discharge	43.75	cfs
Flow Area	18.7	ft²
Wetted Perimete	45.27	ft
Top Width	44.80	ft
Actual Depth	1.60	ft
Critical Elevation	99.85	ft
Critical Slope	0.012955	ft/ft
Velocity	2.33	ft/s
Velocity Head	0.08	ft
Specific Energy	100.08	ft
Froude Number	0.64	
Flow Type	Subcritical	

Roughness Segments

Start Station	End Station	Mannings Coefficient
1+00	1+45	0.025

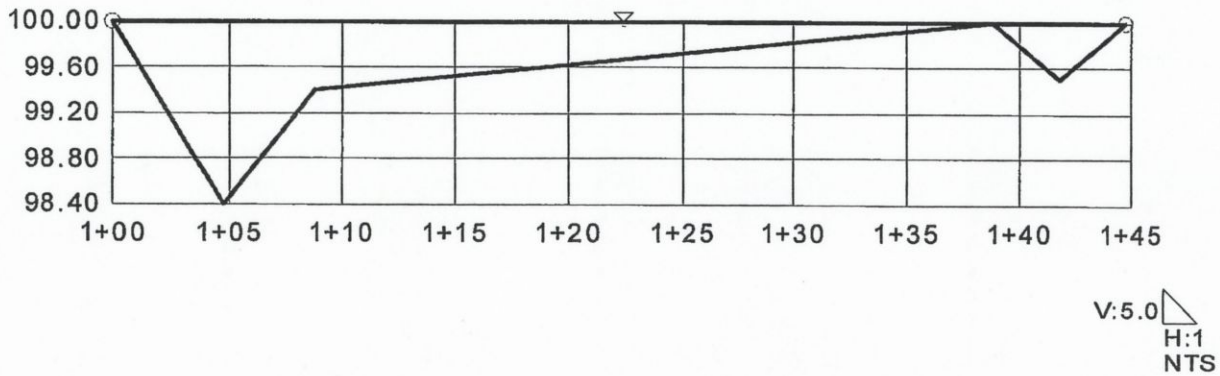
Natural Channel Points

Station (ft)	Elevation (ft)
1+00	100.00
1+05	98.40
1+09	99.40
1+39	100.00
1+42	99.50
1+45	100.00

Cross Section
Cross Section for Irregular Channel

Project Description	
Worksheet	TYPICAL SEC
Flow Element	Irregular Chan
Method	Manning's Forr
Solve For	Discharge

Section Data		
Mannings Coefficie	0.025	
Channel Slope	0.005000	ft/ft
Water Surface Elev.	100.00	ft
Elevation Range	.40 to 100.00	
Discharge	43.75	cfs



ROADSIDE CHANNEL
HEC-RAS
RESULTS

ROADSIDE CHANNEL BETWEEN APPROXIMATELY STA. 448+00 AND 453+00

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: 448-453
Project File : 448453.prj
Run Date and Time: 2/19/2010 3:41:55 AM

Project in English units

PLAN DATA

Plan Title: Plan 01
Plan File :
t:\7TED069904\HYDRO\DRAINAGE\CALCS\Hydraulics\Channels\Ras-Final\revised\448453.p01

Geometry Title: 448-453
Geometry File :
t:\7TED069904\HYDRO\DRAINAGE\CALCS\Hydraulics\Channels\Ras-Final\revised\448453.g11

Flow Title : 0 Flow Profiles
Flow File :
t:\7TED069904\HYDRO\DRAINAGE\CALCS\Hydraulics\Channels\Ras-Final\revised\448453.F01

Plan Summary Information:

Number of:	Cross Sections =	11	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:\7TED069904\HYDRO\DRAINAGE\CALCS\Hydraulics\Channels\Ras-Final\revised\448453.F01

Flow Data (cfs)

River	Reach	RS	PF 1
River #1	Reach #1	453	32

Boundary Conditions

River	Reach	Profile	Upstream	Downstream
River #1	Reach #1	PF 1	Normal S = 0.005	

GEOMETRY DATA

Geometry Title: 448-453
Geometry File :
t:\7TED069904\HYDRO\DRAINAGE\CALCS\Hydraulics\Channels\Ras-Final\revised\448453.g11

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 453

INPUT
Description:
Station Elevation Data num= 25

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
77.74	2844	77.74	2843	89.46	2842.77	116.92	2842.22	120.75	2842.14
120.75	2843.14	152.66	2843.21	153.48	2843	155.66	2842.45	155.71	2842.45
155.76	2842.44	165.25	2841.37	165.93	2841.49	166.22	2841.54	170.53	2842.39
172.18	2842.48	175.18	2842.52	178.62	2842.65	184.19	2842.69	193.73	2842.71
204.09	2842.73	208.65	2842.93	212.62	2843.04	215.52	2843.04	218.58	2843.19

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
77.74	.016	152.66	.03	178.62	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
152.66	178.62	50	50	50	.1	.3

Left Levee Station= 152.66 Elevation= 2843.21

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 452.5

INPUT

Description:
Station Elevation Data num= 28

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
76.9	2843.75	76.9	2842.75	105.67	2842.18	119.91	2841.89	119.91	2842.89
125.91	2842.77	133.9	2840.77	134.82	2840.89	137.29	2841.2	140.73	2841.62
145.91	2842.27	146.2	2842.27	146.88	2842.28	158.89	2842.4	159.91	2842.41
162.67	2841.72	162.72	2841.72	163.45	2841.72	163.88	2841.72	163.93	2841.72
170.66	2841.82	173.76	2842.08	174.92	2842.17	195.85	2842.36	195.85	2842.93
199.04	2842.94	202.34	2842.94	219.24	2843.05				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
76.9	.016	125.91	.03	159.91	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
125.91	159.91	50	50	50	.1	.3

Left Levee Station= 125.91 Elevation= 2842.77
Right Levee Station= 159.91 Elevation= 2842.41

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 452

INPUT
Description:
Station Elevation Data num= 22

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
76.83	2843.5	76.83	2842.5	111.94	2841.8	119.84	2841.64	119.84	2842.64
125.84	2842.52	133.83	2840.52	145.84	2842.02	146.81	2842.03	158.82	2842.15
159.84	2842.16	161.83	2841.66	161.87	2841.66	163.57	2841.73	166.72	2841.87
168.07	2841.94	169.19	2841.95	172.24	2841.78	175.43	2842.28	175.48	2842.29
175.63	2842.3	196.89	2842.33						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
76.83	.016	125.84	.03	159.84	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
125.84	159.84	50	50	50	.1	.3

Left Levee Station= 125.84 Elevation= 2842.52
Right Levee Station= 159.84 Elevation= 2842.16

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 451.5

INPUT
Description:
Station Elevation Data num= 18

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
77.01	2843.75	77.01	2842.25	121.66	2841.36	122.34	2841.36	122.34	2842.86
127.67	2842.77	137.65	2840.27	146.8	2841.91	147.67	2842.06	148.59	2842.07
157.11	2842.17	157.79	2842.18	159.05	2842.19	160.6	2842.21	161.62	2842.22
162.78	2842.61	162.83	2842.61	163.51	2842.66				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
77.01	.016	127.67	.03	147.67	.035

```
Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
        127.67  147.67               50      50      50             .1       .3
Left Levee      Station=  127.67      Elevation= 2842.77

CROSS SECTION


RIVER: River #1
REACH: Reach #1            RS: 451

INPUT
Description:
Station Elevation Data     num=      18
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
   77.79  2843.5   77.79    2842    83.5 2841.89  125.78 2841.04  126.46 2841.04
  126.46 2842.54  131.79  2842.5  141.38 2840.11  141.82    2840   143.7 2840.39
  144.72 2840.59   150.1 2841.68  151.79 2842.02  152.76 2842.03  152.86 2842.03
  164.77  2842.2  165.79 2842.22  166.32  2842.4

Manning's n Values         num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
   77.79    .016  131.79     .03  151.79    .035

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
        131.79  151.79               50      50      50             .1       .3
Left Levee      Station=  131.79      Elevation=  2842.5

CROSS SECTION


RIVER: River #1
REACH: Reach #1            RS: 450.5

INPUT
Description:
Station Elevation Data     num=      15
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
   78.35 2843.27   79.37 2843.27   79.42 2841.77   79.46 2841.77   81.26 2841.75
  132.59 2840.72  133.27 2840.72  133.27 2842.22   138.6 2842.23  148.58 2839.73
  150.61 2840.18  150.61 2840.19   158.6 2841.98  159.57 2841.99  171.58  2842.2

Manning's n Values         num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
   78.35    .016   138.6     .03   158.6    .035

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
         138.6   158.6               50      50      50             .1       .3
Left Levee      Station=   138.6      Elevation= 2842.23

CROSS SECTION


RIVER: River #1
REACH: Reach #1            RS: 450

INPUT
Description:
Station Elevation Data     num=      14
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
   78.17 2843.09   87.52 2841.59   87.52  2841.5   142.2 2840.41  142.87 2840.41
  142.87 2841.91   148.2 2841.96  158.23 2839.46  159.97  2839.9  160.89 2840.11
   168.2 2841.93  168.44 2841.94  169.22 2841.95  176.77  2842.1
```

```
Manning's n Values          num=        3
     Sta   n Val      Sta   n Val      Sta   n Val
   78.17    .016   148.2     .03   168.2    .035

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
         148.2   168.2               50      50      50             .1       .3
Left Levee      Station=   148.2      Elevation= 2841.96

CROSS SECTION


RIVER: River #1
REACH: Reach #1            RS: 449.5

INPUT
Description:
Station Elevation Data     num=       16
     Sta    Elev      Sta    Elev      Sta    Elev      Sta    Elev      Sta    Elev
    78.4 2842.89    78.4 2841.39   92.25 2841.25  147.22 2840.15   147.9 2840.15
   147.9 2841.65  153.23  2841.7  163.26  2839.2     165 2839.65  165.82 2839.85
  173.23  2841.7  174.25 2841.72  174.44 2841.73  177.83  2841.8  179.86 2841.84
  186.26 2841.96

Manning's n Values          num=        3
     Sta   n Val      Sta   n Val      Sta   n Val
    78.4    .016  153.23     .03  173.23    .035

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
        153.23  173.23               50      50      50             .1       .3
Left Levee      Station=  153.23      Elevation=  2841.7

CROSS SECTION


RIVER: River #1
REACH: Reach #1            RS: 449

INPUT
Description:
Station Elevation Data     num=       17
     Sta    Elev      Sta    Elev      Sta    Elev      Sta    Elev      Sta    Elev
   77.55 2842.63   78.18 2842.64   78.23 2841.14   79.63 2841.13   92.22    2841
  143.56 2839.97  147.19  2839.9  147.87  2839.9  147.87  2841.4   153.2 2841.45
  163.23 2838.95  165.02 2839.41  169.52 2840.53   173.2 2841.45  174.22 2841.47
  178.58 2841.56  186.23 2841.71

Manning's n Values          num=        3
     Sta   n Val      Sta   n Val      Sta   n Val
   77.55    .016   153.2     .03   173.2    .035

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
         153.2   173.2               50      50      50             .1       .3
Left Levee      Station=   153.2      Elevation= 2841.45

CROSS SECTION


RIVER: River #1
REACH: Reach #1            RS: 448.5

INPUT
Description:
Station Elevation Data     num=       16
```

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
76.63	2842.39	76.68	2840.89	86.41	2840.79	90.67	2840.75	145.64	2839.65
146.32	2839.65	146.32	2841.15	151.65	2841.2	155.52	2840.234	161.68	2838.7
168.84	2840.49	169.76	2840.73	171.65	2841.2	172.67	2841.22	182.84	2841.43
184.68	2841.46								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
76.63	.016	151.65	.03	171.65	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
151.65	171.65	50	50	50	.1	.3

Left Levee Station= 151.65 Elevation= 2841.2

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 448

INPUT
Description:
Station Elevation Data num= 20

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
75.58	2842.14	75.63	2840.64	89.62	2840.5	121.06	2839.87	144.06	2839.41
144.11	2839.41	144.35	2839.41	144.69	2839.41	144.74	2840.91	150.07	2840.96
160.05	2838.46	167.51	2840.54	167.51	2840.55	168.91	2840.94	170.07	2840.96
173.7	2841.04	173.9	2841.04	180.92	2841.18	181.94	2841.2	185.96	2842.54

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
75.58	.016	150.07	.03	168.91	.035

Bank Sta: Left	Right	Coeff Contr.	Expan.
150.07	168.91	.1	.3

Left Levee Station= 150.07 Elevation= 2840.96

SUMMARY OF MANNING'S N VALUES

River:River #1

Reach	River Sta.	n1	n2	n3
Reach #1	453	.016	.03	.035
Reach #1	452.5	.016	.03	.035
Reach #1	452	.016	.03	.035
Reach #1	451.5	.016	.03	.035
Reach #1	451	.016	.03	.035
Reach #1	450.5	.016	.03	.035
Reach #1	450	.016	.03	.035
Reach #1	449.5	.016	.03	.035
Reach #1	449	.016	.03	.035
Reach #1	448.5	.016	.03	.035
Reach #1	448	.016	.03	.035

SUMMARY OF REACH LENGTHS

River: River #1

Reach	River Sta.	Left	Channel	Right
Reach #1	453	50	50	50
Reach #1	452.5	50	50	50
Reach #1	452	50	50	50
Reach #1	451.5	50	50	50
Reach #1	451	50	50	50
Reach #1	450.5	50	50	50
Reach #1	450	50	50	50
Reach #1	449.5	50	50	50
Reach #1	449	50	50	50
Reach #1	448.5	50	50	50
Reach #1	448			

SUMMARY OF CONTRACTION AND EXPANSION COEFFICIENTS
River: River #1

Reach	River Sta.	Contr.	Expan.
Reach #1	453	.1	.3
Reach #1	452.5	.1	.3
Reach #1	452	.1	.3
Reach #1	451.5	.1	.3
Reach #1	451	.1	.3
Reach #1	450.5	.1	.3
Reach #1	450	.1	.3
Reach #1	449.5	.1	.3
Reach #1	449	.1	.3
Reach #1	448.5	.1	.3
Reach #1	448	.1	.3

Profile Output Table - Standard Table 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.
E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	
			(cfs)	(ft)	(ft)	(ft)
(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		
Reach #1	453	PF 1	32.00	2841.37	2842.49	2842.42
2842.69	0.012944	3.56	9.00	17.78	0.88	
Reach #1	452.5	PF 1	32.00	2840.77	2842.25	2841.90
2842.34	0.003695	2.44	13.13	17.77	0.50	
Reach #1	452	PF 1	32.00	2840.52	2842.08	2841.64
2842.15	0.003758	2.18	14.70	23.95	0.49	
Reach #1	451.5	PF 1	32.00	2840.27	2841.82	2841.50
2841.94	0.004528	2.77	11.53	14.86	0.55	
Reach #1	451	PF 1	32.00	2840.00	2841.59	2841.27
2841.71	0.004690	2.85	11.21	14.17	0.57	
Reach #1	450.5	PF 1	32.00	2839.73	2841.34	2841.02
2841.47	0.004829	2.92	10.95	13.60	0.57	
Reach #1	450	PF 1	32.00	2839.46	2841.09	2840.78
2841.23	0.005010	3.00	10.68	13.12	0.59	
Reach #1	449.5	PF 1	32.00	2839.20	2840.84	2840.52
2840.98	0.004967	2.99	10.70	13.10	0.58	
Reach #1	449	PF 1	32.00	2838.95	2840.60	2840.27

2840.73	0.004821	2.96	10.82	13.18	0.57	
Reach #1	448.5	PF 1	32.00	2838.70	2840.38	2840.02
2840.50	0.004282	2.83	11.31	13.47	0.54	
Reach #1	448	PF 1	32.00	2838.46	2840.13	2839.80
2840.27	0.005001	3.03	10.55	12.64	0.59	

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	453	PF 1	2842.69	2842.49	0.20	
0.31 0.03		32.00		17.78		
Reach #1	452.5	PF 1	2842.34	2842.25	0.09	
0.19 0.01		32.00		17.77		
Reach #1	452	PF 1	2842.15	2842.08	0.07	
0.21 0.00		32.00		23.95		
Reach #1	451.5	PF 1	2841.94	2841.82	0.12	
0.23 0.00		32.00		14.86		
Reach #1	451	PF 1	2841.71	2841.59	0.13	
0.24 0.00		32.00		14.17		
Reach #1	450.5	PF 1	2841.47	2841.34	0.13	
0.25 0.00		32.00		13.60		
Reach #1	450	PF 1	2841.23	2841.09	0.14	
0.25 0.00		32.00		13.12		
Reach #1	449.5	PF 1	2840.98	2840.84	0.14	
0.24 0.00		32.00		13.10		
Reach #1	449	PF 1	2840.73	2840.60	0.14	
0.23 0.00		32.00		13.18		
Reach #1	448.5	PF 1	2840.50	2840.38	0.12	
0.23 0.00		32.00		13.47		
Reach #1	448	PF 1	2840.27	2840.13	0.14	
		32.00		12.64		

ERRORS WARNINGS AND NOTES
Errors Warnings and Notes for Plan : 448-453

River: River #1 Reach: Reach #1 RS: 453 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.
Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was used.
River: River #1 Reach: Reach #1 RS: 452.5 Profile: PF 1
Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was used.
River: River #1 Reach: Reach #1 RS: 452 Profile: PF 1
Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was used.
River: River #1 Reach: Reach #1 RS: 451.5 Profile: PF 1

Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was used.

River: River #1 Reach: Reach #1 RS: 451 Profile: PF 1

Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was used.

River: River #1 Reach: Reach #1 RS: 450.5 Profile: PF 1

Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was used.

River: River #1 Reach: Reach #1 RS: 450 Profile: PF 1

Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was used.

River: River #1 Reach: Reach #1 RS: 449.5 Profile: PF 1

Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was used.

River: River #1 Reach: Reach #1 RS: 449 Profile: PF 1

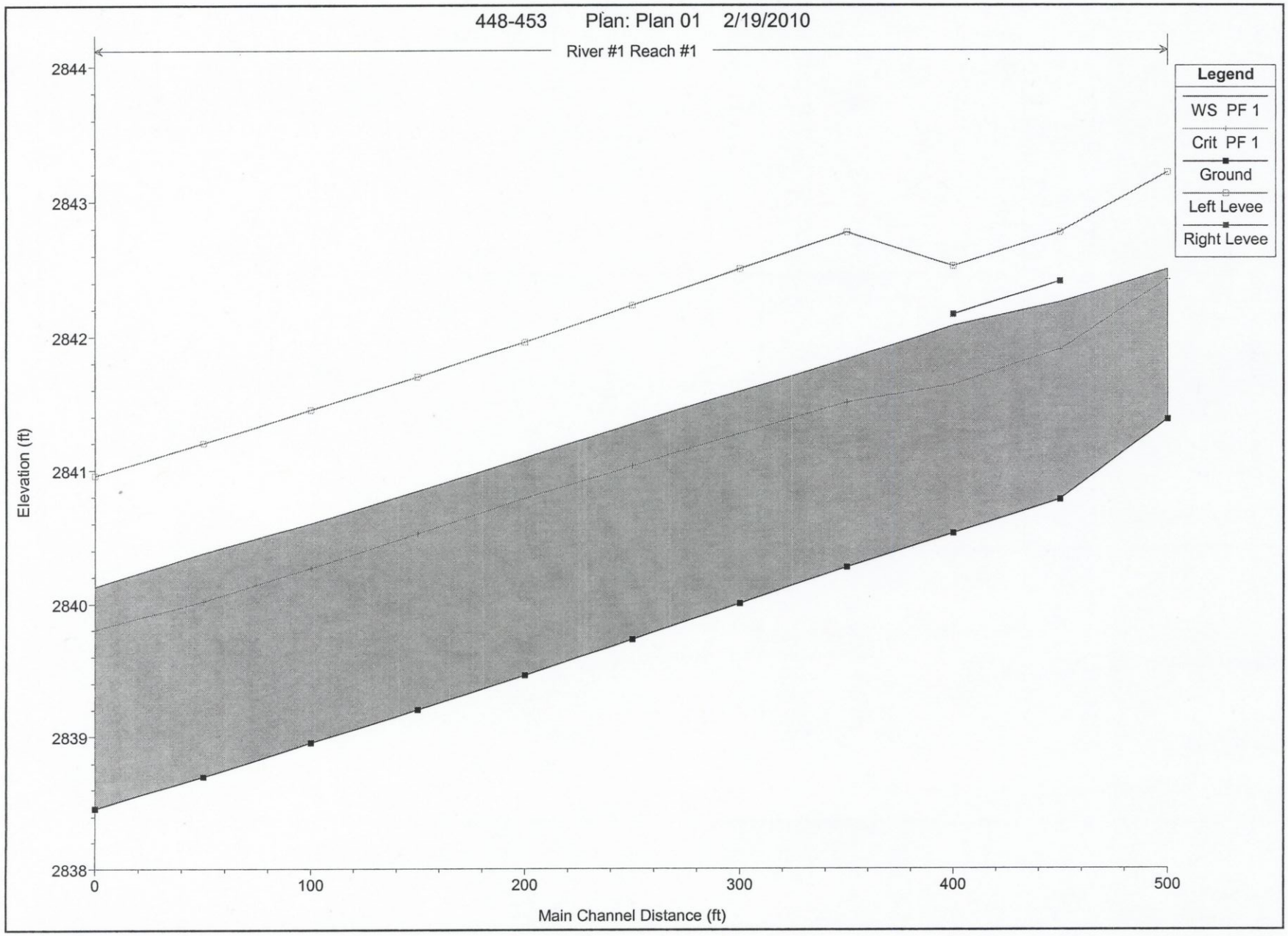
Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was used.

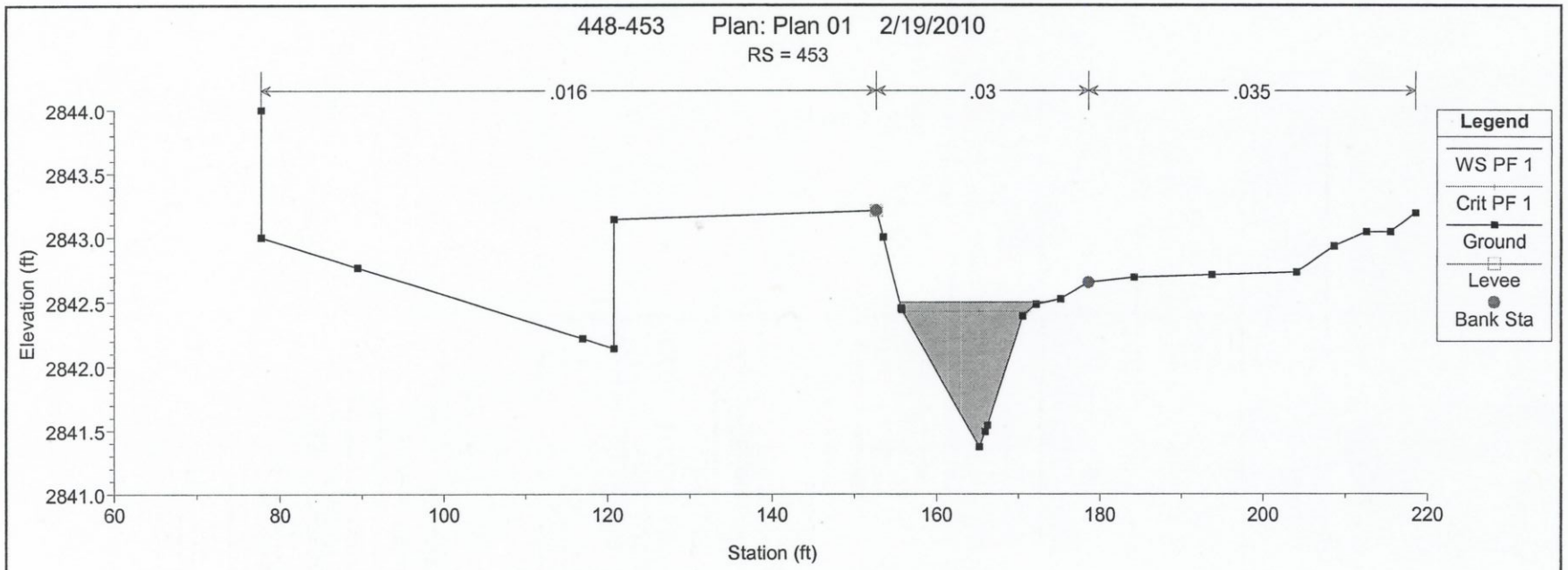
River: River #1 Reach: Reach #1 RS: 448.5 Profile: PF 1

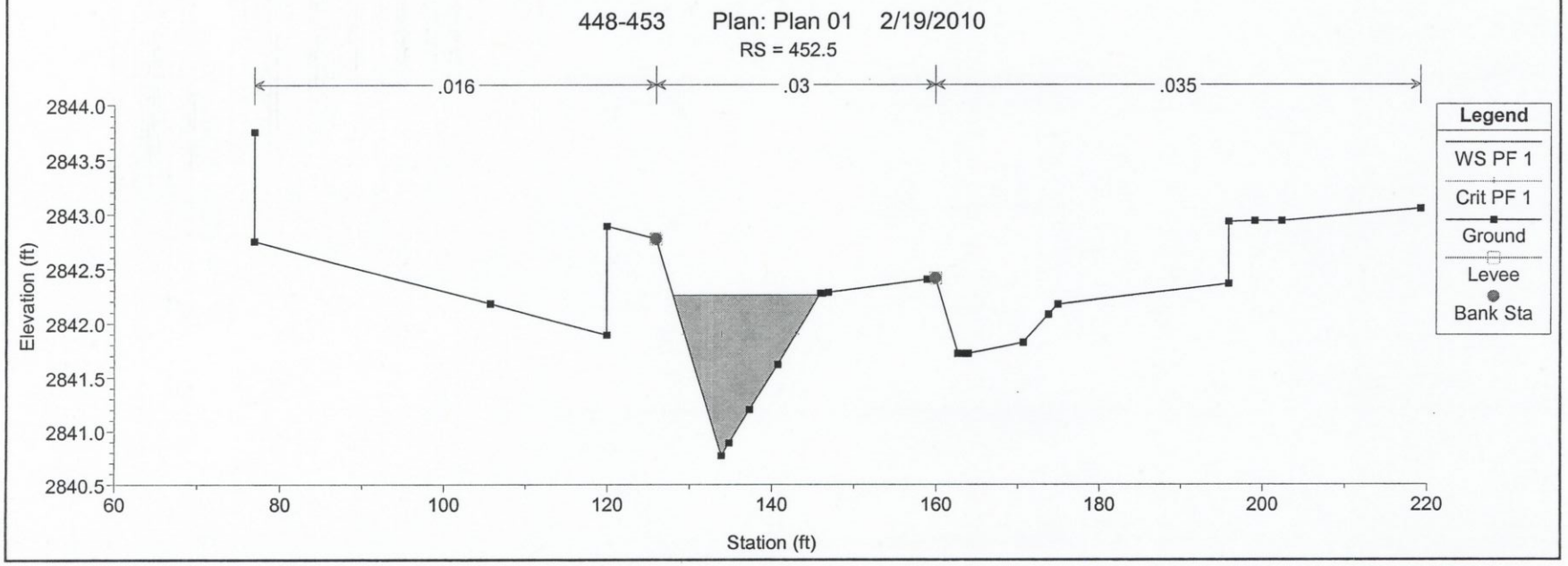
Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was used.

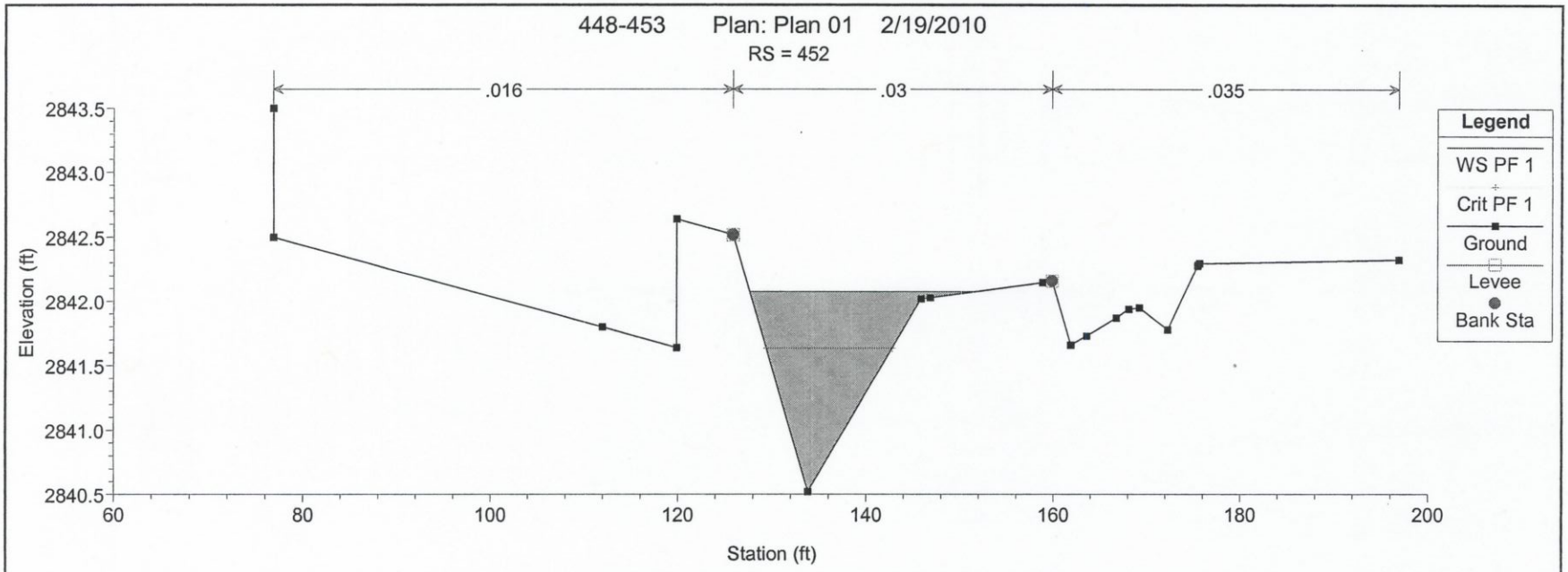
River: River #1 Reach: Reach #1 RS: 448 Profile: PF 1

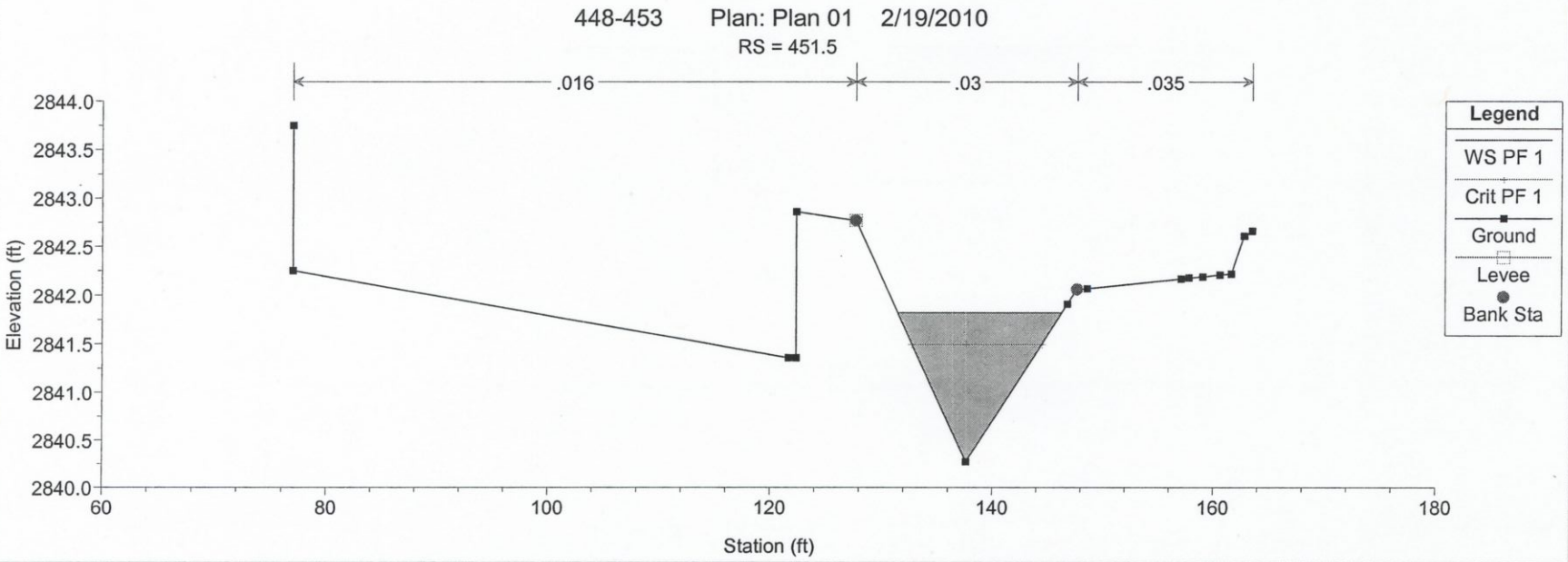
Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was used.

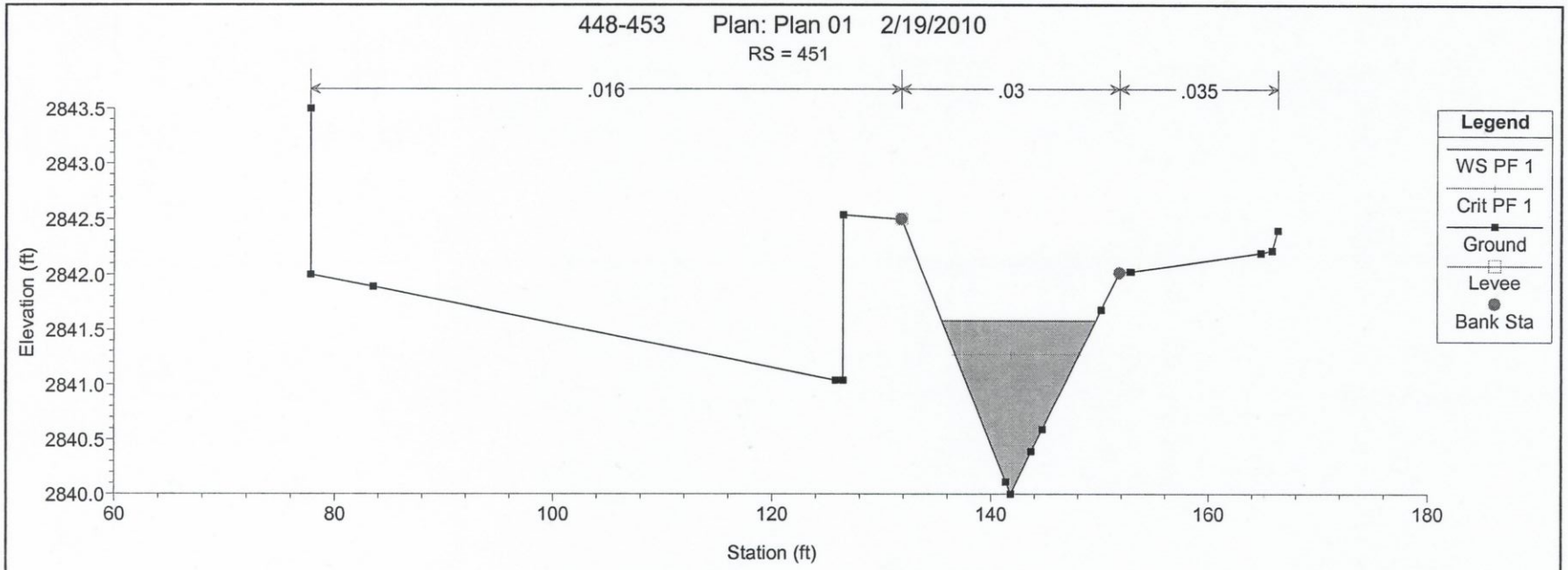

448-453 Plan: Plan 01 2/19/2010
River #1 Reach #1
Legend
WS PF 1
Crit PF 1
Ground
Left Levee
Right Levee
Elevation (ft)
2844
2843
2842
2841
2840
2839
2838
0
100
200
300
400
500
Main Channel Distance (ft)

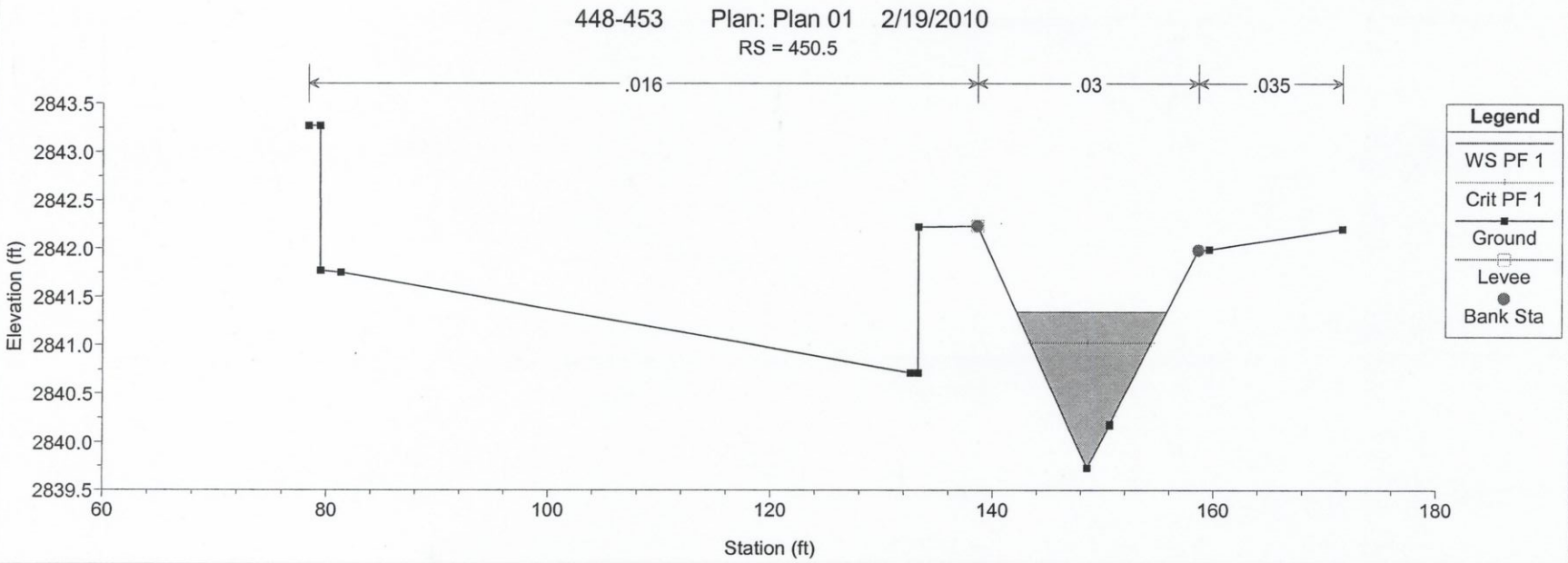

448-453 Plan: Plan 01 2/19/2010
RS = 453
.016
.03
.035
Elevation (ft)
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Levee
Bank Sta

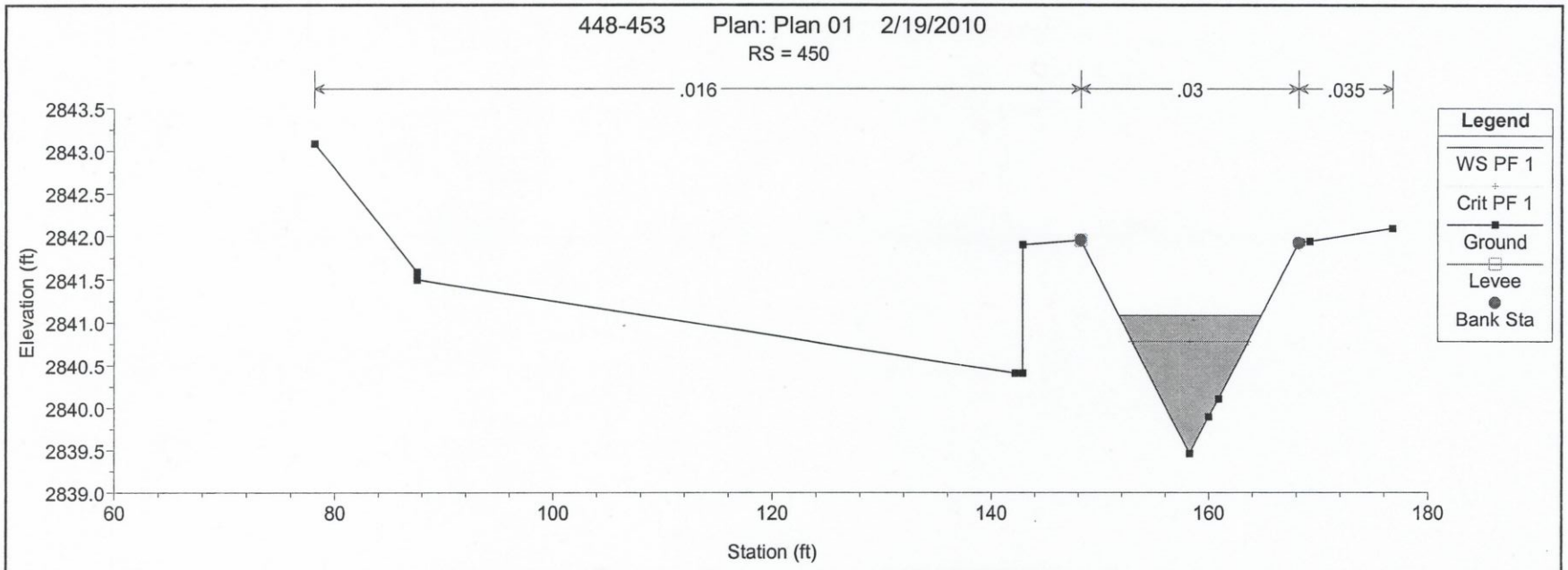

448-453 Plan: Plan 01 2/19/2010
RS = 452.5
.016
.03
.035
Elevation (ft)
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Levee
Bank Sta

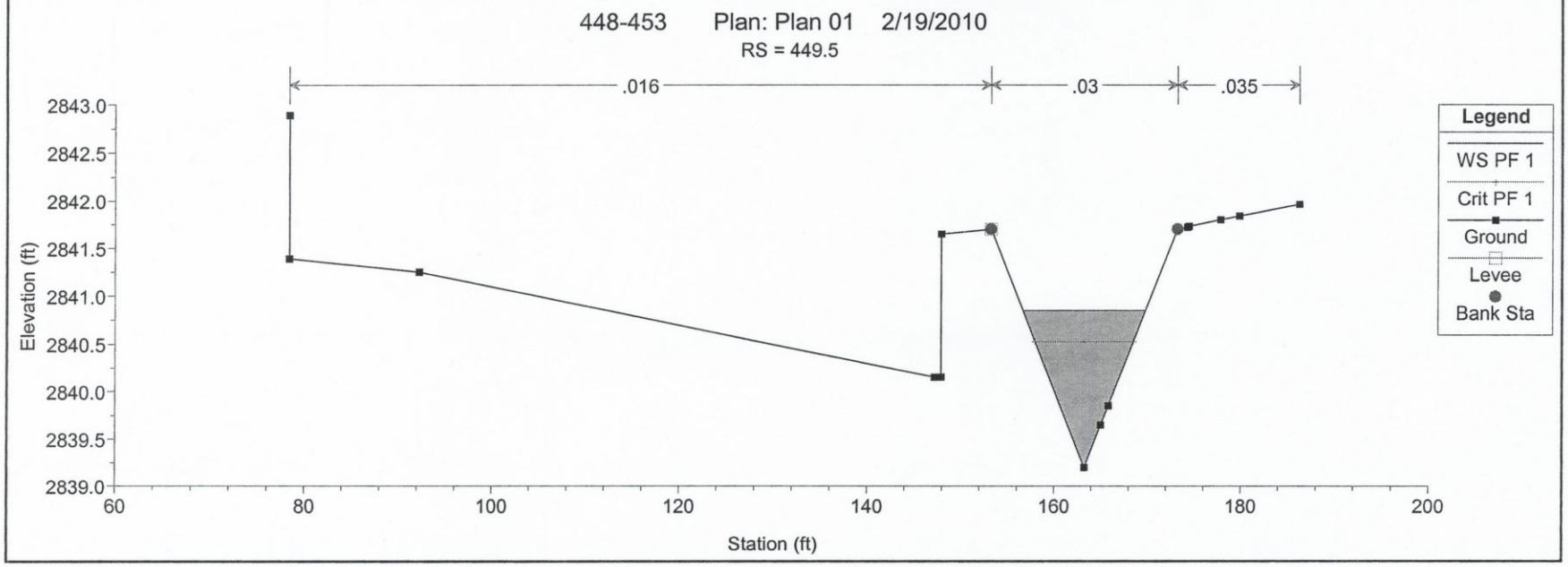

448-453 Plan: Plan 01 2/19/2010
RS = 452
.016
.03
.035
Elevation (ft)
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Levee
Bank Sta

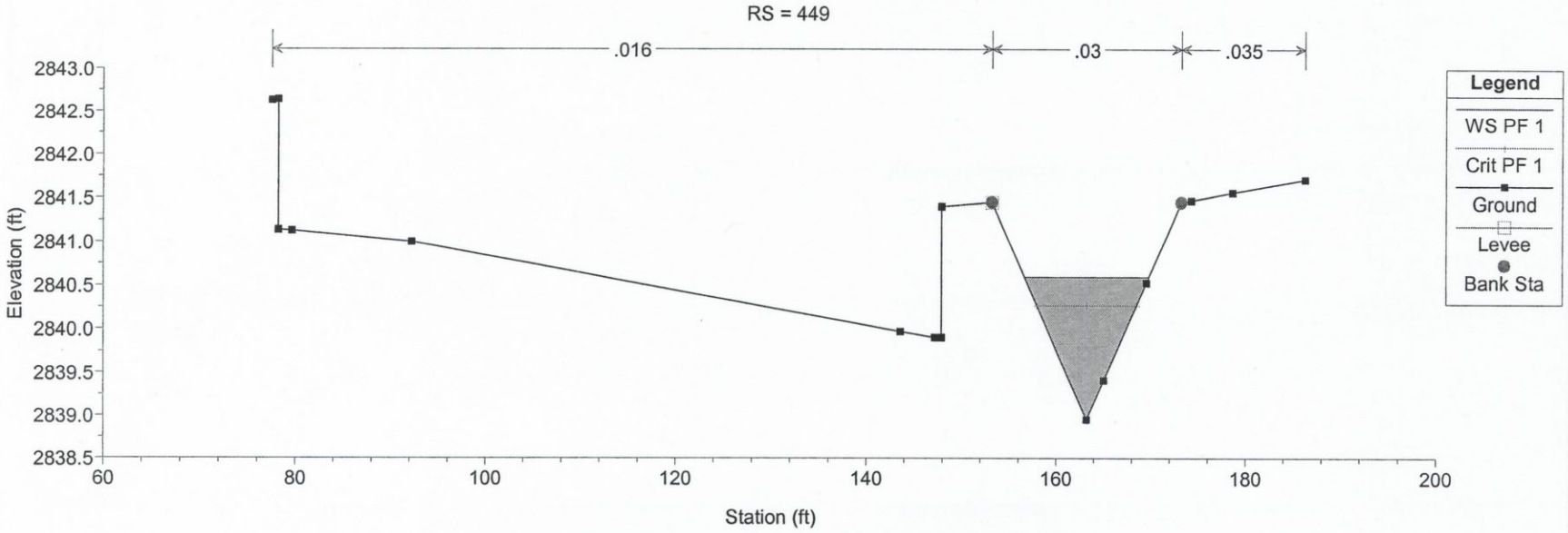

448-453 Plan: Plan 01 2/19/2010
RS = 451.5
.016
.03
.035
Elevation (ft)
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Levee
Bank Sta

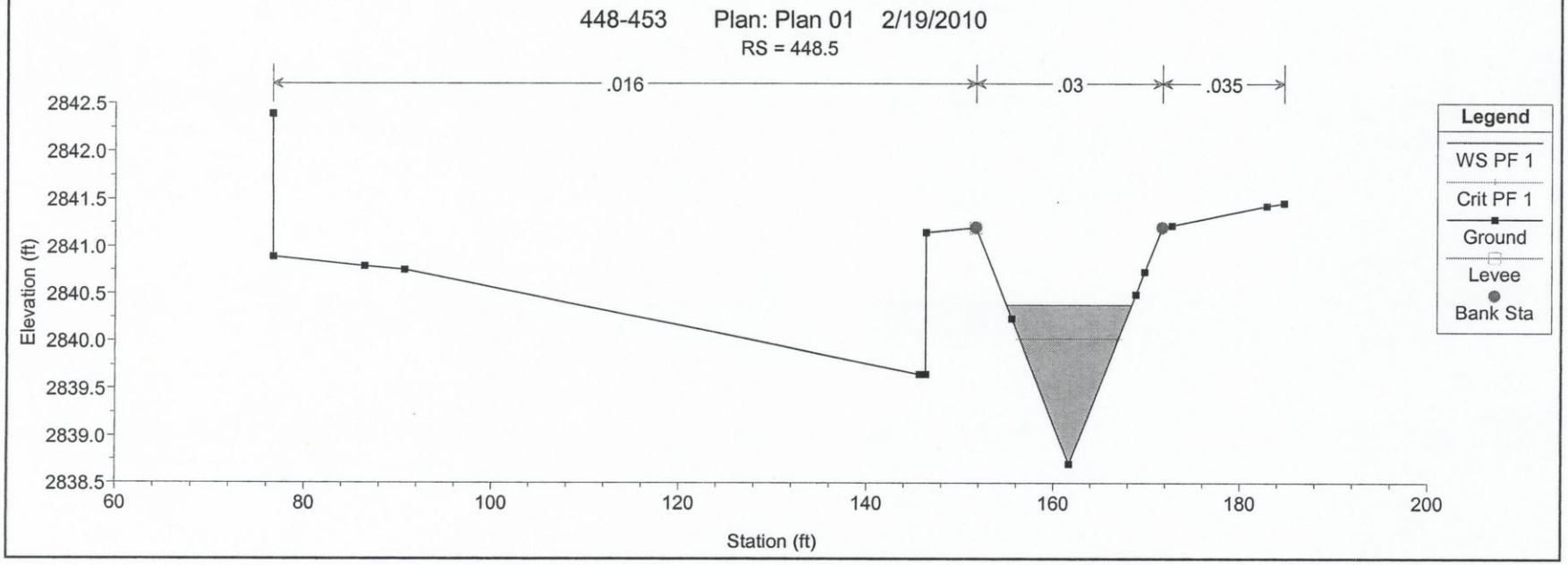

448-453 Plan: Plan 01 2/19/2010
RS = 451
.016
.03
.035
Elevation (ft)
2843.5
2843.0
2842.5
2842.0
2841.5
2841.0
2840.5
2840.0
60
80
100
120
140
160
180
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Levee
Bank Sta

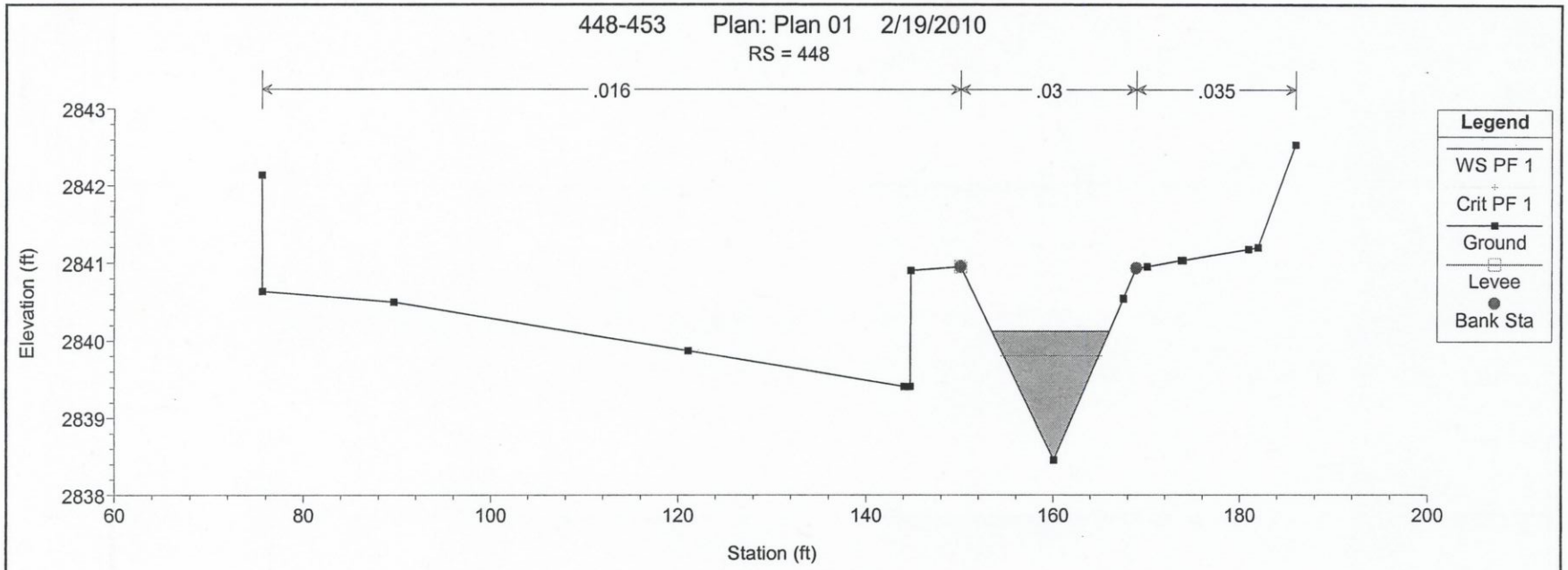

448-453 Plan: Plan 01 2/19/2010
RS = 450.5
.016
.03
.035
Elevation (ft)
2843.5
2843.0
2842.5
2842.0
2841.5
2841.0
2840.5
2840.0
2839.5
60
80
100
120
140
160
180
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Levee
Bank Sta


448-453 Plan: Plan 01 2/19/2010
RS = 450
.016
.03
.035
Elevation (ft)
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Levee
Bank Sta


448-453 Plan: Plan 01 2/19/2010
RS = 449.5
.016
.03
.035
Elevation (ft)
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Levee
Bank Sta


448-453 Plan: Plan 01 2/19/2010
RS = 449
.016
.03
.035
Elevation (ft)
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Levee
Bank Sta


448-453 Plan: Plan 01 2/19/2010
RS = 448.5
.016
.03
.035
Elevation (ft)
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Levee
Bank Sta


448-453 Plan: Plan 01 2/19/2010
RS = 448
.016
.03
.035
Elevation (ft)
2843
2842
2841
2840
2839
2838
60
80
100
120
140
160
180
200
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Levee
Bank Sta

ROADSIDE CHANNEL BETWEEN APPROXIMATELY STA. 466+00 AND 470+50

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: 466-4705
Project File : 4664705.prj
Run Date and Time: 2/19/2010 3:38:43 AM

Project in English units

PLAN DATA

Plan Title: Plan 03
Plan File :
t:\7TED069904\HYDRO\DRAINAGE\CALCS\Hydraulics\Channels\Ras-Final\revised\4664705.p03

Geometry Title: 466-4705
Geometry File :
t:\7TED069904\HYDRO\DRAINAGE\CALCS\Hydraulics\Channels\Ras-Final\revised\4664705.g04

Flow Title : 0 Flow Profiles
Flow File :
t:\7TED069904\HYDRO\DRAINAGE\CALCS\Hydraulics\Channels\Ras-Final\revised\4664705.F01

Plan Summary Information:

Number of:	Cross Sections =	10	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:\7TED069904\HYDRO\DRAINAGE\CALCS\Hydraulics\Channels\Ras-Final\revised\4664705.F01

Flow Data (cfs)

River	Reach	RS	PF 1
River #1	Reach #1	470.5	14

Boundary Conditions

River	Reach	Profile	Upstream	Downstream
River #1	Reach #1	PF 1		

Known WS = 2861.059

GEOMETRY DATA

Geometry Title: 466-4705
Geometry File :
t:\7TED069904\HYDRO\DRAINAGE\CALCS\Hydraulics\Channels\Ras-Final\revised\4664705.g04

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 470.5

INPUT
Description:
Station Elevation Data num= 16

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
77.69	2877.59	77.74	2876.09	115.03	2876.83	120.7	2876.95	120.75	2876.95
120.84	2876.95	121.37	2876.95	121.37	2878.45	140.7	2878.26	141.72	2878.25
159.74	2875.25	159.74	2875.26	162.5	2876.62	162.54	2876.62	165.35	2876.67
168.11	2876.74								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
77.69	.016	141.72	.025	162.5	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
141.72	162.5	50	50	50	.1	.3

Left Levee Station= 141.72 Elevation= 2878.25

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 470

INPUT
Description:

Station Elevation Data num= 24

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
77.59	2876.08	77.59	2874.58	285.89	2875.44	287.3	2875.44	289.14	2875.44
289.14	2876.94	382.75	2876.74	387.45	2876.73	464.6	2874.08	474.72	2873.73
484.55	2874.75	484.79	2874.75	488.09	2874.76	523.2	2874.67	561.7	2874.53
641.42	2874.49	700.07	2874.65	702.88	2874.56	722.35	2874.55	773.73	2874.69
838.48	2875.19	874.13	2875.55	909.05	2875.62	942.85	2875.89		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
77.59	.016	387.45	.025	484.55	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
387.45	484.55	50	50	50	.1	.3

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 469.5

INPUT
Description:
Station Elevation Data num= 32

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
90.21	2875.08	95.15	2875.07	135.25	2873.69	182.13	2872.07	189.2	2872.79
189.44	2872.61	199.27	2870.42	202.81	2870.4	205.13	2870.39	262.38	2870.25
282.09	2870.28	292.65	2870.28	303.88	2870.25	405.69	2870.43	413.44	2870.43
423.51	2870.4	435.96	2870.4	463.37	2870.41	562.61	2870.49	636.03	2870.58
720.44	2870.46	741.32	2870.46	790.38	2870.53	807.96	2870.56	820.6	2870.6
913.97	2870.68	927.1	2870.68	990.2	2871.11	1005.46	2871.11	1019.5	2871.11
1102.56	2871.33	1118.01	2871.33						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
90.21	.016	135.25	.025	189.2	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
135.25	189.2	50	50	50	.1	.3

Right Levee Station= 189.2 Elevation= 2872.79

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 469

INPUT
Description:
Station Elevation Data num= 60

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
76.75	2872.66	76.75	2871.16	113.36	2871.31	285.05	2872.02	288.1	2872.02
288.3	2873.52	343.46	2873.41	381.91	2873.33	384	2873.32	386.57	2873.32
403.23	2872.75	473.84	2870.32	477.37	2870.69	478.78	2871.32	492.38	2870.79
493.06	2870.79	494.46	2870.79	494.95	2870.79	495.19	2870.79	513.01	2870.74
517.47	2870.73	523.81	2870.71	542.8	2870.71	572.82	2870.64	579.65	2870.63
585.27	2870.63	587.35	2870.63	589.73	2870.63	593.7	2870.63	594.18	2870.63
599.56	2870.63	604.74	2870.63	610.6	2870.63	611.28	2870.63	613.41	2870.63
623.48	2870.62	624.89	2870.62	626.29	2870.62	632.15	2870.62	632.88	2870.62
634.52	2870.62	636.41	2870.62	639.9	2870.62	645.08	2870.62	713.32	2870.37
740.54	2870.35	747.56	2870.35	754.15	2870.34	783.93	2870.31	810.42	2870.29
818.42	2870.29	868.15	2870.32	938.48	2870.32	946.47	2870.32	946.95	2870.32
984.73	2870.37	1043.57	2870.46	1060.23	2870.48	1086.48	2870.51	1108.81	2870.63

```
Manning's n Values          num=        3
     Sta   n Val      Sta   n Val      Sta   n Val
   76.75    .016      384    .025   492.38    .035

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
           384  492.38                50      50      50             .1       .3
Right Levee     Station=  478.78      Elevation= 2871.32

CROSS SECTION


RIVER: River #1
REACH: Reach #1            RS: 468.5

INPUT
Description:
Station Elevation Data     num=      35
     Sta    Elev      Sta    Elev      Sta    Elev      Sta    Elev      Sta    Elev
    89.3 2871.13    92.84 2871.13    94.24 2871.12   181.51 2868.12    189.7 2868.96
  191.35 2868.96   236.63 2869.04   241.33 2869.05   243.17 2869.05      276  2868.7
  284.92 2868.66   305.06 2868.61   305.79 2868.59   308.11 2868.53   308.84 2868.51
  309.28  2868.5   309.52  2868.5   311.16 2868.48   311.65 2868.47   312.57 2868.47
  313.97 2868.46   315.86 2868.45   378.48 2868.02   378.97 2868.01   379.21 2868.01
  379.89 2868.01   380.61 2868.01   380.86    2868   381.05    2868   381.29    2868
  383.42 2867.99   384.34 2867.98    388.8 2867.97   454.71 2868.19   455.68 2868.18

Manning's n Values          num=        3
     Sta   n Val      Sta   n Val      Sta   n Val
    89.3    .016    94.24    .025    189.7    .035

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
         94.24   189.7                50      50      50             .1       .3
Right Levee     Station=  241.33      Elevation= 2869.05

CROSS SECTION


RIVER: River #1
REACH: Reach #1            RS: 468

INPUT
Description:
Station Elevation Data     num=      33
     Sta    Elev      Sta    Elev      Sta    Elev      Sta    Elev      Sta    Elev
   76.16 2868.66    76.16 2867.66   284.46 2868.52   284.46 2869.52   286.79 2869.44
  298.99 2869.02   313.52 2869.52   381.32 2869.38   386.02 2869.37   445.59 2867.32
  473.29 2866.37   485.01 2867.59   485.25 2867.59   485.93 2867.59   528.65 2867.84
  534.94 2867.89   537.56  2867.9   538.72  2867.9   539.21  2867.9   565.94 2868.01
  570.64 2868.02   579.55 2868.05   587.73 2868.05    601.1 2867.97   616.31 2867.93
  638.83 2867.89   674.47 2867.95   723.29 2867.72   777.49 2867.59   790.37 2867.64
  806.79 2867.63   875.75 2867.69   982.25 2867.73

Manning's n Values          num=        3
     Sta   n Val      Sta   n Val      Sta   n Val
   76.16    .016   386.02    .025   579.55    .035

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
        386.02  579.55                50      50      50             .1       .3
Left Levee      Station=  386.02      Elevation= 2869.37

CROSS SECTION
```

```
RIVER: River #1
REACH: Reach #1            RS: 467.5

INPUT
Description:
Station Elevation Data     num=      17
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
   76.71 2865.93   76.95 2865.93  285.01 2866.79  285.01 2867.79  287.58  2867.7
  299.54 2867.29  314.07 2867.79   365.7 2867.68  381.87 2867.65  386.81 2867.64
     452 2865.39  474.08 2864.64  482.02 2865.47  501.98 2867.52  502.22 2867.52
  534.14 2867.69  551.96  2867.3

Manning's n Values         num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
   76.71    .016  386.81    .025  501.98    .035

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
        386.81  501.98               50      50      50            .1       .3
Left Levee      Station=  386.81      Elevation= 2867.64

CROSS SECTION


RIVER: River #1
REACH: Reach #1            RS: 467

INPUT
Description:
Station Elevation Data     num=      18
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
   77.42 2865.37   77.42 2864.37  153.41 2864.69   184.6 2864.81  285.72 2865.23
  285.72 2866.23   292.5    2866  300.25 2865.73  314.78 2866.23  382.58 2866.09
  384.47 2866.09  387.52 2866.08  474.55 2863.08  484.38  2864.1   510.2 2866.76
  511.36 2866.88   511.6 2866.88  536.69  2867.2

Manning's n Values         num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
   77.42    .016  387.52    .025  511.36    .035

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
        387.52  511.36               50      50      50            .1       .3
Left Levee      Station=  387.52      Elevation= 2866.08

CROSS SECTION


RIVER: River #1
REACH: Reach #1            RS: 466.5

INPUT
Description:
Station Elevation Data     num=      13
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
   78.15 2864.04   78.39 2863.04  286.45  2863.9  286.69  2864.9  297.69 2864.52
  300.98  2864.4  315.51  2864.9  383.31 2864.76  388.25 2864.75  443.12 2862.86
  475.52 2861.75  491.46  2863.4  519.84 2866.34

Manning's n Values         num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
   78.15    .016  388.25    .025  519.84    .035

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
```

388.25 519.84 50 50 50 .1 .3
Left Levee Station= 388.25 Elevation= 2864.75

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 466

INPUT
Description:
Station Elevation Data num= 21

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
78.92	2862.94	78.92	2861.94	169.92	2862.31	260.25	2862.69	287.22	2862.8
287.22	2863.8	300.35	2863.34	301.75	2863.3	312.31	2863.66	316.28	2863.8
327.08	2863.78	384.08	2863.66	385.25	2863.66	389.02	2863.65	423.26	2862.47
476.05	2860.65	490.1	2862.1	498.57	2862.97	498.81	2862.97	506.32	2863.09
518.23	2863.05								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
78.92	.016	389.02	.025	498.57	.035

Bank Sta: Left Right Coeff Contr. Expan.
389.02 498.57 .1 .3
Left Levee Station= 389.02 Elevation= 2863.65

SUMMARY OF MANNING'S N VALUES

River:River #1

Reach	River Sta.	n1	n2	n3
Reach #1	470.5	.016	.025	.035
Reach #1	470	.016	.025	.035
Reach #1	469.5	.016	.025	.035
Reach #1	469	.016	.025	.035
Reach #1	468.5	.016	.025	.035
Reach #1	468	.016	.025	.035
Reach #1	467.5	.016	.025	.035
Reach #1	467	.016	.025	.035
Reach #1	466.5	.016	.025	.035
Reach #1	466	.016	.025	.035

SUMMARY OF REACH LENGTHS

River: River #1

Reach	River Sta.	Left	Channel	Right
Reach #1	470.5	50	50	50
Reach #1	470	50	50	50
Reach #1	469.5	50	50	50
Reach #1	469	50	50	50
Reach #1	468.5	50	50	50
Reach #1	468	50	50	50
Reach #1	467.5	50	50	50
Reach #1	467	50	50	50

Reach #1	466.5	50	50	50
Reach #1	466			

SUMMARY OF CONTRACTION AND EXPANSION COEFFICIENTS
River: River #1

Reach	River Sta.	Contr.	Expan.
Reach #1	470.5	.1	.3
Reach #1	470	.1	.3
Reach #1	469.5	.1	.3
Reach #1	469	.1	.3
Reach #1	468.5	.1	.3
Reach #1	468	.1	.3
Reach #1	467.5	.1	.3
Reach #1	467	.1	.3
Reach #1	466.5	.1	.3
Reach #1	466	.1	.3

Profile Output Table - Standard Table 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.
E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	
			(cfs)	(ft)	(ft)	(ft)
(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		
Reach #1	470.5	PF 1	14.00	2875.25	2876.20	2876.20
2876.43	0.012465	3.92	3.58	7.58	1.00	
Reach #1	470	PF 1	14.00	2873.73	2874.23	2874.23
2874.36	0.015142	2.90	4.83	19.32	1.02	
Reach #1	469.5	PF 1	14.00	2872.07	2872.58	2872.58
2872.70	0.013955	2.81	4.98	19.65	0.98	
Reach #1	469	PF 1	14.00	2870.32	2870.82	2870.82
2870.95	0.014524	2.92	4.80	18.41	1.01	
Reach #1	468.5	PF 1	14.00	2868.12	2868.63	2868.63
2868.75	0.013720	2.79	5.02	19.74	0.98	
Reach #1	468	PF 1	14.00	2866.37	2866.87	2866.87
2867.00	0.014729	2.87	4.88	19.46	1.01	
Reach #1	467.5	PF 1	14.00	2864.64	2865.15	2865.15
2865.27	0.013161	2.74	5.10	19.95	0.96	
Reach #1	467	PF 1	14.00	2863.08	2863.59	2863.59
2863.71	0.014183	2.83	4.95	19.56	0.99	
Reach #1	466.5	PF 1	14.00	2861.75	2862.26	2862.26
2862.38	0.014001	2.81	4.98	19.67	0.98	
Reach #1	466	PF 1	14.00	2860.65	2861.16	2861.16
2861.28	0.013512	2.78	5.04	19.75	0.97	

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)	

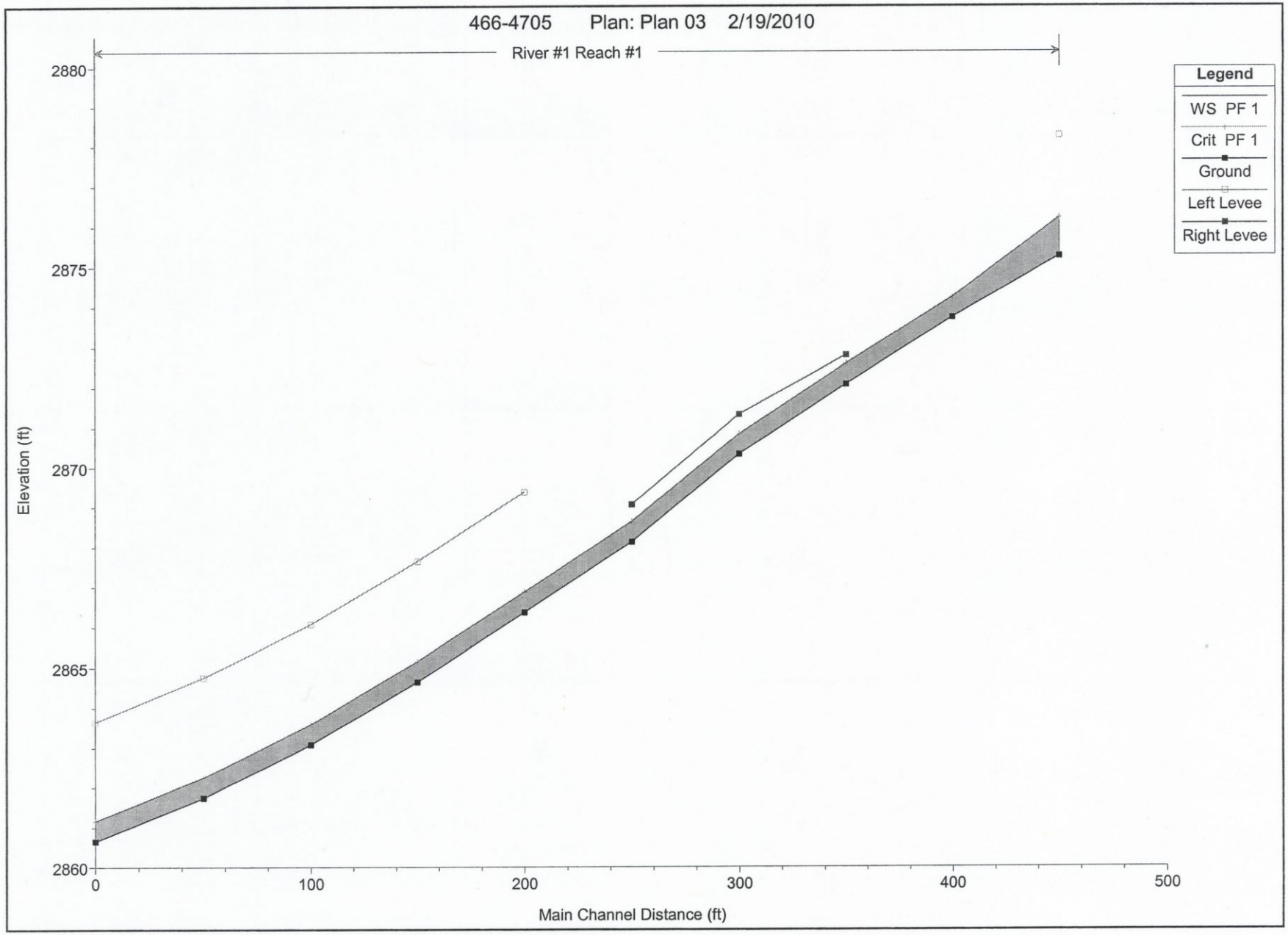
```
  Reach #1      470.5          PF 1        2876.43     2876.20       0.24
0.69          0.03                14.00                  7.58
  Reach #1      470            PF 1        2874.36     2874.23       0.13
0.73          0.00                14.00                 19.32
  Reach #1      469.5          PF 1        2872.70     2872.58       0.12
0.71          0.00                14.00                 19.65
  Reach #1      469            PF 1        2870.95     2870.82       0.13
0.71          0.00                14.00                 18.41
  Reach #1      468.5          PF 1        2868.75     2868.63       0.12
0.71          0.00                14.00                 19.74
  Reach #1      468            PF 1        2867.00     2866.87       0.13
0.70          0.00                14.00                 19.46
  Reach #1      467.5          PF 1        2865.27     2865.15       0.12
0.68          0.00                14.00                 19.95
  Reach #1      467            PF 1        2863.71     2863.59       0.12
0.70          0.00                14.00                 19.56
  Reach #1      466.5          PF 1        2862.38     2862.26       0.12
0.69          0.00                14.00                 19.67
  Reach #1      466            PF 1        2861.28     2861.16       0.12
                             14.00                 19.75
```

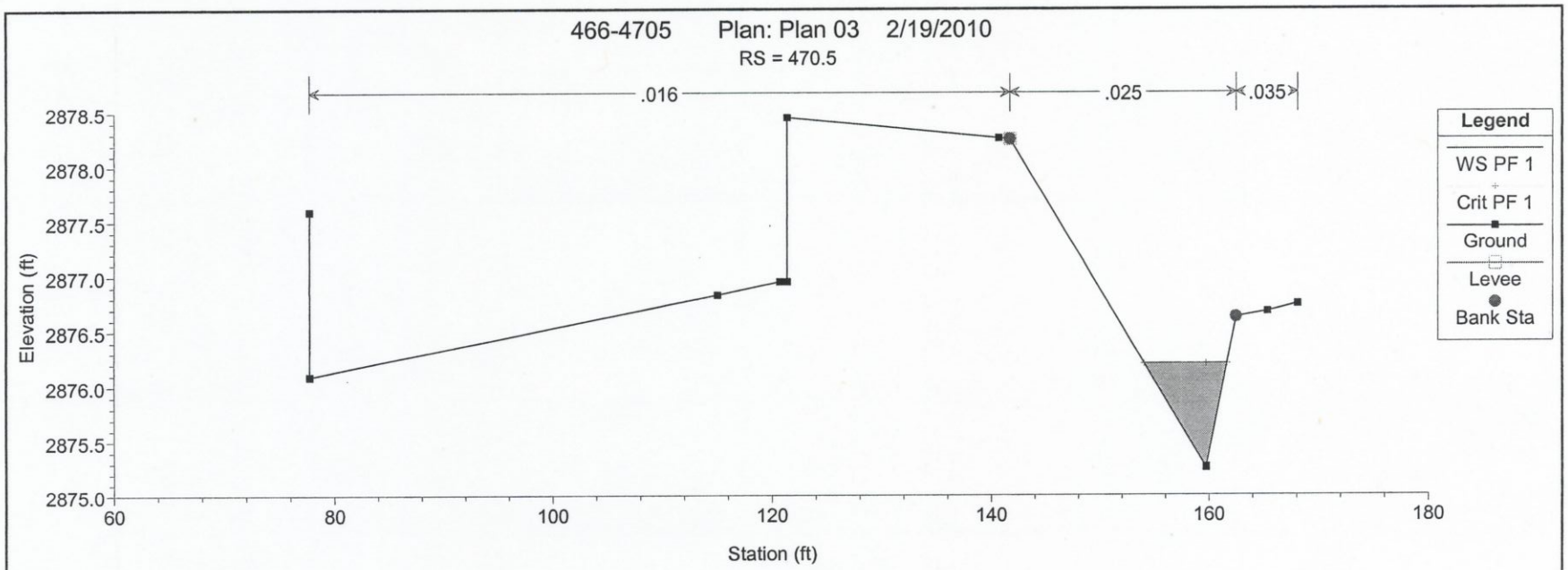
ERRORS WARNINGS AND NOTES
Errors Warnings and Notes for Plan : 466-4705

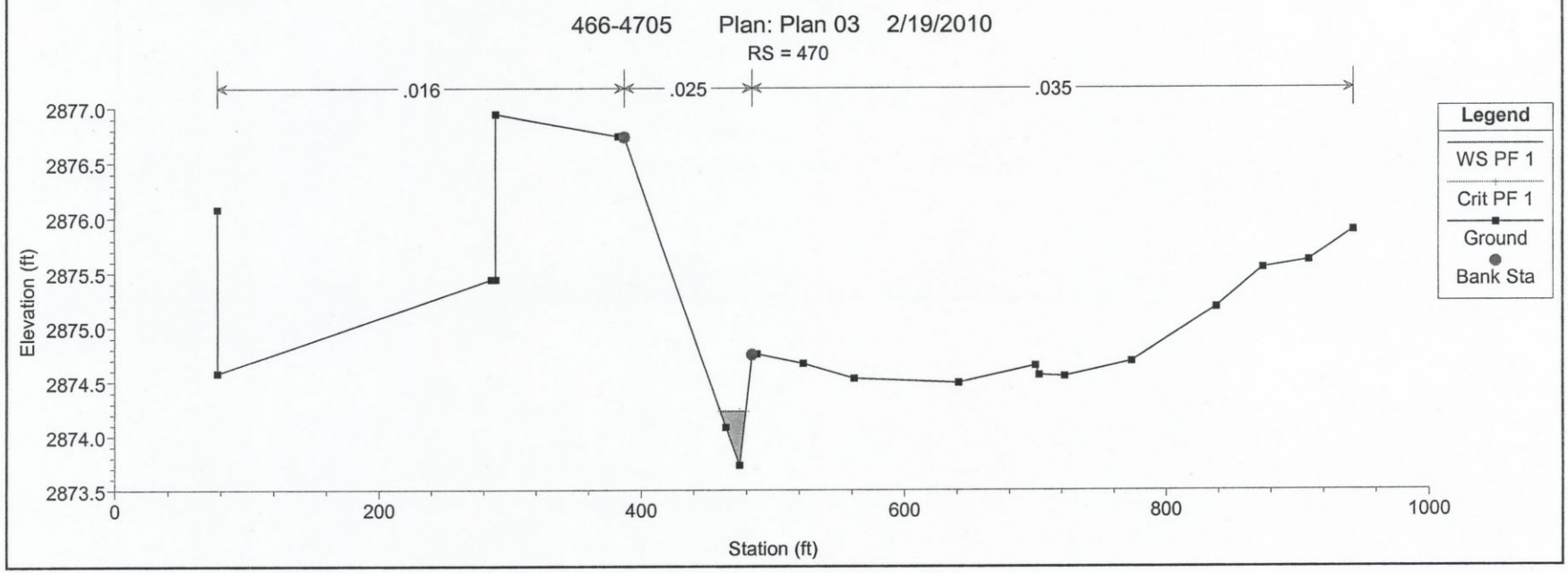
```
River: River #1  Reach: Reach #1     RS: 470.5     Profile: PF 1
     Warning:The energy equation could not be balanced within the specified number
of iterations.  The program used critical depth
             for the water surface and continued on with the calculations.
     Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current
and previous cross section.  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.
     Note:   Multiple critical depths were found at this location.  The critical
depth with the lowest, valid, water surface was
             used.
River: River #1  Reach: Reach #1     RS: 470     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 energy loss was greater than 1.0 ft (0.3 m). between the current
and previous cross section.  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: 469.5     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 energy loss was greater than 1.0 ft (0.3 m). between the current
and previous cross section.  This may indicate
```

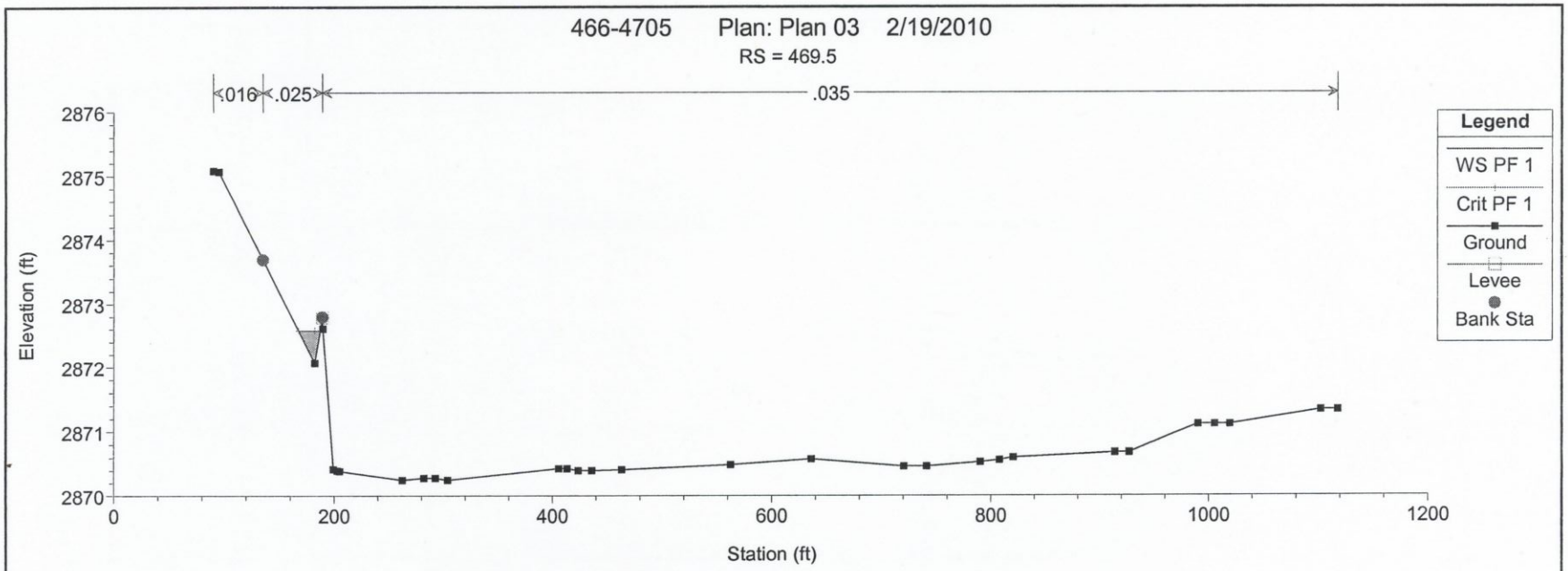
the need for additional cross sections.
Warning:During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated
water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The
program defaulted to critical depth.
Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was
used.
River: River #1 Reach: Reach #1 RS: 469 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 energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. 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.
Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was
used.
River: River #1 Reach: Reach #1 RS: 468.5 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 energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. 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.
Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was
used.
River: River #1 Reach: Reach #1 RS: 468 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 energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. 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.
Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was
used.
River: River #1 Reach: Reach #1 RS: 467.5 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 energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. 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

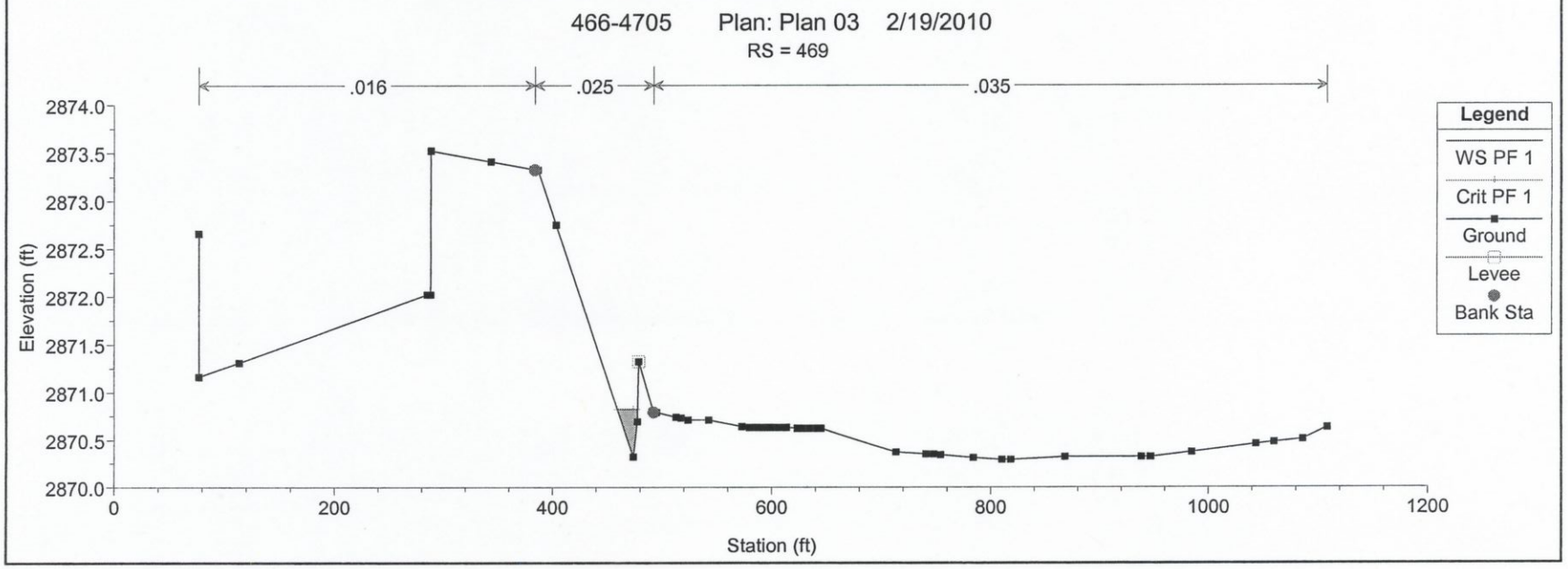
water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The
program defaulted to critical depth.
Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was
used.
River: River #1 Reach: Reach #1 RS: 467 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 energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. 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.
Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was
used.
River: River #1 Reach: Reach #1 RS: 466.5 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 energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. 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.
Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was
used.
River: River #1 Reach: Reach #1 RS: 466 Profile: PF 1
Warning:User specified water surface is not possible for the specified flow regime. The program used critical depth as the
starting water surface.
Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was
used.

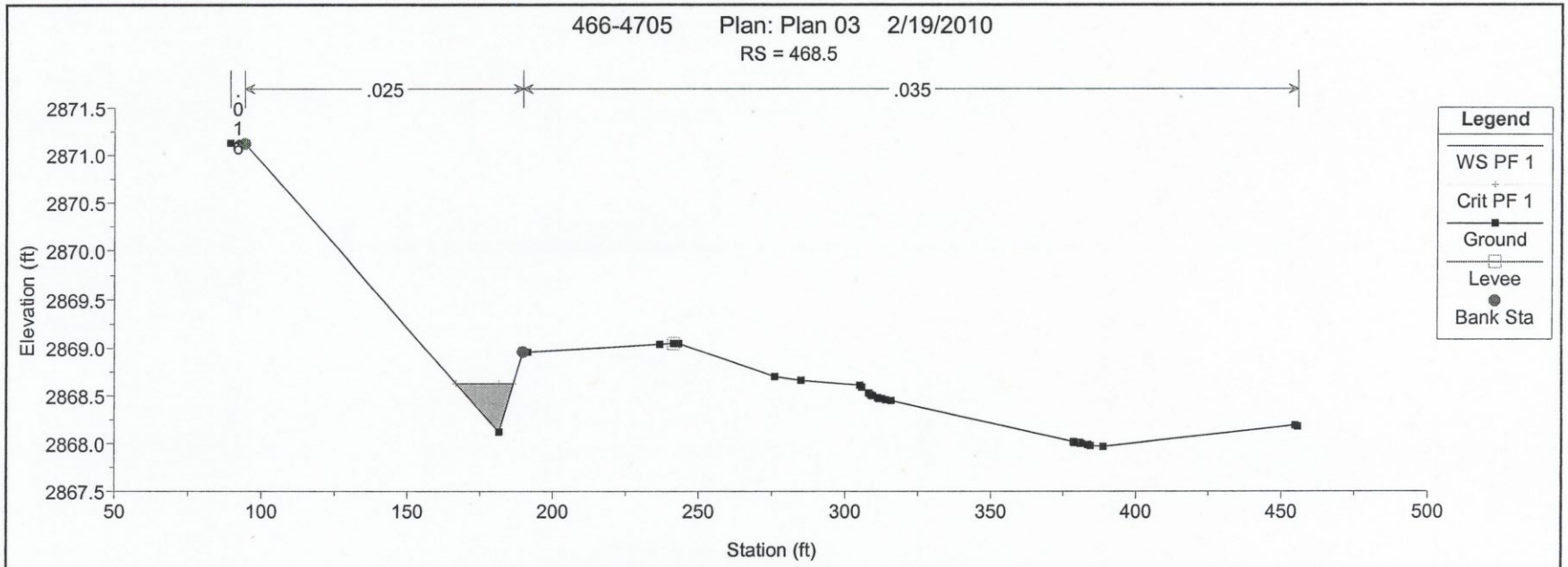

466-4705 Plan: Plan 03 2/19/2010
River #1 Reach #1
Legend
WS PF 1
Crit PF 1
Ground
Left Levee
Right Levee
Elevation (ft)
2880
2875
2870
2865
2860
0
100
200
300
400
500
Main Channel Distance (ft)

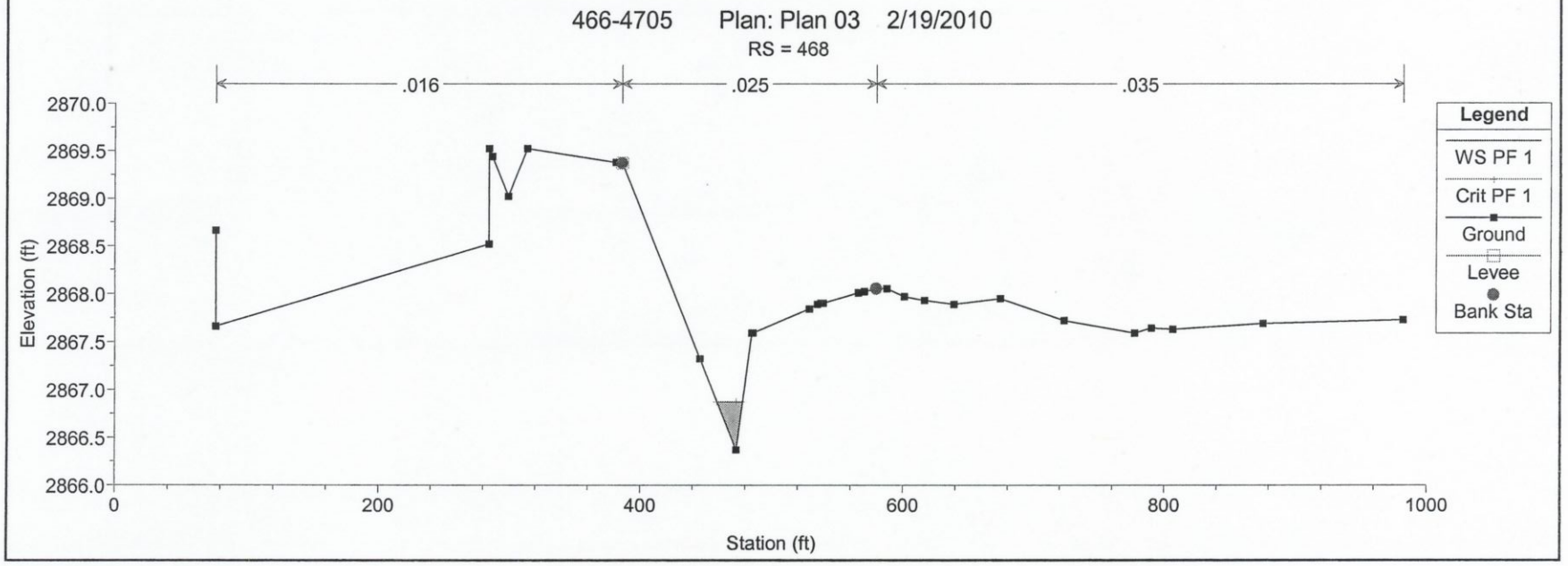

466-4705 Plan: Plan 03 2/19/2010
RS = 470.5
.016
.025
.035
Elevation (ft)
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Levee
Bank Sta

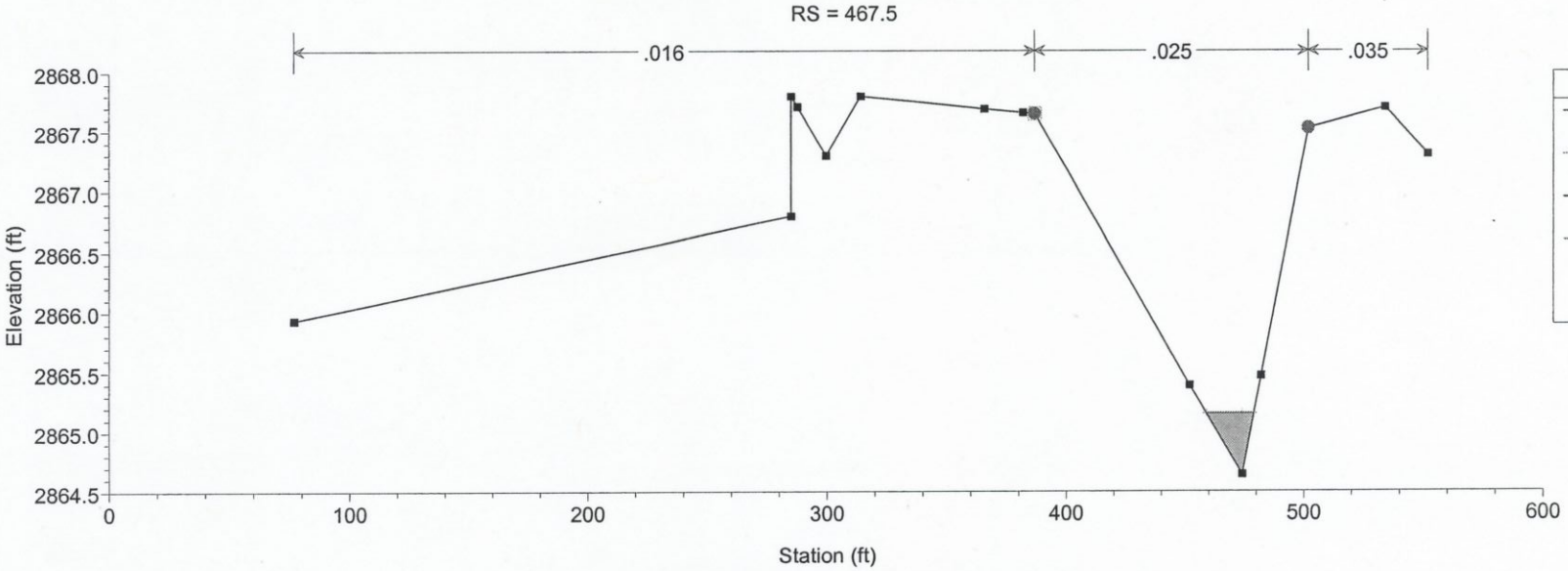

466-4705 Plan: Plan 03 2/19/2010
RS = 470
.016
.025
.035
Elevation (ft)
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Bank Sta

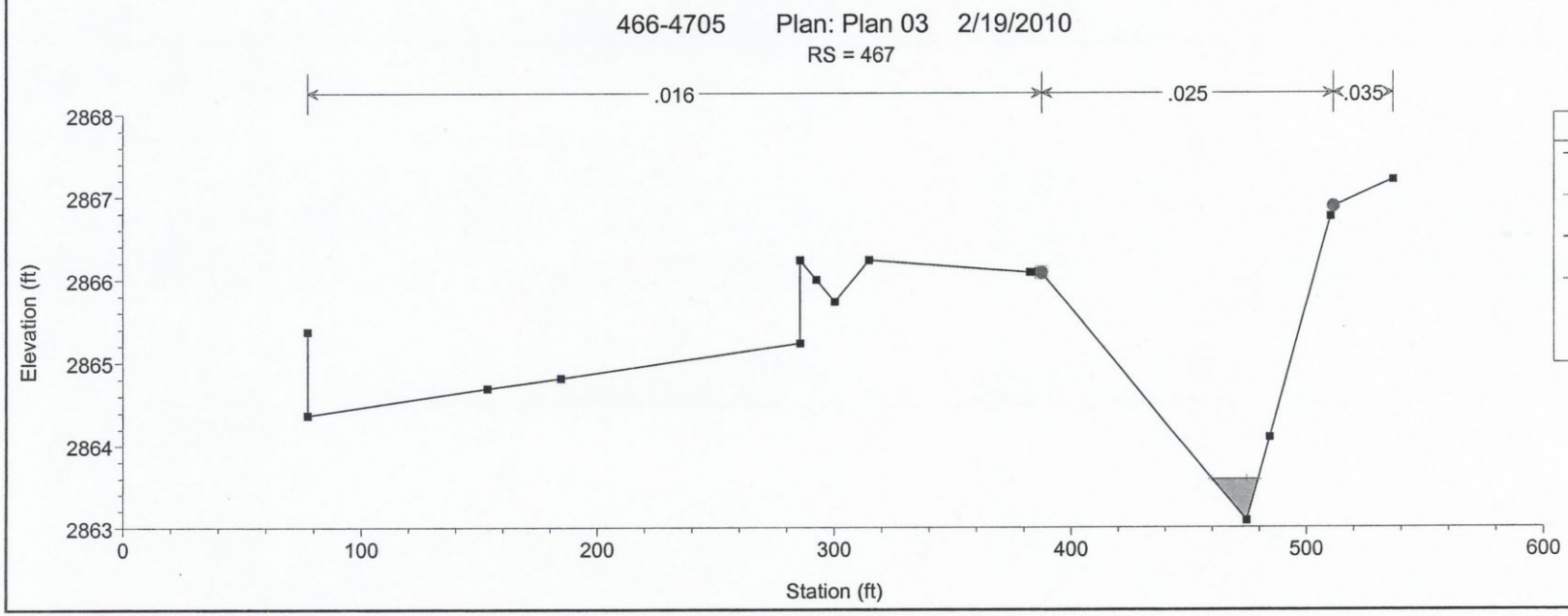

466-4705 Plan: Plan 03 2/19/2010
RS = 469.5
.016
.025
.035
Elevation (ft)
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Levee
Bank Sta

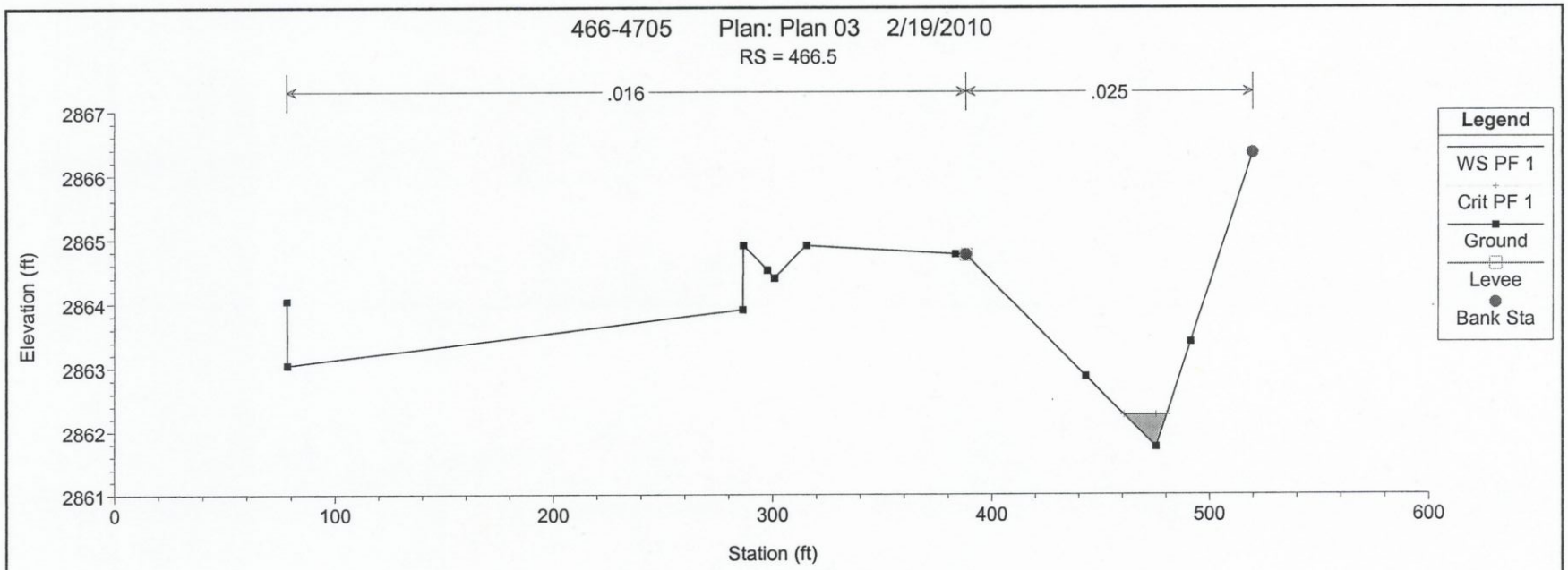

466-4705 Plan: Plan 03 2/19/2010
RS = 469
.016
.025
.035
Elevation (ft)
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Levee
Bank Sta

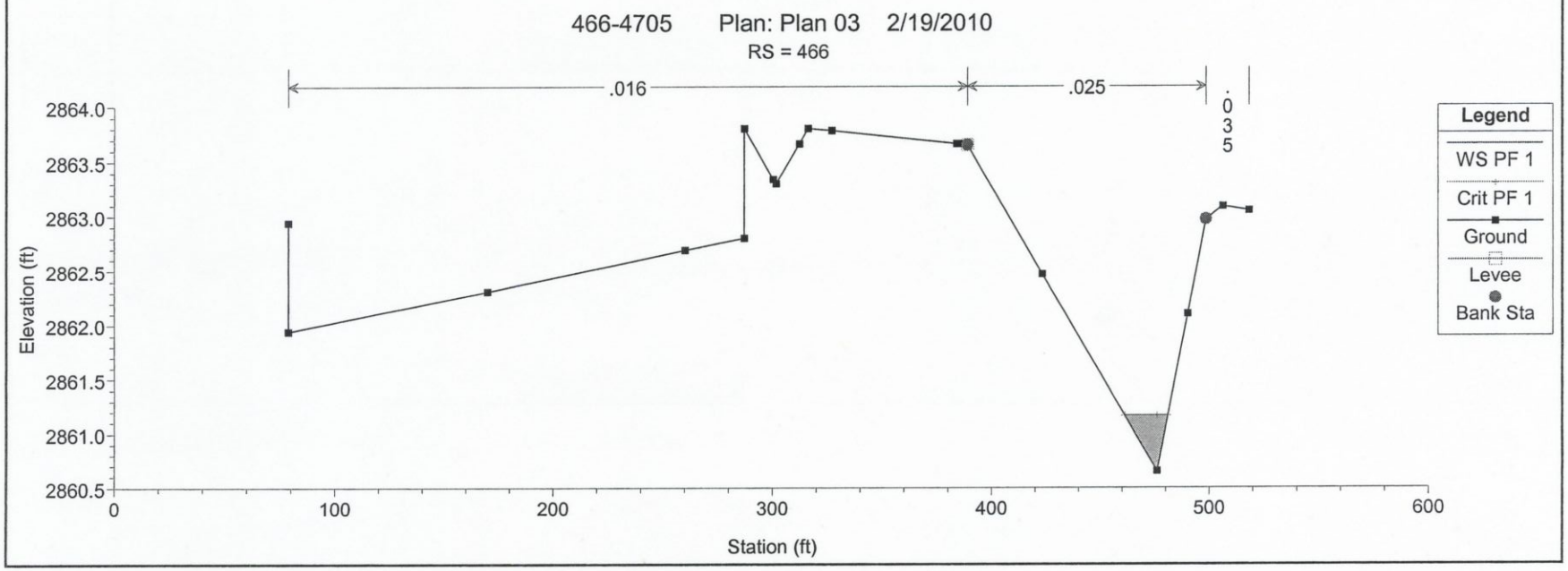

466-4705 Plan: Plan 03 2/19/2010
RS = 468.5
.025
.035
.01
Elevation (ft)
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Levee
Bank Sta


466-4705 Plan: Plan 03 2/19/2010
RS = 468
.016
.025
.035
Elevation (ft)
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Levee
Bank Sta


466-4705 Plan: Plan 03 2/19/2010
RS = 467.5
.016
.025
.035
Elevation (ft)
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Levee
Bank Sta


466-4705 Plan: Plan 03 2/19/2010
RS = 467
.016
.025
.035
Elevation (ft)
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Levee
Bank Sta


466-4705 Plan: Plan 03 2/19/2010
RS = 466.5
.016
.025
Elevation (ft)
2867
2866
2865
2864
2863
2862
2861
0
100
200
300
400
500
600
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Levee
Bank Sta


466-4705 Plan: Plan 03 2/19/2010
RS = 466
.016
.025
.035
Elevation (ft)
2864.0
2863.5
2863.0
2862.5
2862.0
2861.5
2861.0
2860.5
0
100
200
300
400
500
600
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Levee
Bank Sta

ROADSIDE CHANNEL BETWEEN APPROXIMATELY STA. 471+50 AND 473+50

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: 4715-4735
Project File : 47154735.prj
Run Date and Time: 2/19/2010 5:57:06 AM

Project in English units

PLAN DATA

Plan Title: Plan 04
Plan File :
t:\7TED069904\HYDRO\DRAINAGE\CALCS\Hydraulics\Channels\Ras-Final\revised\47154735.p04

Geometry Title: 4715-4735
Geometry File :
t:\7TED069904\HYDRO\DRAINAGE\CALCS\Hydraulics\Channels\Ras-Final\revised\47154735.g05

Flow Title : 0 Flow Profiles
Flow File :
t:\7TED069904\HYDRO\DRAINAGE\CALCS\Hydraulics\Channels\Ras-Final\revised\47154735.F01

Plan Summary Information:

Number of:	Cross Sections =	5	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:\7TED069904\HYDRO\DRAINAGE\CALCS\Hydraulics\Channels\Ras-Final\revised\47154735.F01

Flow Data (cfs)

River	Reach	RS	PF 1
River #1	Reach #1	473.5	57

Boundary Conditions

River	Reach	Profile	Upstream	Downstream
River #1	Reach #1	PF 1	Known WS = 2880.29	

GEOMETRY DATA

Geometry Title: 4715-4735
Geometry File :
t:\7TED069904\HYDRO\DRAINAGE\CALCS\Hydraulics\Channels\Ras-Final\revised\47154735.g05

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 473.5

INPUT
Description:
Station Elevation Data num= 29

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
74.37	2883.57	74.37	2882.07	87.79	2881.94	94.42	2881.87	107.79	2881.6
138.88	2880.98	139.56	2880.98	139.56	2882.48	152.15	2882.35	163.39	2882.24
164.4	2882.23	173.26	2880.01	175.1	2879.56	180.38	2878.23	187.6	2880.64
187.65	2880.64	187.84	2880.64	189.88	2880.6	202.13	2880.52	209.35	2880.59
226.34	2880.89	236.13	2880.85	238.79	2881.04	239.08	2881.04	239.91	2881.05
245.96	2880.93	259.91	2881.18	265.82	2881.21	279.38	2882.68		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
74.37	.016	164.4	.025	187.6	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
164.4	187.6	50	50	50	.1	.3

Left Levee Station= 164.4 Elevation= 2882.23

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 473

INPUT
Description:
Station Elevation Data num= 33

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
78.14	2882.8	78.14	2881.3	101.82	2881.06	126.04	2880.87	126.04	2880.97
126.72	2880.97	126.72	2882.47	126.86	2882.46	152.14	2882.21	153.16	2882.2
160.32	2880.41	169.14	2878.2	174.42	2879.96	174.47	2879.97	174.52	2879.97
178.34	2880	186.28	2880.07	191.03	2880.11	214.86	2880.36	217.04	2880.36
219.89	2880.37	233.36	2880.51	243.43	2880.62	249.44	2880.75	256.7	2880.79
265.08	2880.81	272.01	2880.85	283.19	2881.01	300.58	2881.21	303.49	2881.24
312.49	2881.27	325.09	2881.35	329.15	2881.3				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
78.14	.016	152.14	.025	178.34	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
152.14	178.34	50	50	50	.1	.3

Left Levee Station= 152.14 Elevation= 2882.21

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 472.5

INPUT
Description:
Station Elevation Data num= 27

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
78.04	2882.07	78.09	2880.57	114.56	2880.57	121.05	2880.57	124.53	2880.64
133.06	2880.81	133.74	2880.81	133.74	2882.31	141.63	2882.23	159.06	2882.05
159.69	2882.05	160.08	2882.04	166.32	2880.48	176.06	2878.04	180.22	2879.43
180.27	2879.43	196.16	2879.65	202.55	2879.73	208.65	2879.8	217.03	2879.86
225.56	2880.04	231.47	2880.15	237.24	2880.16	265.81	2880.24	265.81	2880.35
274.96	2880.46	287.22	2880.68						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
78.04	.016	159.69	.025	180.22	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
159.69	180.22	50	50	50	.1	.3

Left Levee Station= 159.69 Elevation= 2882.05

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 472

INPUT
Description:
Station Elevation Data num= 30

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
77.96	2881.18	77.96	2879.68	113.12	2880.03	120.97	2880.11	122.27	2880.14
132.98	2880.35	133.61	2880.35	133.61	2881.85	158.94	2881.6	159.96	2881.59
175.94	2877.59	180.54	2879.12	180.59	2879.12	180.69	2879.13	199.57	2879.46

201.03	2879.49	202.43	2879.51	215.8	2879.62	230.08	2879.7	230.57	2879.7
231	2879.7	245.1	2879.83	259.58	2880.1	259.68	2880.1	274.11	2880.1
274.11	2879.95	288.15	2880.44	288.93	2880.45	308.35	2880.73	316.39	2880.84

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
77.96	.016	158.94	.025	180.54	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
158.94	180.54	50	50	50	.1	.3

Left Levee Station= 158.94 Elevation= 2881.6

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 471.5

INPUT
Description:
Station Elevation Data num= 32

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
77.87	2880.14	77.87	2878.64	112.26	2879.33	120.88	2879.5	121.07	2879.5
121.7	2879.5	121.7	2881	136.86	2880.85	145.62	2880.76	146.64	2880.75
148.43	2880.31	154.48	2878.79	162.62	2876.75	168.09	2878.57	168.15	2878.57
173.72	2878.63	174.83	2878.63	177.01	2878.66	184.28	2878.66	187.71	2878.79
193.28	2878.95	194.88	2879.02	196.38	2879.11	197.16	2879.14	202.58	2879.2
214.06	2879.26	224.81	2879.54	228.83	2879.56	233.09	2879.63	243.56	2879.6
253.39	2879.74	258.33	2879.78						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
77.87	.016	145.62	.025	168.09	.035

Bank Sta: Left	Right	Coeff Contr.	Expan.
145.62	168.09	.1	.3

Left Levee Station= 145.62 Elevation= 2880.76

SUMMARY OF MANNING'S N VALUES

River:River #1

Reach	River Sta.	n1	n2	n3
Reach #1	473.5	.016	.025	.035
Reach #1	473	.016	.025	.035
Reach #1	472.5	.016	.025	.035
Reach #1	472	.016	.025	.035
Reach #1	471.5	.016	.025	.035

SUMMARY OF REACH LENGTHS

River: River #1

Reach	River Sta.	Left	Channel	Right
Reach #1	473.5	50	50	50
Reach #1	473	50	50	50

Reach #1	472.5	50	50	50
Reach #1	472	50	50	50
Reach #1	471.5			

SUMMARY OF CONTRACTION AND EXPANSION COEFFICIENTS
River: River #1

Reach	River Sta.	Contr.	Expan.
Reach #1	473.5	.1	.3
Reach #1	473	.1	.3
Reach #1	472.5	.1	.3
Reach #1	472	.1	.3
Reach #1	471.5	.1	.3

Profile Output Table - Standard Table 1

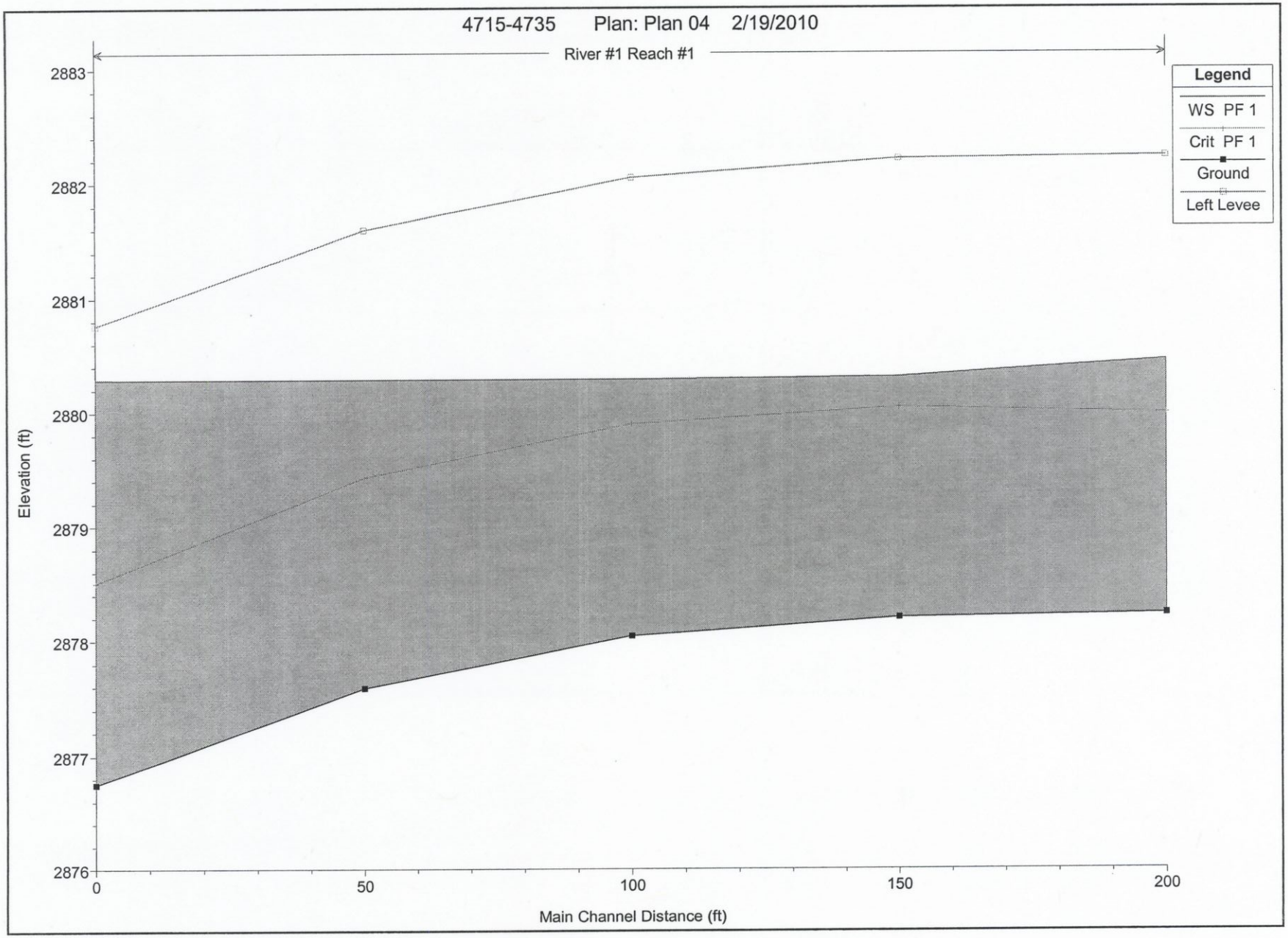
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.
E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	
			(cfs)	(ft)	(ft)	(ft)
(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		
Reach #1	473.5	PF 1	57.00	2878.23	2880.45	2879.98
2880.62	0.002890	3.33	17.13	15.50	0.56	
Reach #1	473	PF 1	57.00	2878.20	2880.30	2880.04
2880.46	0.003338	3.23	21.49	48.76	0.59	
Reach #1	472.5	PF 1	57.00	2878.04	2880.29	2879.89
2880.34	0.001052	2.19	46.69	98.73	0.34	
Reach #1	472	PF 1	57.00	2877.59	2880.29	2879.43
2880.30	0.000279	1.28	80.22	118.63	0.18	
Reach #1	471.5	PF 1	57.00	2876.75	2880.29	2878.50
2880.29	0.000054	0.68	133.81	109.82	0.08	

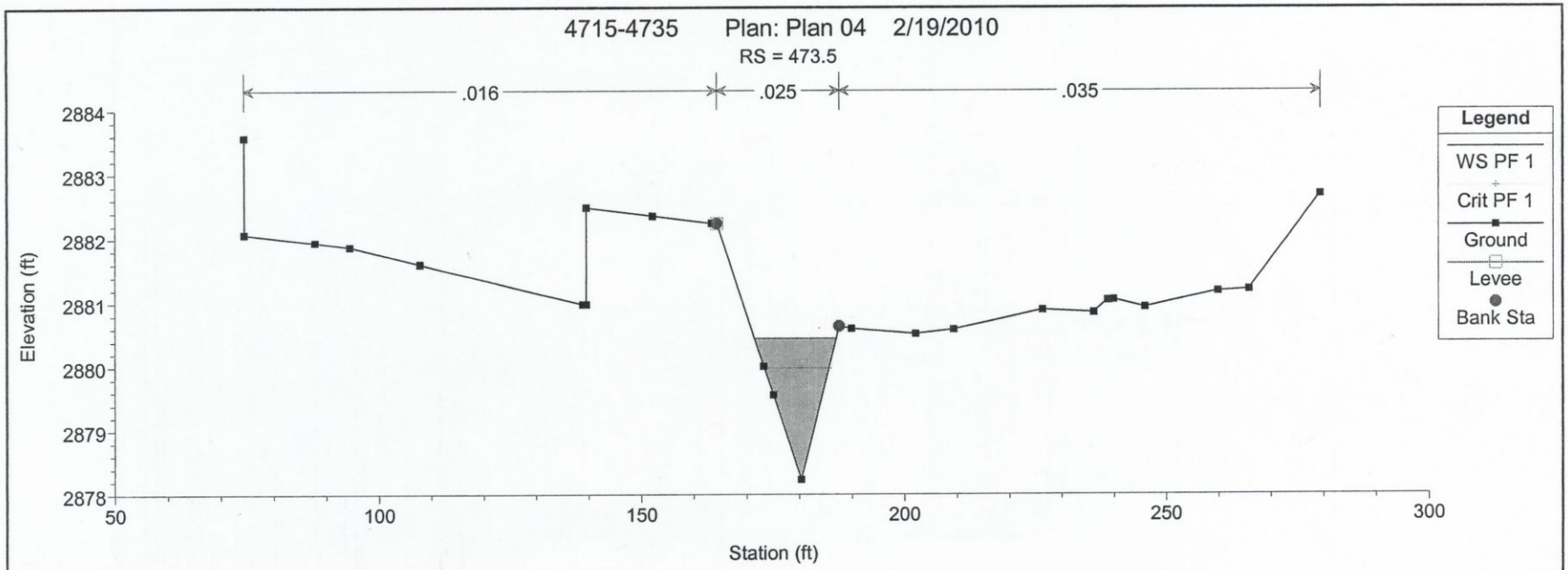
Profile Output Table - Standard Table 2

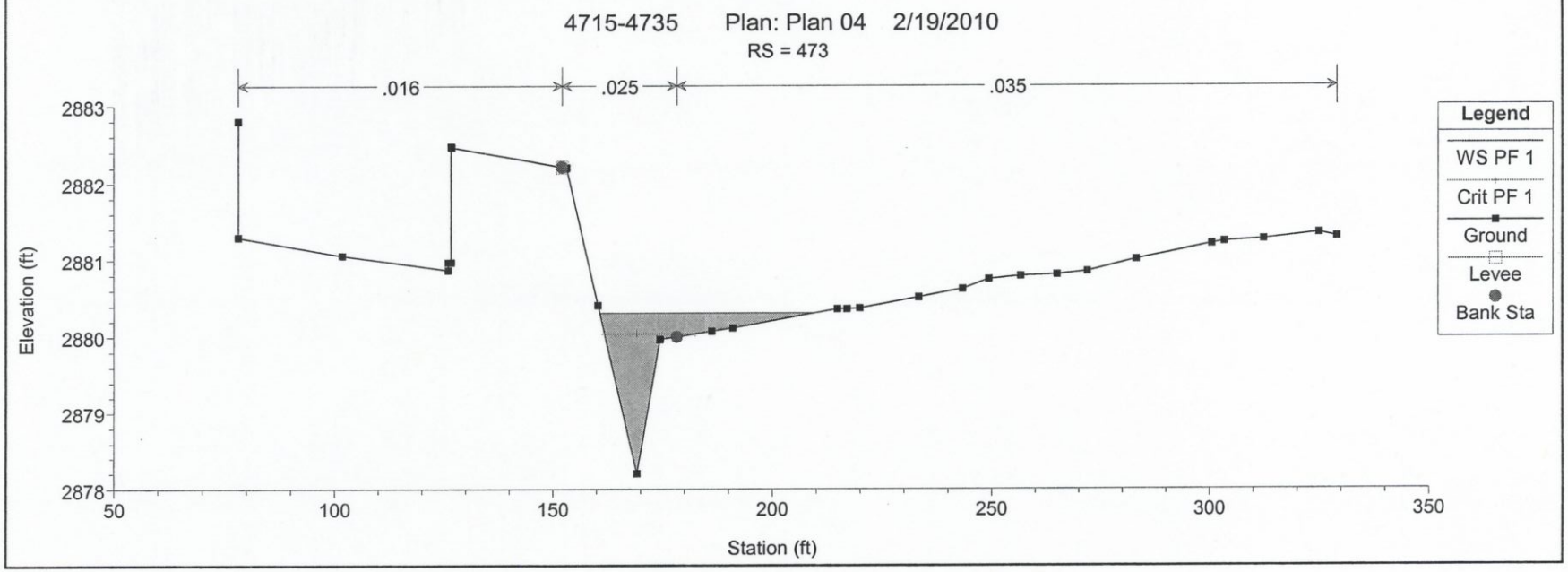
Reach	River Sta	Profile	E.G. Elev	W.S. Elev	Vel Head	Frctn
Loss	C & E Loss	Q Left	Q Channel	Q Right	Top Width	
				(ft)	(ft)	(ft)
(ft)	(ft)	(cfs)	(cfs)	(cfs)	(ft)	
Reach #1	473.5	PF 1	2880.62	2880.45	0.17	
0.16	0.01	57.00		15.50		
Reach #1	473	PF 1	2880.46	2880.30	0.15	
0.09	0.03	53.45	3.55	48.76		
Reach #1	472.5	PF 1	2880.34	2880.29	0.05	
0.02	0.01	36.32	20.68	98.73		
Reach #1	472	PF 1	2880.30	2880.29	0.02	
0.01	0.00	30.02	26.98	118.63		
Reach #1	471.5	PF 1	2880.29	2880.29	0.00	
		26.74	30.26	109.82		

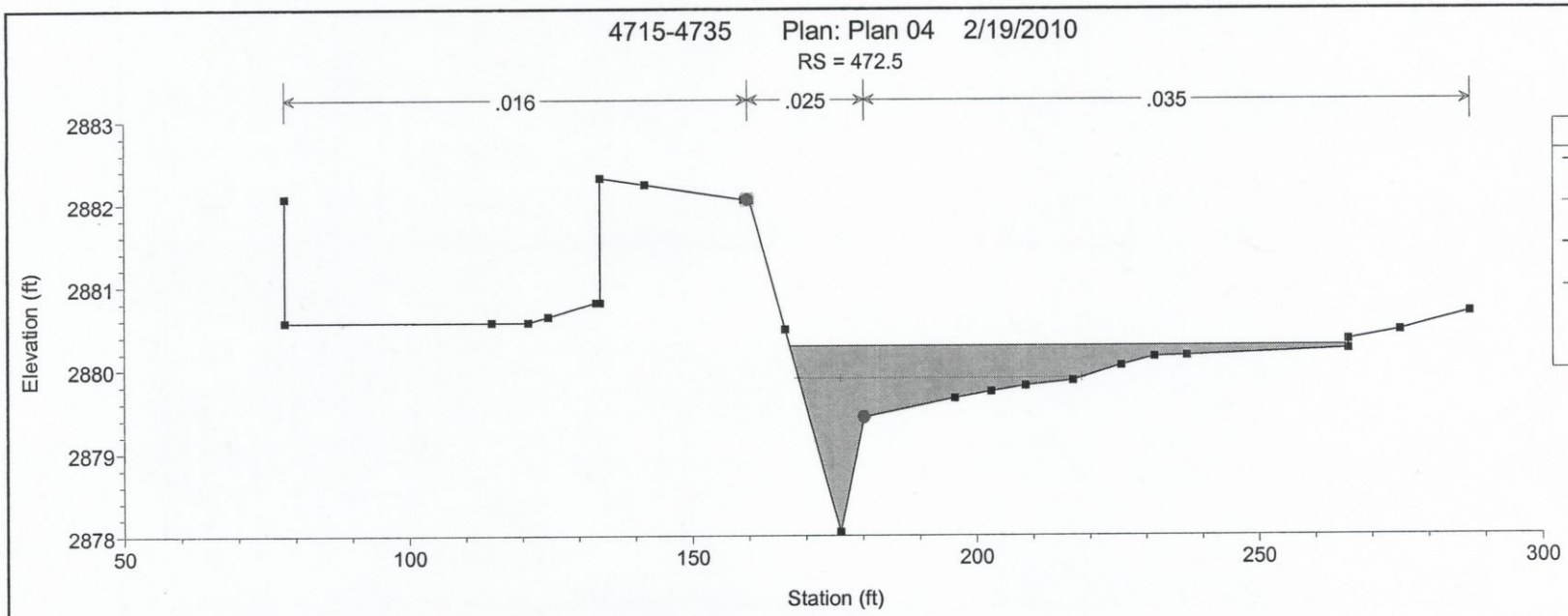
ERRORS WARNINGS AND NOTES
Errors Warnings and Notes for Plan : 4715-4735

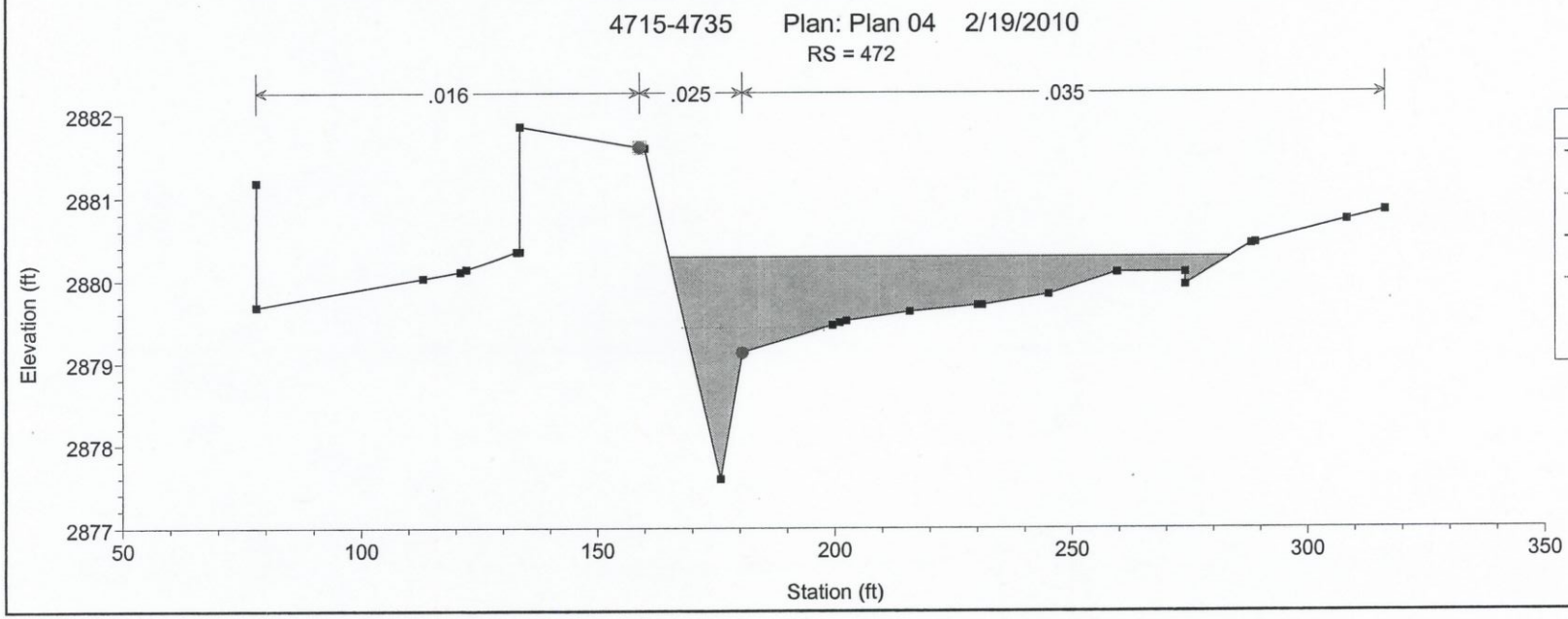
River: River #1 Reach: Reach #1 RS: 473.5 Profile: PF 1
Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was used.
River: River #1 Reach: Reach #1 RS: 473 Profile: PF 1
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was used.
River: River #1 Reach: Reach #1 RS: 472.5 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.
Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was used.
River: River #1 Reach: Reach #1 RS: 472 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.
Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was used.
River: River #1 Reach: Reach #1 RS: 471.5 Profile: PF 1
Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was used.

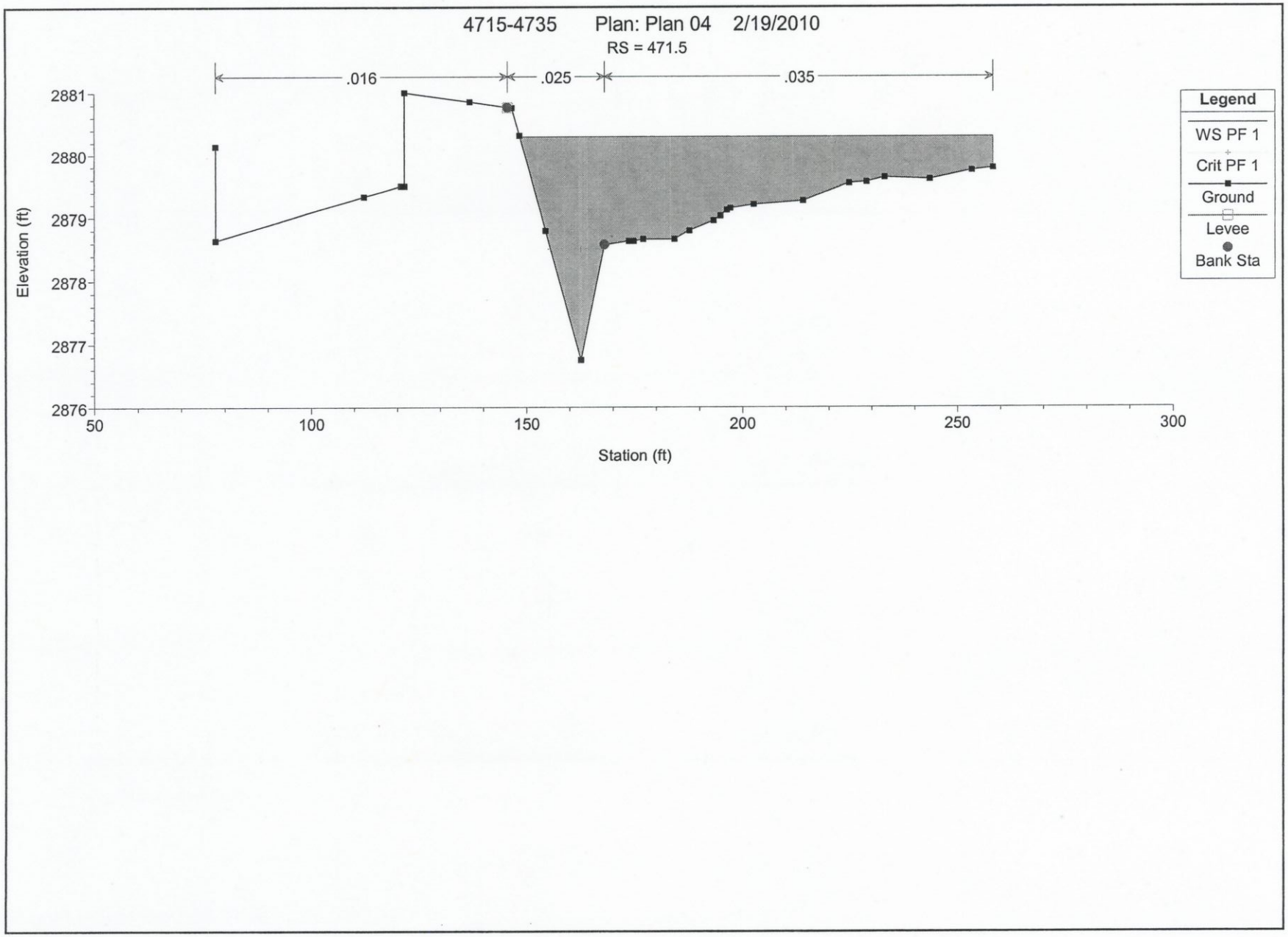

4715-4735 Plan: Plan 04 2/19/2010
River #1 Reach #1
Legend
WS PF 1
Crit PF 1
Ground
Left Levee
Elevation (ft)
2883
2882
2881
2880
2879
2878
2877
2876
0
50
100
150
200
Main Channel Distance (ft)


4715-4735 Plan: Plan 04 2/19/2010
RS = 473.5
.016
.025
.035
Elevation (ft)
2884
2883
2882
2881
2880
2879
2878
50
100
150
200
250
300
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Levee
Bank Sta


4715-4735 Plan: Plan 04 2/19/2010
RS = 473
.016
.025
.035
Elevation (ft)
2883
2882
2881
2880
2879
2878
50
100
150
200
250
300
350
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Levee
Bank Sta


4715-4735 Plan: Plan 04 2/19/2010
RS = 472.5
.016
.025
.035
Elevation (ft)
2883
2882
2881
2880
2879
2878
50
100
150
200
250
300
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Levee
Bank Sta


4715-4735 Plan: Plan 04 2/19/2010
RS = 472
.016
.025
.035
Elevation (ft)
2882
2881
2880
2879
2878
2877
50
100
150
200
250
300
350
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Levee
Bank Sta


4715-4735 Plan: Plan 04 2/19/2010
RS = 471.5
.016
.025
.035
Elevation (ft)
2881
2880
2879
2878
2877
2876
50
100
150
200
250
300
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Levee
Bank Sta

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
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PROJECT DATA
Project Title: 475-478
Project File : 475478.prj
Run Date and Time: 2/19/2010 5:58:44 AM

Project in English units

PLAN DATA

Plan Title: 475-478
Plan File :
t:\7TED069904\HYDRO\DRAINAGE\CALCS\Hydraulics\Channels\Ras-Final\revised\475478.p01

Geometry Title: 475-478
Geometry File :
t:\7TED069904\HYDRO\DRAINAGE\CALCS\Hydraulics\Channels\Ras-Final\revised\475478.g10

Flow Title : 0 Flow Profiles
Flow File :
t:\7TED069904\HYDRO\DRAINAGE\CALCS\Hydraulics\Channels\Ras-Final\revised\475478.F01

Plan Summary Information:

Number of:	Cross Sections =	7	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:\7TED069904\HYDRO\DRAINAGE\CALCS\Hydraulics\Channels\Ras-Final\revised\475478.F01

Flow Data (cfs)

River	Reach	RS	PF 1
River #1	Reach #1	478	57

Boundary Conditions

River	Reach	Profile	Upstream	Downstream
River #1	Reach #1	PF 1		

Known WS = 2881.91

GEOMETRY DATA

Geometry Title: 475-478
Geometry File :
t:\7TED069904\HYDRO\DRAINAGE\CALCS\Hydraulics\Channels\Ras-Final\revised\475478.g10

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 478

INPUT
Description:
Station Elevation Data num= 19

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
79.27	2888.04	82.37	2887.91	83.29	2887.87	83.29	2886.37	126.3	2885.51
126.93	2885.51	126.93	2887.01	143.59	2886.84	144.26	2886.84	145.28	2886.83
161.26	2882.83	164.26	2883.83	169.06	2885.43	169.11	2885.43	172.45	2885.47
175.94	2885.5	178.79	2885.39	184.12	2885.84	191.63	2885.56		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
79.27	.016	145.28	.03	169.06	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
145.28	169.06	50	50	50	.1	.3

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 477.5

INPUT
Description:
Station Elevation Data num= 35

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
79.44	2887.55	82.06	2887.43	83.46	2887.37	83.46	2885.87	104.77	2885.44
128.65	2884.97	129.28	2884.97	129.32	2886.47	146.66	2886.29	147.68	2886.28
163.66	2882.28	169.62	2884.26	169.67	2884.26	174.12	2884.34	175.72	2884.37
175.72	2884.25	175.77	2884.25	175.96	2884.25	176.4	2884.24	177.08	2884.23
179.21	2883.9	179.4	2883.91	179.84	2883.93	181.78	2884.02	191.07	2884.13
196.98	2884.01	204.05	2884.15	207.88	2884.07	213.98	2884.18	217.95	2884.35
229.48	2884.6	241.1	2884.84	243.72	2884.89	246.33	2884.94	257.96	2885.14

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
79.44	.016	146.66	.03	169.62	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
146.66	169.62	50	50	50	.1	.3

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 477

INPUT
Description:
Station Elevation Data num= 25

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
80.1	2886.87	80.1	2885.37	128.63	2884.4	129.31	2884.4	129.31	2885.9
146.64	2885.73	147.66	2885.72	163.64	2881.72	169.31	2883.6	169.36	2883.6
172.41	2883.66	174.15	2883.35	174.83	2883.26	179	2883.28	188.63	2883.33
191.44	2883.35	192.94	2883.35	202.44	2883.62	203.21	2883.66	203.5	2883.66
204.13	2883.68	205.73	2883.7	221.32	2883.9	231.59	2884.15	238.03	2884.27

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
80.1	.016	147.66	.03	169.31	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
147.66	169.31	50	50	50	.1	.3

Right Levee Station= 172.41 Elevation= 2883.66

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 476.5

INPUT
Description:
Station Elevation Data num= 16

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
80.1	2886.37	80.1	2884.87	131.92	2883.83	132.6	2883.83	132.6	2885.33
149.99	2885.16	150.95	2885.15	166.98	2881.15	172.31	2882.92	172.36	2882.8
174.39	2882.81	184.32	2882.86	196.86	2883.05	207.33	2883.29	225.39	2883.65
228.01	2883.68								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
80.1	.016	150.95	.03	172.31	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
150.95	172.31	50	50	50	.1	.3

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 476

INPUT
Description:
Station Elevation Data num= 22

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
80.11	2885.87	80.11	2884.37	80.16	2884.37	135.13	2883.27	135.81	2883.27
135.81	2884.77	135.9	2884.77	150.87	2884.62	153.14	2884.6	154.11	2884.59
170.14	2880.59	176.29	2882.64	176.34	2882.64	181.28	2882.57	190.72	2882.69
219.25	2882.89	219.25	2883.07	221.19	2883.09	233.73	2883.22	245.93	2883.35
247.82	2883.37	267.49	2883.62						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
80.11	.016	154.11	.03	176.29	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
154.11	176.29	50	50	50	.1	.3

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 475.5

INPUT
Description:
Station Elevation Data num= 26

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
80.13	2885.37	80.13	2883.87	113.89	2883.19	134.32	2882.79	135.15	2882.77
135.78	2882.77	135.78	2884.27	137.18	2884.26	153.12	2884.1	154.14	2884.09
170.12	2880.09	176.12	2882.09	176.22	2882.09	184.55	2882.12	191.38	2882.27
198.74	2882.4	206.2	2882.43	213.12	2882.48	222.95	2882.52	241.11	2882.77
241.45	2882.77	241.65	2882.78	260.73	2883.11	270.17	2883.22	282.81	2883.33
298.75	2883.69								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
80.13	.016	153.12	.03	176.12	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
153.12	176.12	50	50	50	.1	.3

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 475

INPUT
Description:
Station Elevation Data num= 23

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
75.98	2885.07	75.98	2883.57	84.65	2883.48	95.98	2883.37	123.73	2882.81
150.95	2882.27	151	2882.27	151.63	2882.27	151.63	2883.77	151.68	2883.77
168.97	2883.6	169.98	2883.59	185.96	2879.59	191.58	2881.46	191.63	2881.45
194.24	2881.36	206.01	2881.5	217.73	2881.68	220.64	2881.73	222.77	2881.75
234.93	2881.96	248.05	2882.27	249.79	2882.28				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
75.98	.016	169.98	.03	191.58	.035

Bank Sta: Left	Right	Coeff Contr.	Expan.
169.98	191.58	.1	.3

SUMMARY OF MANNING'S N VALUES

River:River #1

Reach	River Sta.	n1	n2	n3
Reach #1	478	.016	.03	.035
Reach #1	477.5	.016	.03	.035
Reach #1	477	.016	.03	.035
Reach #1	476.5	.016	.03	.035
Reach #1	476	.016	.03	.035
Reach #1	475.5	.016	.03	.035
Reach #1	475	.016	.03	.035

SUMMARY OF REACH LENGTHS

River: River #1

Reach	River Sta.	Left	Channel	Right
Reach #1	478	50	50	50
Reach #1	477.5	50	50	50
Reach #1	477	50	50	50
Reach #1	476.5	50	50	50
Reach #1	476	50	50	50
Reach #1	475.5	50	50	50
Reach #1	475			

SUMMARY OF CONTRACTION AND EXPANSION COEFFICIENTS
River: River #1

Reach	River Sta.	Contr.	Expan.
Reach #1	478	.1	.3
Reach #1	477.5	.1	.3
Reach #1	477	.1	.3
Reach #1	476.5	.1	.3
Reach #1	476	.1	.3
Reach #1	475.5	.1	.3
Reach #1	475	.1	.3

Profile Output Table - Standard Table 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.
E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	
			(cfs)	(ft)	(ft)	(ft)

(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		
Reach #1	478	PF 1	57.00	2882.83	2884.57	2884.57
2885.02	0.014867	5.36	10.62	12.19	1.01	
Reach #1	477.5	PF 1	57.00	2882.28	2884.22	2884.22
2884.44	0.007012	3.96	18.36	51.31	0.71	
Reach #1	477	PF 1	57.00	2881.72	2883.48	2883.48
2883.91	0.014266	5.28	10.80	12.30	0.99	
Reach #1	476.5	PF 1	57.00	2881.15	2883.02	2883.02
2883.30	0.008700	4.37	15.44	35.49	0.79	
Reach #1	476	PF 1	57.00	2880.59	2882.50	
2882.81	0.008987	4.44	12.84	13.41	0.80	
Reach #1	475.5	PF 1	57.00	2880.09	2881.90	2881.83
2882.29	0.012074	4.96	11.49	12.68	0.92	
Reach #1	475	PF 1	57.00	2879.59	2881.91	2881.34
2881.99	0.001997	2.50	30.97	55.34	0.39	

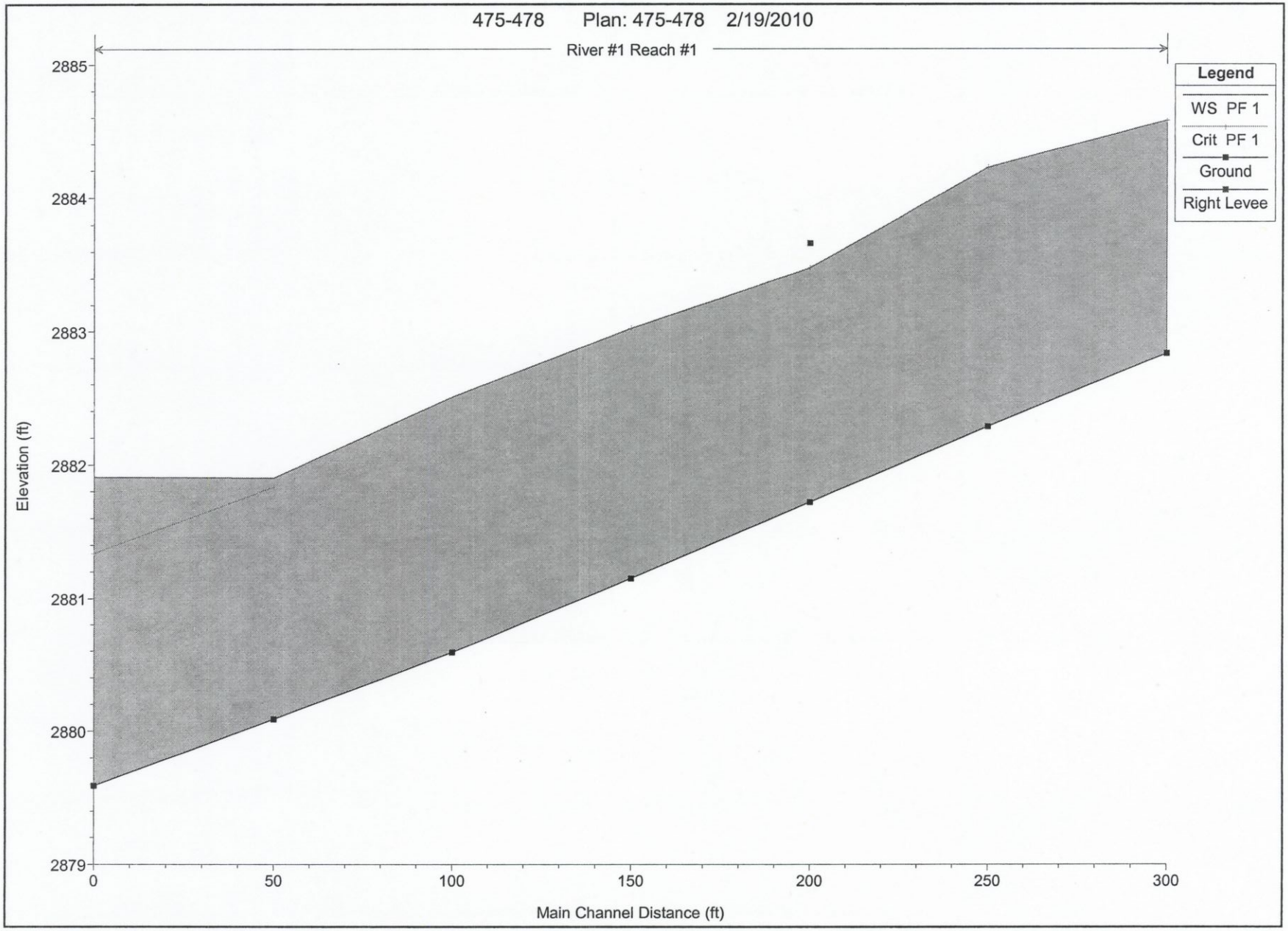
Profile Output Table - Standard Table 2

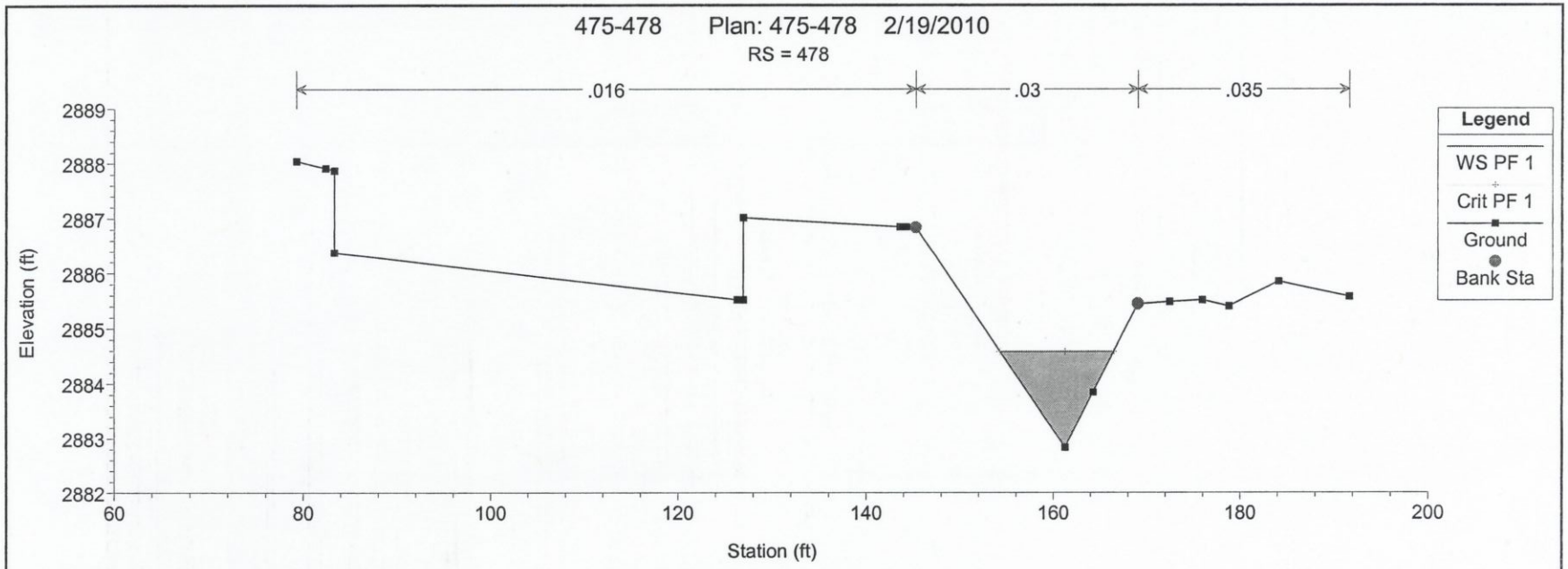
Reach	River Sta	Profile	E.G. Elev	W.S. Elev	Vel Head	Frctn
Loss	C & E Loss	Q Left	Q Channel	Q Right	Top Width	
				(ft)	(ft)	(ft)
(ft)	(ft)	(cfs)	(cfs)	(cfs)	(ft)	
Reach #1	478	PF 1	2885.02	2884.57	0.45	
0.49	0.07	57.00		12.19		
Reach #1	477.5	PF 1	2884.44	2884.22	0.22	
0.48	0.02	52.08	4.92	51.31		
Reach #1	477	PF 1	2883.91	2883.48	0.43	
0.55	0.05	57.00		12.30		
Reach #1	476.5	PF 1	2883.30	2883.02	0.28	
0.44	0.00	53.65	3.35	35.49		
Reach #1	476	PF 1	2882.81	2882.50	0.31	
0.52	0.01	57.00		13.41		
Reach #1	475.5	PF 1	2882.29	2881.90	0.38	
0.20	0.09	57.00		12.68		
Reach #1	475	PF 1	2881.99	2881.91	0.08	
		46.25	10.75	55.34		

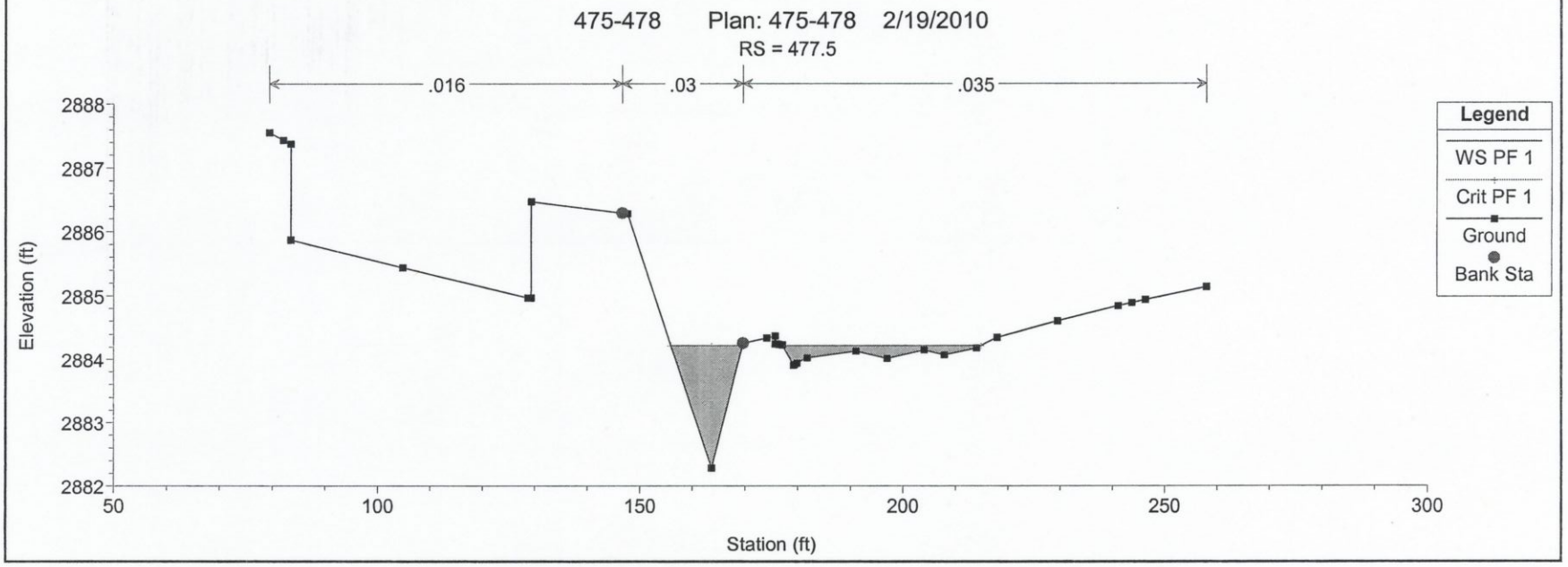
ERRORS WARNINGS AND NOTES
Errors Warnings and Notes for Plan : 475-478

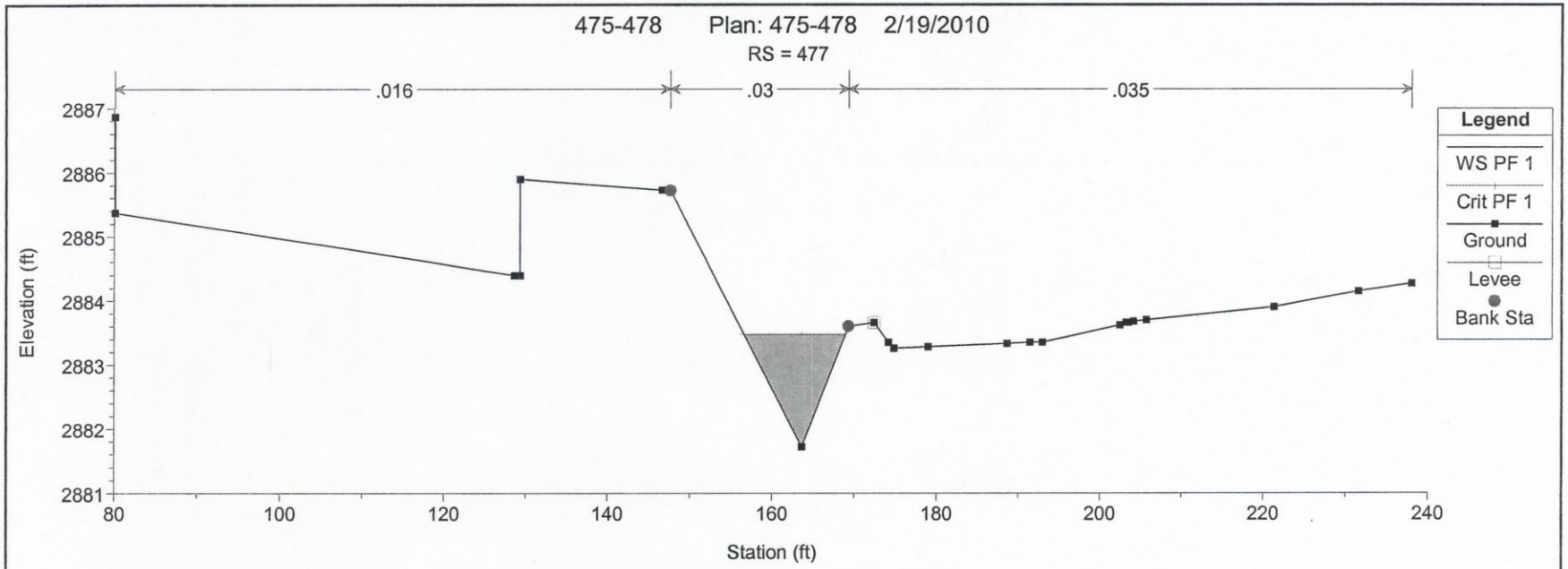
River: River #1 Reach: Reach #1 RS: 478 Profile: PF 1
Warning:The energy equation could not be balanced within the specified number of iterations. The program used critical depth
for the water surface and continued on with the calculations.
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
Warning: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.

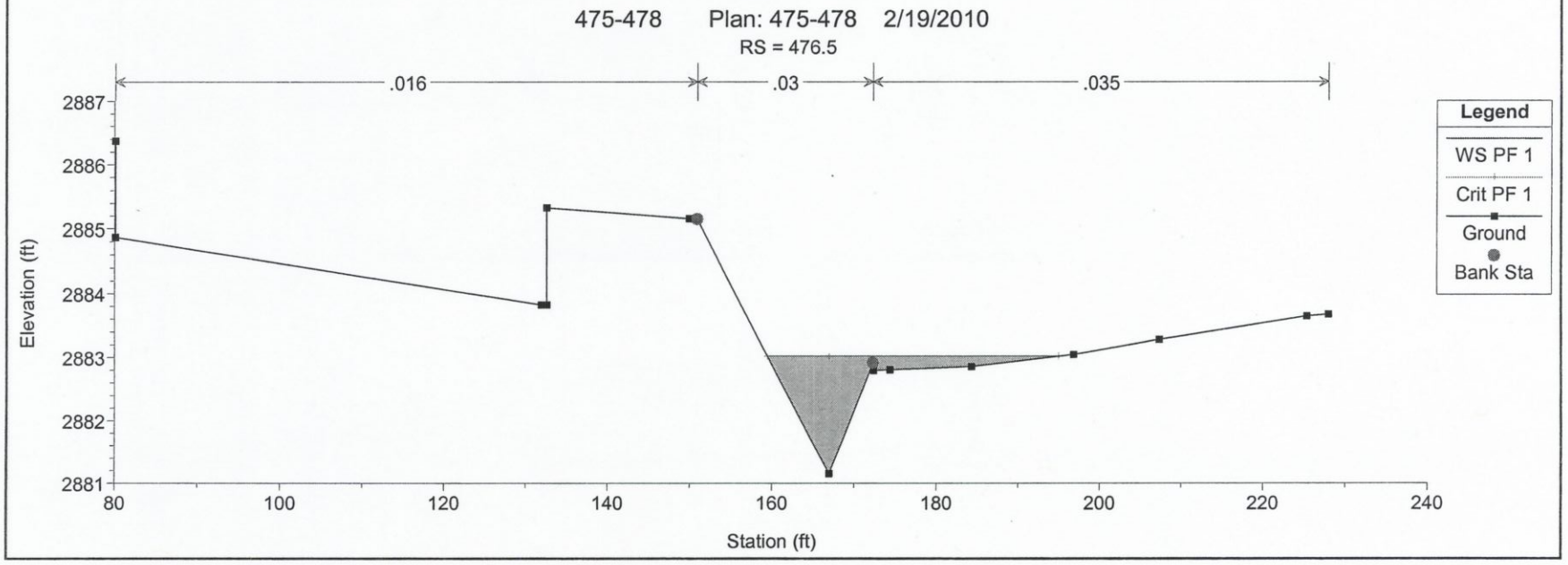
```
River: River #1  Reach: Reach #1     RS: 477.5     Profile: PF 1
     Warning:The energy equation could not be balanced within the specified number
of iterations.  The program used critical depth
             for the water surface and continued on with the calculations.
     Warning:Divided flow 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: 477     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: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.
     Note:   Multiple critical depths were found at this location.  The critical
depth with the lowest, valid, water surface was
             used.
River: River #1  Reach: Reach #1     RS: 476.5     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: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: 475.5     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.
```

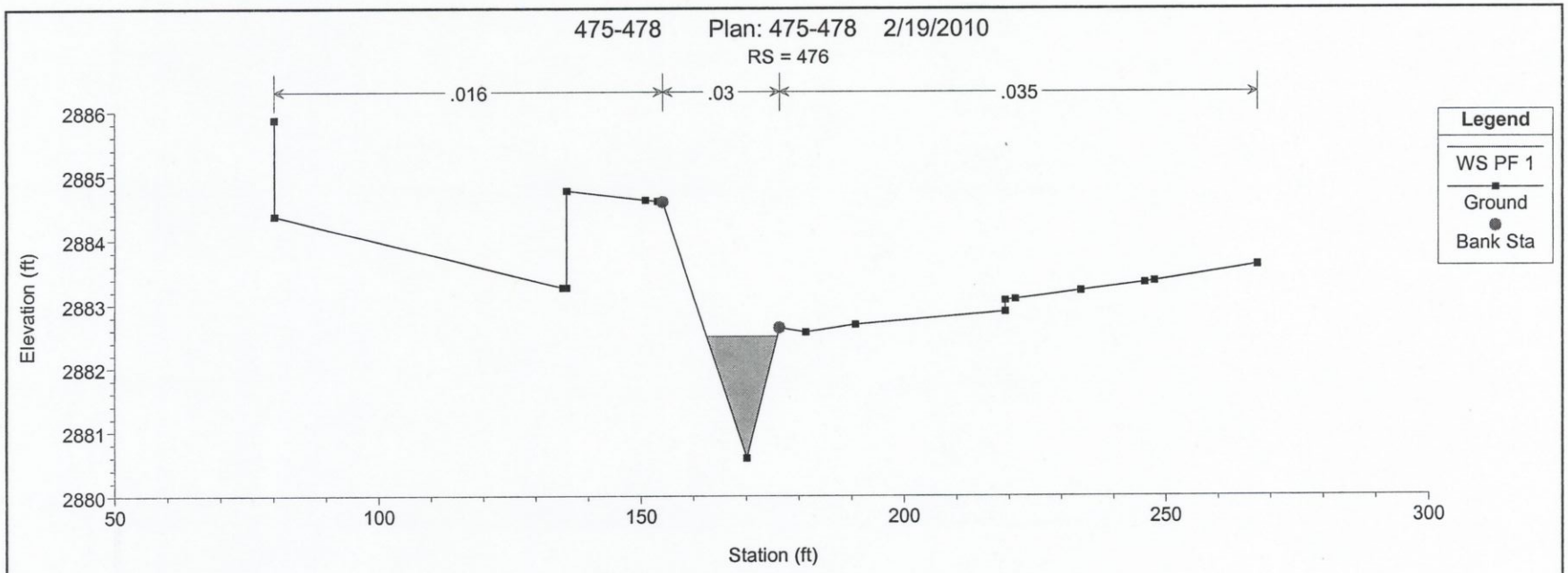

475-478 Plan: 475-478 2/19/2010
River #1 Reach #1
Legend
WS PF 1
Crit PF 1
Ground
Right Levee
Elevation (ft)
2885
2884
2883
2882
2881
2880
2879
0
50
100
150
200
250
300
Main Channel Distance (ft)

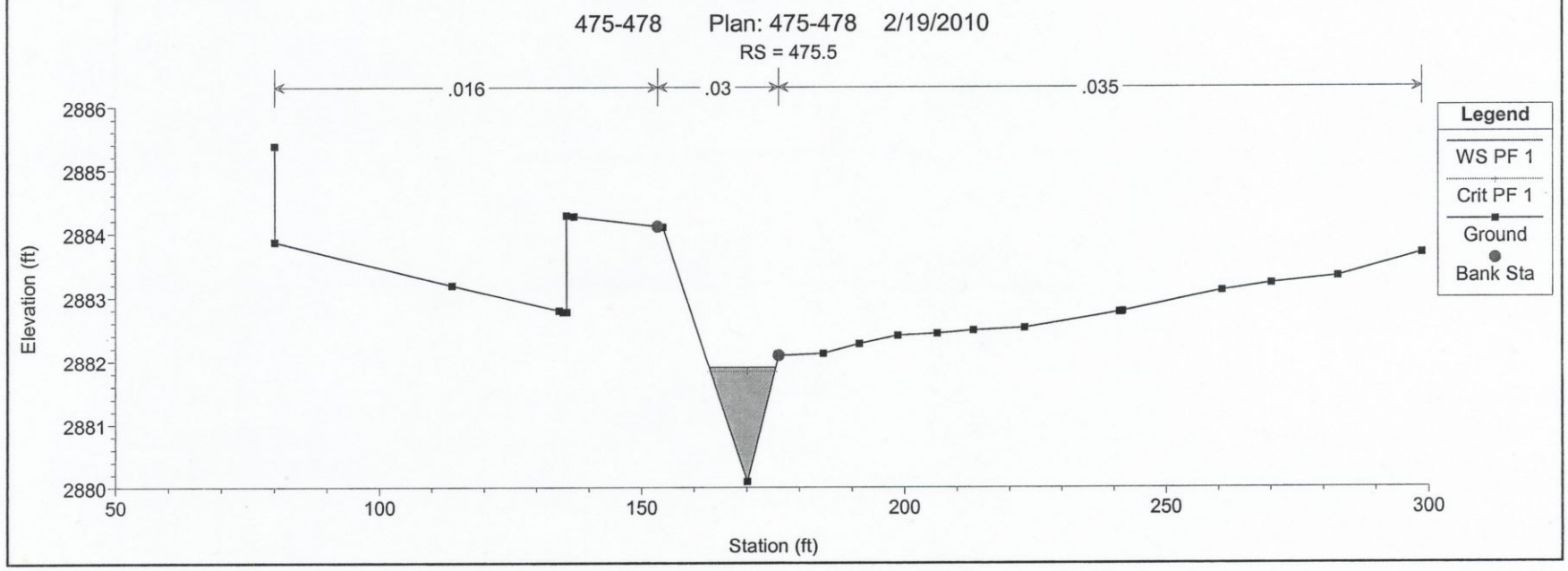

475-478 Plan: 475-478 2/19/2010
RS = 478
.016
.03
.035
Legend
WS PF 1
Crit PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)
2889
2888
2887
2886
2885
2884
2883
2882
60
80
100
120
140
160
180
200

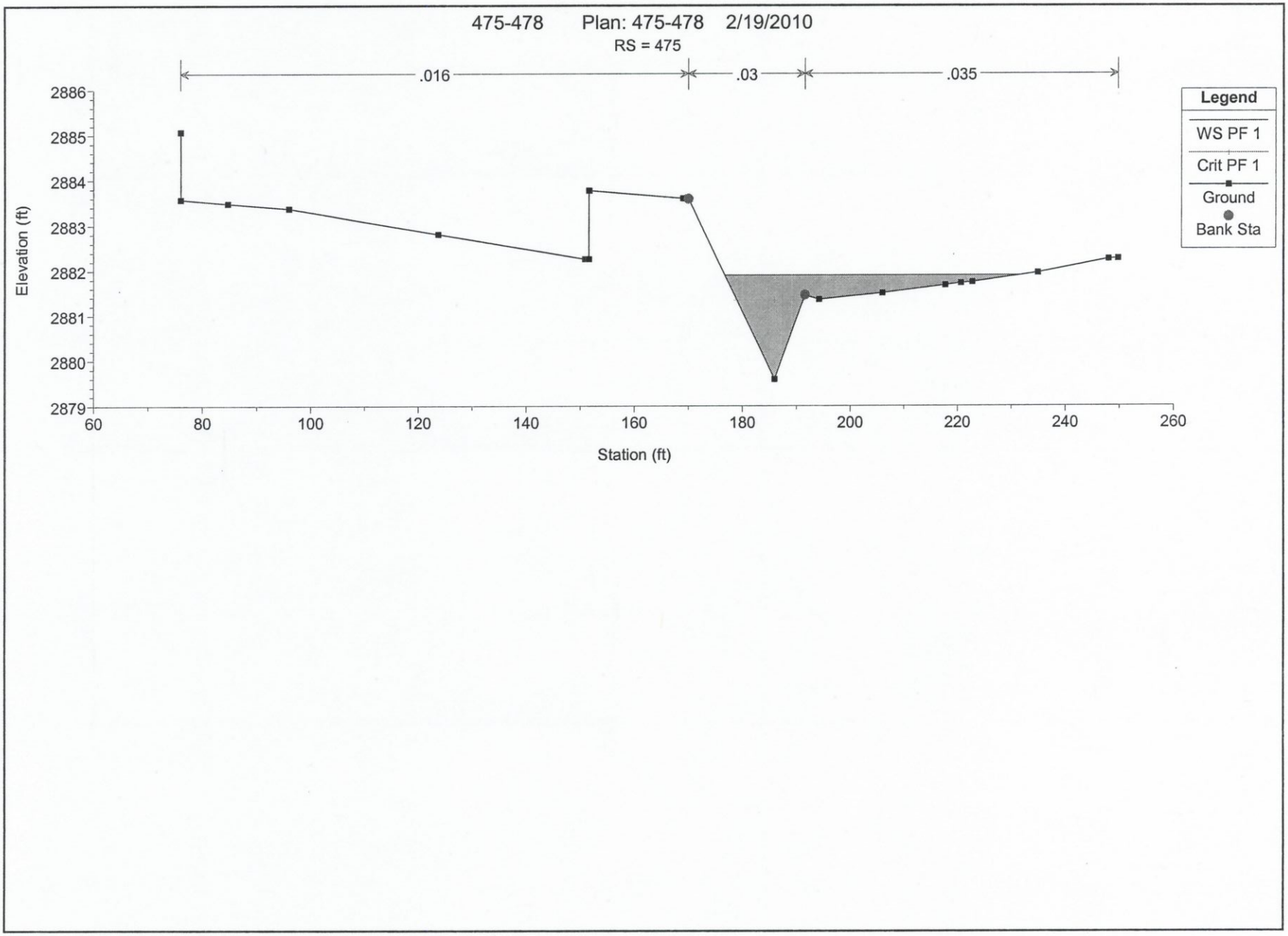

475-478 Plan: 475-478 2/19/2010
RS = 477.5
.016
.03
.035
Legend
WS PF 1
Crit PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)
2888
2887
2886
2885
2884
2883
2882
50
100
150
200
250
300


475-478 Plan: 475-478 2/19/2010
RS = 477
.016
.03
.035
Elevation (ft)
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Levee
Bank Sta


475-478 Plan: 475-478 2/19/2010
RS = 476.5
.016
.03
.035
Elevation (ft)
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Bank Sta


475-478 Plan: 475-478 2/19/2010
RS = 476
.016
.03
.035
Legend
WS PF 1
Ground
Bank Sta
Elevation (ft)
2886
2885
2884
2883
2882
2881
2880
50
100
150
200
250
300
Station (ft)


475-478 Plan: 475-478 2/19/2010
RS = 475.5
.016
.03
.035
Legend
WS PF 1
Crit PF 1
Ground
Bank Sta
Elevation (ft)
2886
2885
2884
2883
2882
2881
2880
50
100
150
200
250
300
Station (ft)


475-478 Plan: 475-478 2/19/2010
RS = 475
.016
.03
.035
Elevation (ft)
2886
2885
2884
2883
2882
2881
2880
2879
60
80
100
120
140
160
180
200
220
240
260
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Bank Sta

ROADSIDE CHANNEL BETWEEN APPROXIMATELY STA. 475+00 AND 478+00

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
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PROJECT DATA
Project Title: 475-478
Project File : 475478.prj
Run Date and Time: 2/19/2010 6:08:50 AM

Project in English units

PLAN DATA

Plan Title: 475-478
Plan File :
t:\7TED069904\HYDRO\DRAINAGE\CALCS\Hydraulics\Channels\Ras-Final\revised\475478.p01

Geometry Title: 475-478
Geometry File :
t:\7TED069904\HYDRO\DRAINAGE\CALCS\Hydraulics\Channels\Ras-Final\revised\475478.g10

Flow Title : 0 Flow Profiles
Flow File :
t:\7TED069904\HYDRO\DRAINAGE\CALCS\Hydraulics\Channels\Ras-Final\revised\475478.F01

Plan Summary Information:

Number of:	Cross Sections =	7	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:\7TED069904\HYDRO\DRAINAGE\CALCS\Hydraulics\Channels\Ras-Final\revised\475478.F01

Flow Data (cfs)

River	Reach	RS	PF 1
River #1	Reach #1	478	57

Boundary Conditions

River	Reach	Profile	Upstream	Downstream
River #1	Reach #1	PF 1		

Known WS = 2881.91

GEOMETRY DATA

Geometry Title: 475-478
Geometry File :
t:\7TED069904\HYDRO\DRAINAGE\CALCS\Hydraulics\Channels\Ras-Final\revised\475478.g10

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 478

INPUT
Description:
Station Elevation Data num= 19

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
79.27	2888.04	82.37	2887.91	83.29	2887.87	83.29	2886.37	126.3	2885.51
126.93	2885.51	126.93	2887.01	143.59	2886.84	144.26	2886.84	145.28	2886.83
161.26	2882.83	164.26	2883.83	169.06	2885.43	169.11	2885.43	172.45	2885.47
175.94	2885.5	178.79	2885.39	184.12	2885.84	191.63	2885.56		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
79.27	.016	145.28	.03	169.06	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
145.28	169.06	50	50	50	.1	.3

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 477.5

INPUT
Description:
Station Elevation Data num= 35

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
79.44	2887.55	82.06	2887.43	83.46	2887.37	83.46	2885.87	104.77	2885.44
128.65	2884.97	129.28	2884.97	129.32	2886.47	146.66	2886.29	147.68	2886.28
163.66	2882.28	169.62	2884.26	169.67	2884.26	174.12	2884.34	175.72	2884.37
175.72	2884.25	175.77	2884.25	175.96	2884.25	176.4	2884.24	177.08	2884.23
179.21	2883.9	179.4	2883.91	179.84	2883.93	181.78	2884.02	191.07	2884.13
196.98	2884.01	204.05	2884.15	207.88	2884.07	213.98	2884.18	217.95	2884.35
229.48	2884.6	241.1	2884.84	243.72	2884.89	246.33	2884.94	257.96	2885.14

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
79.44	.016	146.66	.03	169.62	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
146.66	169.62	50	50	50	.1	.3

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 477

INPUT
Description:
Station Elevation Data num= 25

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
80.1	2886.87	80.1	2885.37	128.63	2884.4	129.31	2884.4	129.31	2885.9
146.64	2885.73	147.66	2885.72	163.64	2881.72	169.31	2883.6	169.36	2883.6
172.41	2883.66	174.15	2883.35	174.83	2883.26	179	2883.28	188.63	2883.33
191.44	2883.35	192.94	2883.35	202.44	2883.62	203.21	2883.66	203.5	2883.66
204.13	2883.68	205.73	2883.7	221.32	2883.9	231.59	2884.15	238.03	2884.27

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
80.1	.016	147.66	.03	169.31	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
147.66	169.31	50	50	50	.1	.3

Right Levee Station= 172.41 Elevation= 2883.66

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 476.5

INPUT
Description:
Station Elevation Data num= 16

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
80.1	2886.37	80.1	2884.87	131.92	2883.83	132.6	2883.83	132.6	2885.33
149.99	2885.16	150.95	2885.15	166.98	2881.15	172.31	2882.92	172.36	2882.8
174.39	2882.81	184.32	2882.86	196.86	2883.05	207.33	2883.29	225.39	2883.65
228.01	2883.68								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
80.1	.016	150.95	.03	172.31	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
150.95	172.31	50	50	50	.1	.3

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 476

INPUT
Description:
Station Elevation Data num= 22

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
80.11	2885.87	80.11	2884.37	80.16	2884.37	135.13	2883.27	135.81	2883.27
135.81	2884.77	135.9	2884.77	150.87	2884.62	153.14	2884.6	154.11	2884.59
170.14	2880.59	176.29	2882.64	176.34	2882.64	181.28	2882.57	190.72	2882.69
219.25	2882.89	219.25	2883.07	221.19	2883.09	233.73	2883.22	245.93	2883.35
247.82	2883.37	267.49	2883.62						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
80.11	.016	154.11	.03	176.29	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
154.11	176.29	50	50	50	.1	.3

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 475.5

INPUT
Description:
Station Elevation Data num= 26

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
80.13	2885.37	80.13	2883.87	113.89	2883.19	134.32	2882.79	135.15	2882.77
135.78	2882.77	135.78	2884.27	137.18	2884.26	153.12	2884.1	154.14	2884.09
170.12	2880.09	176.12	2882.09	176.22	2882.09	184.55	2882.12	191.38	2882.27
198.74	2882.4	206.2	2882.43	213.12	2882.48	222.95	2882.52	241.11	2882.77
241.45	2882.77	241.65	2882.78	260.73	2883.11	270.17	2883.22	282.81	2883.33
298.75	2883.69								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
80.13	.016	153.12	.03	176.12	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
153.12	176.12	50	50	50	.1	.3

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 475

INPUT
Description:
Station Elevation Data num= 23

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
75.98	2885.07	75.98	2883.57	84.65	2883.48	95.98	2883.37	123.73	2882.81
150.95	2882.27	151	2882.27	151.63	2882.27	151.63	2883.77	151.68	2883.77
168.97	2883.6	169.98	2883.59	185.96	2879.59	191.58	2881.46	191.63	2881.45
194.24	2881.36	206.01	2881.5	217.73	2881.68	220.64	2881.73	222.77	2881.75
234.93	2881.96	248.05	2882.27	249.79	2882.28				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
75.98	.016	169.98	.03	191.58	.035

Bank Sta: Left	Right	Coeff Contr.	Expan.
169.98	191.58	.1	.3

SUMMARY OF MANNING'S N VALUES

River:River #1

Reach	River Sta.	n1	n2	n3
Reach #1	478	.016	.03	.035
Reach #1	477.5	.016	.03	.035
Reach #1	477	.016	.03	.035
Reach #1	476.5	.016	.03	.035
Reach #1	476	.016	.03	.035
Reach #1	475.5	.016	.03	.035
Reach #1	475	.016	.03	.035

SUMMARY OF REACH LENGTHS

River: River #1

Reach	River Sta.	Left	Channel	Right
Reach #1	478	50	50	50
Reach #1	477.5	50	50	50
Reach #1	477	50	50	50
Reach #1	476.5	50	50	50
Reach #1	476	50	50	50
Reach #1	475.5	50	50	50
Reach #1	475			

SUMMARY OF CONTRACTION AND EXPANSION COEFFICIENTS
River: River #1

Reach	River Sta.	Contr.	Expan.
Reach #1	478	.1	.3
Reach #1	477.5	.1	.3
Reach #1	477	.1	.3
Reach #1	476.5	.1	.3
Reach #1	476	.1	.3
Reach #1	475.5	.1	.3
Reach #1	475	.1	.3

Profile Output Table - Standard Table 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.
E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	
			(cfs)	(ft)	(ft)	(ft)

(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		
Reach #1	478	PF 1	57.00	2882.83	2884.57	2884.57
2885.02	0.014867	5.36	10.62	12.19	1.01	
Reach #1	477.5	PF 1	57.00	2882.28	2884.22	2884.22
2884.44	0.007012	3.96	18.36	51.31	0.71	
Reach #1	477	PF 1	57.00	2881.72	2883.48	2883.48
2883.91	0.014266	5.28	10.80	12.30	0.99	
Reach #1	476.5	PF 1	57.00	2881.15	2883.02	2883.02
2883.30	0.008700	4.37	15.44	35.49	0.79	
Reach #1	476	PF 1	57.00	2880.59	2882.50	
2882.81	0.008987	4.44	12.84	13.41	0.80	
Reach #1	475.5	PF 1	57.00	2880.09	2881.90	2881.83
2882.29	0.012074	4.96	11.49	12.68	0.92	
Reach #1	475	PF 1	57.00	2879.59	2881.91	2881.34
2881.99	0.001997	2.50	30.97	55.34	0.39	

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	478	PF 1	2885.02	2884.57	0.45	
0.49	0.07	57.00		12.19		
Reach #1	477.5	PF 1	2884.44	2884.22	0.22	
0.48	0.02	52.08	4.92	51.31		
Reach #1	477	PF 1	2883.91	2883.48	0.43	
0.55	0.05	57.00		12.30		
Reach #1	476.5	PF 1	2883.30	2883.02	0.28	
0.44	0.00	53.65	3.35	35.49		
Reach #1	476	PF 1	2882.81	2882.50	0.31	
0.52	0.01	57.00		13.41		
Reach #1	475.5	PF 1	2882.29	2881.90	0.38	
0.20	0.09	57.00		12.68		
Reach #1	475	PF 1	2881.99	2881.91	0.08	
		46.25	10.75	55.34		

ERRORS WARNINGS AND NOTES
Errors Warnings and Notes for Plan : 475-478

River: River #1 Reach: Reach #1 RS: 478 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: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: 477.5 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: 477 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: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.

Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was used.

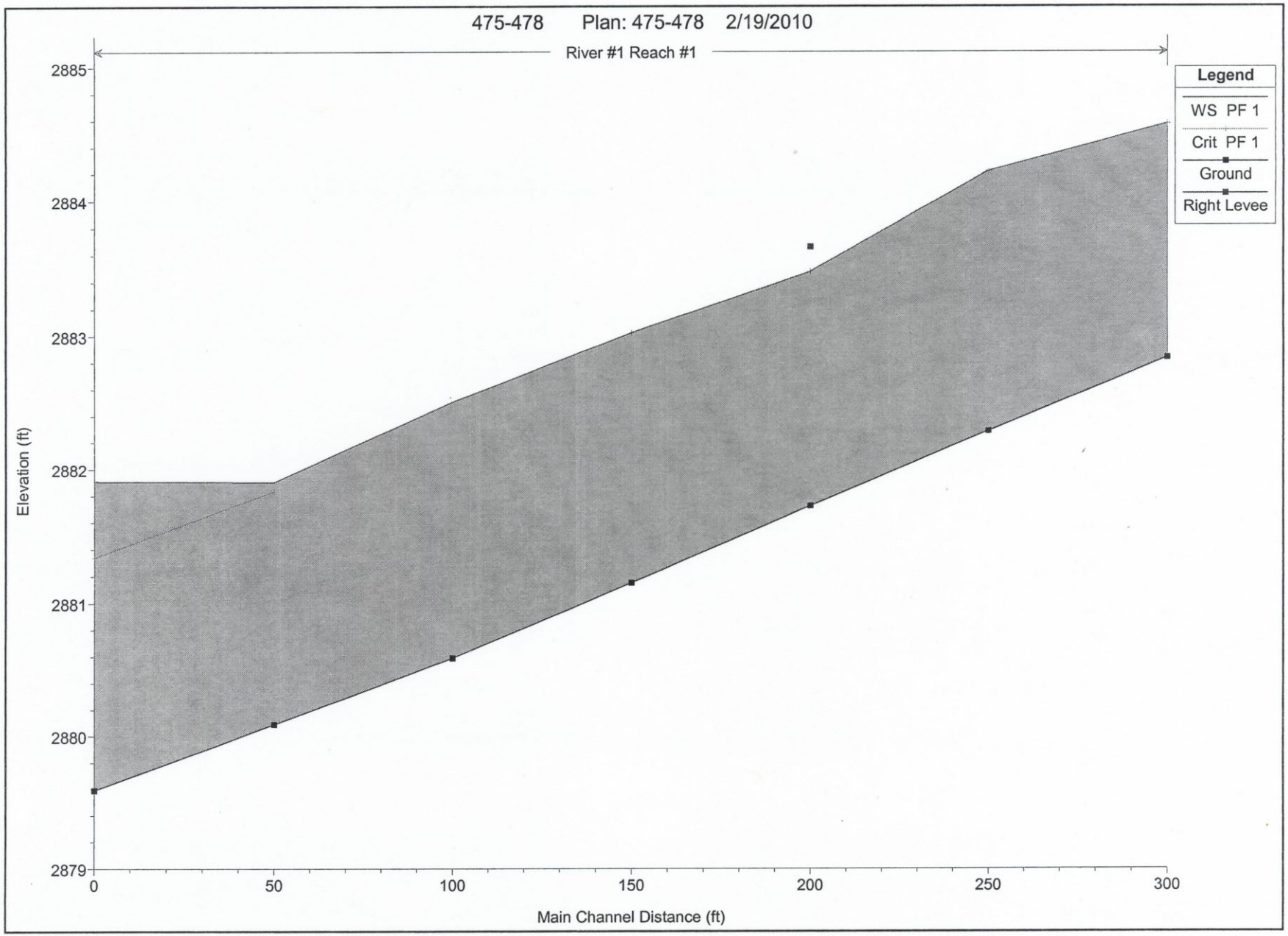
River: River #1 Reach: Reach #1 RS: 476.5 Profile: PF 1

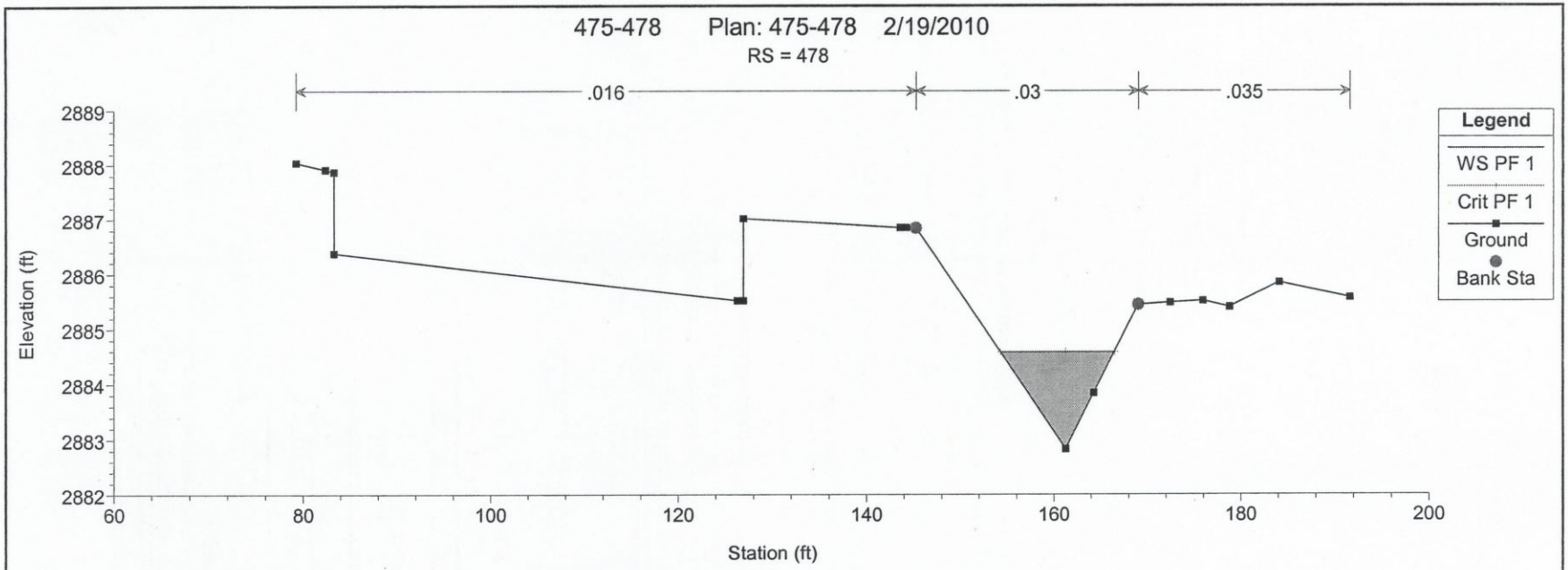
Warning:The energy equation could not be balanced within the specified number of iterations. The program used critical depth for the water surface and continued on with the calculations.

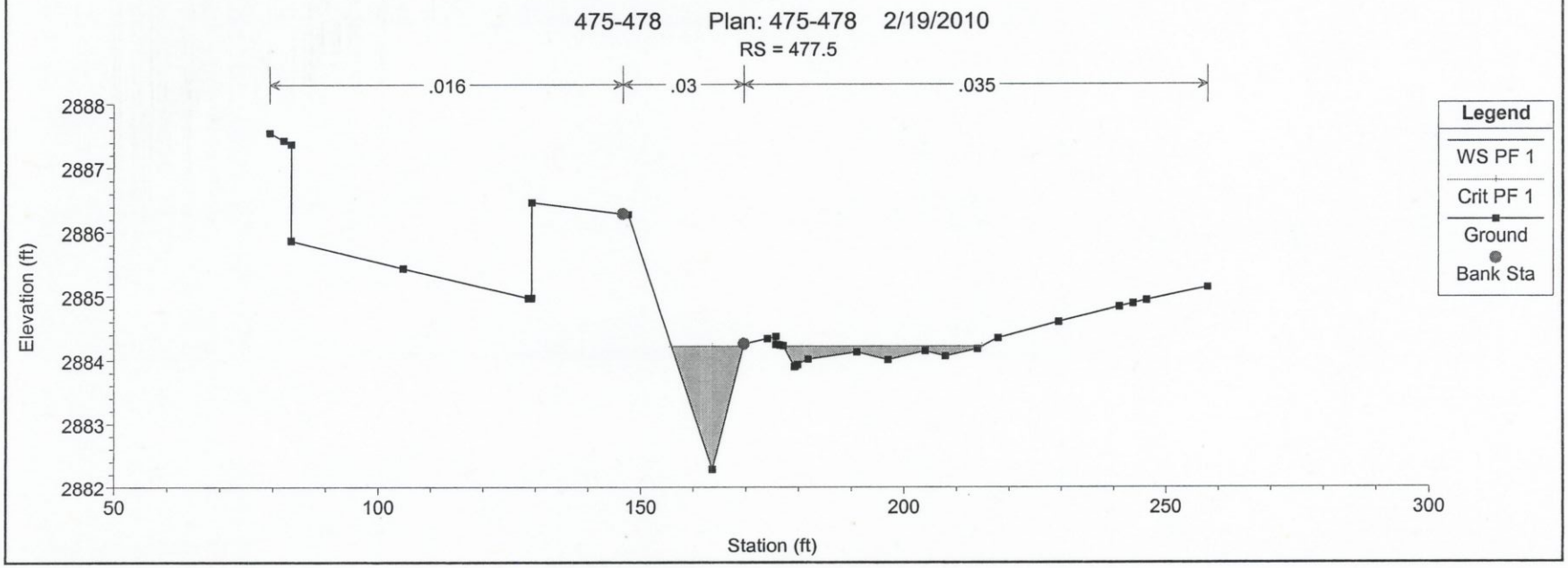
Warning:During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The program defaulted to critical depth.

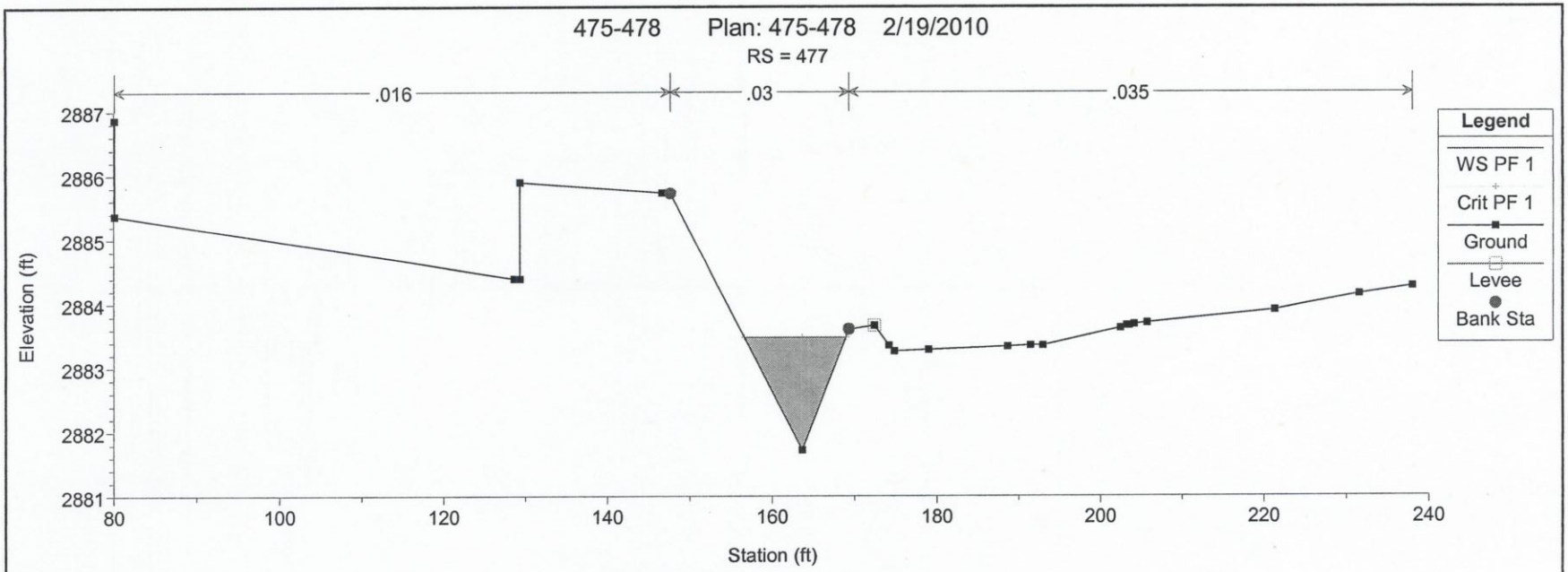
River: River #1 Reach: Reach #1 RS: 475.5 Profile: PF 1

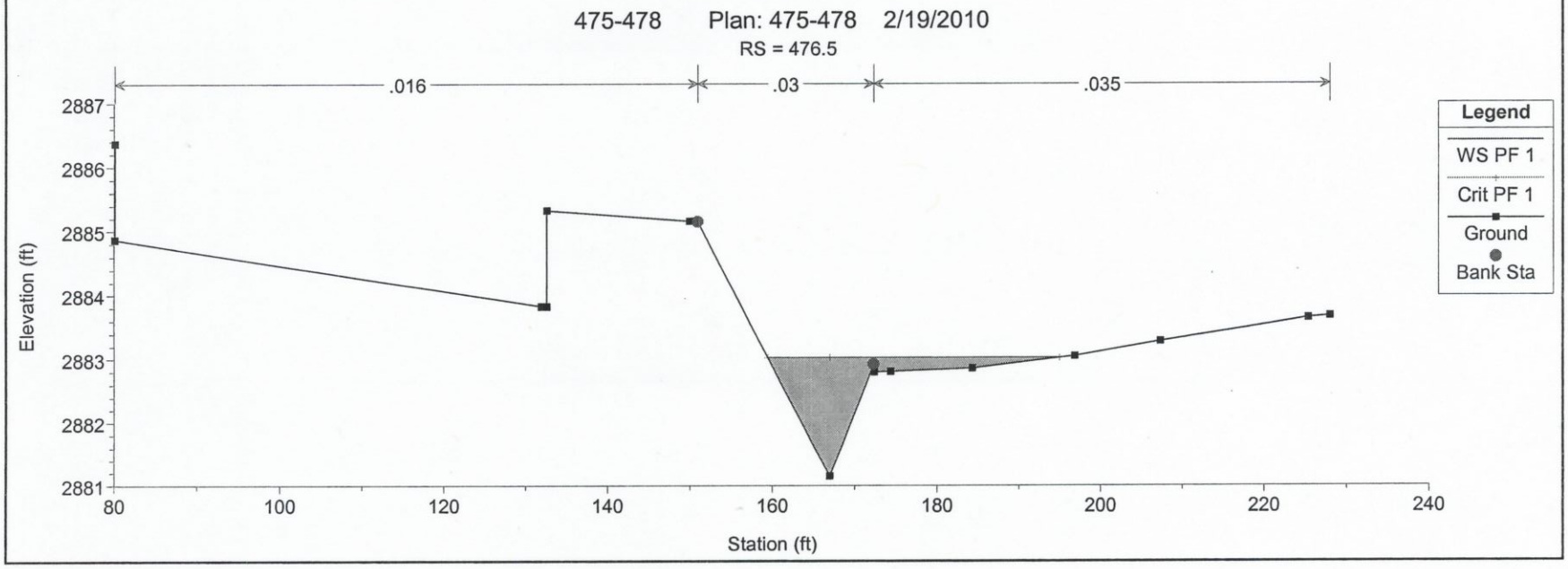
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4. This may indicate the need for additional cross sections.

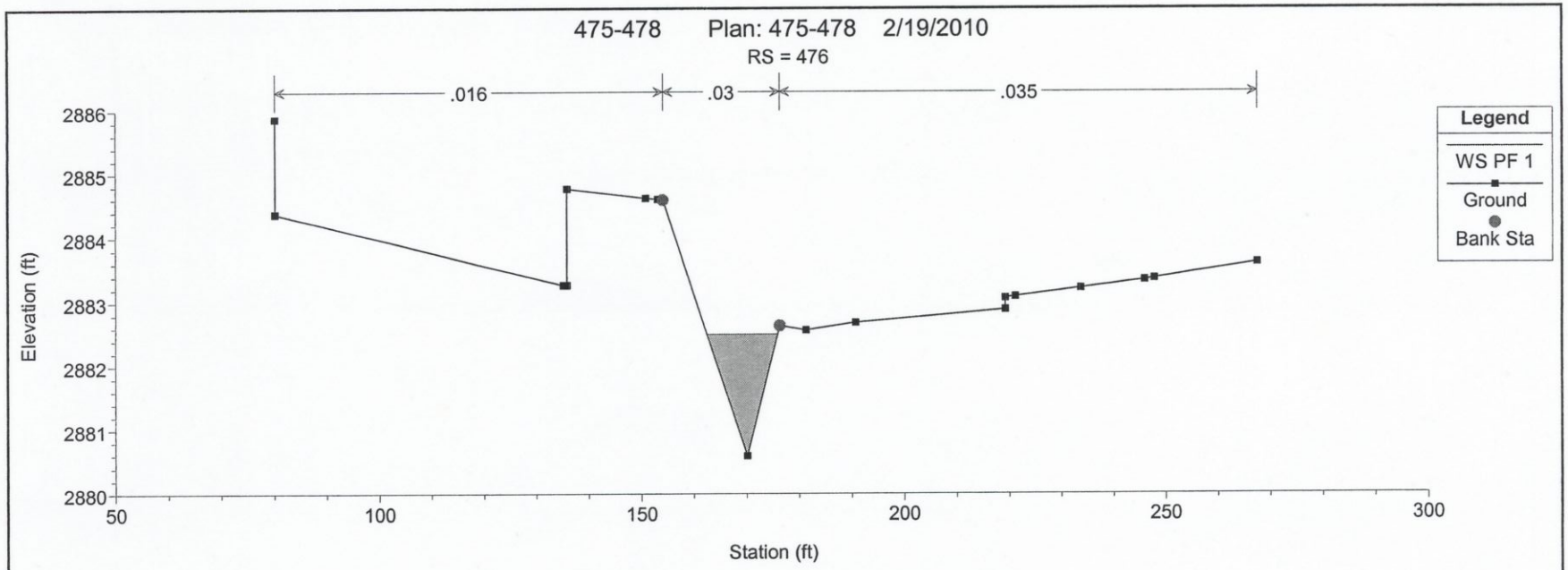

475-478 Plan: 475-478 2/19/2010
River #1 Reach #1
Legend
WS PF 1
Crit PF 1
Ground
Right Levee
Elevation (ft)
2885
2884
2883
2882
2881
2880
2879
0
50
100
150
200
250
300
Main Channel Distance (ft)

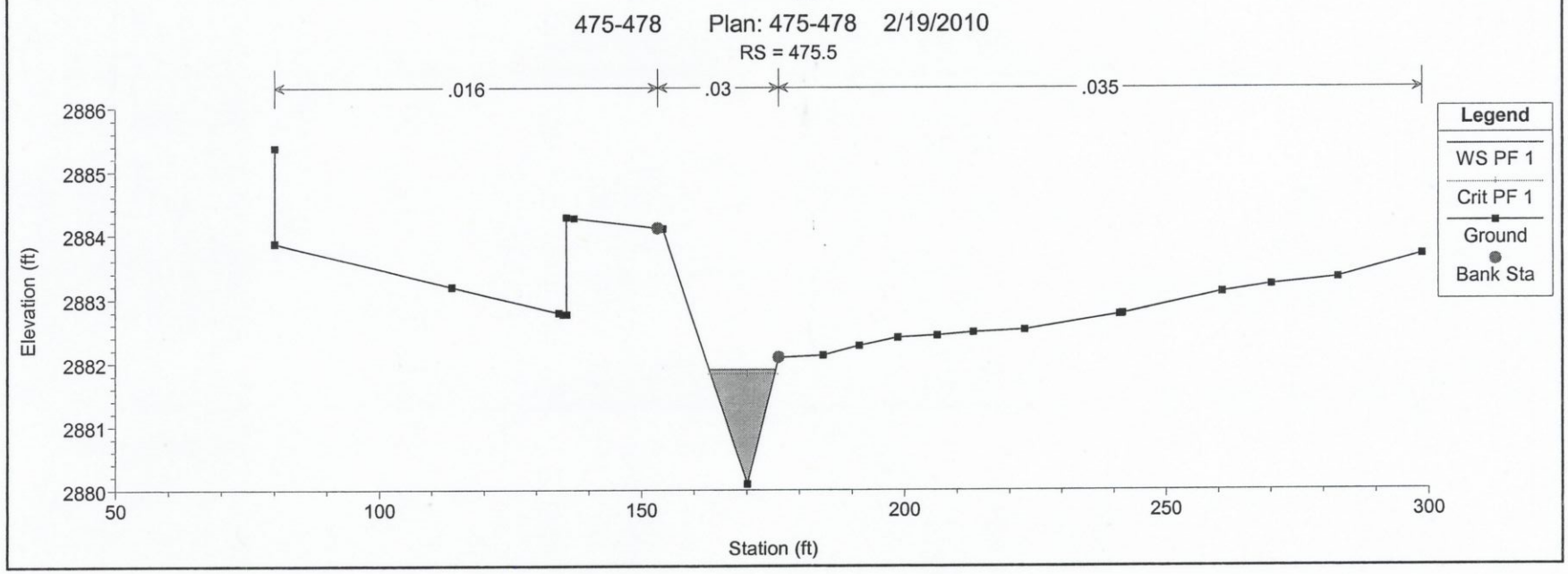

475-478 Plan: 475-478 2/19/2010
RS = 478
.016
.03
.035
Legend
WS PF 1
Crit PF 1
Ground
Bank Sta
Elevation (ft)
2889
2888
2887
2886
2885
2884
2883
2882
60
80
100
120
140
160
180
200
Station (ft)

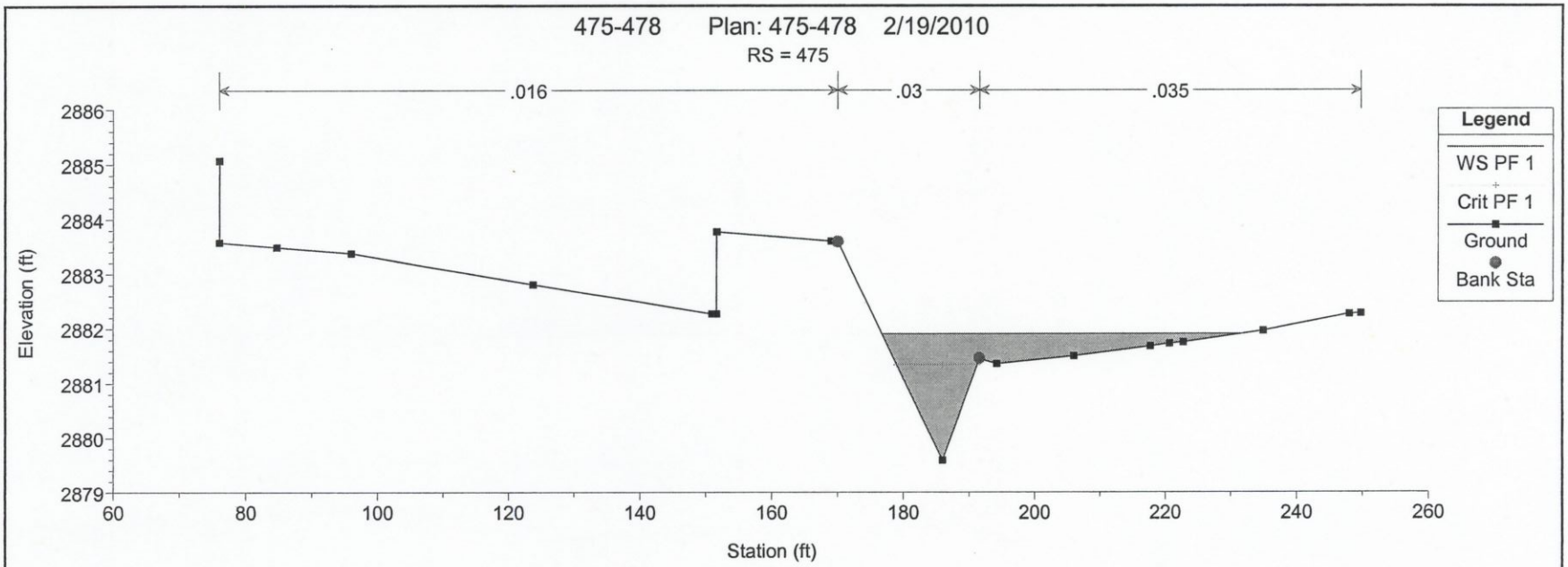

475-478 Plan: 475-478 2/19/2010
RS = 477.5
.016
.03
.035
Legend
WS PF 1
Crit PF 1
Ground
Bank Sta
Elevation (ft)
2888
2887
2886
2885
2884
2883
2882
50
100
150
200
250
300
Station (ft)


475-478 Plan: 475-478 2/19/2010
RS = 477
.016
.03
.035
Elevation (ft)
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Levee
Bank Sta


475-478 Plan: 475-478 2/19/2010
RS = 476.5
.016
.03
.035
Elevation (ft)
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Bank Sta


475-478 Plan: 475-478 2/19/2010
RS = 476
.016
.03
.035
Legend
WS PF 1
Ground
Bank Sta
Elevation (ft)
2886
2885
2884
2883
2882
2881
2880
50
100
150
200
250
300
Station (ft)


475-478 Plan: 475-478 2/19/2010
RS = 475.5
.016
.03
.035
Legend
WS PF 1
Crit PF 1
Ground
Bank Sta
Elevation (ft)
2886
2885
2884
2883
2882
2881
2880
50
100
150
200
250
300
Station (ft)


475-478 Plan: 475-478 2/19/2010
RS = 475
.016
.03
.035
Elevation (ft)
2886
2885
2884
2883
2882
2881
2880
2879
60
80
100
120
140
160
180
200
220
240
260
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Bank Sta

ROADSIDE CHANNEL BETWEEN APPROXIMATELY STA. 478+50 AND 485+00

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: 4785-485
Project File : 4785485.prj
Run Date and Time: 2/19/2010 5:59:37 AM

Project in English units

PLAN DATA

Plan Title: Plan 02
Plan File :
t:\7TED069904\HYDRO\DRAINAGE\CALCS\Hydraulics\Channels\Ras-Final\revised\4785485.p02

Geometry Title: 4785-485
Geometry File :
t:\7TED069904\HYDRO\DRAINAGE\CALCS\Hydraulics\Channels\Ras-Final\revised\4785485.g06

Flow Title : 0 Flow Profiles
Flow File :
t:\7TED069904\HYDRO\DRAINAGE\CALCS\Hydraulics\Channels\Ras-Final\revised\4785485.F01

Plan Summary Information:

Number of:	Cross Sections =	14	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:\7TED069904\HYDRO\DRAINAGE\CALCS\Hydraulics\Channels\Ras-Final\revised\4785485.F01

Flow Data (cfs)

River	Reach	RS	PF 1
River #1	Reach #1	485	51

Boundary Conditions

River	Reach	Profile	Upstream	Downstream
River #1	Reach #1	PF 1		

Known WS = 2885.41

GEOMETRY DATA

Geometry Title: 4785-485
Geometry File :
t:\7TED069904\HYDRO\DRAINAGE\CALCS\Hydraulics\Channels\Ras-Final\revised\4785485.g06

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 485

INPUT
Description:
Station Elevation Data num= 16

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
79.47	2894.72	82.71	2894.69	82.71	2893.19	82.71	2893.18	113.47	2892.57
125.72	2892.33	125.72	2893.33	128.72	2892.83	130.52	2893.13	131.73	2893.33
138.46	2893.26	160.69	2893.04	161.71	2893.03	177.69	2889.03	181.56	2890.32
185.2	2891.53								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
79.47	.016	160.69	.025	185.2	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
160.69	185.2	50	50	50	.1	.3

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 484.5

INPUT
Description:
Station Elevation Data num= 15

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
79.47	2894.37	79.52	2892.87	90.08	2892.66	122.48	2892.01	122.53	2893.01
123.74	2892.81	125.48	2892.53	125.48	2892.51	128.48	2893.01	155.12	2892.74
157.49	2892.72	158.51	2892.71	174.49	2888.71	176.09	2889.25	182	2891.21

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
79.47	.016	158.51	.025	182	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
158.51	182	50	50	50	.1	.3

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 484

INPUT
Description:
Station Elevation Data num= 5

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
88.93	2892.51	117.94	2892.22	118.96	2892.21	134.94	2888.21	142.45	2890.71

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
88.93	.016	117.94	.025	142.45	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
117.94	142.45	50	50	50	.1	.3

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 483.5

INPUT
Description:
Station Elevation Data num= 11

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
78.39	2893.37	78.39	2891.87	121.4	2891.01	121.4	2892.01	124.4	2891.51
127.4	2892.01	156.41	2891.72	157.38	2891.71	173.41	2887.71	175.64	2888.47
180.87	2890.21								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
78.39	.016	156.41	.025	180.87	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
156.41	180.87	50	50	50	.1	.3

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 483

INPUT
Description:
Station Elevation Data num= 11

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
80.64	2891.37	123.65	2890.89	123.65	2891.51	124.62	2891.35	126.65	2891.01

```
  129.65 2891.51  158.66 2891.22  159.68 2891.21  175.66 2887.21  179.73 2888.57
  183.17 2889.71

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
   80.64    .016  159.68    .025  183.17    .035

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
        159.68  183.17               50      50      50             .1       .3

CROSS SECTION


RIVER: River #1
REACH: Reach #1           RS: 482.5

INPUT
Description:
Station Elevation Data    num=      22
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
   82.39 2892.37   82.39 2890.87  118.91 2890.14   125.4 2890.01   125.4 2891.01
  125.74 2890.95   128.4 2890.51   131.4 2891.01  160.41 2890.72  161.38 2890.71
  177.41 2886.71  183.22 2888.65  184.87 2889.21  186.27 2888.86  186.32 2888.86
  186.37 2888.86  196.35 2888.91  213.05 2889.36  222.79 2889.39  222.79 2889.49
  235.19 2889.63  241.59 2889.75

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
   82.39    .016  160.41    .025  184.87    .035

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
        160.41  184.87               50      50      50             .1       .3

CROSS SECTION


RIVER: River #1
REACH: Reach #1           RS: 482

INPUT
Description:
Station Elevation Data    num=      21
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
   91.45 2890.51  120.46 2890.22  121.43 2890.21  137.46 2886.21  144.48 2888.56
  144.92 2888.71  146.37 2888.35  146.42 2888.35  146.52 2888.36  157.99 2888.55
  166.71  2888.7  166.76  2888.7  166.76 2888.71  166.95 2888.71  195.48  2889.1
  195.48 2889.29  195.77  2889.3  196.49  2889.3  216.11 2889.51  224.05 2889.59
  235.48 2889.67

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
   91.45    .016  120.46    .025  166.71    .035

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
        120.46  166.71               50      50      50             .1       .3

CROSS SECTION


RIVER: River #1
REACH: Reach #1           RS: 481.5

INPUT
```

Description:
Station Elevation Data num= 19

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
90.39	2890.01	90.44	2890.01	119.35	2889.72	120.37	2889.71	136.35	2885.71
141.49	2887.41	143.86	2888.21	143.91	2888.22	143.96	2888.22	144.59	2888.23
144.97	2888.24	148.56	2888.29	159.7	2888.47	172.87	2888.63	188.27	2888.84
200.77	2889.02	216.8	2889.21	222.95	2889.31	229.2	2889.38		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
90.39	.016	120.37	.025	143.86	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
120.37	143.86	50	50	50	.1	.3

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 481

INPUT
Description:
Station Elevation Data num= 20

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
89.33	2889.51	104.49	2889.36	118.29	2889.22	119.31	2889.21	135.29	2885.21
138.05	2886.12	142.8	2887.71	142.94	2887.75	142.99	2887.75	143.04	2887.75
145.65	2887.79	149.14	2887.83	151.03	2887.85	152.48	2887.88	178.97	2888.43
206.88	2888.46	206.88	2888.72	209.59	2888.75	234.77	2889.01	238.11	2889.04

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
89.33	.016	118.29	.025	142.94	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
118.29	142.94	50	50	50	.1	.3

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 480.5

INPUT
Description:
Station Elevation Data num= 21

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
88.93	2889.01	115.42	2888.75	117.94	2888.72	118.38	2888.72	118.91	2888.71
126.66	2886.78	134.94	2884.71	135.47	2884.89	142.4	2887.21	143.32	2887.51
143.37	2887.51	145.93	2887.57	155.33	2887.68	165.06	2887.8	174.46	2887.91
179.55	2887.92	184.82	2887.98	194.07	2887.99	203.03	2888.13	213.69	2888.3
231.56	2888.45								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
88.93	.016	117.94	.025	174.46	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
117.94	174.46	50	50	50	.1	.3

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 480

INPUT
Description:
Station Elevation Data num= 22

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
88.79	2888.51	117.8	2888.22	118.82	2888.21	123.81	2886.96	134.46	2884.29
134.8	2884.21	136.16	2884.66	142.31	2886.71	143.61	2887.15	143.66	2887.15
159.83	2887.25	164.05	2887.31	168.16	2887.31	178.58	2887.37	189.38	2887.5
193.11	2887.52	196.69	2887.5	207.59	2887.45	218.87	2887.51	222.12	2887.56
225.26	2887.59	236.6	2887.71						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
88.79	.016	117.8	.025	143.61	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
117.8	143.61	50	50	50	.1	.3

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 479.5

INPUT
Description:
Station Elevation Data num= 17

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
88.65	2888.01	115.72	2887.74	116.74	2887.73	132.72	2883.73	140.23	2886.23
141.58	2886.69	141.68	2886.69	151.46	2886.79	154.41	2886.82	160.13	2886.8
177.52	2886.5	180.86	2886.52	180.86	2886.64	183.57	2886.65	186.23	2886.67
202.7	2886.85	218.97	2887.04						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
88.65	.016	115.72	.025	151.46	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
115.72	151.46	50	50	50	.1	.3

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 479

INPUT
Description:
Station Elevation Data num= 10

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
88.84	2887.51	102.06	2887.38	103.08	2887.37	119.06	2883.37	126.57	2885.87
126.76	2885.93	127.58	2886.21	127.63	2886.21	127.73	2886.21	131.26	2886.3

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
88.84	.016	102.06	.025	127.58	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
102.06	127.58	50	50	50	.1	.3

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 478.5

INPUT
Description:
Station Elevation Data num= 26

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
88.43	2887.51	105.77	2887.34	106.74	2887.33	122.77	2883.33	129.84	2885.69
129.89	2885.69	137.06	2885.72	137.78	2885.73	138.36	2885.73	141.08	2885.84
141.85	2885.9	145.68	2886.11	146.65	2886.12	147.03	2886.12	147.37	2886.12
147.71	2886.12	149.02	2886.13	150.37	2886.14	165.34	2886.29	166.89	2886.31
167.23	2886.31	168.92	2886.32	170.38	2886.3	180.35	2886.49	183.94	2886.55
192.65	2886.72								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
88.43	.016	105.77	.025	129.84	.035

Bank Sta: Left	Right	Coeff Contr.	Expan.
105.77	129.84	.1	.3

SUMMARY OF MANNING'S N VALUES

River:River #1

Reach	River Sta.	n1	n2	n3
Reach #1	485	.016	.025	.035
Reach #1	484.5	.016	.025	.035
Reach #1	484	.016	.025	.035
Reach #1	483.5	.016	.025	.035
Reach #1	483	.016	.025	.035
Reach #1	482.5	.016	.025	.035
Reach #1	482	.016	.025	.035
Reach #1	481.5	.016	.025	.035
Reach #1	481	.016	.025	.035
Reach #1	480.5	.016	.025	.035
Reach #1	480	.016	.025	.035
Reach #1	479.5	.016	.025	.035
Reach #1	479	.016	.025	.035
Reach #1	478.5	.016	.025	.035

SUMMARY OF REACH LENGTHS

River: River #1

Reach	River Sta.	Left	Channel	Right
Reach #1	485	50	50	50
Reach #1	484.5	50	50	50
Reach #1	484	50	50	50
Reach #1	483.5	50	50	50
Reach #1	483	50	50	50
Reach #1	482.5	50	50	50
Reach #1	482	50	50	50
Reach #1	481.5	50	50	50

Reach #1	481	50	50	50
Reach #1	480.5	50	50	50
Reach #1	480	50	50	50
Reach #1	479.5	50	50	50
Reach #1	479	50	50	50
Reach #1	478.5			

SUMMARY OF CONTRACTION AND EXPANSION COEFFICIENTS
River: River #1

Reach	River Sta.	Contr.	Expan.
Reach #1	485	.1	.3
Reach #1	484.5	.1	.3
Reach #1	484	.1	.3
Reach #1	483.5	.1	.3
Reach #1	483	.1	.3
Reach #1	482.5	.1	.3
Reach #1	482	.1	.3
Reach #1	481.5	.1	.3
Reach #1	481	.1	.3
Reach #1	480.5	.1	.3
Reach #1	480	.1	.3
Reach #1	479.5	.1	.3
Reach #1	479	.1	.3
Reach #1	478.5	.1	.3

Profile Output Table - Standard Table 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.
E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	
			(cfs)	(ft)	(ft)	(ft)
(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		
Reach #1	485	PF 1	51.00	2889.03	2890.92	
2891.18	0.005320	4.07	12.54	13.25	0.74	
Reach #1	484.5	PF 1	51.00	2888.71	2890.39	2890.38
2890.81	0.010165	5.19	9.83	11.74	1.00	
Reach #1	484	PF 1	51.00	2888.21	2889.90	2889.87
2890.30	0.009777	5.11	9.98	11.82	0.98	
Reach #1	483.5	PF 1	51.00	2887.71	2889.40	2889.38
2889.81	0.010038	5.16	9.88	11.76	0.99	
Reach #1	483	PF 1	51.00	2887.21	2888.89	2888.88
2889.31	0.010085	5.17	9.86	11.75	0.99	
Reach #1	482.5	PF 1	51.00	2886.71	2888.39	2888.37
2888.80	0.009935	5.14	9.92	11.79	0.99	
Reach #1	482	PF 1	51.00	2886.21	2887.89	2887.88
2888.30	0.010005	5.16	9.89	11.76	0.99	
Reach #1	481.5	PF 1	51.00	2885.71	2887.39	2887.38
2887.80	0.010127	5.18	9.85	11.76	1.00	
Reach #1	481	PF 1	51.00	2885.21	2886.90	2886.87
2887.30	0.009740	5.11	9.99	11.82	0.98	
Reach #1	480.5	PF 1	51.00	2884.71	2886.39	2886.38
2886.81	0.010037	5.16	9.88	11.75	0.99	
Reach #1	480	PF 1	51.00	2884.21	2885.88	2885.87
2886.30	0.010195	5.19	9.82	11.72	1.00	

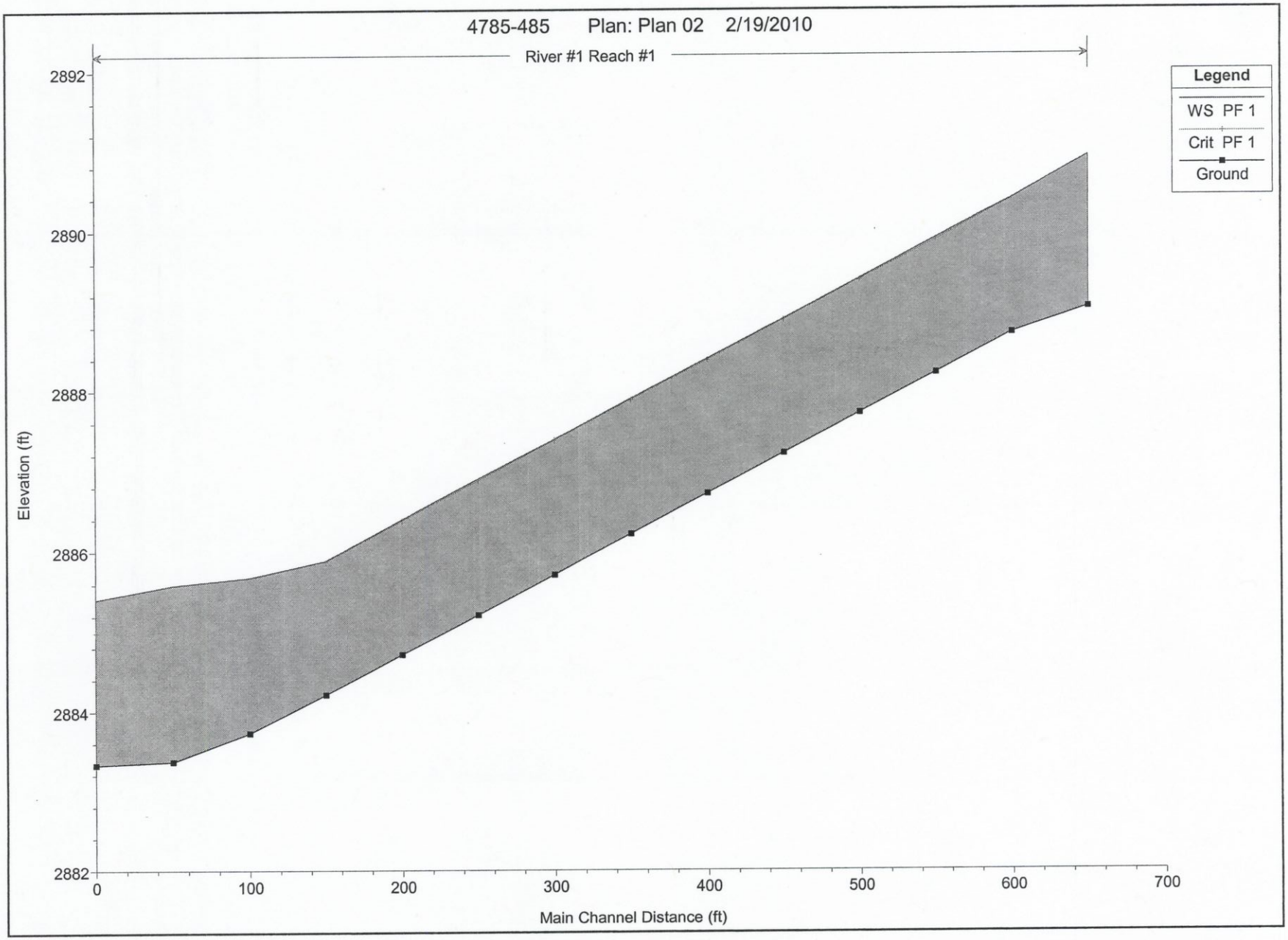
Reach #1	479.5	PF 1	51.00	2883.73	2885.68	
2885.91	0.004525	3.83	13.32	13.65	0.68	
Reach #1	479	PF 1	51.00	2883.37	2885.59	
2885.72	0.002282	2.96	17.22	15.52	0.50	
Reach #1	478.5	PF 1	51.00	2883.33	2885.41	2885.00
2885.59	0.003212	3.37	15.15	14.57	0.58	

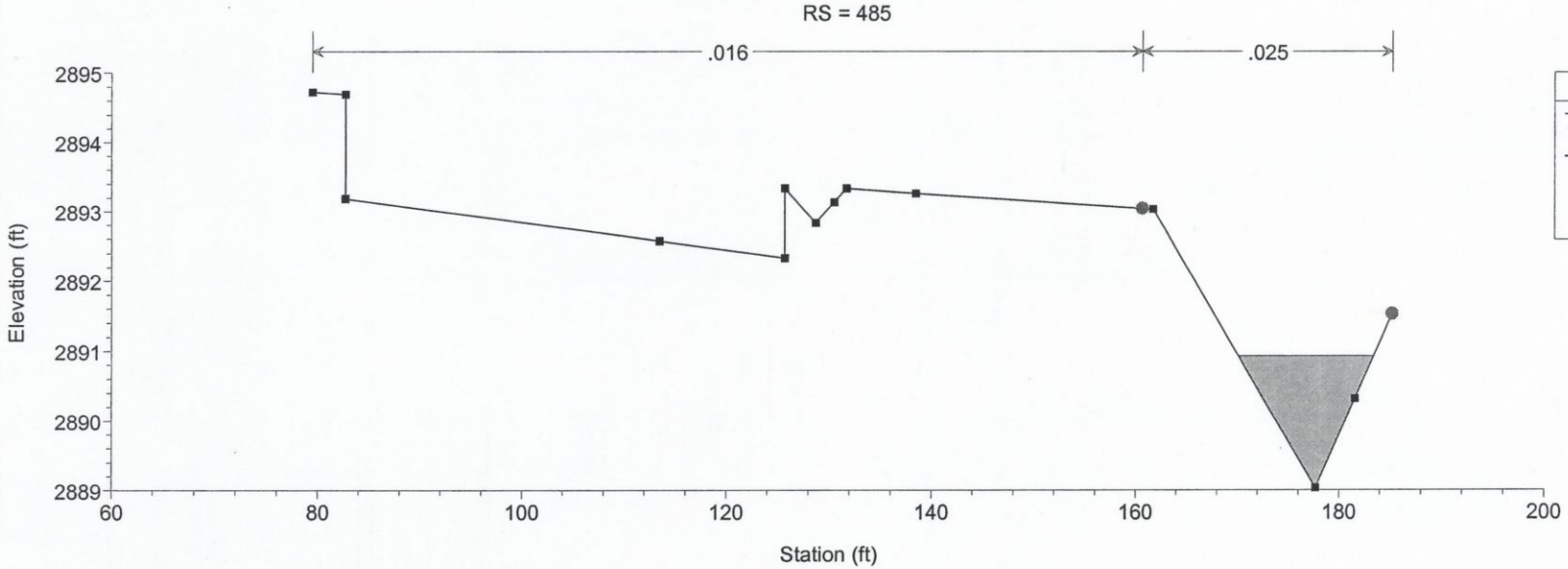
Profile Output Table - Standard Table 2

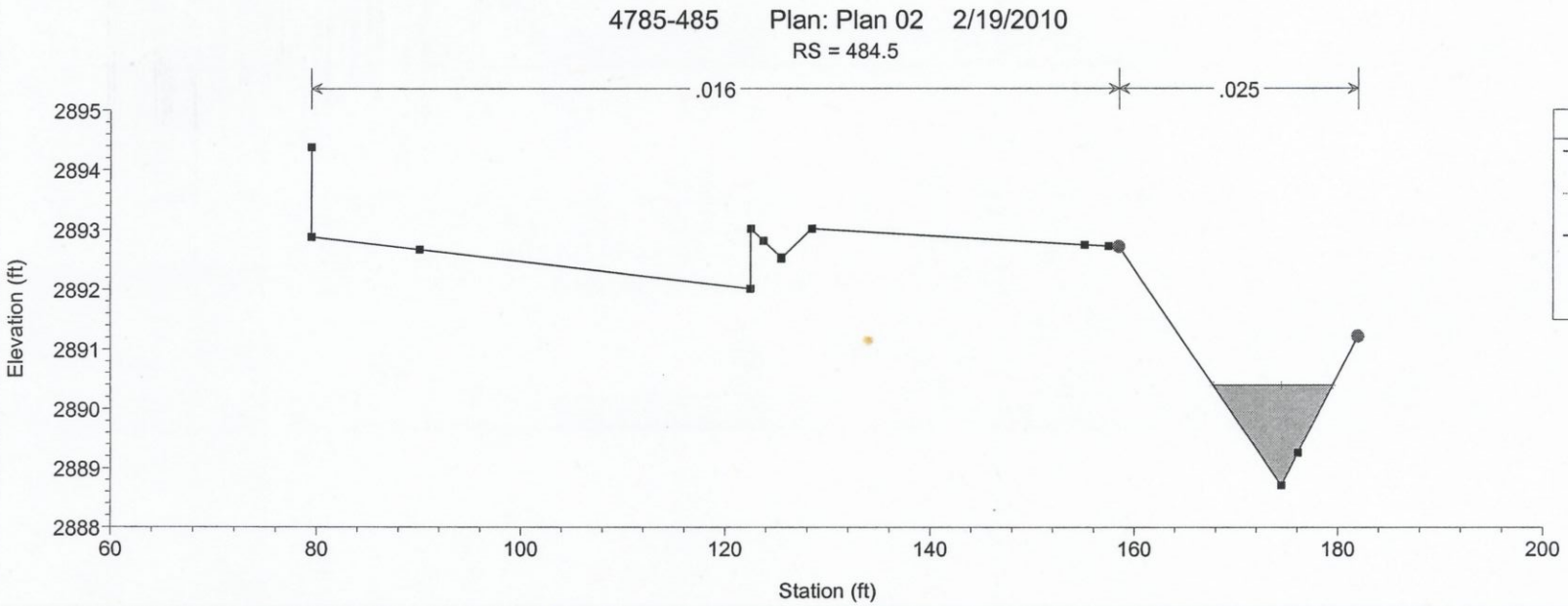
Reach	River Sta	Profile	E.G. Elev	W.S. Elev	Vel Head	Frctn Loss	C & E Loss	Q Left	Q Channel	Q Right	Top Width
					(ft)					(ft)	(ft)
(ft)	(ft)	(cfs)	(cfs)	(cfs)	(ft)						
Reach #1	485	PF 1	2891.18	2890.92	0.26	0.36	0.02	51.00	13.25		
Reach #1	484.5	PF 1	2890.81	2890.39	0.42	0.50	0.00	51.00	11.74		
Reach #1	484	PF 1	2890.30	2889.90	0.41	0.50	0.00	51.00	11.82		
Reach #1	483.5	PF 1	2889.81	2889.40	0.41	0.50	0.00	51.00	11.76		
Reach #1	483	PF 1	2889.31	2888.89	0.42	0.50	0.00	51.00	11.75		
Reach #1	482.5	PF 1	2888.80	2888.39	0.41	0.50	0.00	51.00	11.79		
Reach #1	482	PF 1	2888.30	2887.89	0.41	0.50	0.00	51.00	11.76		
Reach #1	481.5	PF 1	2887.80	2887.39	0.42	0.50	0.00	51.00	11.76		
Reach #1	481	PF 1	2887.30	2886.90	0.40	0.49	0.00	51.00	11.82		
Reach #1	480.5	PF 1	2886.81	2886.39	0.41	0.51	0.00	51.00	11.75		
Reach #1	480	PF 1	2886.30	2885.88	0.42	0.33	0.06	51.00	11.72		
Reach #1	479.5	PF 1	2885.91	2885.68	0.23	0.16	0.03	51.00	13.65		
Reach #1	479	PF 1	2885.72	2885.59	0.14	0.13	0.00	51.00	15.52		
Reach #1	478.5	PF 1	2885.59	2885.41	0.18			51.00	14.57		

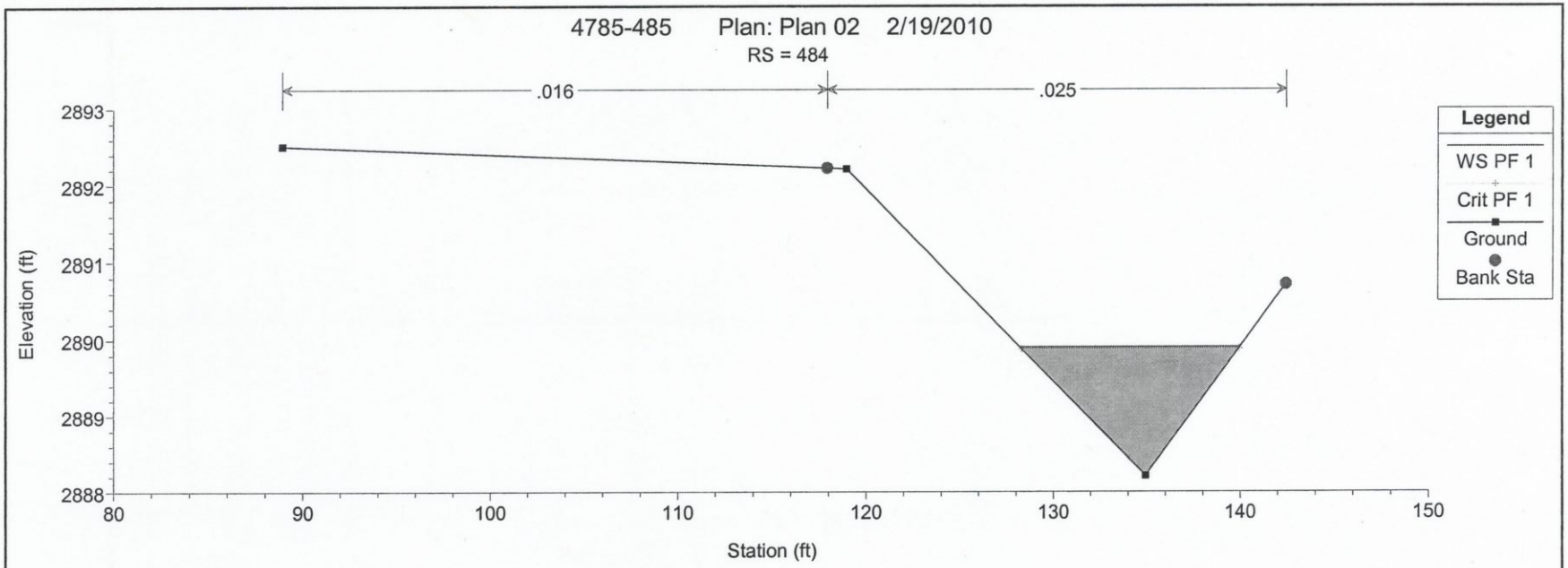
ERRORS WARNINGS AND NOTES
Errors Warnings and Notes for Plan : 4785-485

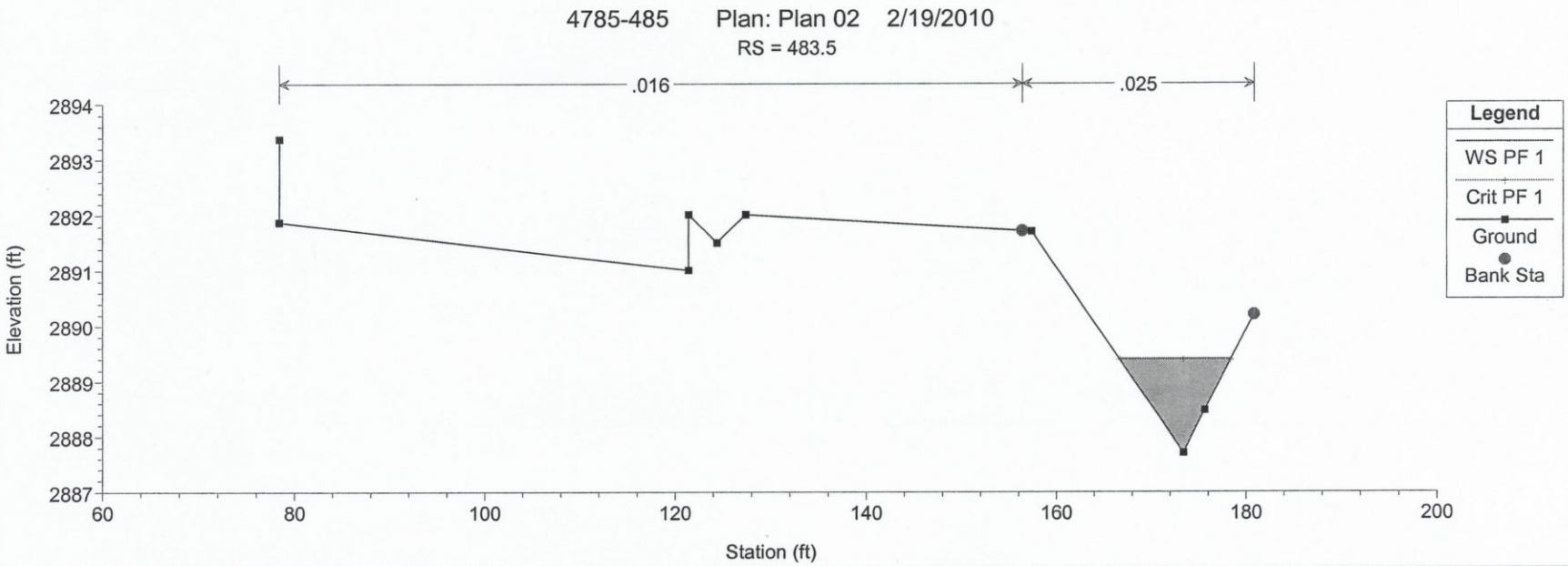
River: River #1 Reach: Reach #1 RS: 480 Profile: PF 1
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.

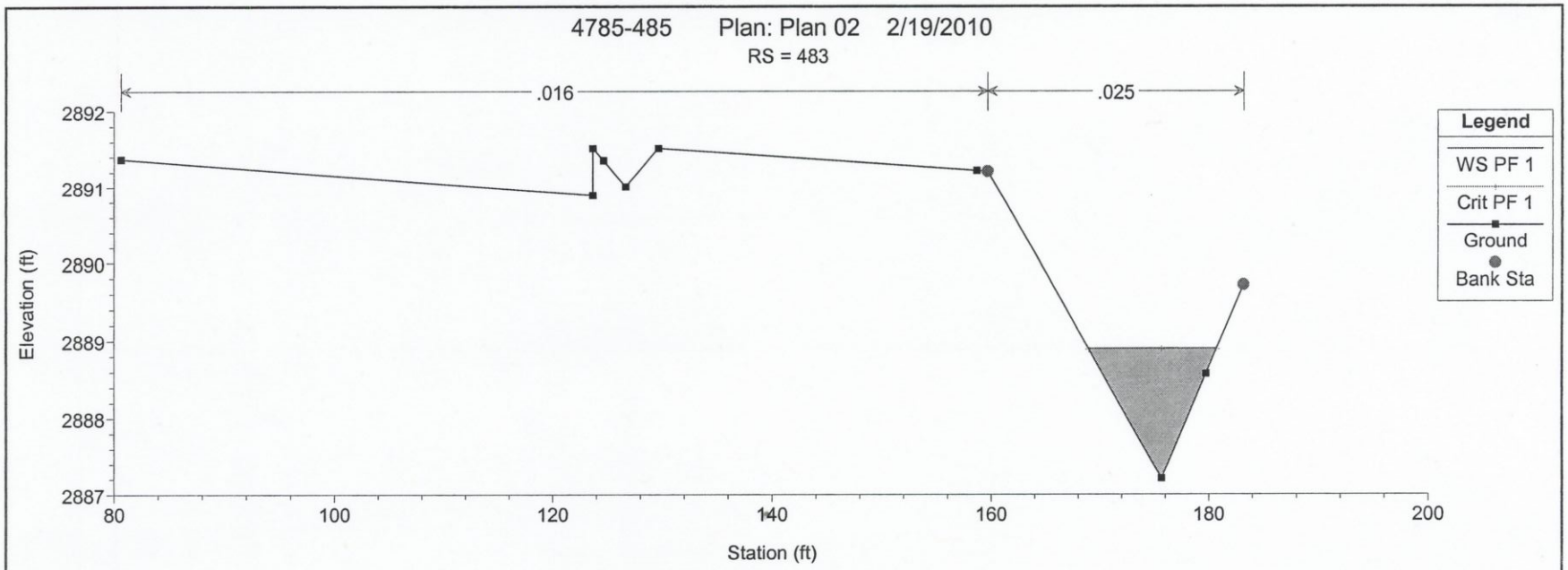

4785-485 Plan: Plan 02 2/19/2010
River #1 Reach #1
Legend
WS PF 1
Crit PF 1
Ground
Elevation (ft)
2892
2890
2888
2886
2884
2882
0
100
200
300
400
500
600
700
Main Channel Distance (ft)

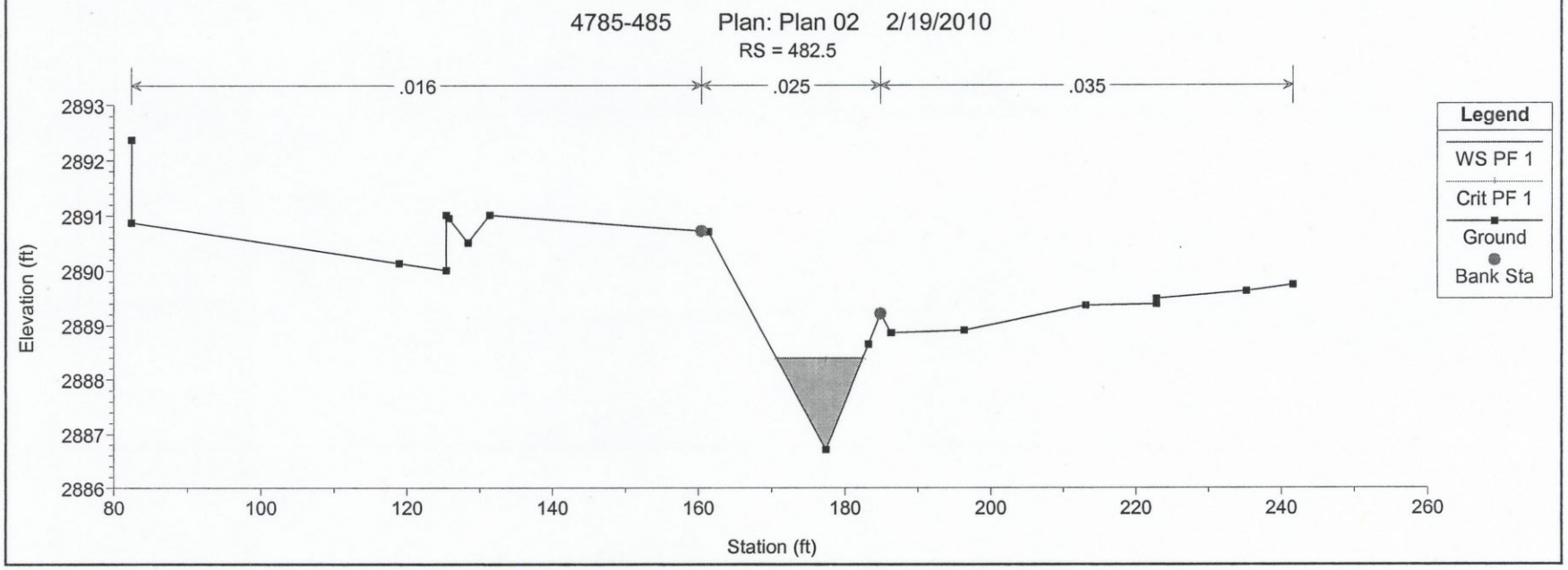

4785-485 Plan: Plan 02 2/19/2010
RS = 485
.016
.025
Legend
WS PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)
2895
2894
2893
2892
2891
2890
2889
60
80
100
120
140
160
180
200

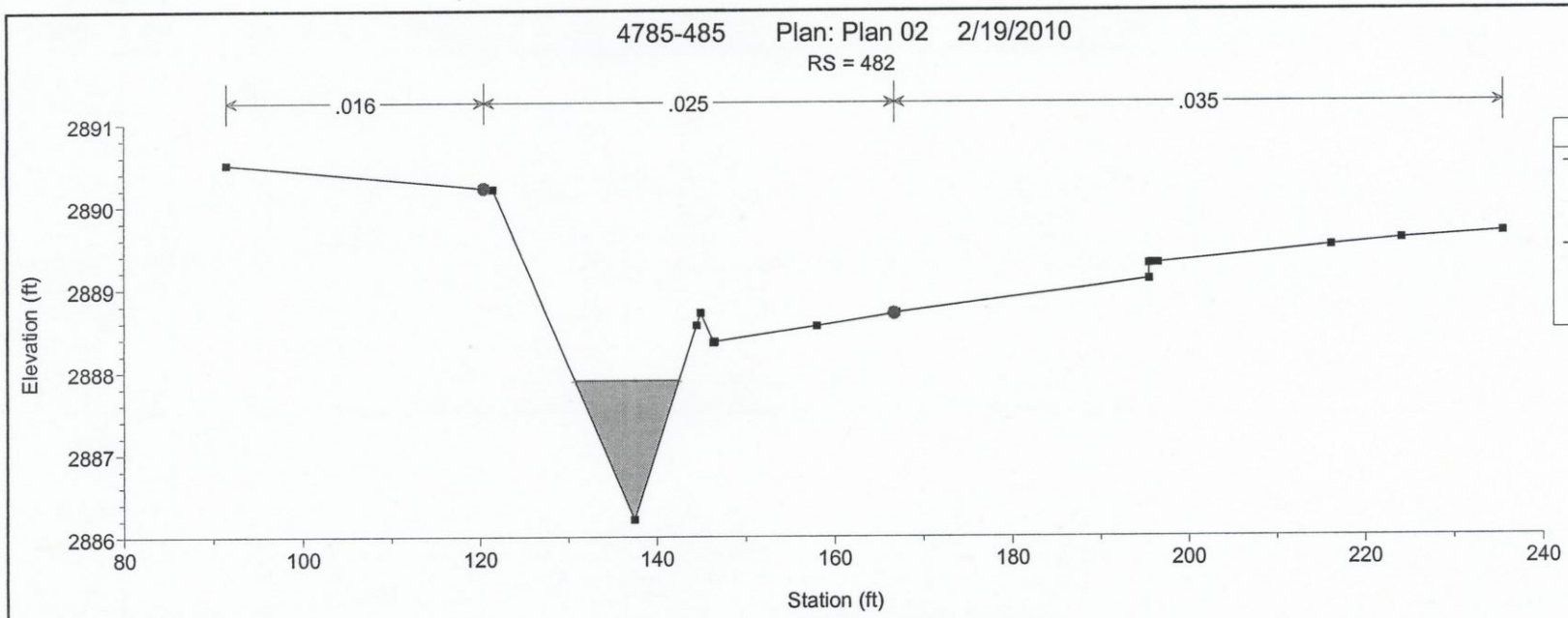

4785-485 Plan: Plan 02 2/19/2010
RS = 484.5
.016
.025
Legend
WS PF 1
Crit PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)
2895
2894
2893
2892
2891
2890
2889
2888
60
80
100
120
140
160
180
200

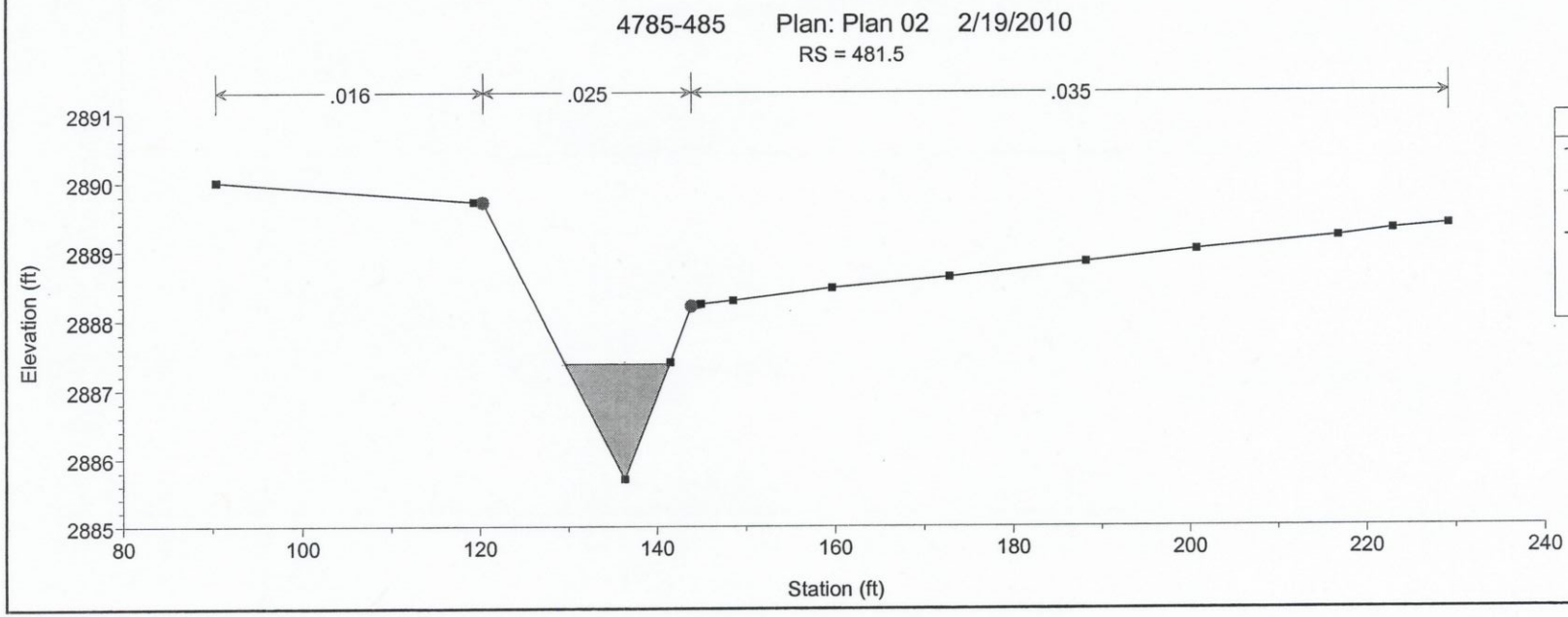

4785-485 Plan: Plan 02 2/19/2010
RS = 484
.016
.025
Elevation (ft)
2893
2892
2891
2890
2889
2888
80
90
100
110
120
130
140
150
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Bank Sta

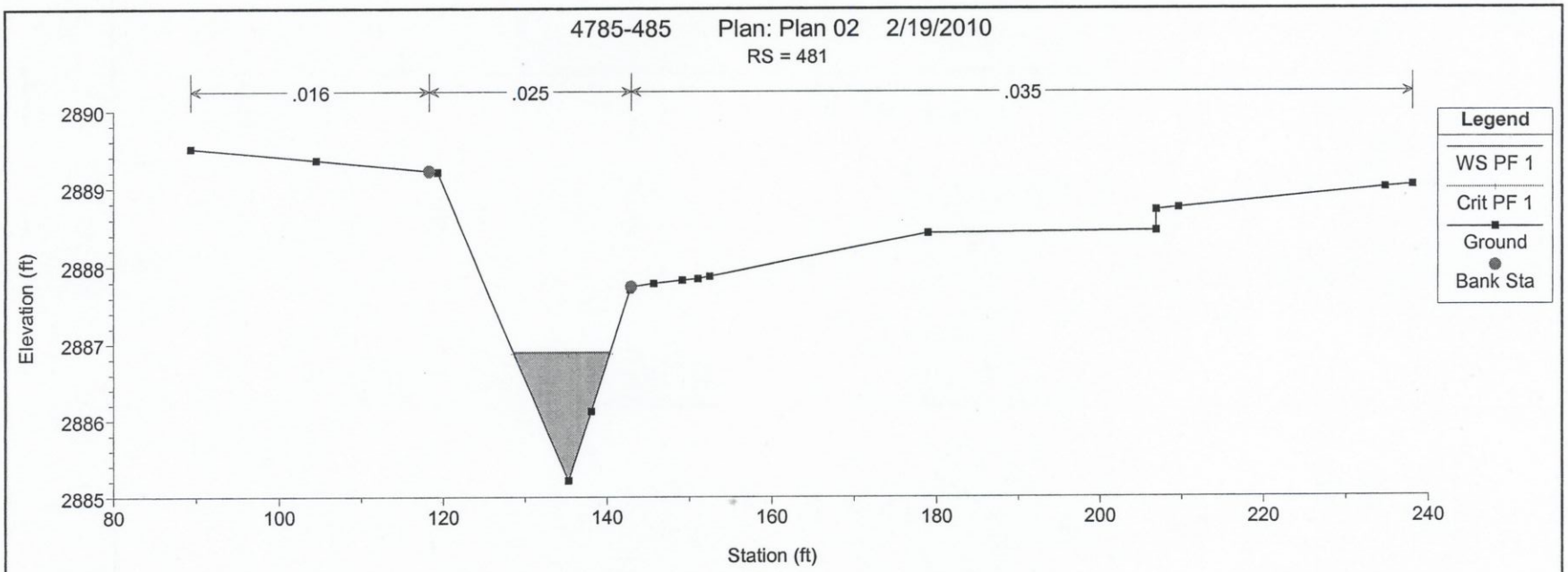

4785-485 Plan: Plan 02 2/19/2010
RS = 483.5
.016
.025
Elevation (ft)
2894
2893
2892
2891
2890
2889
2888
2887
60
80
100
120
140
160
180
200
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Bank Sta

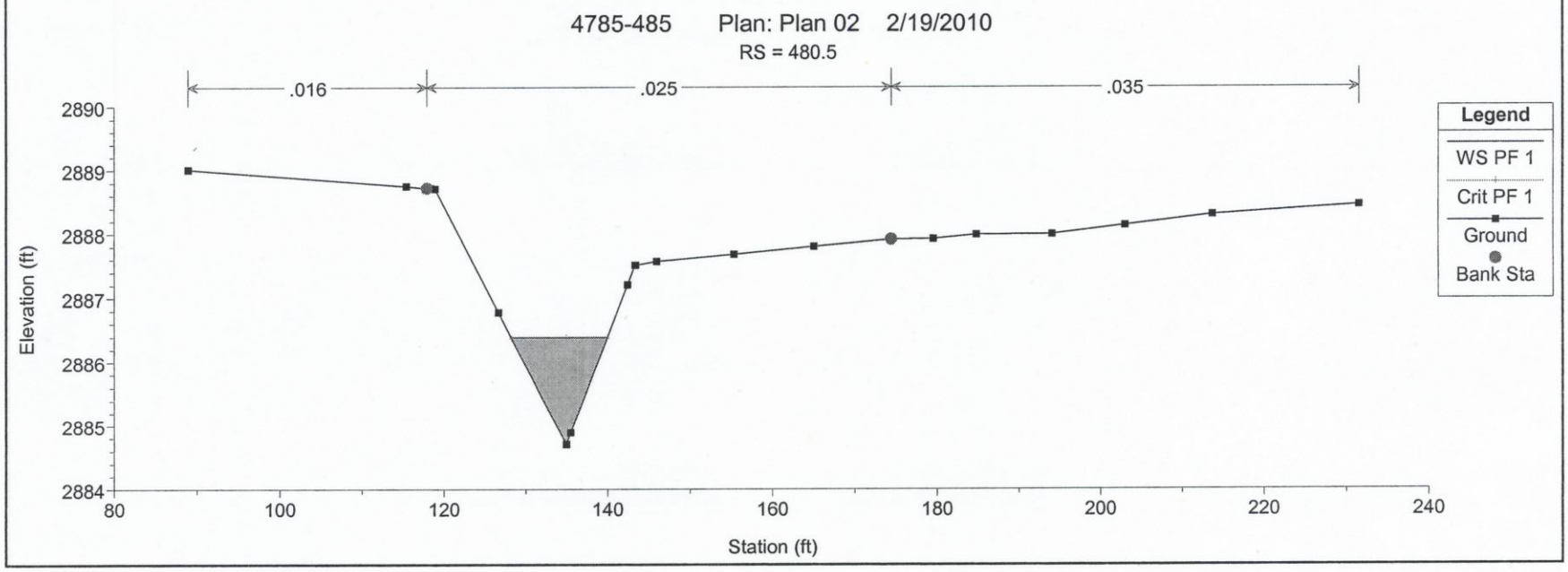

4785-485 Plan: Plan 02 2/19/2010
RS = 483
.016
.025
Legend
WS PF 1
Crit PF 1
Ground
Bank Sta
Elevation (ft)
2892
2891
2890
2889
2888
2887
80
100
120
140
160
180
200
Station (ft)

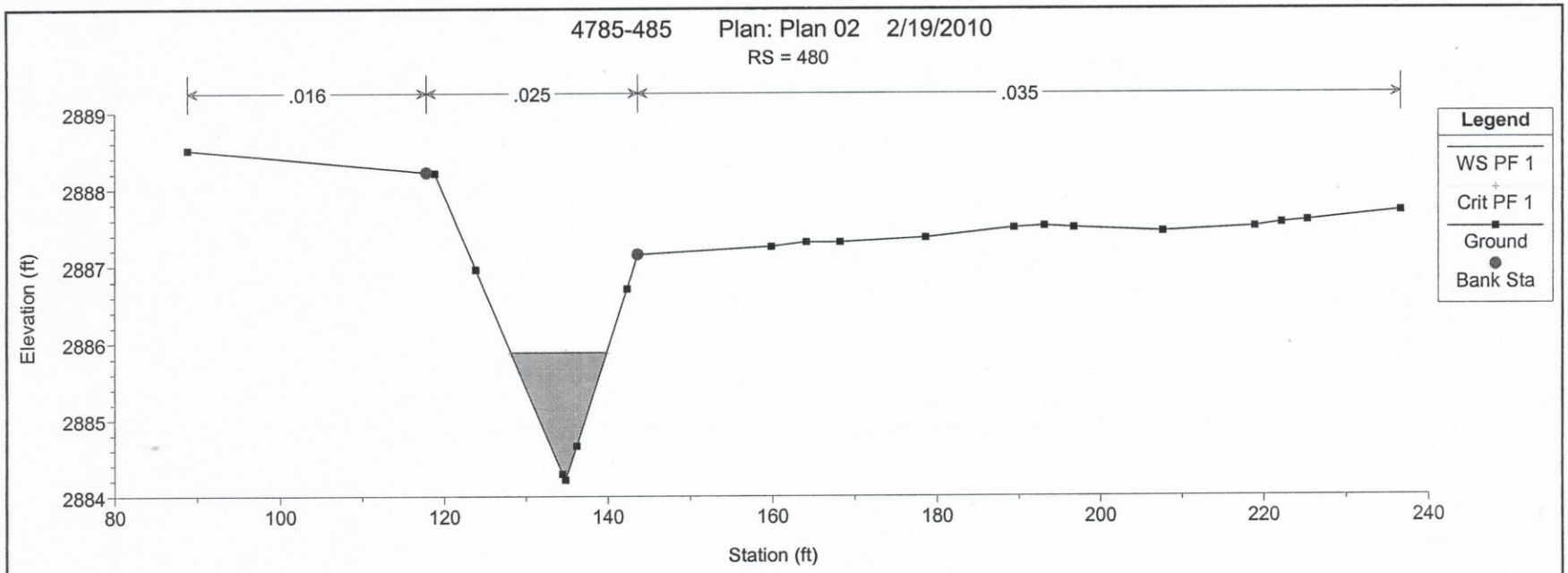

4785-485 Plan: Plan 02 2/19/2010
RS = 482.5
.016
.025
.035
Legend
WS PF 1
Crit PF 1
Ground
Bank Sta
Elevation (ft)
2893
2892
2891
2890
2889
2888
2887
2886
80
100
120
140
160
180
200
220
240
260
Station (ft)

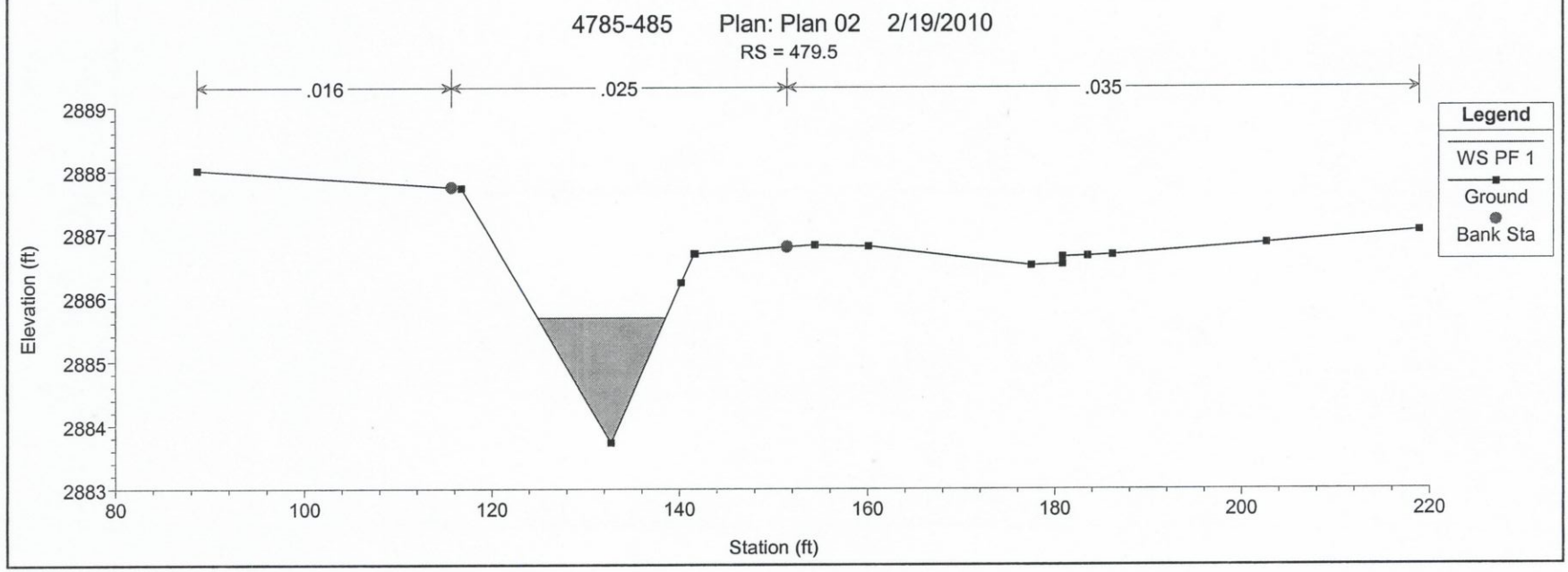

4785-485 Plan: Plan 02 2/19/2010
RS = 482
.016
.025
.035
Elevation (ft)
2891
2890
2889
2888
2887
2886
80
100
120
140
160
180
200
220
240
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Bank Sta

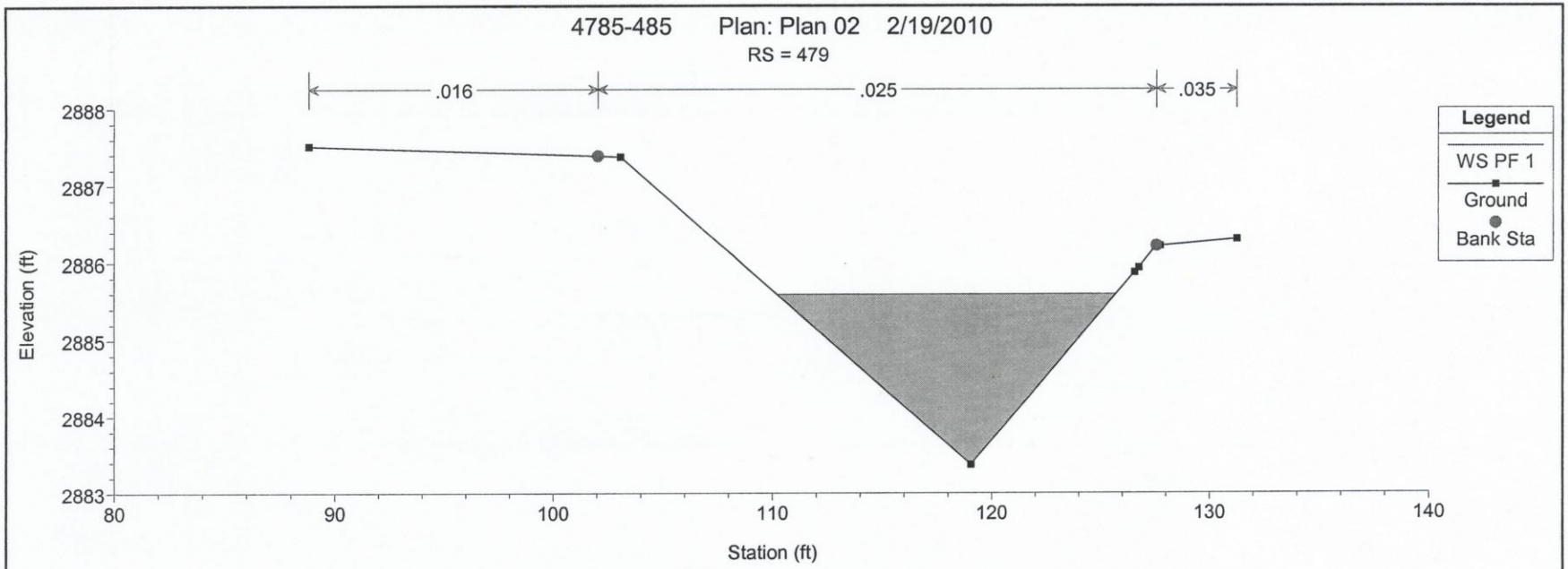

4785-485 Plan: Plan 02 2/19/2010
RS = 481.5
.016
.025
.035
Elevation (ft)
2891
2890
2889
2888
2887
2886
2885
80
100
120
140
160
180
200
220
240
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Bank Sta

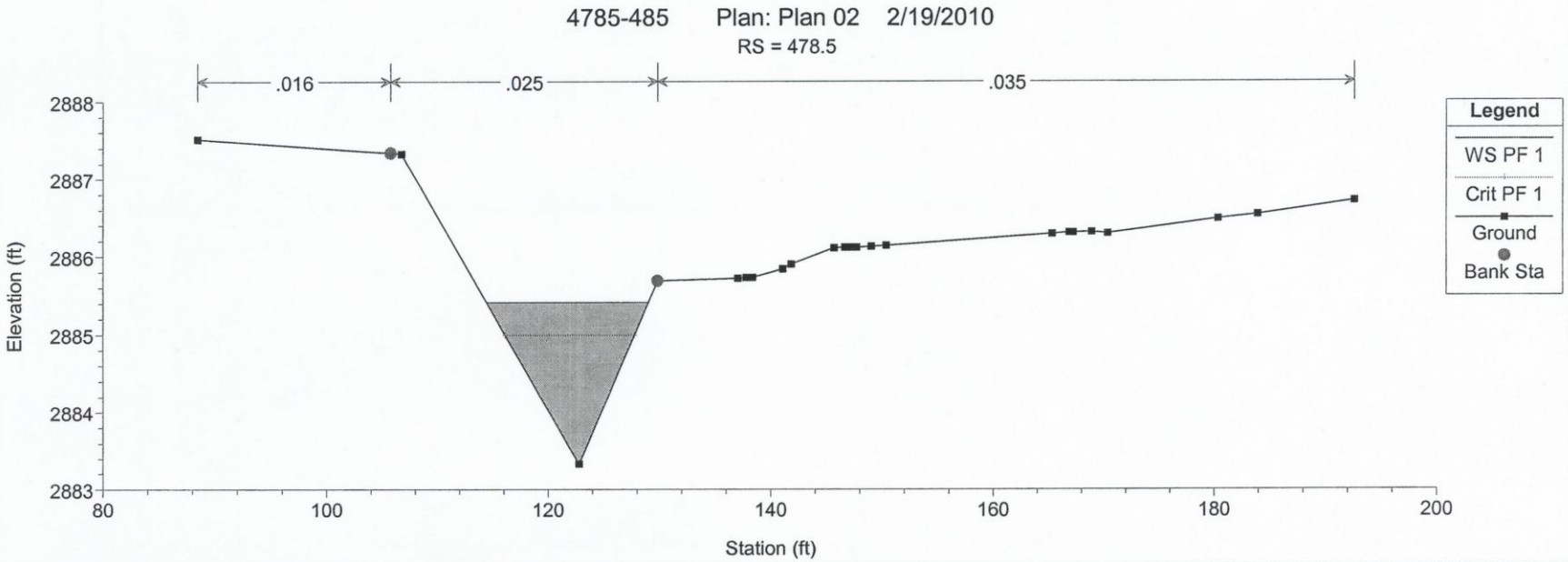

4785-485 Plan: Plan 02 2/19/2010
RS = 481
.016
.025
.035
Elevation (ft)
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Bank Sta


4785-485 Plan: Plan 02 2/19/2010
RS = 480.5
.016
.025
.035
Elevation (ft)
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Bank Sta


4785-485 Plan: Plan 02 2/19/2010
RS = 480
.016
.025
.035
Legend
WS PF 1
Crit PF 1
Ground
Bank Sta
Elevation (ft)
2889
2888
2887
2886
2885
2884
80
100
120
140
160
180
200
220
240
Station (ft)


4785-485 Plan: Plan 02 2/19/2010
RS = 479.5
.016
.025
.035
Legend
WS PF 1
Ground
Bank Sta
Elevation (ft)
2889
2888
2887
2886
2885
2884
2883
80
100
120
140
160
180
200
220
Station (ft)


4785-485 Plan: Plan 02 2/19/2010
RS = 479
.016
.025
.035
Legend
WS PF 1
Ground
Bank Sta
Elevation (ft)
2888
2887
2886
2885
2884
2883
80
90
100
110
120
130
140
Station (ft)


4785-485 Plan: Plan 02 2/19/2010
RS = 478.5
.016
.025
.035
Legend
WS PF 1
Crit PF 1
Ground
Bank Sta
Elevation (ft)
2888
2887
2886
2885
2884
2883
80
100
120
140
160
180
200
Station (ft)

ROADSIDE CHANNEL BETWEEN APPROXIMATELY STA. 485+50 AND 499+50

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
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PROJECT DATA
Project Title: 4855-4995
Project File : 48554995.prj
Run Date and Time: 2/19/2010 6:00:43 AM

Project in English units

PLAN DATA

Plan Title: x
Plan File :
t:\7TED069904\HYDRO\DRAINAGE\CALCS\Hydraulics\Channels\Ras-Final\revised\48554995.p02

Geometry Title: 4855-4995
Geometry File :
t:\7TED069904\HYDRO\DRAINAGE\CALCS\Hydraulics\Channels\Ras-Final\revised\48554995.g11

Flow Title : 0 Flow Profiles
Flow File :
t:\7TED069904\HYDRO\DRAINAGE\CALCS\Hydraulics\Channels\Ras-Final\revised\48554995.F01

Plan Summary Information:

Number of:	Cross Sections =	29	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:\7TED069904\HYDRO\DRAINAGE\CALCS\Hydraulics\Channels\Ras-Final\revised\48554995.F01

Flow Data (cfs)

River	Reach	RS	PF 1
River #1	Reach #1	499.5	152

Boundary Conditions

River	Reach	Profile	Upstream	Downstream
River #1	Reach #1	PF 1		

Known WS = 2892.19

GEOMETRY DATA

Geometry Title: 4855-4995
Geometry File :
t:\7TED069904\HYDRO\DRAINAGE\CALCS\Hydraulics\Channels\Ras-Final\revised\48554995.g11

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 499.5

INPUT
Description:
Station Elevation Data num= 18

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
87.82	2901.59	113.49	2901.33	114.51	2901.32	119.01	2900.2	138.48	2895.32
148.6	2898.7	148.65	2898.7	148.7	2898.7	150.83	2898.66	152.91	2898.97
154.51	2899.21	156.78	2899.71	159.11	2900.87	159.16	2900.88	159.74	2901.04
162.06	2901.64	162.4	2901.68	163.32	2901.77				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
87.82	.016	113.49	.025	148.6	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
113.49	148.6	50	50	50	.1	.3

CROSS SECTION

RIVER: River #1

REACH: Reach #1 RS: 499

INPUT
Description:
Station Elevation Data num= 15

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
89.59	2901.26	104.02	2901.11	115.31	2901	116.28	2900.99	140.3	2894.99
150.81	2898.5	150.86	2898.5	160.5	2898.71	167.18	2898.87	169.84	2898.92
170.04	2898.92	170.52	2898.93	172.26	2898.97	179.19	2899.1	180.93	2899.15

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
89.59	.016	115.31	.025	150.81	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
115.31	150.81	50	50	50	.1	.3

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 498.5

INPUT
Description:
Station Elevation Data num= 14

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
89.86	2900.82	106.28	2900.65	115.19	2900.56	116.21	2900.55	140.18	2894.55
151.42	2898.3	152.05	2898.51	152.1	2898.51	152.39	2898.5	155.73	2897.99
158.59	2897.61	160.23	2898.04	160.86	2898.16	167.06	2899.38		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
89.86	.016	116.21	.025	152.05	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
116.21	152.05	50	50	50	.1	.3

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 498

INPUT
Description:
Station Elevation Data num= 13

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
89.92	2900.57	112.63	2900.34	115.25	2900.31	116.22	2900.3	116.32	2900.29
140.24	2894.3	151.48	2898.05	152.49	2898.39	152.54	2898.38	152.78	2898.33
157.58	2897.34	163.24	2899.04	166.1	2899.93				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
89.92	.016	116.22	.025	152.49	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
116.22	152.49	50	50	50	.1	.3

CROSS SECTION

RIVER: River #1

REACH: Reach #1 RS: 497.5

INPUT
Description:
Station Elevation Data num= 17

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
87.49	2900.08	121.83	2899.73	122.85	2899.72	135	2896.69	146.82	2893.72
147.26	2893.86	157.96	2897.43	158.1	2897.47	158.59	2897.64	160.72	2898.35
160.87	2898.4	161.45	2898.59	161.49	2898.58	163.72	2898.14	167.2	2897.24
170.98	2898.32	175.82	2899.77						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
87.49	.016	121.83	.025	161.45	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
121.83	161.45	50	50	50	.1	.3

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 497

INPUT
Description:
Station Elevation Data num= 18

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
87.55	2899.83	87.79	2899.82	92.54	2899.78	121.89	2899.48	122.91	2899.47
127.02	2898.44	146.88	2893.47	151.63	2895.05	158.12	2897.22	160.73	2898.09
161.94	2898.49	161.99	2898.47	165.67	2897.44	166.2	2897.29	166.49	2897.2
167.03	2897.07	167.61	2897.25	175.5	2899.5				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
87.55	.016	121.89	.025	161.94	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
121.89	161.94	50	50	50	.1	.3

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 496.5

INPUT
Description:
Station Elevation Data num= 16

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
87.61	2899.58	103.64	2899.41	119.19	2899.26	121.95	2899.23	122.92	2899.22
146.94	2893.22	158.18	2896.97	160.31	2897.69	161.86	2898.2	161.95	2898.23
162	2898.22	165.29	2897.47	166.69	2897.15	167.47	2896.94	169.02	2897.4
175.36	2898.77								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
87.61	.016	121.95	.025	161.95	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
121.95	161.95	50	50	50	.1	.3

CROSS SECTION

```
RIVER: River #1
REACH: Reach #1            RS: 496

INPUT
Description:
Station Elevation Data     num=       8
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
   87.66 2899.33     122 2898.98  123.02 2898.97  146.99 2892.97   155.8  2895.9
  158.27 2896.72  159.29 2897.06  161.57 2897.82

Manning's n Values         num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
   87.66    .016     122    .025  161.57    .035

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
           122  161.57               50      50      50             .1       .3

CROSS SECTION


RIVER: River #1
REACH: Reach #1            RS: 495.5

INPUT
Description:
Station Elevation Data     num=       8
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
    94.9 2898.48   95.92 2898.47  119.89 2892.47  119.94 2892.48  131.13 2896.21
  131.18 2896.22  132.34 2896.62  132.39 2896.62

Manning's n Values         num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
    94.9    .016   95.92    .025  132.34    .035

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
         95.92  132.34               50      50      50             .1       .3

CROSS SECTION


RIVER: River #1
REACH: Reach #1            RS: 495

INPUT
Description:
Station Elevation Data     num=       7
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
    94.9 2898.48   95.92 2898.47  119.89 2892.47  119.94 2892.48  131.13 2896.21
  131.18 2896.22  132.34 2896.62

Manning's n Values         num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
    94.9    .016   95.92    .025  132.34    .035

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
         95.92  132.34               50      50      50             .1       .3

CROSS SECTION


RIVER: River #1
```

REACH: Reach #1 RS: 494.5

INPUT
Description:
Station Elevation Data num= 20

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
90.31	2898	112.2	2897.79	113.17	2897.78	121.93	2895.59	137.19	2891.78
140.29	2892.81	145.62	2894.59	148.04	2895.4	148.43	2895.53	150.12	2896.09
150.17	2896.09	150.6	2896.08	150.75	2896.09	150.8	2896.09	150.99	2896.08
156.46	2896	157	2895.98	157.48	2895.96	158.4	2896.1	158.98	2896.05

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
90.31	.016	112.2	.025	150.12	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
112.2	150.12	50	50	50	.1	.3

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 494

INPUT
Description:
Station Elevation Data num= 12

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
94.75	2897.54	95.77	2897.53	98.82	2896.76	119.74	2891.53	126.96	2893.94
128.61	2894.47	128.8	2894.55	130.74	2895.19	130.93	2895.25	130.98	2895.25
131.08	2895.25	136.84	2895.32						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
94.75	.016	95.77	.025	130.93	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
95.77	130.93	50	50	50	.1	.3

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 493.5

INPUT
Description:
Station Elevation Data num= 12

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
88.67	2897.58	110.66	2897.36	116.08	2897.3	117.68	2897.29	118.65	2897.28
142.67	2891.28	152.6	2894.58	152.65	2894.58	156.47	2894.65	161.22	2894.78
167.37	2894.79	167.61	2894.79						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
88.67	.016	117.68	.025	161.22	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
117.68	161.22	50	50	50	.1	.3

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 493

INPUT
Description:
Station Elevation Data num= 12

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
87.93	2896.83	90.93	2896.83	90.93	2897.33	119.94	2897.04	120.96	2897.03
144.93	2891.03	153.45	2893.86	153.5	2893.86	155.49	2893.86	157.33	2893.86
159.27	2894	167.64	2894.57						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
87.93	.016	119.94	.025	153.45	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
119.94	153.45	50	50	50	.1	.3

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 492.5

INPUT
Description:
Station Elevation Data num= 13

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
88.43	2897.08	117.44	2896.79	118.46	2896.78	142.48	2890.78	148.87	2892.91
150.23	2893.37	150.71	2893.53	150.76	2893.53	151.87	2893.51	165.97	2894.01
167.18	2894.06	167.57	2893.98	168.49	2893.78				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
88.43	.016	117.44	.025	167.18	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
117.44	167.18	50	50	50	.1	.3

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 492

INPUT
Description:
Station Elevation Data num= 12

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
88.32	2896.83	117.33	2896.54	118.3	2896.53	130.21	2893.55	142.32	2890.53
145.28	2891.51	152.69	2893.99	152.73	2893.99	155.34	2893.75	156.02	2893.74
157.38	2893.81	163.33	2894.05						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
88.32	.016	118.3	.025	152.69	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
118.3	152.69	50	50	50	.1	.3

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 491.5

INPUT
Description:
Station Elevation Data num= 20

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
88.2	2896.58	117.21	2896.29	118.23	2896.28	142.2	2890.28	150.05	2892.89
150.1	2892.89	150.15	2892.89	151.84	2892.91	154.94	2892.86	161.48	2892.67
165.26	2892.78	168.84	2892.96	171.02	2893.36	175.23	2893.85	177.36	2895.08
177.7	2895.24	180.08	2895.23	180.27	2895.24	180.9	2895.35	182.45	2895.73

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
88.2	.016	118.23	.025	154.94	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
118.23	154.94	50	50	50	.1	.3

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 491

INPUT
Description:
Station Elevation Data num= 17

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
88.09	2896.33	117.1	2896.04	118.07	2896.03	142.09	2890.03	143.11	2890.37
148.68	2892.23	148.73	2892.23	152.94	2892.31	154.44	2892.34	162.19	2892.15
163.4	2892.12	168.39	2892.39	168.68	2892.41	169.7	2892.51	175.27	2893.01
176.72	2893.27	177.16	2893.58						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
88.09	.016	117.1	.025	152.94	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
117.1	152.94	50	50	50	.1	.3

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 490.5

INPUT
Description:
Station Elevation Data num= 14

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
88.17	2896.08	117.18	2895.79	118.2	2895.78	142.17	2889.78	148.37	2891.84
148.42	2891.84	154.71	2891.9	157.81	2891.94	159.12	2891.91	166.39	2891.62
167.5	2891.75	176.46	2893.07	177.67	2894.15	178.49	2894.89		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
88.17	.016	117.18	.025	176.46	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
117.18	176.46	50	50	50	.1	.3

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 490

INPUT
Description:
Station Elevation Data num= 14

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
88.26	2895.83	117.27	2895.54	118.29	2895.53	142.26	2889.53	142.79	2889.7
148.17	2891.49	148.22	2891.49	150.49	2891.49	156.84	2891.46	160.76	2891.4
166.23	2891.29	176.6	2892.72	177.86	2892.87	178.88	2894.41		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
88.26	.016	117.27	.025	176.6	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
117.27	176.6	50	50	50	.1	.3

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 489.5

INPUT
Description:
Station Elevation Data num= 18

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
88.36	2895.58	117.32	2895.29	118.34	2895.28	140.37	2889.77	142.36	2889.28
148.12	2891.21	148.17	2891.21	150.4	2891.25	150.69	2891.26	154.18	2891.21
161.44	2891.21	165.51	2891.21	166.72	2891.2	166.91	2891.23	177.42	2892.15
178	2892.81	178.83	2893.77	179.08	2894.11				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
88.36	.016	117.32	.025	179.08	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
117.32	179.08	50	50	50	.1	.3

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 489

INPUT
Description:
Station Elevation Data num= 17

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
88.45	2895.33	110	2895.11	115.18	2895.06	117.41	2895.04	118.43	2895.03
132.62	2891.48	142.45	2889.03	144.14	2889.59	148.16	2890.94	148.21	2890.94
149.86	2890.96	162.69	2890.82	166.42	2890.75	169.96	2891.14	176.88	2891.87
177.56	2892.68	178.77	2893.98						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
88.45	.016	117.41	.025	177.56	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
117.41	177.56	50	50	50	.1	.3

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 488.5

INPUT
Description:
Station Elevation Data num= 17

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
88.54	2895.08	101.47	2894.95	117.5	2894.79	118.52	2894.78	124.86	2893.2
142.54	2888.78	148.11	2890.64	148.16	2890.64	148.16	2890.65	150.53	2890.7
150.87	2890.71	158.67	2890.56	164.91	2890.45	167.53	2890.73	172.47	2891.2
176.44	2892.33	179.68	2893.28						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
88.54	.016	117.5	.025	176.44	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
117.5	176.44	50	50	50	.1	.3

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 488

INPUT
Description:
Station Elevation Data num= 16

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
88.63	2894.83	114.69	2894.57	117.59	2894.54	118.12	2894.53	118.61	2894.53
142.63	2888.53	146.16	2889.72	148.2	2890.39	148.25	2890.39	151.2	2890.44
164.18	2890.1	165.97	2890.06	166.84	2890.13	172.41	2890.72	178.08	2892.69
179.29	2893.14								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
88.63	.016	117.59	.025	179.29	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
117.59	179.29	50	50	50	.1	.3

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 487.5

INPUT
Description:
Station Elevation Data num= 14

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
88.72	2894.58	117.73	2894.29	118.7	2894.28	142.72	2888.28	149.11	2890.41
149.16	2890.41	157.73	2890.38	161.41	2890.39	163.3	2890.79	165.39	2890.95
168.19	2891.07	171.97	2891.29	176.23	2892.06	179.43	2892.71		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
88.72	.016	117.73	.025	179.43	.035

```
Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
        117.73  179.43                50      50      50             .1       .3

CROSS SECTION


RIVER: River #1
REACH: Reach #1            RS: 487

INPUT
Description: berm
Station Elevation Data     num=      20
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0 2895.74   48.43 2895.69   48.43 2895.19   48.48 2895.19  256.68 2894.33
  256.73 2894.33  271.21 2893.83  285.74 2894.33  426.19 2893.75  431.03 2893.73
  547.26 2888.03  601.75 2891.48  630.81 2893.48  655.03 2893.48  694.01 2889.84
  703.17 2889.85  769.37 2890.03   773.1 2890.04   813.1  2890.1  819.06 2890.12

Manning's n Values         num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
       0    .016  431.03    .025  630.81    .035

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
        431.03  630.81                50      50      50             .1       .3
Right Levee     Station=  630.81      Elevation= 2894.48

CROSS SECTION


RIVER: River #1
REACH: Reach #1            RS: 486.5

INPUT
Description: berm
Station Elevation Data     num=      18
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0 2895.51   48.38 2895.44   48.43 2894.94  256.68 2894.08  271.21 2893.58
  285.74 2894.08  426.19  2893.5  431.03 2893.48  547.27 2887.78  601.75 2891.23
  630.81 2893.23  655.03 2893.23  694.45 2889.42  742.98 2889.74  768.55 2889.93
  806.86 2890.04  812.96 2890.02     821 2890.01

Manning's n Values         num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
       0    .016  426.19    .025  630.81    .035

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
        426.19  630.81                50      50      50             .1       .3
Right Levee     Station=  630.81      Elevation= 2894.23

CROSS SECTION


RIVER: River #1
REACH: Reach #1            RS: 486

INPUT
Description: berm
Station Elevation Data     num=      20
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0 2895.28   48.43 2895.19   48.43 2894.69   48.48 2894.68  256.68 2893.83
  256.73 2893.83  271.21 2893.33  285.74 2893.83  426.19 2893.25  431.03 2893.23
  547.26 2887.53  601.75 2890.98  630.81 2892.98  655.03 2892.98  698.13 2889.81
  702.78 2889.75  706.99 2889.75  767.92 2889.83  809.18 2889.89  826.03 2889.91
```

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.016	431.03	.025	630.81	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
431.03	630.81	50	50	50	.1	.3

Right Levee Station= 630.81 Elevation= 2893.98

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 485.5

INPUT
Description: berm
Station Elevation Data num= 20

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	2894.44	5.18	2894.55	5.18	2895.05	48.38	2894.94	48.43	2894.44
48.43	2894.43	256.68	2893.58	271.21	2893.08	285.74	2893.58	426.19	2893
431.03	2892.98	547.27	2887.28	601.75	2890.73	630.81	2892.73	655.03	2892.73
694.01	2889.87	695.85	2889.83	703.7	2889.79	756.88	2889.54	772.42	2889.56

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.016	426.19	.025	630.81	.035

Bank Sta: Left	Right	Coeff Contr.	Expan.
426.19	630.81	.1	.3

Right Levee Station= 630.81 Elevation= 2893.73

SUMMARY OF MANNING'S N VALUES

River:River #1

Reach	River Sta.	n1	n2	n3
Reach #1	499.5	.016	.025	.035
Reach #1	499	.016	.025	.035
Reach #1	498.5	.016	.025	.035
Reach #1	498	.016	.025	.035
Reach #1	497.5	.016	.025	.035
Reach #1	497	.016	.025	.035
Reach #1	496.5	.016	.025	.035
Reach #1	496	.016	.025	.035
Reach #1	495.5	.016	.025	.035
Reach #1	495	.016	.025	.035
Reach #1	494.5	.016	.025	.035
Reach #1	494	.016	.025	.035
Reach #1	493.5	.016	.025	.035
Reach #1	493	.016	.025	.035
Reach #1	492.5	.016	.025	.035
Reach #1	492	.016	.025	.035
Reach #1	491.5	.016	.025	.035
Reach #1	491	.016	.025	.035
Reach #1	490.5	.016	.025	.035
Reach #1	490	.016	.025	.035
Reach #1	489.5	.016	.025	.035
Reach #1	489	.016	.025	.035
Reach #1	488.5	.016	.025	.035

Reach #1	488	.016	.025	.035
Reach #1	487.5	.016	.025	.035
Reach #1	487	.016	.025	.035
Reach #1	486.5	.016	.025	.035
Reach #1	486	.016	.025	.035
Reach #1	485.5	.016	.025	.035

SUMMARY OF REACH LENGTHS

River: River #1

Reach	River Sta.	Left	Channel	Right
Reach #1	499.5	50	50	50
Reach #1	499	50	50	50
Reach #1	498.5	50	50	50
Reach #1	498	50	50	50
Reach #1	497.5	50	50	50
Reach #1	497	50	50	50
Reach #1	496.5	50	50	50
Reach #1	496	50	50	50
Reach #1	495.5	50	50	50
Reach #1	495	50	50	50
Reach #1	494.5	50	50	50
Reach #1	494	50	50	50
Reach #1	493.5	50	50	50
Reach #1	493	50	50	50
Reach #1	492.5	50	50	50
Reach #1	492	50	50	50
Reach #1	491.5	50	50	50
Reach #1	491	50	50	50
Reach #1	490.5	50	50	50
Reach #1	490	50	50	50
Reach #1	489.5	50	50	50
Reach #1	489	50	50	50
Reach #1	488.5	50	50	50
Reach #1	488	50	50	50
Reach #1	487.5	50	50	50
Reach #1	487	50	50	50
Reach #1	486.5	50	50	50
Reach #1	486	50	50	50
Reach #1	485.5			

SUMMARY OF CONTRACTION AND EXPANSION COEFFICIENTS
River: River #1

Reach	River Sta.	Contr.	Expan.
Reach #1	499.5	.1	.3
Reach #1	499	.1	.3
Reach #1	498.5	.1	.3
Reach #1	498	.1	.3
Reach #1	497.5	.1	.3
Reach #1	497	.1	.3
Reach #1	496.5	.1	.3
Reach #1	496	.1	.3

Reach #1	495.5	.1	.3
Reach #1	495	.1	.3
Reach #1	494.5	.1	.3
Reach #1	494	.1	.3
Reach #1	493.5	.1	.3
Reach #1	493	.1	.3
Reach #1	492.5	.1	.3
Reach #1	492	.1	.3
Reach #1	491.5	.1	.3
Reach #1	491	.1	.3
Reach #1	490.5	.1	.3
Reach #1	490	.1	.3
Reach #1	489.5	.1	.3
Reach #1	489	.1	.3
Reach #1	488.5	.1	.3
Reach #1	488	.1	.3
Reach #1	487.5	.1	.3
Reach #1	487	.1	.3
Reach #1	486.5	.1	.3
Reach #1	486	.1	.3
Reach #1	485.5	.1	.3

Profile Output Table - Standard Table 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.
E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	
			(cfs)	(ft)	(ft)	(ft)
(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		
Reach #1	499.5	PF 1	152.00	2895.32	2898.10	2897.90
2898.59	0.006121	5.64	26.96	19.41	0.84	
Reach #1	499	PF 1	152.00	2894.99	2897.64	2897.57
2898.23	0.007861	6.19	24.56	18.54	0.95	
Reach #1	498.5	PF 1	152.00	2894.55	2897.48	2897.13
2897.88	0.004570	5.05	30.09	20.51	0.73	
Reach #1	498	PF 1	152.00	2894.30	2896.88	2896.88
2897.54	0.009006	6.51	23.33	18.06	1.01	
Reach #1	497.5	PF 1	152.00	2893.72	2896.61	
2897.03	0.004993	5.22	29.10	20.15	0.77	
Reach #1	497	PF 1	152.00	2893.47	2896.36	
2896.78	0.004960	5.21	29.18	20.20	0.76	
Reach #1	496.5	PF 1	152.00	2893.22	2896.10	
2896.53	0.005056	5.24	28.98	20.14	0.77	
Reach #1	496	PF 1	152.00	2892.97	2895.74	
2896.24	0.006168	5.65	26.90	19.41	0.85	
Reach #1	495.5	PF 1	152.00	2892.47	2895.71	
2895.97	0.002691	4.14	36.71	22.66	0.57	
Reach #1	495	PF 1	152.00	2892.47	2895.05	2895.05
2895.71	0.008994	6.51	23.35	18.07	1.01	
Reach #1	494.5	PF 1	152.00	2891.78	2894.67	
2895.09	0.004922	5.19	29.28	20.25	0.76	
Reach #1	494	PF 1	152.00	2891.53	2894.42	
2894.84	0.004922	5.19	29.31	20.30	0.76	
Reach #1	493.5	PF 1	152.00	2891.28	2894.19	
2894.60	0.004771	5.13	29.63	20.38	0.75	
Reach #1	493	PF 1	152.00	2891.03	2893.97	
2894.36	0.004359	5.00	30.87	25.74	0.72	
Reach #1	492.5	PF 1	152.00	2890.78	2893.75	
2894.10	0.005608	4.75	31.98	28.16	0.79	
Reach #1	492	PF 1	152.00	2890.53	2893.33	

2893.81	0.005780	5.51	27.56	19.65	0.82	
Reach #1	491.5	PF 1	152.00	2890.28	2893.02	2893.02
2893.47	0.007415	5.46	30.34	37.94	0.90	
Reach #1	491	PF 1	152.00	2890.03	2892.66	2892.66
2893.09	0.006847	5.44	32.51	39.86	0.87	
Reach #1	490.5	PF 1	152.00	2889.78	2892.46	
2892.70	0.004996	3.97	38.25	40.84	0.72	
Reach #1	490	PF 1	152.00	2889.53	2892.34	
2892.50	0.002678	3.24	46.97	42.78	0.54	
Reach #1	489.5	PF 1	152.00	2889.28	2892.26	
2892.38	0.001796	2.76	55.01	47.10	0.45	
Reach #1	489	PF 1	152.00	2889.03	2892.23	
2892.30	0.000923	2.25	67.49	47.53	0.33	
Reach #1	488.5	PF 1	152.00	2888.78	2892.20	
2892.26	0.000606	1.99	76.31	47.12	0.28	
Reach #1	488	PF 1	152.00	2888.53	2892.19	
2892.23	0.000356	1.67	90.75	48.66	0.22	
Reach #1	487.5	PF 1	152.00	2888.28	2892.16	
2892.21	0.000459	1.80	84.65	49.55	0.24	
Reach #1	487	PF 1	152.00	2888.03	2892.19	2889.38
2892.20	0.000025	0.49	312.96	149.67	0.06	
Reach #1	486.5	PF 1	152.00	2887.78	2892.19	2889.12
2892.19	0.000018	0.43	351.38	158.39	0.05	
Reach #1	486	PF 1	152.00	2887.53	2892.19	2888.88
2892.19	0.000014	0.39	392.00	167.10	0.04	
Reach #1	485.5	PF 1	152.00	2887.28	2892.19	2888.62
2892.19	0.000010	0.35	434.81	175.82	0.04	

Profile Output Table - Standard Table 2

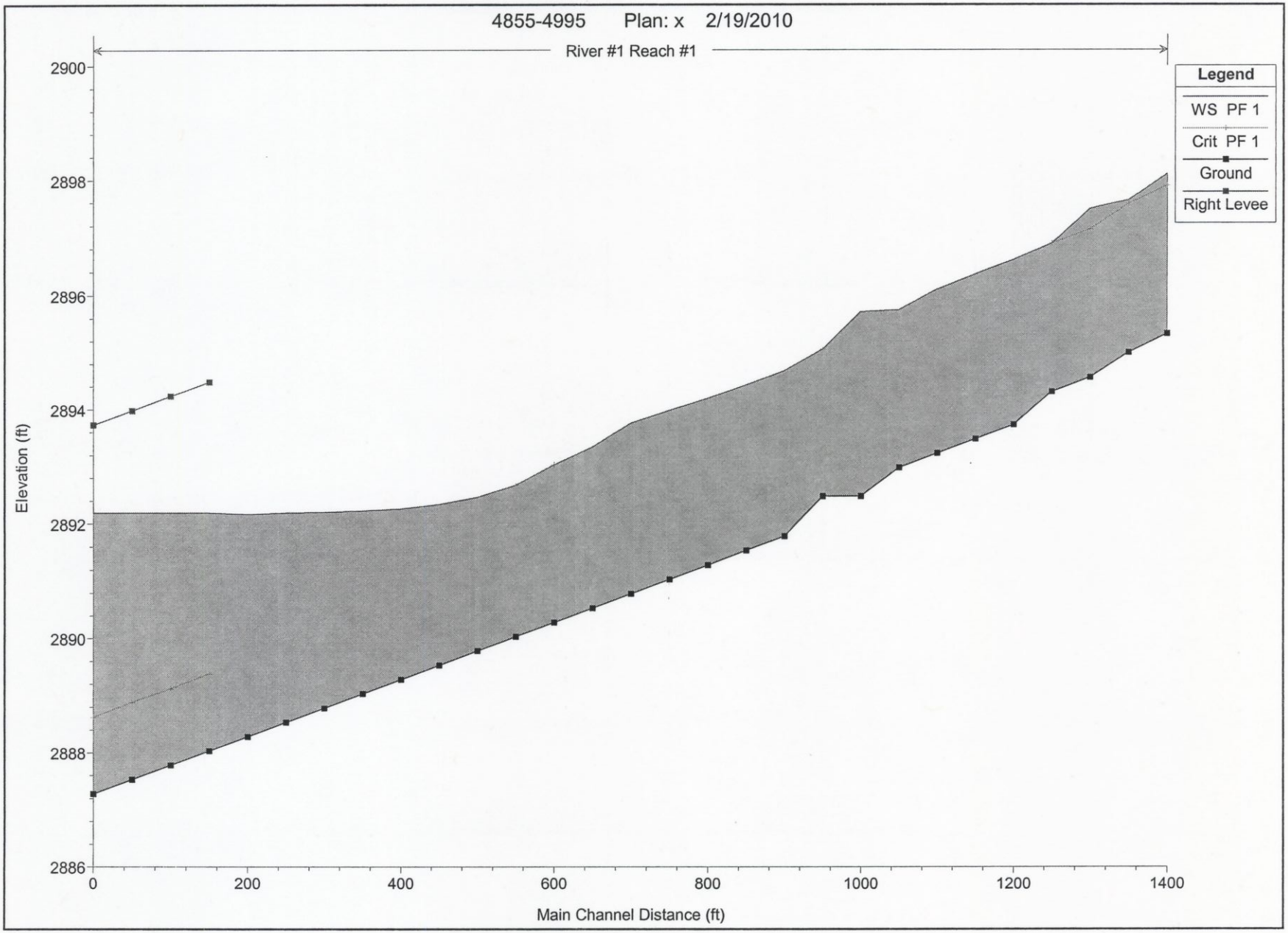
Reach	River Sta	Profile	E.G. Elev	W.S. Elev	Vel Head	Frctn
Loss C & E Loss	Q Left	Q Channel	Q Right	Top Width		
(ft)	(ft)	(cfs)	(cfs)	(ft)	(ft)	(ft)
Reach #1	499.5	PF 1	2898.59	2898.10	0.49	
0.35	0.01	152.00		19.41		
Reach #1	499	PF 1	2898.23	2897.64	0.59	
0.29	0.06	152.00		18.54		
Reach #1	498.5	PF 1	2897.88	2897.48	0.40	
0.31	0.03	152.00		20.51		
Reach #1	498	PF 1	2897.54	2896.88	0.66	
0.33	0.07	152.00		18.06		
Reach #1	497.5	PF 1	2897.03	2896.61	0.42	
0.25	0.00	152.00		20.15		
Reach #1	497	PF 1	2896.78	2896.36	0.42	
0.25	0.00	152.00		20.20		
Reach #1	496.5	PF 1	2896.53	2896.10	0.43	
0.28	0.01	152.00		20.14		
Reach #1	496	PF 1	2896.24	2895.74	0.50	
0.20	0.07	152.00		19.41		
Reach #1	495.5	PF 1	2895.97	2895.71	0.27	
0.22	0.04	152.00		22.66		
Reach #1	495	PF 1	2895.71	2895.05	0.66	
0.33	0.07	152.00		18.07		
Reach #1	494.5	PF 1	2895.09	2894.67	0.42	
0.25	0.00	152.00		20.25		
Reach #1	494	PF 1	2894.84	2894.42	0.42	
0.24	0.00	152.00		20.30		

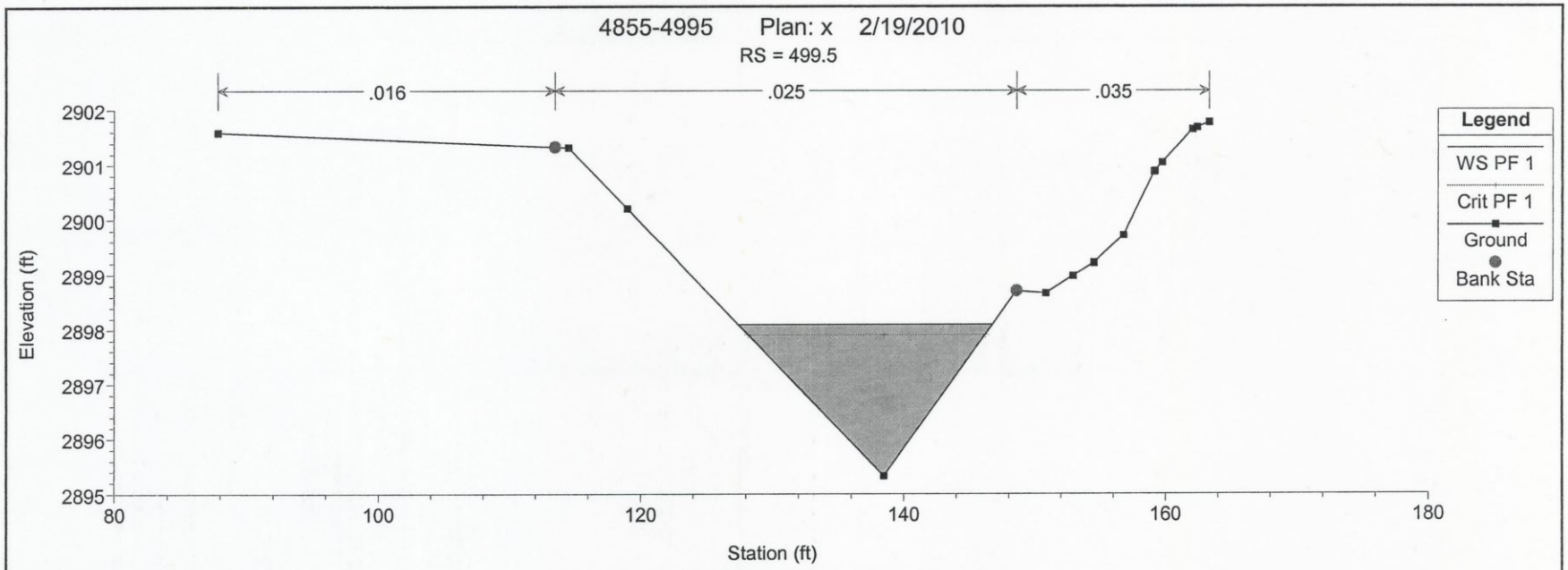
```
  Reach #1      493.5         PF 1        2894.60     2894.19       0.41
0.23          0.01              152.00                 20.38
  Reach #1      493           PF 1        2894.36     2893.97       0.39
0.25          0.01              151.68       0.32      25.74
  Reach #1      492.5         PF 1        2894.10     2893.75       0.35
0.28          0.01              152.00                 28.16
  Reach #1      492           PF 1        2893.81     2893.33       0.47
0.33          0.01              152.00                 19.65
  Reach #1      491.5         PF 1        2893.47     2893.02       0.45
0.36          0.01              147.29       4.71      37.94
  Reach #1      491           PF 1        2893.09     2892.66       0.43
0.29          0.05              139.60      12.40      39.86
  Reach #1      490.5         PF 1        2892.70     2892.46       0.25
0.18          0.02              152.00                 40.84
  Reach #1      490           PF 1        2892.50     2892.34       0.16
0.11          0.01              152.00                 42.78
  Reach #1      489.5         PF 1        2892.38     2892.26       0.12
0.06          0.01              152.00                 47.10
  Reach #1      489           PF 1        2892.30     2892.23       0.08
0.04          0.01              152.00                 47.53
  Reach #1      488.5         PF 1        2892.26     2892.20       0.06
0.02          0.01              152.00                 47.12
  Reach #1      488           PF 1        2892.23     2892.19       0.04
0.02          0.00              152.00                 48.66
  Reach #1      487.5         PF 1        2892.21     2892.16       0.05
0.00          0.01              152.00                 49.55
  Reach #1      487           PF 1        2892.20     2892.19       0.00
0.00          0.00              152.00                149.67
  Reach #1      486.5         PF 1        2892.19     2892.19       0.00
0.00          0.00              152.00                158.39
  Reach #1      486           PF 1        2892.19     2892.19       0.00
0.00          0.00              152.00                167.10
  Reach #1      485.5         PF 1        2892.19     2892.19       0.00
                            152.00                175.82
```

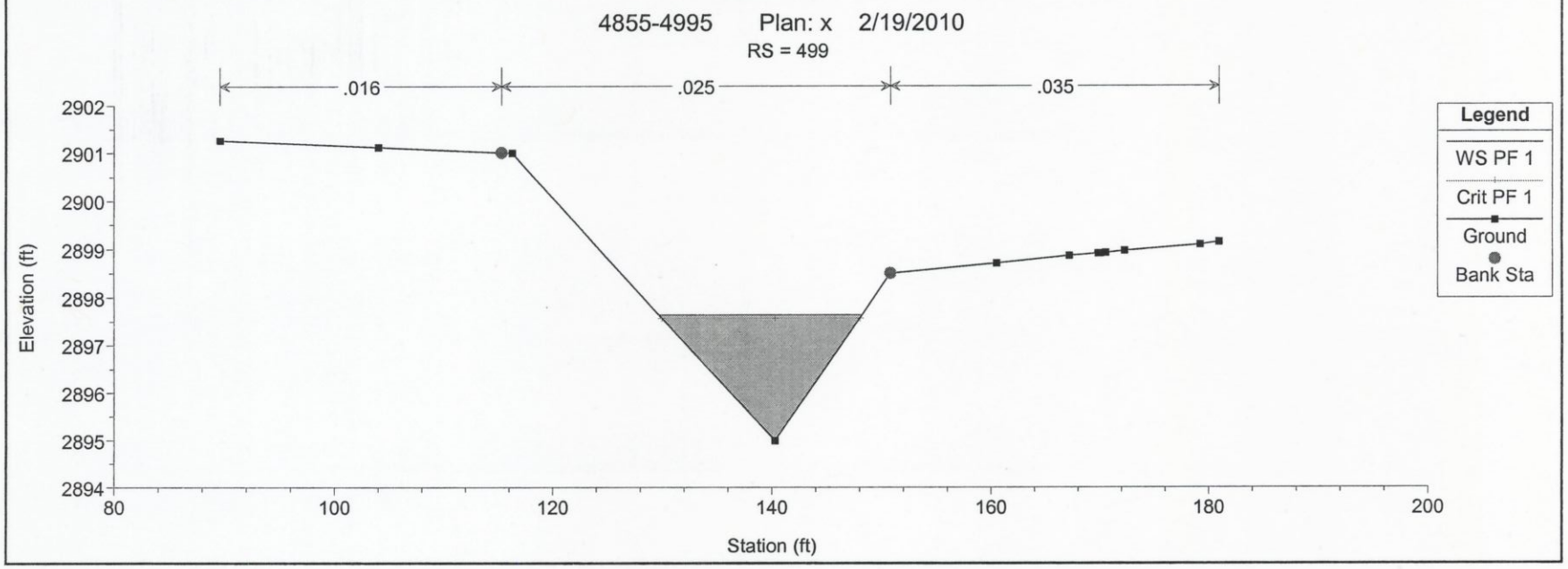
ERRORS WARNINGS AND NOTES
Errors Warnings and Notes for Plan : 4855-4995

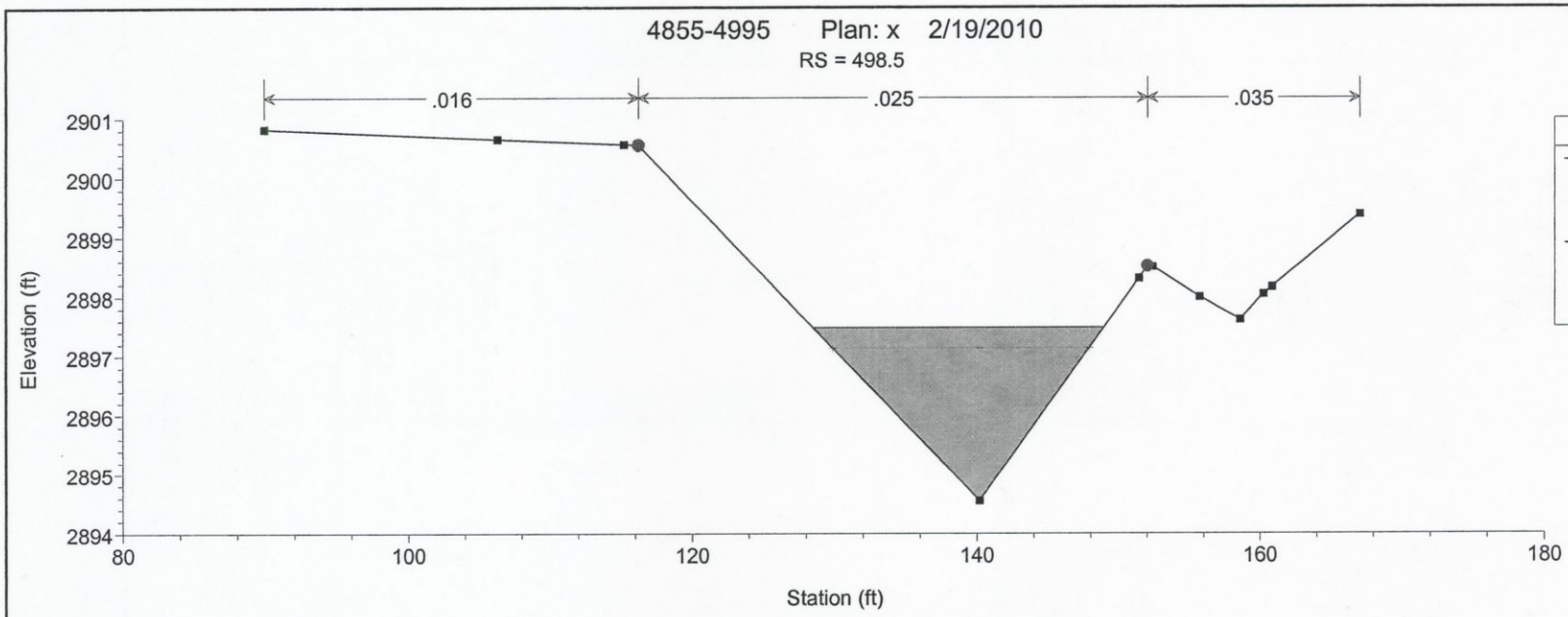
```
River: River #1  Reach: Reach #1     RS: 498.5     Profile: PF 1
     Warning:The conveyance ratio (upstream conveyance divided by downstream
conveyance) is less than 0.7 or greater than 1.4.
             This may indicate the need for additional cross sections.
River: River #1  Reach: Reach #1     RS: 498     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: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: 496     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: 495.5     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.
```

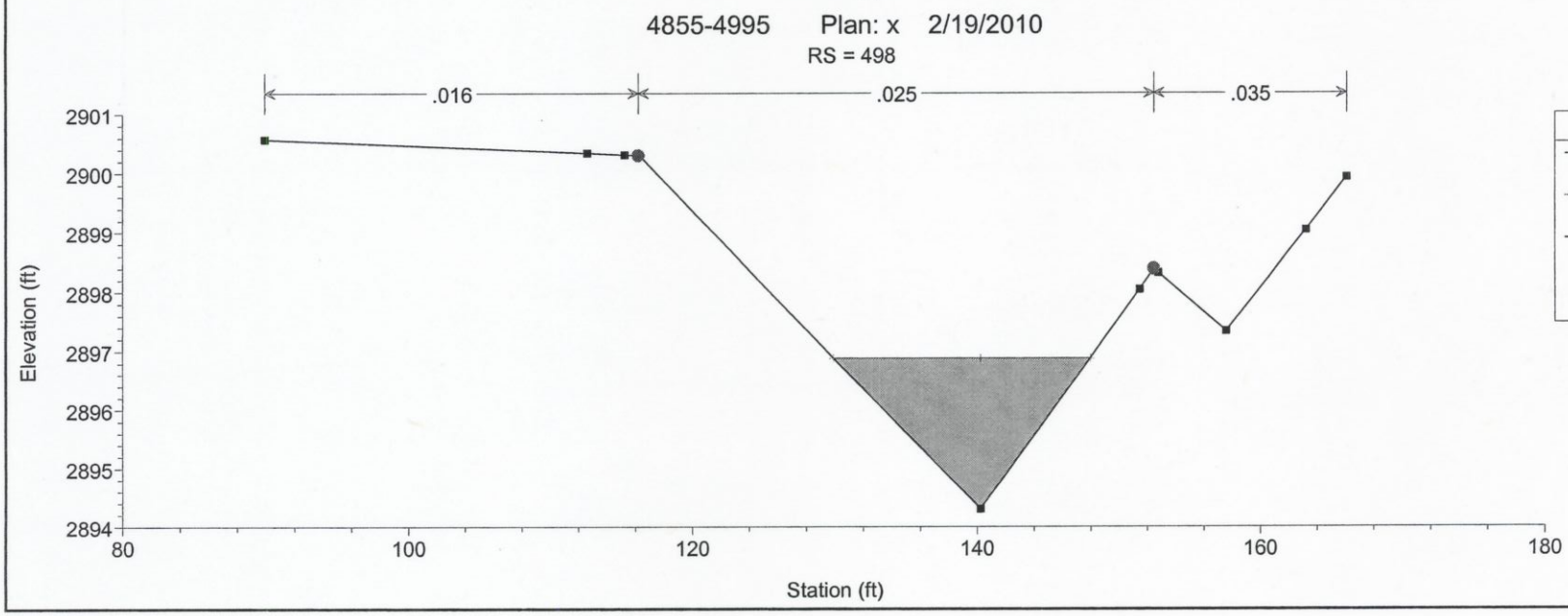
```
River: River #1  Reach: Reach #1     RS: 495     Profile: PF 1
     Warning:The energy equation could not be balanced within the specified number
of iterations.  The program used critical depth
             for the water surface and continued on with the calculations.
     Warning:During the standard 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: 491.5     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: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: 491     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: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: 487.5     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: 487     Profile: PF 1
     Note:   Multiple critical depths were found at this location.  The critical
depth with the lowest, valid, water surface was
             used.
River: River #1  Reach: Reach #1     RS: 486.5     Profile: PF 1
     Note:   Multiple critical depths were found at this location.  The critical
depth with the lowest, valid, water surface was
             used.
River: River #1  Reach: Reach #1     RS: 486     Profile: PF 1
     Note:   Multiple critical depths were found at this location.  The critical
depth with the lowest, valid, water surface was
             used.
River: River #1  Reach: Reach #1     RS: 485.5     Profile: PF 1
     Note:   Multiple critical depths were found at this location.  The critical
depth with the lowest, valid, water surface was
             used.
```

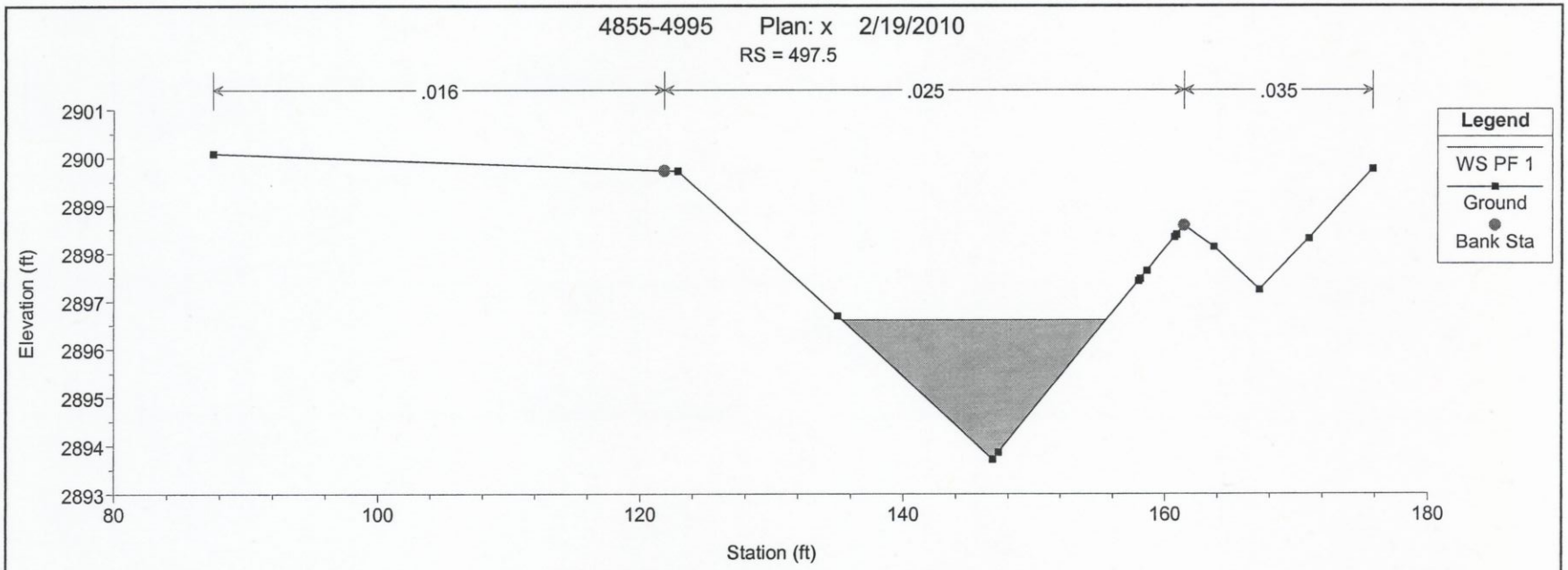

4855-4995 Plan: x 2/19/2010
River #1 Reach #1
Legend
WS PF 1
Crit PF 1
Ground
Right Levee
Elevation (ft)
2900
2898
2896
2894
2892
2890
2888
2886
0
200
400
600
800
1000
1200
1400
Main Channel Distance (ft)

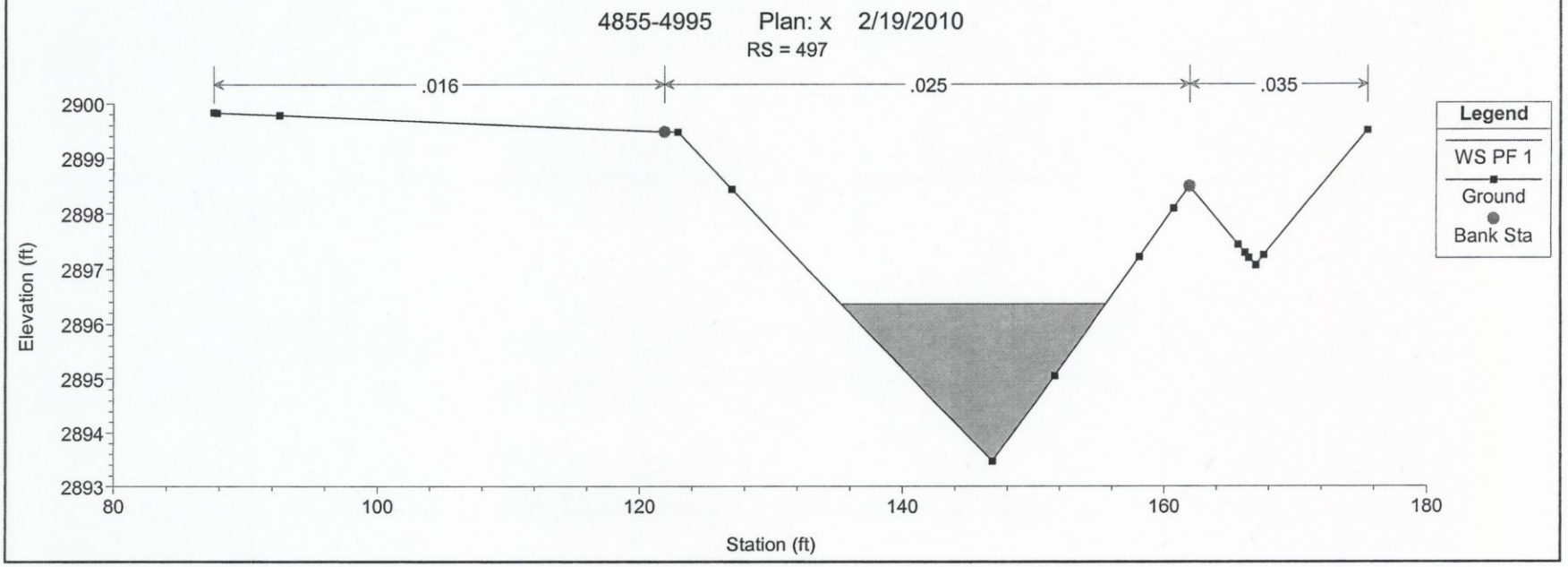

4855-4995 Plan: x 2/19/2010
RS = 499.5
.016
.025
.035
Elevation (ft)
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Bank Sta

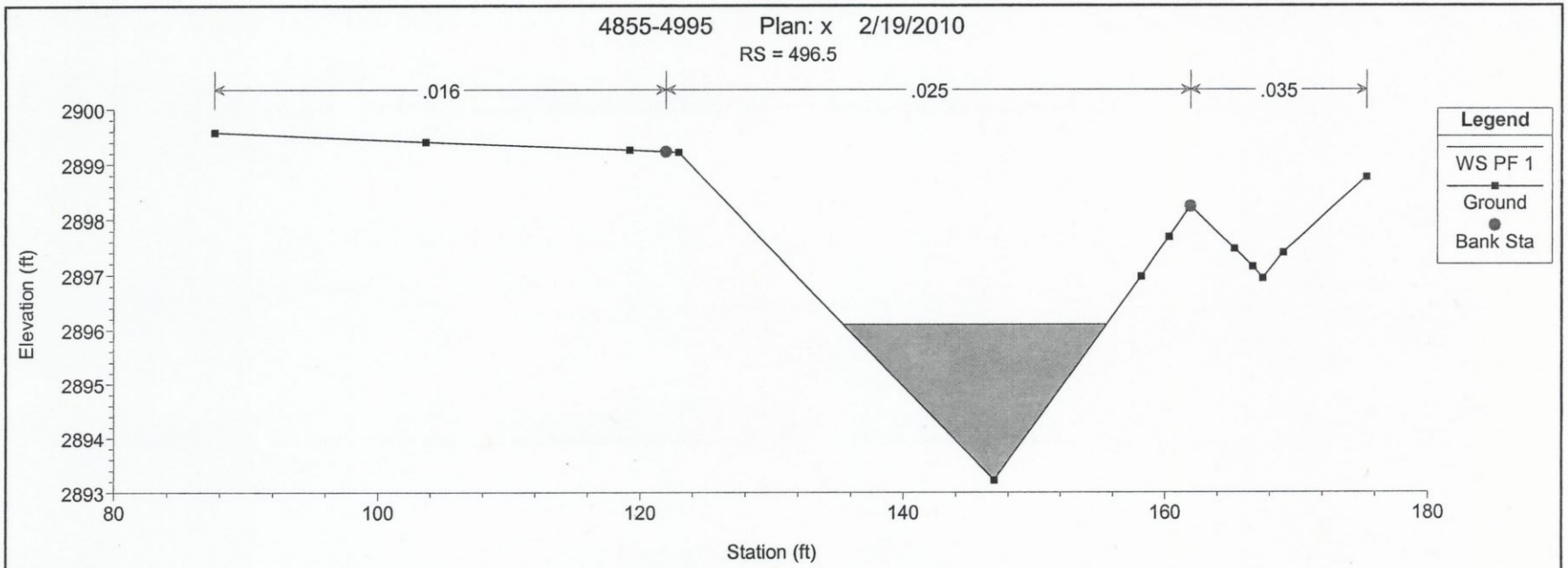

4855-4995 Plan: x 2/19/2010
RS = 499
.016
.025
.035
Elevation (ft)
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Bank Sta

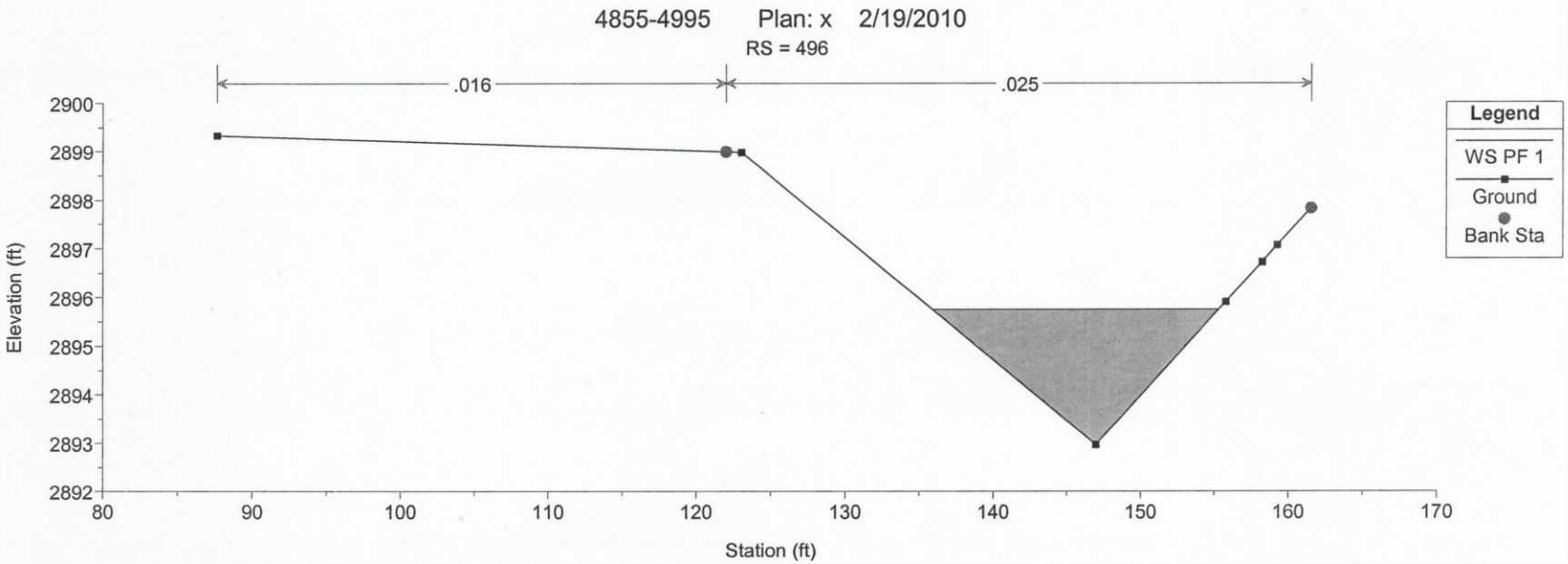

4855-4995 Plan: x 2/19/2010
RS = 498.5
.016
.025
.035
Elevation (ft)
2901
2900
2899
2898
2897
2896
2895
2894
80
100
120
140
160
180
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Bank Sta


4855-4995 Plan: x 2/19/2010
RS = 498
.016
.025
.035
Elevation (ft)
2901
2900
2899
2898
2897
2896
2895
2894
80
100
120
140
160
180
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Bank Sta


4855-4995 Plan: x 2/19/2010
RS = 497.5
.016
.025
.035
Legend
WS PF 1
Ground
Bank Sta
Elevation (ft)
2901
2900
2899
2898
2897
2896
2895
2894
2893
80
100
120
140
160
180
Station (ft)


4855-4995 Plan: x 2/19/2010
RS = 497
.016
.025
.035
Legend
WS PF 1
Ground
Bank Sta
Elevation (ft)
2900
2899
2898
2897
2896
2895
2894
2893
80
100
120
140
160
180
Station (ft)


4855-4995 Plan: x 2/19/2010
RS = 496.5
.016
.025
.035
Legend
WS PF 1
Ground
Bank Sta
Elevation (ft)
2900
2899
2898
2897
2896
2895
2894
2893
80
100
120
140
160
180
Station (ft)


4855-4995 Plan: x 2/19/2010
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.016
.025
Legend
WS PF 1
Ground
Bank Sta
Elevation (ft)
2900
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80
90
100
110
120
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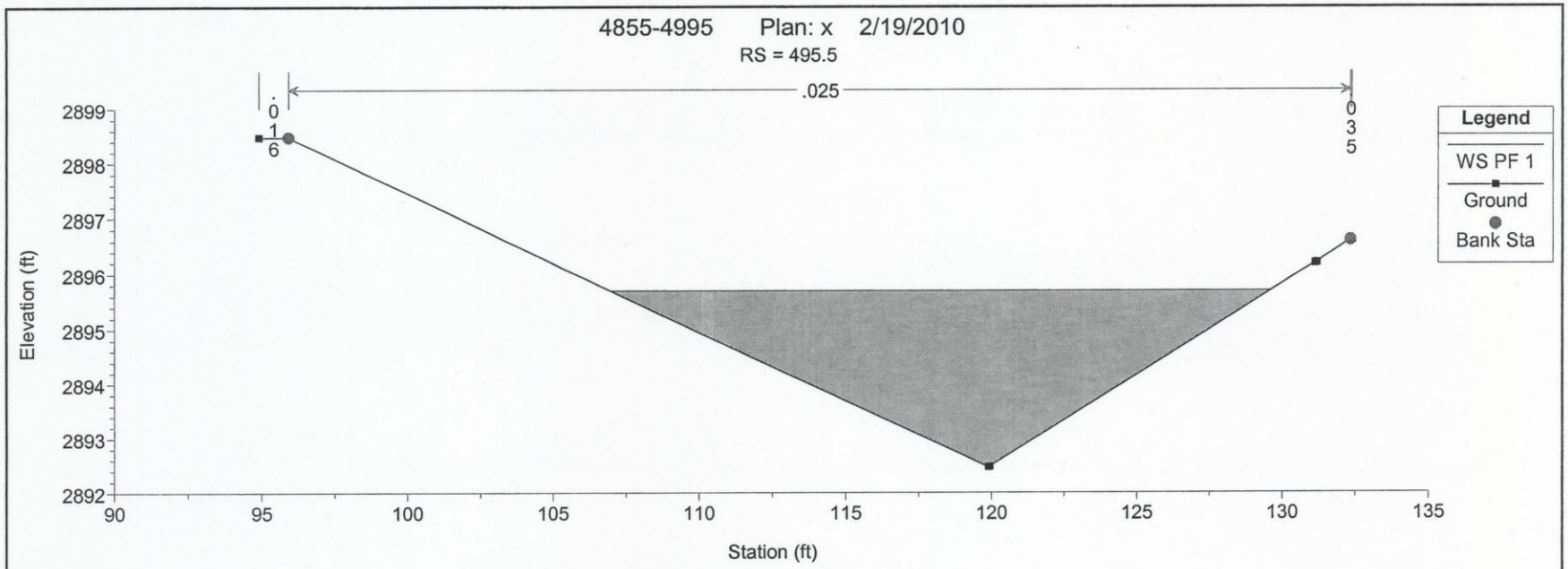
140
150
160
170
Station (ft)


4855-4995 Plan: x 2/19/2010
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.025
.016
.035
Legend
WS PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)
2899
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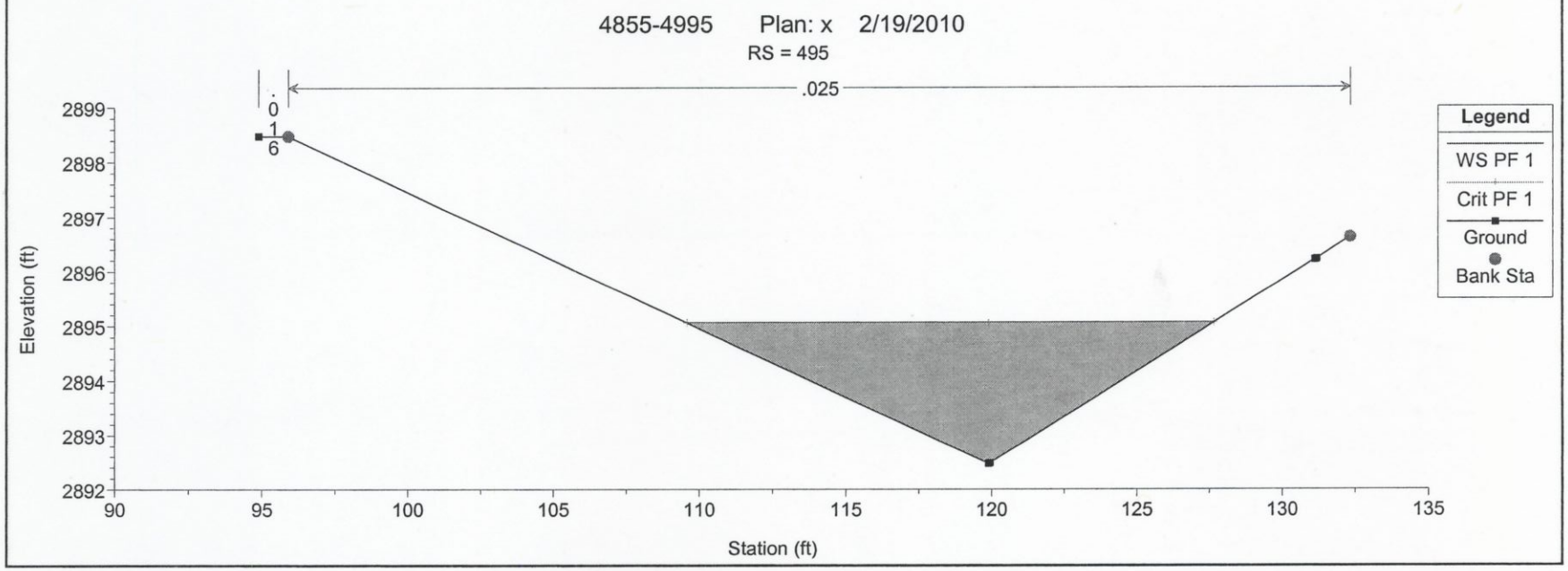
2893
2892
90
95
100
105
110
115
120
125
130
135


4855-4995 Plan: x 2/19/2010
RS = 495
.025
.016
Legend
WS PF 1
Crit PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)
2899
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2892
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100
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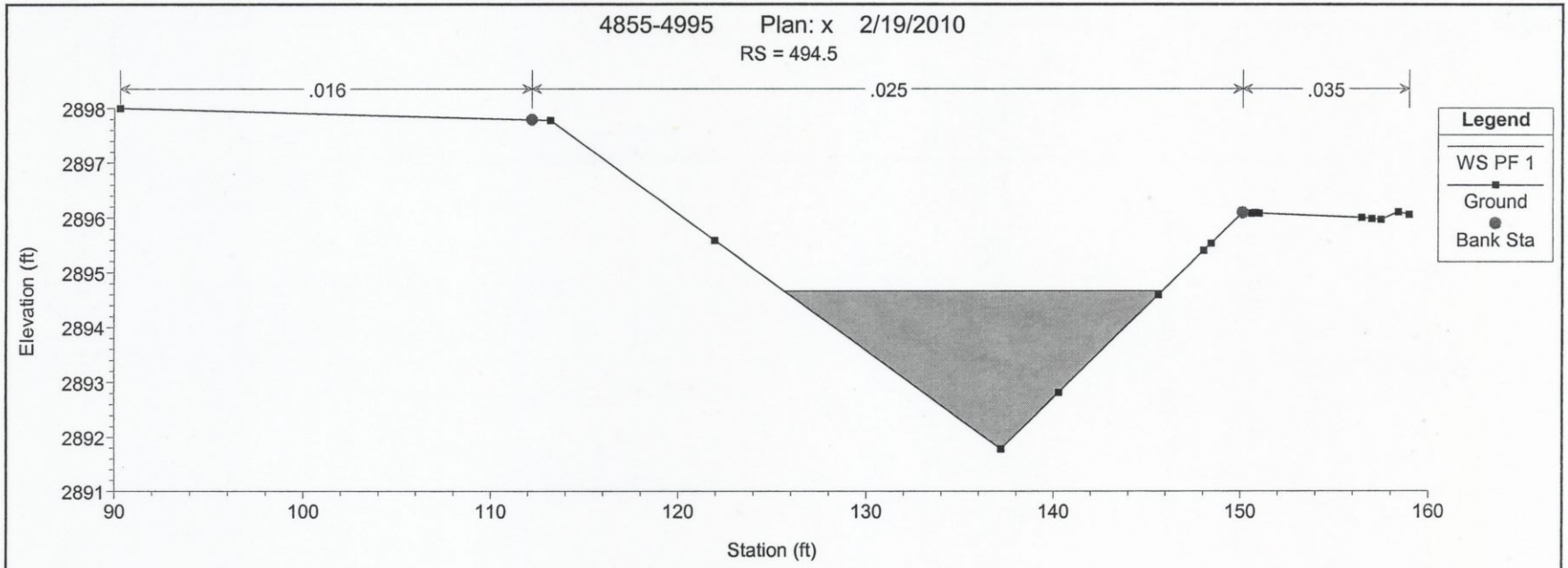
120
125
130
135


4855-4995 Plan: x 2/19/2010
RS = 494.5
.016
.025
.035
Legend
WS PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)
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130
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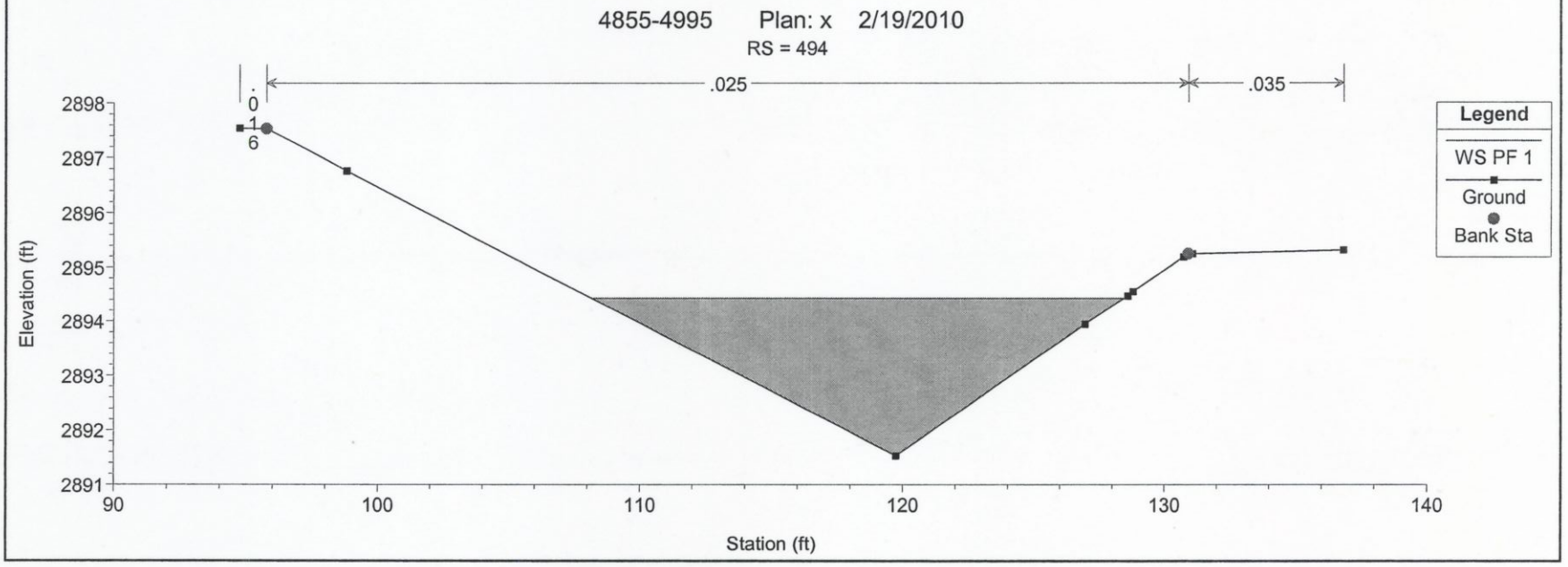
150
160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.016
.025
.035
Legend
WS PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)
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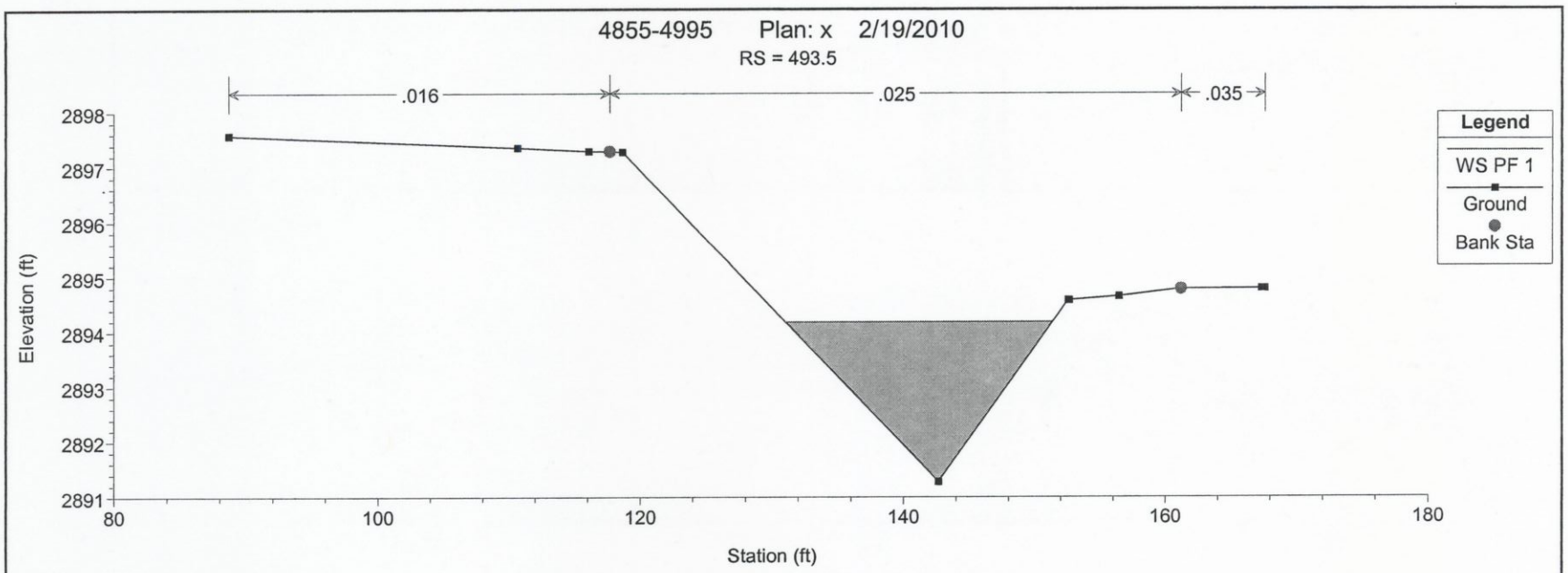
130
140


4855-4995 Plan: x 2/19/2010
RS = 493.5
.016
.025
.035
Legend
WS PF 1
Ground
Bank Sta
Elevation (ft)
2898
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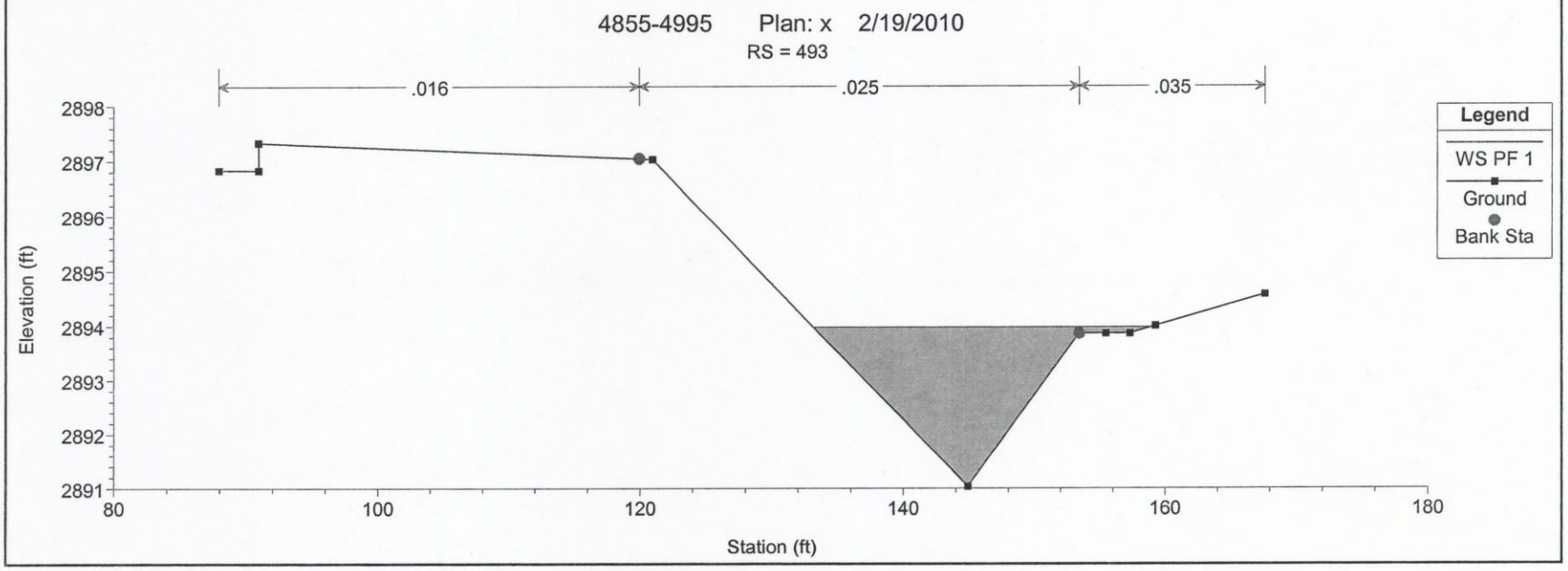
160
180
Station (ft)


4855-4995 Plan: x 2/19/2010
RS = 493
.016
.025
.035
Legend
WS PF 1
Ground
Bank Sta
Elevation (ft)
2898
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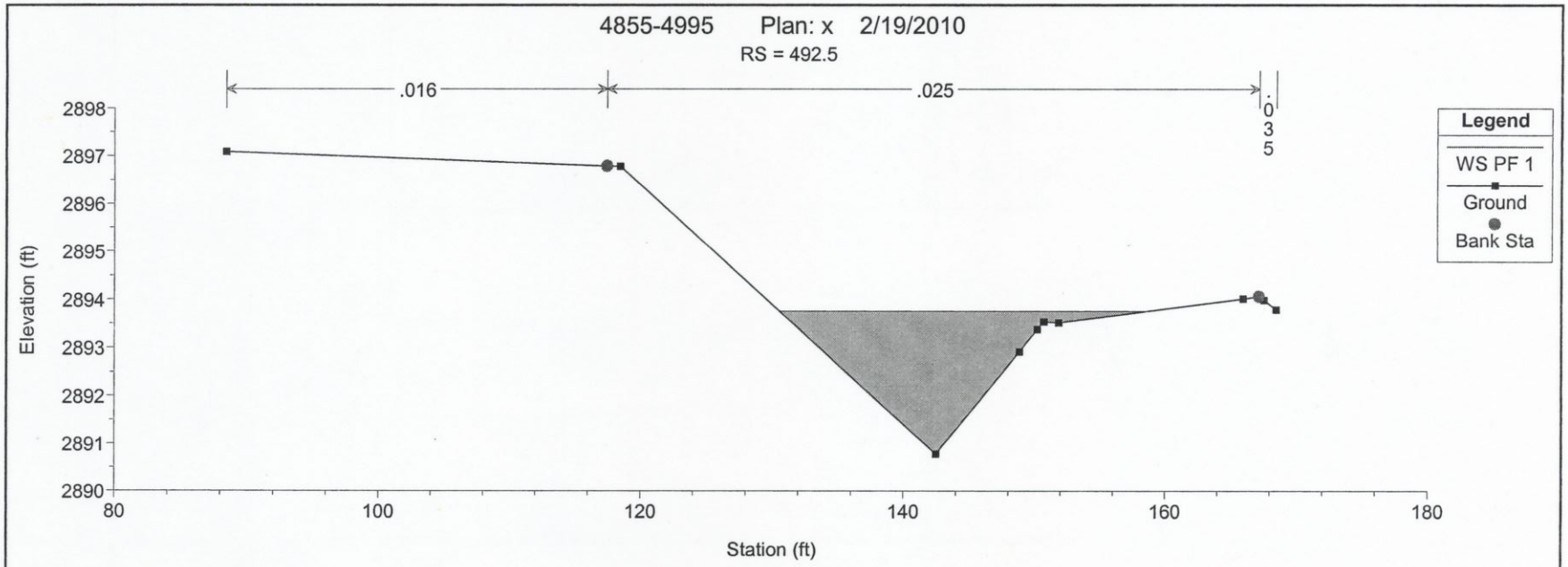
2892
2891
80
100
120
140
160
180
Station (ft)


4855-4995 Plan: x 2/19/2010
RS = 492.5
.016
.025
.035
Legend
WS PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)
2898
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2895
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2893
2892
2891
2890
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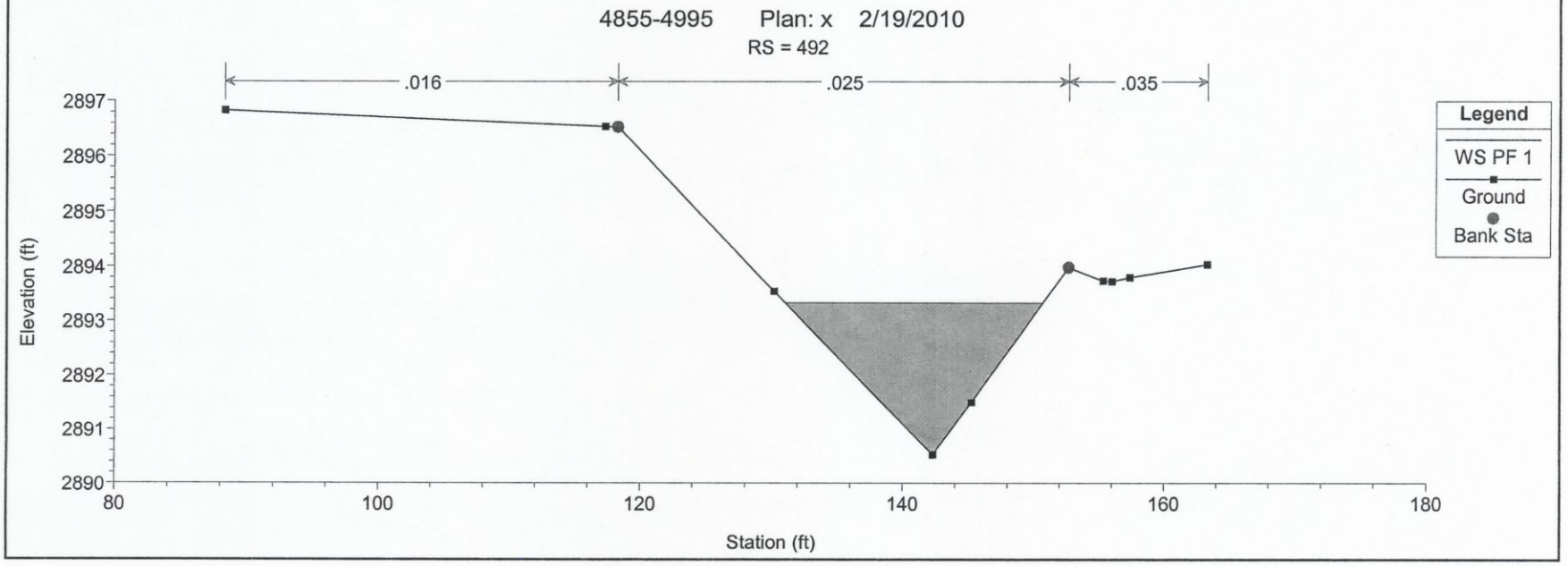
100
120
140
160
180


4855-4995 Plan: x 2/19/2010
RS = 492
.016
.025
.035
Legend
WS PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)
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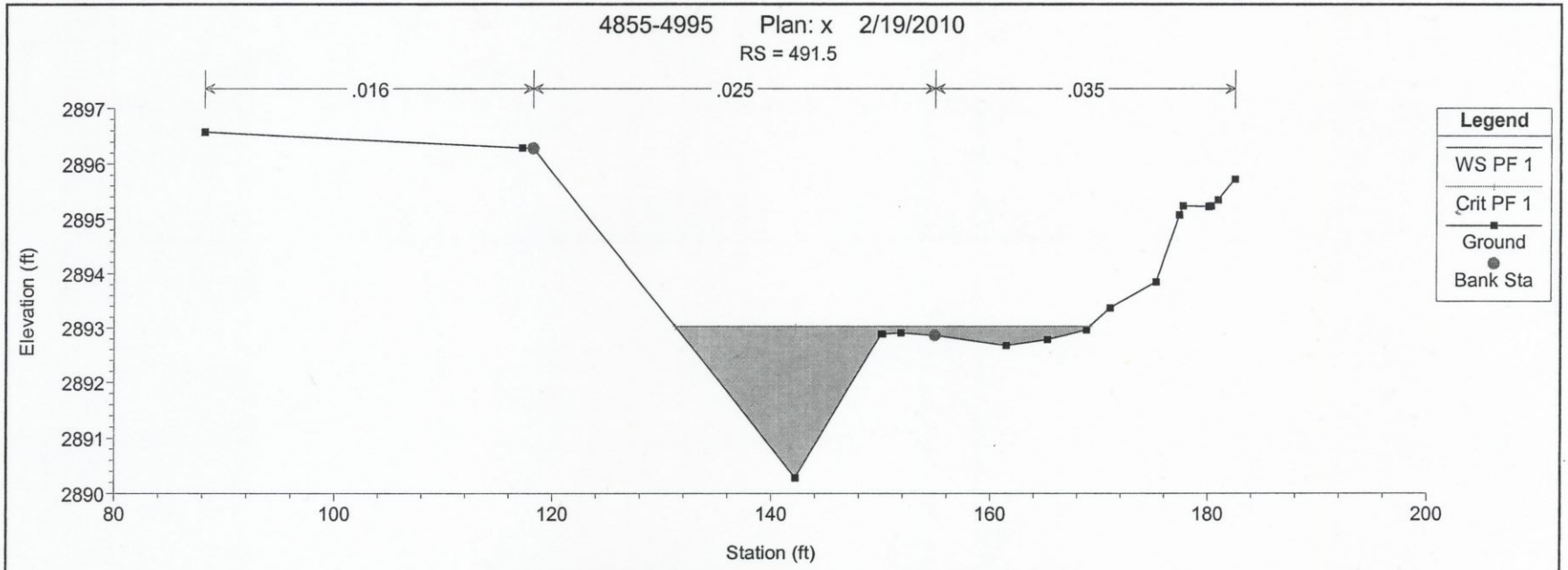
160
180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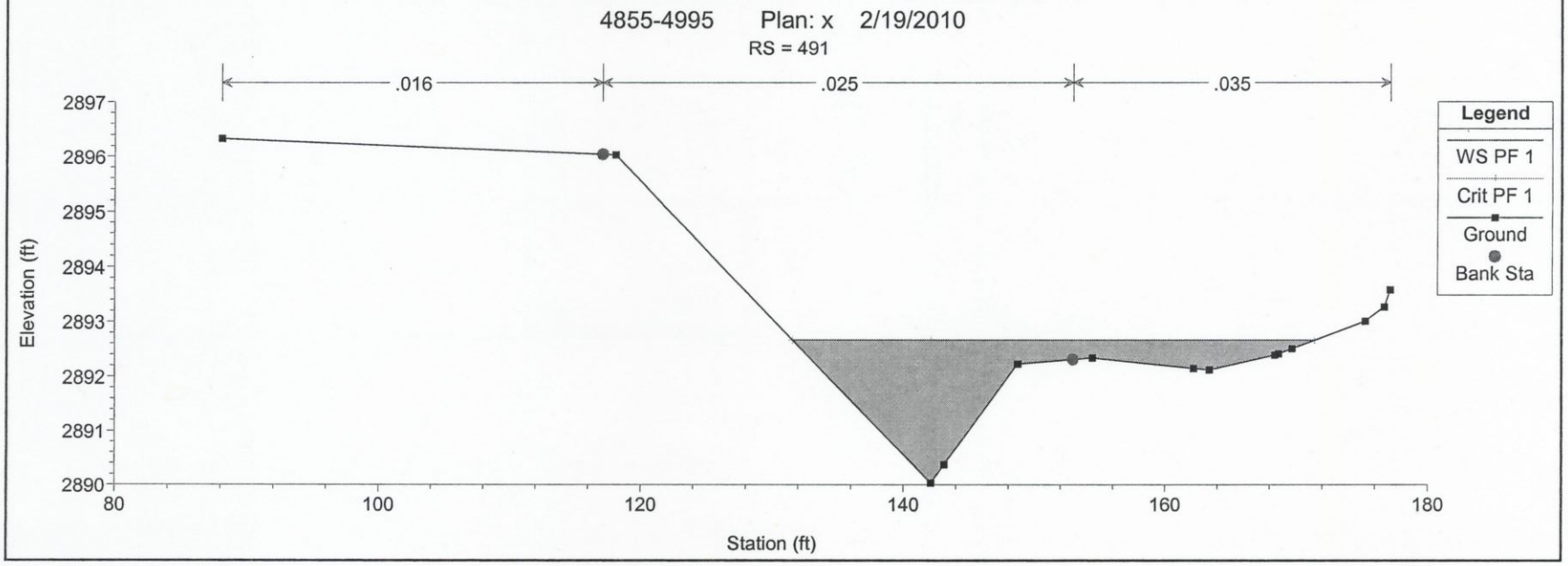
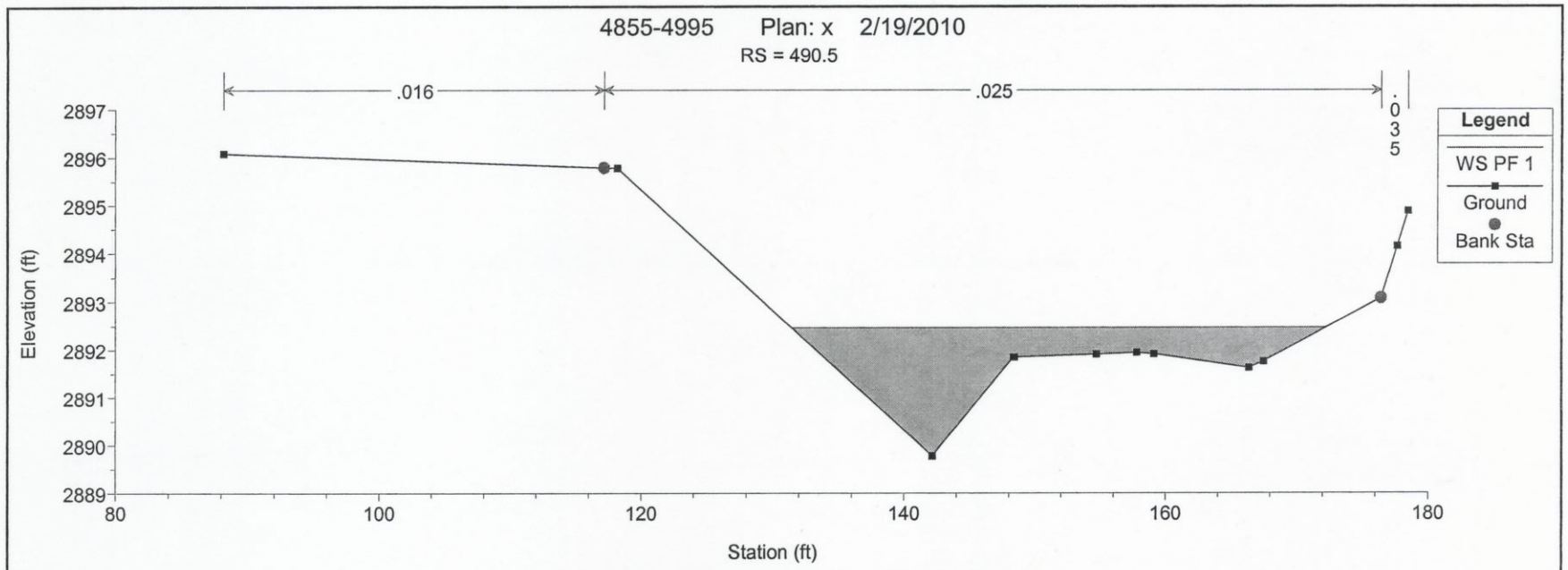
.016
.025
.035
Elevation (ft)
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Bank Sta


4855-4995 Plan: x 2/19/2010
RS = 491
.016
.025
.035
Elevation (ft)
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Bank Sta


4855-4995 Plan: x 2/19/2010
RS = 490.5
.016
.025
.035
Legend
WS PF 1
Ground
Bank Sta
Elevation (ft)
2897
2896
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2894
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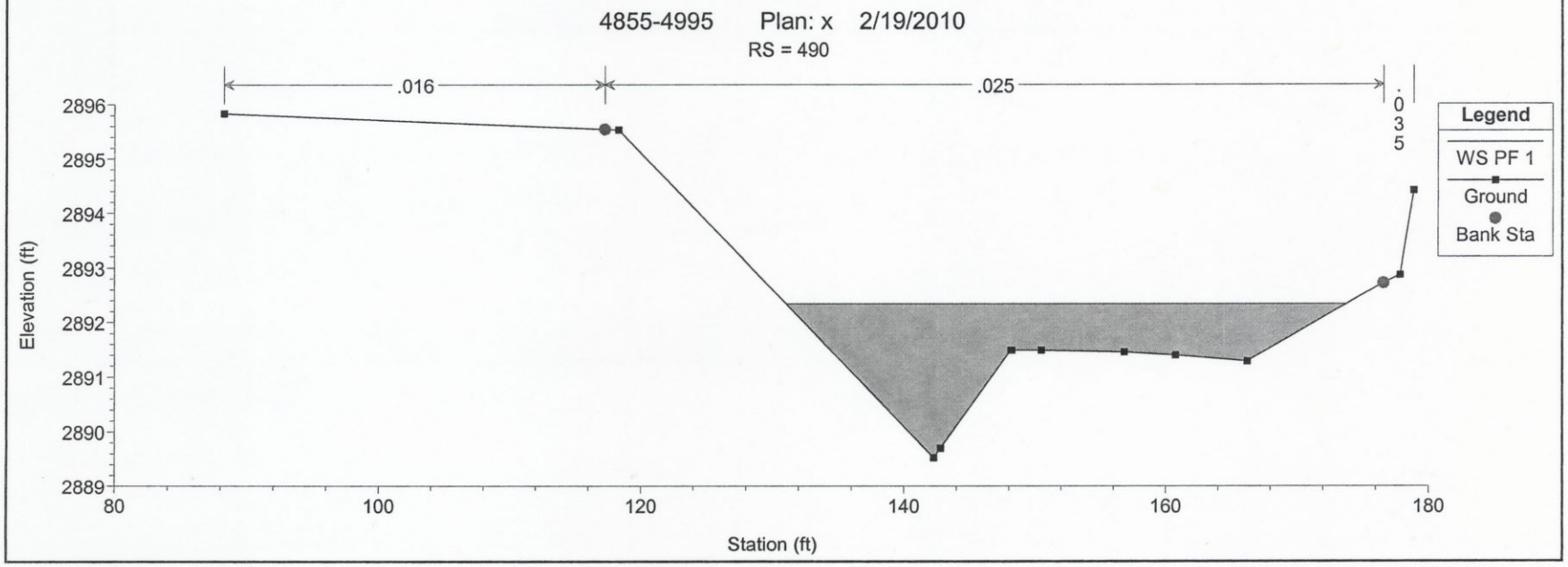
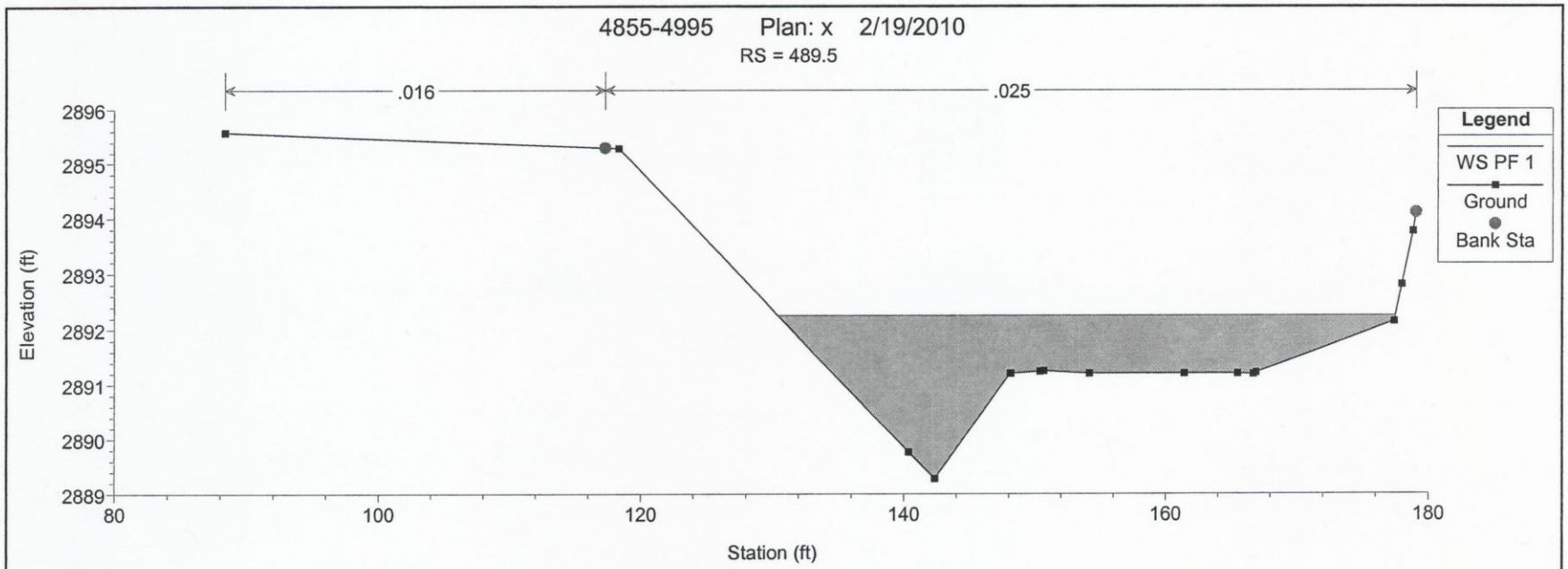
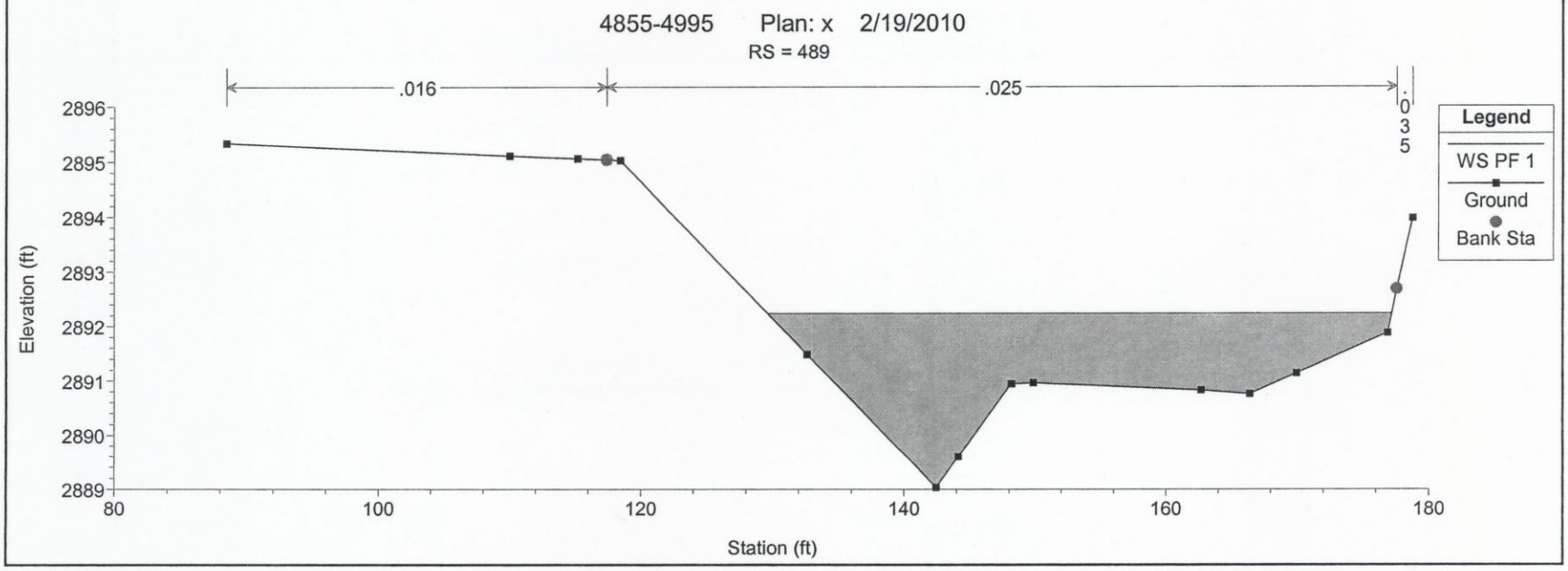
2891
2890
2889
80
100
120
140
160
180
Station (ft)


4855-4995 Plan: x 2/19/2010
RS = 490
.016
.025
.035
Legend
WS PF 1
Ground
Bank Sta
Elevation (ft)
2896
2895
2894
2893
2892
2891
2890
2889
80
100
120
140
160
180
Station (ft)


4855-4995 Plan: x 2/19/2010
RS = 489.5
.016
.025
Legend
WS PF 1
Ground
Bank Sta
Elevation (ft)
2896
2895
2894
2893
2892
2891
2890
2889
80
100
120
140
160
180
Station (ft)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RS = 489
.016
.025
.035
Legend
WS PF 1
Ground
Bank Sta
Elevation (ft)
2896
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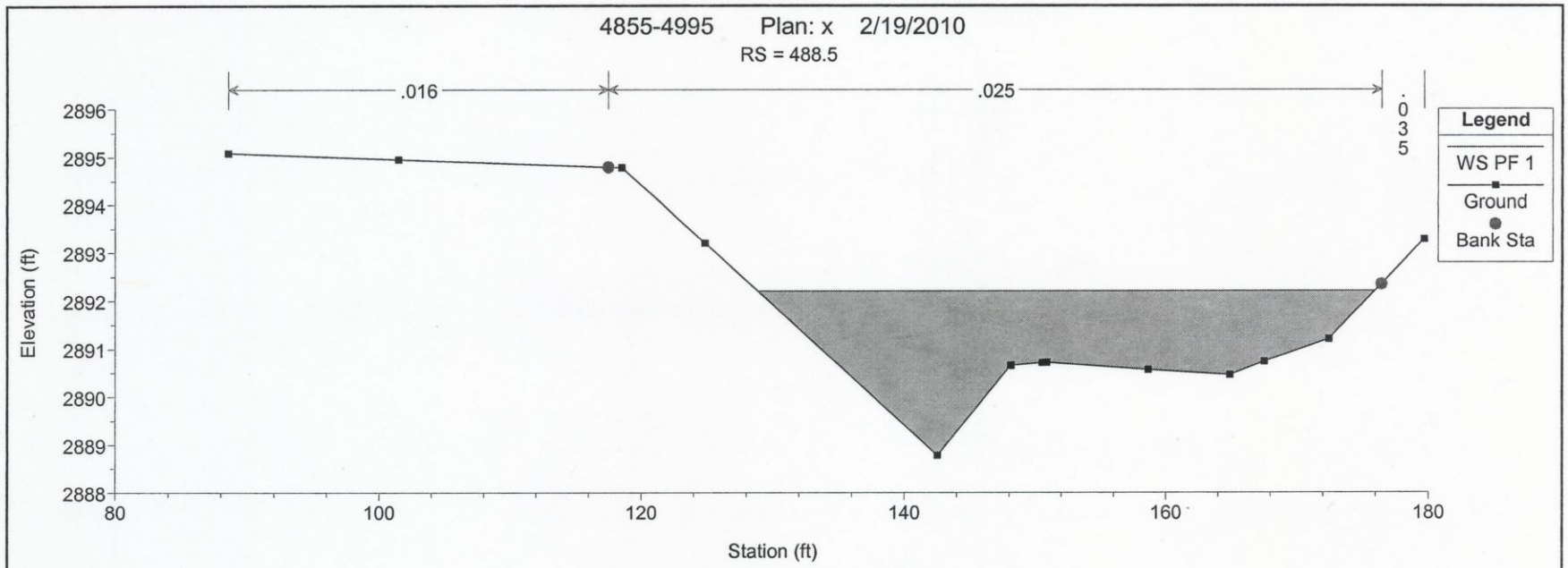
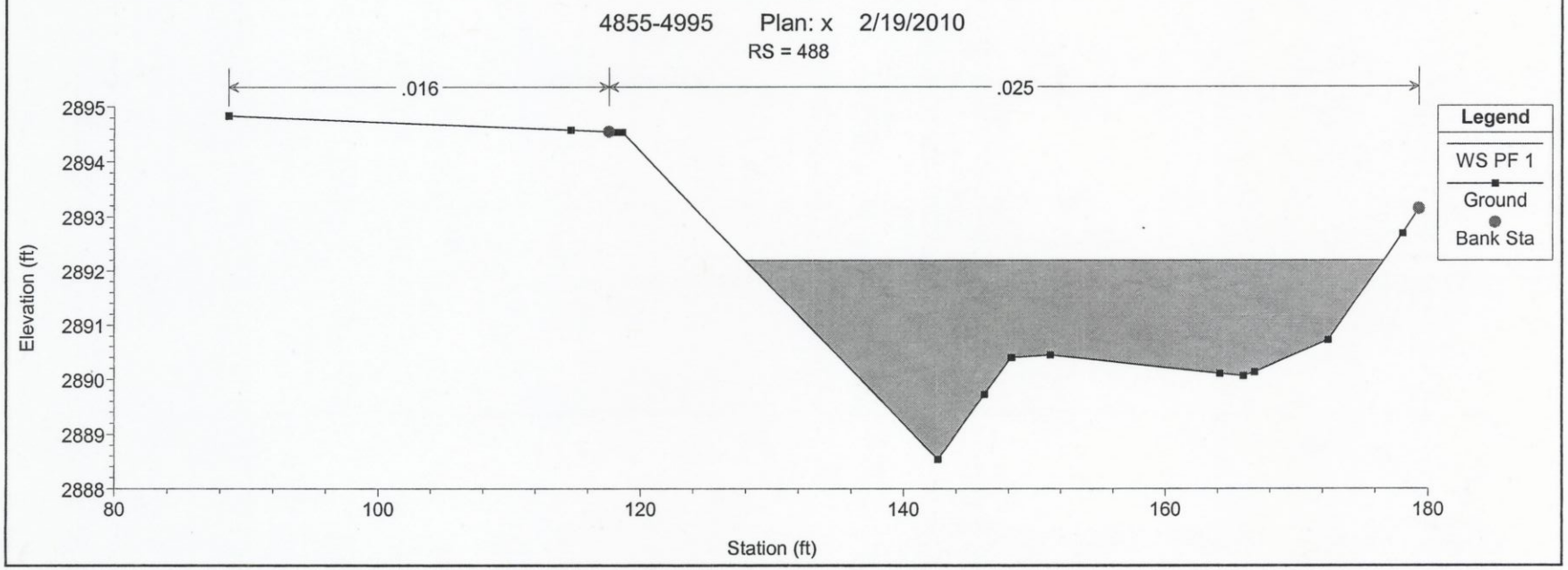
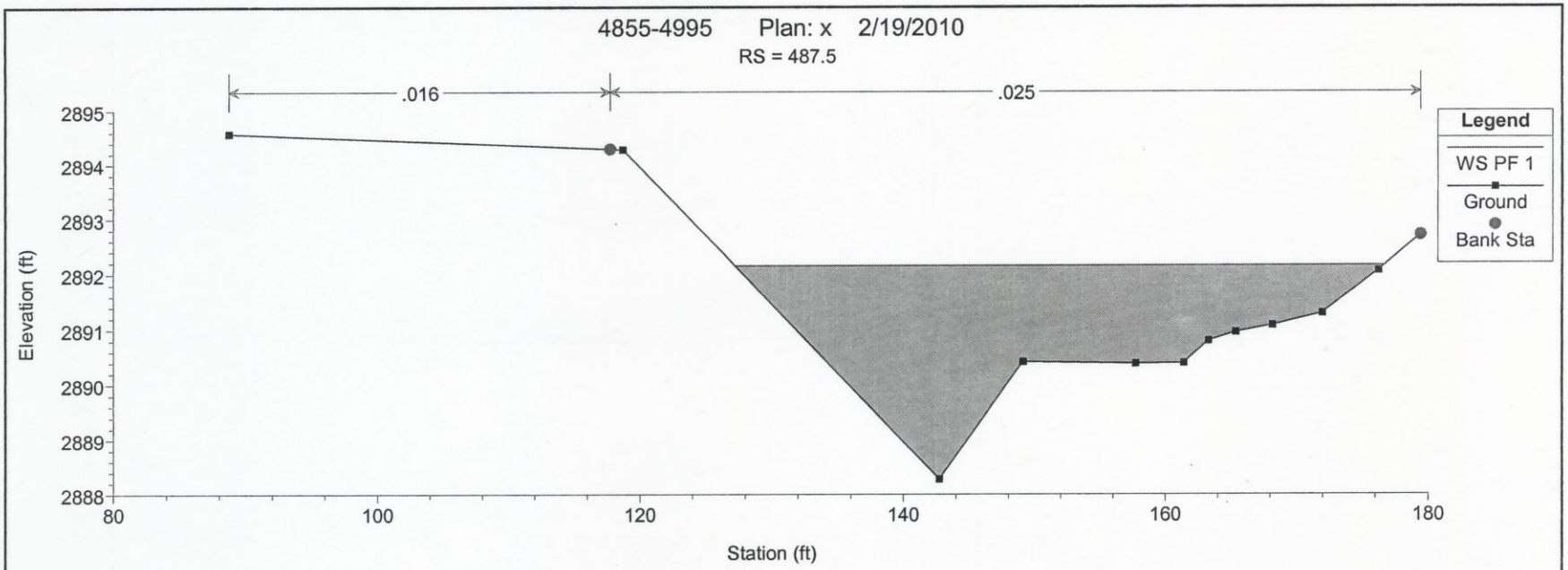
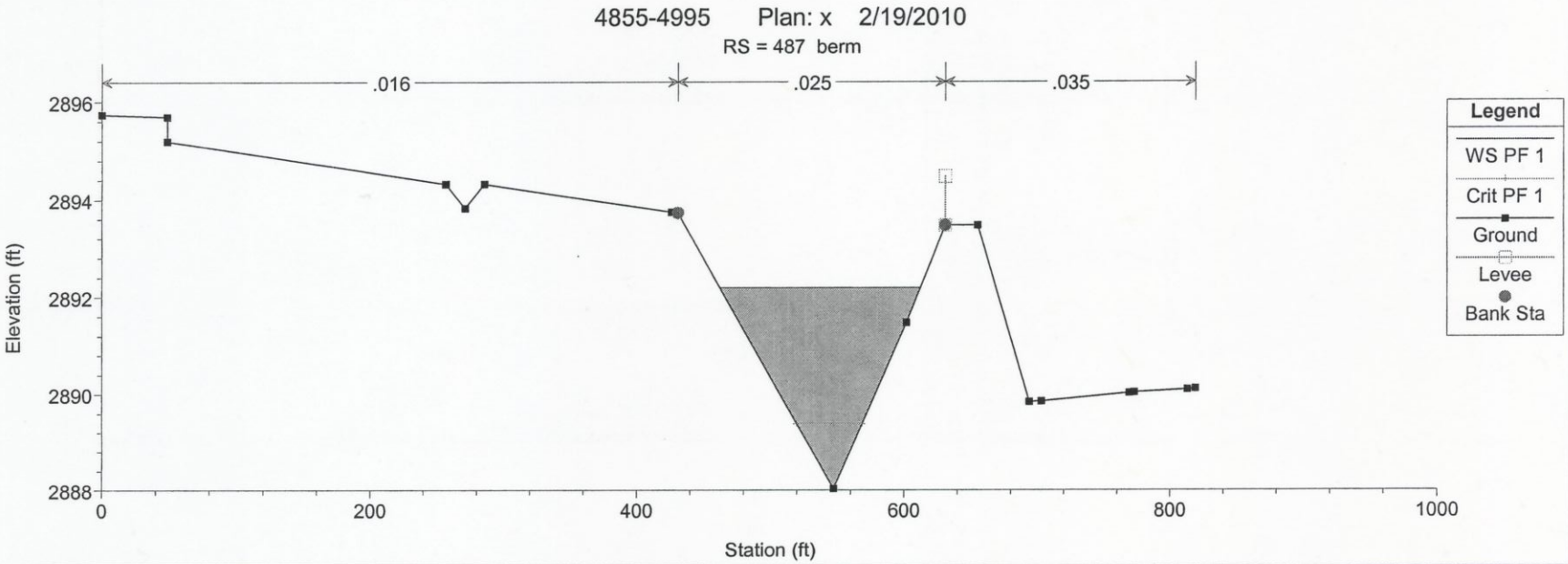
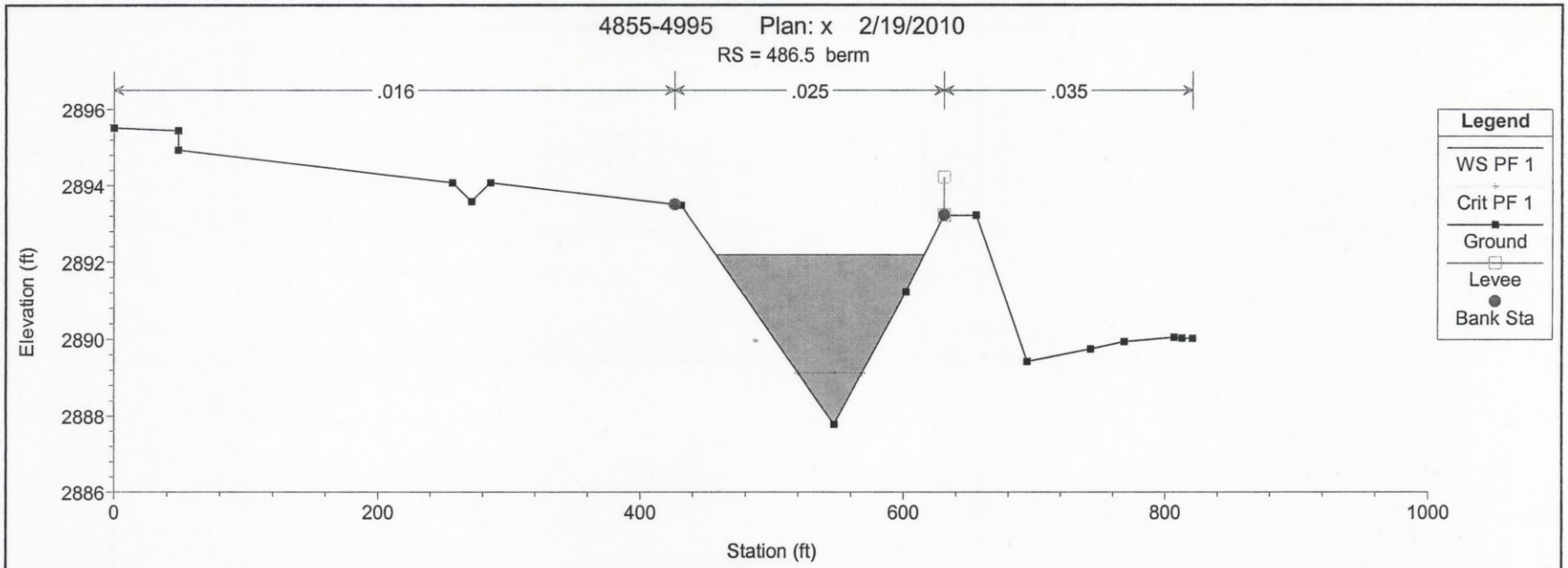
2894
2893
2892
2891
2890
2889
80
100
120
140
160
180
Station (ft)


4855-4995 Plan: x 2/19/2010
RS = 488.5
.016
.025
.035
Legend
WS PF 1
Ground
Bank Sta
Elevation (ft)
2896
2895
2894
2893
2892
2891
2890
2889
2888
80
100
120
140
160
180
Station (ft)


4855-4995 Plan: x 2/19/2010
RS = 488
.016
.025
Legend
WS PF 1
Ground
Bank Sta
Elevation (ft)
2895
2894
2893
2892
2891
2890
2889
2888
80
100
120
140
160
180
Station (ft)


4855-4995 Plan: x 2/19/2010
RS = 487.5
.016
.025
Legend
WS PF 1
Ground
Bank Sta
Elevation (ft)
2895
2894
2893
2892
2891
2890
2889
2888
80
100
120
140
160
180
Station (ft)


4855-4995 Plan: x 2/19/2010
RS = 487 berm
.016
.025
.035
Legend
WS PF 1
Crit PF 1
Ground
Levee
Bank Sta
Elevation (ft)
2896
2894
2892
2890
2888
0
200
400
600
800
1000
Station (ft)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.016
.025
.035
Elevation (ft)
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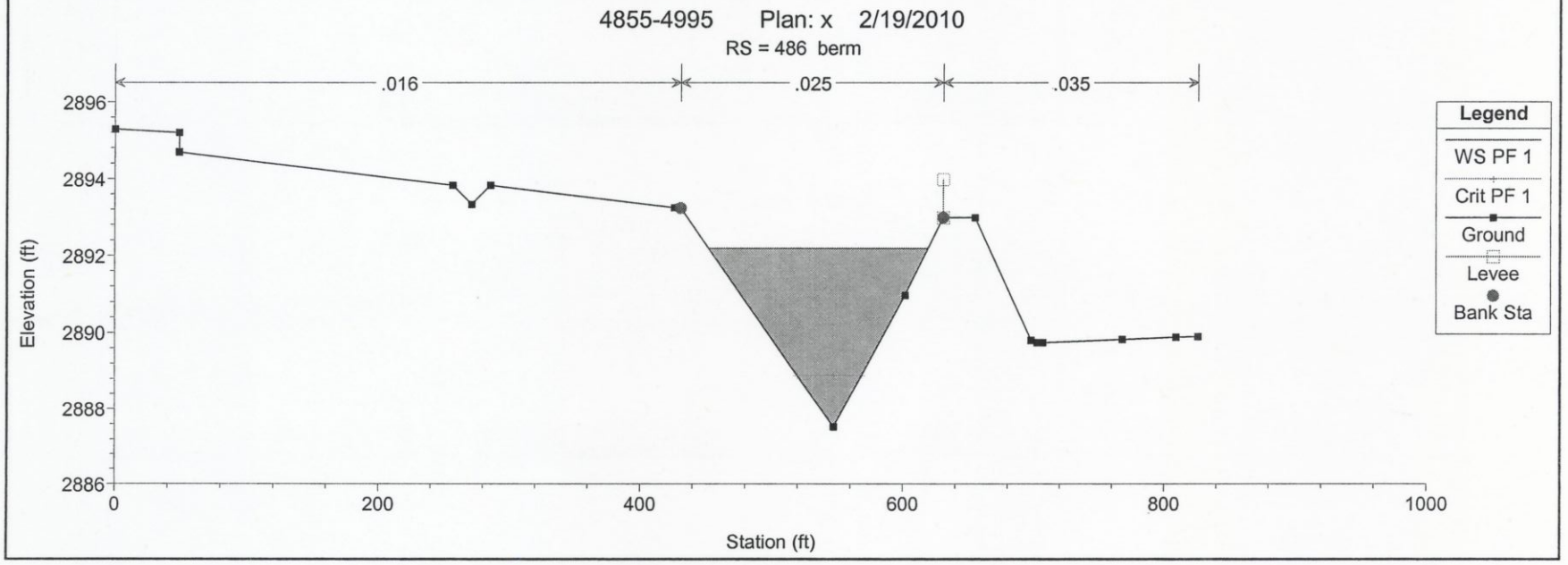
2894
2892
2890
2888
2886
0
200
400
600
800
1000
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Levee
Bank Sta


4855-4995 Plan: x 2/19/2010
RS = 486 berm
.016
.025
.035
Elevation (ft)
2896
2894
2892
2890
2888
2886
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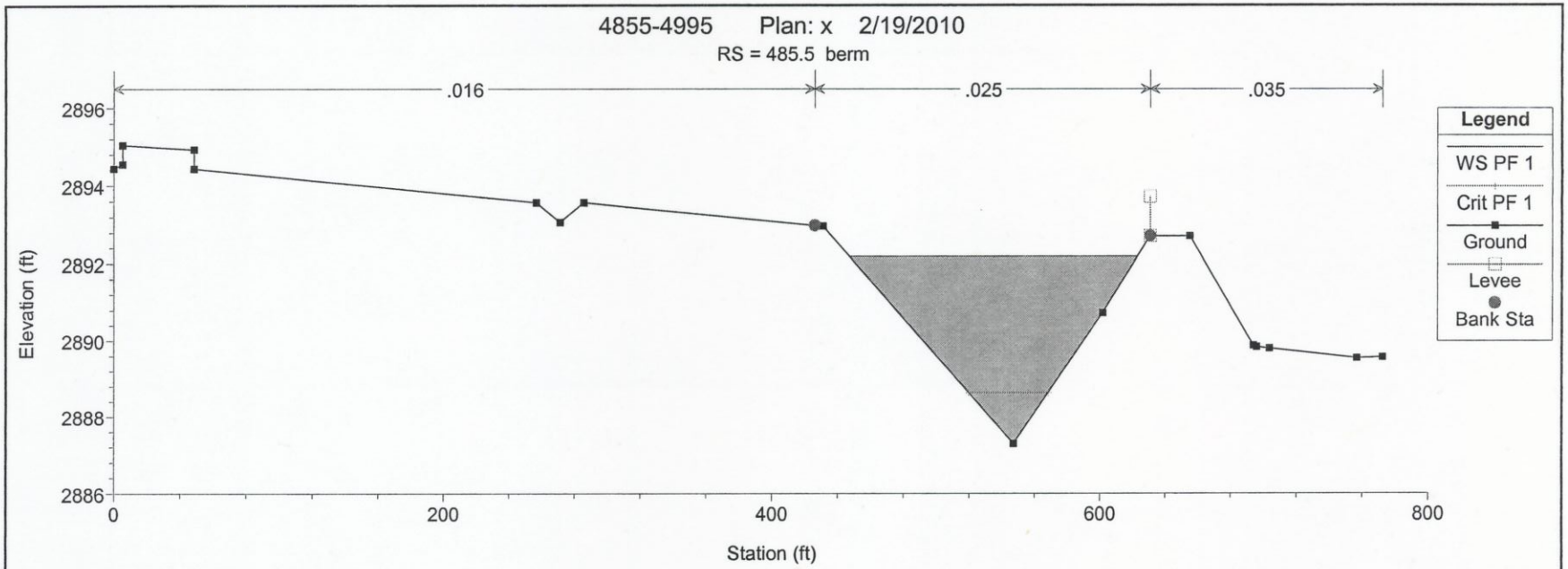
200
400
600
800
1000
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Levee
Bank Sta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RS = 485.5 berm
.016
.025
.035
Elevation (ft)
2896
2894
2892
2890
2888
2886
0
200
400
600
800
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Levee
Bank Sta

ROADSIDE CHANNEL BETWEEN APPROXIMATELY STA. 501+00 AND 513+50

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: 501-5135
Project File : 5015135.prj
Run Date and Time: 2/19/2010 6:02:41 AM

Project in English units

PLAN DATA

Plan Title: Plan 06
Plan File :
t:\7TED069904\HYDRO\DRAINAGE\CALCS\Hydraulics\Channels\Ras-Final\revised\5015135.p06

Geometry Title: 501-5135 riprap
Geometry File :
t:\7TED069904\HYDRO\DRAINAGE\CALCS\Hydraulics\Channels\Ras-Final\revised\5015135.g01

Flow Title : 0 Flow Profiles
Flow File :
t:\7TED069904\HYDRO\DRAINAGE\CALCS\Hydraulics\Channels\Ras-Final\revised\5015135.F01

Plan Summary Information:

Number of:	Cross Sections =	26	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:\7TED069904\HYDRO\DRAINAGE\CALCS\Hydraulics\Channels\Ras-Final\revised\5015135.F01

Flow Data (cfs)

River	Reach	RS	PF 1
River #1	Reach #1	513.5	111

Boundary Conditions

River	Reach	Profile	Upstream	Downstream
River #1	Reach #1	PF 1		

Known WS = 2901.1

GEOMETRY DATA

Geometry Title: 501-5135 riprap
Geometry File :
t:\7TED069904\HYDRO\DRAINAGE\CALCS\Hydraulics\Channels\Ras-Final\revised\5015135.g01

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 513.5

INPUT
Description:
Station Elevation Data num= 48

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
88.31	2914.66	88.6	2914.66	105.99	2914.48	112.91	2914.41	121.15	2914.33
122.16	2914.32	131.75	2911.92	131.89	2911.89	133.69	2911.44	138.14	2910.32
138.87	2910.57	141.87	2911.56	142.84	2911.88	142.89	2911.88	148.51	2911.88
150.49	2911.97	152.04	2912.02	153.11	2912.05	154.27	2912.08	154.71	2912.1
155.24	2912.11	155.48	2912.12	156.06	2912.14	161.29	2912.29	162.99	2912.35
163.18	2912.35	163.28	2912.36	163.62	2912.37	164.15	2912.4	164.29	2912.41
165.7	2912.45	170.64	2912.74	171.75	2912.78	173.11	2912.83	173.5	2912.84
174.61	2912.88	175.09	2912.89	175.92	2912.92	176.45	2912.94	178.05	2913
179.02	2913.03	180.57	2913.09	181.15	2913.1	183.13	2913.14	183.72	2913.16
185.12	2913.19	185.51	2913.2	187.74	2913.25				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
88.31	.016	122.16	.025	142.84	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
122.16	142.84	50	50	50	.1	.3

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 513

INPUT
Description:
Station Elevation Data num= 35

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
88.09	2914.44	91.74	2914.26	95.18	2914.1	95.38	2914.09	98.69	2910.09
99.44	2911.3	99.45	2911.3	100.85	2911.29	101.09	2911.29	101.16	2911.29
101.5	2911.27	104.79	2911.29	104.8	2911.28	105.29	2910.49	106.26	2908.97
106.36	2908.88	106.75	2908.51	106.81	2908.49	107.02	2908.4	107.63	2908.3
108.95	2908.27	111.74	2908.42	115.18	2908.55	116.86	2908.51	118.42	2908.55
122.04	2908.7	124.41	2908.91	127.32	2908.94	129.21	2908.99	130.14	2908.97
132.42	2911.23	132.7	2911.53	132.73	2911.56	133.21	2912.03	133.45	2912.31

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
88.09	.016	95.18	.025	99.44	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
95.18	99.44	50	50	50	.1	.3

Right Levee Station= 104.79 Elevation= 2911.29

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 512.5

INPUT
Description:
Station Elevation Data num= 14

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
87.81	2914.19	122.1	2913.85	123.12	2913.84	139.1	2909.84	142.59	2910.99
142.64	2910.99	143.41	2910.98	151.5	2910.97	154.21	2910.95	155.13	2910.94
155.28	2910.97	155.67	2910.98	162.64	2911.28	163	2912.5		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
87.81	.016	123.12	.025	142.59	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
123.12	142.59	50	50	50	.1	.3

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 512

INPUT
Description:
Station Elevation Data num= 12

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
87.55	2913.94	116.12	2913.65	121.89	2913.6	122.9	2913.59	138.88	2909.59
142.95	2910.95	143	2910.95	143.72	2910.93	155.78	2910.64	162.37	2910.71
167.99	2910.95	170.36	2911.82						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
87.55	.016	122.9	.025	142.95	.035

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.

122.9	142.95	50	50	50	.1	.3

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 511.5

INPUT
Description:
Station Elevation Data num= 20

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
88.51	2913.48	116.99	2913.19	118	2913.18	133.98	2909.18	138.1	2910.55
138.15	2910.55	149.38	2910.76	152.25	2910.72	154.86	2910.66	161.74	2910.68
163.34	2910.68	164.06	2910.93	165.81	2911.45	175.01	2911.38	180.97	2911.29
186.92	2911.45	191.77	2911.61	260.97	2911.69	260.97	2911.87	263.74	2911.75

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
88.51	.016	118	.025	149.38	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
118	149.38	50	50	50	.1	.3

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 511

INPUT
Description:
Station Elevation Data num= 20

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
87.27	2913.04	121.61	2912.69	122.62	2912.68	130.76	2910.65	138.6	2908.68
143.4	2910.28	143.45	2910.28	150.08	2910.37	152.7	2910.41	154.73	2910.39
157.74	2910.14	164.03	2910.16	171.1	2910.37	172.89	2910.67	173.81	2910.96
179.77	2910.95	189.31	2911.05	197.06	2911.25	201.23	2911.34	217.55	2911.6

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
87.27	.016	122.62	.025	143.4	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
122.62	143.4	50	50	50	.1	.3

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 510.5

INPUT
Description:
Station Elevation Data num= 22

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
88.32	2912.04	117.33	2911.75	118.35	2911.74	134.33	2907.74	136.95	2908.61
141.35	2910.07	141.4	2910.07	144.5	2910.06	146.87	2910.05	147.74	2909.94
149.49	2909.75	151.62	2909.58	155.15	2909.62	163.63	2909.99	164.16	2910.06
164.69	2910.11	170.02	2910.67	174.09	2910.74	178.16	2910.77	186.83	2910.79
194.82	2910.81	202.18	2910.94						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
88.32	.016	118.35	.025	141.35	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
118.35	141.35	50	50	50	.1	.3

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 510

INPUT
Description:
Station Elevation Data num= 19

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
87.83	2911.54	95.24	2911.46	116.84	2911.25	117.81	2911.24	133.84	2907.24
140.81	2909.56	140.86	2909.57	143.72	2909.59	145.94	2909.61	152.82	2909.16
152.87	2909.16	152.97	2909.15	153.11	2909.15	154.42	2909.09	162.07	2908.79
162.6	2908.9	165.36	2909.9	165.56	2909.91	168.71	2910.59		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
87.83	.016	117.81	.025	140.81	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
117.81	140.81	50	50	50	.1	.3

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 509.5

INPUT
Description:
Station Elevation Data num= 17

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
87.41	2911.04	116.42	2910.75	117.44	2910.74	118.31	2910.74	133.42	2906.74
140.35	2909.05	140.39	2909.05	146.35	2909.15	146.93	2909.14	157.68	2908.6
160.58	2908.44	165.33	2909	170.32	2909.42	171.87	2909.57	173.47	2909.69
183.3	2909.82	191.73	2910.02						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
87.41	.016	118.31	.025	140.35	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
118.31	140.35	50	50	50	.1	.3

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 509

INPUT
Description:
Station Elevation Data num= 16

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
87.15	2910.54	116.16	2910.25	117.18	2910.24	117.71	2910.24	133.16	2906.24
137.23	2907.59	139.84	2908.46	139.89	2908.46	146.28	2908.47	155.1	2908.32
158.58	2908.24	165.7	2908.92	171.22	2909.42	173.89	2909.41	179.5	2909.6

```
  184.06 2909.73

Manning's n Values          num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
   87.15    .016  117.71    .025  139.84    .035

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
        117.71  139.84               50      50      50             .1       .3

CROSS SECTION


RIVER: River #1
REACH: Reach #1            RS: 508.5

INPUT
Description:
Station Elevation Data     num=      16
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
   87.15 2910.54  116.16 2910.25  117.18 2910.24  117.71 2910.24  133.16 2906.24
  137.23 2907.59  139.84 2908.46  139.89 2908.46  146.28 2908.47   155.1 2908.32
  158.58 2908.24   165.7 2908.92  171.22 2909.42  173.89 2909.41   179.5  2909.6
  184.06 2909.73

Manning's n Values          num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
   87.15    .016  117.71    .025  139.84    .035

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
        117.71  139.84               50      50      50             .1       .3

CROSS SECTION


RIVER: River #1
REACH: Reach #1            RS: 508

INPUT
Description:
Station Elevation Data     num=      13
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
   87.32 2910.04  116.33 2909.75  117.44 2909.74  133.33 2905.74  138.07 2907.32
  139.72 2907.88  139.77 2907.88  142.53 2907.87  154.59 2907.75  159.09 2907.68
  160.93 2908.04  167.23 2909.47  170.52 2909.57

Manning's n Values          num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
   87.32    .016  117.44    .025  139.72    .035

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
        117.44  139.72               50      50      50             .1       .3

CROSS SECTION


RIVER: River #1
REACH: Reach #1            RS: 507.5

INPUT
Description:
Station Elevation Data     num=      12
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
    87.7 2909.54  116.71 2909.25  117.73 2909.24  133.71 2905.24  140.01 2907.33
```

```
  140.06 2907.33  140.45 2907.33   141.8 2907.35  146.65 2907.32  159.62 2907.14
  162.48 2908.64  165.63 2910.06

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
    87.7    .016  117.73    .025  140.01    .035

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
        117.73  140.01                50      50      50             .1       .3

CROSS SECTION


RIVER: River #1
REACH: Reach #1           RS: 507

INPUT
Description:
Station Elevation Data    num=      13
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
   88.34 2908.54  117.35 2908.36  117.35 2908.25  118.37 2908.24  134.35 2904.24
  139.97 2906.11  140.02 2906.11  140.07 2906.11  155.13 2905.85  155.18 2905.85
  157.45 2905.81  159.63 2907.57  164.38 2911.41

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
   88.34    .016  118.37    .025  139.97    .035

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
        118.37  139.97                50      50      50             .1       .3

CROSS SECTION


RIVER: River #1
REACH: Reach #1           RS: 506.5

INPUT
Description:
Station Elevation Data    num=      10
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
   88.49 2908.04    91.2 2908.01   117.5 2907.75  118.47 2907.74   134.5 2903.74
  140.75 2905.82   140.8 2905.82  156.59 2905.67  158.72 2907.24   163.8 2911.16

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
   88.49    .016  118.47    .025  140.75    .035

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
        118.47  140.75                50      50      50             .1       .3

CROSS SECTION


RIVER: River #1
REACH: Reach #1           RS: 506

INPUT
Description:
Station Elevation Data    num=      11
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
   92.85 2907.33  101.42 2907.25  102.44 2907.24  118.42 2903.24  125.35 2905.54
   125.4 2905.54  125.45 2905.54  139.83 2905.38  140.07 2905.38  140.12 2905.42
```

```
   146.8 2911.27

Manning's n Values          num=        3
     Sta   n Val     Sta   n Val     Sta   n Val
   92.85    .016  102.44    .025  125.35    .035

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
        102.44  125.35                50      50      50             .1       .3

CROSS SECTION


RIVER: River #1
REACH: Reach #1            RS: 505.5

INPUT
Description:
Station Elevation Data     num=       11
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
   87.79 2907.52  121.55 2907.18  122.56 2907.17  138.54 2903.17  144.79 2905.26
  144.84 2905.26  155.44 2905.08  156.75 2905.05  159.08    2905  159.56 2905.47
  166.34 2911.21

Manning's n Values          num=        3
     Sta   n Val     Sta   n Val     Sta   n Val
   87.79    .016  122.56    .025  144.79    .035

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
        122.56  144.79                50      50      50             .1       .3

CROSS SECTION


RIVER: River #1
REACH: Reach #1            RS: 505

INPUT
Description:
Station Elevation Data     num=        9
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
   94.45 2906.66   95.47 2906.65  111.45 2902.65  118.04 2904.86  118.09 2904.86
  132.76 2904.62   133.3 2904.62  134.51 2905.59  140.12 2910.15

Manning's n Values          num=        3
     Sta   n Val     Sta   n Val     Sta   n Val
   94.45    .016   95.47    .025  118.04    .035

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
         95.47  118.04                50      50      50             .1       .3

CROSS SECTION


RIVER: River #1
REACH: Reach #1            RS: 504.5

INPUT
Description:
Station Elevation Data     num=       13
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
   89.03 2906.39  106.42 2906.21  107.39 2906.21  107.39  2906.2  123.42  2902.2
  125.79 2903.01  129.67  2904.3  129.76  2904.3  131.55  2904.3  137.65 2904.32
  145.11 2904.51  154.17 2904.59  161.48 2910.03
```

```
Manning's n Values          num=        3
     Sta   n Val     Sta   n Val     Sta   n Val
   89.03    .016  106.42    .025  129.67    .035

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
        106.42  129.67                50      50      50             .1       .3

CROSS SECTION


RIVER: River #1
REACH: Reach #1             RS: 504

INPUT
Description:
Station Elevation Data      num=       13
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
   89.65 2905.82   92.41 2905.79  102.15  2905.7  107.04 2905.65  108.05 2905.64
  108.73 2905.46  124.03 2901.64  130.43 2903.77  130.48 2903.77  134.74 2903.64
  140.99 2903.74  151.69 2903.83  157.74 2908.49

Manning's n Values          num=        3
     Sta   n Val     Sta   n Val     Sta   n Val
   89.65    .016  108.05    .025  130.43    .035

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
        108.05  130.43                50      50      50             .1       .3

CROSS SECTION


RIVER: River #1
REACH: Reach #1             RS: 503.5

INPUT
Description:
Station Elevation Data      num=       14
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
   89.85  2905.3  107.19 2905.12  108.21 2905.11  124.19 2901.11  130.54 2903.22
  130.58 2903.22  131.01 2903.24  131.64 2903.24  133.92 2903.24  138.47 2903.24
  139.25 2903.24  142.54 2903.22  150.19 2903.25  153.58 2905.79

Manning's n Values          num=        3
     Sta   n Val     Sta   n Val     Sta   n Val
   89.85    .016  108.21    .025  130.54    .035

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
        108.21  130.54                50      50      50             .1       .3

CROSS SECTION


RIVER: River #1
REACH: Reach #1             RS: 503

INPUT
Description:
Station Elevation Data      num=       23
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
   89.79  2904.8  103.06 2904.66  107.13 2904.62  109.11 2904.61  124.12 2900.61
  129.16  2902.3  129.21  2902.3  130.42  2902.3  137.59 2902.27  139.09 2902.25
  140.73 2902.23  146.89  2902.2   154.3 2902.92  156.38 2903.12  157.06 2903.16
```

```
   157.4 2903.16  160.01 2903.23  161.85 2903.24  162.29 2903.25  163.74 2903.32
  167.42 2904.05  168.29 2904.12  171.83 2904.38

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
   89.79    .016  109.11    .025  129.16    .035

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
        109.11  129.16               50      50      50             .1       .3

CROSS SECTION


RIVER: River #1
REACH: Reach #1           RS: 502.5

INPUT
Description:
Station Elevation Data    num=      20
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
   89.73  2904.3  107.02 2904.12  108.04 2904.11  109.05 2904.11  124.02 2900.11
  128.28 2901.52  128.33 2901.53  134.19 2901.71  147.46 2901.92  148.23 2901.93
  148.43 2901.93  148.57 2901.94  161.07 2902.67  164.65  2902.7  169.93 2902.74
  177.63 2902.77  181.17  2902.8  183.49 2902.99   191.1 2904.12  193.91 2905.02

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
   89.73    .016  109.05    .025  134.19    .035

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
        109.05  134.19               50      50      50             .1       .3

CROSS SECTION


RIVER: River #1
REACH: Reach #1           RS: 502

INPUT
Description:
Station Elevation Data    num=      18
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
   89.67  2903.8  107.01 2903.62  108.03 2903.61  108.99 2903.61     124 2899.61
  129.19 2901.34  129.24 2901.34  136.55  2901.3  140.62 2901.25  146.63 2901.36
  149.29 2901.41  150.55 2901.46  157.28 2902.12  160.86 2902.17  172.68 2902.13
  176.94 2902.62  187.26  2903.5  191.81 2904.57

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
   89.67    .016  108.99    .025  129.19    .035

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
        108.99  129.19               50      50      50             .1       .3

CROSS SECTION


RIVER: River #1
REACH: Reach #1           RS: 501.5

INPUT
Description:
Station Elevation Data    num=      17
```

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
89.64	2903.3	106.98	2903.12	107.95	2903.11	108.96	2903.11	123.97	2899.11
129.25	2900.88	129.3	2900.88	131.14	2900.89	136.81	2900.92	140.73	2900.74
147.66	2901.18	151.48	2901.32	156.62	2901.25	161.18	2901.2	165.78	2901.16
178.37	2903.52	182.39	2904.09						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
89.64	.016	108.96	.025	129.25	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
108.96	129.25	50	50	50	.1	.3

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 501

INPUT
Description:
Station Elevation Data num= 59

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
89.19	2902.84	107.98	2902.65	109	2902.64	124.98	2898.64	133.12	2901.34
133.17	2901.34	134.38	2901.35	134.86	2901.34	138.16	2901.37	138.3	2901.37
138.4	2901.37	138.98	2901.35	139.22	2901.36	140.63	2901.33	141.01	2901.34
141.06	2901.34	142.66	2901.3	143.63	2901.32	145.32	2901.39	145.37	2901.39
145.66	2901.4	145.81	2901.4	146.2	2901.41	146.34	2901.42	146.78	2901.43
146.97	2901.44	147.5	2901.46	147.7	2901.46	148.33	2901.48	148.38	2901.48
148.52	2901.49	149.59	2901.52	149.88	2901.52	150.02	2901.53	150.17	2901.53
150.22	2901.53	150.26	2901.53	151.81	2901.57	152.25	2901.58	152.78	2901.59
152.98	2901.59	153.07	2901.6	156.66	2901.68	157.09	2901.7	157.24	2901.7
158.11	2901.72	158.45	2901.73	158.5	2901.73	158.74	2901.74	158.79	2901.74
159.27	2901.75	159.42	2901.76	161.84	2901.81	161.89	2901.82	161.98	2901.82
163	2901.85	163.15	2901.86	163.29	2901.86	168.62	2901.99		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
89.19	.016	109	.025	133.12	.035

Bank Sta: Left	Right	Coeff Contr.	Expan.
109	133.12	.1	.3

SUMMARY OF MANNING'S N VALUES

River:River #1

Reach	River Sta.	n1	n2	n3
Reach #1	513.5	.016	.025	.035
Reach #1	513	.016	.025	.035
Reach #1	512.5	.016	.025	.035
Reach #1	512	.016	.025	.035
Reach #1	511.5	.016	.025	.035
Reach #1	511	.016	.025	.035
Reach #1	510.5	.016	.025	.035
Reach #1	510	.016	.025	.035
Reach #1	509.5	.016	.025	.035
Reach #1	509	.016	.025	.035
Reach #1	508.5	.016	.025	.035
Reach #1	508	.016	.025	.035

Reach #1	507.5	.016	.025	.035
Reach #1	507	.016	.025	.035
Reach #1	506.5	.016	.025	.035
Reach #1	506	.016	.025	.035
Reach #1	505.5	.016	.025	.035
Reach #1	505	.016	.025	.035
Reach #1	504.5	.016	.025	.035
Reach #1	504	.016	.025	.035
Reach #1	503.5	.016	.025	.035
Reach #1	503	.016	.025	.035
Reach #1	502.5	.016	.025	.035
Reach #1	502	.016	.025	.035
Reach #1	501.5	.016	.025	.035
Reach #1	501	.016	.025	.035

SUMMARY OF REACH LENGTHS

River: River #1

Reach	River Sta.	Left	Channel	Right
Reach #1	513.5	50	50	50
Reach #1	513	50	50	50
Reach #1	512.5	50	50	50
Reach #1	512	50	50	50
Reach #1	511.5	50	50	50
Reach #1	511	50	50	50
Reach #1	510.5	50	50	50
Reach #1	510	50	50	50
Reach #1	509.5	50	50	50
Reach #1	509	50	50	50
Reach #1	508.5	50	50	50
Reach #1	508	50	50	50
Reach #1	507.5	50	50	50
Reach #1	507	50	50	50
Reach #1	506.5	50	50	50
Reach #1	506	50	50	50
Reach #1	505.5	50	50	50
Reach #1	505	50	50	50
Reach #1	504.5	50	50	50
Reach #1	504	50	50	50
Reach #1	503.5	50	50	50
Reach #1	503	50	50	50
Reach #1	502.5	50	50	50
Reach #1	502	50	50	50
Reach #1	501.5	50	50	50
Reach #1	501			

SUMMARY OF CONTRACTION AND EXPANSION COEFFICIENTS
River: River #1

Reach	River Sta.	Contr.	Expan.
Reach #1	513.5	.1	.3
Reach #1	513	.1	.3
Reach #1	512.5	.1	.3

Reach #1	512	.1	.3
Reach #1	511.5	.1	.3
Reach #1	511	.1	.3
Reach #1	510.5	.1	.3
Reach #1	510	.1	.3
Reach #1	509.5	.1	.3
Reach #1	509	.1	.3
Reach #1	508.5	.1	.3
Reach #1	508	.1	.3
Reach #1	507.5	.1	.3
Reach #1	507	.1	.3
Reach #1	506.5	.1	.3
Reach #1	506	.1	.3
Reach #1	505.5	.1	.3
Reach #1	505	.1	.3
Reach #1	504.5	.1	.3
Reach #1	504	.1	.3
Reach #1	503.5	.1	.3
Reach #1	503	.1	.3
Reach #1	502.5	.1	.3
Reach #1	502	.1	.3
Reach #1	501.5	.1	.3
Reach #1	501	.1	.3

Profile Output Table - Standard Table 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.
E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	
			(cfs)	(ft)	(ft)	(ft)
(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		
Reach #1	513.5	PF 1	111.00	2910.32	2912.56	2912.56
2912.93	0.006501	5.37	27.43	38.34	0.85	
Reach #1	513	PF 1	111.00	2910.09	2912.14	2911.30
2912.16	0.000195	0.65	99.36	36.32	0.11	
Reach #1	512.5	PF 1	111.00	2909.84	2911.82	
2912.11	0.006580	5.07	28.73	31.61	0.84	
Reach #1	512	PF 1	111.00	2909.59	2911.64	
2911.82	0.004164	4.08	36.35	39.17	0.67	
Reach #1	511.5	PF 1	111.00	2909.18	2911.17	2911.17
2911.50	0.009230	4.93	26.14	38.83	0.96	
Reach #1	511	PF 1	111.00	2908.68	2910.81	2910.81
2911.11	0.006163	5.03	30.95	43.24	0.82	
Reach #1	510.5	PF 1	111.00	2907.74	2910.12	2910.12
2910.50	0.006209	5.15	26.22	39.93	0.83	
Reach #1	510	PF 1	111.00	2907.24	2909.50	2909.50
2909.92	0.007485	5.44	24.65	32.58	0.90	
Reach #1	509.5	PF 1	111.00	2906.74	2909.07	2909.07
2909.51	0.007483	5.55	23.85	34.67	0.90	
Reach #1	509	PF 1	111.00	2906.24	2909.08	
2909.22	0.001825	3.30	43.77	45.32	0.47	
Reach #1	508.5	PF 1	111.00	2906.24	2908.65	2908.65
2909.05	0.006082	5.22	25.48	39.01	0.82	
Reach #1	508	PF 1	111.00	2905.74	2908.10	2908.10
2908.50	0.006238	5.24	25.73	37.26	0.83	
Reach #1	507.5	PF 1	111.00	2905.24	2907.59	2907.59
2907.98	0.006270	5.25	25.71	36.14	0.84	
Reach #1	507	PF 1	111.00	2904.24	2906.46	
2906.84	0.006880	5.36	26.06	32.78	0.87	
Reach #1	506.5	PF 1	111.00	2903.74	2906.07	2906.07

2906.49	0.006712	5.40	24.23	31.98	0.86	
Reach #1	506	PF 1	111.00	2903.24	2905.92	
2906.16	0.003117	4.07	31.83	32.97	0.60	
Reach #1	505.5	PF 1	111.00	2903.17	2905.50	2905.50
2905.92	0.006672	5.38	24.23	30.37	0.86	
Reach #1	505	PF 1	111.00	2902.65	2905.03	2905.03
2905.44	0.006395	5.30	24.25	31.86	0.84	
Reach #1	504.5	PF 1	111.00	2902.20	2904.63	2904.63
2905.03	0.005795	5.18	25.24	40.53	0.81	
Reach #1	504	PF 1	111.00	2901.64	2904.03	2904.03
2904.41	0.005903	5.15	26.00	37.48	0.81	
Reach #1	503.5	PF 1	111.00	2901.11	2903.49	2903.49
2903.90	0.006228	5.29	24.76	35.83	0.84	
Reach #1	503	PF 1	111.00	2900.61	2902.82	2902.82
2903.17	0.006669	5.33	27.88	37.39	0.86	
Reach #1	502.5	PF 1	111.00	2900.11	2902.26	2902.26
2902.64	0.007728	5.21	25.90	38.16	0.91	
Reach #1	502	PF 1	111.00	2899.61	2901.84	2901.84
2902.19	0.006578	5.32	28.02	38.73	0.85	
Reach #1	501.5	PF 1	111.00	2899.11	2901.56	
2901.78	0.003552	4.21	38.05	53.17	0.64	
Reach #1	501	PF 1	111.00	2898.64	2901.10	2900.91
2901.53	0.006201	5.23	21.21	17.25	0.83	

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	513.5	PF 1	2912.93	2912.56	0.38	
0.03 0.11		90.31	20.69	38.34		
Reach #1	513	PF 1	2912.16	2912.14	0.02	
0.03 0.03		1.84	109.16	36.32		
Reach #1	512.5	PF 1	2912.11	2911.82	0.29	
0.26 0.03		64.55	46.45	31.61		
Reach #1	512	PF 1	2911.82	2911.64	0.18	
0.30 0.02		56.93	54.07	39.17		
Reach #1	511.5	PF 1	2911.50	2911.17	0.33	
0.37 0.01		94.00	17.00	38.83		
Reach #1	511	PF 1	2911.11	2910.81	0.30	
0.31 0.01		77.78	33.22	43.24		
Reach #1	510.5	PF 1	2910.50	2910.12	0.38	
0.34 0.00		101.96	9.04	39.93		
Reach #1	510	PF 1	2909.92	2909.50	0.41	
0.37 0.00		97.76	13.24	32.58		
Reach #1	509.5	PF 1	2909.51	2909.07	0.44	
0.16 0.09		101.89	9.11	34.67		
Reach #1	509	PF 1	2909.22	2909.08	0.14	
0.15 0.03		89.66	21.34	45.32		
Reach #1	508.5	PF 1	2909.05	2908.65	0.40	
0.31 0.00		103.81	7.19	39.01		
Reach #1	508	PF 1	2908.50	2908.10	0.39	
0.31 0.00		101.53	9.47	37.26		
Reach #1	507.5	PF 1	2907.98	2907.59	0.39	
0.33 0.00		100.87	10.13	36.14		
Reach #1	507	PF 1	2906.84	2906.46	0.38	
0.34 0.00		91.45	19.55	32.78		

```
  Reach #1      506.5          PF 1         2906.49     2906.07        0.42
0.22          0.06               102.44       8.56       31.98
  Reach #1      506            PF 1         2906.16     2905.92        0.24
0.22          0.02               101.43       9.57       32.97
  Reach #1      505.5          PF 1         2905.92     2905.50        0.42
0.33          0.00               101.72       9.28       30.37
  Reach #1      505            PF 1         2905.44     2905.03        0.41
0.30          0.00               104.27       6.73       31.86
  Reach #1      504.5          PF 1         2905.03     2904.63        0.40
0.29          0.00               105.67       5.33       40.53
  Reach #1      504            PF 1         2904.41     2904.03        0.38
0.30          0.00               102.39       8.61       37.48
  Reach #1      503.5          PF 1         2903.90     2903.49        0.41
0.32          0.02               104.29       6.71       35.83
  Reach #1      503            PF 1         2903.17     2902.82        0.36
0.36          0.00                85.26      25.74       37.39
  Reach #1      502.5          PF 1         2902.64     2902.26        0.38
0.36          0.01                97.26      13.74       38.16
  Reach #1      502            PF 1         2902.19     2901.84        0.36
0.24          0.04                86.93      24.07       38.73
  Reach #1      501.5          PF 1         2901.78     2901.56        0.21
0.23          0.02                82.50      28.50       53.17
  Reach #1      501            PF 1         2901.53     2901.10        0.43
                             111.00                   17.25
```

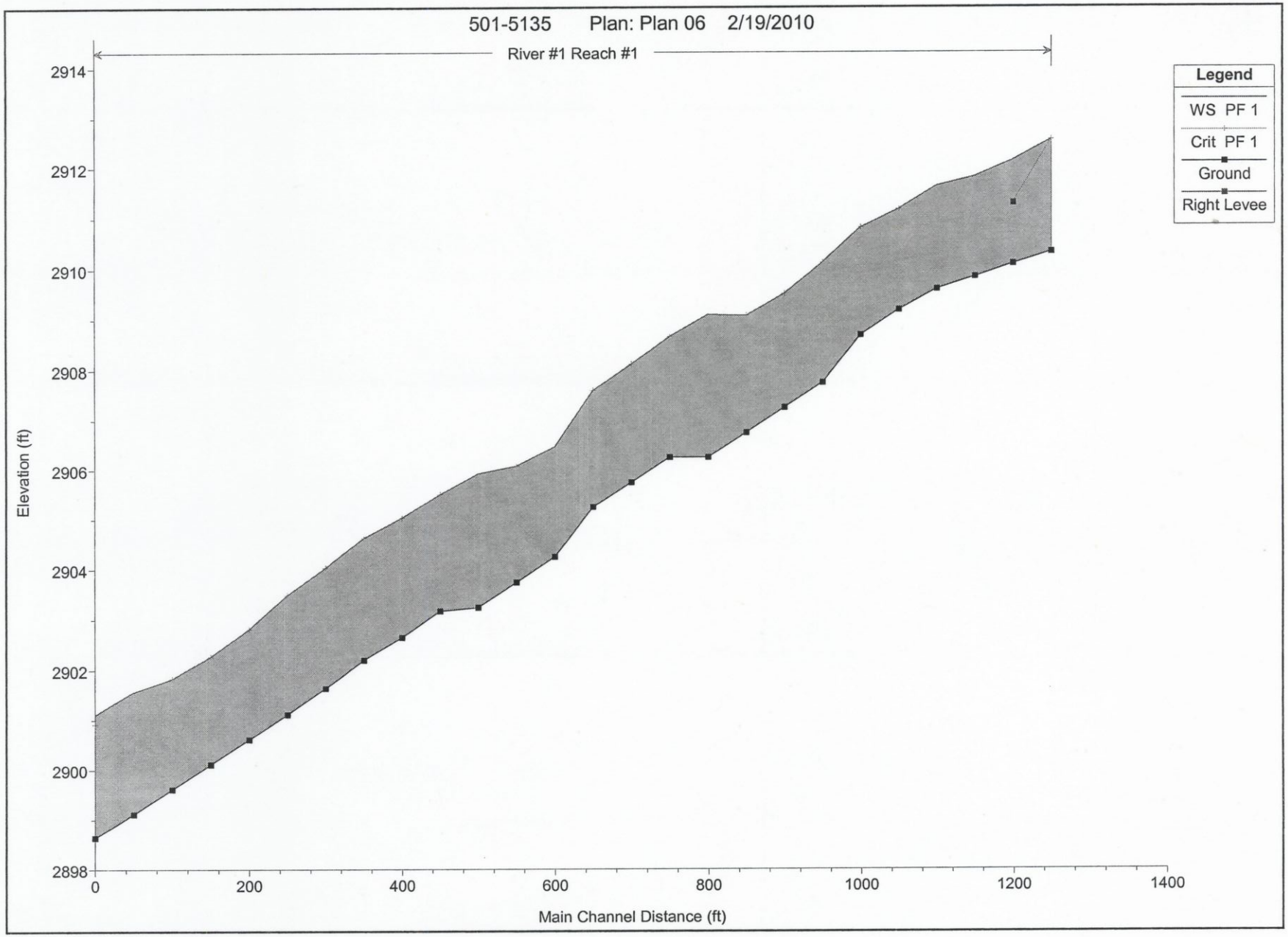
ERRORS WARNINGS AND NOTES
Errors Warnings and Notes for Plan : 501-5135

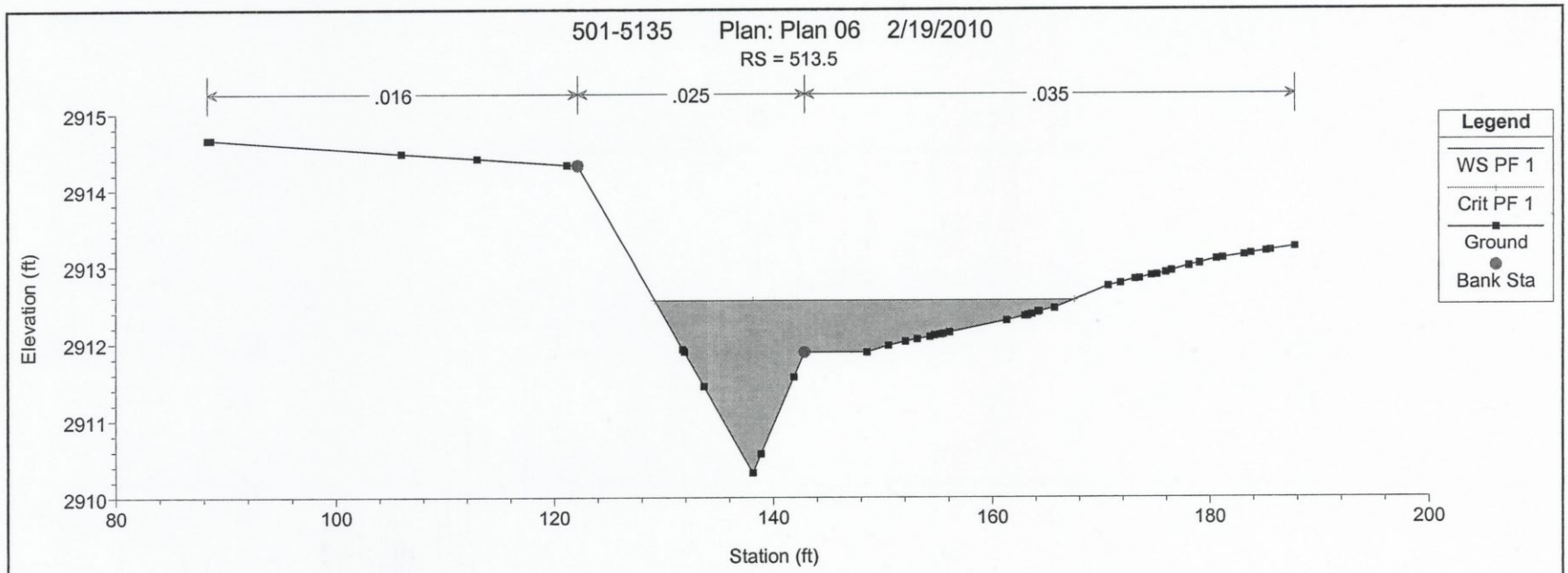
```
River: River #1  Reach: Reach #1     RS: 513.5     Profile: PF 1
     Warning:The energy equation could not be balanced within the specified number
of iterations.  The program used critical depth
             for the water surface and continued on with the calculations.
     Warning:The conveyance 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: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: 513     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.
     Warning:Critical depth could not be determined within the specified number of
iterations.  The program used the iteration
             with the lowest energy.
River: River #1  Reach: Reach #1     RS: 512     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: 511.5     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: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
```

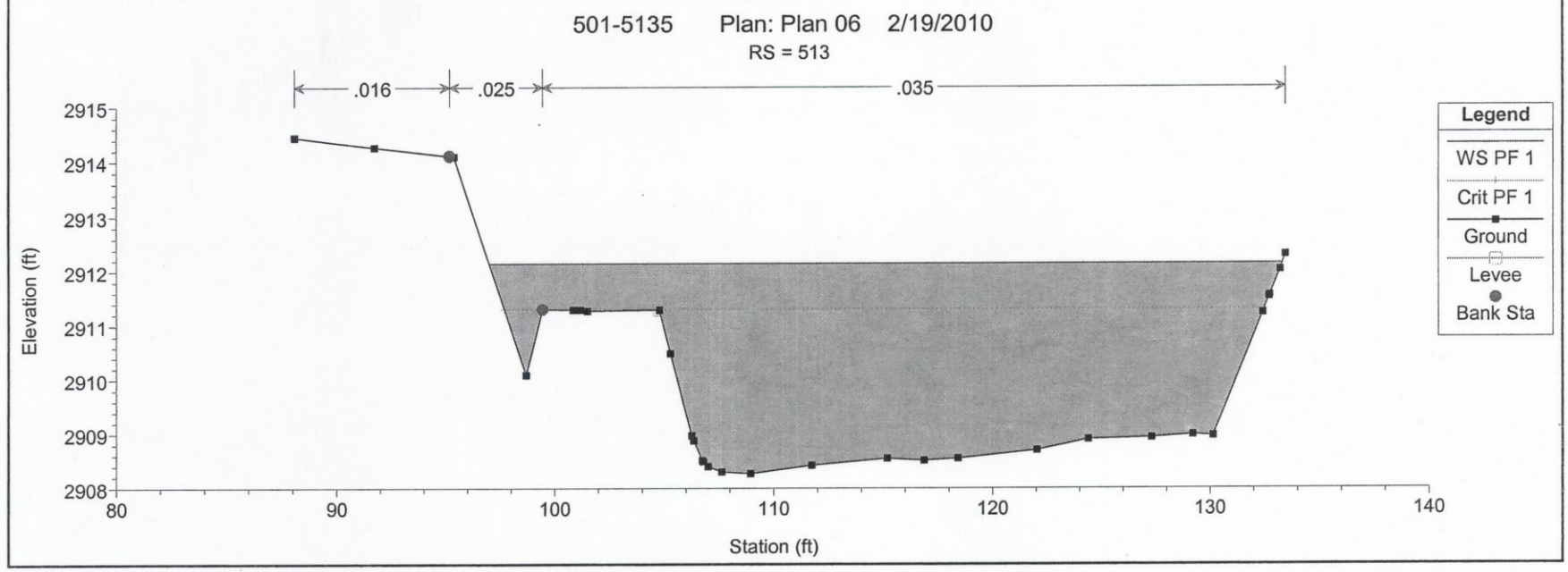
program defaulted to critical depth.
River: River #1 Reach: Reach #1 RS: 511 Profile: PF 1
Warning:The energy equation could not be balanced within the specified number of iterations. The program used critical depth
for the water surface and continued on with the calculations.
Warning:During the standard 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: 510.5 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: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: 510 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: 509.5 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: 509 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: 508.5 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: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: 508 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: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

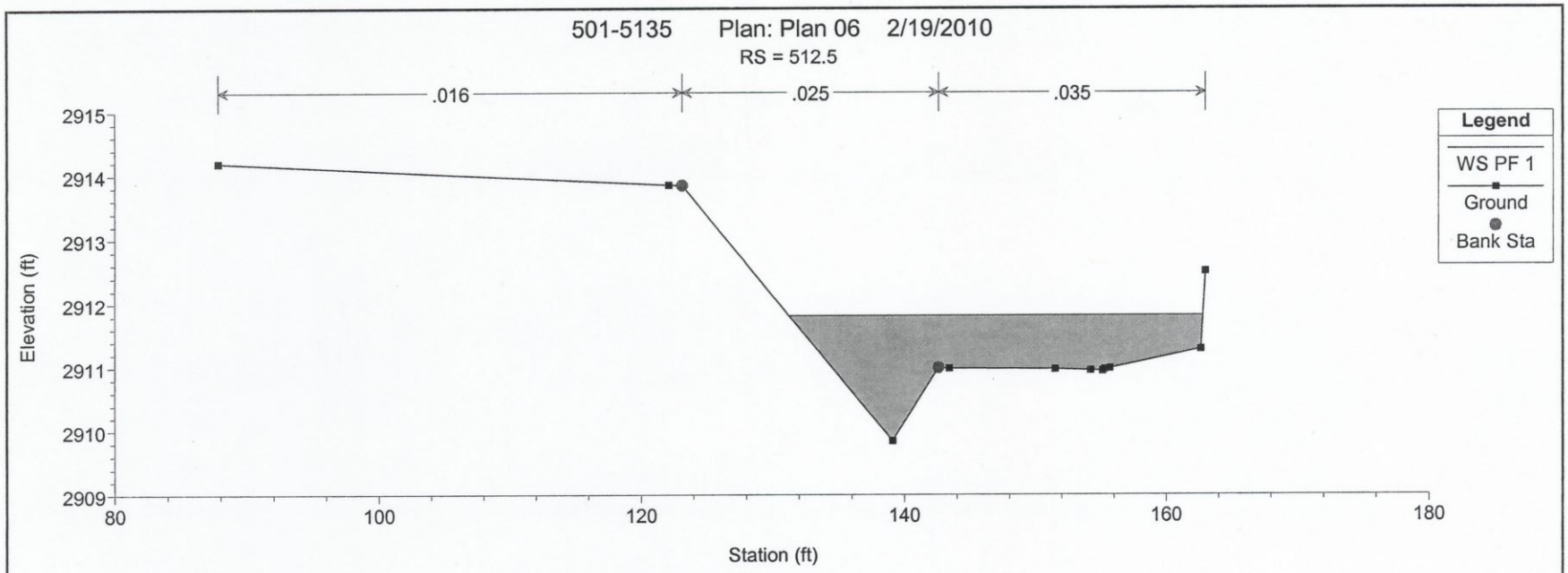
program defaulted to critical depth.
River: River #1 Reach: Reach #1 RS: 507.5 Profile: PF 1
Warning:The energy equation could not be balanced within the specified number of iterations. The program used critical depth
for the water surface and continued on with the calculations.
Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. 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: 506.5 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: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: 506 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: 505.5 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: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: 505 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: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: 504.5 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: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: 504 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: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

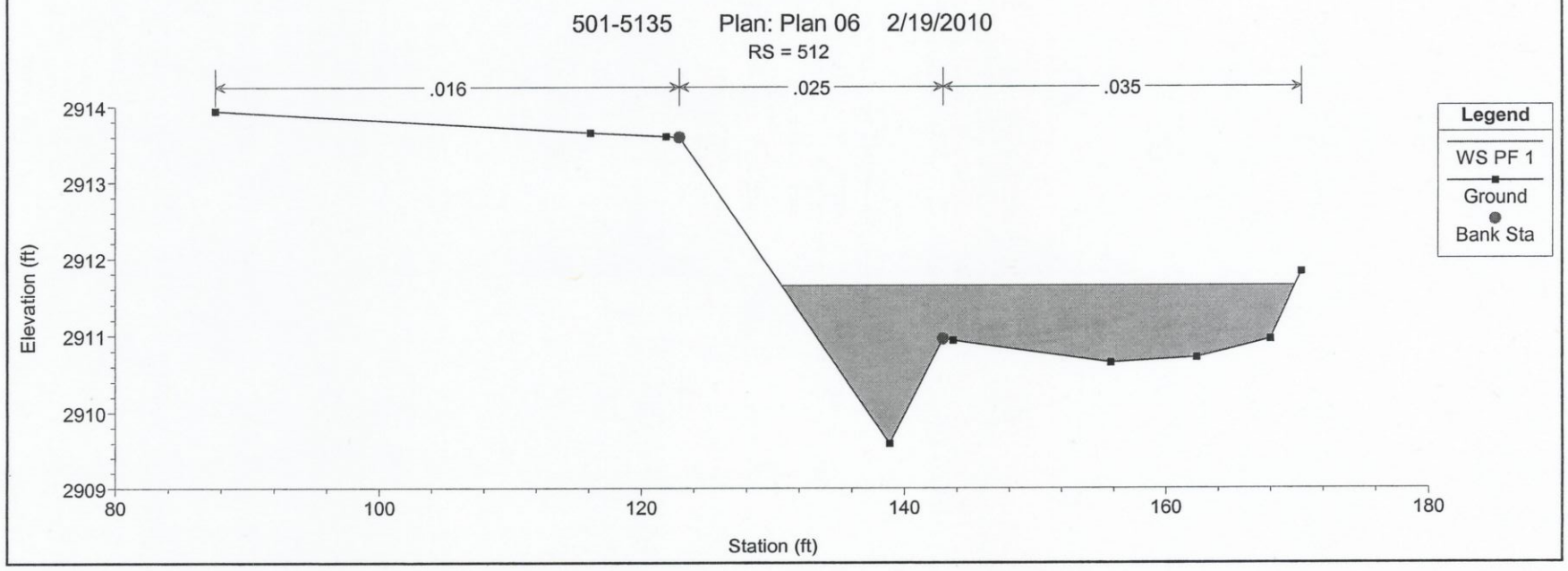
there is not a valid subcritical answer. The
program defaulted to critical depth.
River: River #1 Reach: Reach #1 RS: 503.5 Profile: PF 1
Warning:The energy equation could not be balanced within the specified number of iterations. The program used critical depth
for the water surface and continued on with the calculations.
Warning: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: 503 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: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: 502.5 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: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: 502 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: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.


501-5135 Plan: Plan 06 2/19/2010
River #1 Reach #1
Legend
WS PF 1
Crit PF 1
Ground
Right Levee
Elevation (ft)
2914
2912
2910
2908
2906
2904
2902
2900
2898
0
200
400
600
800
1000
1200
1400
Main Channel Distance (ft)


501-5135 Plan: Plan 06 2/19/2010
RS = 513.5
.016
.025
.035
Elevation (ft)
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Bank Sta


501-5135 Plan: Plan 06 2/19/2010
RS = 513
.016
.025
.035
Elevation (ft)
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Levee
Bank Sta


501-5135 Plan: Plan 06 2/19/2010
RS = 512.5
.016
.025
.035
Legend
WS PF 1
Ground
Bank Sta
Elevation (ft)
2915
2914
2913
2912
2911
2910
2909
80
100
120
140
160
180
Station (ft)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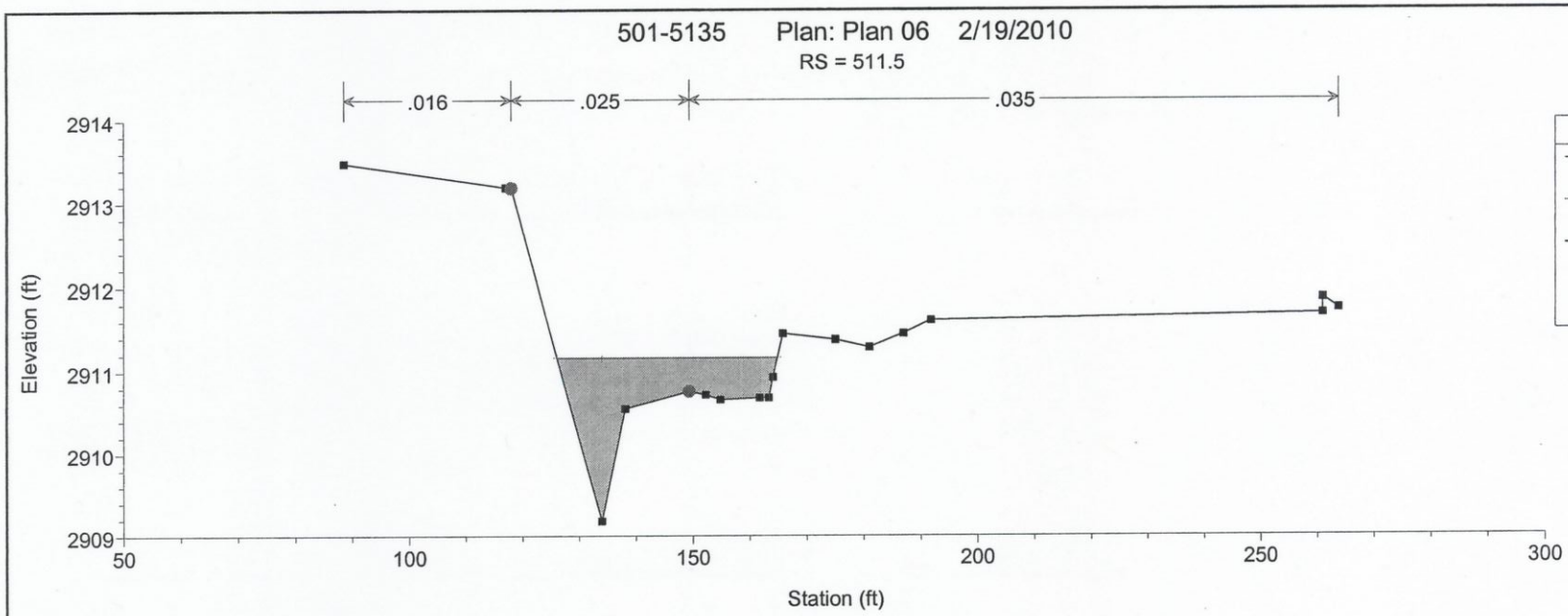
RS = 512
.016
.025
.035
Legend
WS PF 1
Ground
Bank Sta
Elevation (ft)
2914
2913
2912
2911
2910
2909
80
100
120
140
160
180
Station (ft)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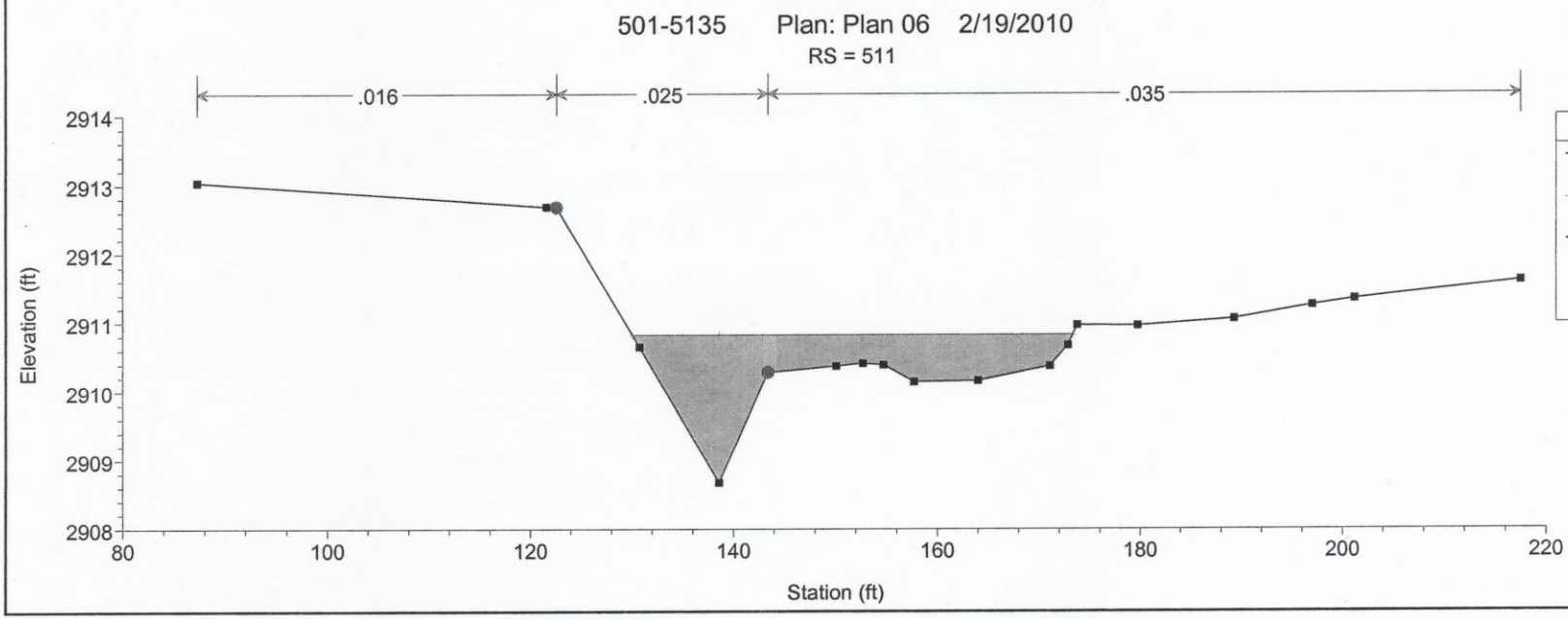
RS = 511.5
.016
.025
.035
Elevation (ft)
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Bank Sta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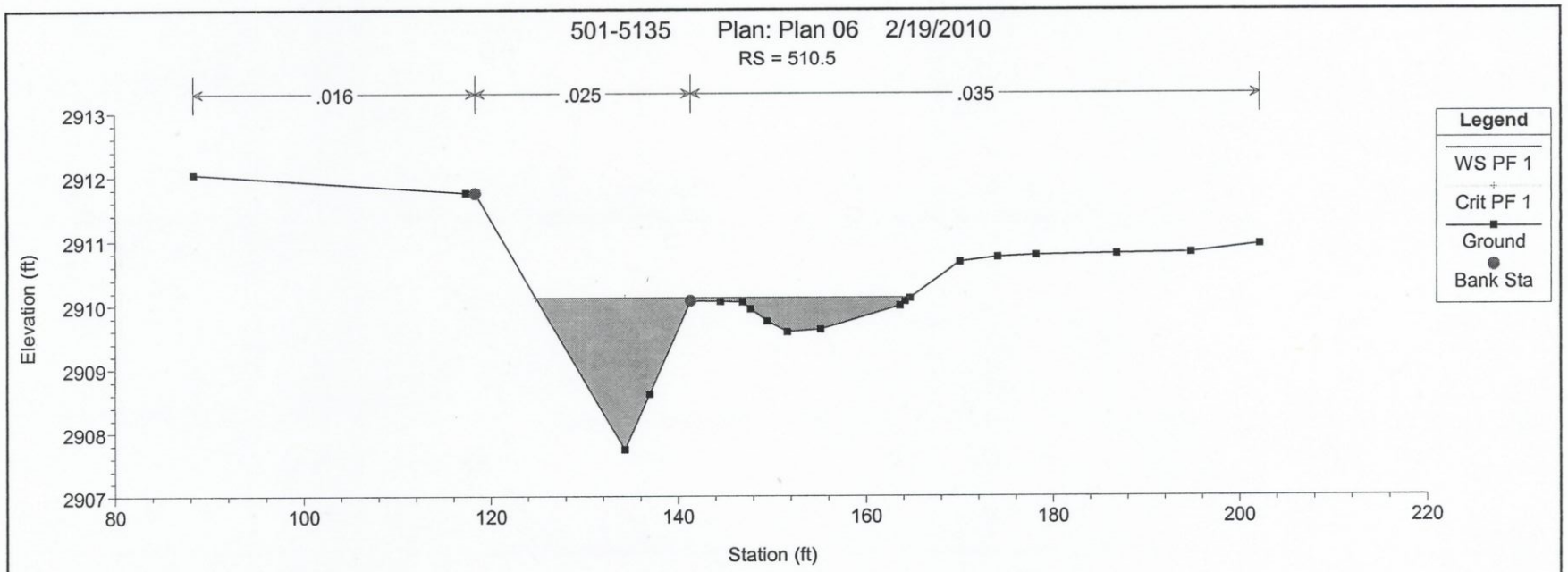
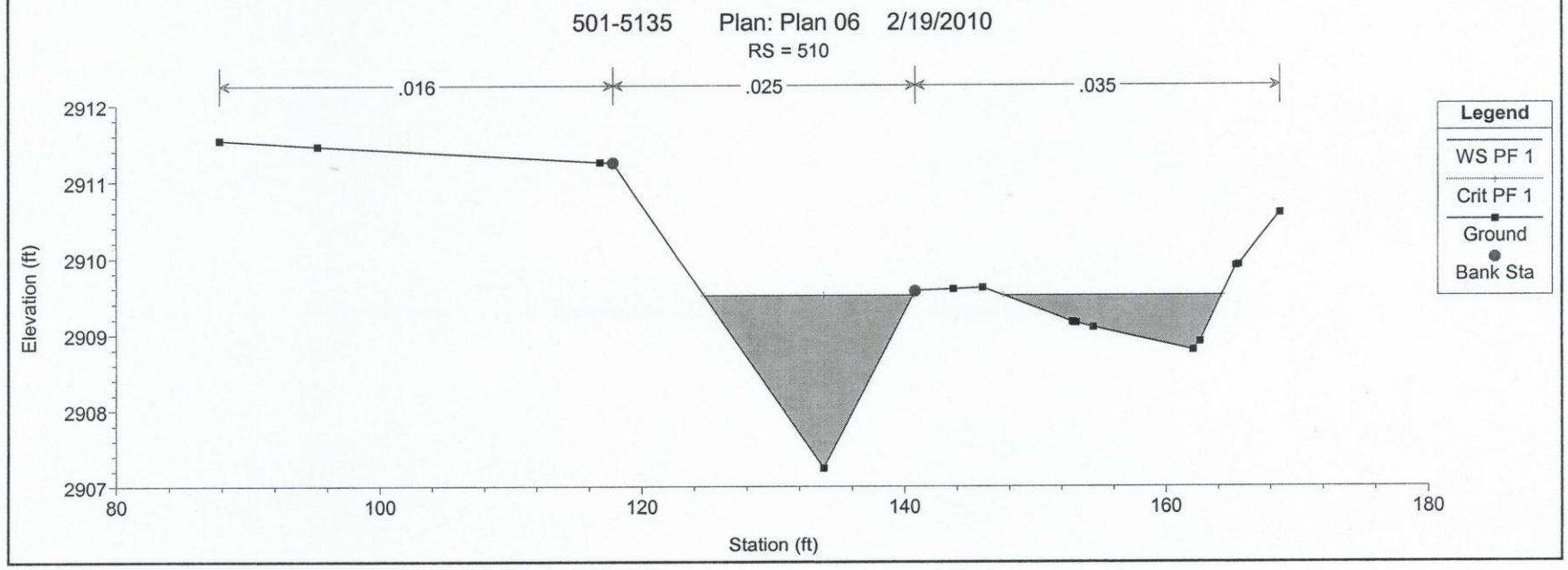
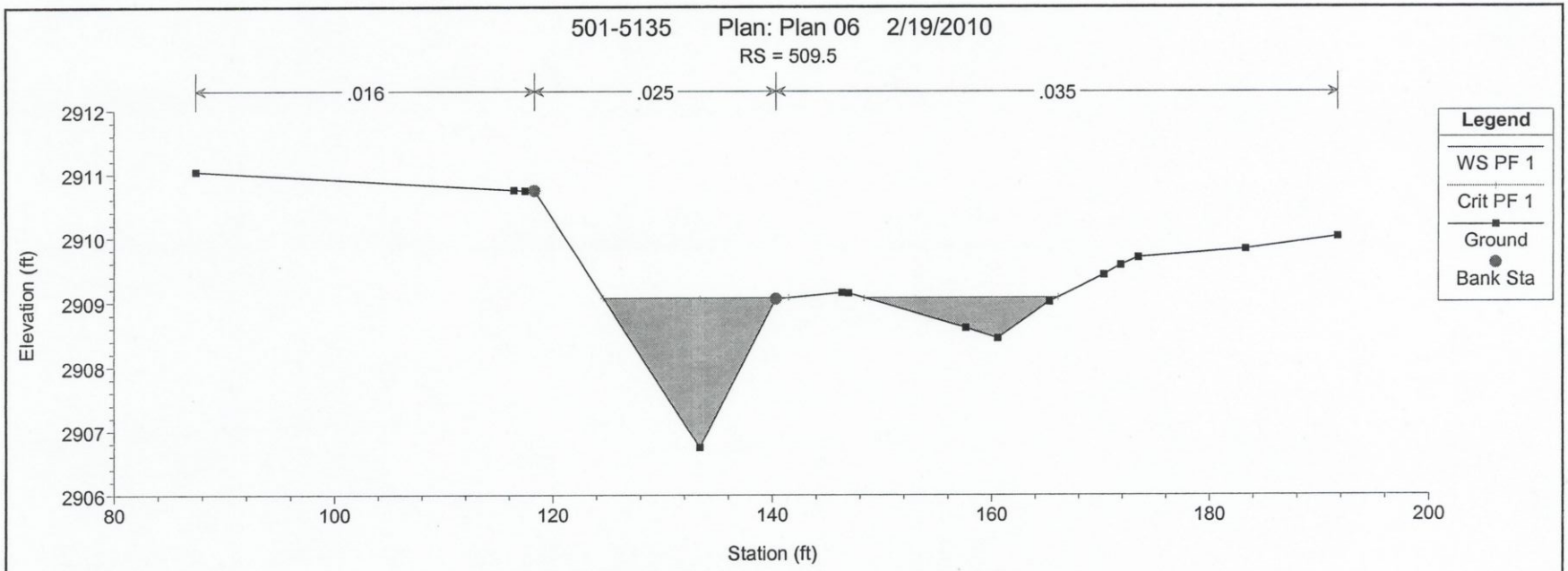
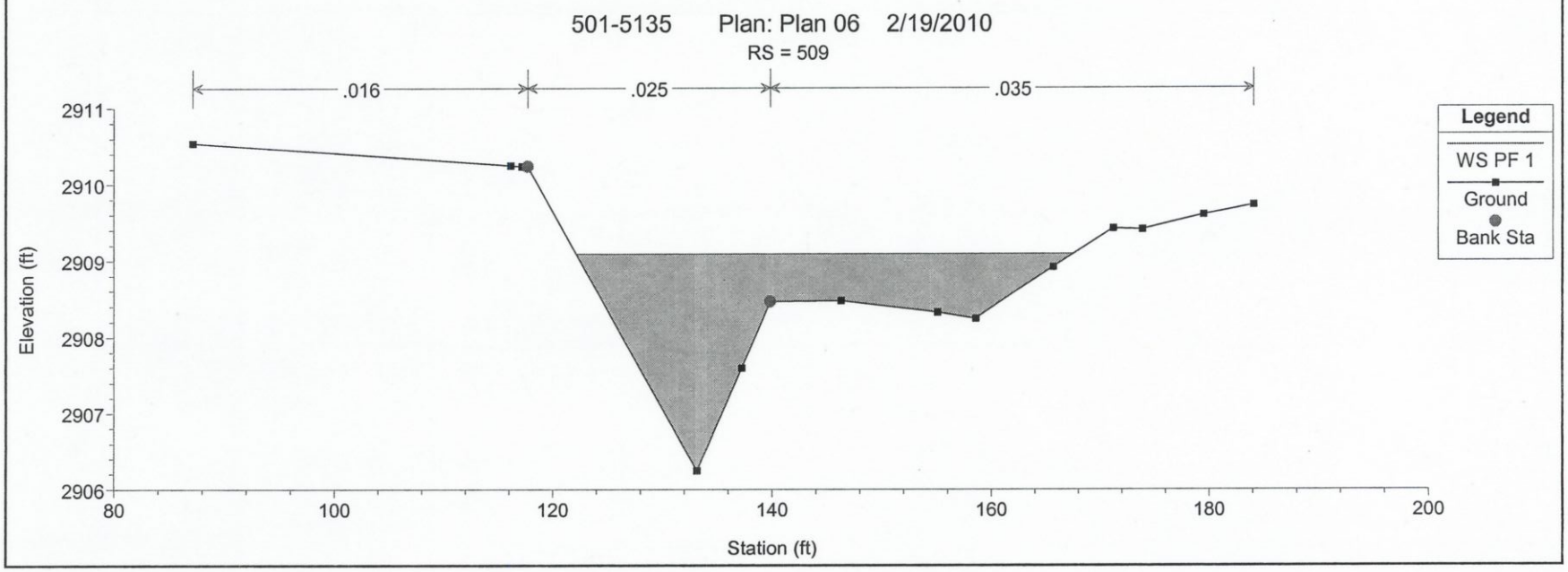
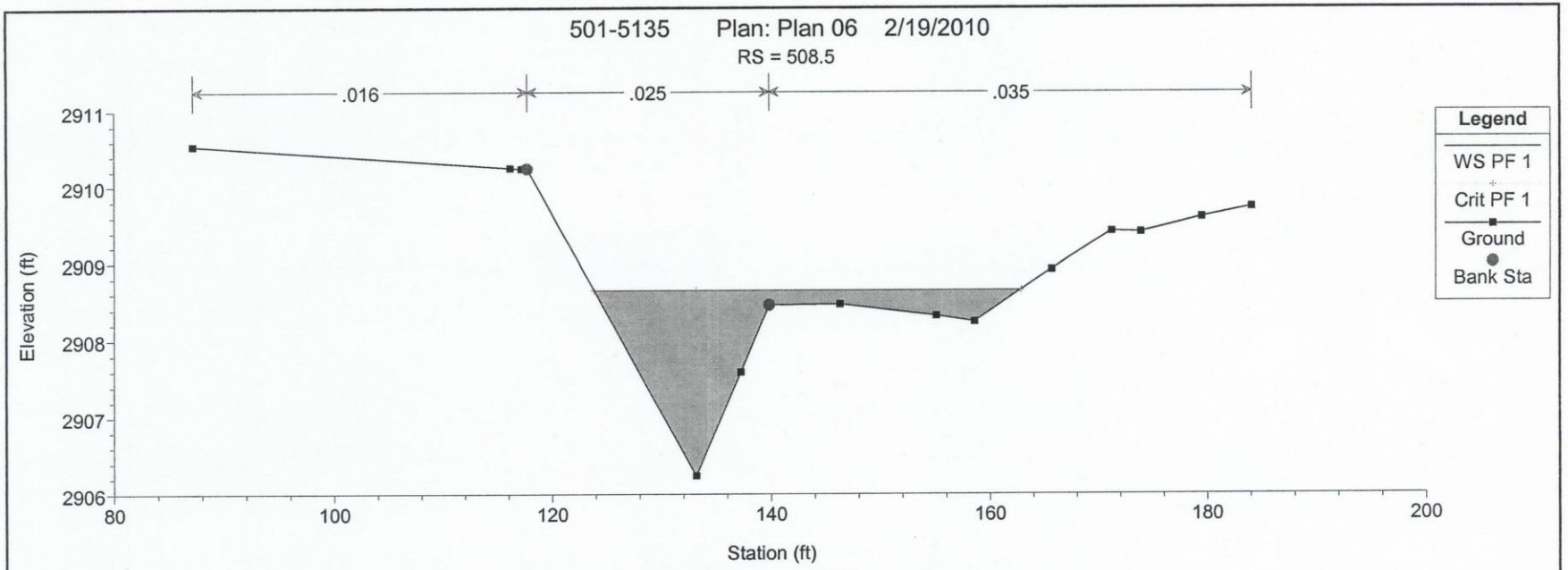
RS = 511
.016
.025
.035
Elevation (ft)
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Bank Sta

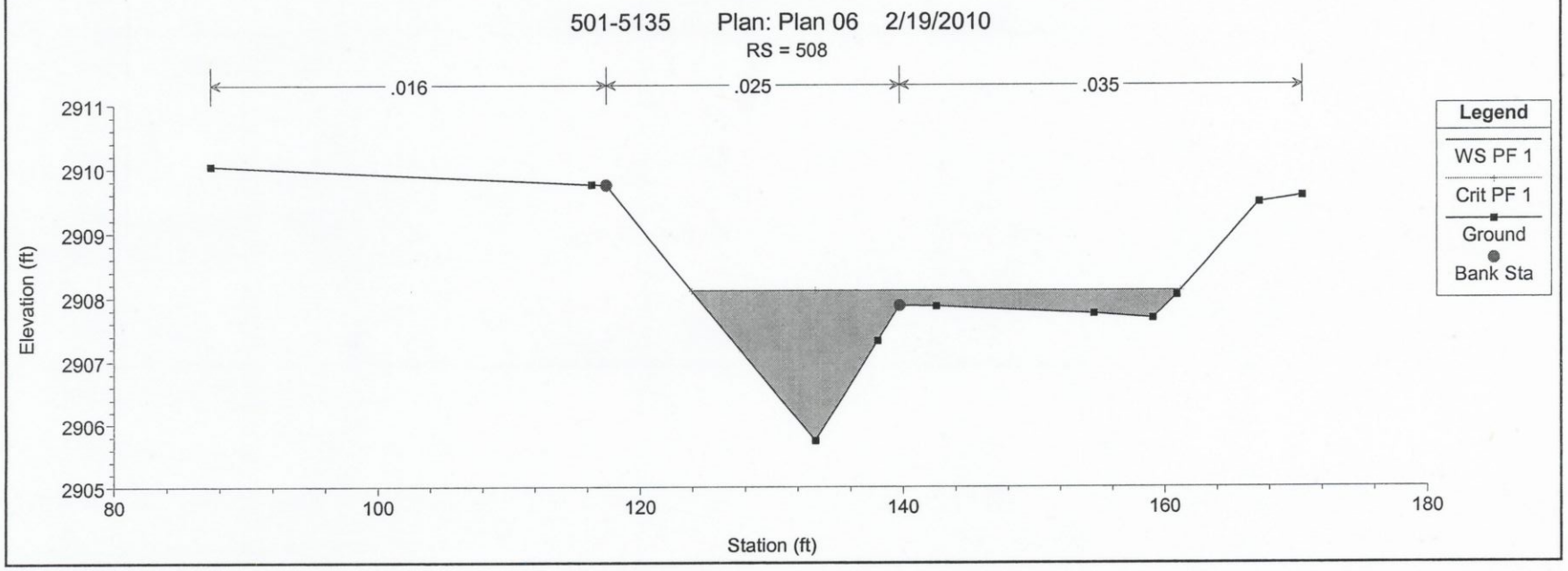

501-5135 Plan: Plan 06 2/19/2010
RS = 510.5
.016
.025
.035
Elevation (ft)
2913
2912
2911
2910
2909
2908
2907
80
100
120
140
160
180
200
220
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Bank Sta

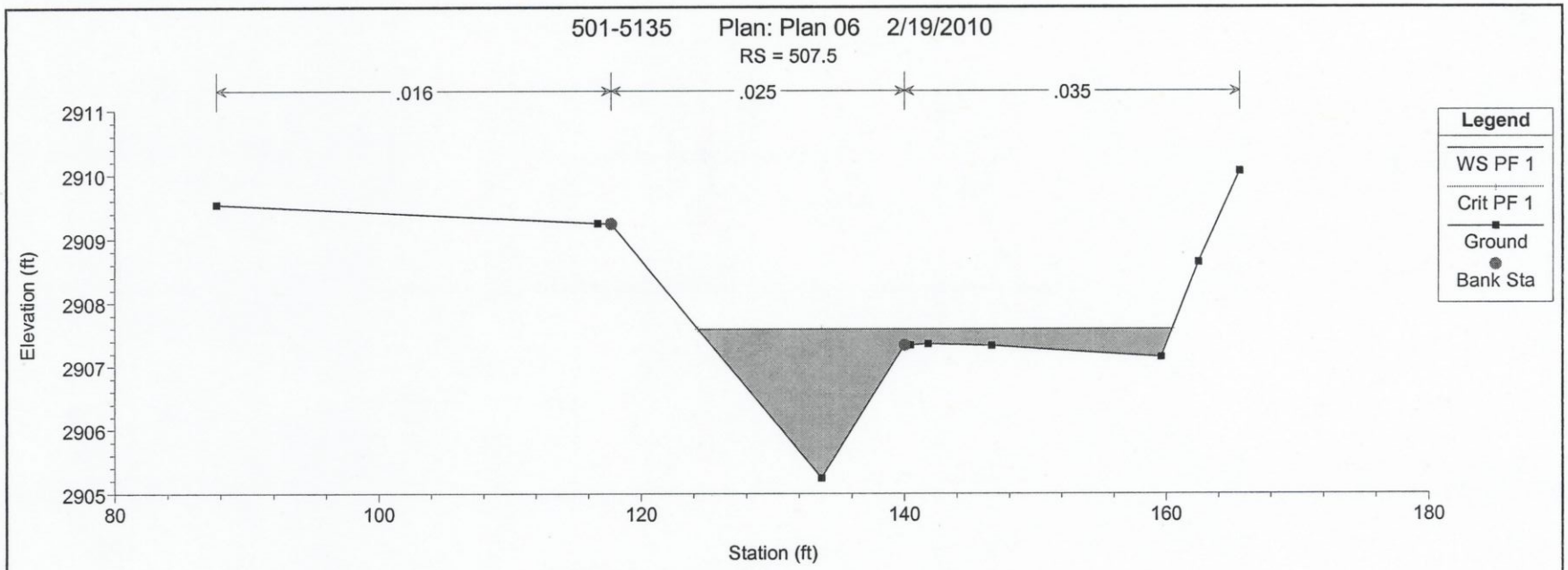

501-5135 Plan: Plan 06 2/19/2010
RS = 510
.016
.025
.035
Elevation (ft)
2912
2911
2910
2909
2908
2907
80
100
120
140
160
180
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Bank Sta

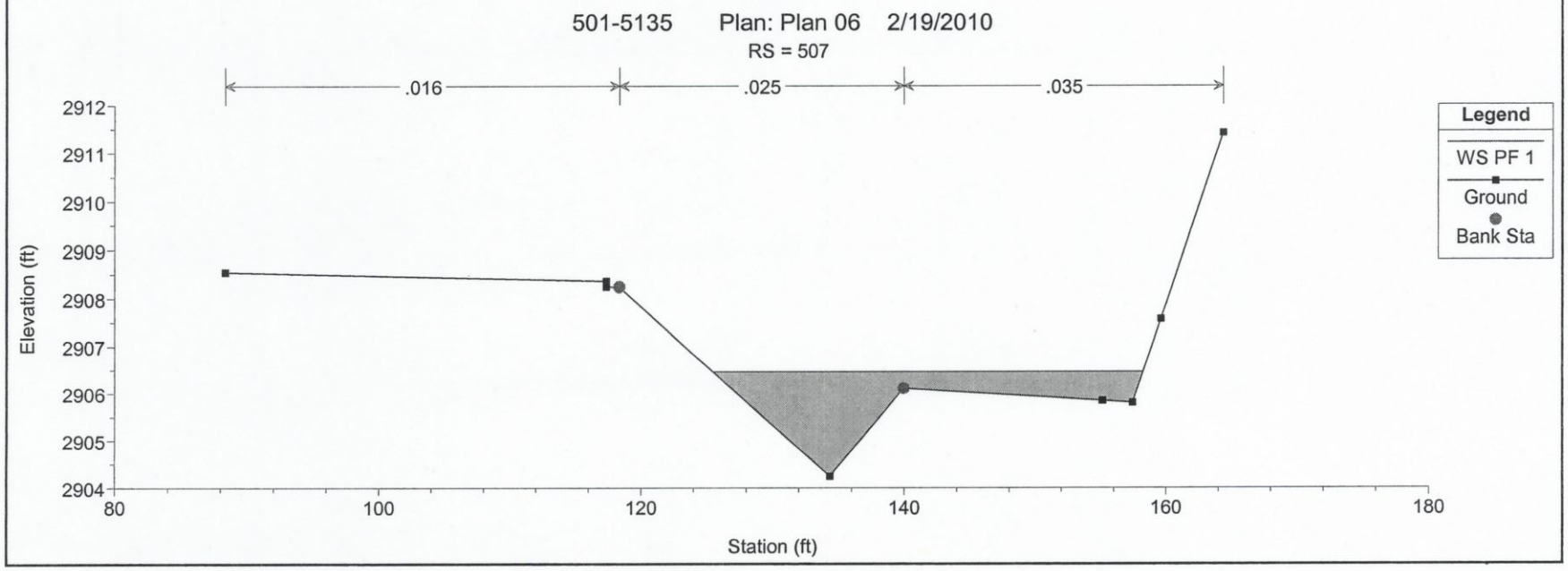

501-5135 Plan: Plan 06 2/19/2010
RS = 509.5
.016
.025
.035
Elevation (ft)
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Bank Sta

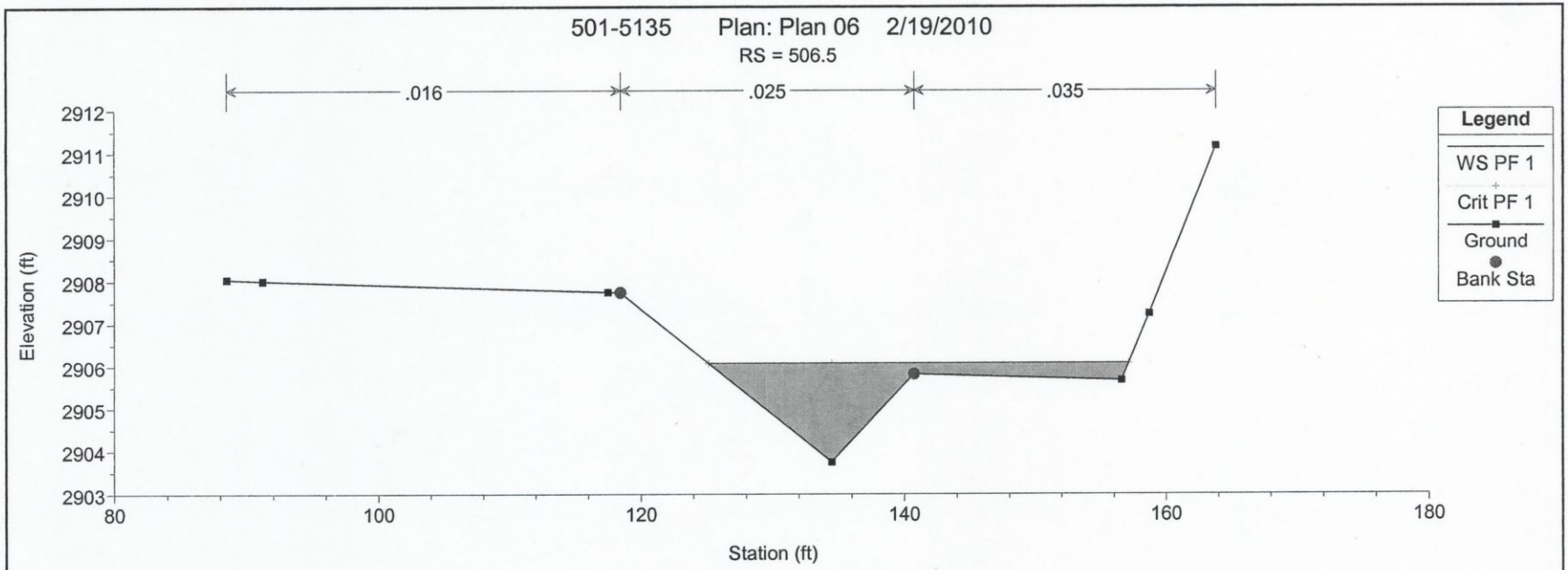

501-5135 Plan: Plan 06 2/19/2010
RS = 509
.016
.025
.035
Elevation (ft)
Station (ft)
Legend
WS PF 1
Ground
Bank Sta

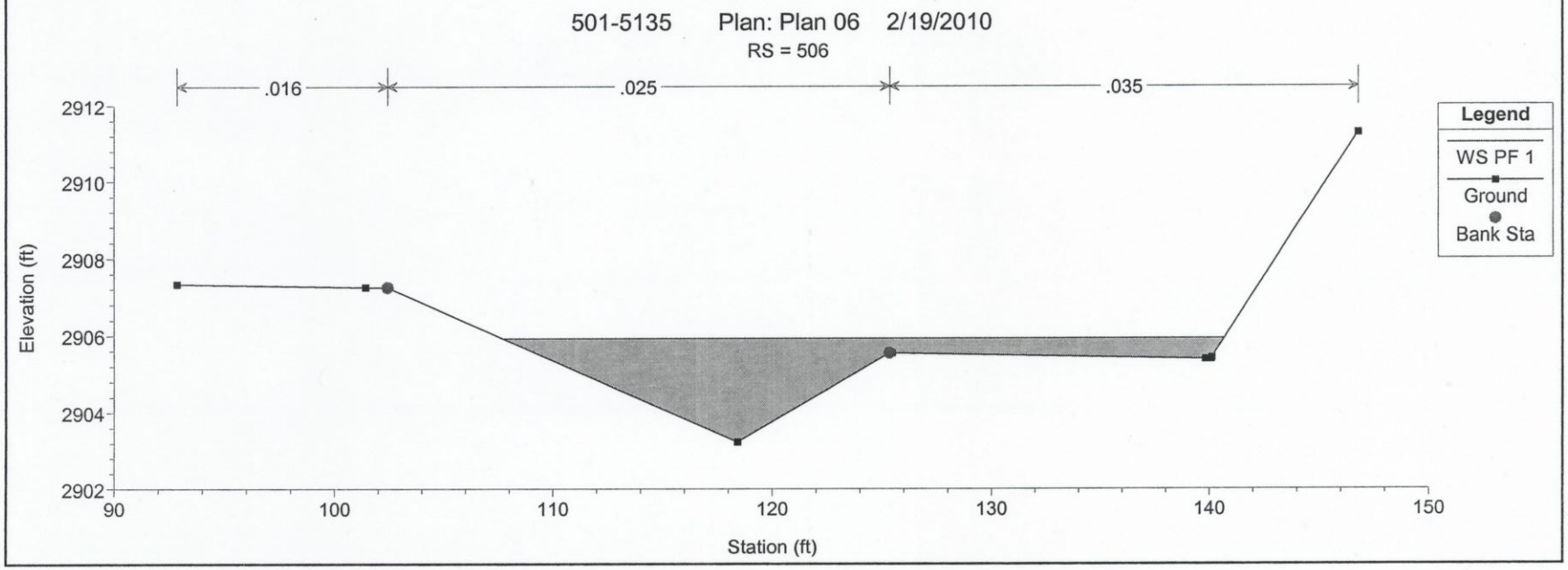

501-5135 Plan: Plan 06 2/19/2010
RS = 508.5
.016
.025
.035
Elevation (ft)
2911
2910
2909
2908
2907
2906
80
100
120
140
160
180
200
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Bank Sta

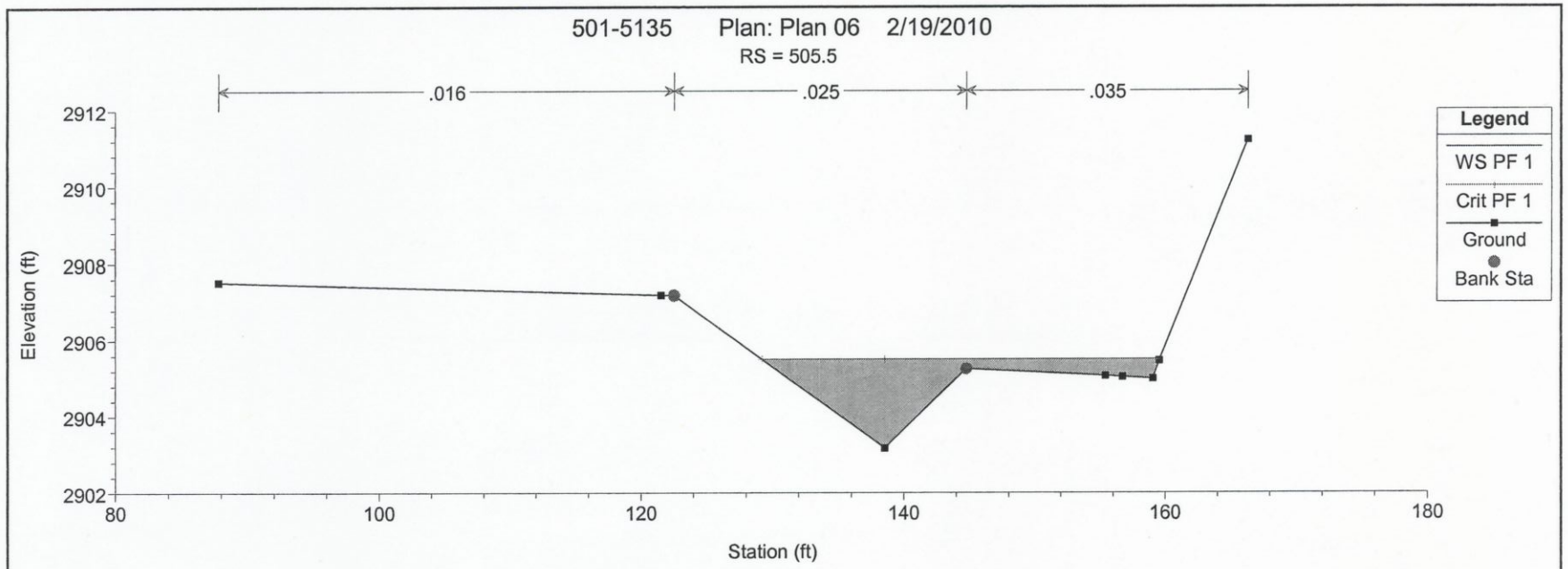

501-5135 Plan: Plan 06 2/19/2010
RS = 508
.016
.025
.035
Elevation (ft)
2911
2910
2909
2908
2907
2906
2905
80
100
120
140
160
180
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Bank Sta

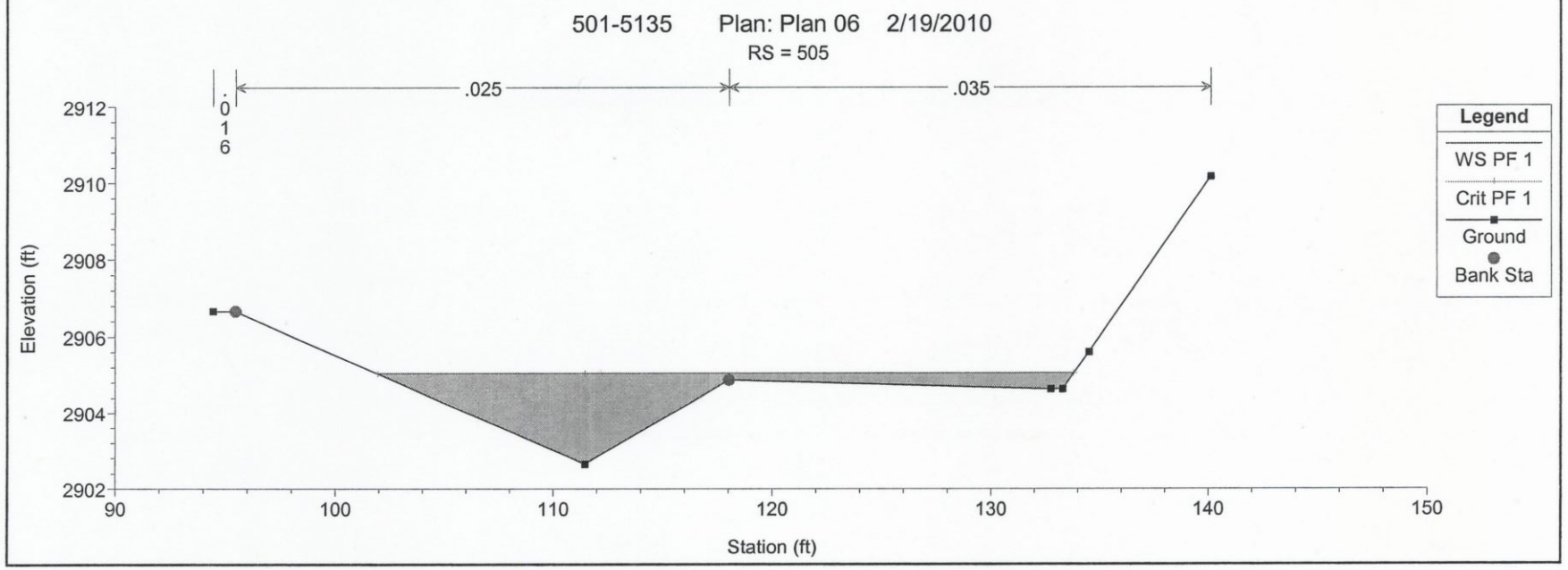

501-5135 Plan: Plan 06 2/19/2010
RS = 507.5
.016
.025
.035
Elevation (ft)
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Bank Sta

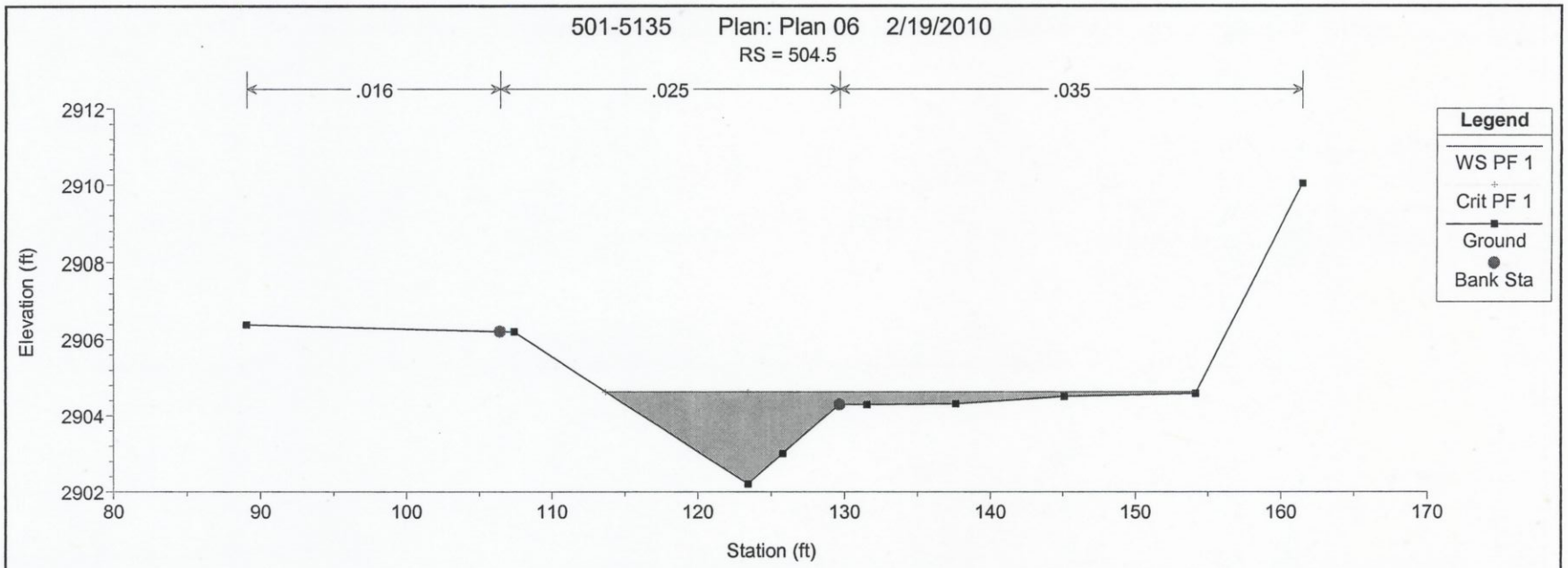

501-5135 Plan: Plan 06 2/19/2010
RS = 507
.016
.025
.035
Elevation (ft)
Station (ft)
Legend
WS PF 1
Ground
Bank Sta

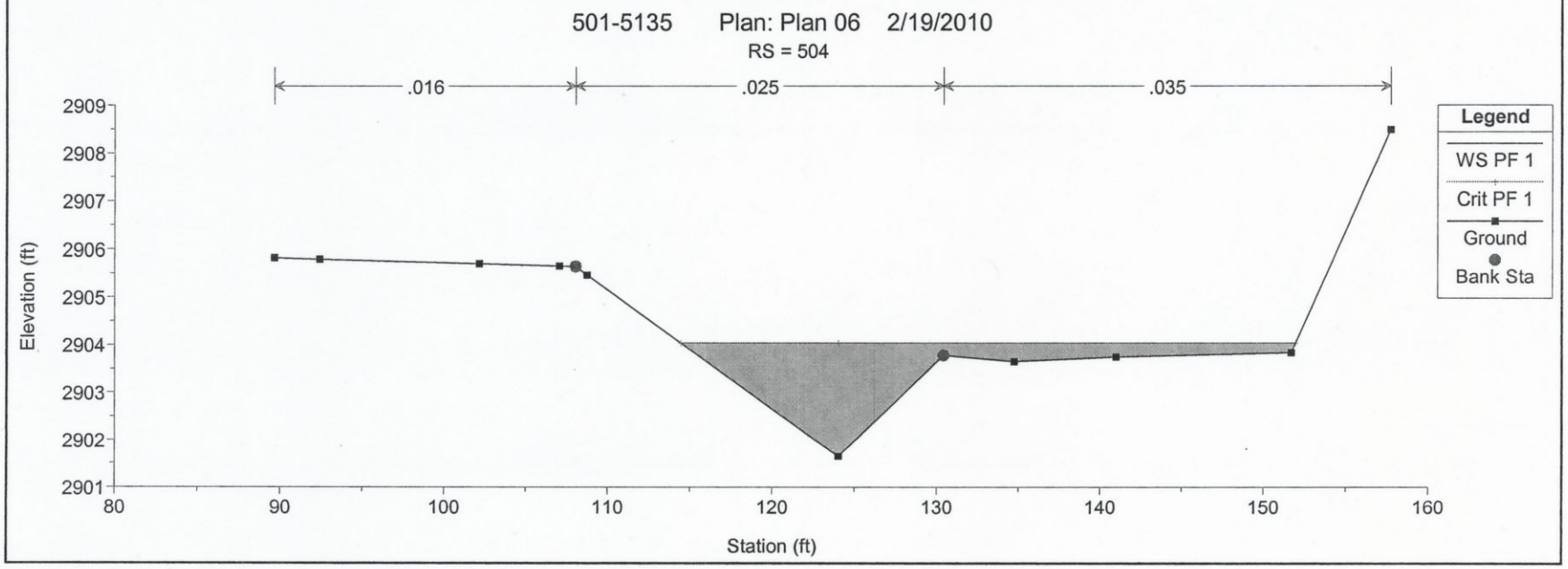

501-5135 Plan: Plan 06 2/19/2010
RS = 506.5
.016
.025
.035
Elevation (ft)
2912
2911
2910
2909
2908
2907
2906
2905
2904
2903
80
100
120
140
160
180
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Bank Sta

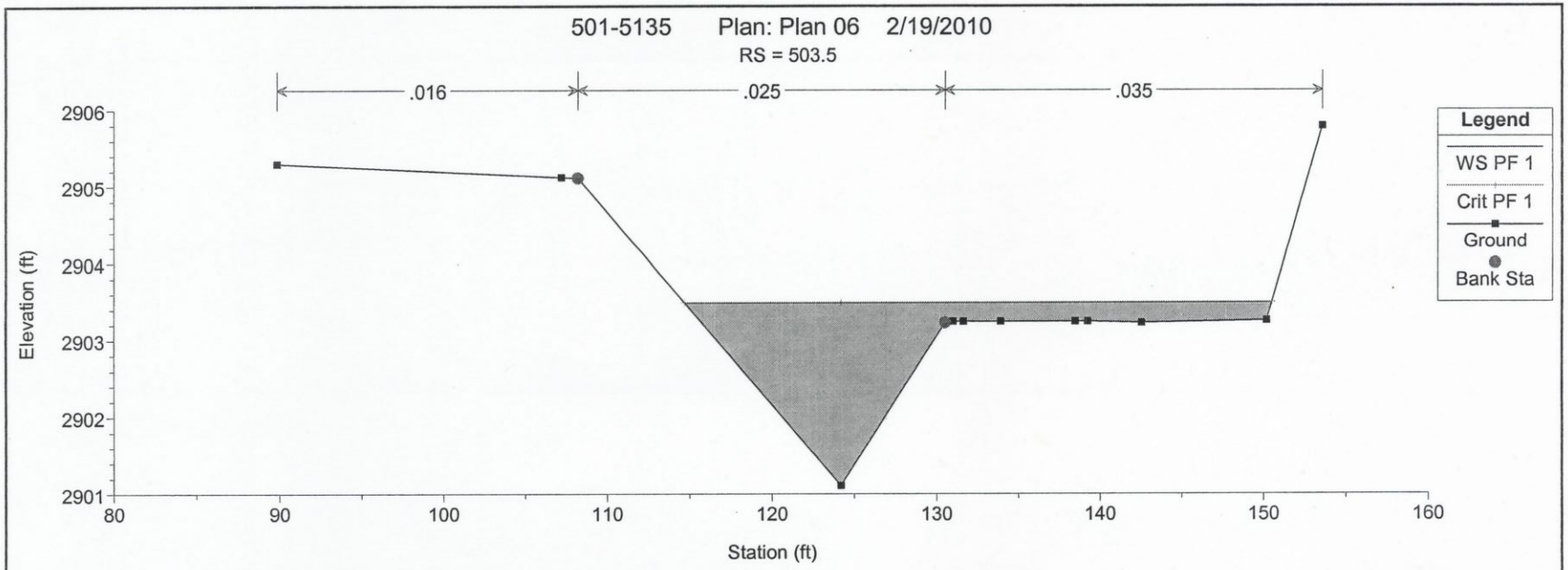

501-5135 Plan: Plan 06 2/19/2010
RS = 506
.016
.025
.035
Elevation (ft)
2912
2910
2908
2906
2904
2902
90
100
110
120
130
140
150
Station (ft)
Legend
WS PF 1
Ground
Bank Sta

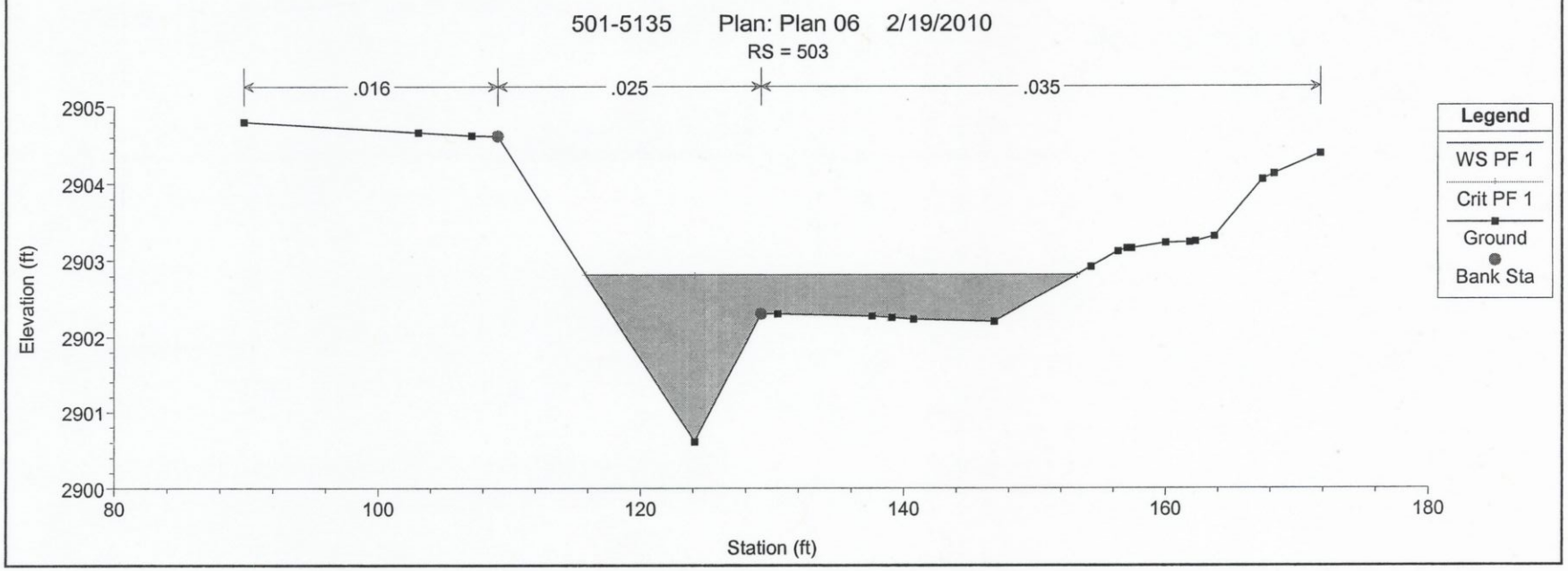

501-5135 Plan: Plan 06 2/19/2010
RS = 505.5
.016
.025
.035
Elevation (ft)
2912
2910
2908
2906
2904
2902
80
100
120
140
160
180
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Bank Sta

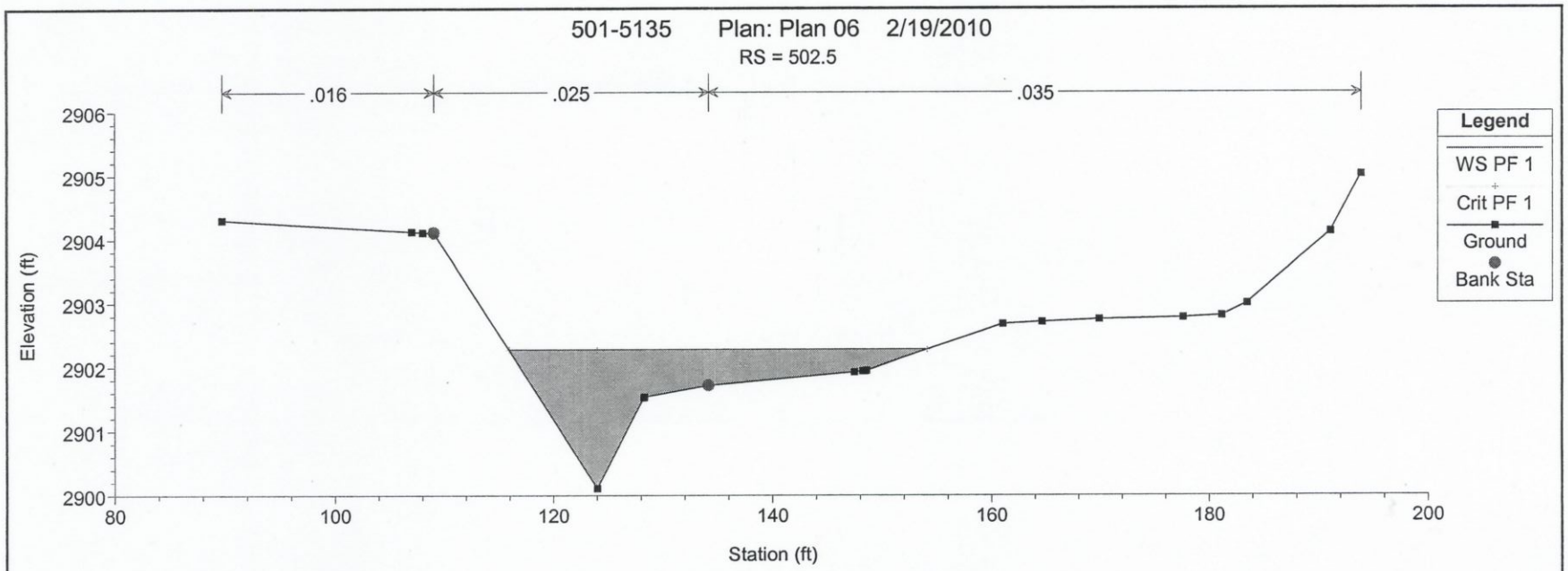

501-5135 Plan: Plan 06 2/19/2010
RS = 505
.016
.025
.035
Elevation (ft)
2912
2910
2908
2906
2904
2902
90
100
110
120
130
140
150
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Bank Sta

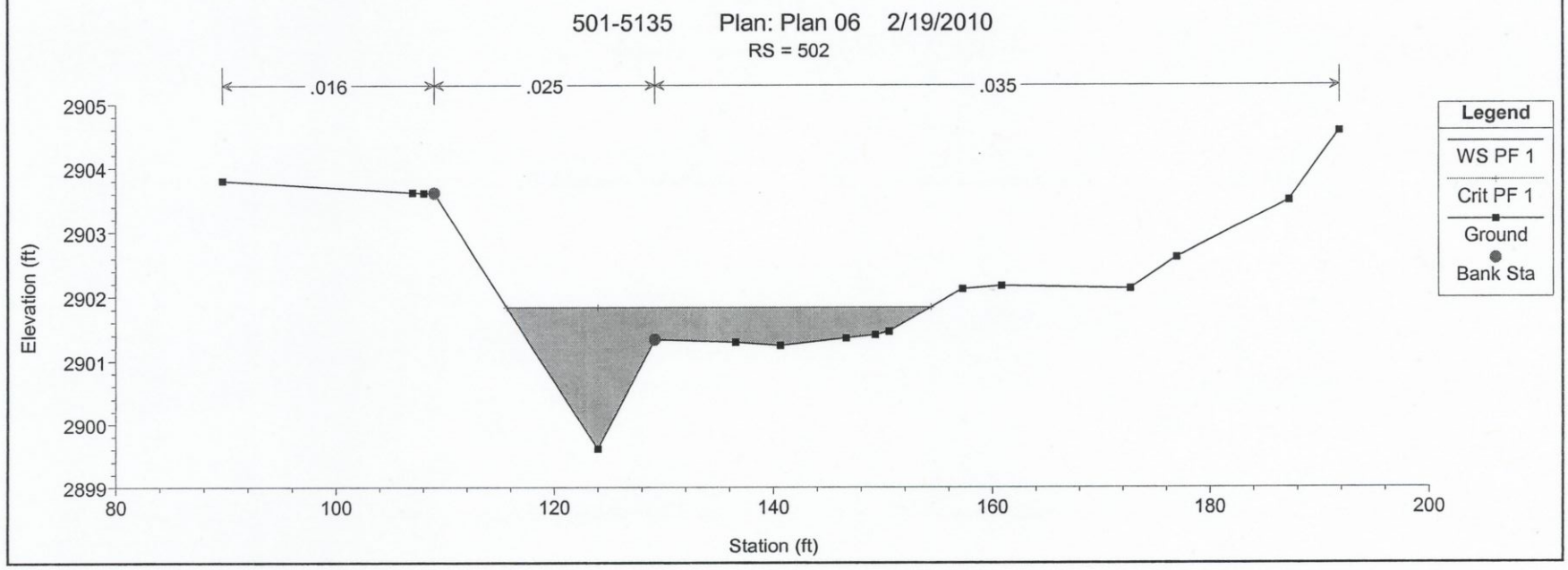

501-5135 Plan: Plan 06 2/19/2010
RS = 504.5
.016
.025
.035
Elevation (ft)
2912
2910
2908
2906
2904
2902
80
90
100
110
120
130
140
150
160
170
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Bank Sta

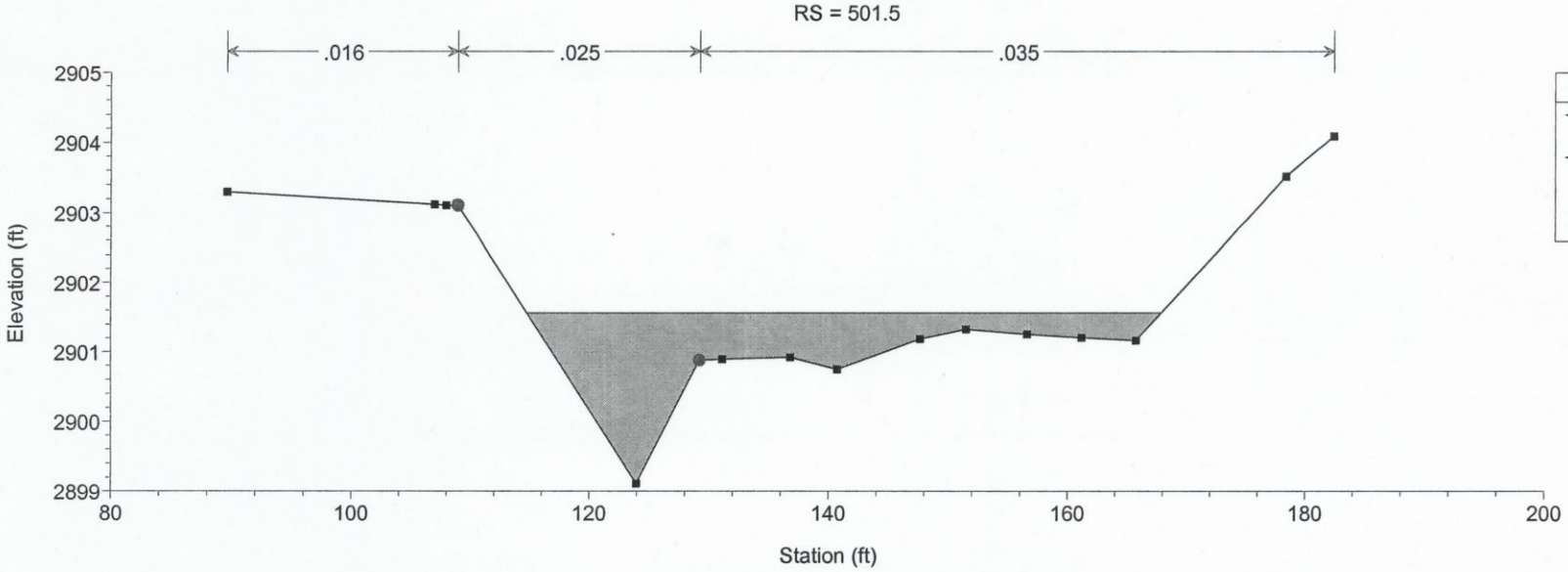

501-5135 Plan: Plan 06 2/19/2010
RS = 504
.016
.025
.035
Elevation (ft)
2909
2908
2907
2906
2905
2904
2903
2902
2901
80
90
100
110
120
130
140
150
160
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Bank Sta

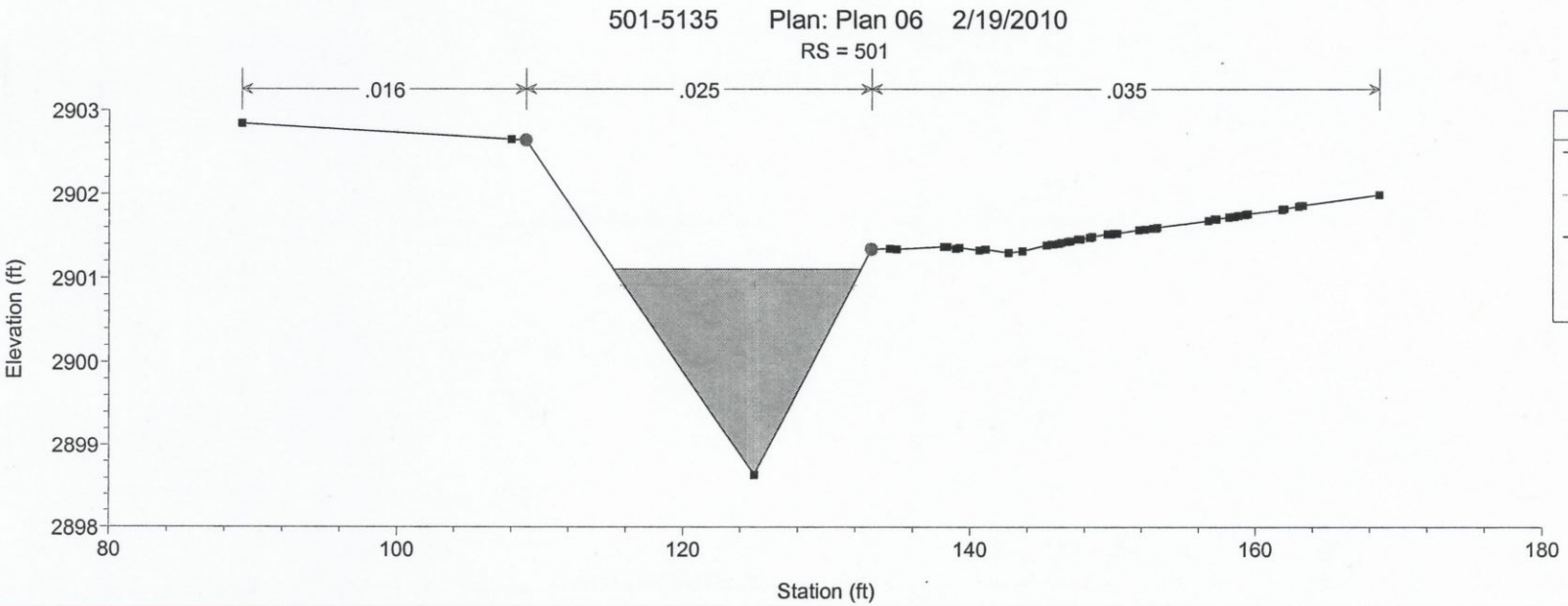

501-5135 Plan: Plan 06 2/19/2010
RS = 503.5
.016
.025
.035
Elevation (ft)
2906
2905
2904
2903
2902
2901
80
90
100
110
120
130
140
150
160
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Bank Sta


501-5135 Plan: Plan 06 2/19/2010
RS = 503
.016
.025
.035
Elevation (ft)
2905
2904
2903
2902
2901
2900
80
100
120
140
160
180
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Bank Sta


501-5135 Plan: Plan 06 2/19/2010
RS = 502.5
.016
.025
.035
Elevation (ft)
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Bank Sta


501-5135 Plan: Plan 06 2/19/2010
RS = 502
.016
.025
.035
Elevation (ft)
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Bank Sta


501-5135 Plan: Plan 06 2/19/2010
RS = 501.5
.016
.025
.035
Elevation (ft)
Station (ft)
Legend
WS PF 1
Ground
Bank Sta


501-5135 Plan: Plan 06 2/19/2010
RS = 501
.016
.025
.035
Elevation (ft)
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Bank Sta

ROADSIDE CHANNEL BETWEEN APPROXIMATELY STA. 514+50 AND 522+50

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: 5145-5225
Project File : 51455225.prj
Run Date and Time: 2/19/2010 6:04:50 AM

Project in English units

PLAN DATA

Plan Title: b
Plan File :
t:\7TED069904\HYDRO\DRAINAGE\CALCS\Hydraulics\Channels\Ras-Final\revised\51455225.p05

Geometry Title: 5145-5225
Geometry File :
t:\7TED069904\HYDRO\DRAINAGE\CALCS\Hydraulics\Channels\Ras-Final\revised\51455225.g11

Flow Title : 0 Flow Profiles
Flow File :
t:\7TED069904\HYDRO\DRAINAGE\CALCS\Hydraulics\Channels\Ras-Final\revised\51455225.F01

Plan Summary Information:

Number of:	Cross Sections	= 17	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:\7TED069904\HYDRO\DRAINAGE\CALCS\Hydraulics\Channels\Ras-Final\revised\51455225.F01

Flow Data (cfs)

River	Reach	RS	PF 1
River #1	Reach #1	522.5	59

Boundary Conditions

River	Reach	Profile	Upstream	Downstream
River #1	Reach #1	PF 1	Known WS = 2911.71	

GEOMETRY DATA

Geometry Title: 5145-5225
Geometry File :
t:\7TED069904\HYDRO\DRAINAGE\CALCS\Hydraulics\Channels\Ras-Final\revised\51455225.g11

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 522.5

INPUT
Description:
Station Elevation Data num= 29

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	2919.74	.11	2919.75	.12	2920.25	9.99	2920.05	10	2919.55
53	2918.69	53.01	2919.19	54	2919.19	73	2918.81	74	2918.79
90	2914.79	98.64	2912.63	98.69	2912.63	112.33	2912.76	115.92	2912.92
122.39	2913.16	132	2913.12	133.68	2913.11	134.02	2913.12	134.24	2913.23
134.49	2913.34	135.58	2913.83	138.24	2915.06	142.62	2917.01	144.94	2917
149.22	2916.72	151.87	2916.53	155.04	2916.56	157.87	2916.58		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.016	73	.025	142.62	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
73	142.62	50	50	50	.1	.3

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 522

INPUT
Description:
Station Elevation Data num= 25

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	2919.81	10	2919.8	10	2919.3	10.01	2919.3	53	2918.44
53.01	2918.44	53.01	2918.94	54	2918.94	73	2918.56	74	2918.54
90	2914.54	96.19	2912.99	96.24	2913	97.73	2913.01	111.97	2912.92
112.67	2912.92	113.26	2912.94	124.16	2913.27	127.66	2913.37	134.51	2913.39
140.61	2916.47	142.19	2917.31	143.99	2917.32	154.98	2917.38	156.39	2917.38

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.016	73	.025	142.19	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
73	142.19	50	50	50	.1	.3

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 521.5

INPUT
Description:
Station Elevation Data num= 23

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	2918.05	9.99	2919.05	10	2919.05	53	2918.19	56	2917.69
59	2918.19	78.95	2917.79	79.95	2917.77	95.95	2913.77	98	2913.26
98.07	2913.26	98.09	2913.26	104.76	2913.21	113.27	2913.11	119.58	2913.36
125.55	2913.51	133.82	2913.57	134.74	2913.56	136.97	2914.57	143.23	2917.55
150.31	2917.53	152.28	2917.5	154.88	2917.5				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.016	78.95	.025	143.23	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
78.95	143.23	50	50	50	.1	.3

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 521

INPUT
Description:
Station Elevation Data num= 24

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	2917.8	9.99	2918.8	10	2918.8	53	2917.94	56	2917.44
59	2917.94	92.5	2917.27	93.5	2917.25	110.67	2913.64	110.72	2913.64
114.09	2913.64	114.12	2913.64	122.75	2913.73	126.36	2913.77	130.03	2913.65
132.44	2913.61	134.85	2913.55	135.68	2913.56	137.55	2914.61	139.32	2915.6
142.94	2917.67	148.48	2917.86	150.22	2917.86	154.56	2917.75		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.016	92.5	.025	142.94	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
92.5	142.94	50	50	50	.1	.3

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 520.5

INPUT
Description:
Station Elevation Data num= 27

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	2917.51	9.99	2918.51	10	2918.51	53	2917.65	56	2917.15
59	2917.65	92.21	2916.99	93.21	2916.97	109.21	2913.39	112.38	2914.02
112.43	2914.02	113.7	2914.02	114.98	2914.02	125.32	2914.37	126.74	2914.39
128.5	2914.42	135.28	2914.43	138.77	2915.8	142.5	2917.6	147.38	2917.88
149.6	2917.35	150.32	2917.34	173.45	2917.81	180.29	2917.99	180.57	2918
180.61	2918	180.66	2918						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.016	92.21	.025	142.5	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
92.21	142.5	50	50	50	.1	.3

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 520

INPUT
Description:
Station Elevation Data num= 22

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	2917.11	10	2918.11	10.01	2918.11	53	2917.25	53.01	2917.25
56	2916.75	59	2917.25	91.93	2916.59	92.93	2916.57	108.93	2913.14
115.47	2914.75	115.52	2914.76	128.42	2915.17	131.06	2915	134.62	2914.9
141.52	2917.05	142.15	2917.23	142.94	2917.31	143.22	2917.32	147.97	2917.68
150.87	2917.71	153.72	2917.64						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.016	91.93	.025	141.52	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
91.93	141.52	50	50	50	.1	.3

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 519.5

INPUT
Description:
Station Elevation Data num= 21

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	2916.71	10	2917.71	10.01	2917.71	53	2916.85	53.01	2916.85
56	2916.35	59	2916.85	91.64	2916.2	92.64	2916.18	108.64	2912.89

```
  116.14 2914.68     119 2915.63  119.05 2915.63  121.83 2915.72  127.97 2915.92
  130.98 2915.91  134.35 2915.96  138.68 2917.06  138.79 2917.08  139.34  2917.1
  147.54 2917.34

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
       0    .016   92.64    .025  138.68    .035

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
         92.64  138.68                50      50      50             .1       .3

CROSS SECTION


RIVER: River #1
REACH: Reach #1           RS: 519

INPUT
Description:
Station Elevation Data    num=      20
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0 2916.31      10 2917.31   10.01 2917.31      53 2916.45   53.01 2916.45
      56 2915.95      59 2916.45   91.35 2915.81   92.35 2915.79  108.35 2912.64
  115.85 2914.29  122.55 2916.52   122.6 2916.52  125.17 2916.59  126.89 2916.64
  133.65 2916.56  136.43 2916.94     138 2917.09  145.69 2917.31  150.06 2917.45

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
       0    .016   91.35    .025  122.55    .035

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
         91.35  122.55                50      50      50             .1       .3

CROSS SECTION


RIVER: River #1
REACH: Reach #1           RS: 518.5

INPUT
Description:
Station Elevation Data    num=      20
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0 2915.91      10 2916.91   10.01 2916.91      53 2916.05   53.01 2916.05
      56 2915.55      59 2916.05   91.07 2915.41   92.07 2915.39  108.07 2912.39
  115.57 2913.89  126.24 2917.45  126.29 2917.45   126.3 2917.45  133.22 2917.38
  136.54 2917.78  138.35 2917.88  145.64 2918.24  147.03 2918.25  165.43    2918

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
       0    .016   91.07    .025  126.24    .035

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
         91.07  126.24                50      50      50             .1       .3

CROSS SECTION


RIVER: River #1
REACH: Reach #1           RS: 518

INPUT
Description:
```

Station Elevation Data num= 21

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	2918.55	10	2918.55	10	2918.05	10.01	2918.05	55.97	2917.13
55.98	2917.63	56.97	2917.63	90.78	2916.96	91.78	2916.94	107.78	2912.53
115.28	2913.9	126.66	2917.69	126.71	2917.69	131.68	2917.58	133	2917.56
135.15	2917.73	137.94	2917.97	139.21	2917.91	141.42	2917.76	147.58	2917.93
148.91	2917.96								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.016	91.78	.025	126.66	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
91.78	126.66	50	50	50	.1	.3

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 517.5

INPUT
Description:
Station Elevation Data num= 19

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	2917.83	9.99	2917.83	10	2917.33	59.3	2916.35	59.31	2916.85
60.3	2916.85	90.49	2916.24	91.49	2916.22	107.49	2912.22	114.99	2913.5
126.2	2917.24	126.25	2917.24	129.37	2917.22	132.2	2917.15	138.7	2917.33
141.51	2917.41	142.48	2917.44	147.28	2917.55	155.94	2917.6		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.016	90.49	.025	126.2	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
90.49	126.2	50	50	50	.1	.3

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 517

INPUT
Description:
Station Elevation Data num= 20

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	2917.54	10	2917.54	10	2917.04	10.01	2916.04	62.64	2915.99
62.65	2916.49	63.64	2916.49	90.21	2915.96	91.21	2915.94	107.21	2911.94
114.71	2913.11	123.88	2916.16	123.93	2916.17	125.82	2916.24	132.45	2916.44
137.43	2916.77	141.65	2917.04	142.62	2917.24	148.44	2917.29	154.74	2917.5

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.016	90.21	.025	123.88	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
90.21	123.88	50	50	50	.1	.3

CROSS SECTION

RIVER: River #1

REACH: Reach #1 RS: 516.5

INPUT
Description:
Station Elevation Data num= 21

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	2918.31	10	2918.31	10	2916.21	10.01	2916.21	65	2916.21
65.01	2916.21	66	2916.21	90.26	2915.73	91.26	2915.72	107.26	2911.72
114.76	2912.71	122.62	2915.33	122.67	2915.33	122.68	2915.33	138.3	2916
139.99	2916.55	140.9	2916.86	141.39	2916.84	141.85	2916.83	147.81	2916.86
152.09	2916.88								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.016	91.26	.025	122.62	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
91.26	122.62	50	50	50	.1	.3

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 516

INPUT
Description:
Station Elevation Data num= 19

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	2917.09	10	2917.09	10	2916.59	10.01	2916.59	65	2915.49
65.01	2915.49	65.01	2915.99	66	2915.99	91.13	2915.49	92.13	2915.47
108.13	2911.47	115.63	2912.29	120.6	2913.95	120.65	2913.94	120.88	2913.94
121.82	2913.9	125.99	2914.04	134.6	2914.11	140.78	2912.85		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.016	92.13	.025	120.6	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
92.13	120.6	50	50	50	.1	.3

Right Levee Station= 134.6 Elevation= 2915.11

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 515.5

INPUT
Description:
Station Elevation Data num= 20

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	2916.86	9.99	2916.86	10	2916.36	65	2915.26	65.01	2915.76
66	2915.76	92	2915.24	93	2915.22	109	2911.22	116.5	2911.87
120.66	2913.26	120.71	2913.26	120.72	2913.26	134.05	2913.22	138.15	2912.42
143.67	2911.53	144.83	2911.43	148.7	2911.09	152.19	2910.84	154.95	2911.02

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.016	92	.025	120.66	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
92	120.66	50	50	50	.1	.3

Right Levee Station= 134.05 Elevation= 2914.22

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 515

INPUT
Description:
Station Elevation Data num= 25

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	2916.47	10	2916.47	10	2915.97	10.01	2915.97	65	2914.87
65.01	2914.87	65.01	2915.37	66	2915.37	85	2914.99	86	2914.97
102	2910.97	109.5	2911.61	113.02	2912.78	113.07	2912.79	116.26	2912.93
119.89	2913.09	122.17	2912.98	122.35	2912.98	132.44	2912.71	132.95	2912.68
134.12	2912.67	141.57	2911.17	143.07	2910.86	143.9	2910.82	148.81	2910.5

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.016	85	.025	113.02	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
85	113.02	50	50	50	.1	.3

Right Levee Station= 119.89 Elevation= 2914.09

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 514.5

INPUT
Description:
Station Elevation Data num= 26

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	2916.24	9.99	2916.24	10	2915.74	63.14	2914.68	63.15	2915.18
64.14	2915.18	85	2914.76	86	2914.74	102	2910.74	112.5	2912.21
117.46	2913.87	117.51	2913.87	117.52	2913.87	128.43	2914.28	128.98	2914.29
132.11	2914.42	133.41	2914.46	133.71	2914.47	133.76	2914.47	133.99	2914.48
134.16	2914.49	141.6	2914.58	142.73	2914.59	143.66	2914.63	143.75	2914.63
144.32	2914.65								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.016	85	.025	117.46	.035

Bank Sta: Left	Right	Coeff Contr.	Expan.
85	117.46	.1	.3

SUMMARY OF MANNING'S N VALUES

River:River #1

Reach	River Sta.	n1	n2	n3
Reach #1	522.5	.016	.025	.035
Reach #1	522	.016	.025	.035
Reach #1	521.5	.016	.025	.035
Reach #1	521	.016	.025	.035
Reach #1	520.5	.016	.025	.035

Reach #1	520	.016	.025	.035
Reach #1	519.5	.016	.025	.035
Reach #1	519	.016	.025	.035
Reach #1	518.5	.016	.025	.035
Reach #1	518	.016	.025	.035
Reach #1	517.5	.016	.025	.035
Reach #1	517	.016	.025	.035
Reach #1	516.5	.016	.025	.035
Reach #1	516	.016	.025	.035
Reach #1	515.5	.016	.025	.035
Reach #1	515	.016	.025	.035
Reach #1	514.5	.016	.025	.035

SUMMARY OF REACH LENGTHS

River: River #1

Reach	River Sta.	Left	Channel	Right
Reach #1	522.5	50	50	50
Reach #1	522	50	50	50
Reach #1	521.5	50	50	50
Reach #1	521	50	50	50
Reach #1	520.5	50	50	50
Reach #1	520	50	50	50
Reach #1	519.5	50	50	50
Reach #1	519	50	50	50
Reach #1	518.5	50	50	50
Reach #1	518	50	50	50
Reach #1	517.5	50	50	50
Reach #1	517	50	50	50
Reach #1	516.5	50	50	50
Reach #1	516	50	50	50
Reach #1	515.5	50	50	50
Reach #1	515	50	50	50
Reach #1	514.5			

SUMMARY OF CONTRACTION AND EXPANSION COEFFICIENTS
River: River #1

Reach	River Sta.	Contr.	Expan.
Reach #1	522.5	.1	.3
Reach #1	522	.1	.3
Reach #1	521.5	.1	.3
Reach #1	521	.1	.3
Reach #1	520.5	.1	.3
Reach #1	520	.1	.3
Reach #1	519.5	.1	.3
Reach #1	519	.1	.3
Reach #1	518.5	.1	.3
Reach #1	518	.1	.3
Reach #1	517.5	.1	.3
Reach #1	517	.1	.3
Reach #1	516.5	.1	.3
Reach #1	516	.1	.3

Reach #1	515.5	.1	.3
Reach #1	515	.1	.3
Reach #1	514.5	.1	.3

Profile Output Table - Standard Table 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.
E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	
			(cfs)	(ft)	(ft)	(ft)
(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		
Reach #1	522.5	PF 1	59.00	2912.63	2915.36	
2915.36	0.000033	0.55	106.64	51.18	0.07	
Reach #1	522	PF 1	59.00	2912.92	2915.36	
2915.36	0.000040	0.58	100.95	51.66	0.07	
Reach #1	521.5	PF 1	59.00	2913.11	2915.35	
2915.36	0.000063	0.68	86.58	48.98	0.09	
Reach #1	521	PF 1	59.00	2913.55	2915.33	
2915.35	0.000245	1.16	51.03	36.20	0.17	
Reach #1	520.5	PF 1	59.00	2913.39	2915.29	
2915.33	0.000700	1.58	37.39	36.76	0.28	
Reach #1	520	PF 1	59.00	2913.14	2915.08	
2915.24	0.005992	3.21	18.37	31.04	0.74	
Reach #1	519.5	PF 1	59.00	2912.89	2914.78	
2914.99	0.004196	3.66	16.12	16.97	0.66	
Reach #1	519	PF 1	59.00	2912.64	2914.67	
2914.81	0.002510	3.01	19.63	18.91	0.52	
Reach #1	518.5	PF 1	59.00	2912.39	2914.61	
2914.70	0.001325	2.36	25.03	21.53	0.39	
Reach #1	518	PF 1	59.00	2912.53	2914.21	2914.11
2914.55	0.007427	4.61	12.79	14.55	0.87	
Reach #1	517.5	PF 1	59.00	2912.22	2913.91	
2914.19	0.006230	4.28	13.80	15.47	0.80	
Reach #1	517	PF 1	59.00	2911.94	2913.63	
2913.89	0.005582	4.10	14.38	15.81	0.76	
Reach #1	516.5	PF 1	59.00	2911.72	2913.32	
2913.60	0.006171	4.24	13.91	15.70	0.79	
Reach #1	516	PF 1	59.00	2911.47	2913.03	2912.87
2913.29	0.005714	4.12	14.32	15.96	0.77	
Reach #1	515.5	PF 1	59.00	2911.22	2912.84	2912.54
2913.04	0.003999	3.62	16.30	16.85	0.65	
Reach #1	515	PF 1	59.00	2910.97	2912.70	2912.29
2912.86	0.002914	3.23	18.26	17.67	0.56	
Reach #1	514.5	PF 1	59.00	2910.74	2912.20	2912.20
2912.58	0.010751	4.95	11.93	16.30	1.02	

Profile Output Table - Standard Table 2

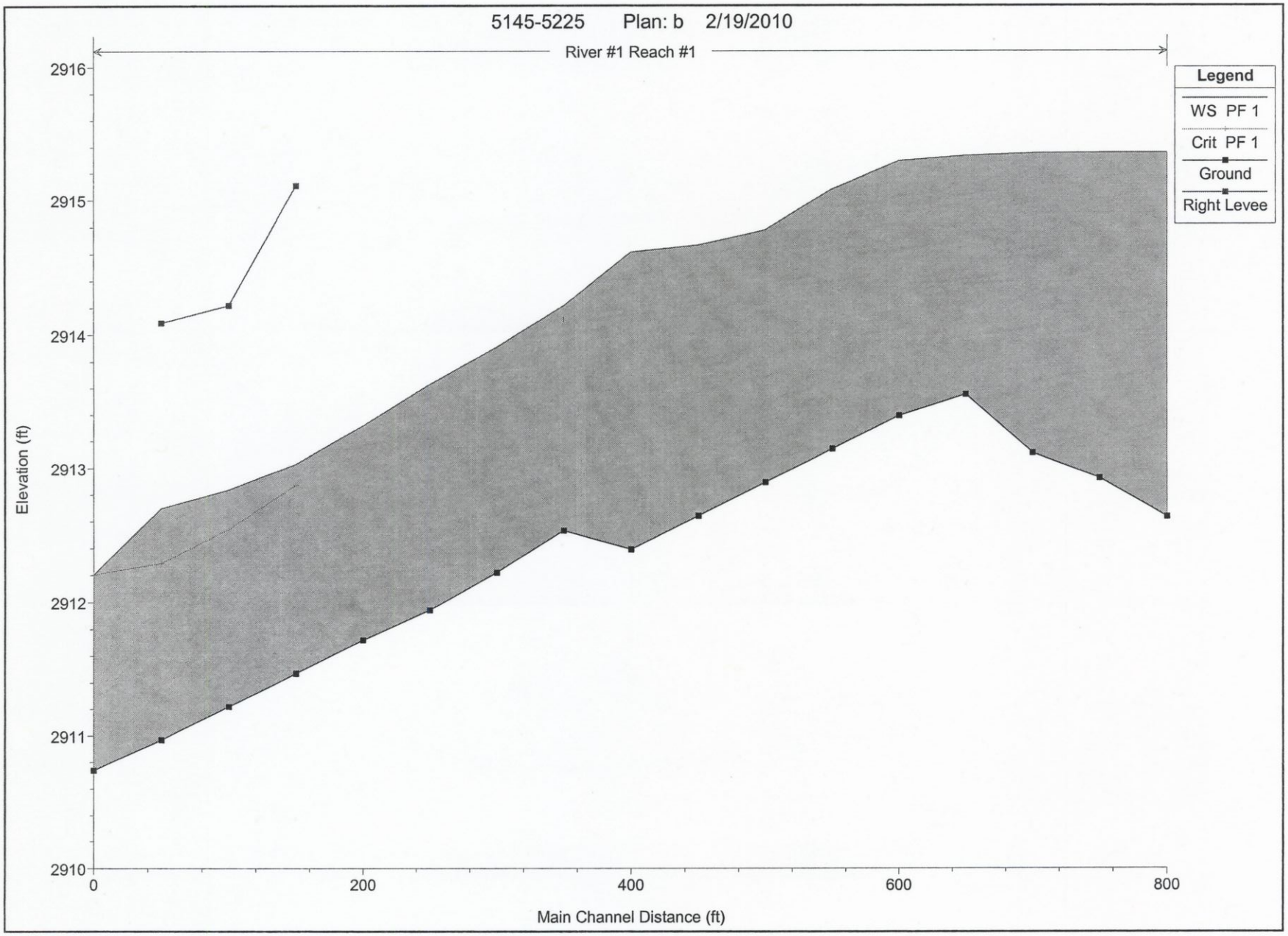
Reach	River Sta	Profile	E.G. Elev	W.S. Elev	Vel Head	Frctn
Loss	C & E Loss	Q Left	Q Channel	Q Right	Top Width	
				(ft)	(ft)	(ft)
(ft)	(ft)	(cfs)	(cfs)	(cfs)	(ft)	
Reach #1	522.5	PF 1	2915.36	2915.36	0.00	
0.00	0.00	59.00		51.18		
Reach #1	522	PF 1	2915.36	2915.36	0.01	

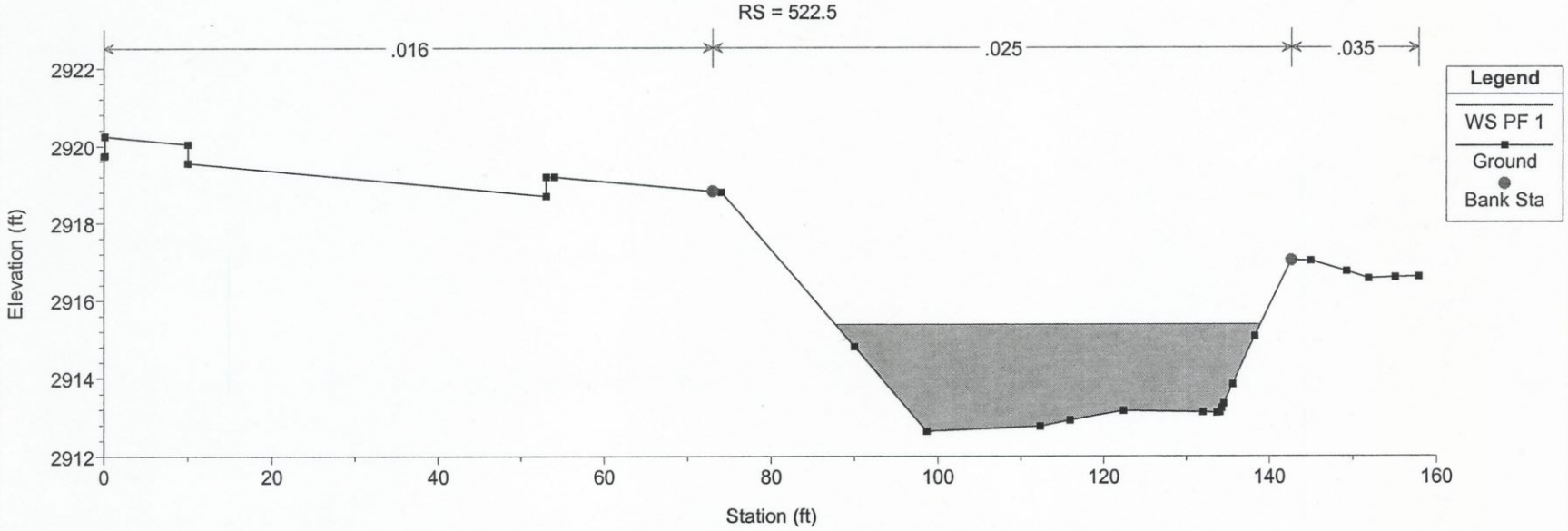
```
0.00          0.00                 59.00                 51.66
  Reach #1      521.5          PF 1        2915.36     2915.35        0.01
0.01          0.00                 59.00                 48.98
  Reach #1      521            PF 1        2915.35     2915.33        0.02
0.02          0.00                 59.00                 36.20
  Reach #1      520.5          PF 1        2915.33     2915.29        0.04
0.08          0.01                 59.00                 36.76
  Reach #1      520            PF 1        2915.24     2915.08        0.16
0.25          0.00                 59.00                 31.04
  Reach #1      519.5          PF 1        2914.99     2914.78        0.21
0.16          0.02                 59.00                 16.97
  Reach #1      519            PF 1        2914.81     2914.67        0.14
0.09          0.02                 59.00                 18.91
  Reach #1      518.5          PF 1        2914.70     2914.61        0.09
0.13          0.02                 59.00                 21.53
  Reach #1      518            PF 1        2914.55     2914.21        0.33
0.34          0.01                 59.00                 14.55
  Reach #1      517.5          PF 1        2914.19     2913.91        0.28
0.29          0.01                 59.00                 15.47
  Reach #1      517            PF 1        2913.89     2913.63        0.26
0.29          0.00                 59.00                 15.81
  Reach #1      516.5          PF 1        2913.60     2913.32        0.28
0.30          0.00                 59.00                 15.70
  Reach #1      516            PF 1        2913.29     2913.03        0.26
0.24          0.02                 59.00                 15.96
  Reach #1      515.5          PF 1        2913.04     2912.84        0.20
0.17          0.01                 59.00                 16.85
  Reach #1      515            PF 1        2912.86     2912.70        0.16
0.25          0.02                 59.00                 17.67
  Reach #1      514.5          PF 1        2912.58     2912.20        0.38
                              59.00                 16.30
```

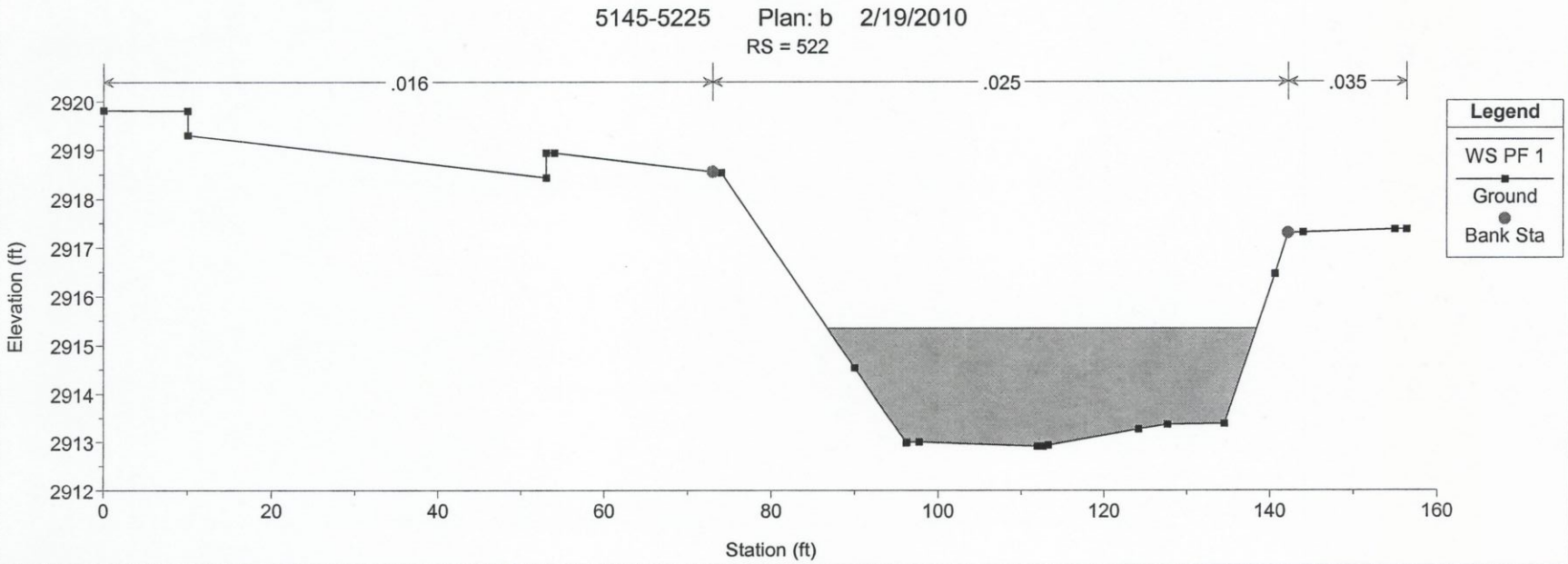
ERRORS WARNINGS AND NOTES
Errors Warnings and Notes for Plan : 5145-5225

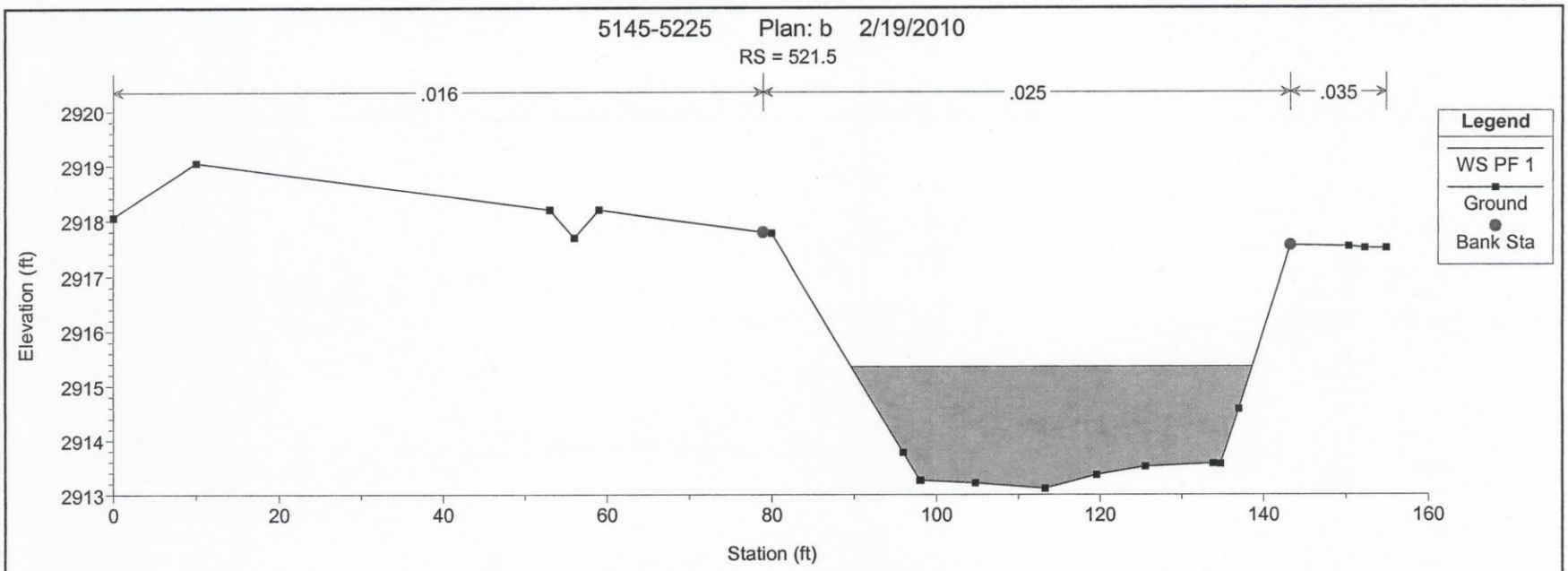
```
River: River #1  Reach: Reach #1     RS: 521.5     Profile: PF 1
     Warning:The conveyance ratio (upstream conveyance divided by downstream
conveyance) is less than 0.7 or greater than 1.4.
             This may indicate the need for additional cross sections.
River: River #1  Reach: Reach #1     RS: 521     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: 520.5     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: 520     Profile: PF 1
     Warning:Divided flow computed for this cross-section.
River: River #1  Reach: Reach #1     RS: 518.5     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: 516     Profile: PF 1
     Note:   Multiple critical depths were found at this location.  The critical
depth with the lowest, valid, water surface was
             used.
River: River #1  Reach: Reach #1     RS: 515.5     Profile: PF 1
     Note:   Multiple critical depths were found at this location.  The critical
```

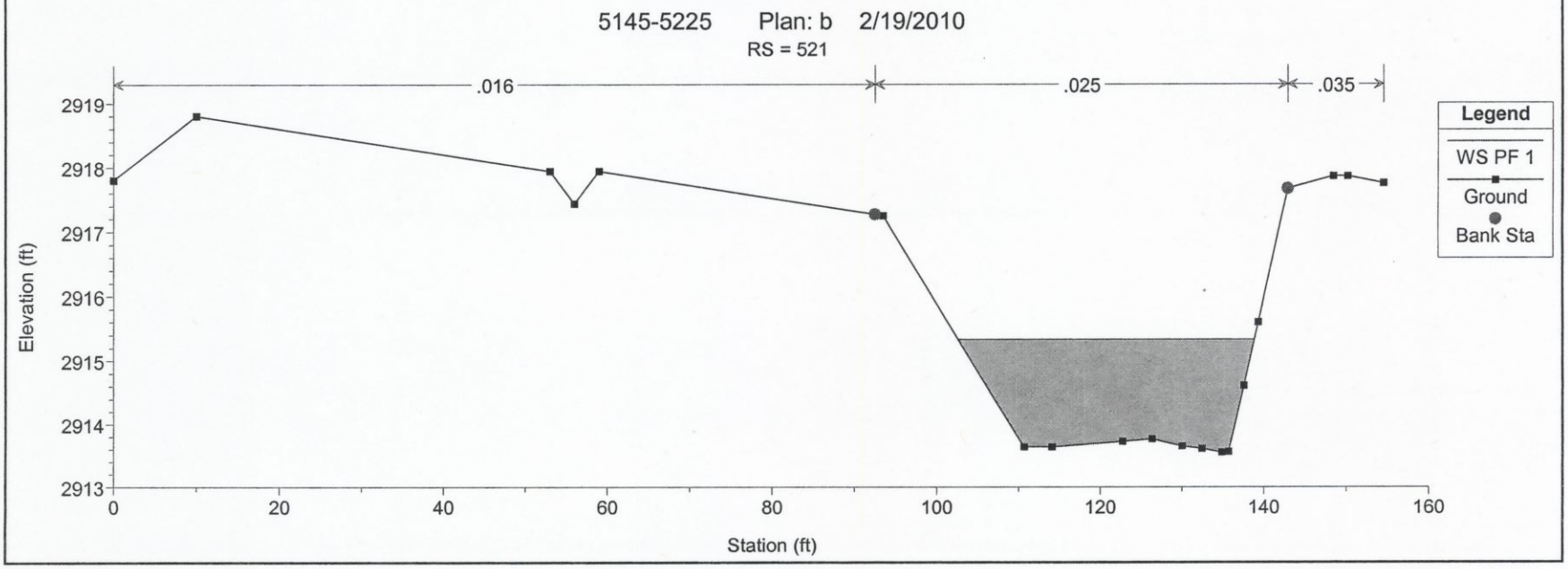
depth with the lowest, valid, water surface was
used.
River: River #1 Reach: Reach #1 RS: 515 Profile: PF 1
Warning:The conveyance ratio (upstream conveyance divided by downstream
conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
Note: Multiple critical depths were found at this location. The critical
depth with the lowest, valid, water surface was
used.
River: River #1 Reach: Reach #1 RS: 514.5 Profile: PF 1
Warning:User specified water surface is not possible for the specified flow
regime. The program used critical depth as the
starting water surface.

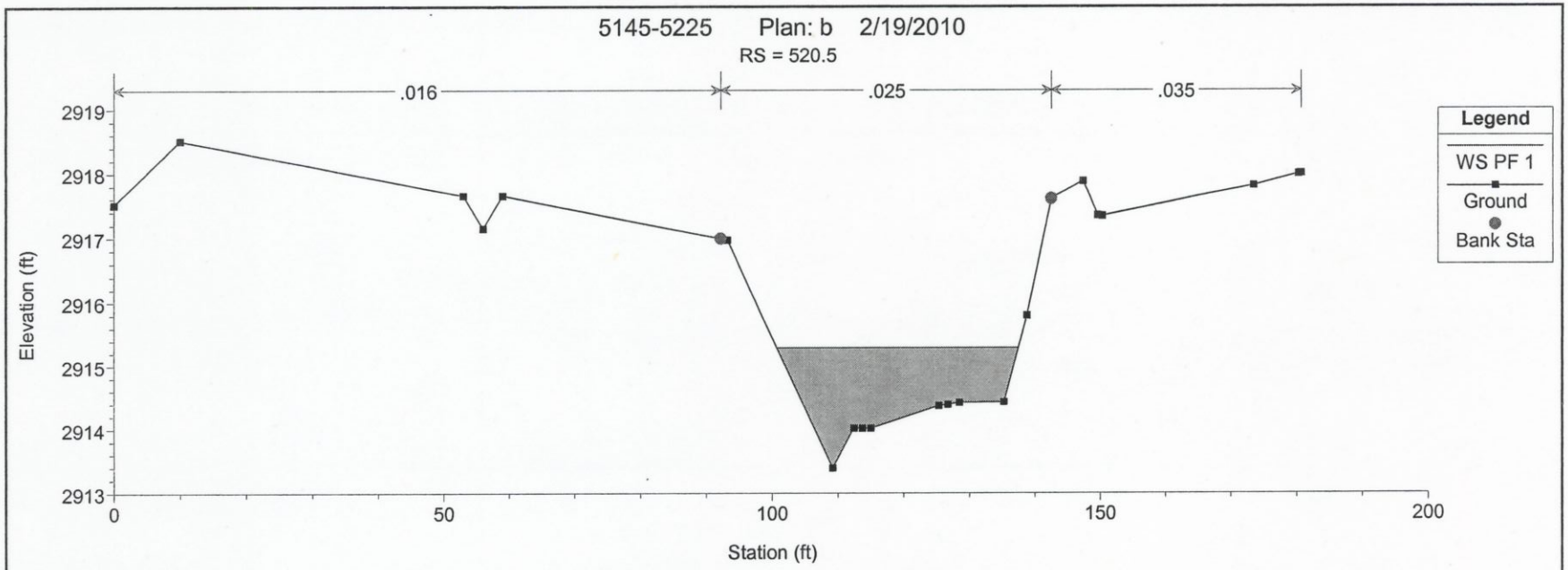

5145-5225 Plan: b 2/19/2010
River #1 Reach #1
Legend
WS PF 1
Crit PF 1
Ground
Right Levee
Elevation (ft)
2916
2915
2914
2913
2912
2911
2910
0
200
400
600
800
Main Channel Distance (ft)

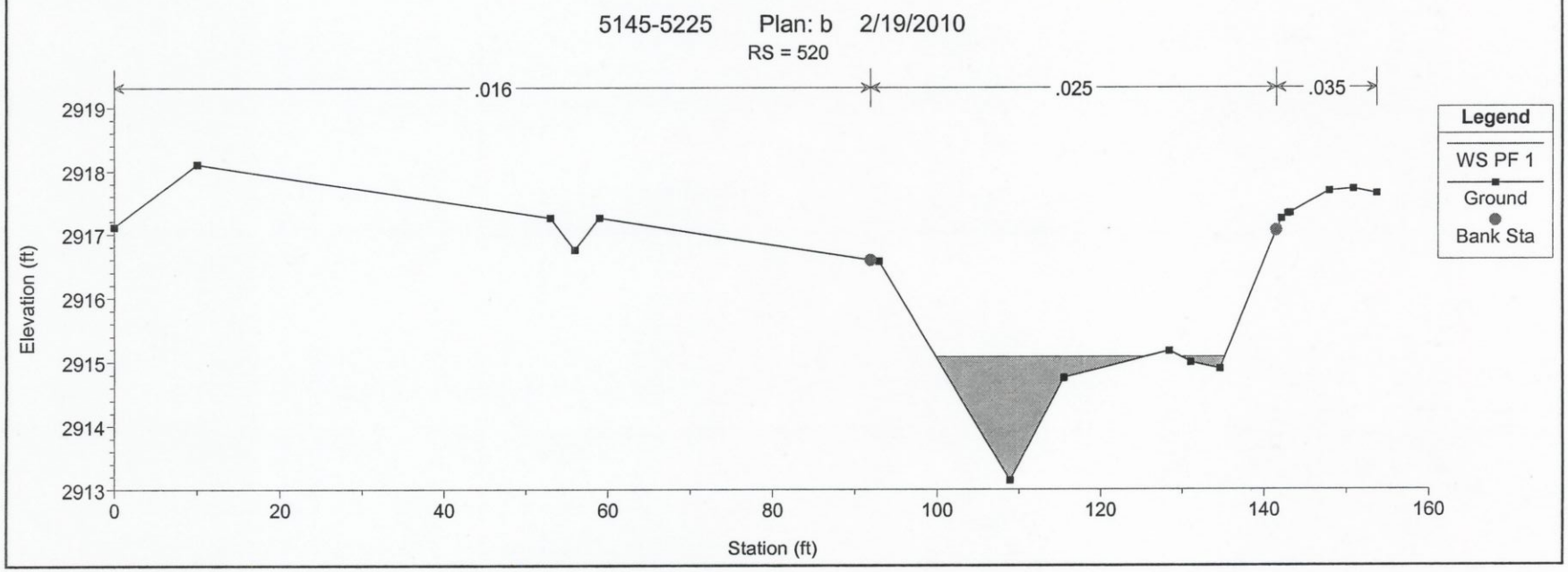

5145-5225 Plan: b 2/19/2010
RS = 522.5
.016
.025
.035
Legend
WS PF 1
Ground
Bank Sta
Elevation (ft)
2922
2920
2918
2916
2914
2912
0
20
40
60
80
100
120
140
160
Station (ft)

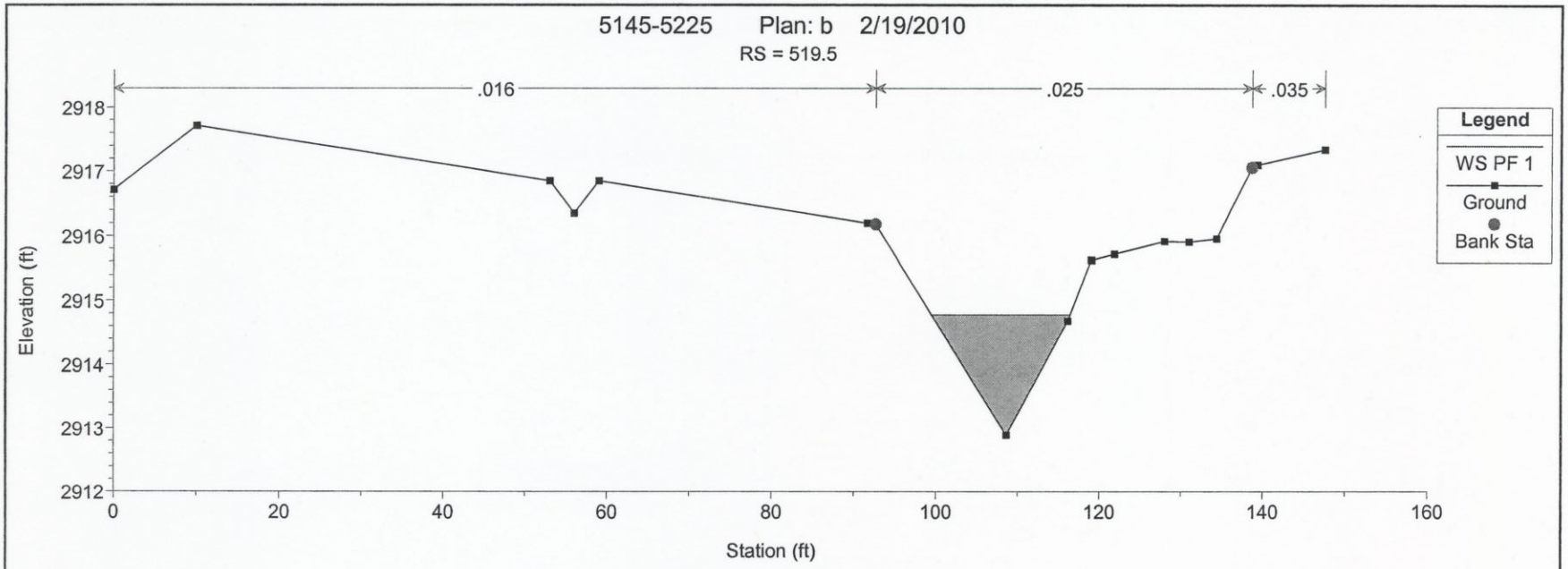

5145-5225 Plan: b 2/19/2010
RS = 522
.016
.025
.035
Legend
WS PF 1
Ground
Bank Sta
Elevation (ft)
2920
2919
2918
2917
2916
2915
2914
2913
2912
0
20
40
60
80
100
120
140
160
Station (ft)

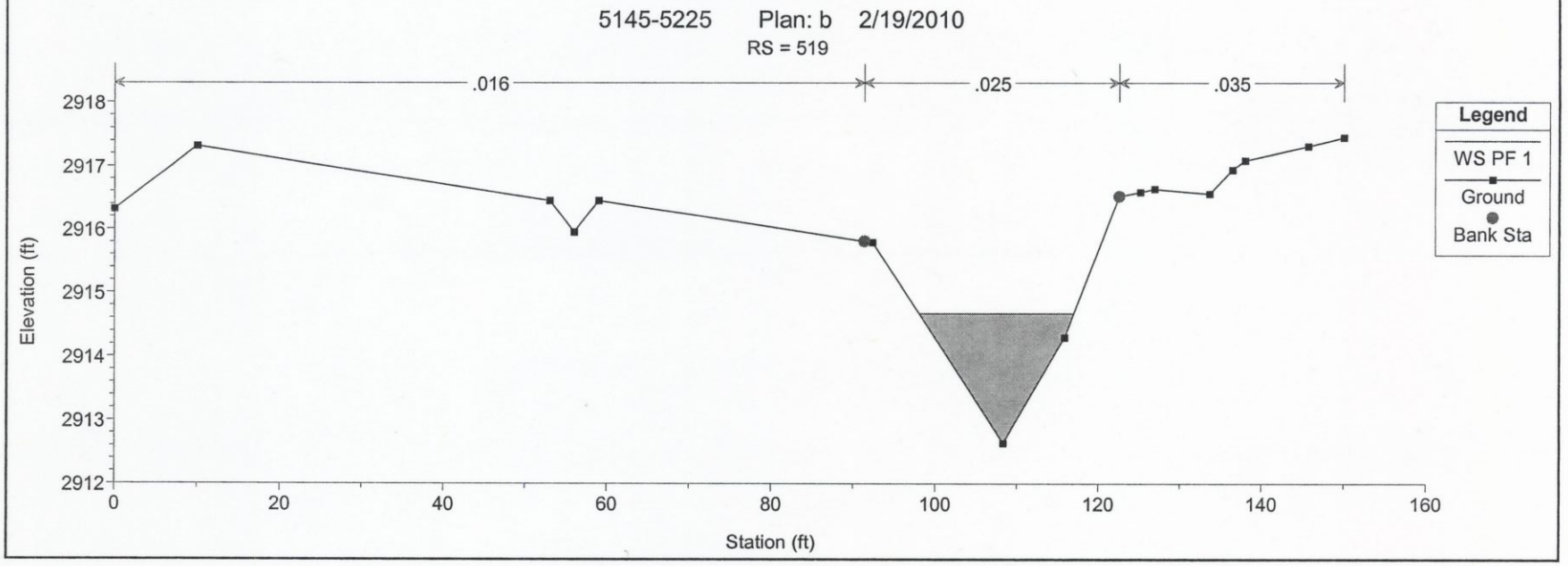

5145-5225 Plan: b 2/19/2010
RS = 521.5
.016
.025
.035
Legend
WS PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)
2920
2919
2918
2917
2916
2915
2914
2913
0
20
40
60
80
100
120
140
160

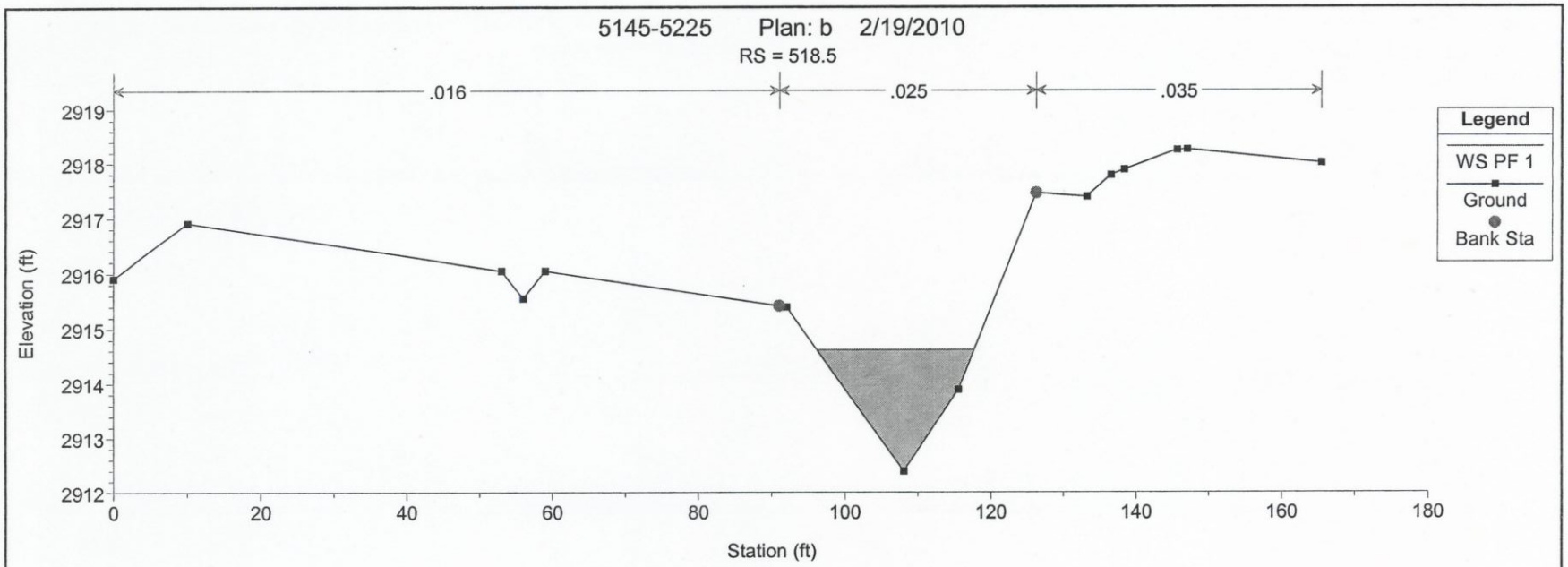

5145-5225 Plan: b 2/19/2010
RS = 521
.016
.025
.035
Legend
WS PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)
2919
2918
2917
2916
2915
2914
2913
0
20
40
60
80
100
120
140
160


5145-5225 Plan: b 2/19/2010
RS = 520.5
.016
.025
.035
Legend
WS PF 1
Ground
Bank Sta
Elevation (ft)
2919
2918
2917
2916
2915
2914
2913
0
50
100
150
200
Station (ft)


5145-5225 Plan: b 2/19/2010
RS = 520
.016
.025
.035
Legend
WS PF 1
Ground
Bank Sta
Elevation (ft)
2919
2918
2917
2916
2915
2914
2913
0
20
40
60
80
100
120
140
160
Station (ft)


5145-5225 Plan: b 2/19/2010
RS = 519.5
.016
.025
.035
Legend
WS PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)
2912
2913
2914
2915
2916
2917
2918
0
20
40
60
80
100
120
140
160


5145-5225 Plan: b 2/19/2010
RS = 519
.016
.025
.035
Legend
WS PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)
2912
2913
2914
2915
2916
2917
2918
0
20
40
60
80
100
120
140
160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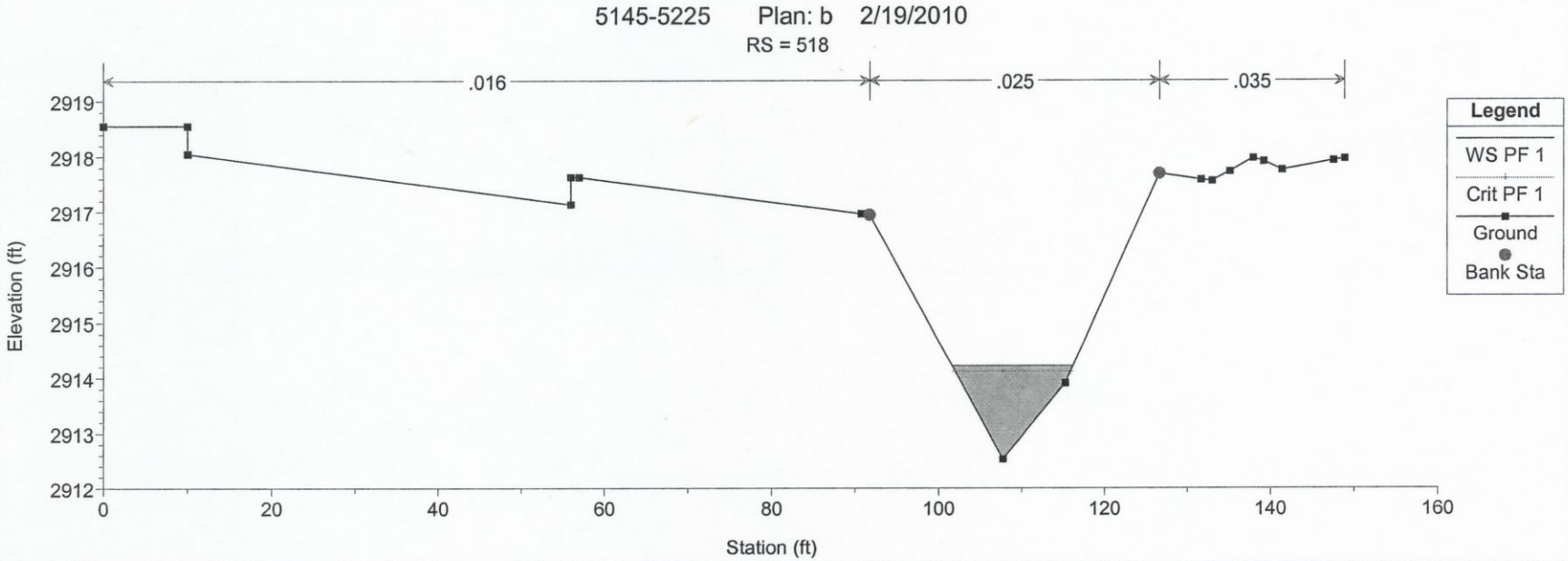
.016
.025
.035
Legend
WS PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)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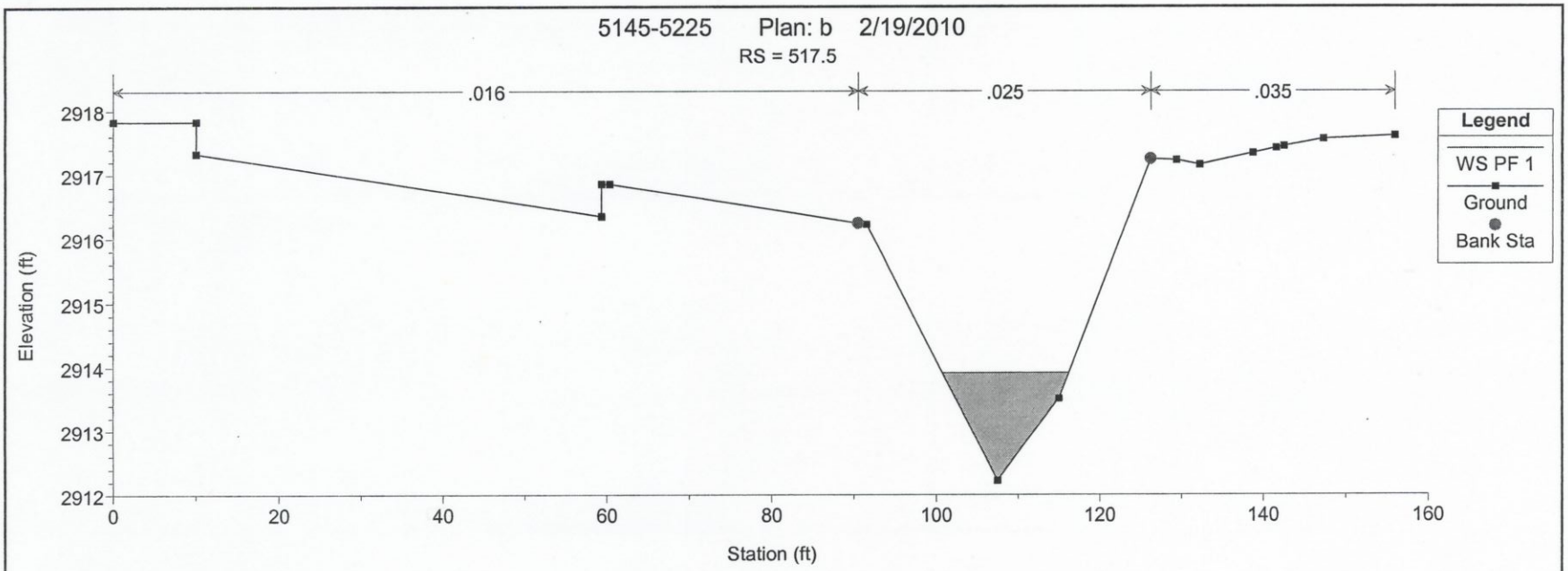
.016
.025
.035
Legend
WS PF 1
Crit PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)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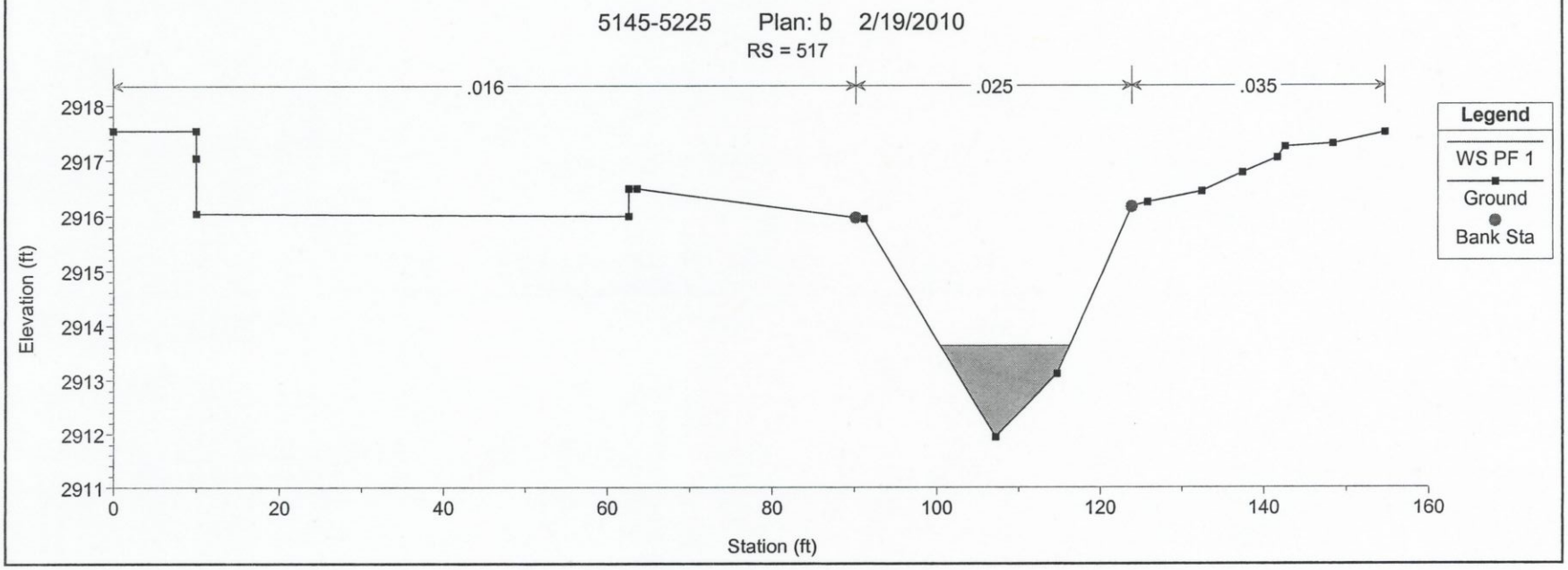
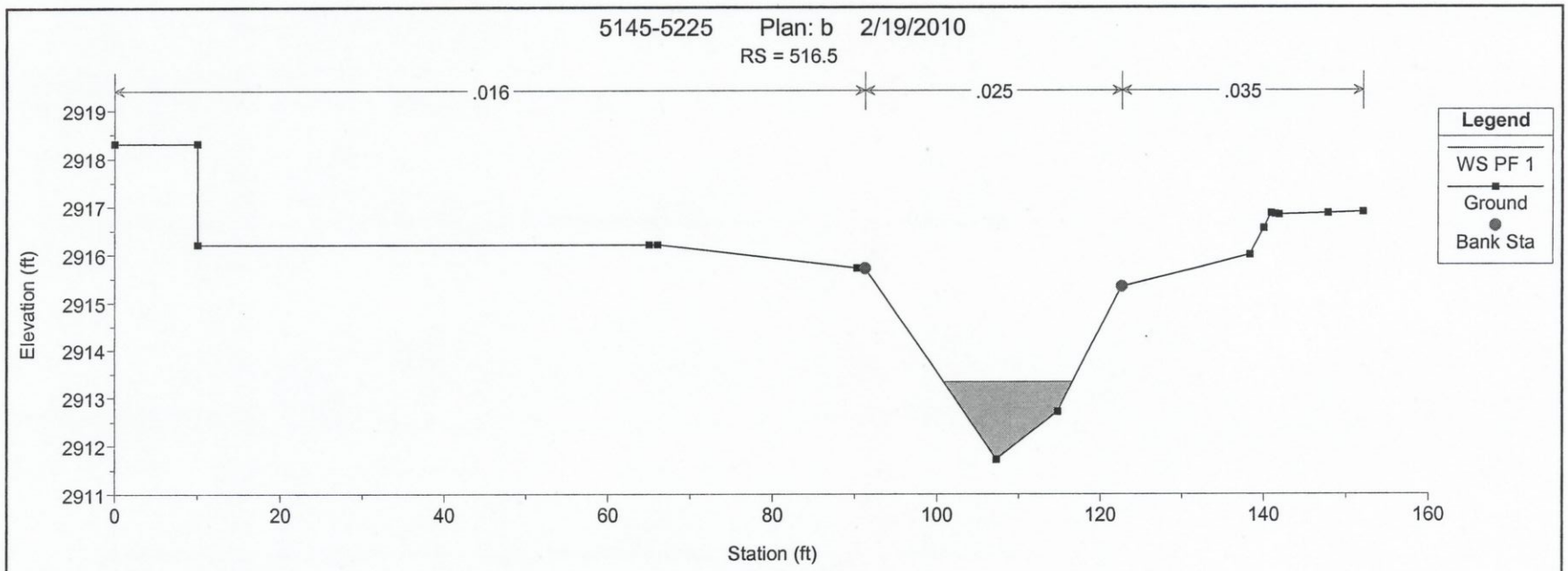
RS = 517.5
.016
.025
.035
Legend
WS PF 1
Ground
Bank Sta
Elevation (ft)
2918
2917
2916
2915
2914
2913
2912
0
20
40
60
80
100
120
140
160
Station (ft)


5145-5225 Plan: b 2/19/2010
RS = 517
.016
.025
.035
Legend
WS PF 1
Ground
Bank Sta
Elevation (ft)
2918
2917
2916
2915
2914
2913
2912
2911
0
20
40
60
80
100
120
140
160
Station (ft)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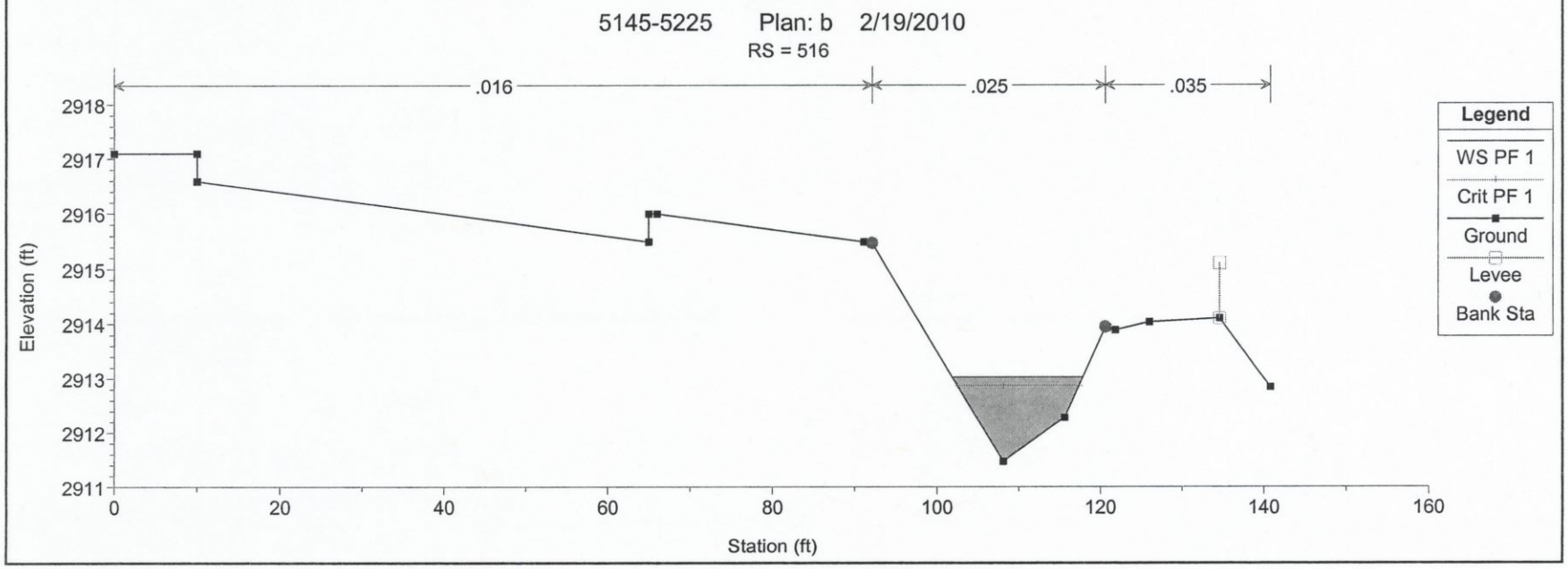
.016
.025
.035
Legend
WS PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)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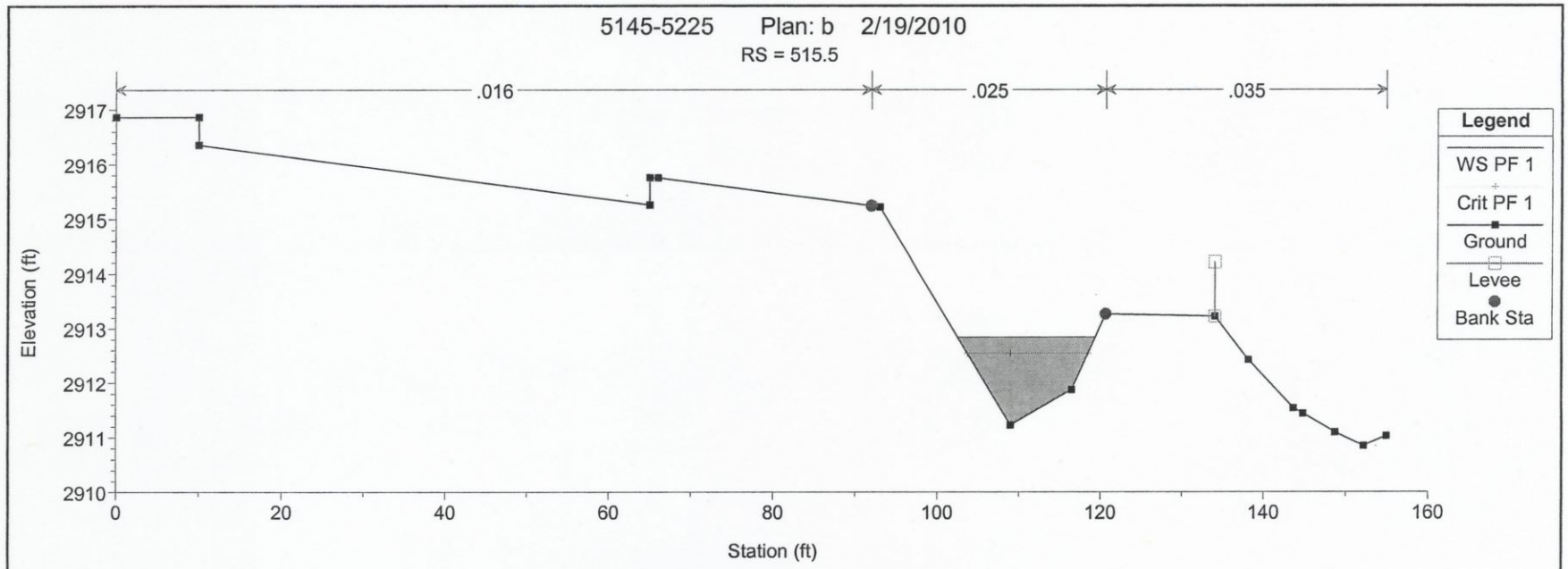
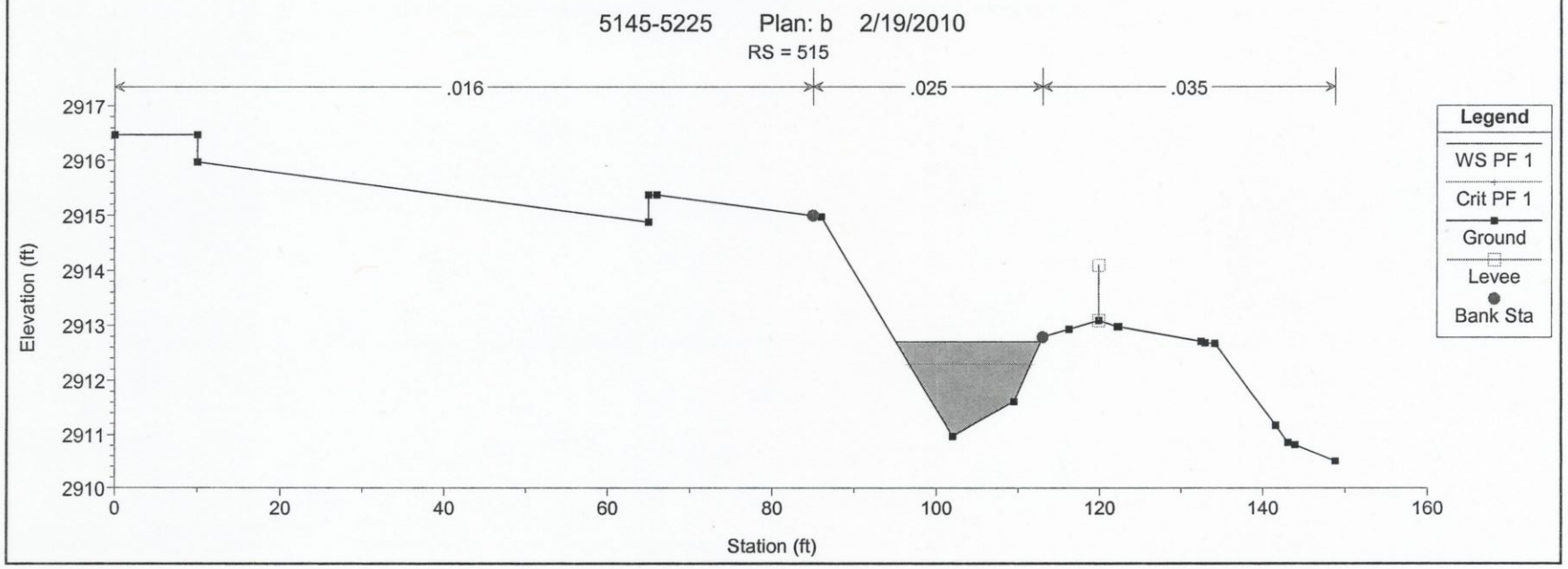
.025
.035
Legend
WS PF 1
Crit PF 1
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)


5145-5225 Plan: b 2/19/2010
RS = 515.5
.016
.025
.035
Elevation (ft)
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Levee
Bank Sta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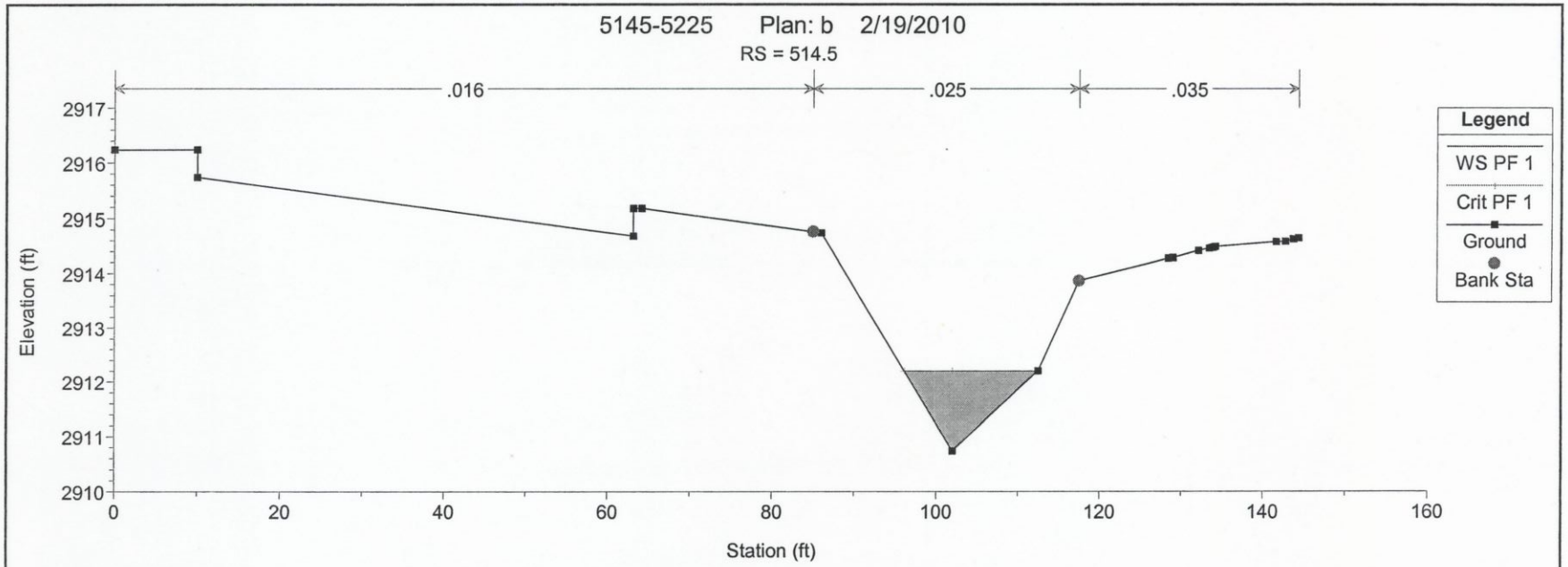
RS = 515
.016
.025
.035
Elevation (ft)
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Levee
Bank Sta


5145-5225 Plan: b 2/19/2010
RS = 514.5
.016
.025
.035
Elevation (ft)
2917
2916
2915
2914
2913
2912
2911
2910
0
20
40
60
80
100
120
140
160
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Bank Sta

ROADSIDE CHANNEL BETWEEN APPROXIMATELY STA. 523+50 AND 526+00

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: 5235-526
Project File : 5235526.prj
Run Date and Time: 2/19/2010 6:07:25 AM

Project in English units

PLAN DATA

Plan Title: c
Plan File :
t:\7TED069904\HYDRO\DRAINAGE\CALCS\Hydraulics\Channels\Ras-Final\revised\5235526.p05

Geometry Title: 5235-526
Geometry File :
t:\7TED069904\HYDRO\DRAINAGE\CALCS\Hydraulics\Channels\Ras-Final\revised\5235526.g11

Flow Title : 0 Flow Profiles
Flow File :
t:\7TED069904\HYDRO\DRAINAGE\CALCS\Hydraulics\Channels\Ras-Final\revised\5235526.F01

Plan Summary Information:

Number of:	Cross Sections =	6	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:\7TED069904\HYDRO\DRAINAGE\CALCS\Hydraulics\Channels\Ras-Final\revised\5235526.F01

Flow Data (cfs)

River	Reach	RS	PF 1
River #1	Reach #1	526	17.4
River #1	Reach #1	524.5	49

Boundary Conditions

River	Reach	Profile	Upstream	Downstream
River #1	Reach #1	PF 1		

Known WS = 2914.78

GEOMETRY DATA

Geometry Title: 5235-526
Geometry File :
t:\7TED069904\HYDRO\DRAINAGE\CALCS\Hydraulics\Channels\Ras-Final\revised\5235526.g11

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 526

INPUT
Description:
Station Elevation Data num= 23

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	2921.8	10	2921.8	10	2921.3	10.01	2921.3	53	2920.44
53.01	2920.44	53.01	2920.94	54	2920.94	76.03	2920.5	77.03	2920.48
93.03	2916.48	102.28	2914.17	102.33	2914.17	102.34	2914.17	107.26	2914.17
111.7	2914.05	118.38	2914.21	124.14	2914.41	125.91	2914.42	126.14	2914.42
133.23	2914.32	135.07	2914.33	140.26	2914.31				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.016	77.03	.025	124.14	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
77.03	124.14	50	50	50	.1	.3

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 525.5

INPUT

Description:
Station Elevation Data num= 30

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	2921.03	6	2921.45	6.01	2921.95	10	2921.55	10	2921.05
10.01	2921.05	53	2920.19	58.02	2920.29	58.02	2920.79	59.01	2920.79
84.36	2920.28	85.36	2920.26	101.36	2916.26	111.36	2913.76	111.41	2913.76
112.68	2913.81	119.95	2914.11	129.92	2913.93	135	2913.86	139.1	2914.02
142.26	2914.12	146.74	2913.22	148.88	2912.66	152.61	2911.57	158.26	2911.54
161.25	2911.54	165.86	2911.33	166.76	2911.29	167.3	2911.44	177.46	2914.52

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.016	85.36	.025	142.26	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
85.36	142.26	50	50	50	.1	.3

Right Levee Station= 142.26 Elevation= 2915.12

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 525

INPUT
Description:
Station Elevation Data num= 25

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	2920.77	6	2921.19	6.01	2921.69	10	2921.3	10	2920.8
10.01	2920.8	53	2919.94	65.01	2920.18	65.01	2920.68	66	2920.68
91	2920.18	92	2920.16	108	2916.16	118.45	2913.55	118.5	2913.55
119.31	2913.56	125.32	2913.57	134.18	2913.56	139.75	2914.12	141	2914.2
147.04	2912.79	150.78	2911.88	151.89	2911.63	153.93	2911.67	160.1	2911.79

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.016	91	.025	141	.035

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
91	141	50	50	50	.1	.3

Right Levee Station= 141 Elevation= 2915.2

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 524.5

INPUT
Description:
Station Elevation Data num= 26

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	2920.48	6	2920.92	6	2921.42	9.99	2921.05	10	2920.55
53	2919.69	65	2919.93	65.01	2920.43	66	2920.43	91	2919.93
92	2919.91	108	2915.91	117.46	2913.54	117.51	2913.55	119.48	2913.6
126.69	2913.56	134.02	2913.38	139.83	2913.86	141.51	2914.01	142.15	2914.06
149.32	2912.16	150.44	2911.9	151.41	2911.9	154.37	2911.89	158.84	2911.85
160.65	2911.8								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.016	91	.025	141.51	.035

```
Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
            91  141.51               50      50      50             .1       .3
Right Levee     Station=  141.51      Elevation= 2915.01
```

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 524

INPUT
Description:
Station Elevation Data num= 40

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	2920.2	6	2920.65	6	2921.15	9.99	2920.8	10	2920.3
53	2919.44	61.76	2919.62	61.77	2920.12	62.76	2920.12	88.55	2919.6
89.55	2919.58	105.55	2915.58	115.72	2913.04	115.77	2913.04	118.06	2913.09
121.15	2913.21	121.27	2913.21	121.48	2913.22	121.62	2913.23	121.63	2913.23
121.74	2913.23	121.78	2913.23	124.34	2913.26	125.42	2913.3	126.29	2913.34
126.9	2913.37	134.09	2913.63	135.13	2913.76	136.35	2913.85	138.33	2913.93
143.11	2914.15	144.09	2914.06	144.43	2914.04	147.6	2912.99	151.97	2911.6
154.82	2911.56	157.81	2911.44	164.18	2911.56	164.55	2911.56	164.75	2911.56

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.016	88.55	.025	143.11	.035

```
Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
         88.55  143.11               50      50      50             .1       .3
Right Levee     Station=  143.11      Elevation= 2915.15
```

CROSS SECTION

RIVER: River #1
REACH: Reach #1 RS: 523.5

INPUT
Description:
Station Elevation Data num= 43

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	2919.91	6	2920.38	6.01	2920.88	10	2920.55	10	2920.05
10.01	2920.05	53	2919.19	53.01	2919.19	53.01	2919.69	54	2919.69
76.05	2919.25	77.05	2919.23	93.05	2915.23	103.29	2912.67	103.34	2912.67
103.36	2912.67	109.78	2912.6	113.83	2912.56	119.22	2912.85	120.71	2912.94
122.06	2912.91	132.99	2912.9	135.66	2913.82	139.42	2914.81	143.04	2915.92
149.53	2916.13	153.13	2916.24	156.11	2916.27	166.89	2916.46	168.49	2916.49
178.05	2916.56	190.85	2916.65	202.55	2916.9	213.62	2916.95	233.83	2916.95
236.89	2916.95	239.16	2916.9	252.04	2916.86	252.96	2916.75	257.58	2916.29
260.14	2916.04	264.24	2915.55	268.41	2914.97				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.016	76.05	.025	143.04	.035

```
Bank Sta: Left   Right    Coeff Contr.   Expan.
         76.05  143.04             .1       .3
```

SUMMARY OF MANNING'S N VALUES

River:River #1

Reach	River Sta.	n1	n2	n3
Reach #1	526	.016	.025	.035
Reach #1	525.5	.016	.025	.035
Reach #1	525	.016	.025	.035
Reach #1	524.5	.016	.025	.035
Reach #1	524	.016	.025	.035
Reach #1	523.5	.016	.025	.035

SUMMARY OF REACH LENGTHS

River: River #1

Reach	River Sta.	Left	Channel	Right
Reach #1	526	50	50	50
Reach #1	525.5	50	50	50
Reach #1	525	50	50	50
Reach #1	524.5	50	50	50
Reach #1	524	50	50	50
Reach #1	523.5			

SUMMARY OF CONTRACTION AND EXPANSION COEFFICIENTS
River: River #1

Reach	River Sta.	Contr.	Expan.
Reach #1	526	.1	.3
Reach #1	525.5	.1	.3
Reach #1	525	.1	.3
Reach #1	524.5	.1	.3
Reach #1	524	.1	.3
Reach #1	523.5	.1	.3

Profile Output Table - Standard Table 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.
E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	
			(cfs)	(ft)	(ft)	(ft)
(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		
Reach #1	526	PF 1	17.40	2914.05	2914.85	
2914.86	0.000386	0.86	23.51	40.70	0.19	
Reach #1	525.5	PF 1	17.40	2913.76	2914.84	2914.17
2914.85	0.000132	0.59	29.31	35.23	0.11	
Reach #1	525	PF 1	17.40	2913.55	2914.84	2913.88
2914.84	0.000092	0.59	29.74	27.70	0.10	
Reach #1	524.5	PF 1	49.00	2913.38	2914.79	2914.08
2914.82	0.000599	1.52	32.15	29.03	0.26	
Reach #1	524	PF 1	49.00	2913.04	2914.78	2913.88
2914.80	0.000346	1.21	40.44	34.34	0.20	
Reach #1	523.5	PF 1	49.00	2912.56	2914.78	2913.19

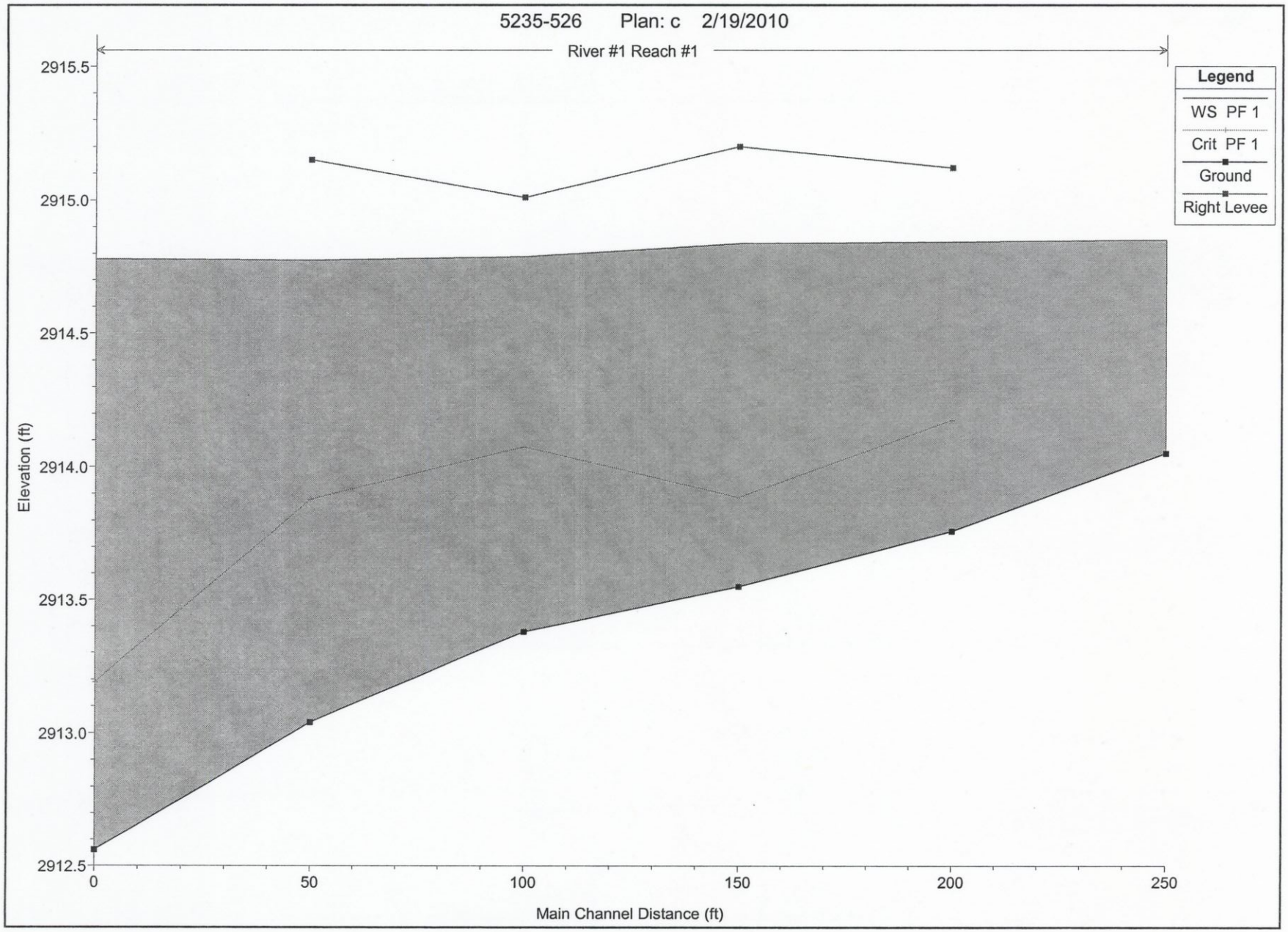
2914.79	0.000063	0.66	74.27	44.46	0.09

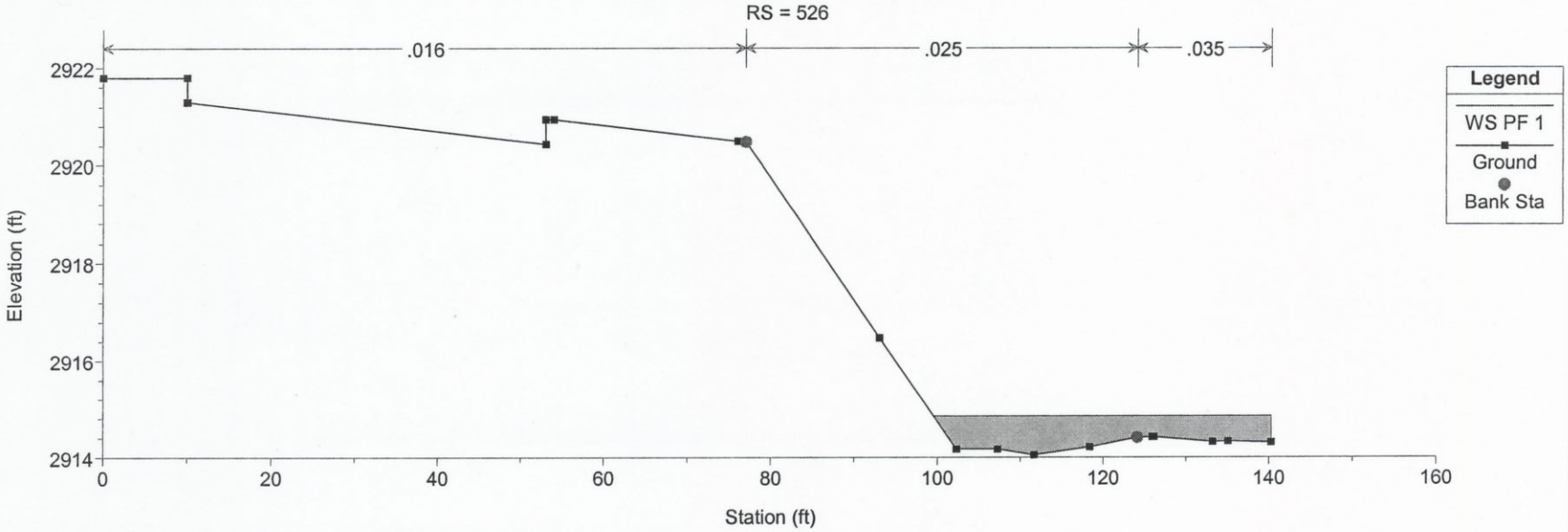
Profile Output Table - Standard Table 2

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)	(cfs)	(cfs)	(cfs)	(ft)
Reach #1	526	PF 1	2914.86	2914.85	0.01	0.01	0.00	13.31	4.09	40.70	
Reach #1	525.5	PF 1	2914.85	2914.84	0.01	0.01	0.00	17.40		35.23	
Reach #1	525	PF 1	2914.84	2914.84	0.01	0.02	0.00	17.40		27.70	
Reach #1	524.5	PF 1	2914.82	2914.79	0.04	0.02	0.00	49.00		29.03	
Reach #1	524	PF 1	2914.80	2914.78	0.02	0.01	0.00	49.00		34.34	
Reach #1	523.5	PF 1	2914.79	2914.78	0.01			49.00		44.46	

ERRORS WARNINGS AND NOTES
Errors Warnings and Notes for Plan : c

River: River #1 Reach: Reach #1 RS: 526 Profile: PF 1
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: 525.5 Profile: PF 1
Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was
used.
River: River #1 Reach: Reach #1 RS: 525 Profile: PF 1
Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was
used.
River: River #1 Reach: Reach #1 RS: 524.5 Profile: PF 1
Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was
used.
River: River #1 Reach: Reach #1 RS: 524 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.
Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was
used.


5235-526 Plan: c 2/19/2010
River #1 Reach #1
Legend
WS PF 1
Crit PF 1
Ground
Right Levee
Elevation (ft)
2915.5
2915.0
2914.5
2914.0
2913.5
2913.0
2912.5
0
50
100
150
200
250
Main Channel Distance (ft)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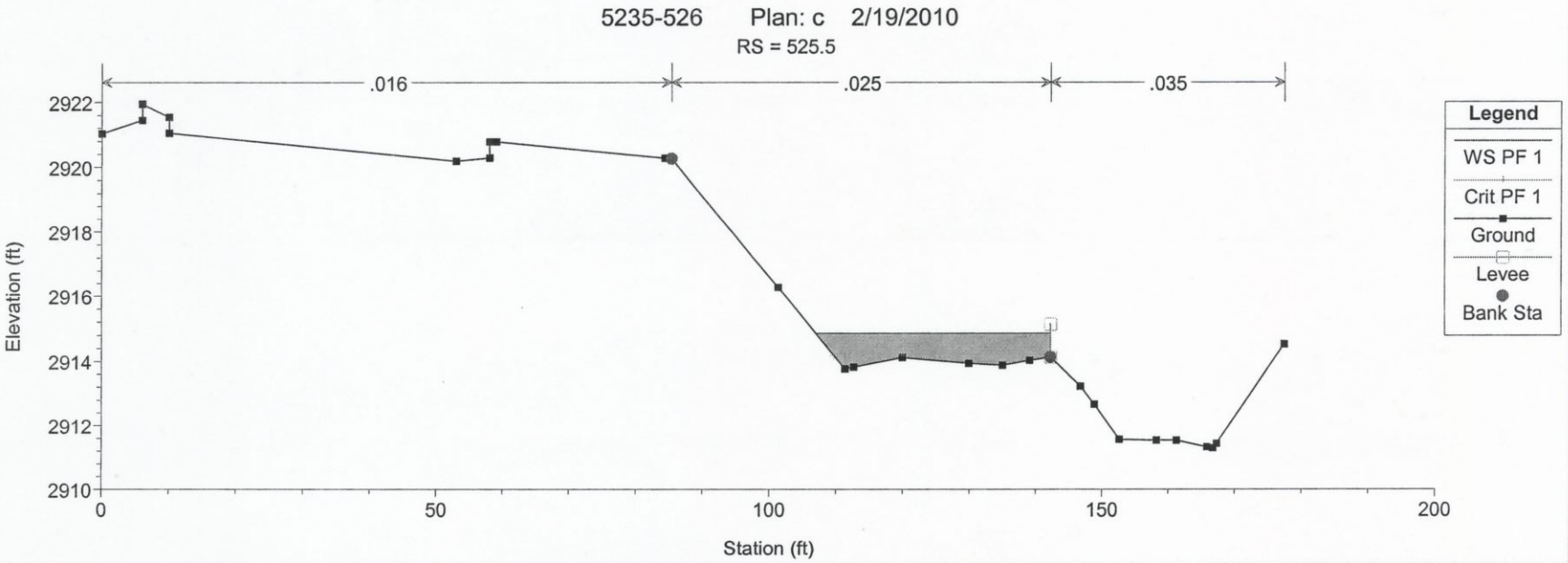
RS = 526
.016
.025
.035
Legend
WS PF 1
Ground
Bank Sta
Elevation (ft)
2922
2920
2918
2916
2914
0
20
40
60
80
100
120
140
160
Station (ft)


5235-526 Plan: c 2/19/2010
RS = 525.5
.016
.025
.035
Legend
WS PF 1
Crit PF 1
Ground
Levee
Bank Sta
Elevation (ft)
2922
2920
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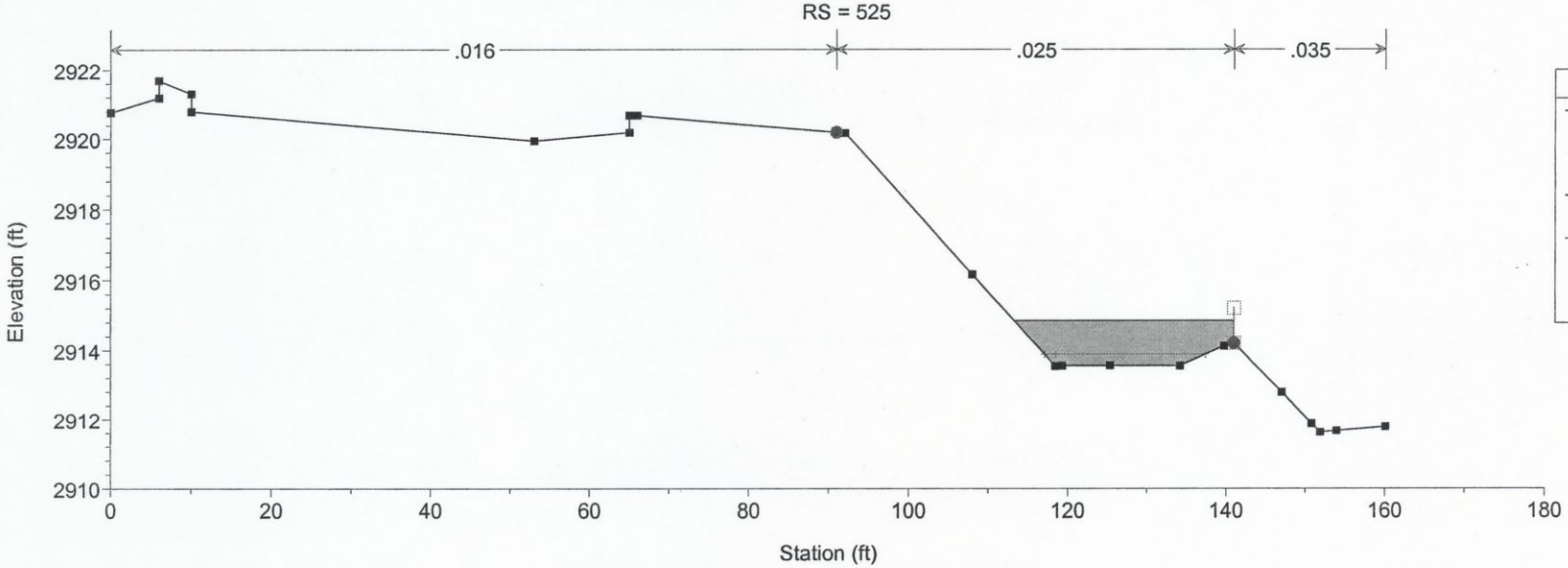
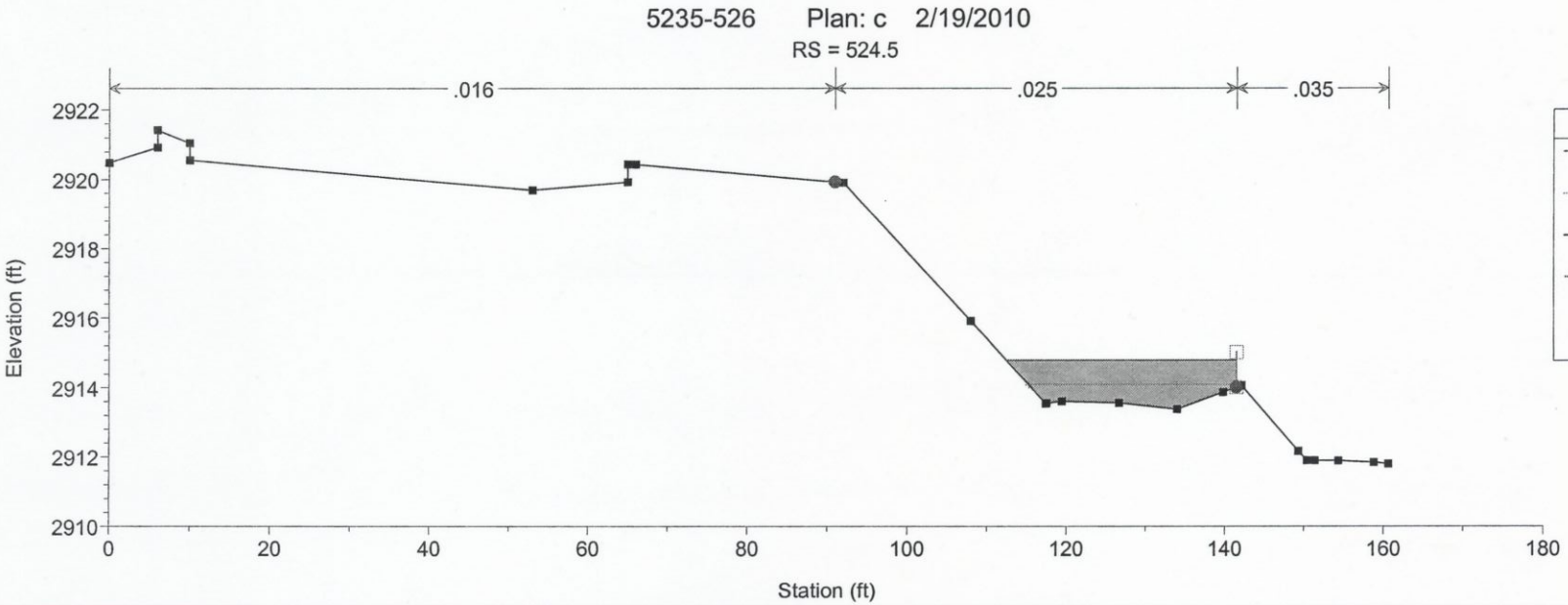
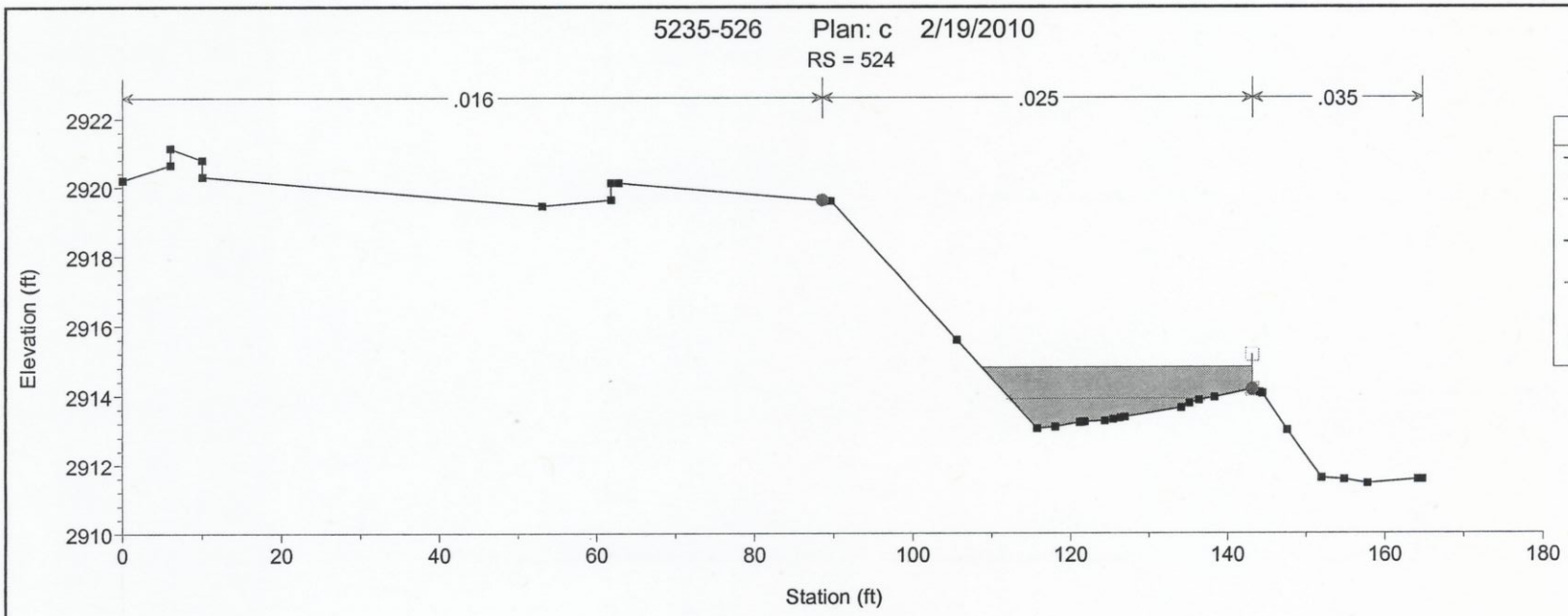
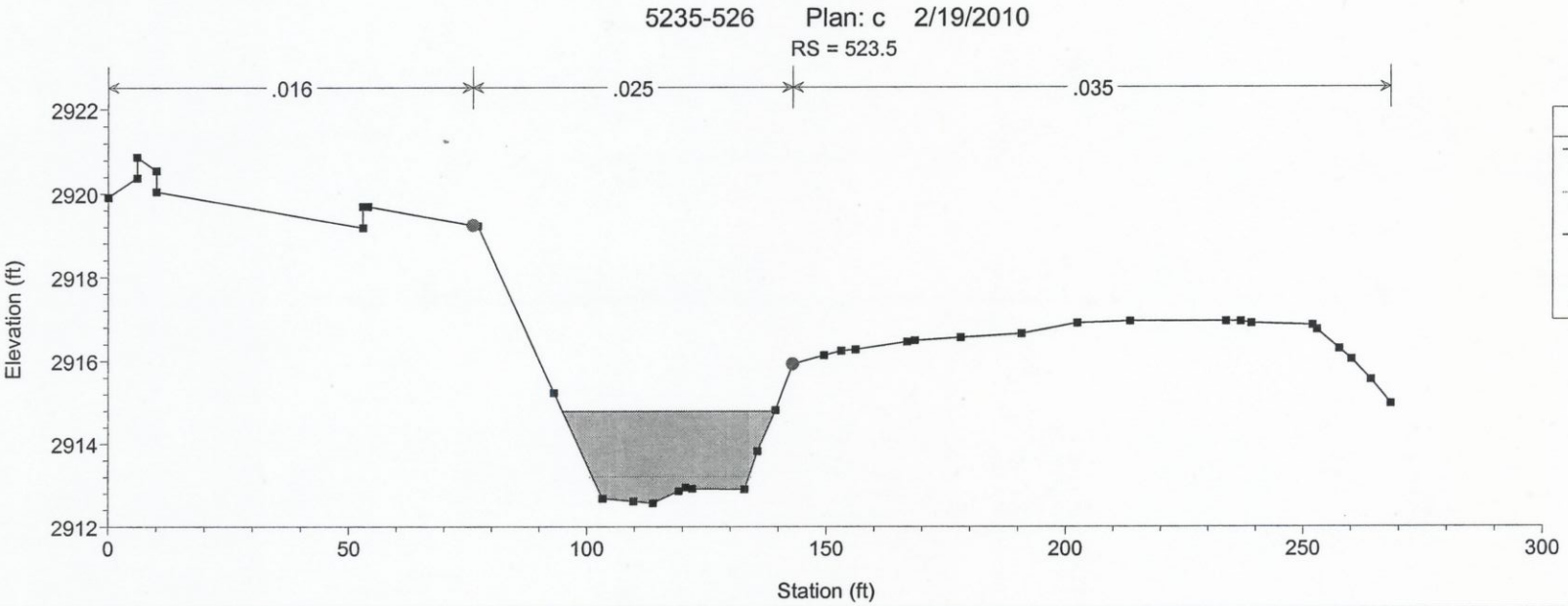
2916
2914
2912
2910
0
50
100
150
200
Station (ft)


5235-526 Plan: c 2/19/2010
RS = 525
.016
.025
.035
Elevation (ft)
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Levee
Bank Sta


5235-526 Plan: c 2/19/2010
RS = 524.5
.016
.025
.035
Elevation (ft)
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Levee
Bank Sta


5235-526 Plan: c 2/19/2010
RS = 524
.016
.025
.035
Legend
WS PF 1
Crit PF 1
Ground
Levee
Bank Sta
Elevation (ft)
2910
2912
2914
2916
2918
2920
2922
0
20
40
60
80
100
120
140
160
180
Station (ft)


5235-526 Plan: c 2/19/2010
RS = 523.5
.016
.025
.035
Legend
WS PF 1
Crit PF 1
Ground
Bank Sta
Elevation (ft)
2912
2914
2916
2918
2920
2922
0
50
100
150
200
250
300
Station (ft)

STORM DRAIN HYDRAULIC ANALYSIS

Table DS 4-8.

Headloss Coefficients

Type of Structure	Loss Coefficient (k_m, k_j)	Equation
Entrance Loss Coefficients [a]		
Pipe projecting from fill – Socket end of pipe	0.2	Equation DS 4-1
Pipe projecting from fill – Square cut end of pipe	0.5	
Pipe with Headwall – Socket end of pipe	0.2	
Pipe with Headwall – Square cut end of pipe	0.5	
Pipe with Headwall – Rounded entrance	0.2	
Pipe mitered on conform to fill slope	0.7	
Pipe with End section conformed to fill slope	0.5	
Beveled edges or Side slope tapered inlet	0.2	
Exit Loss Coefficient [b]	1.0	
Manhole / Inlet / Junctions Loss Coefficients [c]		
Inlet or Manhole at Beginning of Line	1.25	Equation DS 4-1
Inlet on Main Line, with No Branch Laterals	0.50	Equation DS 4-2
Inlet on Main Line, with Branch Laterals	0.25	
Manhole on Main Line, with Branch Laterals at $\theta°$		
$\theta = 22.5°$	0.75	Equation DS 4-2
$\theta = 45°$	0.50	
$\theta = 60°$	0.35	
$\theta = 90°$	0.25	

(a) U. S. Department of Transportation, Federal Highway Administration, *Hydraulic Design of Highway Culverts*, (September 2001)

(b) Exit losses include discharge of a storm drain system into a channel or detention basins.

(c) Water Environment Federation and American Society of Civil Engineers, *Design and Construction of Urban Stormwater Management Systems*, (1992)

h. Alignment:

i. Storm drain pipelines shall be installed adjacent to the curb and gutter in line with the curb inlet structure and within the public right of way, or with the approval of the Director of Public Works within dedicated public easements. Storm Drain pipe will only be considered for locating within easements when it is not possible to locate the pipe within the public street/sidewalk right of way.

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	(Pipe 1) outfall	293.3	72	Cir	19.800	2764.93	2765.01	0.404	2770.93	2771.01	1.67	2772.68	End	Manhole
2	(Pipe 2)	293.3	72	Cir	183.780	2765.31	2766.06	0.408	2772.68*	2773.57*	0.52	2774.08	1	Manhole
3	(Pipe 3)	293.3	72	Cir	391.940	2766.35	2768.04	0.431	2774.08*	2775.96*	0.25	2776.22	2	Manhole
4	(Pipe4-1)	293.3	72	Cir	201.560	2768.34	2772.45	2.039	2776.22	2777.01	0.63	2777.01	3	None
5	(Pipe 15)	2.95	18	Cir	4.680	2776.92	2776.97	1.069	2777.45	2777.76	0.08	2777.83	4	None
6	(Pipe 14)	1.25	18	Cir	99.780	2776.97	2777.37	0.401	2777.83	2777.90	0.10	2778.00	5	None
7	(Pipe 4-2)	290.4	72	Cir	140.000	2772.45	2775.31	2.043	2777.01	2779.85	0.62	2779.85	4	Manhole
8	(Pipe 5-1)	288.1	72	Cir	91.020	2775.61	2779.13	3.867	2779.85	2783.65	n/a	2783.65	7	None
9	(Pipe 5-2)	269.1	72	Cir	72.090	2779.13	2781.92	3.870	2783.65	2786.29	n/a	2786.29	8	None
10	(Pipe 5-3)	268.1	72	Cir	69.450	2781.92	2784.62	3.888	2786.29	2788.98	n/a	2788.98	9	Manhole
11	(Pipe 6-1)	266.4	72	Cir	43.000	2784.92	2785.93	2.349	2788.98	2790.27	n/a	2790.27	10	None
12	(Pipe 6-2)	263.2	72	Cir	212.300	2785.93	2790.94	2.360	2790.27	2795.26	0.57	2795.26	11	Manhole
13	(pipe 7)	232.1	54	Cir	466.000	2792.74	2807.79	3.230	2795.40	2812.01	0.87	2812.01	12	Manhole
14	(pipe 8-1)	202.1	54	Cir	36.560	2808.09	2808.98	2.434	2812.01	2813.04	0.70	2813.04	13	None
15	(Pipe 8-2)	173.9	54	Cir	461.370	2808.98	2820.24	2.441	2813.04	2824.02	0.00	2824.02	14	Manhole
16	(Pipe 9)	156.4	54	Cir	320.000	2820.54	2822.40	0.581	2824.43	2826.29	0.45	2826.73	15	Manhole
17	(Pipe 10)	141.1	54	Cir	347.100	2822.70	2825.09	0.689	2826.73	2828.50	n/a	2828.50	16	Manhole
18	(Pipe 11-1)	125.1	54	Cir	335.300	2825.39	2826.63	0.370	2829.30	2830.54	0.28	2830.82	17	None
19	(Pipe 11-2)	83.05	54	Cir	50.590	2826.63	2826.82	0.376	2830.82	2830.88	0.12	2831.00	18	Manhole
20	(Pipe 12-1)	78.45	54	Cir	228.370	2827.12	2827.81	0.302	2831.00	2831.27	0.14	2831.41	19	None
21	(Pipe12-2)	76.45	54	Cir	181.000	2827.81	2828.35	0.298	2831.41	2831.63	0.15	2831.78	20	Manhole
22	(Pipe 13)	36.45	54	Cir	100.710	2828.65	2830.30	1.639	2831.78	2832.03	n/a	2832.03 j	21	Manhole
23	(Pipe 36)	34.45	30	Cir	20.500	2831.90	2832.11	1.025	2833.64	2834.33	0.44	2834.76	22	None

Houghton Stormdrain Mainline | Number of lines: 44 | Run Date: 02-19-2010

NOTES: Return period = 10 Yrs. ; *Surcharged (HGL above crown). ; j - Line contains hyd. jump.

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
24	(Pipe 37)	32.00	30	Cir	10.450	2832.11	2832.21	0.956	2834.76*	2834.83*	0.83	2835.65	23	None
25	(Pipe 16)	2.30	18	Cir	40.770	2779.39	2779.80	1.006	2779.87	2780.38	n/a	2780.38	7	None
26	(Pipe 20)	1.70	18	Cir	3.980	2788.75	2788.79	1.006	2789.16	2789.37	0.14	2789.51	10	None
27	(Pipe 21)	3.15	18	Cir	121.140	2790.41	2791.62	0.999	2790.97	2792.30	0.32	2792.30	11	None
28	(pipe 24)	10.70	18	Cir	7.500	2795.33	2795.41	1.064	2796.54	2796.68	0.87	2797.55	12	None
29	(Pipe 25)	30.00	30	Cir	43.050	2809.54	2814.56	11.661	2812.01	2816.39	n/a	2816.39 j	13	None
30	(Pipe 26)	28.25	24	Cir	31.270	2811.46	2811.77	0.992	2813.46*	2813.95*	1.57	2815.52	14	None
31	(Pipe 27)	17.50	18	Cir	56.130	2822.89	2823.45	0.998	2824.39*	2825.95*	1.91	2827.86	15	None
32	(Pipe 28)	15.30	24	Cir	56.130	2824.47	2825.03	0.998	2826.73	2826.97	0.47	2827.44	16	None
33	(Pipe 29)	16.00	24	Cir	56.130	2827.14	2827.70	0.998	2828.50	2829.12	0.88	2829.12	17	None
34	(Pipe 30)	42.00	24	Cir	57.900	2828.00	2828.58	1.002	2830.82*	2832.82*	3.47	2836.29	18	None
35	(Pipe 31)	3.00	18	Cir	7.530	2829.38	2829.46	1.063	2831.00*	2831.01*	0.06	2831.06	19	None
36	(Pipe 33)	2.00	18	Cir	93.250	2830.80	2831.73	0.997	2831.41	2832.27	n/a	2832.27 j	20	None
37	(Pipe 34)	40.00	30	Cir	54.010	2830.21	2830.75	1.000	2832.21	2832.87	1.58	2834.45	21	None
38	(Pipe 35)	2.00	18	Cir	91.500	2832.90	2833.82	1.006	2833.34	2834.36	0.24	2834.36	22	None
39	(Pipe 18)	19.00	18	Cir	146.150	2783.08	2784.54	0.999	2784.58*	2789.37*	0.90	2790.27	8	None
40	(Pipe 23)	20.40	30	Cir	107.510	2794.33	2794.87	0.502	2795.87	2796.42	0.32	2796.74	12	None
41	(Pipe 32)	1.60	18	Cir	91.470	2829.38	2830.29	0.995	2831.00	2831.02	0.07	2831.09	19	None
42	(Pipe 19)	4.20	18	Cir	45.350	2784.72	2785.17	0.992	2790.27*	2790.34*	0.11	2790.45	39	None
43	(Pipe 22)	18.25	30	Cir	41.820	2794.87	2795.06	0.454	2796.74	2796.79	0.49	2797.28	40	None
44	(Pipe 17)	1.00	18	Cir	23.500	2786.42	2786.66	1.021	2786.73	2787.05	0.15	2787.20	9	None

Houghton Stormdrain Mainline | Number of lines: 44 | Run Date: 02-19-2010

NOTES: Return period = 10 Yrs. ; *Surcharged (HGL above crown). ; j - Line contains hyd. jump.

MyR ort

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	269.37	4.56	....	....	....	145.000	6.00	6.00	Outfall	0.00	154072.12	2772.60	2772.68	0.095
2	28.27	28.27	1	0.20	0.50	0.90	270.59	4.56	....	....	....	-40.560	6.00	6.00	1	0.00	154026.30	2774.36	2775.24	0.881
3	28.27	28.27	2	0.20	0.50	0.90	278.14	4.56	....	....	....	-15.003	6.00	6.00	2	0.00	154030.15	2775.76	2777.64	1.880
4	28.27	23.05	3	0.20	0.50	0.90	604.84	4.56	....	....	....	-0.049	6.00	4.56**	3	0.00	154032.30	2777.89	2779.53	1.048
5	0.56	0.94	4	0.20	0.50	0.90	10.86	0.66	....	....	....	90.052	0.53	0.79	4	0.00	154027.62	2777.88	2777.91	0.031
6	1.05	0.55	5	0.20	0.50	0.90	6.65	0.43	....	....	....	-2.958	0.86	0.52	5	0.00	153928.03	2777.86	2777.98	0.121
7	23.05	22.93	3	0.20	0.50	0.90	605.42	4.54	....	....	....	-0.049	4.56	4.54**	4	0.00	154033.92	2779.48	2782.34	0.772
8	21.34	22.84	7	0.20	0.50	0.90	832.95	4.52	....	....	....	-0.001	4.24	4.52**	7	0.00	154034.97	2782.68	2786.12	0.545
9	22.84	22.04	8	0.20	0.50	0.90	833.30	4.37	....	....	....	0.000	4.52	4.37**	8	0.00	154035.80	2785.81	2788.60	0.361
10	22.04	22.00	9	0.20	0.50	0.90	835.21	4.36	....	....	....	0.000	4.37	4.36**	9	0.00	154036.60	2788.59	2791.29	0.360
11	20.35	21.92	10	0.20	0.50	0.90	649.17	4.34	....	....	....	-0.104	4.06	4.34**	10	0.00	154037.18	2791.64	2792.57	0.244
12	21.92	21.78	11	0.20	0.50	0.90	650.69	4.32	....	....	....	-0.003	4.34	4.32**	11	0.00	154040.03	2792.52	2797.53	1.081
13	9.79	15.49	12	0.20	0.50	0.90	353.42	4.22	....	....	....	-0.304	2.66	4.22**	12	0.00	154048.75	2804.14	2815.50	10.325
14	14.70	15.10	13	0.20	0.50	0.90	306.82	4.06	....	....	....	0.901	3.92	4.06**	13	0.00	154048.86	2814.95	2815.82	0.346
15	15.10	14.27	14	0.20	0.50	0.90	307.23	3.78	....	....	....	0.008	4.06	3.78**	14	0.00	154050.18	2815.10	2826.33	3.311
16	14.61	14.61	15	0.20	0.50	0.90	149.93	3.59	....	....	....	-0.909	3.89	3.89	15	0.00	154056.18	2826.21	2828.07	1.860
17	15.03	12.92	16	0.20	0.50	0.90	163.19	3.41	....	....	....	-0.002	4.03	3.41**	16	0.00	154062.69	2828.10	2830.35	1.839
18	14.66	14.67	17	0.20	0.50	0.90	119.60	3.21	....	....	....	0.001	3.91	3.91	17	0.00	154068.97	2830.43	2831.67	1.239
19	15.43	15.11	18	0.20	0.50	0.90	120.58	2.61	....	....	....	0.026	4.19	4.06	18	0.00	154069.90	2831.27	2831.35	0.079
20	14.59	13.13	19	0.20	0.50	0.90	108.10	2.54	....	....	....	0.006	3.88	3.46	19	0.00	154074.05	2831.45	2831.83	0.374
21	13.65	12.42	20	0.20	0.50	0.90	107.42	2.51	....	....	....	0.004	3.60	3.28	20	0.00	154077.33	2831.90	2832.22	0.319
22	11.80	5.64	21	0.20	0.50	0.90	251.74	1.73	....	....	....	-0.004	3.13	1.73**	21	0.00	154079.16	2831.93	2832.68	0.201

Houghton Stormdrain Mainline | Number of lines: 44 | Date: 02-19-2010

NOTES: ** Critical depth

MyR ort

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)
23	3.64	4.60	22	0.20	0.50	0.90	41.53	1.96	....	....	....	-89.519	1.74	2.22	22	0.00	154099.66	2835.03	2835.20	0.170
24	4.91	4.91	23	0.20	0.50	0.90	40.09	1.89	....	....	....	-24.084	2.50	2.50	23	0.00	154109.16	2835.42	2835.49	0.064
25	0.48	0.63	7	0.20	0.50	0.90	10.53	0.58	....	....	....	90.054	0.48	0.58**	7	0.00	153993.15	2780.22	2780.59	0.303
26	0.39	0.63	10	0.20	0.50	0.90	10.53	0.50	....	....	....	-90.119	0.41	0.58	10	0.00	154040.58	2789.46	2789.48	0.025
27	0.61	0.77	11	0.20	0.50	0.90	10.50	0.68	....	....	....	90.012	0.56	0.68**	11	0.00	153916.05	2791.39	2792.55	0.915
28	1.53	1.60	12	0.20	0.50	0.90	10.83	1.25	....	....	....	-90.294	1.21	1.27	12	0.00	154047.53	2797.30	2797.38	0.077
29	4.90	3.85	13	0.20	0.50	0.90	140.05	1.83	....	....	....	-88.906	2.47	1.83**	13	0.00	154091.80	2812.59	2817.33	0.252
30	3.14	3.14	14	0.20	0.50	0.90	22.52	1.84	....	....	....	-89.886	2.00	2.00	14	0.00	154080.13	2814.72	2815.21	0.488
31	1.77	1.77	15	0.20	0.50	0.90	10.49	1.45	....	....	....	-90.910	1.50	1.50	15	0.00	154106.30	2825.92	2827.47	1.559
32	3.14	3.11	16	0.20	0.50	0.90	22.59	1.39	....	....	....	-90.002	2.00	1.94	16	0.00	154112.30	2827.10	2827.35	0.241
33	2.27	2.38	17	0.20	0.50	0.90	22.59	1.42	....	....	....	-89.996	1.36	1.42**	17	0.00	154118.81	2829.27	2829.82	0.412
34	3.14	3.14	18	0.20	0.50	0.90	22.64	1.96	....	....	....	-90.234	2.00	2.00	18	0.00	154126.86	2833.60	2835.60	1.997
35	1.77	1.77	19	0.20	0.50	0.90	10.83	0.66	....	....	....	-90.020	1.50	1.50	19	0.00	154077.43	2831.05	2831.05	0.006
36	0.68	0.57	20	0.20	0.50	0.90	10.49	0.54	....	....	....	92.750	0.61	0.54**	20	0.00	153980.84	2831.55	2832.46	0.359
37	4.20	4.43	21	0.20	0.50	0.90	41.01	2.11	....	....	....	-88.944	2.00	2.12**	21	0.00	154131.34	2833.62	2834.13	0.513
38	0.44	0.57	22	0.20	0.50	0.90	10.53	0.54	....	....	....	90.474	0.44	0.54**	22	0.00	153987.67	2833.67	2834.55	0.675
39	1.77	1.77	10	0.20	0.50	0.90	10.50	1.46	....	....	....	89.908	1.50	1.50	8	0.00	153888.83	2786.38	2791.16	4.786
40	3.18	3.19	12	0.20	0.50	0.90	29.07	1.51	....	....	....	89.695	1.54	1.55	12	0.00	153932.54	2796.51	2797.05	0.539
41	1.77	0.85	19	0.20	0.50	0.90	10.48	0.48	....	....	....	89.974	1.50	0.73	19	0.00	153978.44	2831.01	2831.07	0.058
42	1.77	1.77	39	0.20	0.50	0.90	10.46	0.78	....	....	....	-90.000	1.50	1.50	39	0.00	153889.43	2790.35	2790.43	0.073
43	3.93	3.62	40	0.20	0.50	0.90	27.64	1.43	....	....	....	-1.926	1.86	1.73	40	0.00	153890.77	2797.07	2797.18	0.111
44	0.27	0.36	1	0.20	0.50	0.90	10.61	0.38	....	....	....	-90.000	0.31	0.39**	9	0.00	154059.30	2786.95	2787.17	0.171

Houghton Stormdrain Mainline | Number of lines: 44 | Date: 02-19-2010

NOTES: ** Critical depth

MyR ort

Flow Rate (cfs)	Sf Ave (ft/ft)	Sf Dn (ft/ft)	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 (%)
293.30	0.478	0.480	....	....	....	2770.95	2777.29	....	....	....	....	2770.93	2771.01	2772.68	....	....	0.00	0.00	....	....
293.30	0.480	0.480	....	....	....	2777.29	2776.00	....	....	....	....	2772.68	2773.57	2774.08	....	....	0.00	0.00	....	....
293.30	0.480	0.480	....	....	....	2776.00	2777.59	....	....	....	....	2774.08	2775.96	2776.22	....	....	0.00	0.00	....	....
293.30	0.520	0.480	....	....	....	2777.59	2781.86	....	....	....	....	2776.22	2777.01	2777.01	....	....	0.00	0.00	....	....
2.95	0.669	1.070	....	....	....	2781.86	2780.47	....	....	....	....	2777.45	2777.76	2777.83	....	....	0.00	1.70	....	....
1.25	0.121	0.036	....	....	....	2780.47	2780.33	....	....	....	....	2777.83	2777.90	2778.00	....	....	0.00	1.25	....	....
290.35	0.552	0.549	....	....	....	2781.86	2785.67	....	....	....	....	2777.01	2779.85	2779.85	....	....	0.00	0.00	....	....
288.05	0.598	0.645	....	....	....	2785.67	2787.70	....	....	....	....	2779.85	2783.65	2783.65	....	....	0.00	0.00	....	....
269.05	0.501	0.481	....	....	....	2787.70	2789.72	....	....	....	....	2783.65	2786.29	2786.29	....	....	0.00	0.00	....	....
268.05	0.519	0.518	....	....	....	2789.72	2795.03	....	....	....	....	2786.29	2788.98	2788.98	....	....	0.00	0.00	....	....
266.35	0.568	0.618	....	....	....	2795.03	2795.86	....	....	....	....	2788.98	2790.27	2790.27	....	....	0.00	0.00	....	....
263.20	0.509	0.505	....	....	....	2795.86	2805.21	....	....	....	....	2790.27	2795.26	2795.26	....	....	0.00	0.00	....	....
232.10	2.216	3.228	....	....	....	2805.21	2820.54	....	....	....	....	2795.40	2812.01	2812.01	....	....	0.00	0.00	....	....
202.10	0.945	0.962	....	....	....	2820.54	2820.76	....	....	....	....	2812.01	2813.04	2813.04	....	....	0.00	0.00	....	....
173.85	0.718	0.687	....	....	....	2820.76	2831.39	....	....	....	....	2813.04	2824.02	2824.02	....	....	0.00	0.00	....	....
156.35	0.581	0.581	....	....	....	2831.39	2833.71	....	....	....	....	2824.43	2826.29	2826.73	....	....	0.00	0.00	....	....
141.05	0.530	0.454	....	....	....	2833.71	2836.20	....	....	....	....	2826.73	2828.50	2828.50	....	....	0.00	0.00	....	....
125.05	0.370	0.370	....	....	....	2836.20	2837.03	....	....	....	....	2829.30	2830.54	2830.82	....	....	0.00	0.00	....	....
83.05	0.155	0.154	....	....	....	2837.03	2838.30	....	....	....	....	2830.82	2830.88	2831.00	....	....	0.00	0.00	....	....
78.45	0.164	0.147	....	....	....	2838.30	2838.46	....	....	....	....	2831.00	2831.27	2831.41	....	....	0.00	0.00	....	....
76.45	0.176	0.158	....	....	....	2838.46	2840.42	....	....	....	....	2831.41	2831.63	2831.78	....	....	0.00	0.00	....	....
36.45	0.199	0.050	....	....	....	2840.42	2840.95	....	....	....	....	2831.78	2832.03 j	2832.03	2831.70	2830.59	0.00	0.00	....	....

Houghton Stormdrain Mainline | Number of lines: 44 | Date: 02-19-2010

NOTES: ** Critical depth

MyR ort

Flow Rate (cfs)	Sf Ave (ft/ft)	Sf Dn (ft/ft)	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 (%)
34.45	0.827	1.025	....	....	....	2840.95	2839.48	....	....	....	....	2833.64	2834.33	2834.76	....	....	0.00	2.45	....	....
32.00	0.609	0.609	....	....	....	2839.48	2837.60	....	....	....	....	2834.76	2834.83	2835.65	....	....	0.00	32.00	....	....
2.30	0.743	1.003	....	....	....	2785.67	2785.38	....	....	....	....	2779.87	2780.38	2780.38	....	....	0.00	2.30	....	....
1.70	0.636	1.004	....	....	....	2795.03	2793.91	....	....	....	....	2789.16	2789.37	2789.51	....	....	0.00	1.70	....	....
3.15	0.756	0.999	....	....	....	2795.86	2795.95	....	....	....	....	2790.97	2792.30	2792.30	....	....	0.00	3.15	....	....
10.70	1.022	1.064	....	....	....	2805.21	2804.03	....	....	....	....	2796.54	2796.68	2797.55	....	....	0.00	10.70	....	....
30.00	0.585	0.488	....	....	....	2820.54	2819.83	....	....	....	....	2812.01	2816.39 j	2816.39	2811.87	2812.48	0.00	30.00	....	....
28.25	1.560	1.561	....	....	....	2820.76	2820.90	....	....	....	....	2813.46	2813.95	2815.52	....	....	0.00	28.25	....	....
17.50	2.778	2.778	....	....	....	2831.39	2831.40	....	....	....	....	2824.39	2825.95	2827.86	....	....	0.00	17.50	....	....
15.30	0.430	0.458	....	....	....	2833.71	2833.95	....	....	....	....	2826.73	2826.97	2827.44	....	....	0.00	15.30	....	....
16.00	0.734	0.776	....	....	....	2836.20	2834.36	....	....	....	....	2828.50	2829.12	2829.12	....	....	0.00	16.00	....	....
42.00	3.449	3.450	....	....	....	2837.03	2835.67	....	....	....	....	2830.82	2832.82	2836.29	....	....	0.00	42.00	....	....
3.00	0.082	0.082	....	....	....	2838.30	2837.09	....	....	....	....	2831.00	2831.01	2831.06	....	....	0.00	3.00	....	....
2.00	0.385	0.297	....	....	....	2838.46	2838.24	....	....	....	....	2831.41	2832.27 j	2832.27	2831.44	2831.37	0.00	2.00	....	....
40.00	0.950	1.000	....	....	....	2840.42	2839.65	....	....	....	....	2832.21	2832.87	2834.45	....	....	0.00	40.00	....	....
2.00	0.737	1.002	....	....	....	2840.95	2839.72	....	....	....	....	2833.34	2834.36	2834.36	....	....	0.00	2.00	....	....
19.00	3.274	3.275	....	....	....	2787.70	2799.11	....	....	....	....	2784.58	2789.37	2790.27	....	....	0.00	14.80	....	....
20.40	0.501	0.502	....	....	....	2805.21	2804.32	....	....	....	....	2795.87	2796.42	2796.74	....	....	0.00	2.15	....	....
1.60	0.063	0.023	....	....	....	2838.30	2837.09	....	....	....	....	2831.00	2831.02	2831.09	....	....	0.00	1.60	....	....
4.20	0.160	0.160	....	....	....	2799.11	2799.43	....	....	....	....	2790.27	2790.34	2790.45	....	....	0.00	4.20	....	....
18.25	0.267	0.241	....	....	....	2804.32	2805.00	....	....	....	....	2796.74	2796.79	2797.28	....	....	0.00	18.25	....	....
1.00	0.727	1.019	....	....	....	2789.72	2789.75	....	....	....	....	2786.73	2787.05	2787.20	....	....	0.00	1.00	....	....

Houghton Stormdrain Mainline | Number of lines: 44 | Date: 02-19-2010

NOTES: ** Critical depth

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)
	Sag	....	0.0	0.00	0.00	2764.93	2765.01	....	....	0.00	0.00	1.00	MH	0.00
	Sag	....	0.0	0.00	0.00	2765.31	2766.06	....	....	0.00	0.00	0.31	MH	0.00
	Sag	....	0.0	0.00	0.00	2766.35	2768.04	....	....	0.00	0.00	0.15	MH	0.00
	On Grade	....	0.0	0.00	0.00	2768.34	2772.45	....	....	0.00	0.00	0.25	None	0.00
PV20(3.4CFS)	On Grade	....	0.0	0.00	0.00	2776.92	2776.97	....	....	0.00	0.00	0.50	None	1.70
PV21(2.5CFS)	On Grade	....	0.0	0.00	0.00	2776.97	2777.37	....	....	0.00	0.00	1.25	None	1.25
	Sag	....	0.0	0.00	0.00	2772.45	2775.31	....	....	0.00	0.00	0.25	MH	0.00
New	Sag	....	0.0	0.00	0.00	2775.61	2779.13	....	....	0.00	0.00	0.25	None	0.00
New	Sag	....	0.0	0.00	0.00	2779.13	2781.92	....	....	0.00	0.00	0.25	None	0.00
	Sag	....	0.0	0.00	0.00	2781.92	2784.62	....	....	0.00	0.00	0.25	MH	0.00
	On Grade	....	0.0	0.00	0.00	2784.92	2785.93	....	....	0.00	0.00	0.25	None	0.00
PV19(7CFS)+CH1(7.2CFS)	Sag	....	0.0	0.00	0.00	2785.93	2790.94	....	....	0.00	0.00	0.25	MH	0.00
	Sag	....	0.0	0.00	0.00	2792.74	2807.79	....	....	0.00	0.00	0.25	MH	0.00
	On Grade	....	0.0	0.00	0.00	2808.09	2808.98	....	....	0.00	0.00	0.25	None	0.00
	Sag	....	0.0	0.00	0.00	2808.98	2820.24	....	....	0.00	0.00	0.00	MH	0.00
	Sag	....	0.0	0.00	0.00	2820.54	2822.40	....	....	0.00	0.00	0.25	MH	0.00
	Sag	....	0.0	0.00	0.00	2822.70	2825.09	....	....	0.00	0.00	0.25	MH	0.00
	On Grade	....	0.0	0.00	0.00	2825.39	2826.63	....	....	0.00	0.00	0.25	None	0.00
	Sag	....	0.0	0.00	0.00	2826.63	2826.82	....	....	0.00	0.00	0.25	MH	0.00
	On Grade	....	0.0	0.00	0.00	2827.12	2827.81	....	....	0.00	0.00	0.25	None	0.00
	Sag	....	0.0	0.00	0.00	2827.81	2828.35	....	....	0.00	0.00	0.25	MH	0.00
	Sag	....	0.0	0.00	0.00	2828.65	2830.30	30.21	12.79	0.24	1.63	1.25	MH	0.00

Houghton Stormdrain Mainline | Number of lines: 44 | Date: 02-19-2010

NOTES: Intensity = 88.24 / (Inlet time + 15.50) ^ 0.83 -- Return period = 10 Yrs. ; ** Critical depth

MyR ort

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)
PV 13 (4.9CFS)	On Grade	....	0.0	0.00	0.00	2831.90	2832.11	....	....	0.00	0.00	0.50	None	2.45
Area Grate(nursery) (42cfs)	On Grade	....	0.0	0.00	0.00	2832.11	2832.21	....	....	0.00	0.00	1.25	None	32.00
PV21.1(4.6CFS)	On Grade	....	0.0	0.00	0.00	2779.39	2779.80	....	....	0.00	0.00	1.25	None	2.30
PV20.1(3.4CFS)	On Grade	....	0.0	0.00	0.00	2788.75	2788.79	....	....	0.00	0.00	1.25	None	1.70
PV22(1.6CFS)+PV23(1.5CFS)+PV21.2(3.2CFS)	On Grade	....	0.0	0.00	0.00	2790.41	2791.62	....	....	0.00	0.00	1.25	None	3.15
PV19 (7.0 CFS),CH1(7.2CFS)	On Grade	....	0.0	0.00	0.00	2795.33	2795.41	....	....	0.00	0.00	1.25	None	10.70
Tansverse Grate Civano Blvd(30CFS)	On Grade	....	0.0	0.00	0.00	2809.54	2814.56	4.31	9.15	0.94	1.85	1.25	None	30.00
BAsin Outlet Civano Blvd(20CFS)+CH2(5.1CFS)+ST2(6.3CFS)	On Grade	....	0.0	0.00	0.00	2811.46	2811.77	....	....	0.00	0.00	1.25	None	28.25
CP D109 (12cfs)+ST3(3.5CFS)+CH3(4.0CFS)	Sag	....	0.0	0.00	0.00	2822.89	2823.45	....	....	0.00	0.00	1.25	None	17.50
CP D106 (9cfs)+ST4(3.6CFS)+CH4(4.5CFS)	Sag	....	0.0	0.00	0.00	2824.47	2825.03	....	....	0.00	0.00	1.25	None	15.30
CP D102 (9cfs)+ ST5(4.4cfs)+CH5(4.8CFS)	On Grade	....	0.0	0.00	0.00	2827.14	2827.70	....	....	0.00	0.00	1.25	None	16.00
CP D1 (37cfs)+ CH6 (5cfs)	On Grade	....	0.0	0.00	0.00	2828.00	2828.58	....	....	0.00	0.00	1.25	None	42.00
PV 16 (6.0CFS)	On Grade	....	0.0	0.00	0.00	2829.38	2829.46	....	....	0.00	0.00	1.25	None	3.00
PV15 (4 CFS)	On Grade	....	0.0	0.00	0.00	2830.80	2831.73	9.33	2.72	0.19	0.31	1.25	None	2.00
Trans Grate-7 Generation(40cfs)	On Grade	....	0.0	0.00	0.00	2830.21	2830.75	....	....	0.00	0.00	1.25	None	40.00
PV14 (4.0 CFS)	On Grade	....	0.0	0.00	0.00	2832.90	2833.82	....	....	0.00	0.00	1.25	None	2.00
ST13(14CFS)	On Grade	....	0.0	0.00	0.00	2783.08	2784.54	....	....	0.00	0.00	0.50	None	14.80
PV18 (4.3CFS)	On Grade	....	0.0	0.00	0.00	2794.33	2794.87	....	....	0.00	0.00	0.50	None	2.15
PV17 (3.2 CFS)	On Grade	....	0.0	0.00	0.00	2829.38	2830.29	....	....	0.00	0.00	1.25	None	1.60
Small portion of ST13	On Grade	....	0.0	0.00	0.00	2784.72	2785.17	....	....	0.00	0.00	1.25	None	4.20
ST14(15CFS) +ST8(6.5CFS)	On Grade	....	0.0	0.00	0.00	2794.87	2795.06	....	....	0.00	0.00	1.25	None	18.25
POWER POLE GRATE (1CFS)	On Grade	....	0.0	0.00	0.00	2786.42	2786.66	....	....	0.00	0.00	1.25	None	1.00

Houghton Stormdrain Mainline | Number of lines: 44 | Date: 02-19-2010

NOTES: Intensity = 88.24 / (Inlet time + 15.50) ^ 0.83 -- Return period = 10 Yrs. ; ** Critical depth

MyR ort

Cost RCP ($)	Cost CMP ($)	Cost PVC ($)	Line ID	Line Length (ft)	Line Size (in)	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)
2,033	1,829	1,728	(Pipe 1) outfall	19.800	72	0.40	Cir	....	....	0.013	1.67	126089.67	0.11	....	....	....	72	0.00	72	0.00
19,353	17,417	16,450	(Pipe 2)	183.780	72	0.41	Cir	....	....	0.013	0.52	125911.70	1.02	....	....	....	72	0.00	72	0.00
37,333	33,599	31,733	(Pipe 3)	391.940	72	0.43	Cir	....	....	0.013	0.25	125519.78	2.18	....	....	....	72	0.00	72	0.00
19,283	17,354	16,390	(Pipe4-1)	201.560	72	2.04	Cir	....	....	0.013	0.63	125318.23	1.12	....	....	....	72	0.00	72	0.00
268	241	228	(Pipe 15)	4.680	18	1.07	Cir	....	....	0.013	0.08	125318.18	0.03	....	....	....	18	0.00	18	0.00
3,284	2,956	2,791	(Pipe 14)	99.780	18	0.40	Cir	....	....	0.013	0.10	125312.06	0.55	....	....	....	18	0.00	18	0.00
13,985	12,587	11,887	(Pipe 4-2)	140.000	72	2.04	Cir	....	....	0.013	0.62	125178.24	0.78	....	....	....	72	0.00	72	0.00
8,820	7,938	7,497	(Pipe 5-1)	91.020	72	3.87	Cir	....	....	0.013	n/a	125087.23	0.51	....	....	....	72	0.00	72	0.00
6,780	6,102	5,763	(Pipe 5-2)	72.090	72	3.87	Cir	....	....	0.013	n/a	125015.14	0.40	....	....	....	72	0.00	72	0.00
6,760	6,084	5,746	(Pipe 5-3)	69.450	72	3.89	Cir	....	....	0.013	n/a	124945.70	0.39	....	....	....	72	0.00	72	0.00
4,485	4,037	3,812	(Pipe 6-1)	43.000	72	2.35	Cir	....	....	0.013	n/a	124902.70	0.24	....	....	....	72	0.00	72	0.00
23,640	21,276	20,094	(Pipe 6-2)	212.300	72	2.36	Cir	....	....	0.013	0.57	124690.42	1.18	....	....	....	72	0.00	72	0.00
46,760	42,084	39,746	(pipe 7)	466.000	54	3.23	Cir	....	....	0.013	0.87	124224.50	2.59	....	....	....	54	0.00	54	0.00
3,680	3,312	3,128	(pipe 8-1)	36.560	54	2.43	Cir	....	....	0.013	0.70	124187.94	0.20	....	....	....	54	0.00	54	0.00
41,640	37,476	35,394	(Pipe 8-2)	461.370	54	2.44	Cir	....	....	0.013	0.00	123726.57	2.56	....	....	....	54	0.00	54	0.00
28,950	26,055	24,608	(Pipe 9)	320.000	54	0.58	Cir	....	....	0.013	0.45	123406.63	1.78	....	....	....	54	0.00	54	0.00
31,380	28,242	26,673	(Pipe 10)	347.100	54	0.69	Cir	....	....	0.013	n/a	123059.59	1.93	....	....	....	54	0.00	54	0.00
30,300	27,270	25,755	(Pipe 11-1)	335.300	54	0.37	Cir	....	....	0.013	0.28	122724.35	1.86	....	....	....	54	0.00	54	0.00
4,695	4,226	3,991	(Pipe 11-2)	50.590	54	0.38	Cir	....	....	0.013	0.12	122673.77	0.28	....	....	....	54	0.00	54	0.00
20,670	18,603	17,570	(Pipe 12-1)	228.370	54	0.30	Cir	....	....	0.013	0.14	122445.43	1.27	....	....	....	54	0.00	54	0.00
16,540	14,886	14,059	(Pipe12-2)	181.000	54	0.30	Cir	....	....	0.013	0.15	122264.46	1.01	....	....	....	54	0.00	54	0.00
9,195	8,276	7,816	(Pipe 13)	100.710	54	1.64	Cir	....	....	0.013	n/a	122163.77	0.56	....	....	....	54	0.00	54	0.00

Houghton Stormdrain Mainline | Number of lines: 44 | Date: 02-19-2010

NOTES: ** Critical depth

MyR ort

Cost RCP ($)	Cost CMP ($)	Cost PVC ($)	Line ID	Line Length (ft)	Line Size (in)	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)
1,378	1,240	1,171	(Pipe 36)	20.500	30	1.03	Cir	....	....	0.013	0.44	122163.97	0.11	....	....	....	30	0.00	30	0.00
656	590	558	(Pipe 37)	10.450	30	0.96	Cir	....	....	0.013	0.83	122168.33	0.06	....	....	....	30	0.00	30	0.00
1,820	1,638	1,547	(Pipe 16)	40.770	18	1.01	Cir	....	....	0.013	n/a	125177.81	0.23	....	....	....	18	0.00	18	0.00
263	236	223	(Pipe 20)	3.980	18	1.01	Cir	....	....	0.013	0.14	124945.75	0.02	....	....	....	18	0.00	18	0.00
4,960	4,464	4,216	(Pipe 21)	121.140	18	1.00	Cir	....	....	0.013	0.32	124901.11	0.67	....	....	....	18	0.00	18	0.00
515	464	438	(pipe 24)	7.500	18	1.06	Cir	....	....	0.013	0.87	124690.56	0.04	....	....	....	18	0.00	18	0.00
2,724	2,452	2,315	(Pipe 25)	43.050	30	11.66	Cir	....	....	0.013	n/a	124224.48	0.24	....	....	....	30	0.00	30	0.00
2,000	1,800	1,700	(Pipe 26)	31.270	24	0.99	Cir	....	....	0.013	1.57	124187.97	0.17	....	....	....	24	0.00	24	0.00
2,905	2,615	2,469	(Pipe 27)	56.130	18	1.00	Cir	....	....	0.013	1.91	123727.62	0.31	....	....	....	18	0.00	18	0.00
3,500	3,150	2,975	(Pipe 28)	56.130	24	1.00	Cir	....	....	0.013	0.47	123407.68	0.31	....	....	....	24	0.00	24	0.00
3,238	2,914	2,752	(Pipe 29)	56.130	24	1.00	Cir	....	....	0.013	0.88	123060.64	0.31	....	....	....	24	0.00	24	0.00
3,364	3,028	2,859	(Pipe 30)	57.900	24	1.00	Cir	....	....	0.013	3.47	122725.67	0.32	....	....	....	24	0.00	24	0.00
493	443	419	(Pipe 31)	7.530	18	1.06	Cir	....	....	0.013	0.06	122673.91	0.04	....	....	....	18	0.00	18	0.00
4,315	3,884	3,668	(Pipe 33)	93.250	18	1.00	Cir	....	....	0.013	n/a	122448.21	0.52	....	....	....	18	0.00	18	0.00
3,664	3,298	3,114	(Pipe 34)	54.010	30	1.00	Cir	....	....	0.013	1.58	122264.45	0.30	....	....	....	30	0.00	30	0.00
4,225	3,803	3,591	(Pipe 35)	91.500	18	1.01	Cir	....	....	0.013	0.24	122162.86	0.51	....	....	....	18	0.00	18	0.00
7,690	6,921	6,537	(Pipe 18)	146.150	18	1.00	Cir	....	....	0.013	0.90	125085.30	0.81	....	....	....	18	0.00	18	0.00
7,548	6,793	6,416	(Pipe 23)	107.510	30	0.50	Cir	....	....	0.013	0.32	124688.40	0.60	....	....	....	30	0.00	30	0.00
4,423	3,980	3,759	(Pipe 32)	91.470	18	1.00	Cir	....	....	0.013	0.07	122672.05	0.51	....	....	....	18	0.00	18	0.00
3,095	2,786	2,631	(Pipe 19)	45.350	18	0.99	Cir	....	....	0.013	0.11	125039.96	0.25	....	....	....	18	0.00	18	0.00
2,796	2,516	2,377	(Pipe 22)	41.820	30	0.45	Cir	....	....	0.013	0.49	124686.21	0.23	....	....	....	30	0.00	30	0.00
852	767	724	(Pipe 17)	23.500	18	1.02	Cir	....	....	0.013	0.15	125015.41	0.13	....	....	....	18	0.00	18	0.00

Houghton Stormdrain Mainline | Number of lines: 44 | Date: 02-19-2010

NOTES: ** Critical depth

MyR ort

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)	Vel Hd Dn (ft)	Vel Hd Up (ft)	Vel Up (ft/s)	Cover Dn (ft)	Cover Up (ft)	Storage (cft)
0.00	0.00	22.4	....	0.00	0.00	0.00	10.37	10.38	1.67	1.67	10.37	0.02	6.28	559.79
0.00	0.00	21.3	....	0.00	0.00	0.00	10.37	10.38	1.67	1.67	10.37	5.98	3.94	5195.23
0.00	0.00	19.2	....	0.00	0.00	0.00	10.37	10.38	1.67	1.67	10.37	3.65	3.55	11079.66
0.00	0.00	18.0	....	0.00	0.00	0.00	11.55	10.38	1.67	2.52	12.73	3.25	3.41	5522.32
0.00	0.00	0.6	....	0.00	0.00	0.00	4.19	5.23	0.42	0.15	3.14	3.44	2.00	3.51
0.00	0.00	0.0	....	0.00	0.00	0.00	1.73	1.19	0.02	0.08	2.27	2.00	1.46	79.86
0.00	0.00	17.3	....	0.00	0.00	0.00	12.63	12.60	2.47	2.49	12.66	3.41	4.36	3218.61
0.00	0.00	16.8	....	0.00	0.00	0.00	13.06	13.50	2.83	2.47	12.61	4.06	2.57	2010.83
0.00	0.00	16.4	....	0.00	0.00	0.00	11.99	11.78	2.16	2.32	12.21	2.57	1.80	1617.75
0.00	0.00	16.0	....	0.00	0.00	0.00	12.17	12.16	2.30	2.31	12.19	1.80	4.41	1529.11
0.00	0.00	15.7	....	0.00	0.00	0.00	12.62	13.09	2.66	2.29	12.15	4.11	3.93	909.14
0.00	0.00	14.5	....	0.00	0.00	0.00	12.04	12.01	2.24	2.27	12.08	3.93	8.27	4639.27
0.00	0.00	12.0	....	0.00	0.00	0.00	19.35	23.71	8.74	3.49	14.99	7.97	8.25	6014.72
0.00	0.00	11.8	....	0.00	0.00	0.00	13.57	13.75	2.94	2.78	13.38	7.95	7.28	544.83
0.00	0.00	9.2	....	0.00	0.00	0.00	11.85	11.51	2.06	2.31	12.18	7.28	6.65	6781.81
0.00	0.00	7.4	....	0.00	0.00	0.00	10.70	10.70	1.78	1.78	10.70	6.35	6.81	4675.87
0.00	0.00	5.5	....	0.00	0.00	0.00	10.15	9.38	1.37	1.85	10.92	6.51	6.61	4870.79
0.00	0.00	3.6	....	0.00	0.00	0.00	8.52	8.53	1.13	1.13	8.52	6.31	5.90	4918.42
0.00	0.00	3.3	....	0.00	0.00	0.00	5.44	5.38	0.45	0.47	5.50	5.90	6.98	772.81
0.00	0.00	2.1	....	0.00	0.00	0.00	5.68	5.38	0.45	0.55	5.97	6.68	6.15	3170.49
0.00	0.00	1.1	....	0.00	0.00	0.00	5.88	5.60	0.49	0.59	6.16	6.15	7.57	2360.53
0.00	0.00	0.5	....	0.00	0.00	0.00	4.78	3.09	0.15	0.65	6.46	7.27	6.15	880.62

Houghton Stormdrain Mainline | Number of lines: 44 | Date: 02-19-2010

NOTES: ** Critical depth

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)	Vel Hd Dn (ft)	Vel Hd Up (ft)	Vel Up (ft/s)	Cover Dn (ft)	Cover Up (ft)	Storage (cft)
0.00	0.00	0.1	....	0.00	0.00	0.00	8.47	9.46	1.39	0.87	7.48	6.55	4.87	85.10
0.00	0.00	0.0	....	0.00	0.00	0.00	6.52	6.52	0.66	0.66	6.52	4.87	2.89	51.29
0.00	0.00	0.0	....	0.00	0.00	0.00	4.21	4.76	0.35	0.21	3.66	4.78	4.08	22.64
0.00	0.00	0.0	....	0.00	0.00	0.00	3.55	4.38	0.30	0.11	2.72	4.78	3.62	2.01
0.00	0.00	0.0	....	0.00	0.00	0.00	4.63	5.19	0.42	0.26	4.07	3.95	2.83	83.62
0.00	0.00	0.0	....	0.00	0.00	0.00	6.84	6.99	0.76	0.70	6.69	8.38	7.12	11.74
0.00	0.00	0.0	....	0.00	0.00	0.00	6.96	6.13	0.58	0.94	7.79	8.50	2.77	191.61
0.00	0.00	0.0	....	0.00	0.00	0.00	8.99	8.99	1.26	1.26	8.99	7.30	7.13	98.22
0.00	0.00	0.0	....	0.00	0.00	0.00	9.90	9.90	1.53	1.52	9.90	7.00	6.45	99.17
0.00	0.00	0.0	....	0.00	0.00	0.00	4.89	4.87	0.37	0.38	4.91	7.24	6.92	176.04
0.00	0.00	0.0	....	0.00	0.00	0.00	6.89	7.05	0.77	0.70	6.72	7.06	4.66	130.47
0.00	0.00	0.0	....	0.00	0.00	0.00	13.37	13.37	2.78	2.78	13.37	7.03	5.09	181.86
0.00	0.00	0.0	....	0.00	0.00	0.00	1.70	1.70	0.04	0.04	1.70	7.42	6.13	13.30
0.00	0.00	0.0	....	0.00	0.00	0.00	3.22	2.95	0.14	0.19	3.49	6.16	5.01	58.25
0.00	0.00	0.0	....	0.00	0.00	0.00	9.27	9.52	1.41	1.26	9.02	7.71	6.40	233.32
0.00	0.00	0.0	....	0.00	0.00	0.00	4.04	4.58	0.33	0.19	3.49	6.55	4.40	46.13
0.00	0.00	0.3	....	0.00	0.00	0.00	10.75	10.75	1.80	1.80	10.75	3.12	13.07	258.22
0.00	0.00	0.2	....	0.00	0.00	0.00	6.40	6.41	0.64	0.64	6.40	8.38	6.95	342.44
0.00	0.00	0.0	....	0.00	0.00	0.00	1.39	0.91	0.01	0.06	1.88	7.42	5.30	130.44
0.00	0.00	0.0	....	0.00	0.00	0.00	2.38	2.38	0.09	0.09	2.38	12.89	12.76	80.12
0.00	0.00	0.0	....	0.00	0.00	0.00	4.84	4.65	0.34	0.40	5.04	6.95	7.44	157.85
0.00	0.00	0.0	....	0.00	0.00	0.00	3.28	3.77	0.22	0.12	2.79	1.80	1.59	7.32

Houghton Stormdrain Mainline | Number of lines: 44 | Date: 02-19-2010

NOTES: ** Critical depth

Hydr lic 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	293.3	2764.93	2770.93	6.00	28.27	10.38	1.67	2772.60	0.480	19.800	2765.01	2771.01	6.00	28.27	10.37	1.67	2772.68	0.477	0.478	0.095	1.00	1.67
2	72	293.3	2765.31	2772.68	6.00	28.27	10.38	1.67	2774.36	0.480	183.780	2766.06	2773.57	6.00	28.27	10.37	1.67	2775.24	0.479	0.480	0.881	0.31	0.52
3	72	293.3	2766.35	2774.08	6.00	28.27	10.38	1.67	2775.76	0.480	391.940	2768.04	2775.96	6.00	28.27	10.37	1.67	2777.64	0.479	0.480	1.880	0.15	0.25
4	72	293.3	2768.34	2776.22	6.00	28.27	10.38	1.67	2777.89	0.480	201.560	2772.45	2777.01	4.56**	23.05	12.73	2.52	2779.53	0.560	0.520	n/a	0.25	0.63
5	18	2.95	2776.92	2777.45	0.53*	0.56	5.23	0.42	2777.88	1.070	4.680	2776.97	2777.76	0.79	0.94	3.14	0.15	2777.91	0.269	0.669	0.031	0.50	0.08
6	18	1.25	2776.97	2777.83	0.86	1.05	1.19	0.02	2777.86	0.036	99.780	2777.37	2777.90	0.52	0.55	2.27	0.08	2777.98	0.206	0.121	0.121	1.25	0.10
7	72	290.4	2772.45	2777.01	4.56	23.05	12.60	2.47	2779.48	0.549	140.000	2775.31	2779.85	4.54**	22.93	12.66	2.49	2782.34	0.555	0.552	n/a	0.25	0.62
8	72	288.1	2775.61	2779.85	4.24	21.34	13.50	2.83	2782.68	0.645	91.020	2779.13	2783.65	4.52**	22.84	12.61	2.47	2786.12	0.551	0.598	n/a	0.25	n/a
9	72	269.1	2779.13	2783.65	4.52	22.84	11.78	2.16	2785.81	0.481	72.090	2781.92	2786.29	4.37**	22.04	12.21	2.32	2788.60	0.522	0.501	n/a	0.25	n/a
10	72	268.1	2781.92	2786.29	4.37	22.04	12.16	2.30	2788.59	0.518	69.450	2784.62	2788.98	4.36**	22.00	12.19	2.31	2791.29	0.520	0.519	n/a	0.25	n/a
11	72	266.4	2784.92	2788.98	4.06	20.35	13.09	2.66	2791.64	0.618	43.000	2785.93	2790.27	4.34**	21.92	12.15	2.29	2792.57	0.518	0.568	n/a	0.25	n/a
12	72	263.2	2785.93	2790.27	4.34	21.92	12.01	2.24	2792.52	0.505	212.300	2790.94	2795.26	4.32**	21.78	12.08	2.27	2797.53	0.513	0.509	n/a	0.25	0.57
13	54	232.1	2792.74	2795.40	2.66*	9.79	23.71	8.74	2804.14	3.228	466.000	2807.79	2812.01	4.22**	15.49	14.99	3.49	2815.50	1.204	2.216	n/a	0.25	0.87
14	54	202.1	2808.09	2812.01	3.92	14.70	13.75	2.94	2814.95	0.962	36.560	2808.98	2813.04	4.06**	15.10	13.38	2.78	2815.82	0.928	0.945	n/a	0.25	0.70
15	54	173.9	2808.98	2813.04	4.06	15.10	11.51	2.06	2815.10	0.687	461.370	2820.24	2824.02	3.78**	14.27	12.18	2.31	2826.33	0.749	0.718	n/a	0.00	0.00
16	54	156.4	2820.54	2824.43	3.89*	14.61	10.70	1.78	2826.21	0.581	320.000	2822.40	2826.29	3.89	14.61	10.70	1.78	2828.07	0.581	0.581	1.860	0.25	0.45
17	54	141.1	2822.70	2826.73	4.03	15.03	9.38	1.37	2828.10	0.454	347.100	2825.09	2828.50	3.41**	12.92	10.92	1.85	2830.35	0.605	0.530	n/a	0.25	n/a
18	54	125.1	2825.39	2829.30	3.91*	14.66	8.53	1.13	2830.43	0.370	335.300	2826.63	2830.54	3.91	14.67	8.52	1.13	2831.67	0.369	0.370	1.239	0.25	0.28
19	54	83.05	2826.63	2830.82	4.19	15.43	5.38	0.45	2831.27	0.154	50.590	2826.82	2830.88	4.06	15.11	5.50	0.47	2831.35	0.157	0.155	0.079	0.25	0.12
20	54	78.45	2827.12	2831.00	3.88	14.59	5.38	0.45	2831.45	0.147	228.370	2827.81	2831.27	3.46	13.13	5.97	0.55	2831.83	0.181	0.164	0.374	0.25	0.14
21	54	76.45	2827.81	2831.41	3.60	13.65	5.60	0.49	2831.90	0.158	181.000	2828.35	2831.63	3.28	12.42	6.16	0.59	2832.22	0.195	0.176	0.319	0.25	0.15

Houghton Stormdrain Mainline | Number of lines: 44 | Run Date: 02-19-2010

Notes: * Normal depth assumed.; ** Critical depth. ; c = cir e = ellip b = box

Hydr lic 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)
22	54	36.45	2828.65	2831.78	3.13	11.80	3.09	0.15	2831.93	0.050	100.71	2830.30	2832.03 j	1.73**	5.64	6.46	0.65	2832.68	0.349	0.199	n/a	1.25	0.81
23	30	34.45	2831.90	2833.64	1.74*	3.64	9.46	1.39	2835.03	1.025	20.500	2832.11	2834.33	2.22	4.60	7.48	0.87	2835.20	0.629	0.827	0.170	0.50	0.44
24	30	32.00	2832.11	2834.76	2.50	4.91	6.52	0.66	2835.42	0.609	10.450	2832.21	2834.83	2.50	4.91	6.52	0.66	2835.49	0.609	0.609	0.064	1.25	0.83
25	18	2.30	2779.39	2779.87	0.48*	0.48	4.76	0.35	2780.22	1.003	40.770	2779.80	2780.38	0.58**	0.63	3.66	0.21	2780.59	0.482	0.743	n/a	1.25	n/a
26	18	1.70	2788.75	2789.16	0.41*	0.39	4.38	0.30	2789.46	1.004	3.980	2788.79	2789.37	0.58	0.63	2.72	0.11	2789.48	0.267	0.636	0.025	1.25	0.14
27	18	3.15	2790.41	2790.97	0.56*	0.61	5.19	0.42	2791.39	0.999	121.14	2791.62	2792.30	0.68**	0.77	4.07	0.26	2792.55	0.512	0.756	n/a	1.25	0.32
28	18	10.70	2795.33	2796.54	1.21*	1.53	6.99	0.76	2797.30	1.064	7.500	2795.41	2796.68	1.27	1.60	6.69	0.70	2797.38	0.980	1.022	0.077	1.25	0.87
29	30	30.00	2809.54	2812.01	2.47	4.90	6.13	0.58	2812.59	0.488	43.050	2814.56	2816.39 j	1.83**	3.85	7.79	0.94	2817.33	0.681	0.585	n/a	1.25	n/a
30	24	28.25	2811.46	2813.46	2.00*	3.14	8.99	1.26	2814.72	1.561	31.270	2811.77	2813.95	2.00	3.14	8.99	1.26	2815.21	1.560	1.560	0.488	1.25	1.57
31	18	17.50	2822.89	2824.39	1.50*	1.77	9.90	1.53	2825.92	2.778	56.130	2823.45	2825.95	1.50	1.77	9.90	1.52	2827.47	2.777	2.778	1.559	1.25	1.91
32	24	15.30	2824.47	2826.73	2.00	3.14	4.87	0.37	2827.10	0.458	56.130	2825.03	2826.97	1.94	3.11	4.91	0.38	2827.35	0.403	0.430	0.241	1.25	0.47
33	24	16.00	2827.14	2828.50	1.36	2.27	7.05	0.77	2829.27	0.776	56.130	2827.70	2829.12	1.42**	2.38	6.72	0.70	2829.82	0.692	0.734	n/a	1.25	0.88
34	24	42.00	2828.00	2830.82	2.00	3.14	13.37	2.78	2833.60	3.450	57.900	2828.58	2832.82	2.00	3.14	13.37	2.78	2835.60	3.448	3.449	1.997	1.25	3.47
35	18	3.00	2829.38	2831.00	1.50	1.77	1.70	0.04	2831.05	0.082	7.530	2829.46	2831.01	1.50	1.77	1.70	0.04	2831.05	0.082	0.082	0.006	1.25	0.06
36	18	2.00	2830.80	2831.41	0.61	0.68	2.95	0.14	2831.55	0.297	93.250	2831.73	2832.27 j	0.54**	0.57	3.49	0.19	2832.46	0.473	0.385	n/a	1.25	0.24
37	30	40.00	2830.21	2832.21	2.00*	4.20	9.52	1.41	2833.62	1.000	54.010	2830.75	2832.87	2.12**	4.43	9.02	1.26	2834.13	0.900	0.950	0.513	1.25	1.58
38	18	2.00	2832.90	2833.34	0.44*	0.44	4.58	0.33	2833.67	1.002	91.500	2833.82	2834.36	0.54**	0.57	3.49	0.19	2834.55	0.473	0.737	n/a	1.25	0.24
39	18	19.00	2783.08	2784.58	1.50*	1.77	10.75	1.80	2786.38	3.275	146.15	2784.54	2789.37	1.50	1.77	10.75	1.80	2791.16	3.274	3.274	4.786	0.50	0.90
40	30	20.40	2794.33	2795.87	1.54*	3.18	6.41	0.64	2796.51	0.502	107.51	2794.87	2796.42	1.55	3.19	6.40	0.64	2797.05	0.500	0.501	0.539	0.50	0.32
41	18	1.60	2829.38	2831.00	1.50	1.77	0.91	0.01	2831.01	0.023	91.470	2830.29	2831.02	0.73	0.85	1.88	0.06	2831.07	0.103	0.063	0.058	1.25	0.07
42	18	4.20	2784.72	2790.27	1.50	1.77	2.38	0.09	2790.35	0.160	45.350	2785.17	2790.34	1.50	1.77	2.38	0.09	2790.43	0.160	0.160	0.073	1.25	0.11

Houghton Stormdrain Mainline | Number of lines: 44 | Run Date: 02-19-2010

Notes: * Normal depth assumed.; ** Critical depth.; j-Line contains hyd. jump. ; c = cir e = ellip b = box

Hydr lic 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)
43	30	18.25	2794.87	2796.74	1.86	3.93	4.65	0.34	2797.07	0.241	41.820	2795.06	2796.79	1.73	3.62	5.04	0.40	2797.18	0.292	0.267	0.111	1.25	0.49
44	18	1.00	2786.42	2786.73	0.31*	0.27	3.77	0.22	2786.95	1.019	23.500	2786.66	2787.05	0.39**	0.36	2.79	0.12	2787.17	0.436	0.727	0.171	1.25	0.15

Houghton Stormdrain Mainline | Number of lines: 44 | Run Date: 02-19-2010

Notes: * Normal depth assumed.; ** Critical depth.; j-Line contains hyd. jump. ; c = cir e = ellip b = box

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.

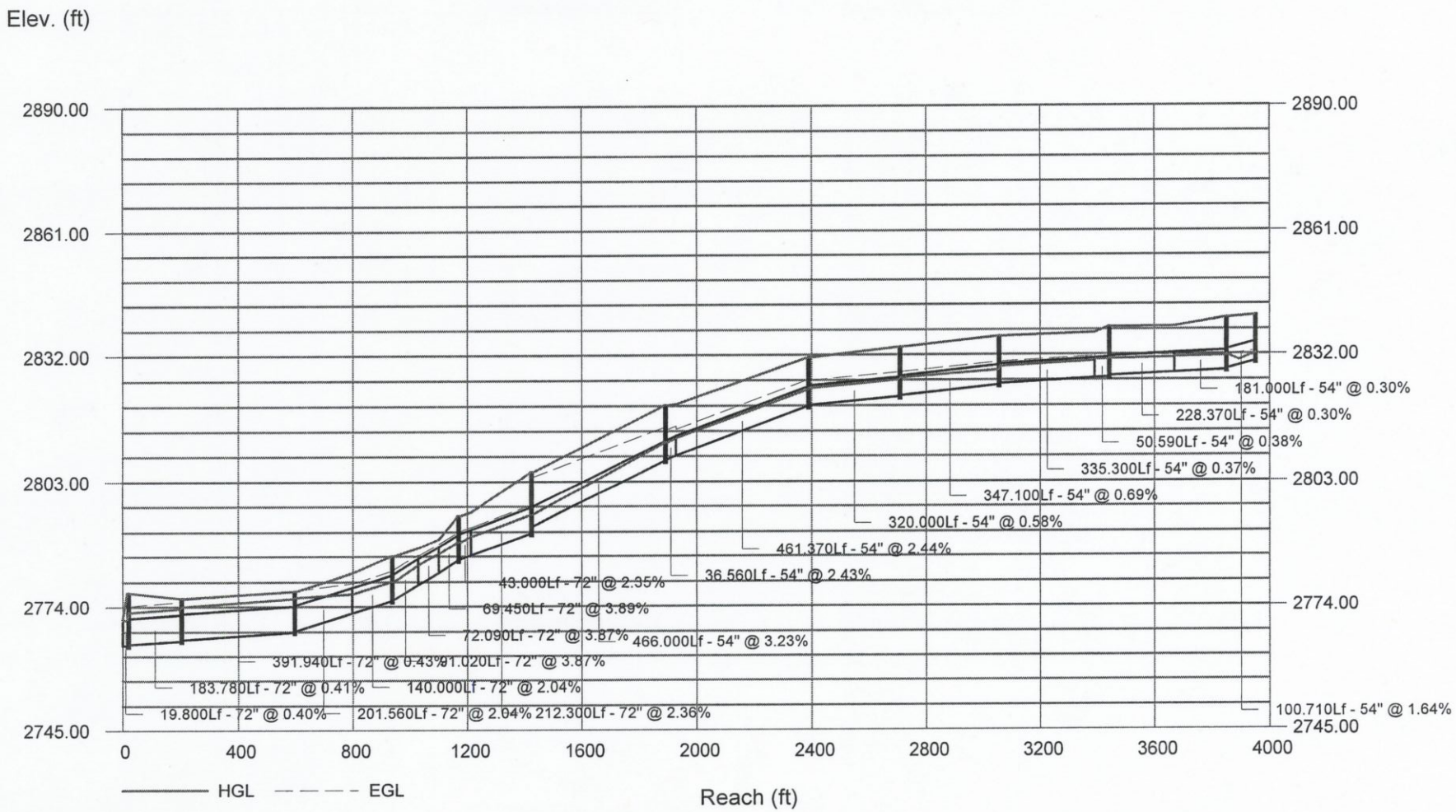
Col. 22 Energy loss. Average Sf/100 x Line Length (Col. 21/100 x Col. 12). Equals (EGL upstream - EGL downstream) +/- tolerance.

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 Profile

Proj. file: 10-[illegible]-08-10.stm



Storm Sewer Profile

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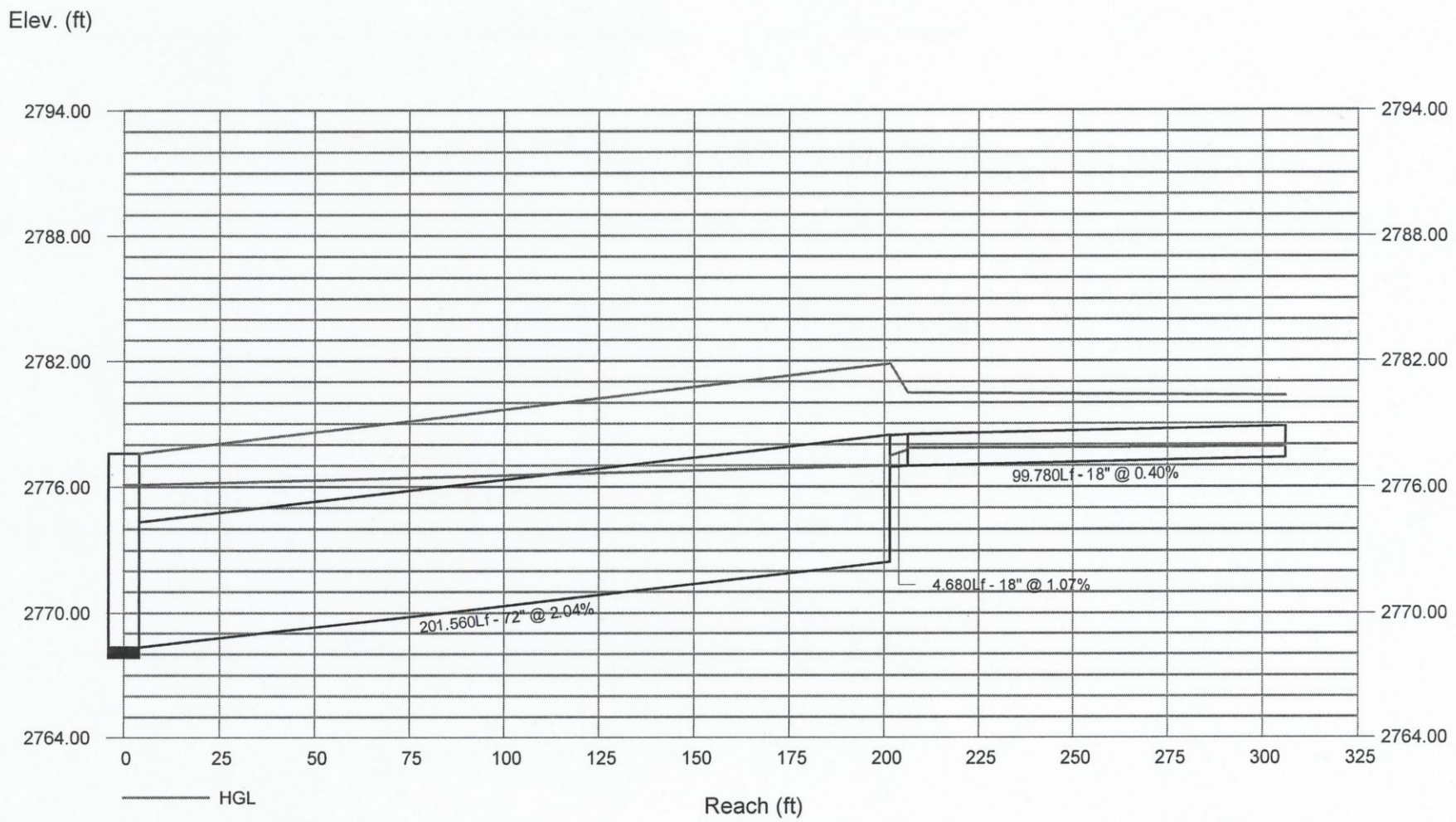

Storm Sewer Profile

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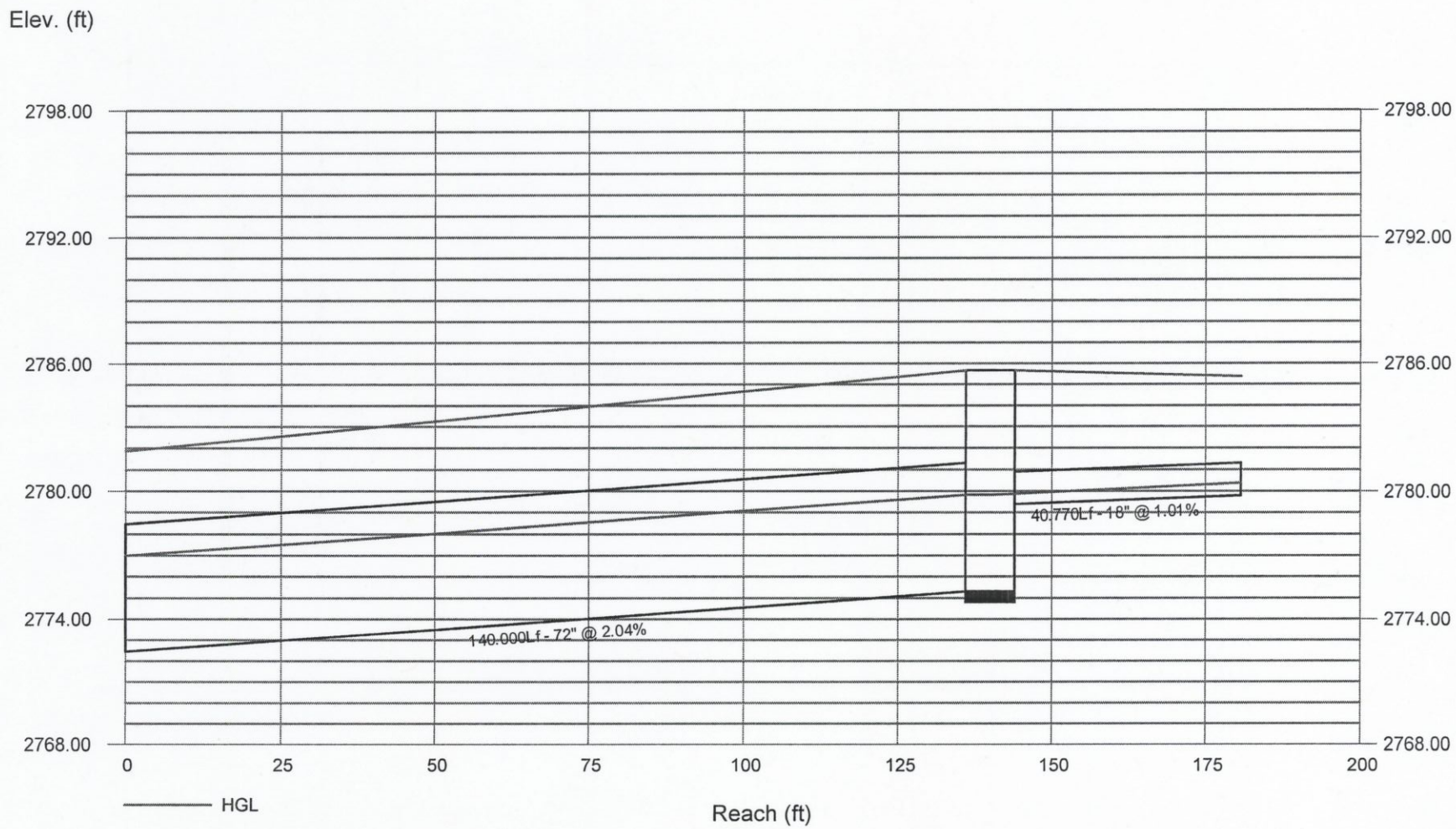

Storm Sewer Profile

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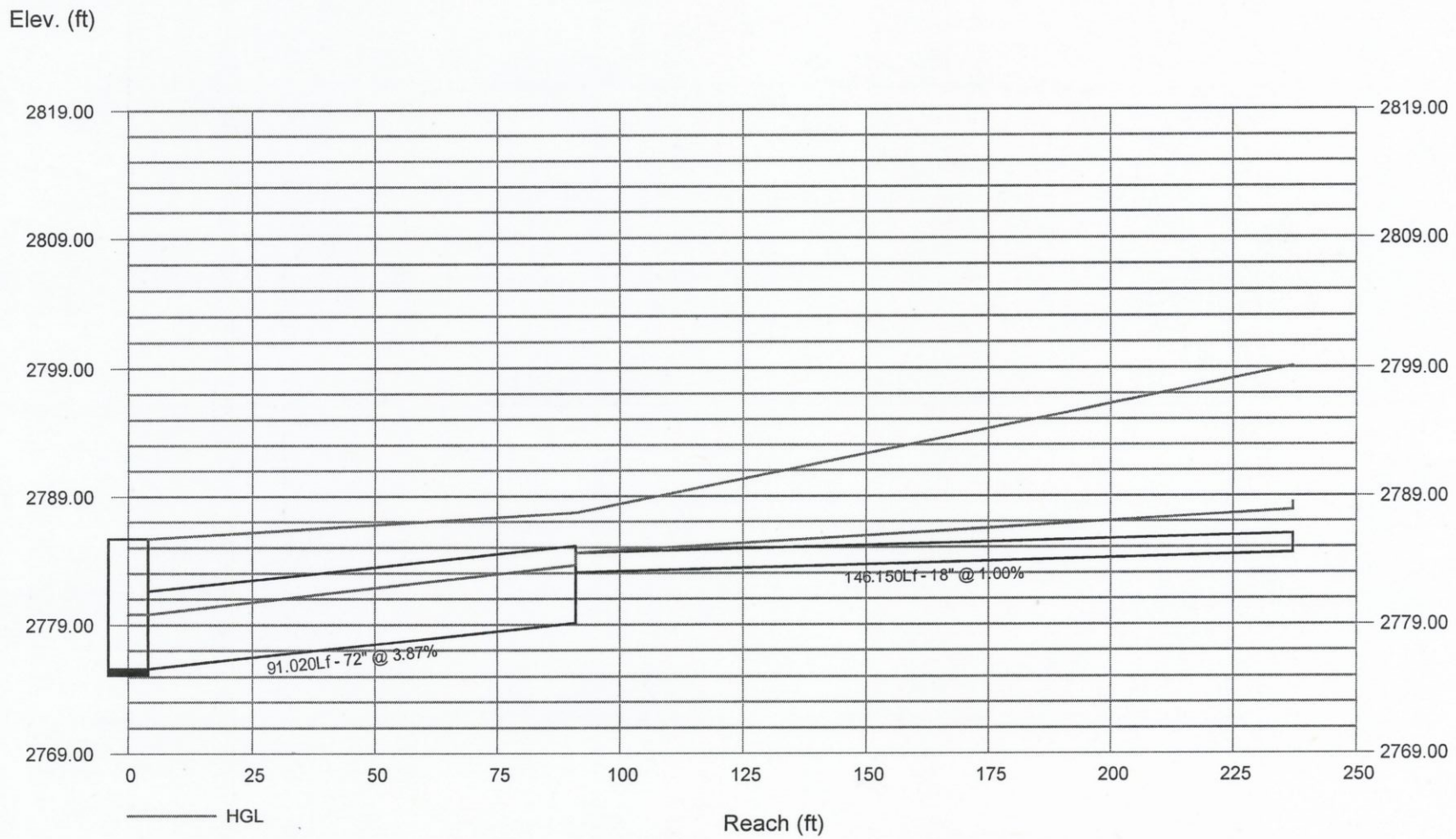

Storm Sewer Profile

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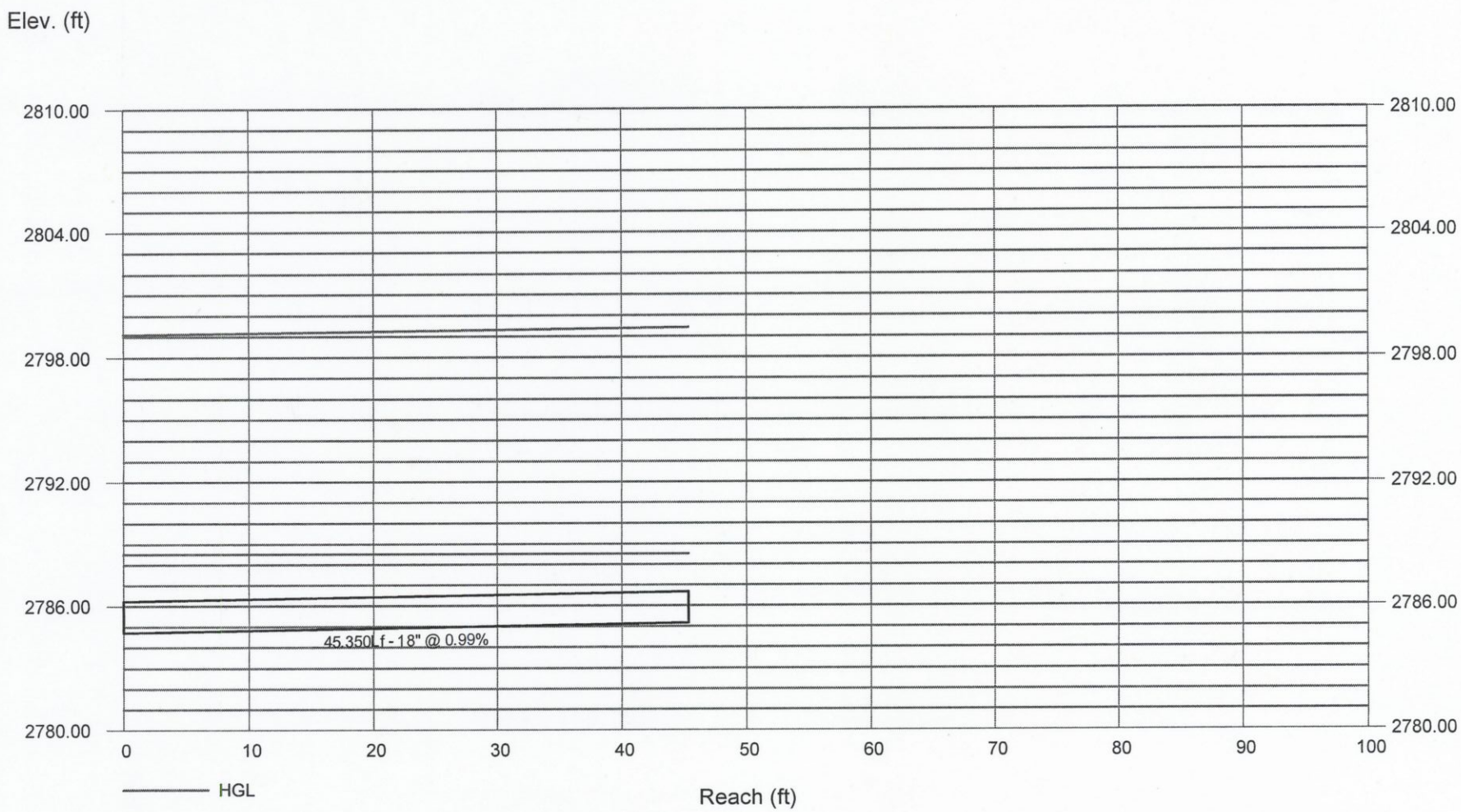

Hydraflow Storm Sewers Extension

Storm Sewer Profile

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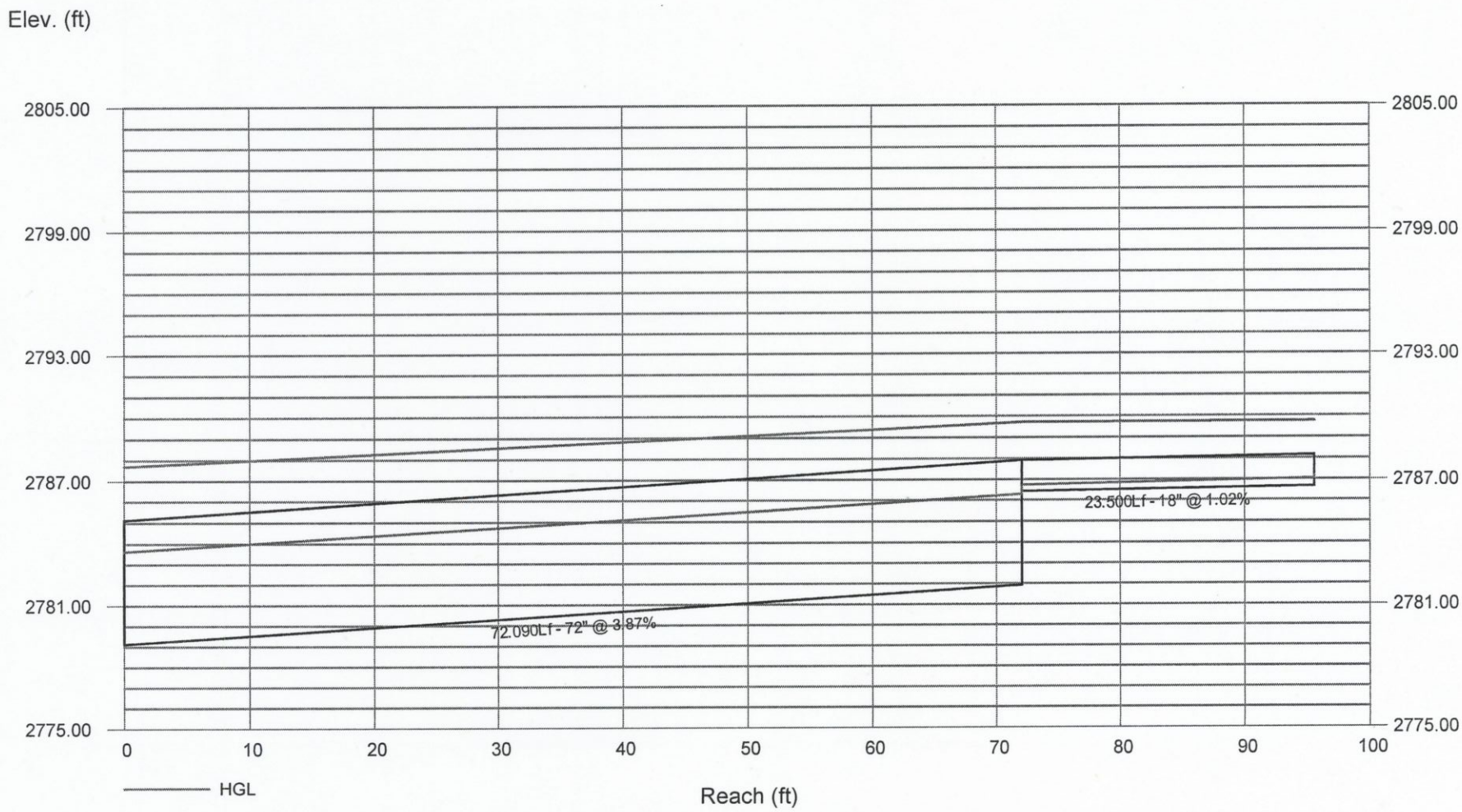

Storm Sewer Profile

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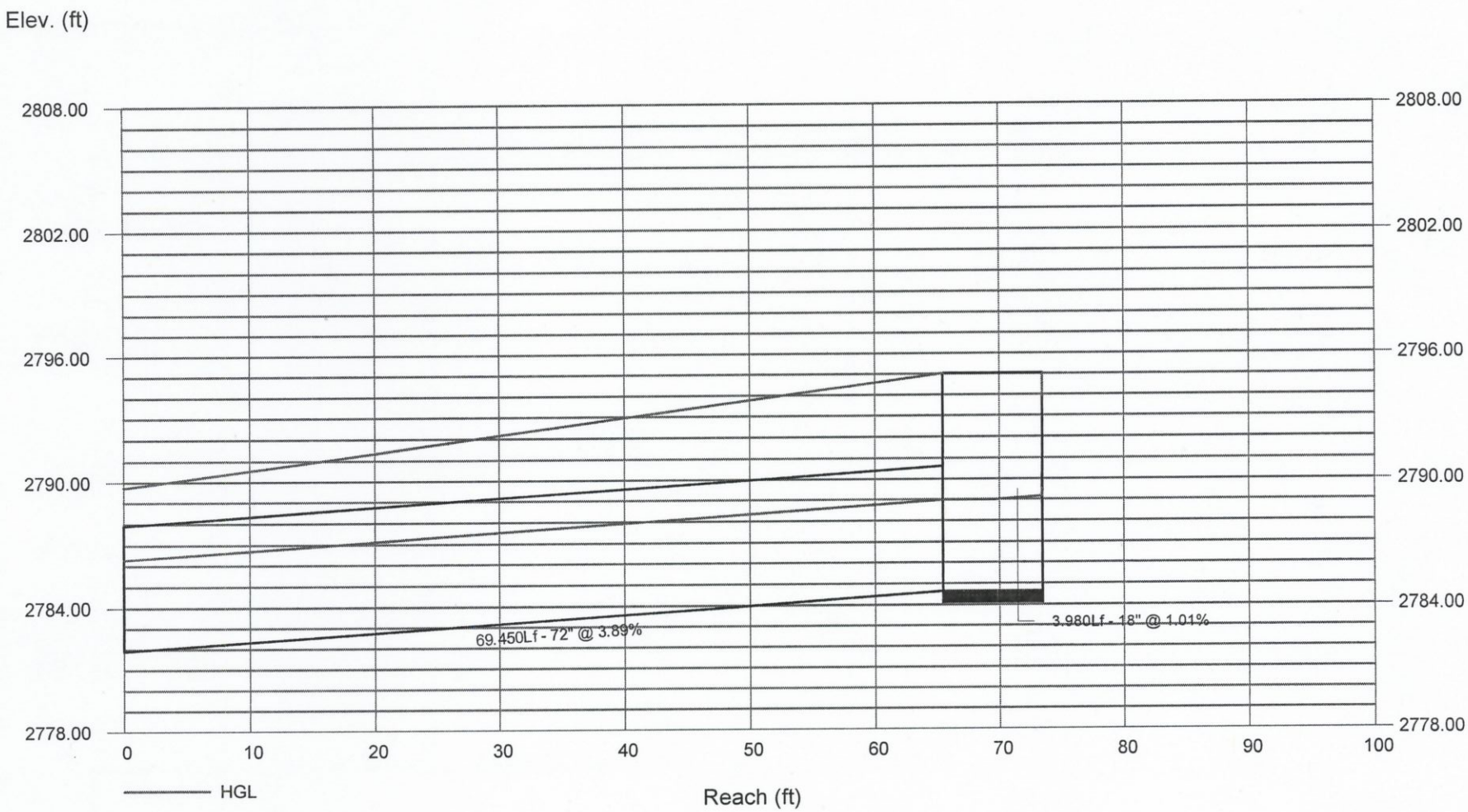

Hydraflow Storm Sewers Extension

Storm Sewer Profile

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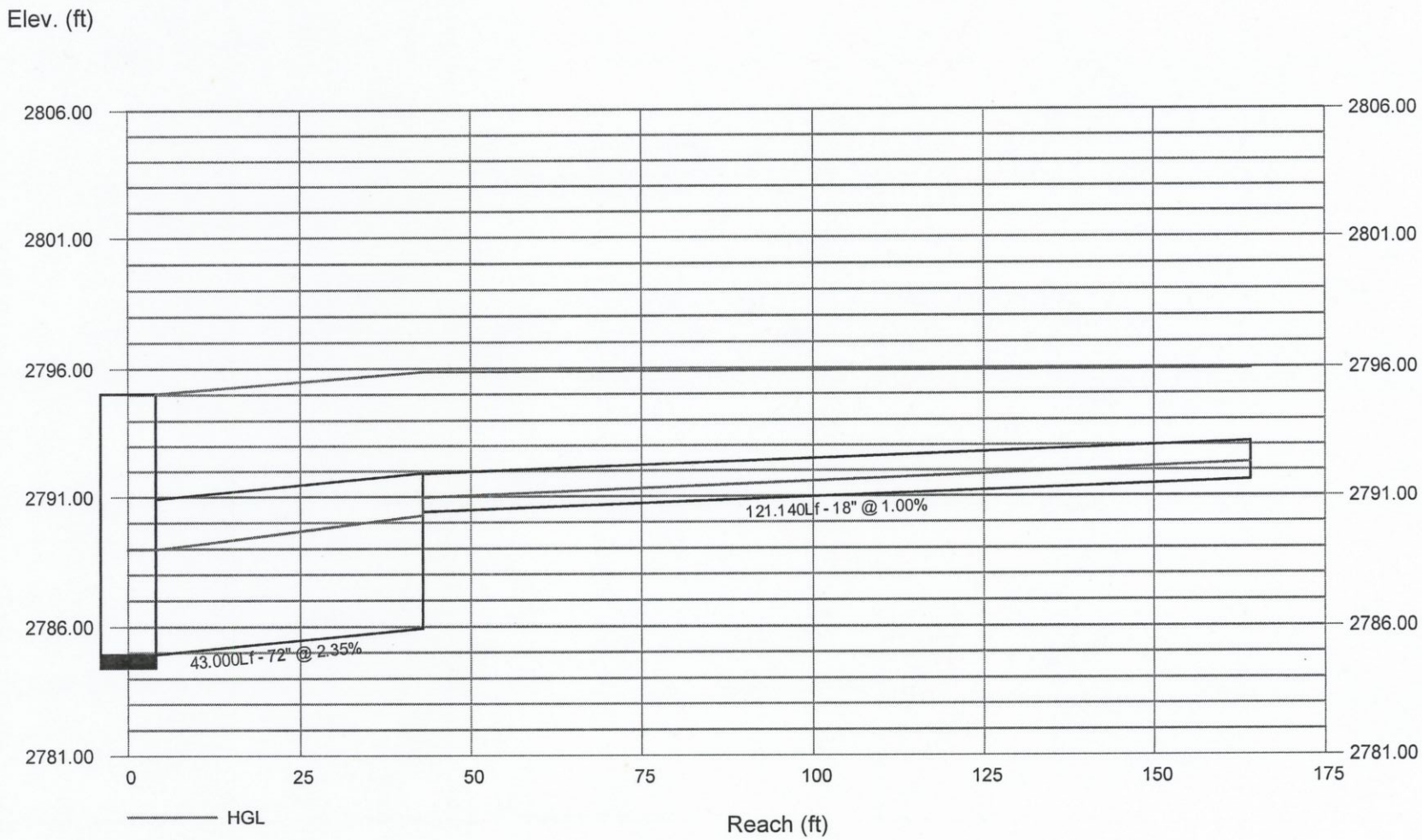

Hydraflow Storm Sewers Extension

Storm Sewer Profile

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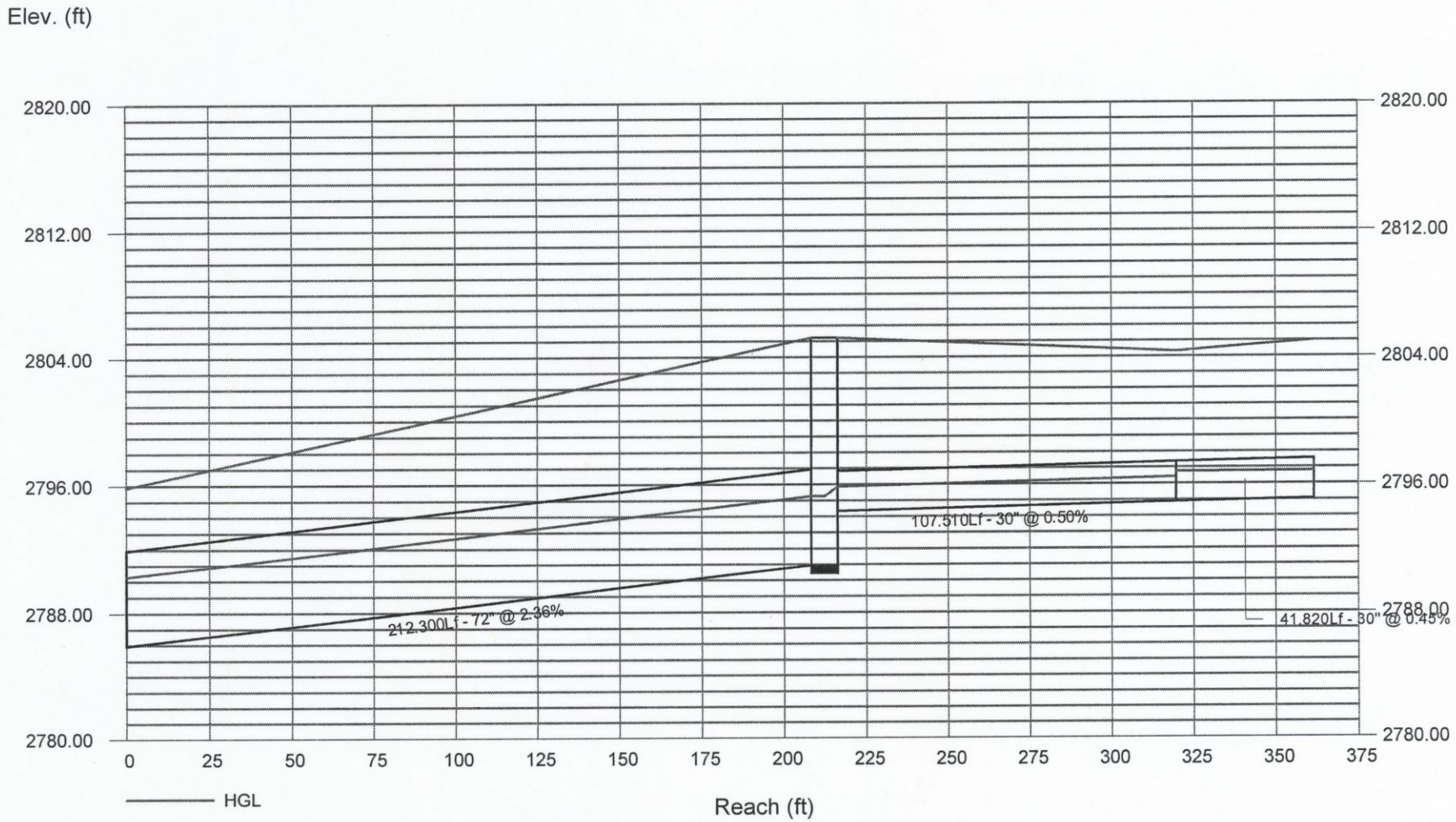

Storm Sewer Profile

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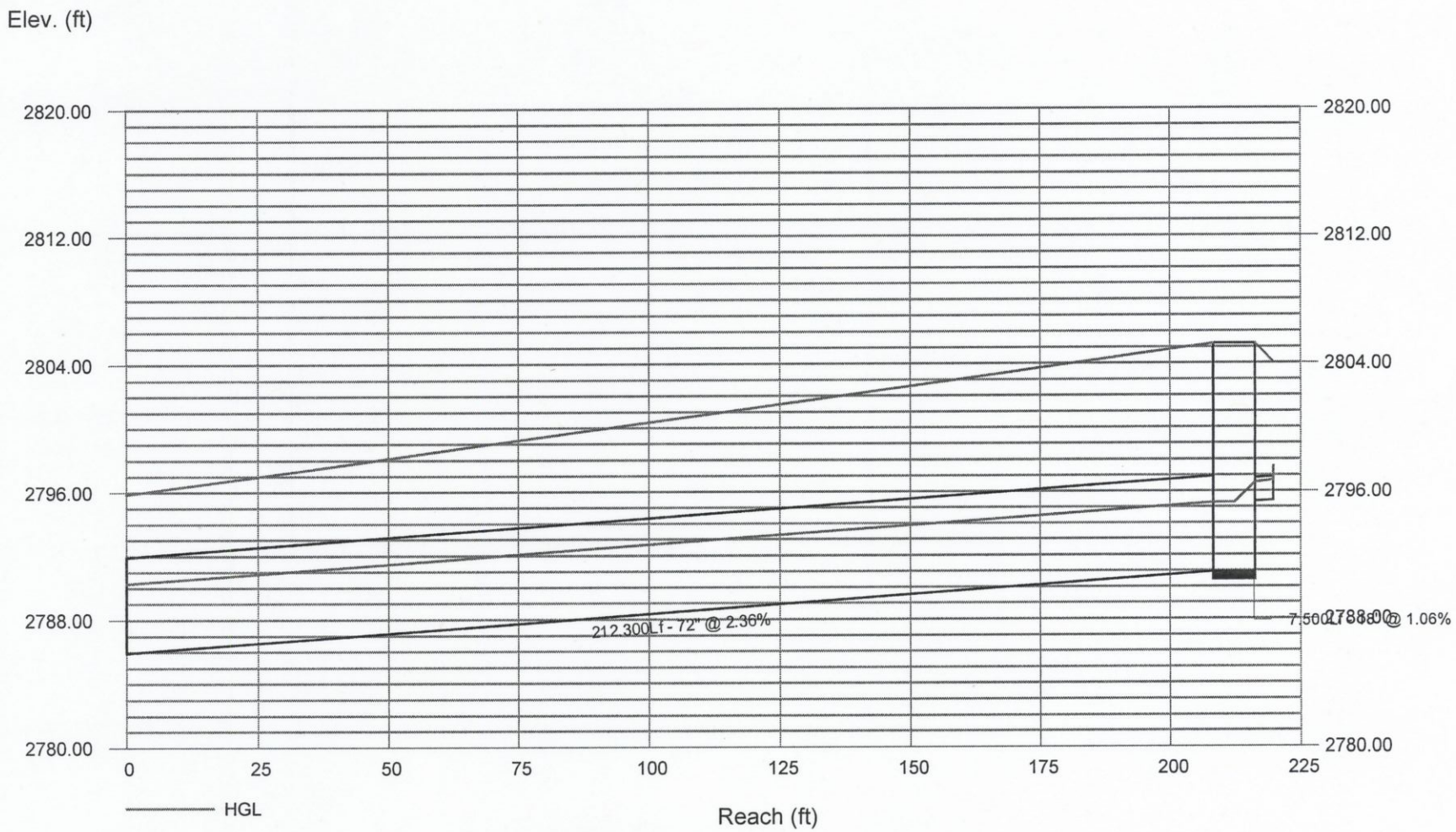

Hydraflow Storm Sewers Extension

Storm Sewer Profile

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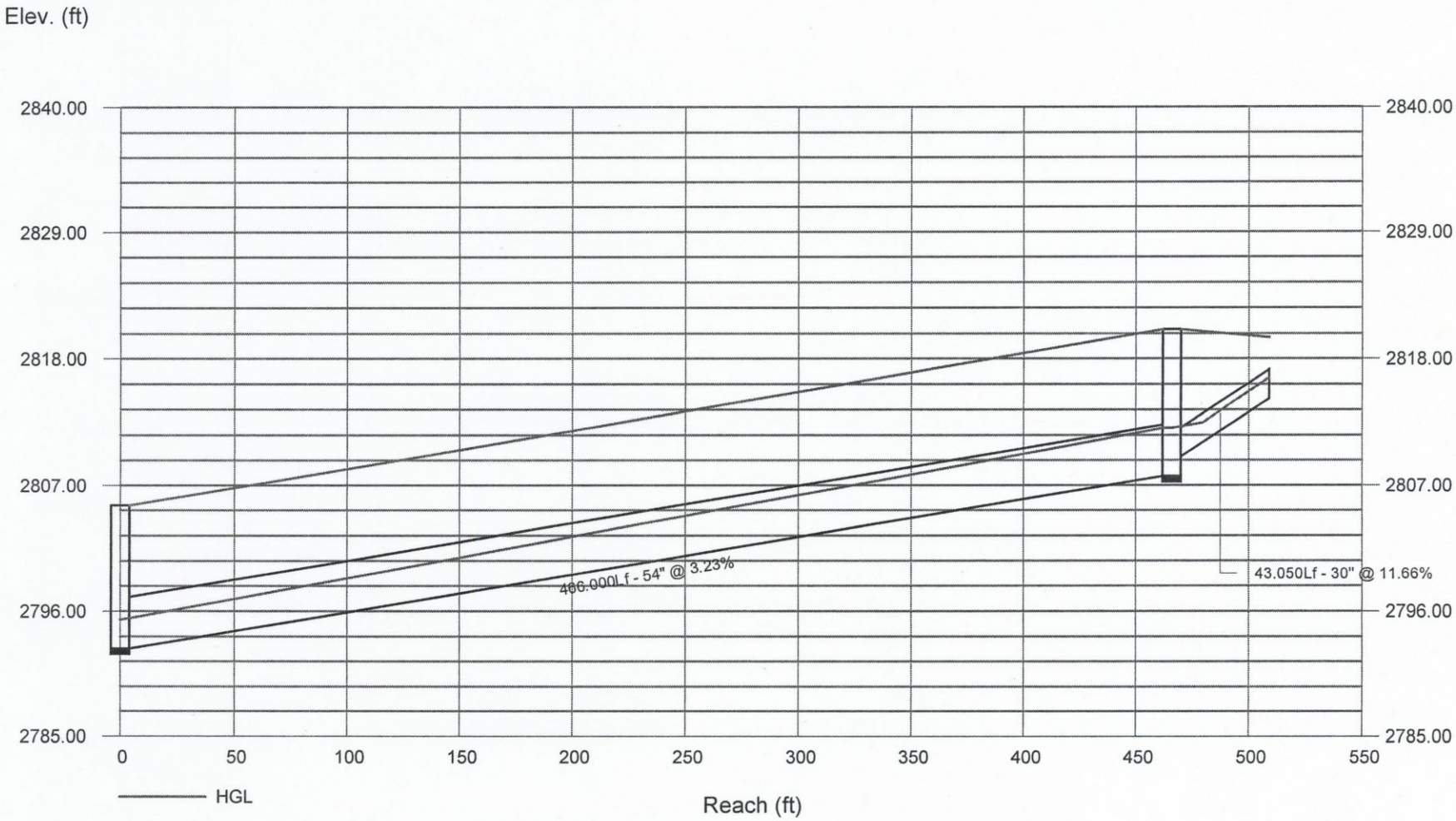
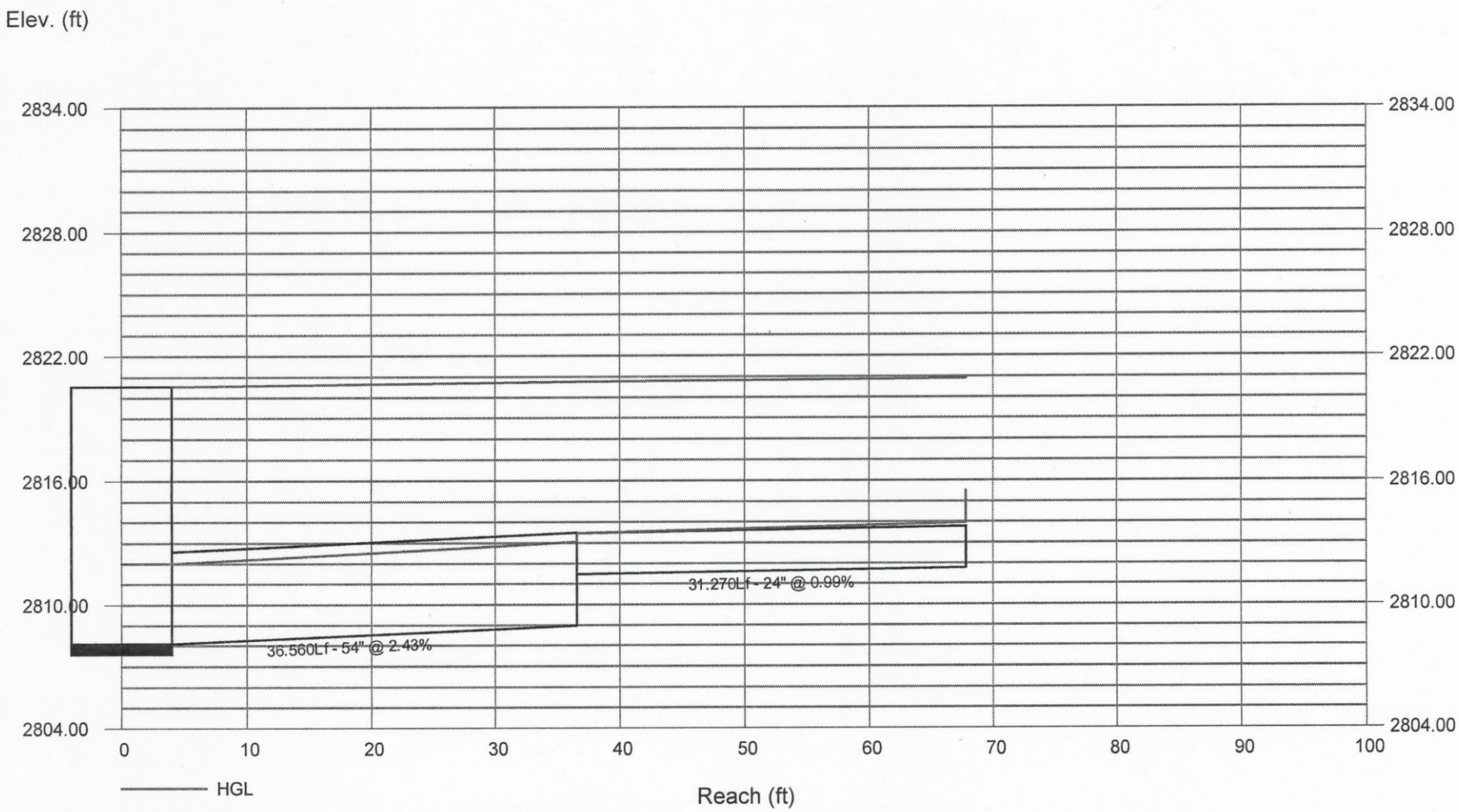


Storm Sewer Profile

Proj. file: 10-yr 2-08-10.stm



Storm Sewer Profile

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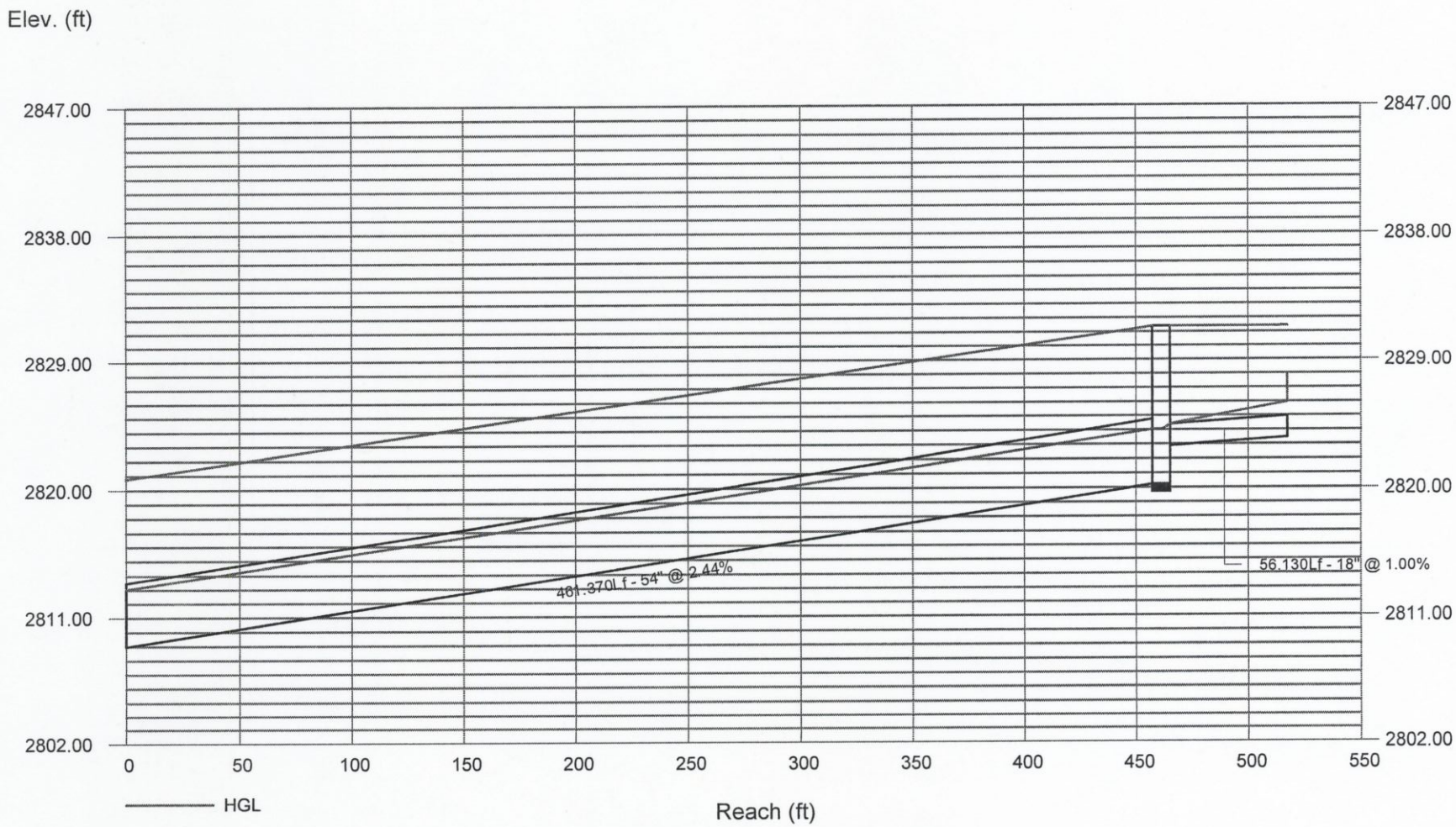

Hydraflow Storm Sewers Extension

Storm Sewer Profile

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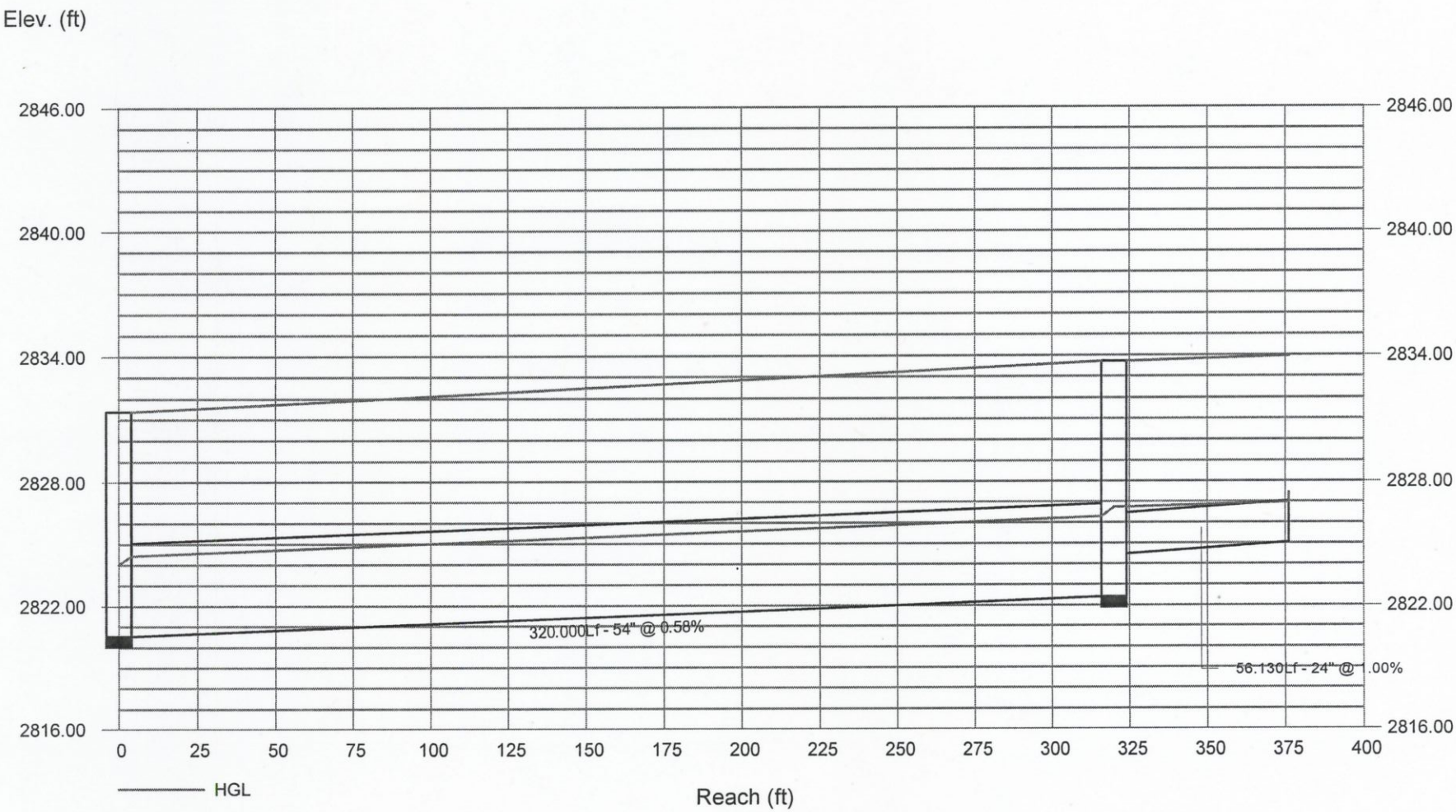

Hydraflow Storm Sewers Extension

Storm Sewer Profile

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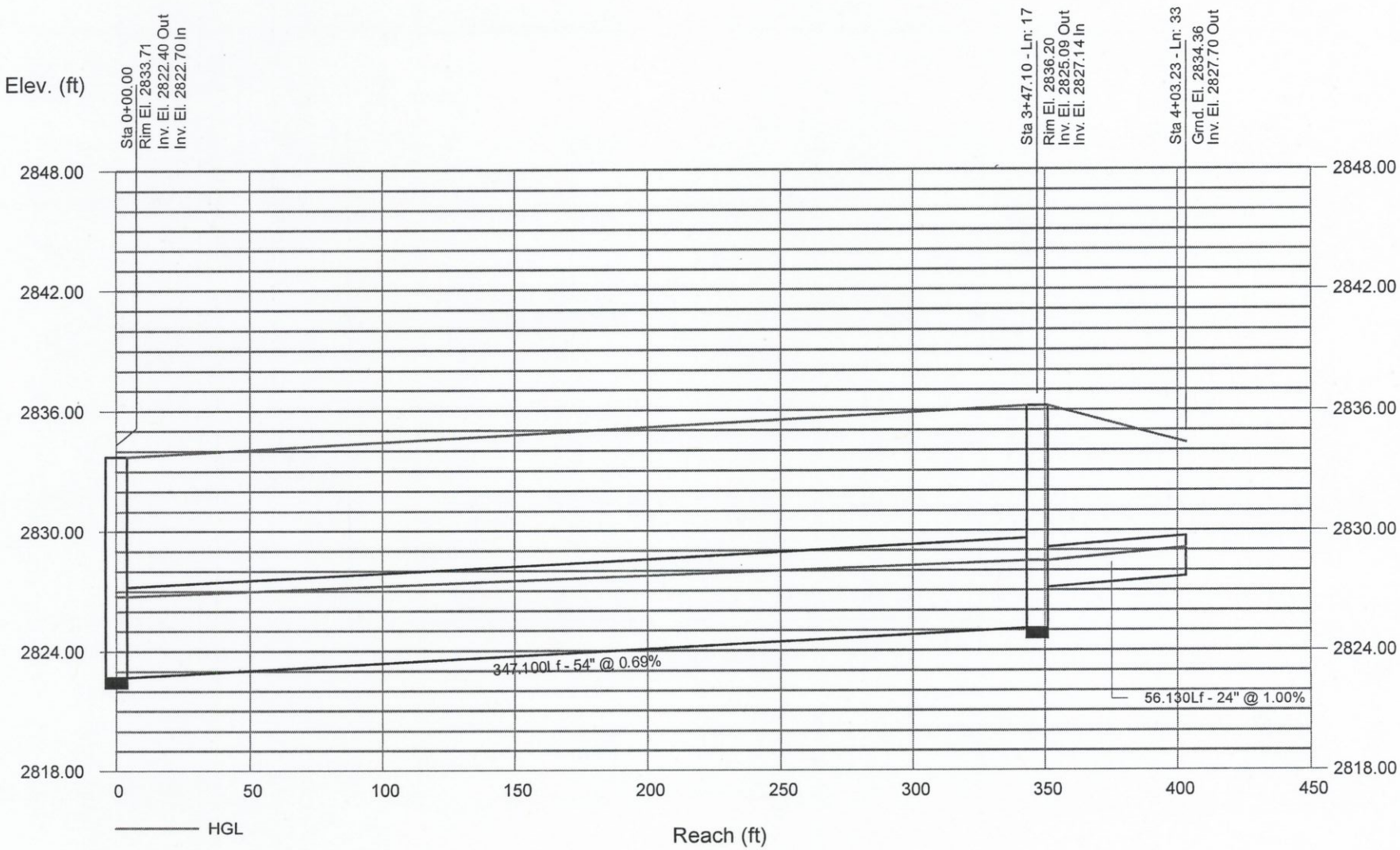

Storm Sewer Profile

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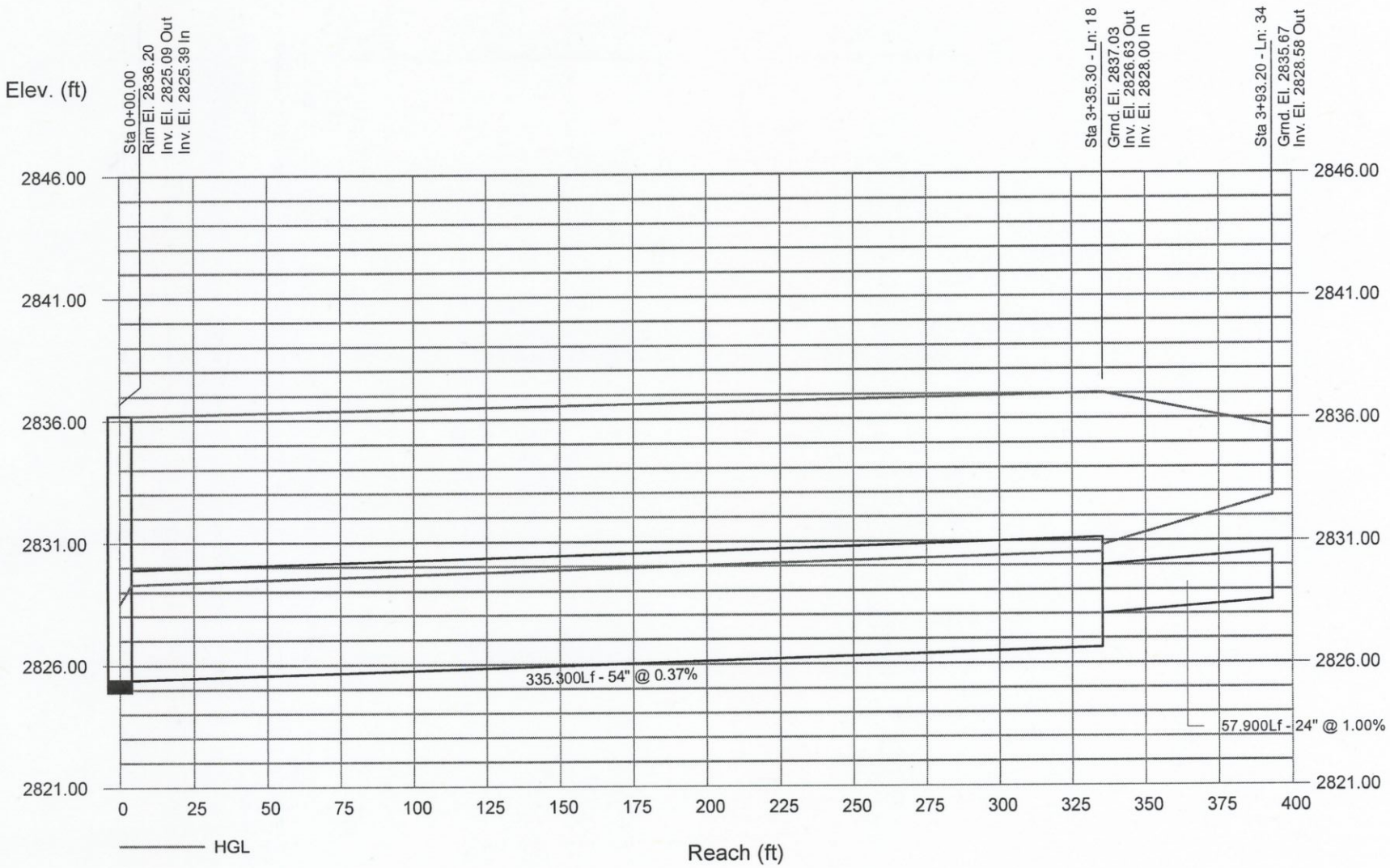

Hydraflow Storm Sewers Extension

Storm Sewer Profile

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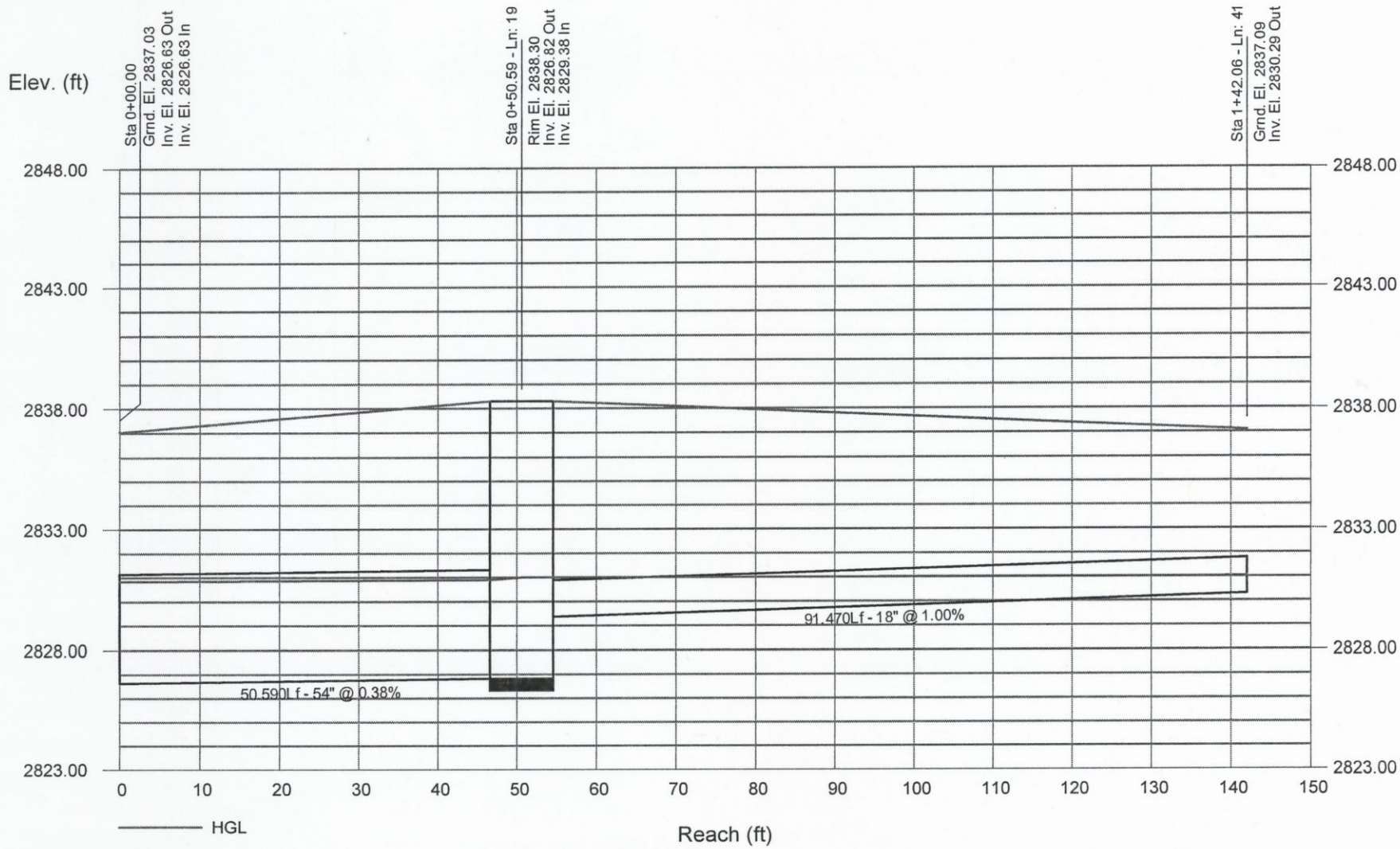

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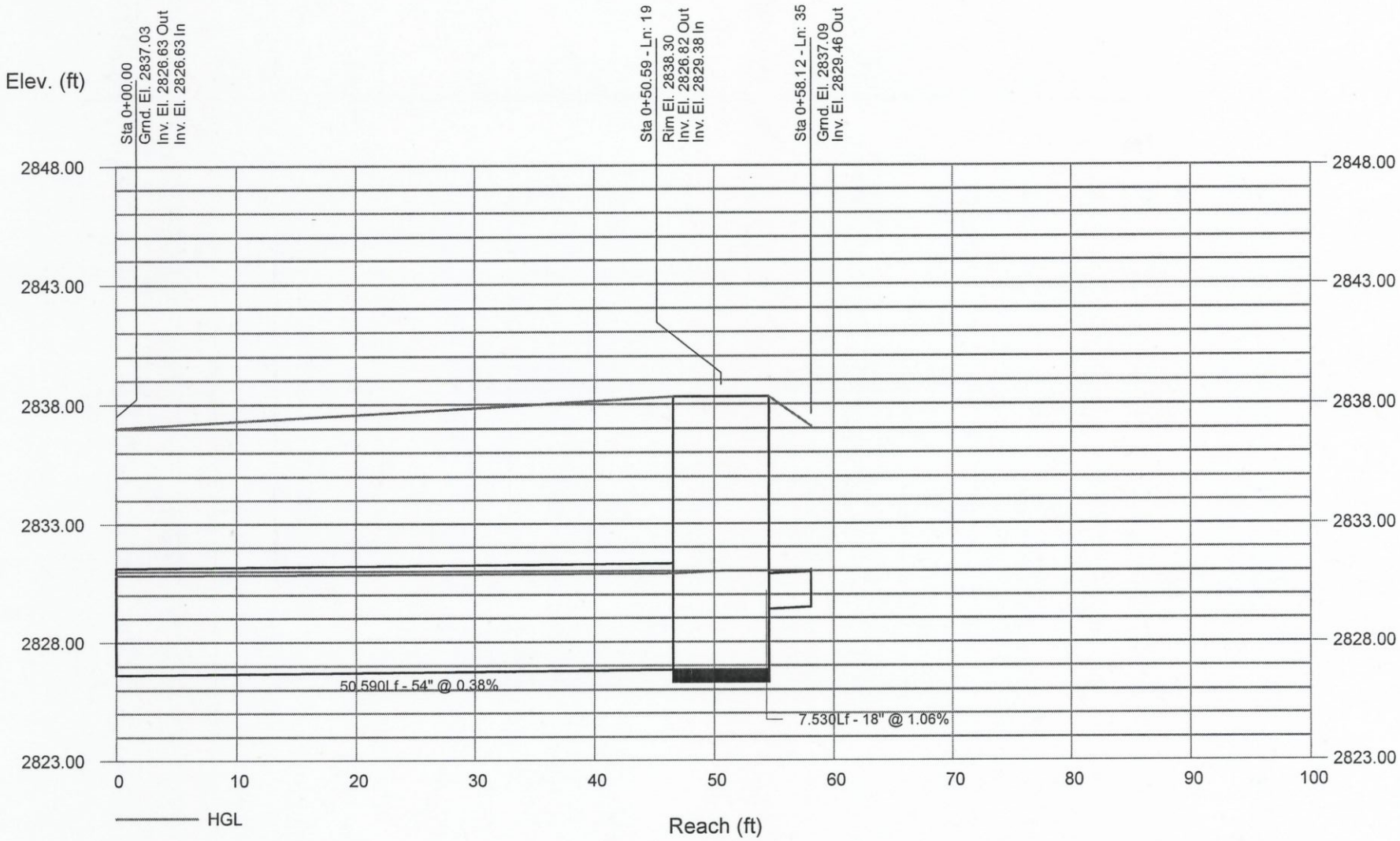

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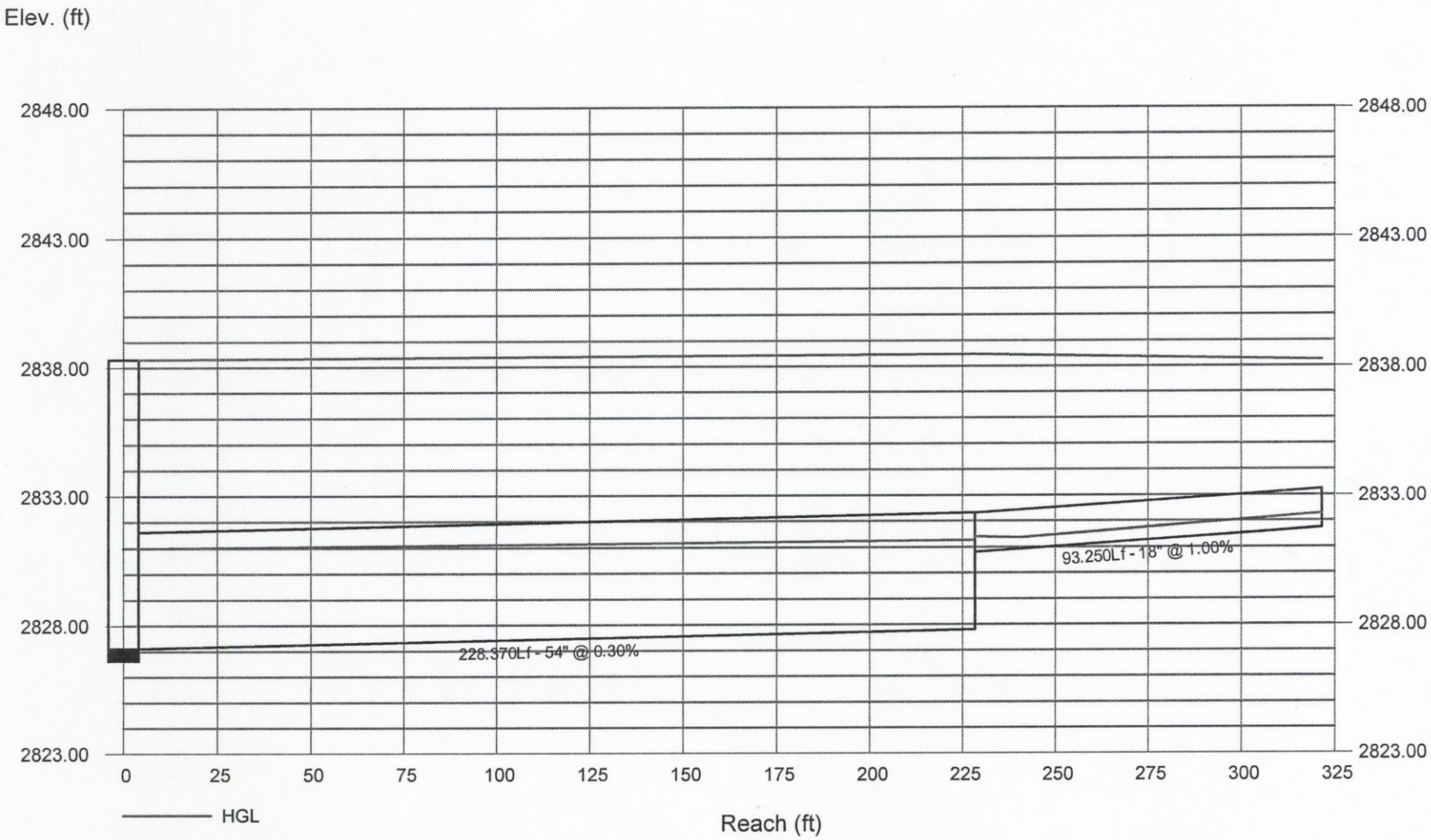

Hydraflow Storm Sewers Extension

Storm Sewer Profile

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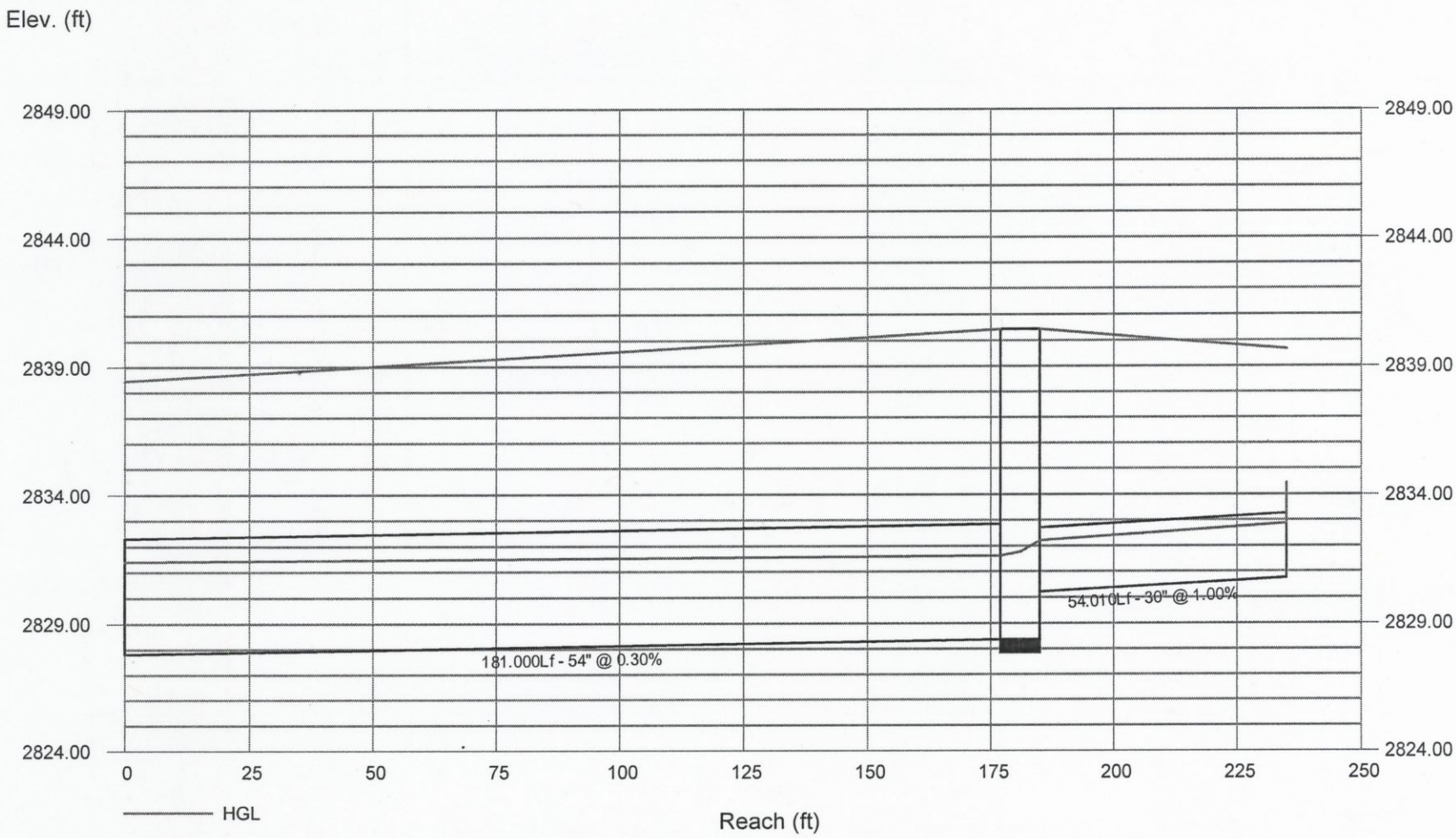

Hydraflow Storm Sewers Extension

Storm Sewer Profile

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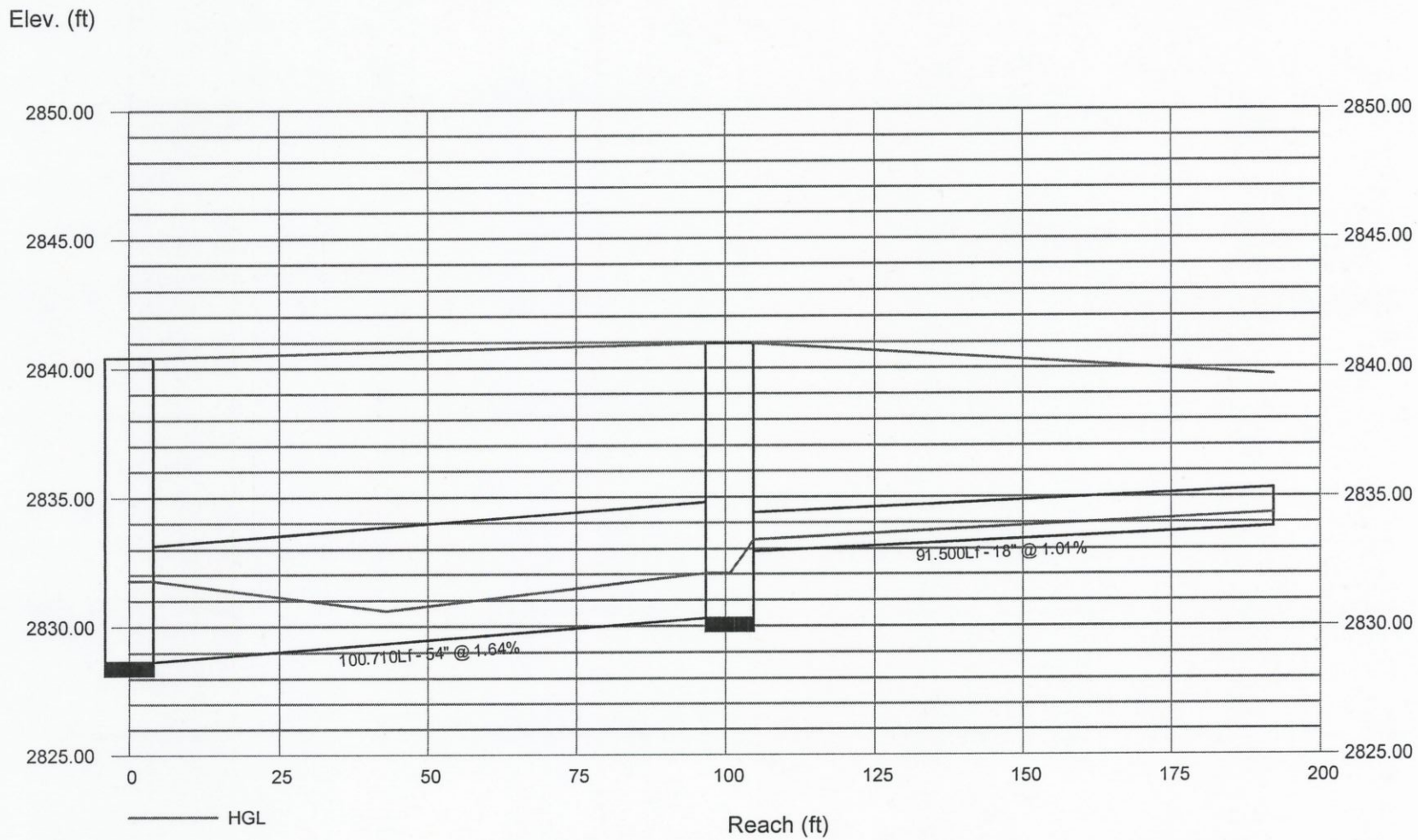

Hydraflow Storm Sewers Extension

Storm Sewer Profile

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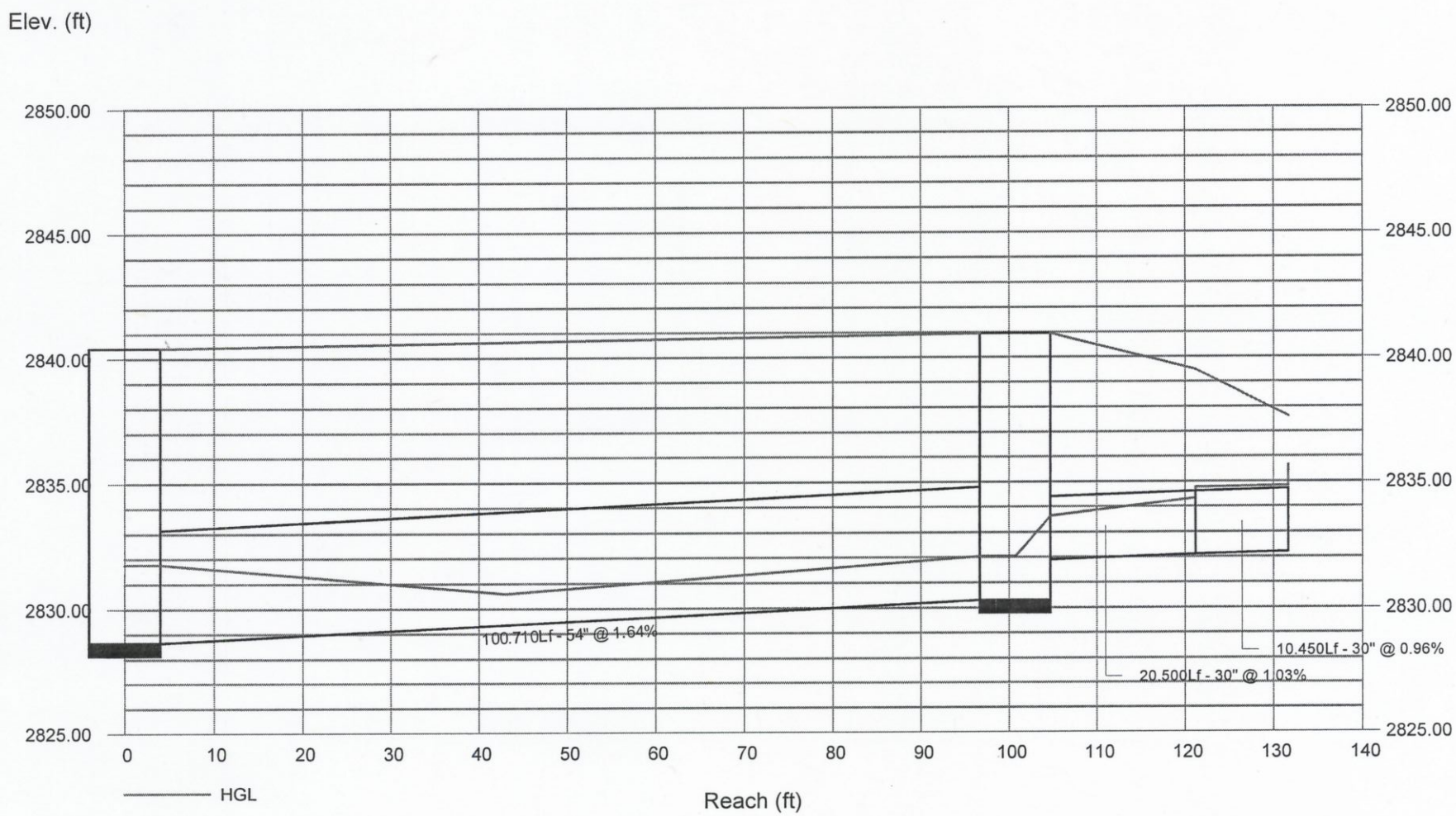

Storm Sewer Summary Report

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	PIPE 39	7.24	18	Cir	26.750	2866.97	2867.08	0.412	2868.47	2868.58	0.13	2868.71	End	None
2	PIPE 38	4.58	18	Cir	60.000	2867.08	2867.32	0.400	2868.71	2868.82	0.13	2868.95	1	None
3	PIPE 40	4.45	18	Cir	73.850	2872.06	2873.02	1.300	2873.56	2873.83	n/a	2873.83 j	End	None
4	Pipe 41	4.30	18	Cir	37.650	2879.30	2879.41	0.292	2880.80	2880.86	0.12	2880.98	End	None
5	Pipe 43	2.25	18	Cir	7.720	2882.92	2882.95	0.389	2884.42	2884.42	0.01	2884.44	End	None
6	Pipe 42	1.50	18	Cir	25.000	2882.95	2883.05	0.400	2884.44	2884.44	0.01	2884.45	5	None
7	Pipe 47	3.80	18	Cir	32.980	2899.10	2899.43	1.000	2900.60	2900.62	0.12	2900.74	End	None
8	Pipe 45	9.80	14x23	Ell	52.500	2895.21	2895.37	0.305	2896.38*	2896.86*	n/a	2897.11	End	None
9	Pipe 44	6.00	14x23	Ell	123.000	2895.37	2895.74	0.301	2897.59*	2898.02*	0.23	2898.24	8	None
10	Pipe 47	5.90	18	Cir	18.570	2908.53	2908.60	0.377	2910.03	2910.09	0.09	2910.17	End	None
11	Pipe 50	3.73	18	Cir	46.170	2910.43	2911.35	1.993	2911.93	2912.09	n/a	2912.09 j	End	None
12	Pipe 49	1.45	18	Cir	107.000	2911.35	2913.49	2.000	2912.09	2913.95	n/a	2913.95 j	11	None
13	Pipe 52	8.37	18	Cir	47.420	2914.08	2915.03	2.003	2915.58	2916.13	n/a	2916.13 j	End	None
14	Pipe 51	5.40	18	Cir	111.000	2915.03	2916.14	1.000	2916.13	2917.03	n/a	2917.03 j	13	None
15	Pipe 53	2.35	12	Cir	18.530	2917.18	2917.37	1.026	2918.18	2918.23	0.00	2918.23	End	None
16	Pipe 46	6.40	18	Cir	40.790	2895.95	2896.11	0.393	2897.45	2897.59	0.26	2897.85	End	None

South of Civano | Number of lines: 16 | Run Date: 02-09-2010

NOTES: Return period = 100 Yrs. ; *Surcharged (HGL above crown). ; j - Line contains hyd. jump.

MyR ort

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	1.77	1.77	n/a	0.20	0.50	0.90	6.74	1.03	....	....	....	-0.586	1.50	1.50	Outfall	0.00	154009.39	2868.73	2868.84	0.126
2	1.77	1.77	1	0.20	0.50	0.90	6.64	0.82	....	....	....	0.005	1.50	1.50	1	0.00	154069.39	2868.81	2868.92	0.113
3	1.77	0.97	n/a	0.20	0.50	0.90	11.97	0.81	....	....	....	90.000	1.50	0.81**	Outfall	0.00	154011.41	2873.66	2874.16	0.276
4	1.77	1.75	n/a	0.20	0.50	0.90	5.67	0.79	....	....	....	179.420	1.50	1.45	Outfall	0.00	154140.43	2880.89	2880.95	0.059
5	1.77	1.76	n/a	0.20	0.50	0.90	6.55	0.57	....	....	....	-45.000	1.50	1.47	Outfall	0.00	154203.74	2884.45	2884.45	0.003
6	1.76	1.71	5	0.20	0.50	0.90	6.64	0.47	....	....	....	45.000	1.49	1.39	5	0.00	154228.74	2884.45	2884.45	0.005
7	1.77	1.50	n/a	0.20	0.50	0.90	10.50	0.74	....	....	....	179.474	1.50	1.19	Outfall	0.00	154175.07	2900.67	2900.72	0.045
8	1.76	1.76	n/a	0.20	0.50	0.90	5.64	1.17	....	....	....	179.482	1.17	1.17**	Outfall	0.00	154192.17	2896.86	2897.35	0.484
9	1.76	1.76	8	0.20	0.50	0.90	5.60	0.93	....	....	....	-0.006	1.17	1.17	8	0.00	154069.18	2897.77	2898.20	0.425
10	1.77	1.76	n/a	0.20	0.50	0.90	6.45	0.93	....	....	....	179.483	1.50	1.49	Outfall	0.00	154194.71	2910.20	2910.26	0.056
11	1.77	0.86	n/a	0.20	0.50	0.90	14.82	0.74	....	....	....	-50.523	1.50	0.74**	Outfall	0.00	154059.98	2912.00	2912.38	0.153
12	0.86	0.46	11	0.20	0.50	0.90	14.85	0.46	....	....	....	50.003	0.74	0.46**	11	0.00	154166.97	2912.13	2914.11	0.288
13	1.77	1.39	n/a	0.20	0.50	0.90	14.86	1.10	....	....	....	179.482	1.50	1.10**	Outfall	0.00	154173.47	2915.93	2916.69	0.340
14	1.39	1.09	13	0.20	0.50	0.90	10.50	0.89	....	....	....	-0.004	1.10	0.89**	13	0.00	154062.48	2916.37	2917.41	0.525
15	0.79	0.72	n/a	0.20	0.50	0.90	3.61	0.65	....	....	....	-90.226	1.00	0.86	Outfall	0.00	154187.05	2918.32	2918.40	0.078
16	1.77	1.76	n/a	0.20	0.50	0.90	6.58	0.97	....	....	....	0.000	1.50	1.48	Outfall	0.00	154231.34	2897.65	2897.80	0.145

South of Civano | Number of lines: 16 | Date: 02-09-2010

NOTES: ** Critical depth

MyReport

Flow Rate (cfs)	Sf Ave (ft/ft)	Sf Dn (ft/ft)	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 (%)
7.24	0.471	0.476	....	....	....	2867.50	2871.14	....	....	....	....	2868.47	2868.58	2868.71	....	....	0.00	2.66	....	....
4.58	0.188	0.190	....	....	....	2871.14	2871.14	....	....	....	....	2868.71	2868.82	2868.95	....	....	0.00	4.58	....	....
4.45	0.373	0.180	....	....	....	2873.56	2878.56	....	....	....	....	2873.56	2873.83 j	2873.83	2873.55	2873.16	0.00	4.45	....	....
4.30	0.157	0.168	....	....	....	2880.80	2883.10	....	....	....	....	2880.80	2880.86	2880.98	....	....	0.00	4.30	....	....
2.25	0.044	0.046	....	....	....	2893.70	2898.11	....	....	....	....	2884.42	2884.42	2884.44	....	....	0.00	0.75	....	....
1.50	0.018	0.019	....	....	....	2898.11	2898.11	....	....	....	....	2884.44	2884.44	2884.45	....	....	0.00	1.50	....	....
3.80	0.136	0.131	....	....	....	2899.62	2901.82	....	....	....	....	2900.60	2900.62	2900.74	....	....	0.00	3.80	....	....
9.80	0.922	0.922	....	....	....	2906.68	2909.61	....	....	....	....	2896.38	2896.86	2897.11	....	....	0.00	3.80	....	....
6.00	0.346	0.346	....	....	....	2909.61	2909.61	....	....	....	....	2897.59	2898.02	2898.24	....	....	0.00	6.00	....	....
5.90	0.304	0.316	....	....	....	0.00	2912.58	....	....	....	....	2910.03	2910.09	2910.17	....	....	0.00	5.90	....	....
3.73	0.331	0.126	....	....	....	2911.94	2918.06	....	....	....	....	2911.93	2912.09 j	2912.09	2911.90	2911.53	0.00	2.28	....	....
1.45	0.270	0.081	....	....	....	2918.06	2918.06	....	....	....	....	2912.09	2913.95 j	2913.95	2912.03	2911.94	0.00	1.45	....	....
8.37	0.717	0.636	....	....	....	2914.87	2920.22	....	....	....	....	2915.58	2916.13 j	2916.13	2915.48	2915.38	0.00	2.97	....	....
5.40	0.473	0.332	....	....	....	2920.22	2919.42	....	....	....	....	2916.13	2917.03 j	2917.03	2916.14	2916.07	0.00	5.40	....	....
2.35	0.419	0.436	....	....	....	2918.49	2920.82	....	....	....	....	2918.18	2918.23	2918.23	....	....	0.00	2.35	....	....
6.40	0.357	0.372	....	....	....	2867.50	2910.00	....	....	....	....	2897.45	2897.59	2897.85	....	....	0.00	6.40	....	....

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NOTES: ** Critical depth

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)
PV12, BYPASS PV12.1	On Grade	....	0.0	0.00	0.00	2866.97	2867.08	....	....	0.00	0.00	0.50	None	2.66
PV11, PV11.1 BYPASS PV10	On Grade	....	0.0	0.00	0.00	2867.08	2867.32	....	....	0.00	0.00	1.25	None	4.58
PV 12.1	On Grade	....	0.0	0.00	0.00	2872.06	2873.02	29.54	5.54	0.16	0.59	1.25	None	4.45
PV10	On Grade	....	0.0	0.00	0.00	2879.30	2879.41	....	....	0.00	0.00	1.25	None	4.30
1/2 PV26 (1.5)	On Grade	....	0.0	0.00	0.00	2882.92	2882.95	....	....	0.00	0.00	0.50	None	0.75
1/2 PV26	On Grade	....	0.0	0.00	0.00	2882.95	2883.05	....	....	0.00	0.00	1.25	None	1.50
PV7	On Grade	....	0.0	0.00	0.00	2899.10	2899.43	....	....	0.00	0.00	1.25	None	3.80
PV8	On Grade	....	0.0	0.00	0.00	2895.21	2895.37	....	....	0.00	0.00	0.50	None	3.80
PV9	On Grade	....	0.0	0.00	0.00	2895.37	2895.74	....	....	0.00	0.00	1.25	None	6.00
PV5	On Grade	....	0.0	0.00	0.00	2908.53	2908.60	....	....	0.00	0.00	0.50	None	5.90
PV2.1, bypass PV2	On Grade	....	0.0	0.00	0.00	2910.43	2911.35	23.09	5.03	0.14	0.65	0.50	None	2.28
PV3.1, bypass PV3	On Grade	....	0.0	0.00	0.00	2911.35	2913.49	10.70	2.32	0.15	0.39	1.25	None	1.45
PV3, bypass PV1	On Grade	....	0.0	0.00	0.00	2914.08	2915.03	14.23	5.55	0.55	0.88	0.50	None	2.97
PV2	On Grade	....	0.0	0.00	0.00	2915.03	2916.14	22.20	4.45	0.38	0.53	1.25	None	5.40
PV1	On Grade	....	0.0	0.00	0.00	2917.18	2917.37	....	....	0.00	0.00	0.00	None	2.35
PV 8.1	Sag	....	0.0	0.00	0.00	2895.95	2896.11	....	....	0.00	0.00	1.25	None	6.40

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NOTES: Intensity = 127.16 / (Inlet time + 17.80) ^ 0.82 -- Return period = 100 Yrs. ; ** Critical depth

Cost RCP ($)	Cost CMP ($)	Cost PVC ($)	Line ID	Line Length (ft)	Line Size (in)	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)
972	875	826	PIPE 39	26.750	18	0.41	Cir	....	....	0.013	0.13	119981.28	0.15	....	....	....	18	0.00	18	0.00
2,136	1,922	1,816	PIPE 38	60.000	18	0.40	Cir	....	....	0.013	0.13	119981.89	0.33	....	....	....	18	0.00	18	0.00
2,696	2,426	2,292	PIPE 40	73.850	18	1.30	Cir	....	....	0.013	n/a	119661.13	0.41	....	....	....	18	0.00	18	0.00
1,300	1,170	1,105	Pipe 41	37.650	18	0.29	Cir	....	....	0.013	0.12	119379.34	0.21	....	....	....	18	0.00	18	0.00
620	558	527	Pipe 43	7.720	18	0.39	Cir	....	....	0.013	0.01	117388.56	0.04	....	....	....	18	0.00	18	0.00
1,795	1,616	1,526	Pipe 42	25.000	18	0.40	Cir	....	....	0.013	0.01	117388.56	0.14	....	....	....	18	0.00	18	0.00
1,140	1,026	969	Pipe 47	32.980	18	1.00	Cir	....	....	0.013	0.12	116755.65	0.18	....	....	....	18	0.00	18	0.00
170	153	145	Pipe 45	52.500	14 x 23	0.31	Ell	....	....	0.013	n/a	117039.18	0.29	....	....	....	14	0.00	23	0.00
160	144	136	Pipe 44	123.000	14 x 23	0.30	Ell	....	....	0.013	0.23	117038.06	0.68	....	....	....	14	0.00	23	0.00
692	623	588	Pipe 47	18.570	18	0.38	Cir	....	....	0.013	0.09	115410.99	0.10	....	....	....	18	0.00	18	0.00
1,827	1,644	1,553	Pipe 50	46.170	18	1.99	Cir	....	....	0.013	n/a	114714.23	0.26	....	....	....	18	0.00	18	0.00
4,575	4,118	3,889	Pipe 49	107.000	18	2.00	Cir	....	....	0.013	n/a	114715.20	0.59	....	....	....	18	0.00	18	0.00
1,724	1,552	1,465	Pipe 52	47.420	18	2.00	Cir	....	....	0.013	n/a	114284.70	0.26	....	....	....	18	0.00	18	0.00
4,204	3,784	3,573	Pipe 51	111.000	18	1.00	Cir	....	....	0.013	n/a	114283.69	0.62	....	....	....	18	0.00	18	0.00
618	556	525	Pipe 53	18.530	12	1.03	Cir	....	....	0.013	0.00	114116.15	0.10	....	....	....	12	0.00	12	0.00
1,625	1,462	1,381	Pipe 46	40.790	18	0.39	Cir	....	....	0.013	0.26	116821.96	0.23	....	....	....	18	0.00	18	0.00

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NOTES: ** Critical depth

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)	Vel Hd Dn (ft)	Vel Hd Up (ft)	Vel Up (ft/s)	Cover Dn (ft)	Cover Up (ft)	Storage (cft)
0.00	0.00	0.3	....	0.00	0.00	0.00	4.10	4.10	0.26	0.26	4.10	-0.97	2.56	47.27
0.00	0.00	0.0	....	0.00	0.00	0.00	2.59	2.59	0.10	0.10	2.59	2.56	2.32	106.01
0.00	0.00	0.0	....	0.00	0.00	0.00	3.56	2.52	0.10	0.33	4.61	0.00	4.04	105.37
0.00	0.00	0.0	....	0.00	0.00	0.00	2.45	2.43	0.09	0.09	2.46	0.00	2.19	66.24
0.00	0.00	0.1	....	0.00	0.00	0.00	1.28	1.27	0.03	0.03	1.28	9.28	13.66	13.62
0.00	0.00	0.0	....	0.00	0.00	0.00	0.86	0.85	0.01	0.01	0.88	13.66	13.56	43.49
0.00	0.00	0.0	....	0.00	0.00	0.00	2.34	2.15	0.07	0.10	2.53	-0.98	0.89	54.65
0.00	0.00	0.7	....	0.00	0.00	0.00	5.58	5.58	0.48	0.48	5.58	10.30	13.07	92.20
0.00	0.00	0.0	....	0.00	0.00	0.00	3.42	3.42	0.18	0.18	3.42	13.07	12.70	216.02
0.00	0.00	0.0	....	0.00	0.00	0.00	3.34	3.34	0.17	0.17	3.34	N/A	2.48	32.79
0.00	0.00	0.6	....	0.00	0.00	0.00	3.21	2.11	0.07	0.29	4.32	0.01	5.21	63.74
0.00	0.00	0.0	....	0.00	0.00	0.00	2.42	1.68	0.04	0.16	3.16	5.21	3.07	70.54
0.00	0.00	0.6	....	0.00	0.00	0.00	5.37	4.74	0.35	0.56	6.00	-0.71	3.69	76.48
0.00	0.00	0.0	....	0.00	0.00	0.00	4.42	3.87	0.23	0.38	4.96	3.69	1.78	138.07
0.00	0.00	0.0	....	0.00	0.00	0.00	3.13	2.99	0.14	0.17	3.27	0.31	2.45	14.05
0.00	0.00	0.0	....	0.00	0.00	0.00	3.63	3.62	0.20	0.20	3.63	-29.95	12.39	72.02

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NOTES: ** Critical depth

Hydr lic 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	18	7.24	2866.97	2868.47	1.50	1.77	4.10	0.26	2868.73	0.476	26.750	2867.08	2868.58	1.50	1.77	4.10	0.26	2868.84	0.466	0.471	0.126	0.50	0.13
2	18	4.58	2867.08	2868.71	1.50	1.77	2.59	0.10	2868.81	0.190	60.000	2867.32	2868.82	1.50	1.77	2.59	0.10	2868.92	0.186	0.188	0.113	1.25	0.13
3	18	4.45	2872.06	2873.56	1.50*	1.77	2.52	0.10	2873.66	0.180	73.850	2873.02	2873.83 j	0.81**	0.97	4.61	0.33	2874.16	0.567	0.373	n/a	1.25	0.41
4	18	4.30	2879.30	2880.80	1.50*	1.77	2.43	0.09	2880.89	0.168	37.650	2879.41	2880.86	1.45	1.75	2.46	0.09	2880.95	0.147	0.157	0.059	1.25	0.12
5	18	2.25	2882.92	2884.42	1.50*	1.77	1.27	0.03	2884.45	0.046	7.720	2882.95	2884.42	1.47	1.76	1.28	0.03	2884.45	0.041	0.044	0.003	0.50	0.01
6	18	1.50	2882.95	2884.44	1.49	1.76	0.85	0.01	2884.45	0.019	25.000	2883.05	2884.44	1.39	1.71	0.88	0.01	2884.45	0.018	0.018	0.005	1.25	0.01
7	18	3.80	2899.10	2900.60	1.50*	1.77	2.15	0.07	2900.67	0.131	32.980	2899.43	2900.62	1.19	1.50	2.53	0.10	2900.72	0.140	0.136	0.045	1.25	0.12
8	14 23 e	9.80	2895.21	2896.38	1.17	1.76	5.58	0.48	2896.86	0.922	52.500	2895.37	2896.86	1.17**	1.76	5.58	0.48	2897.35	0.922	0.922	0.484	0.50	n/a
9	14 23 e	6.00	2895.37	2897.59	1.17	1.76	3.42	0.18	2897.77	0.346	123.00	2895.74	2898.02	1.17	1.76	3.42	0.18	2898.20	0.346	0.346	0.425	1.25	0.23
10	18	5.90	2908.53	2910.03	1.50*	1.77	3.34	0.17	2910.20	0.316	18.570	2908.60	2910.09	1.49	1.76	3.34	0.17	2910.26	0.292	0.304	0.056	0.50	0.09
11	18	3.73	2910.43	2911.93	1.50*	1.77	2.11	0.07	2912.00	0.126	46.170	2911.35	2912.09 j	0.74**	0.86	4.32	0.29	2912.38	0.535	0.331	n/a	0.50	n/a
12	18	1.45	2911.35	2912.09	0.74	0.86	1.68	0.04	2912.13	0.081	107.00	2913.49	2913.95 j	0.46**	0.46	3.16	0.16	2914.11	0.458	0.270	n/a	1.25	0.19
13	18	8.37	2914.08	2915.58	1.50*	1.77	4.74	0.35	2915.93	0.636	47.420	2915.03	2916.13 j	1.10**	1.39	6.00	0.56	2916.69	0.798	0.717	n/a	0.50	n/a
14	18	5.40	2915.03	2916.13	1.10	1.39	3.87	0.23	2916.37	0.332	111.00	2916.14	2917.03 j	0.89**	1.09	4.96	0.38	2917.41	0.613	0.473	n/a	1.25	n/a
15	12	2.35	2917.18	2918.18	1.00*	0.79	2.99	0.14	2918.32	0.436	18.530	2917.37	2918.23	0.86	0.72	3.27	0.17	2918.40	0.403	0.419	0.078	0.00	0.00
16	18	6.40	2895.95	2897.45	1.50*	1.77	3.62	0.20	2897.65	0.372	40.790	2896.11	2897.59	1.48	1.76	3.63	0.20	2897.80	0.342	0.357	0.145	1.25	0.26

South of Civano | Number of lines: 16 | Run Date: 02-09-2010

Notes: * Normal depth assumed.; ** Critical depth.; j-Line contains hyd. jump. ; c = cir e = ellip b = box

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.

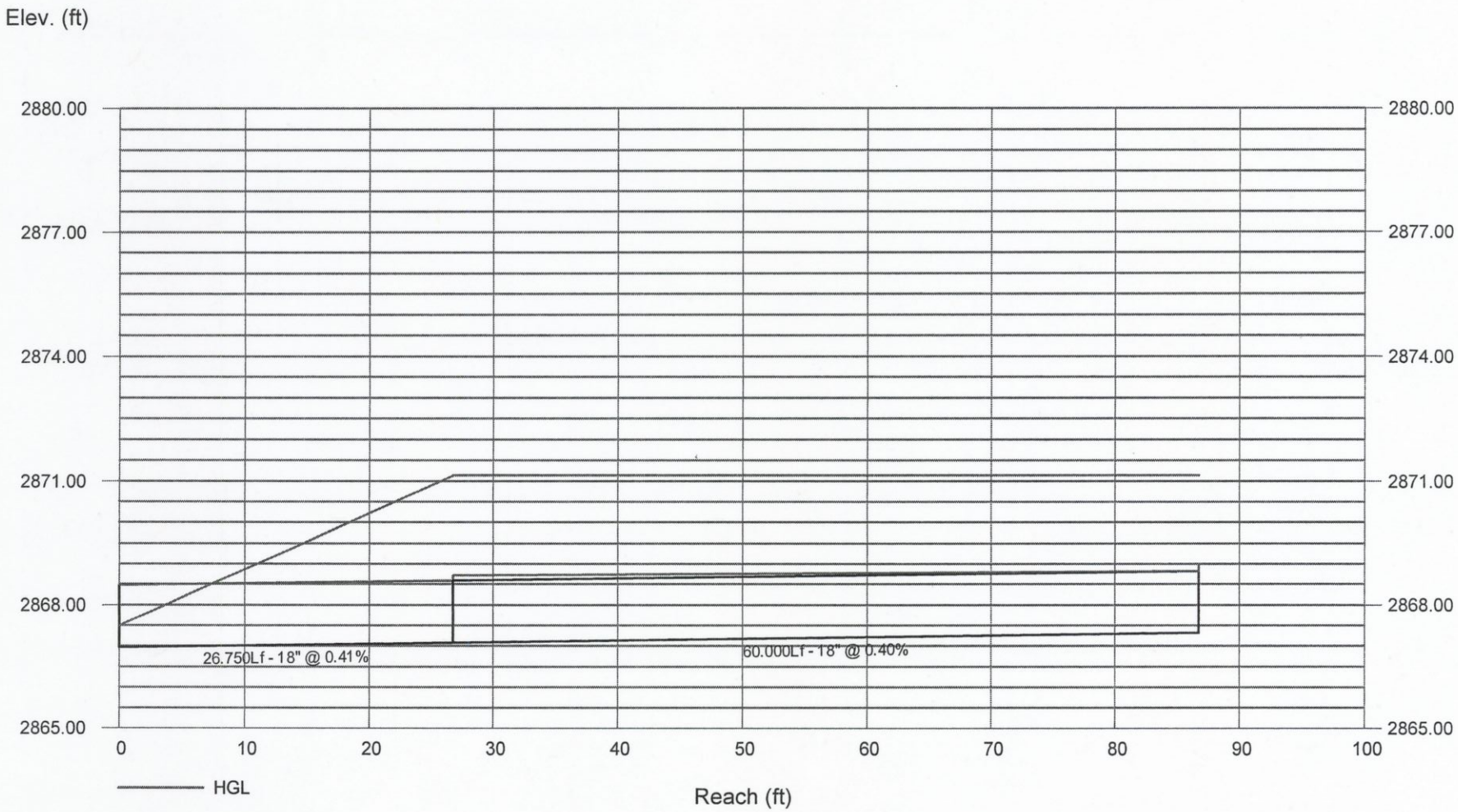
Col. 22 Energy loss. Average Sf/100 x Line Length (Col. 21/100 x Col. 12). Equals (EGL upstream - EGL downstream) +/- tolerance.

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 Profile

Proj. file: South of Civar 2-08-10.stm



Storm Sewer Profile

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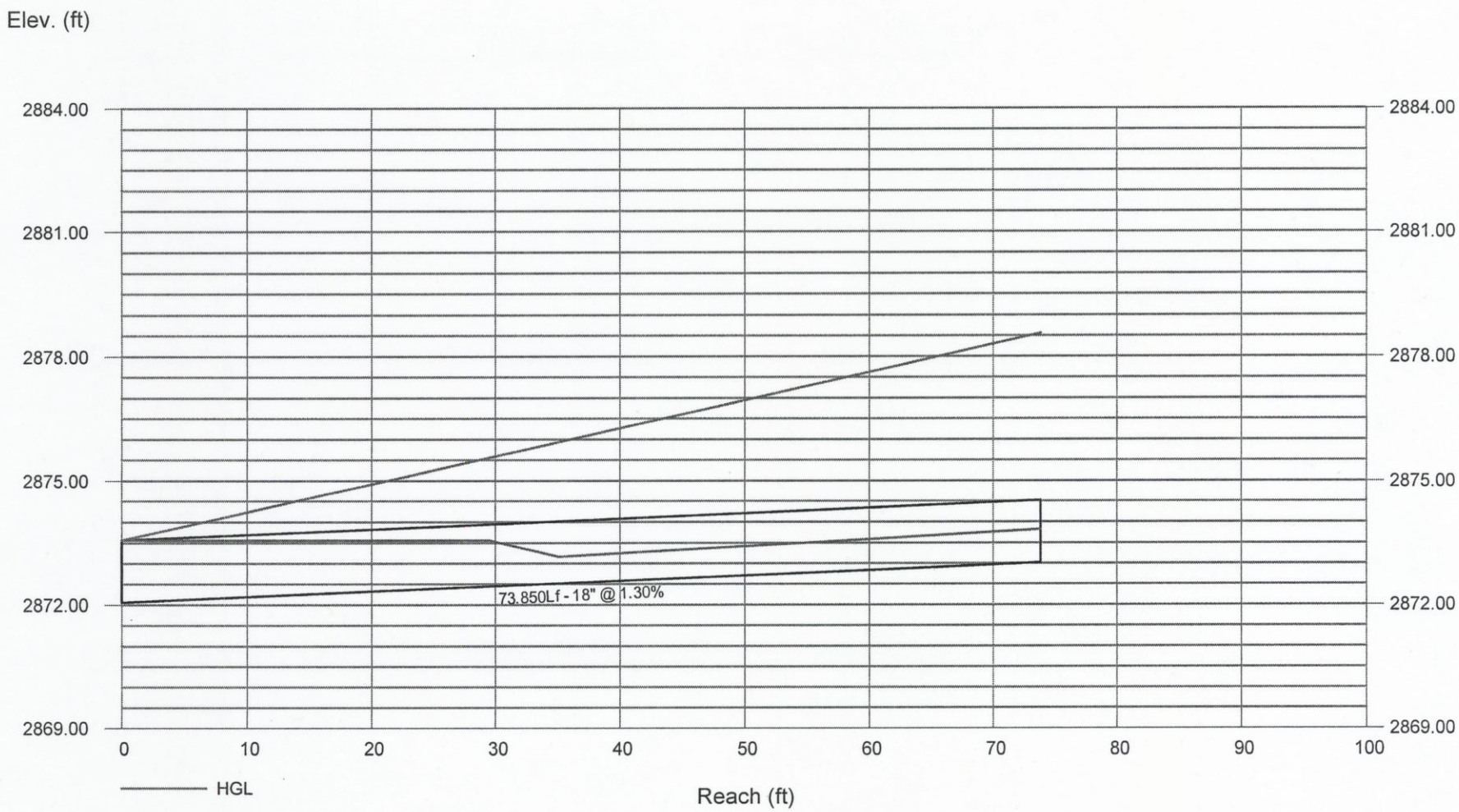

Storm Sewer Profile

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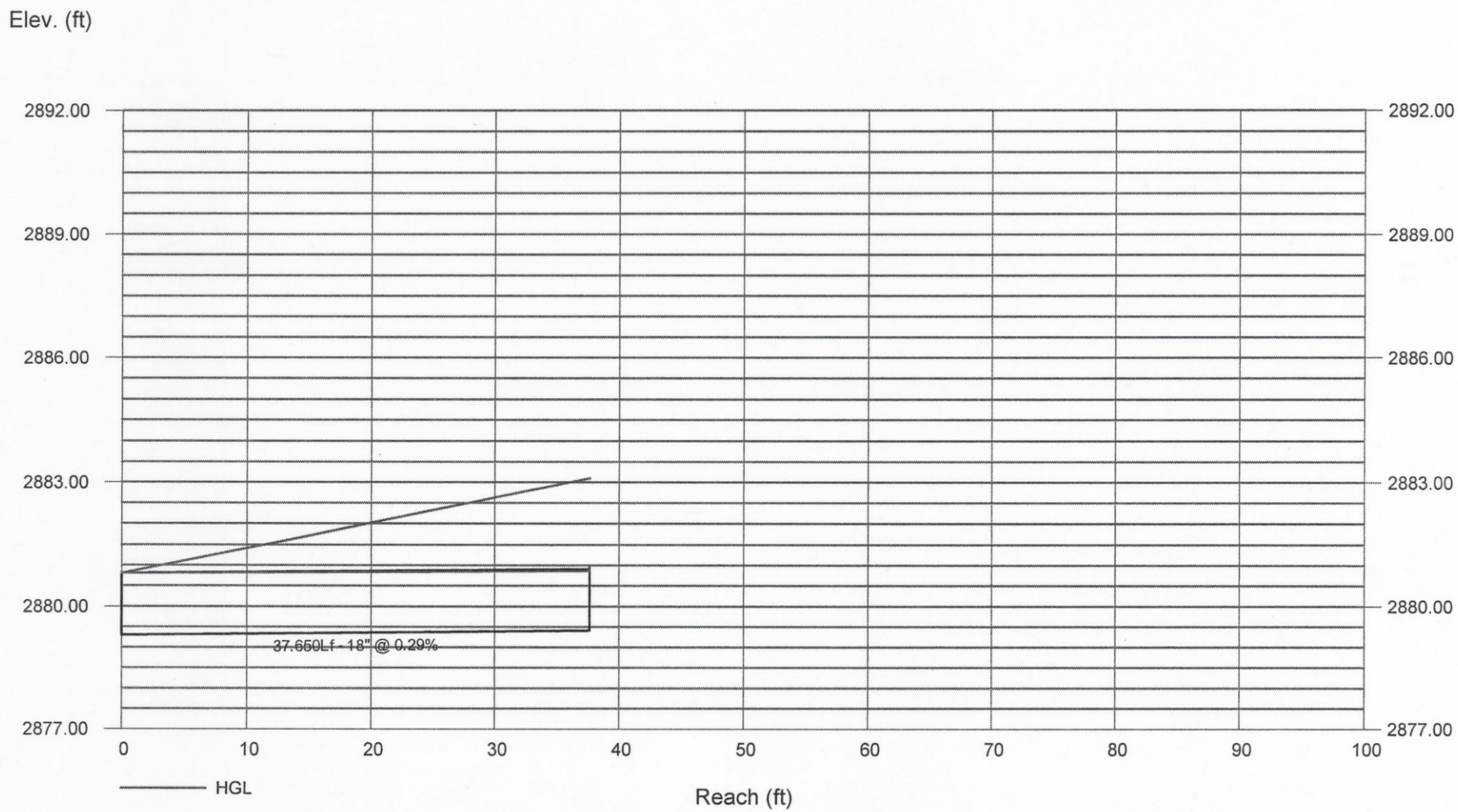

Hydraflow Storm Sewers Extension

Storm Sewer Profile

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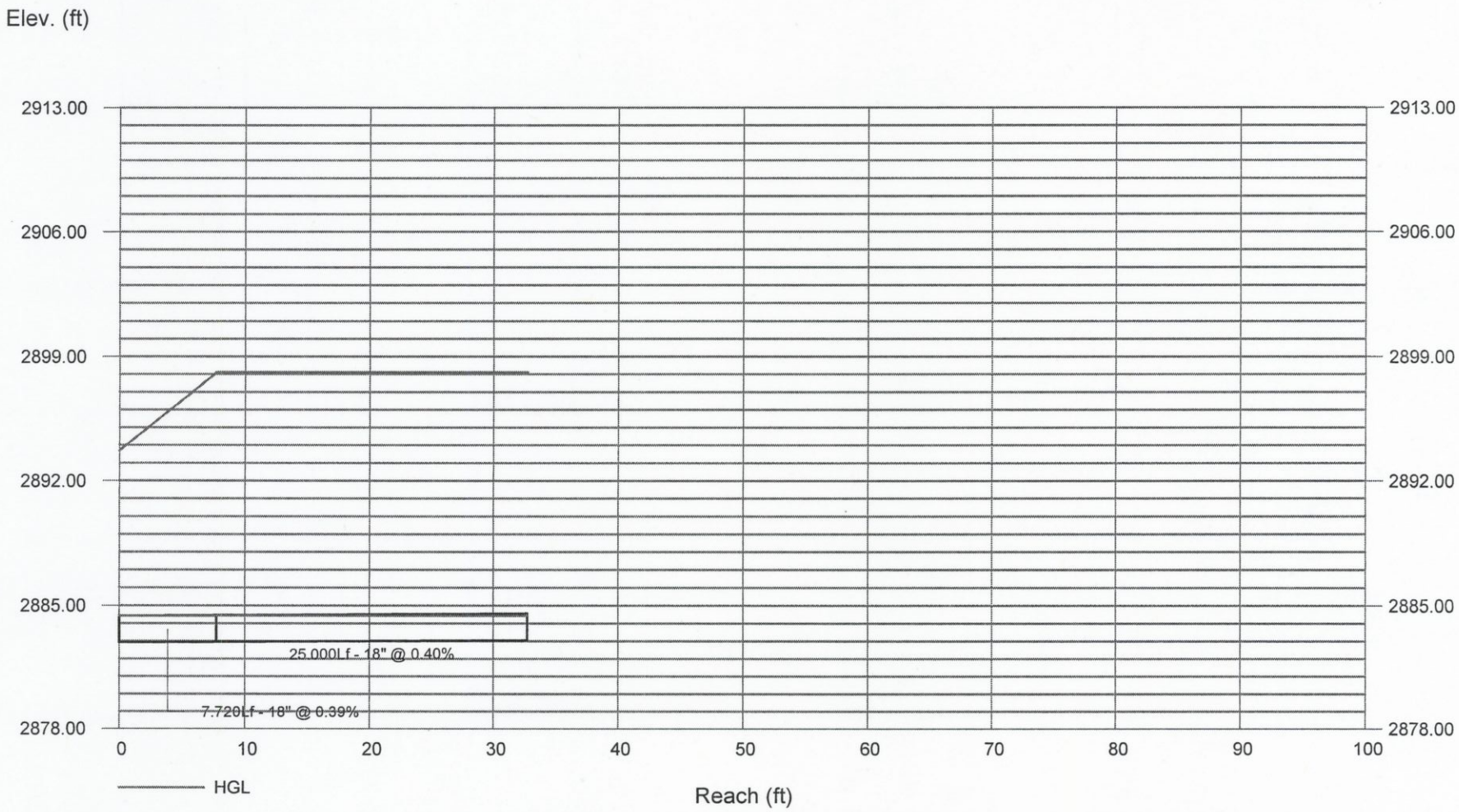

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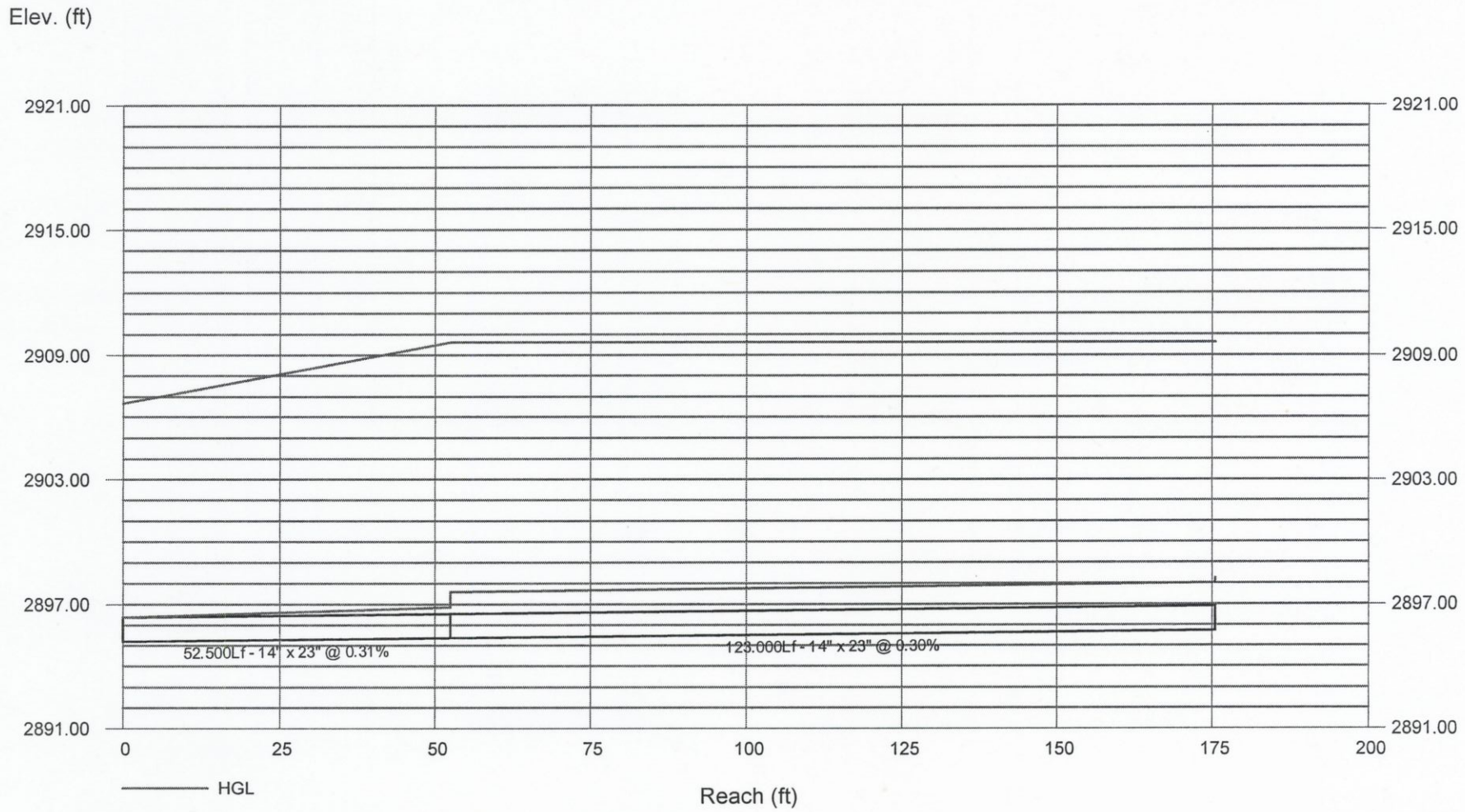

Storm Sewer Profile

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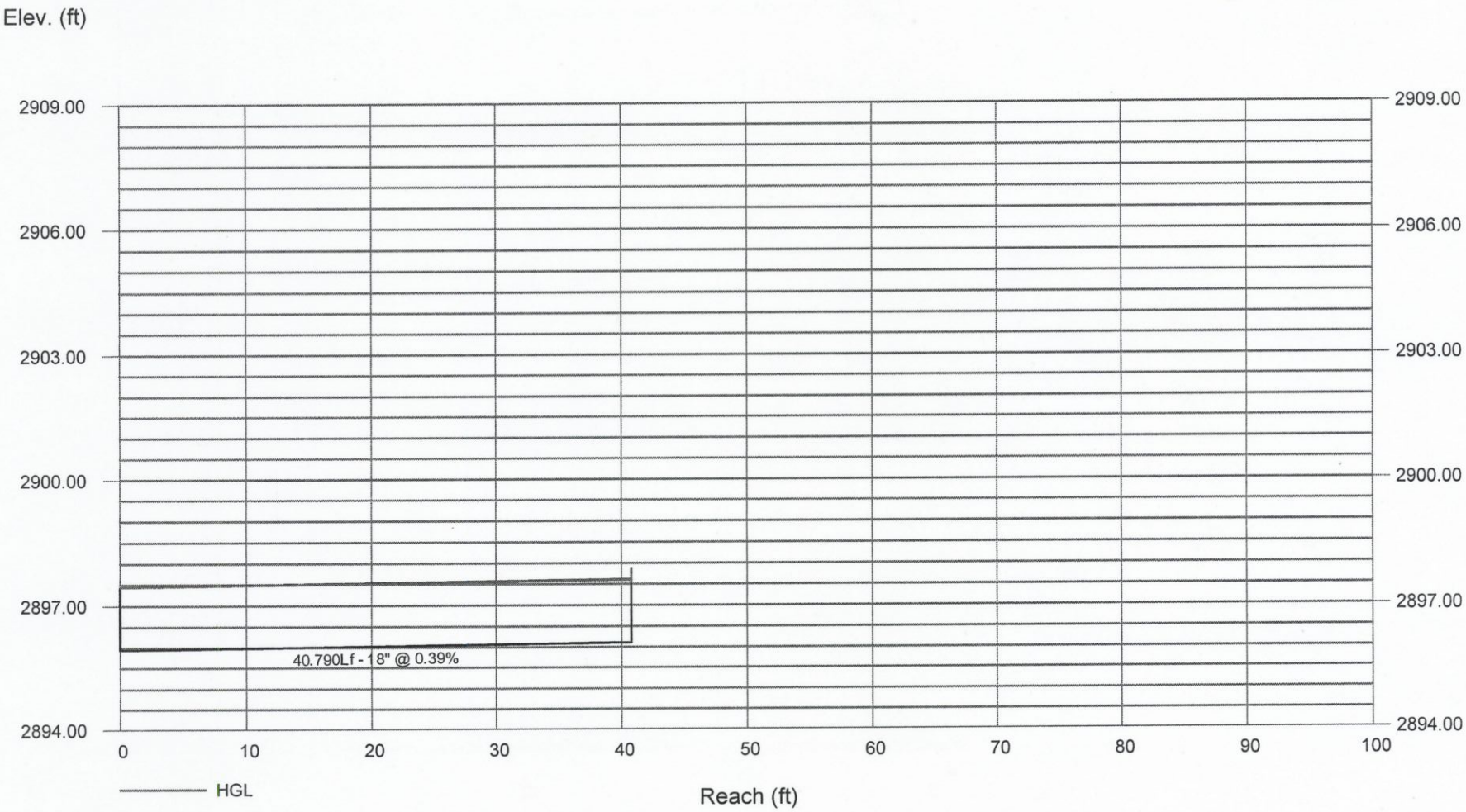

Hydraflow Storm Sewers Extension

Storm Sewer Profile

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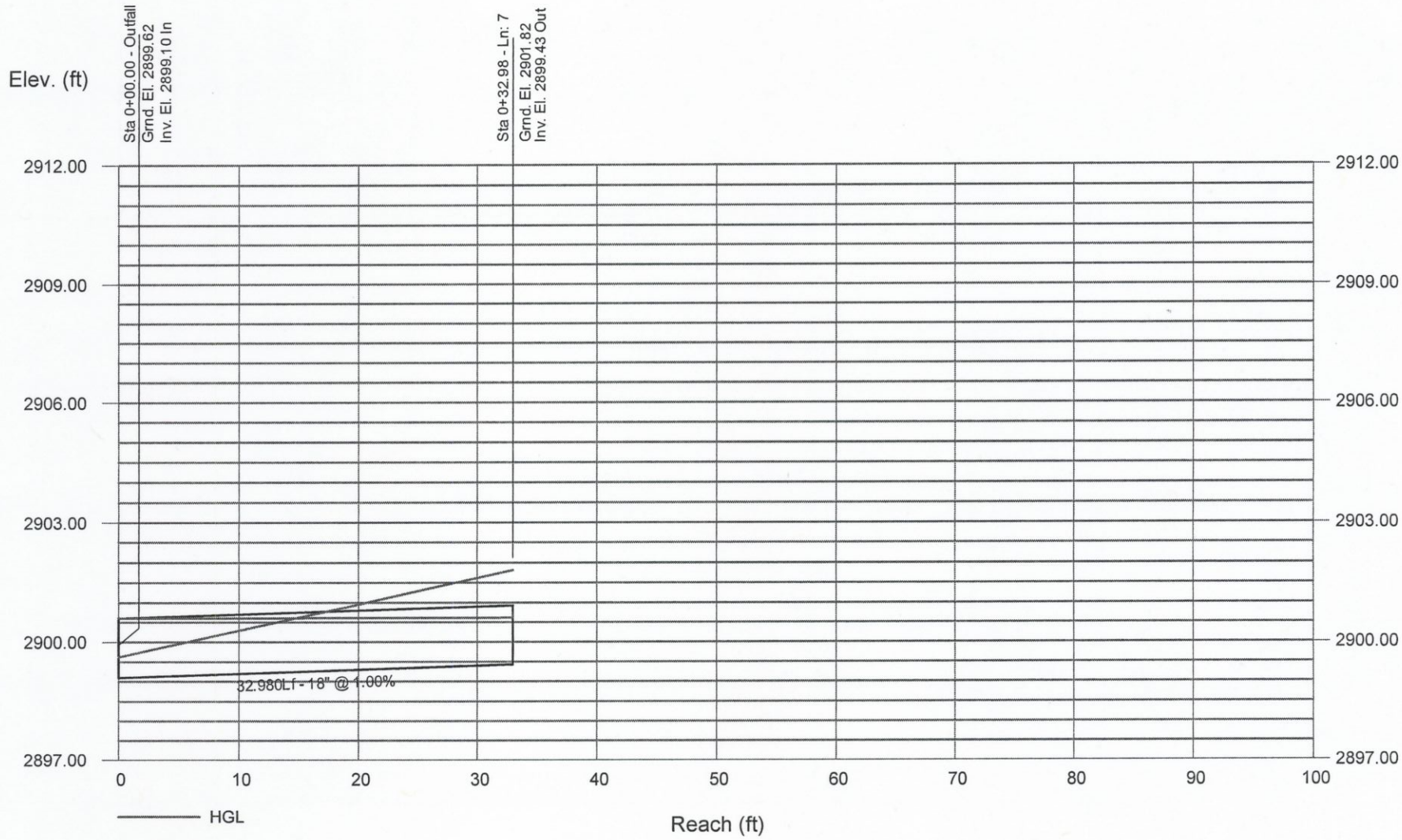

Storm Sewer Profile

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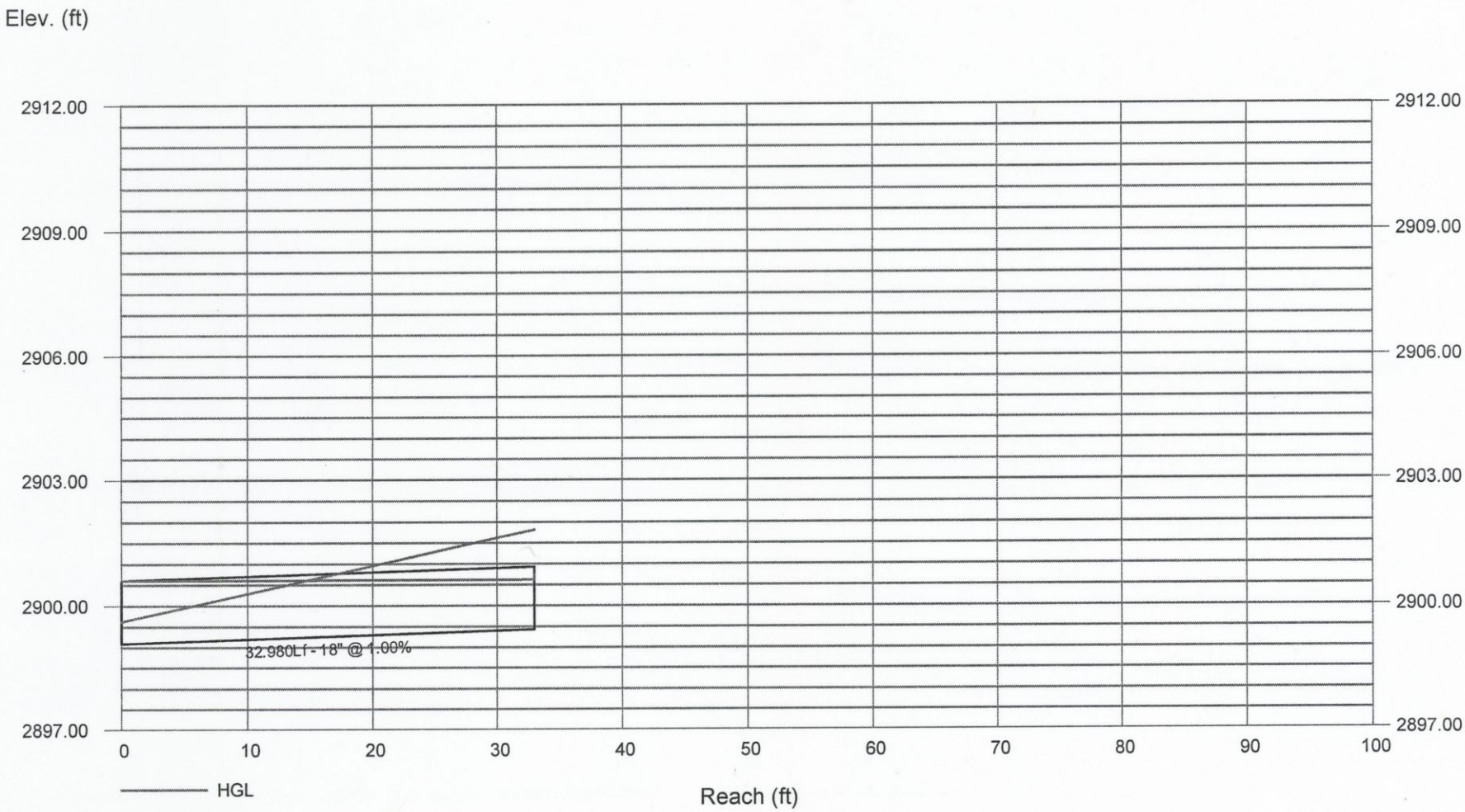

Hydraflow Storm Sewers Extension

Storm Sewer Profile

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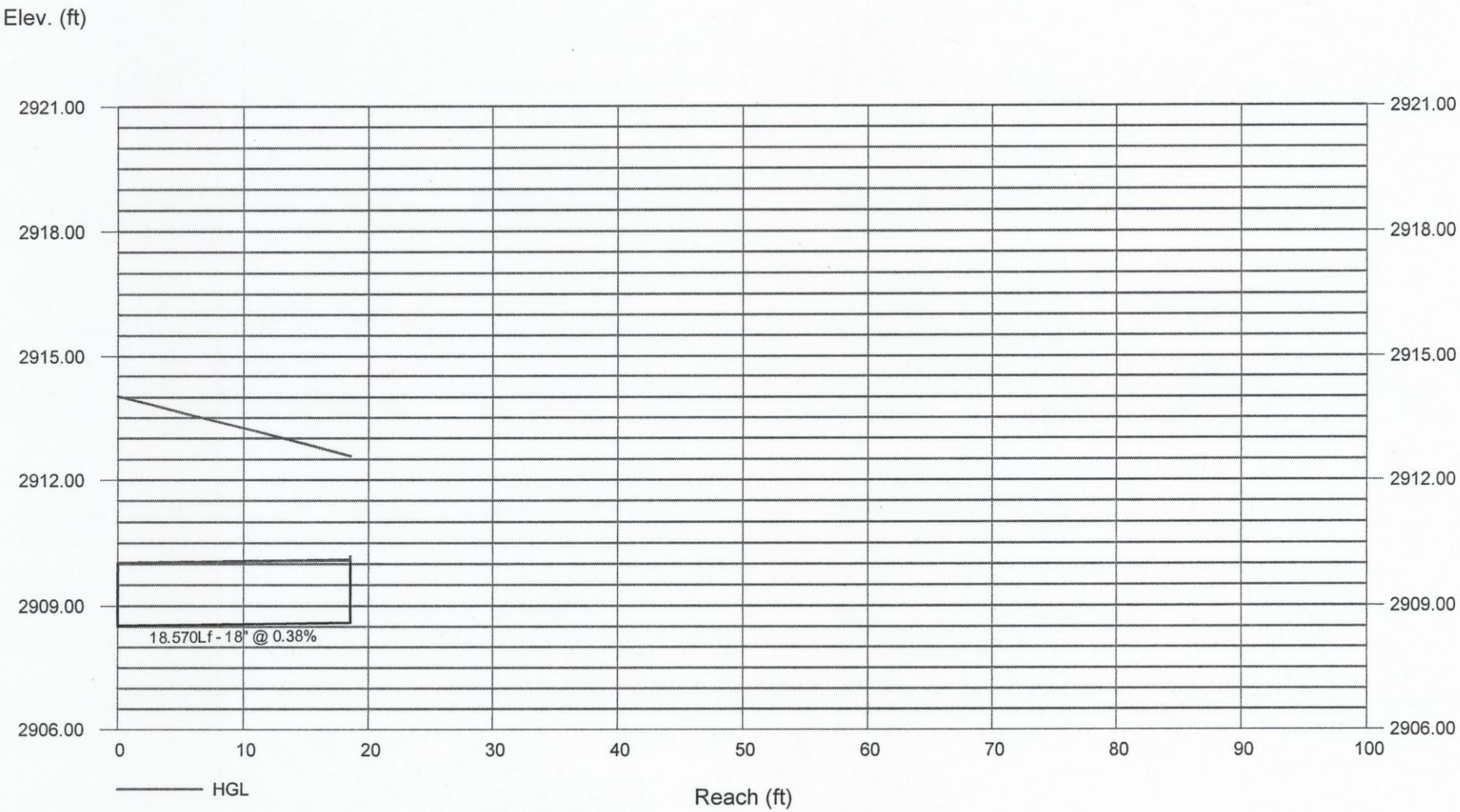

Storm Sewer Profile

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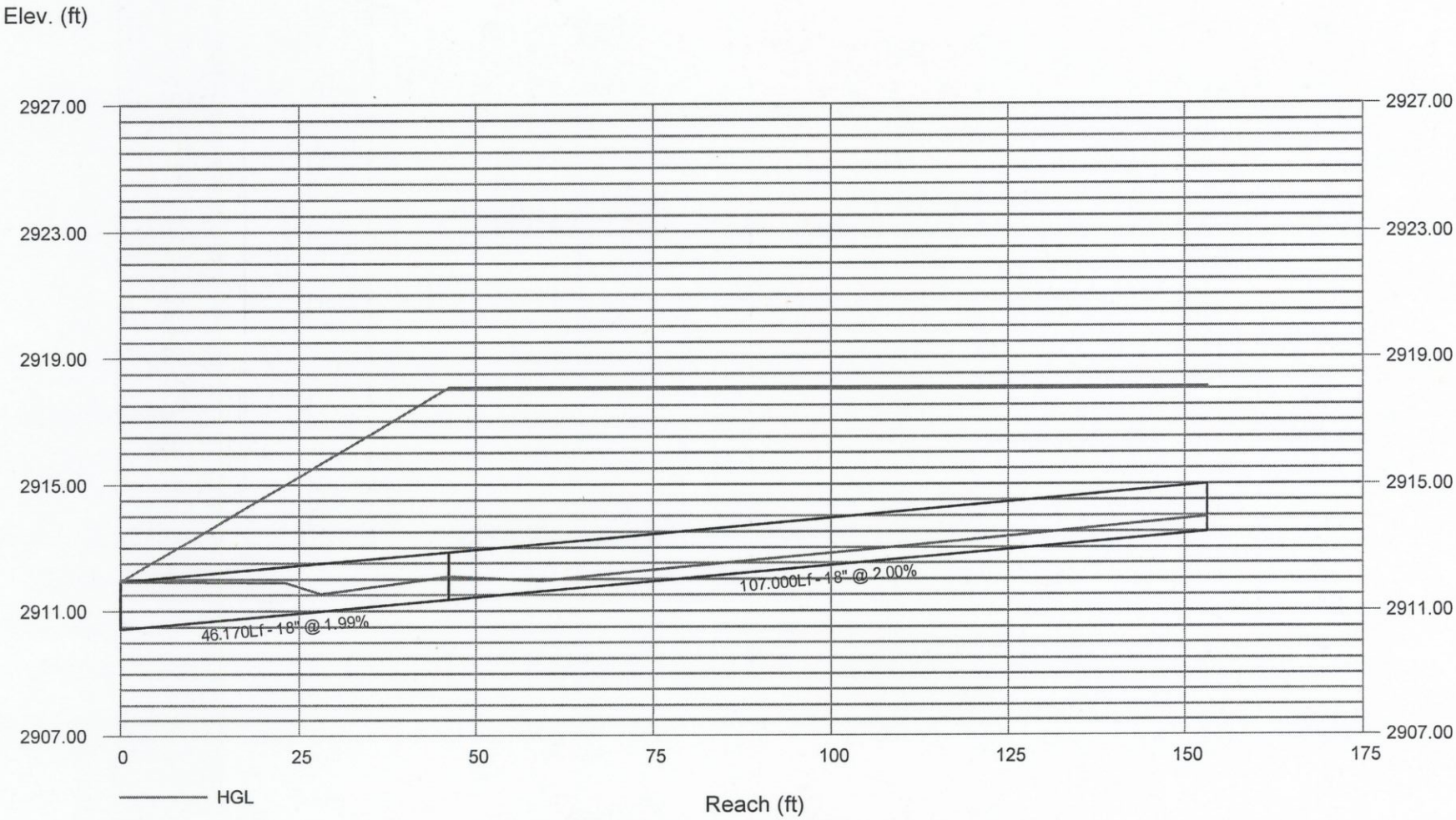

Hydraflow Storm Sewers Extension

Storm Sewer Profile

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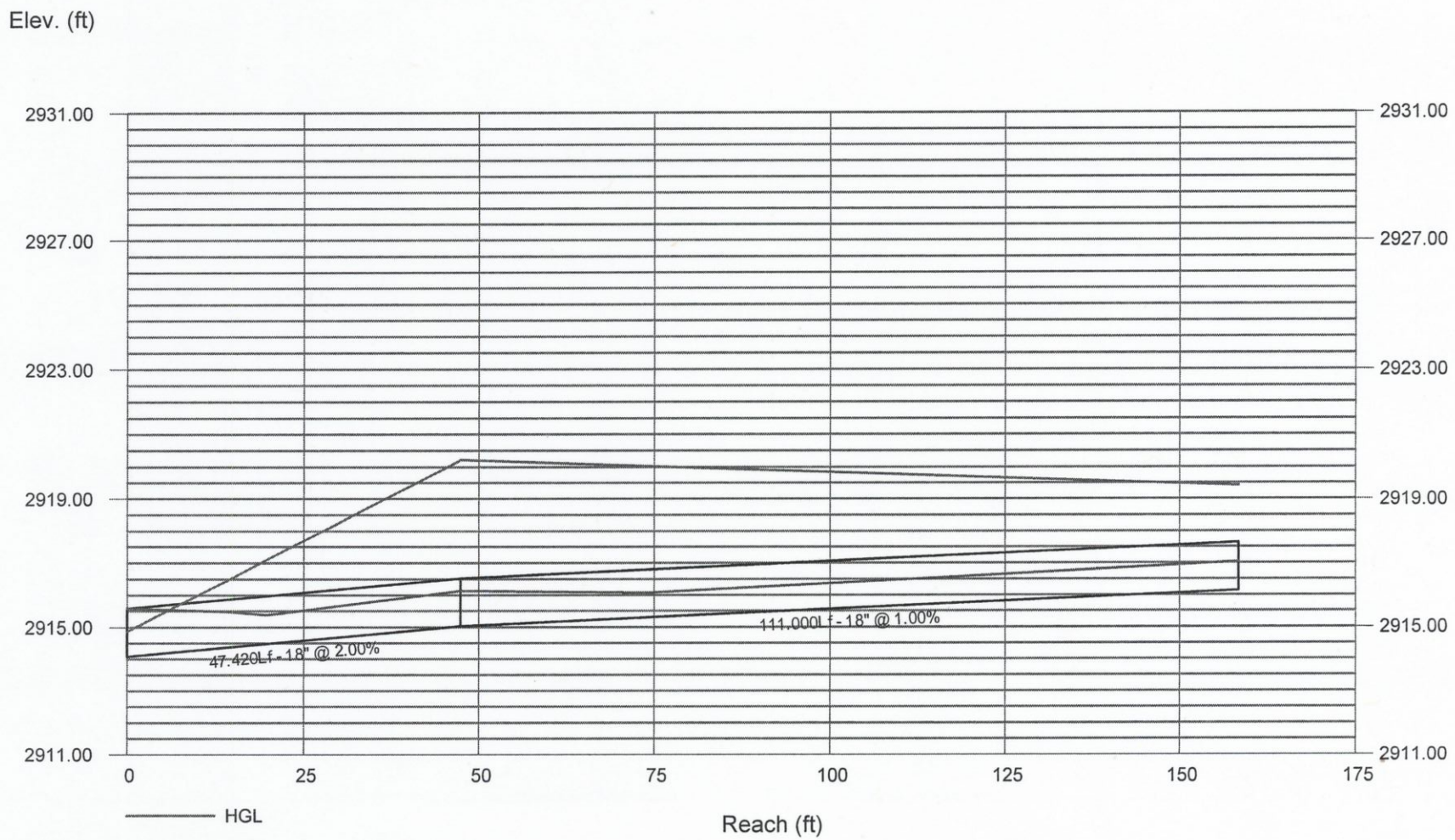

Storm Sewer Profile

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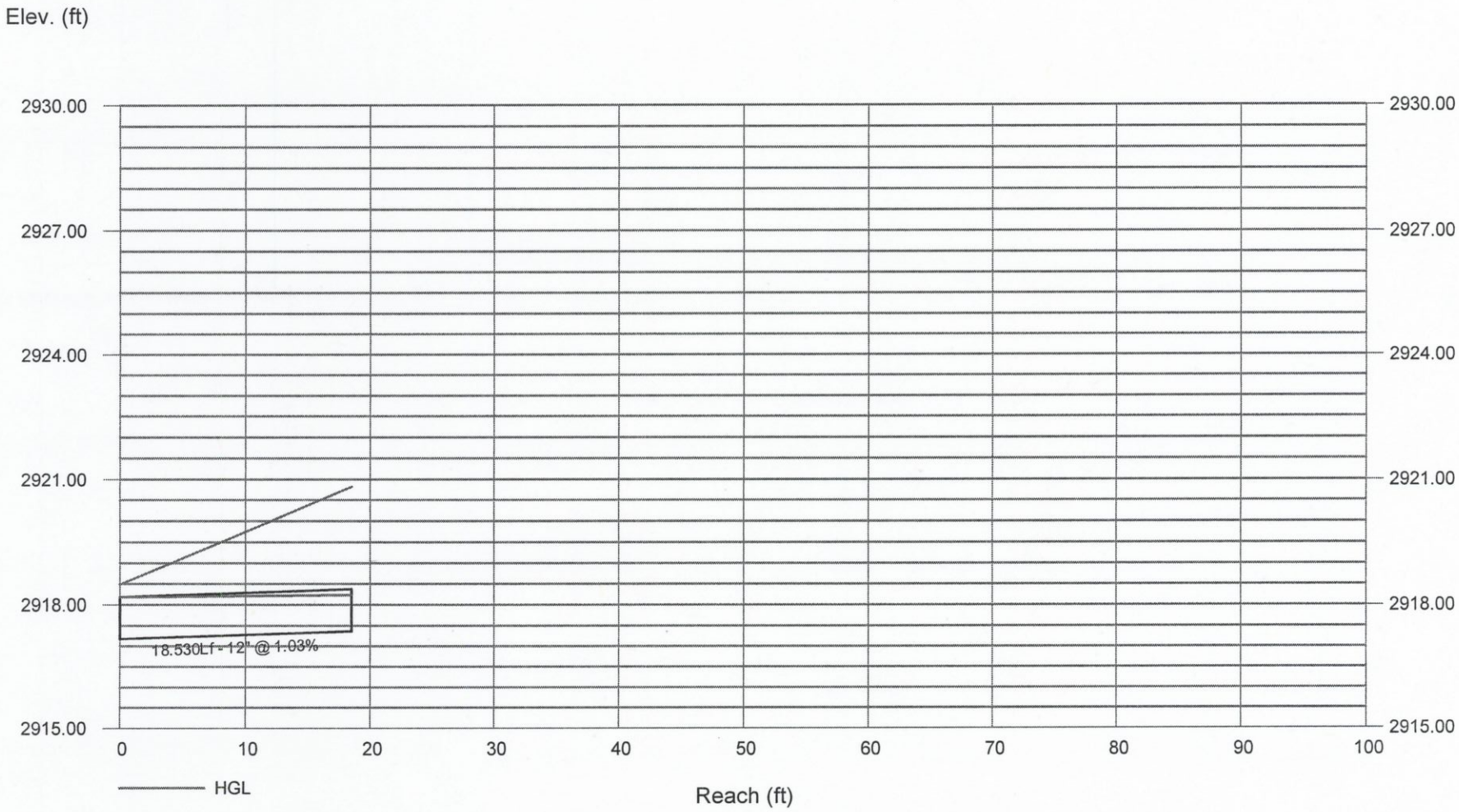

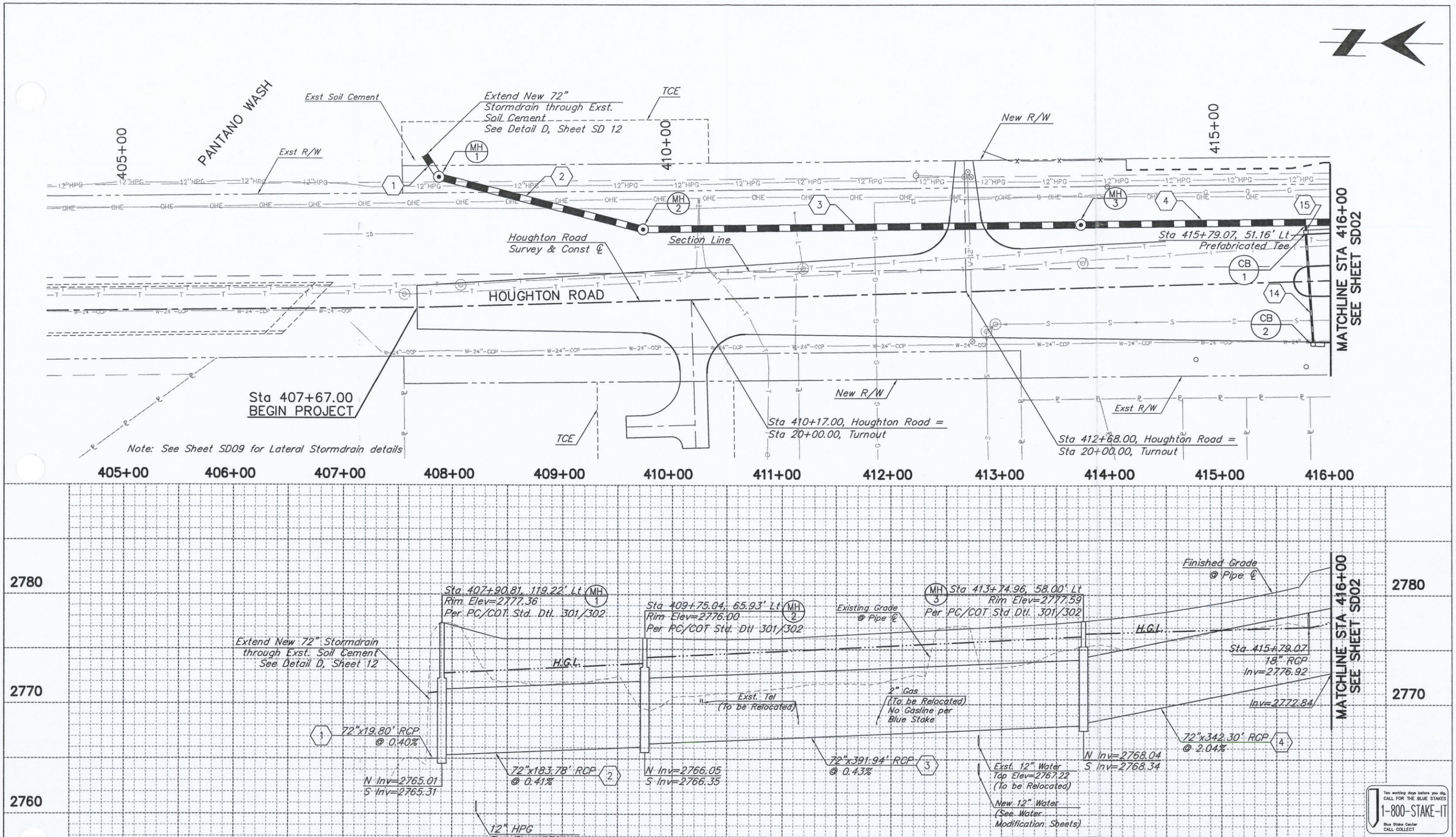

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CHKD. BY MED	02/10	PLAN NO. I-2007-001	

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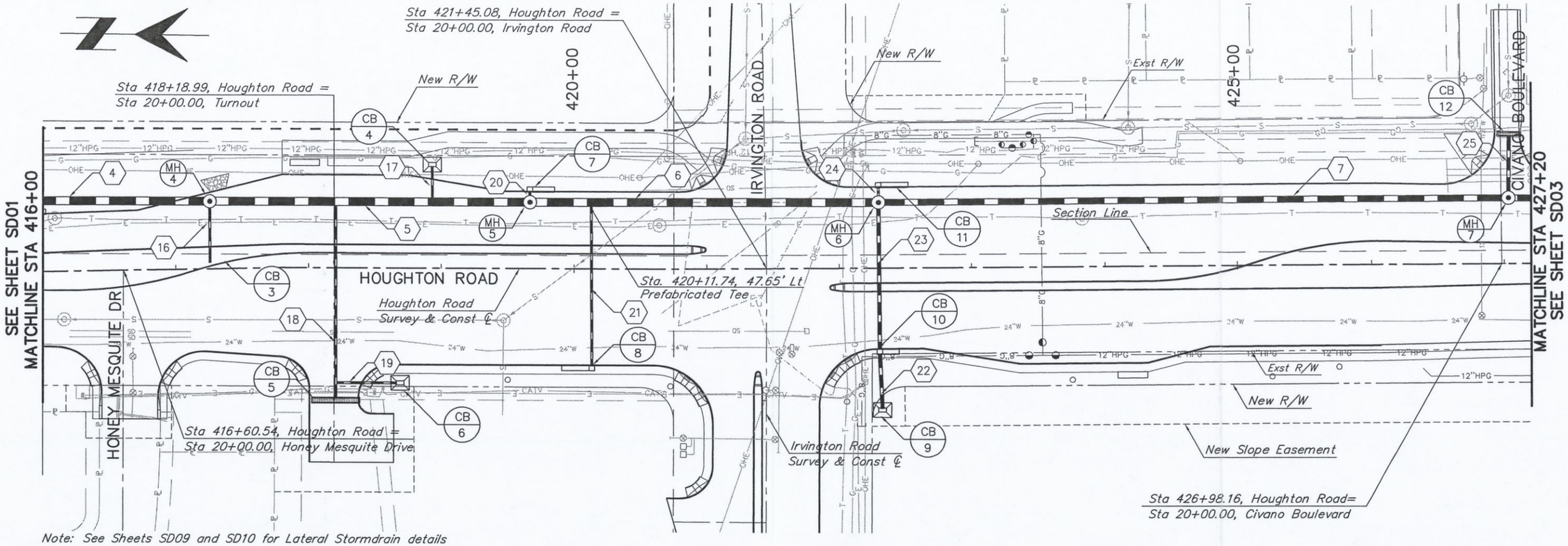

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CHKD. BY MED	02/10	PLAN NO. I-2007-001	

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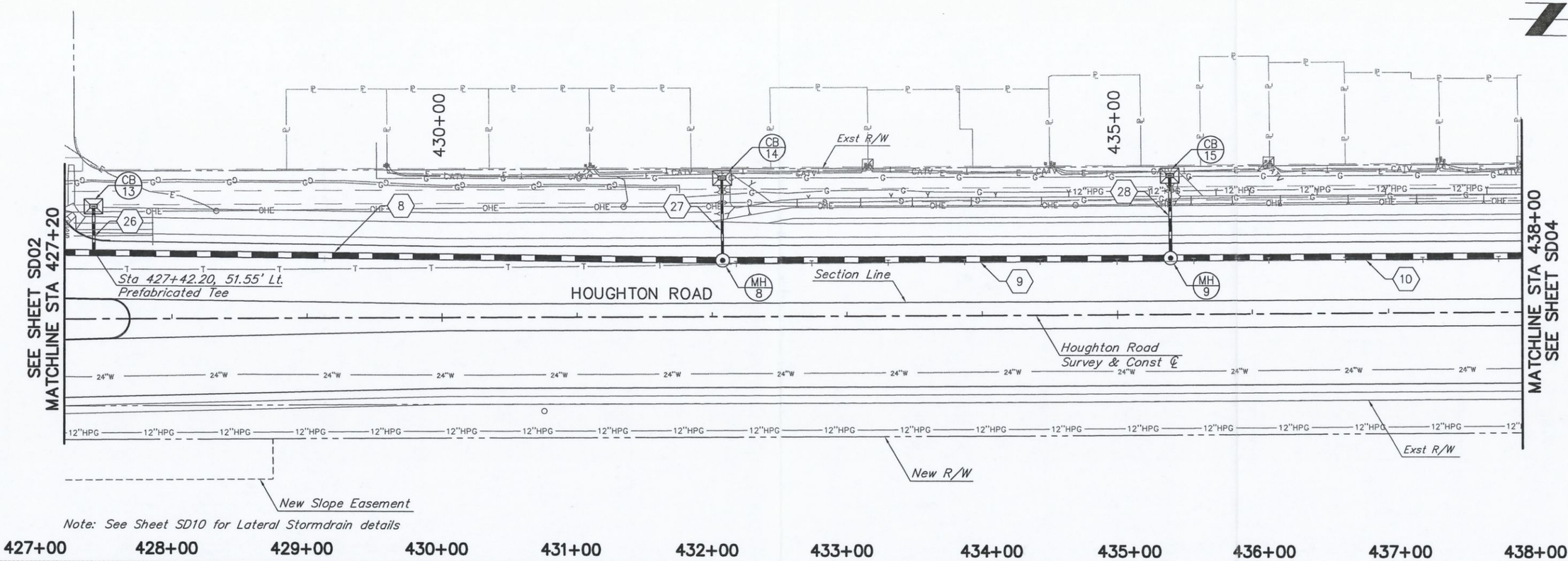
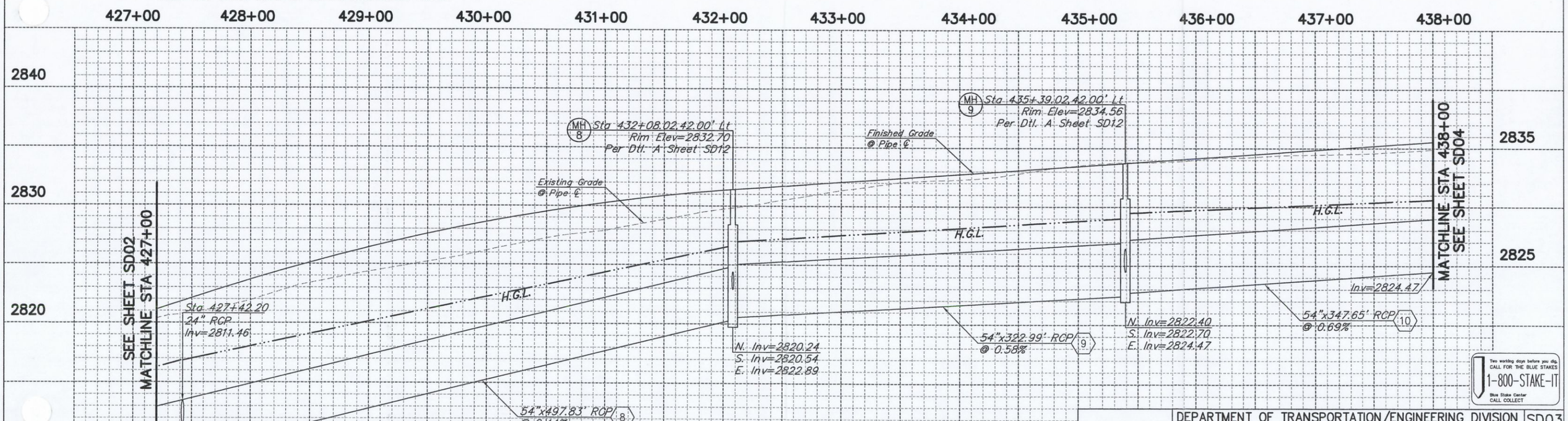


Note: See Sheet SD10 for Lateral Stormdrain details



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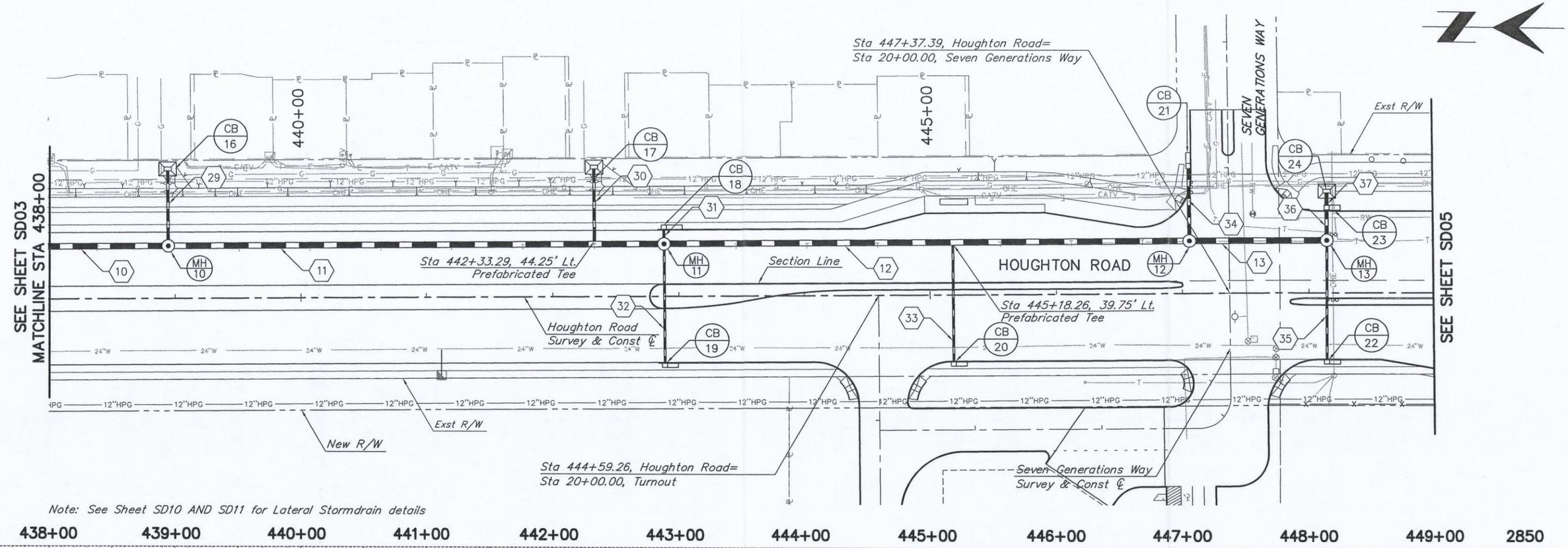
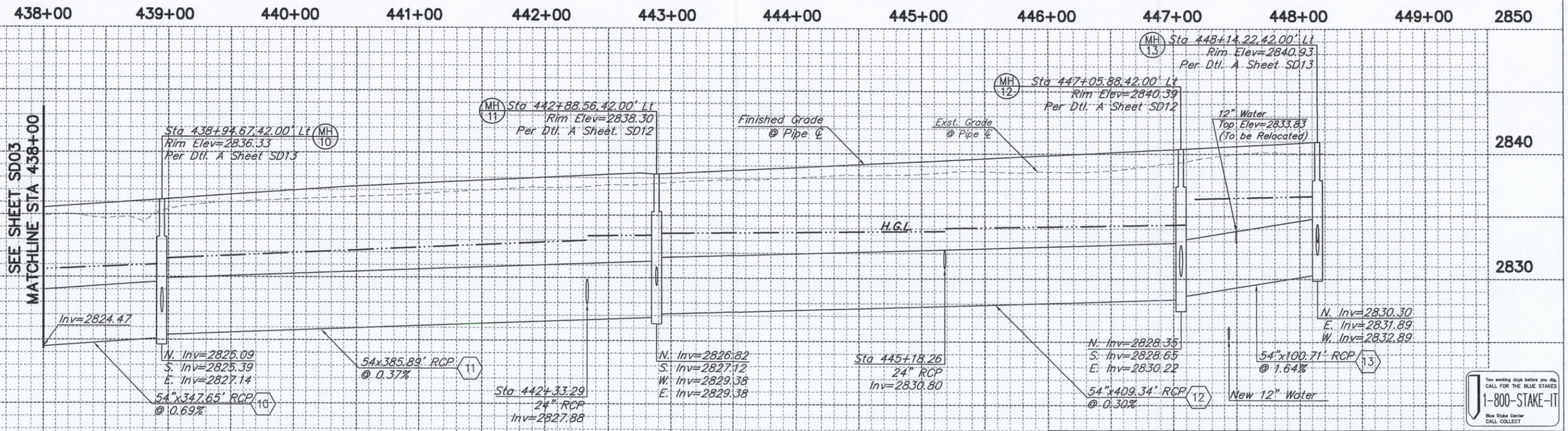


Note: See Sheet SD10 AND SD11 for Lateral Stormdrain details



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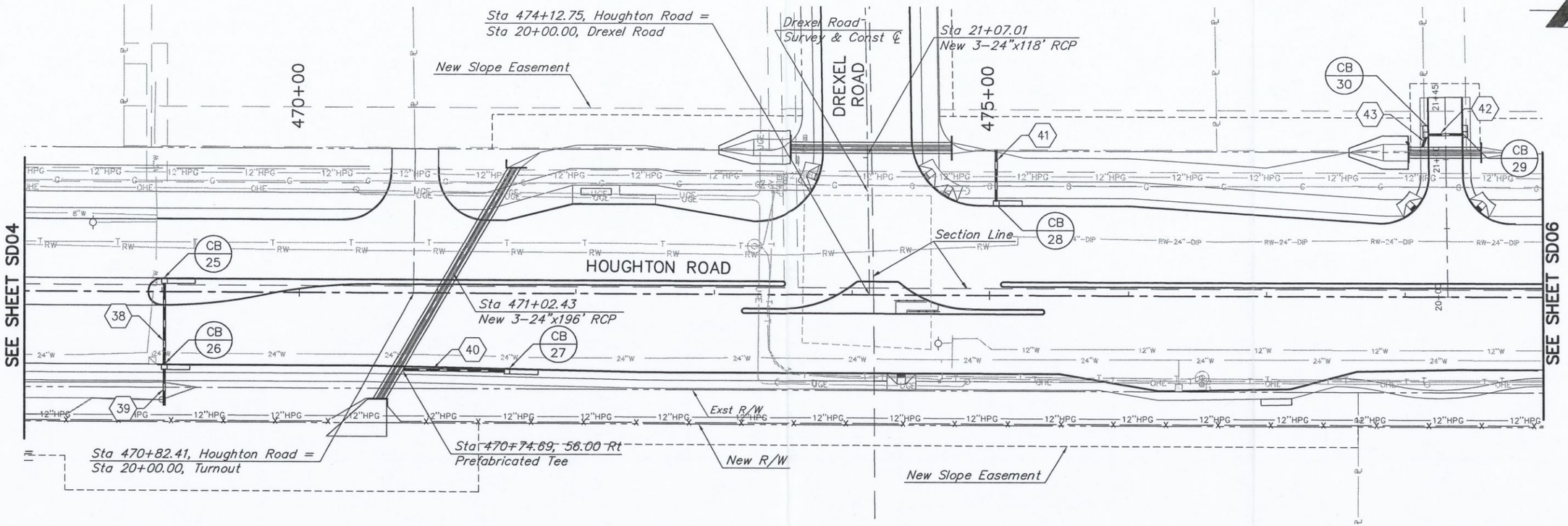
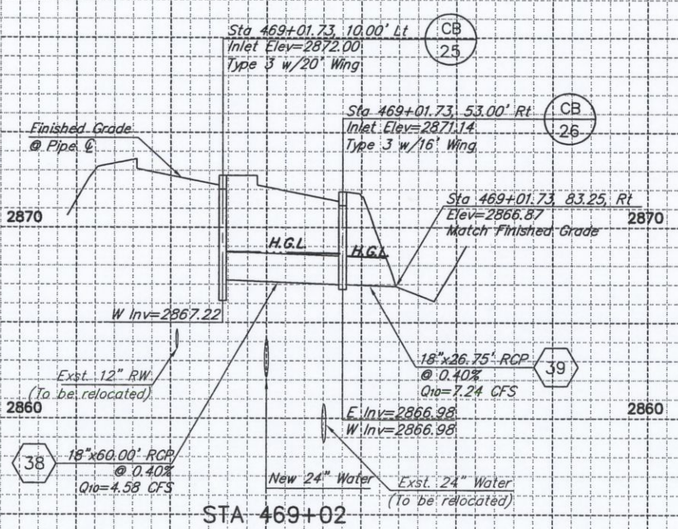
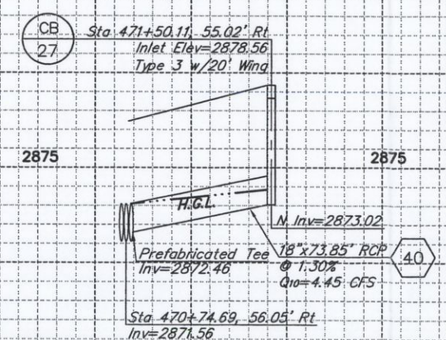




STA 469+02



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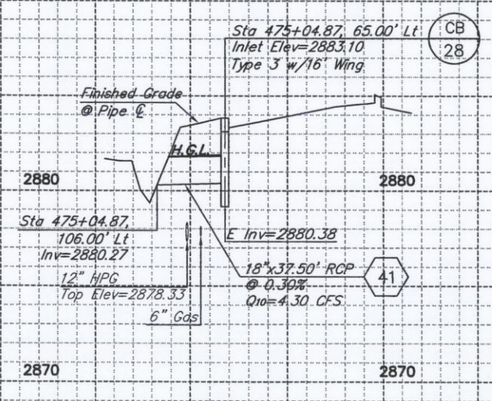
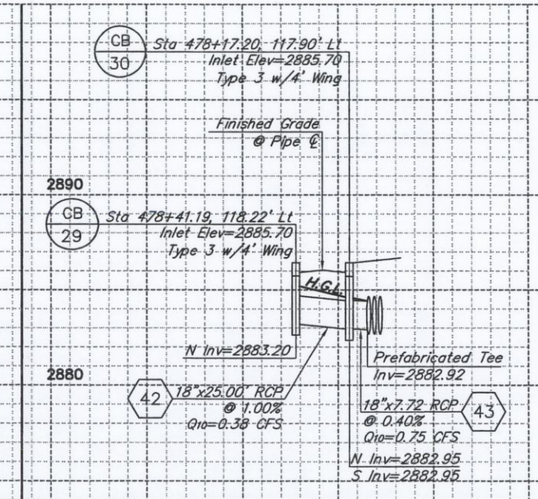


STA 474+04



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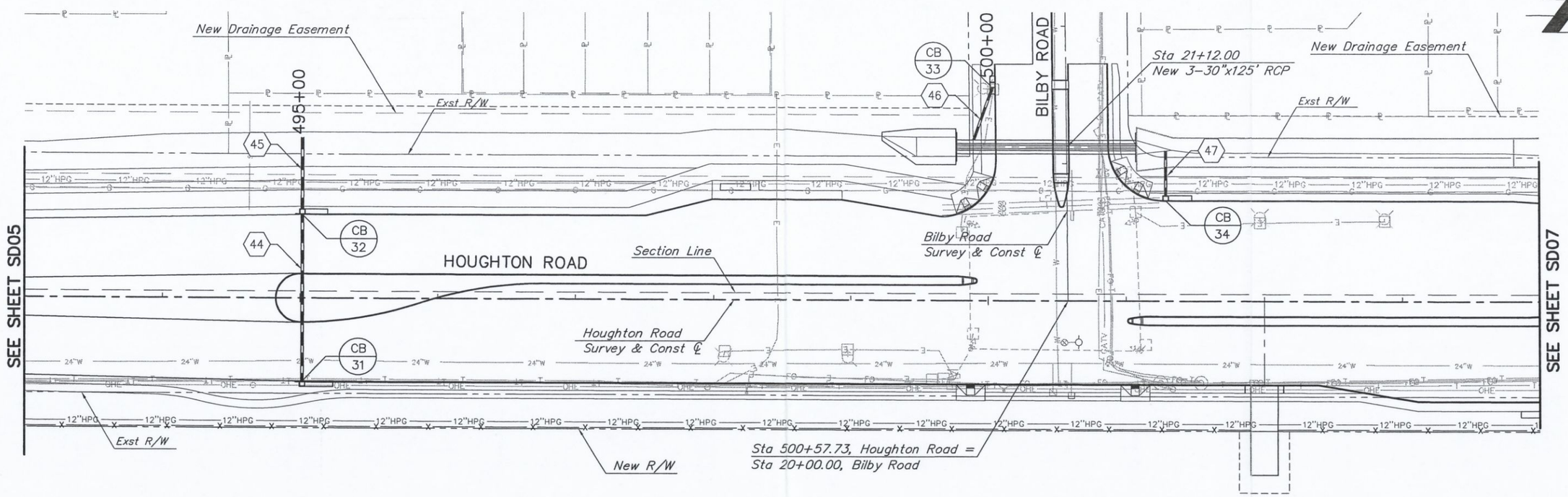

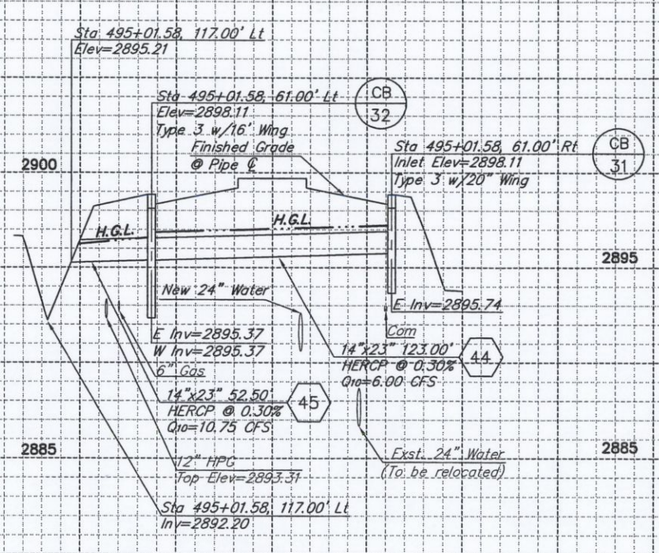

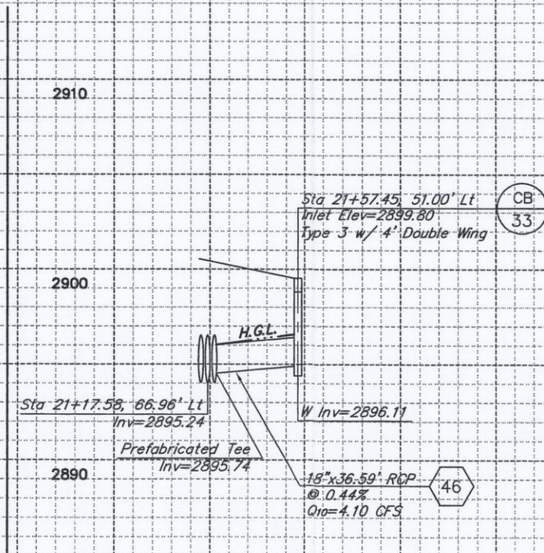

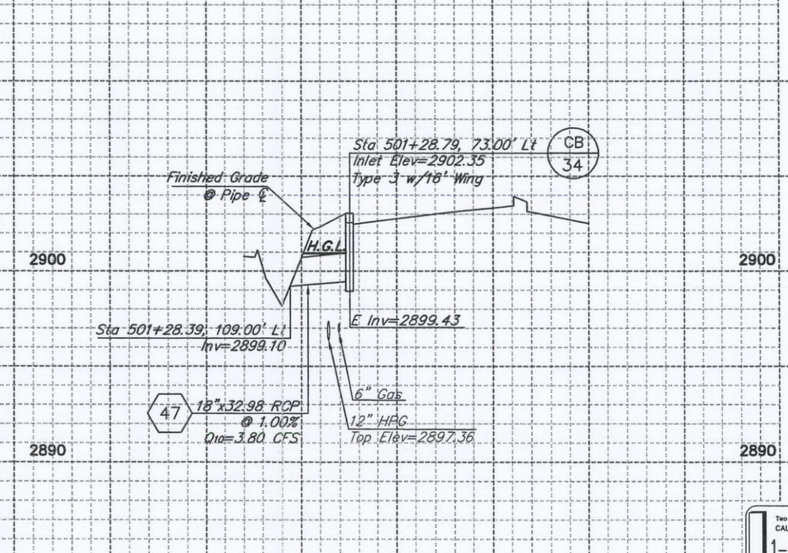

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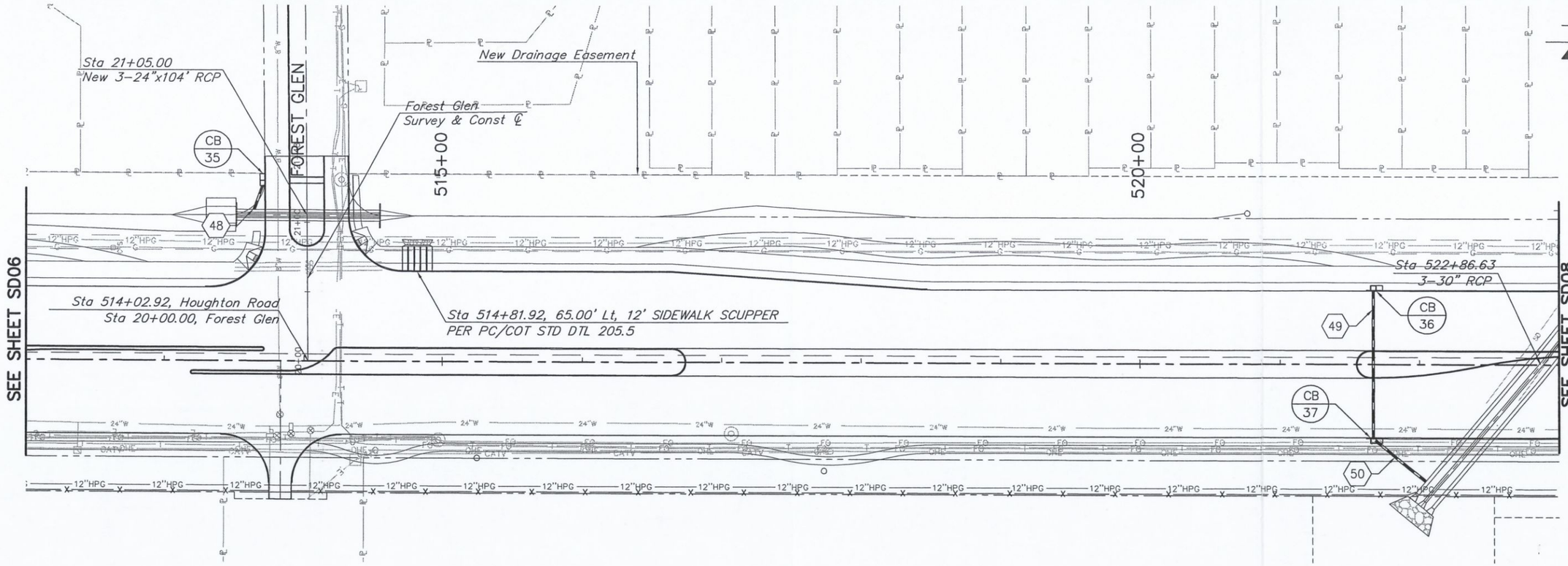
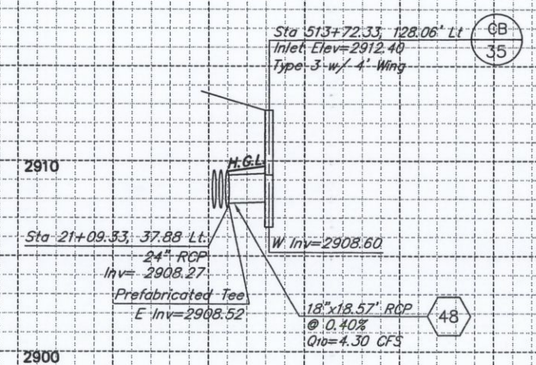
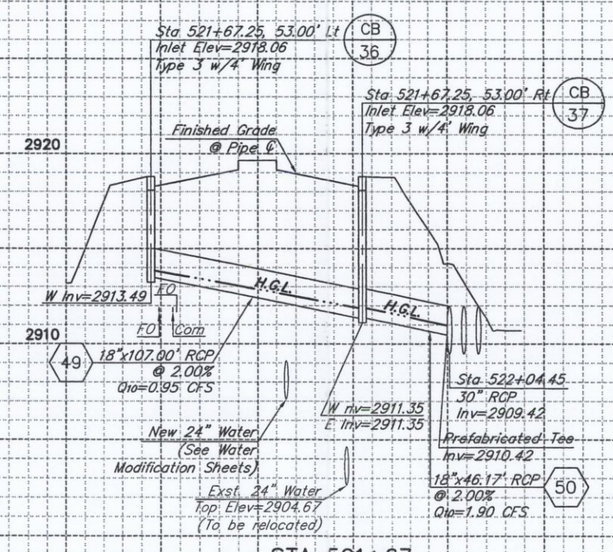




STA 513+72



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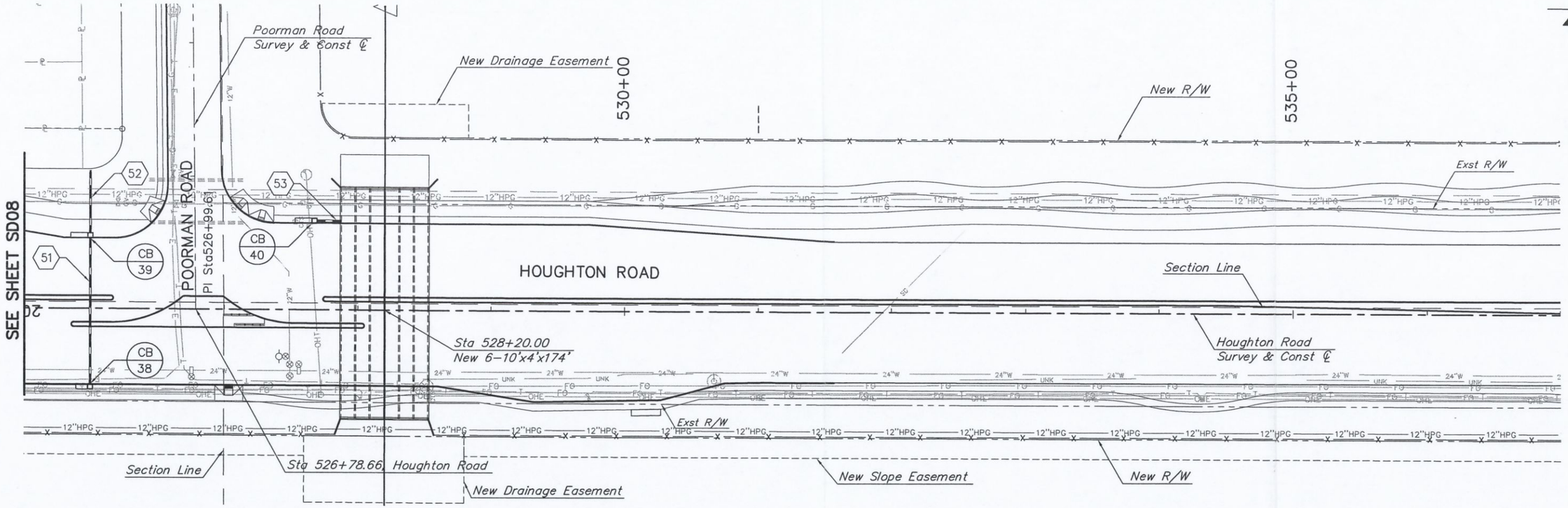

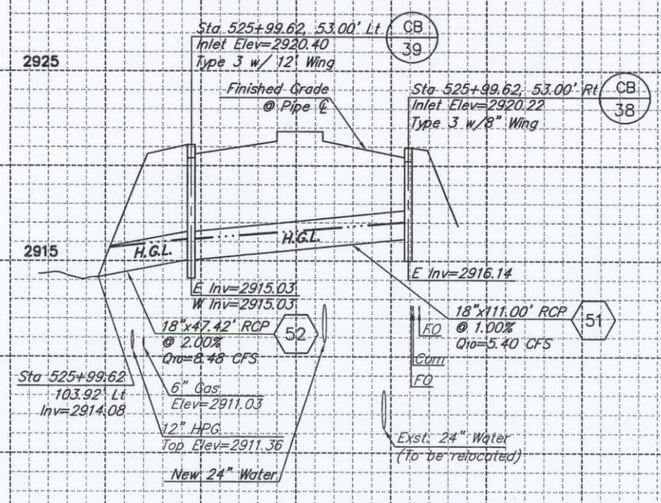

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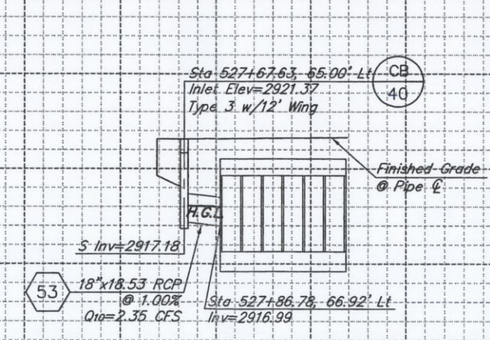

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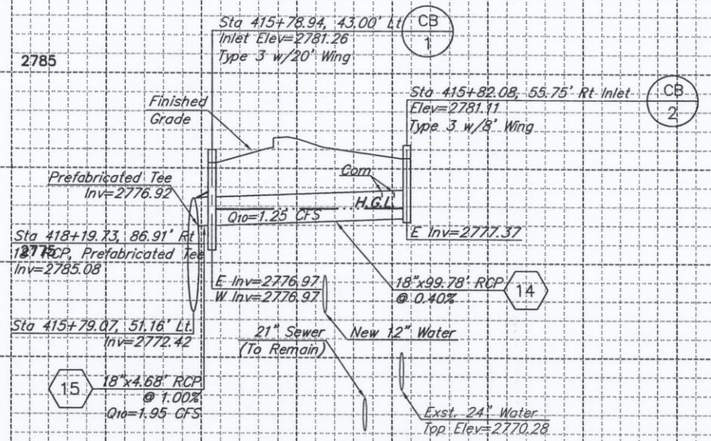

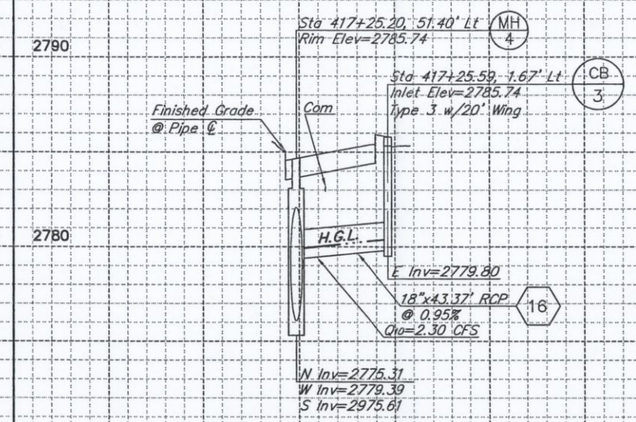

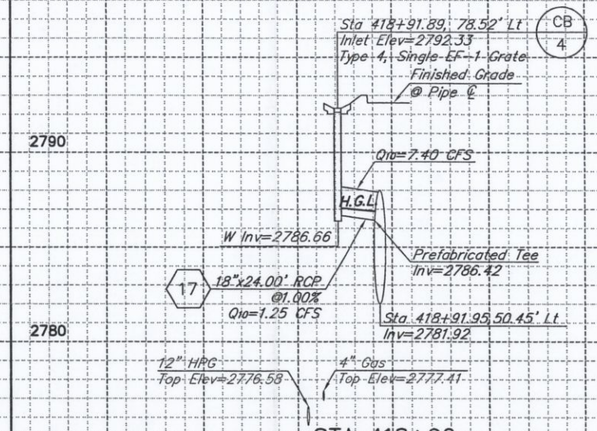

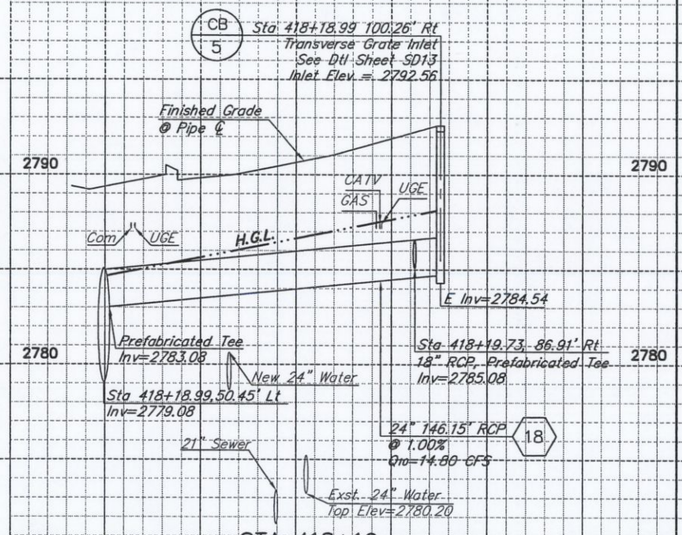

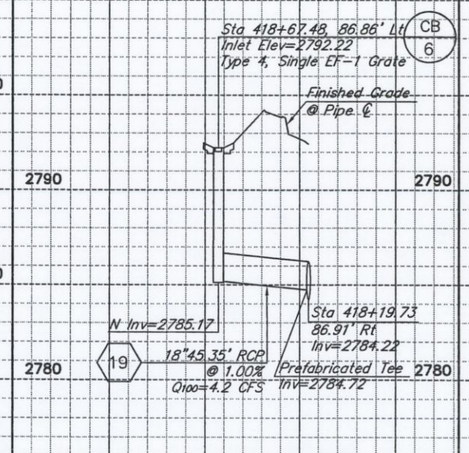

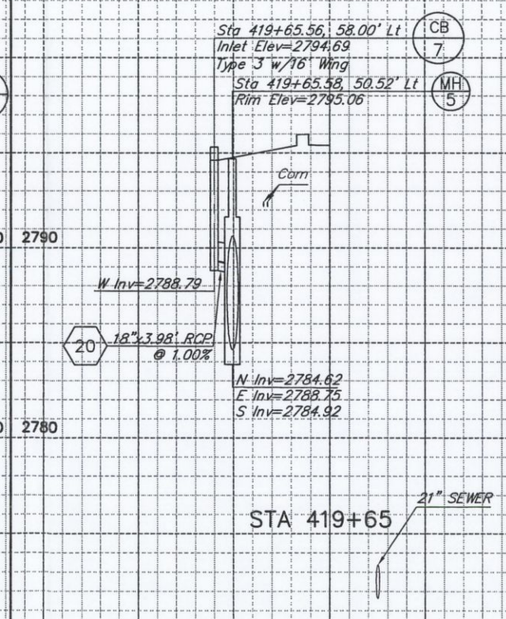

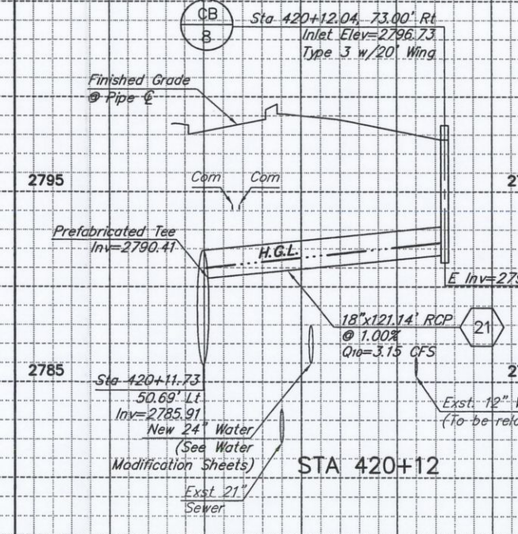

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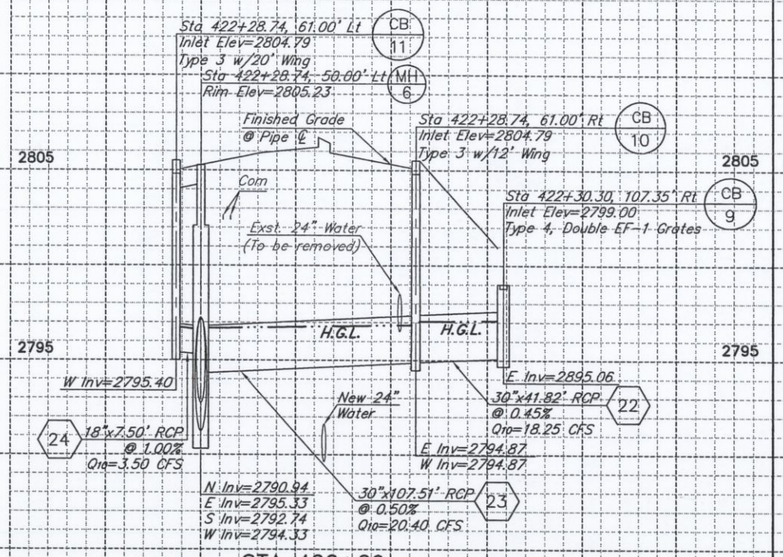

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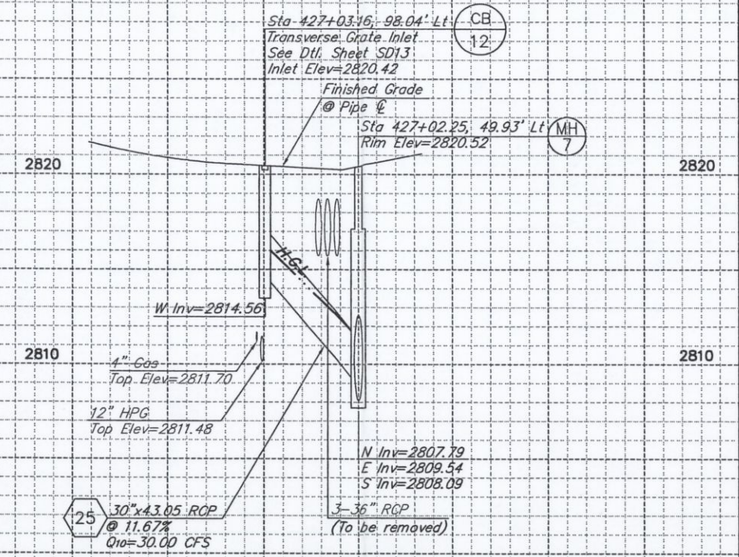

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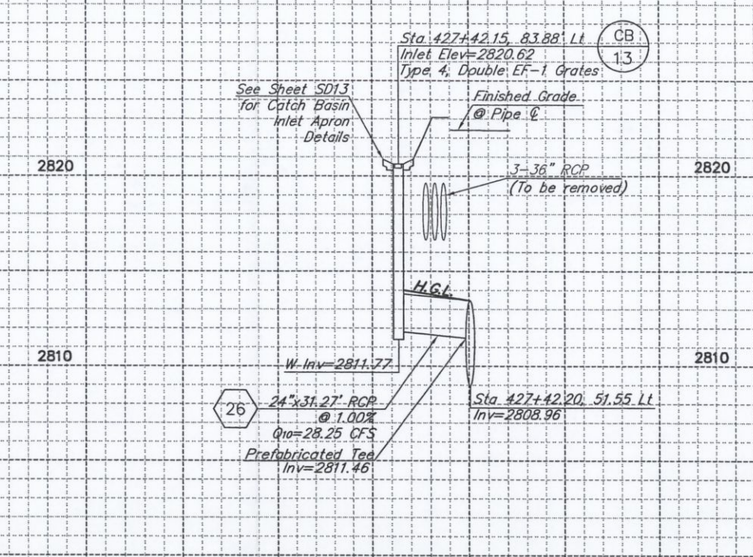

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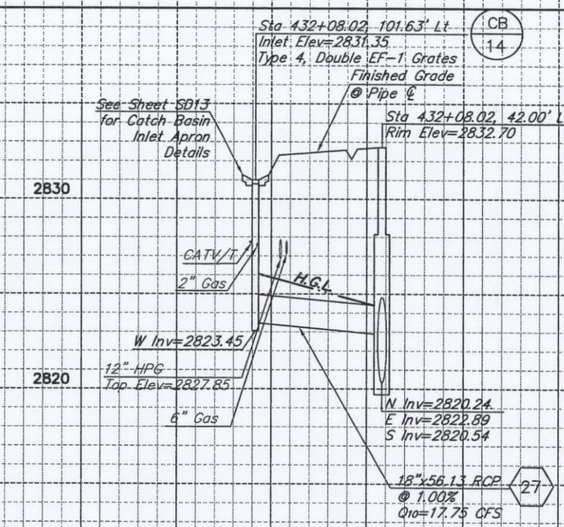

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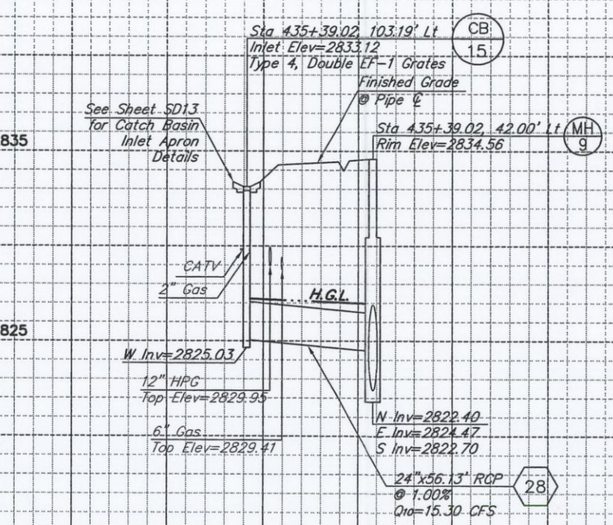

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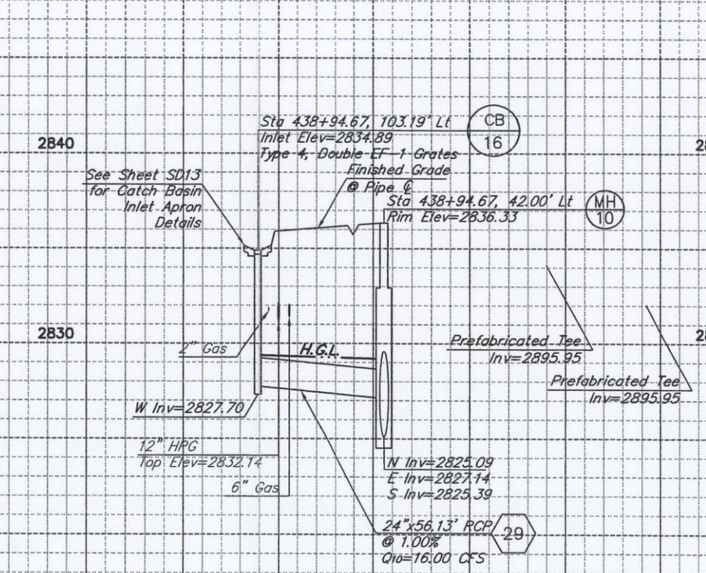

STA 438+95

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STORMDRAIN PLAN & PROFILE

CITY OF TUCSON

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DSGN. BY JO	02/10		
CHKD. BY MED	02/10	PLAN NO. I-2007-001	

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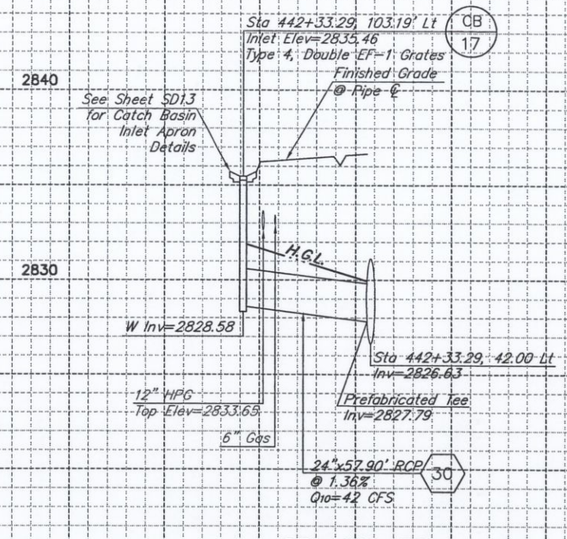

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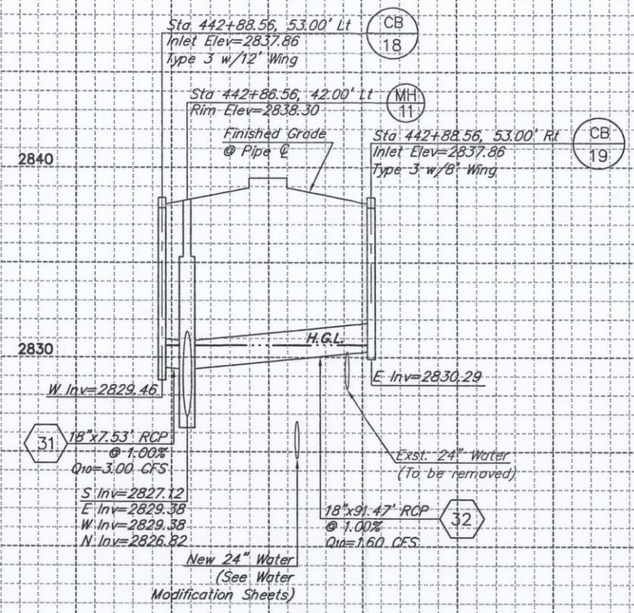

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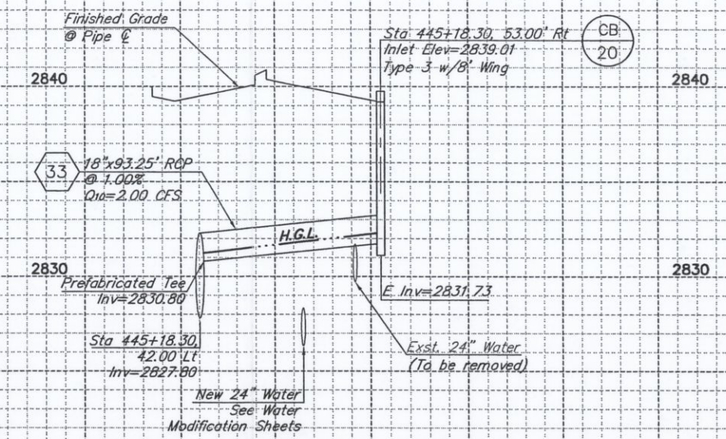

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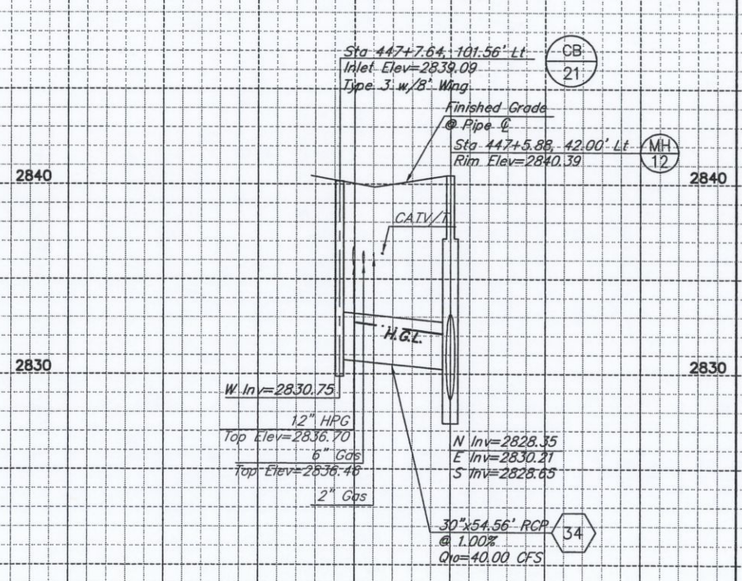
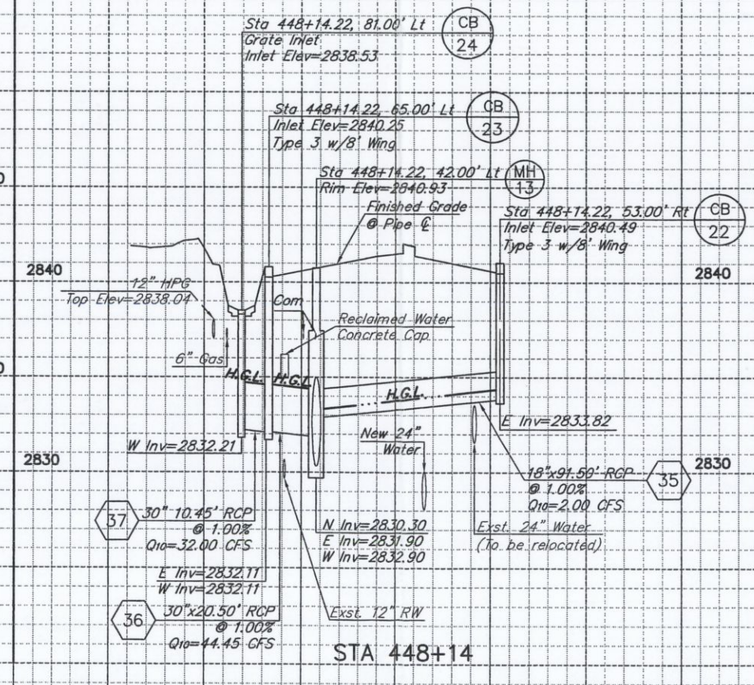


STA 447+05



STA 448+14

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DSGN. BY JO	02/10		
CHKD. BY MED	02/10	PLAN NO. I-2007-001	

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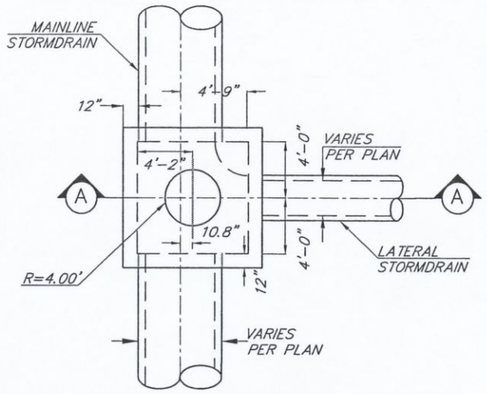
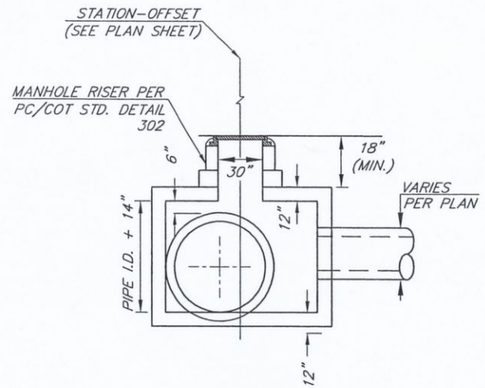
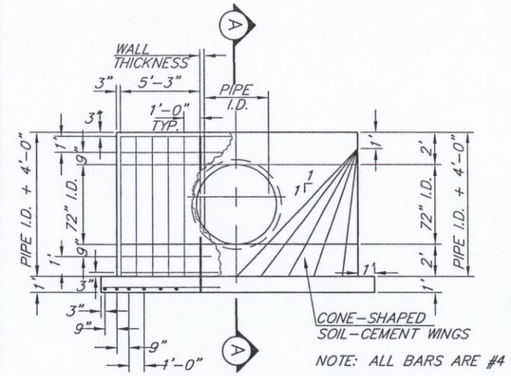


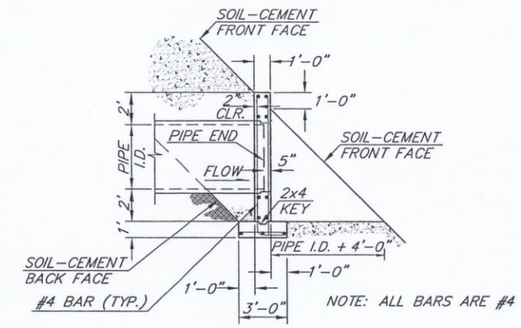
DETAIL FOR MANHOLE #4 THROUGH #13
NTS



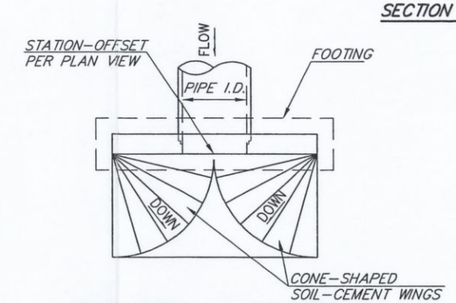
SECTION A
NTS



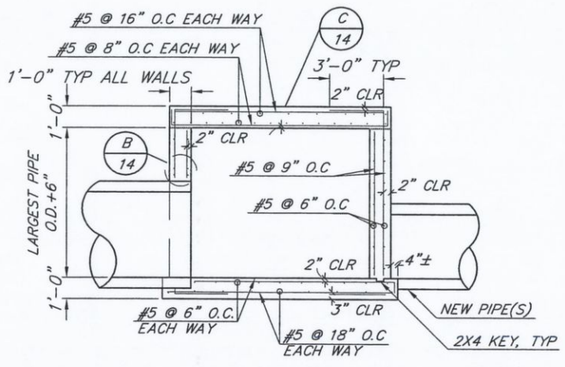
OUTLET HEADWALL – END VIEW
NTS

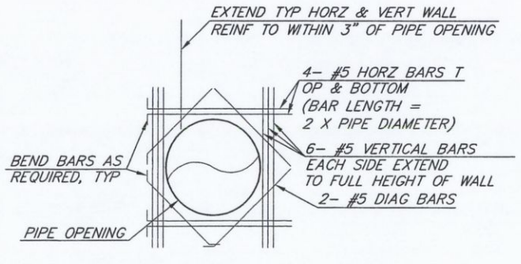


SECTION A
NTS

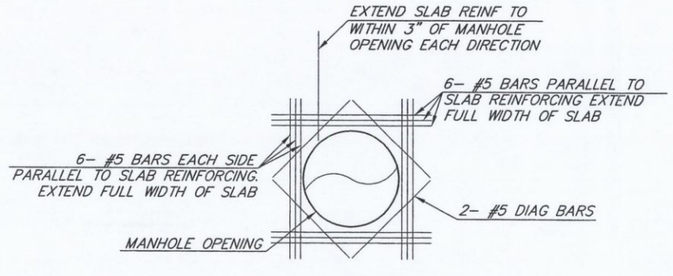


OUTLET HEADWALL – TOP VIEW
NTS

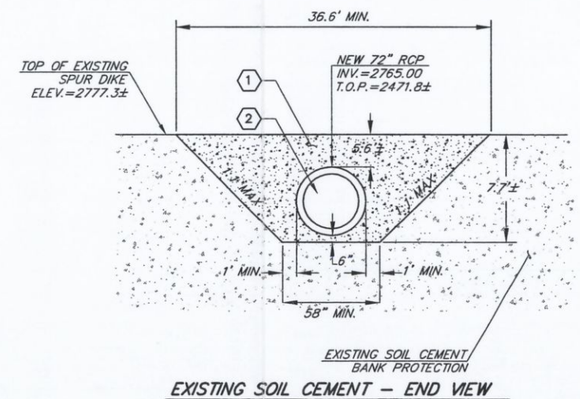




DETAIL B
REINFORCEMENT AT WALL OPENING
NTS



DETAIL C
REINFORCEMENT AT MANHOLE OPENING
NTS



EXISTING SOIL CEMENT – END VIEW
NTS

DETAIL D
SOIL CEMENT PENETRATION AND CULVERT OUTLET DETAILS

1. REPLACE EXISTING SOIL CEMENT WITH CLSM NO. 3 PER PC/COT STD. SPEC. 501-2.03 (SEE TABLE 501-1)
2. INSTALL FLAPGATE AT OUTLET OF 72" RCP. SHOP DRAWINGS AND FLAPGATE SPECIFICATIONS SHALL BE SUBMITTED TO THE ENGINEER FOR REVIEW AND APPROVAL PRIOR TO INSTALLATION. FLAPGATE SHALL BE NEENAH OR APPROVED EQUIVALENT.

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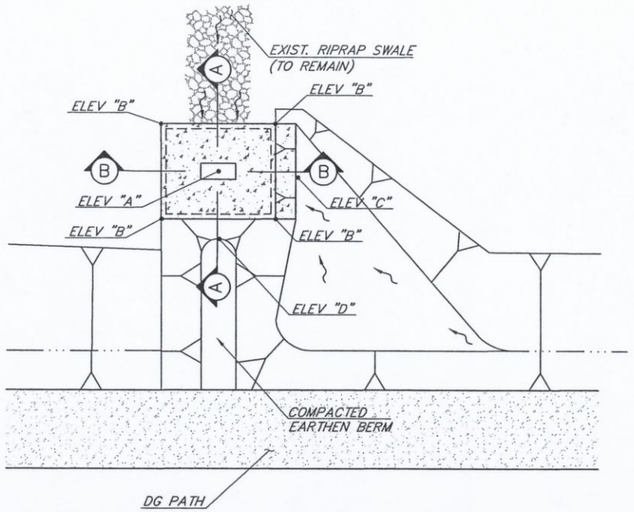
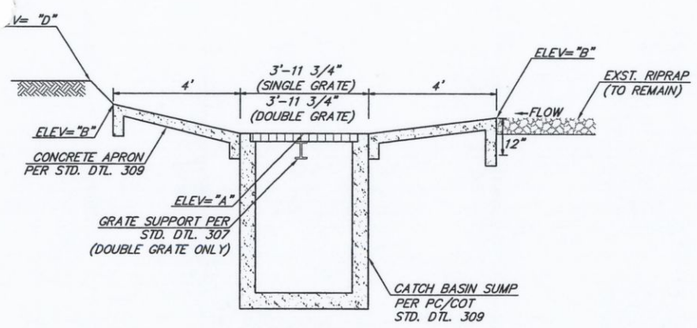
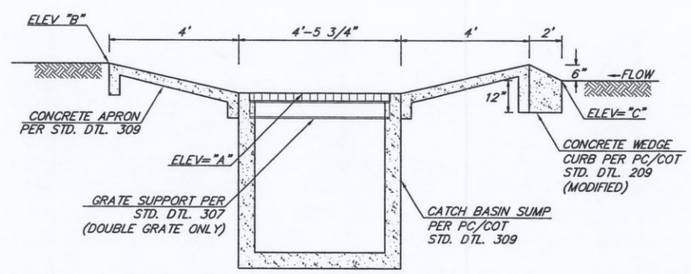
CHKD. BY MED	02/10	PLAN NO. I-2007-001	



TYPICAL DETAIL FOR CIVANO SIDE DRAINAGE
NTS

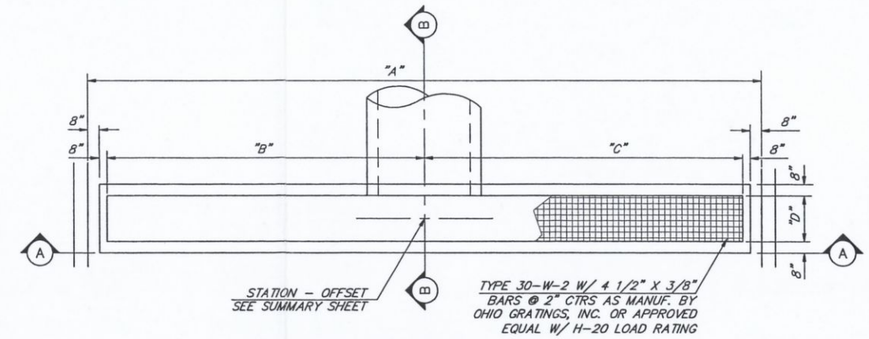


SECTION A
NTS

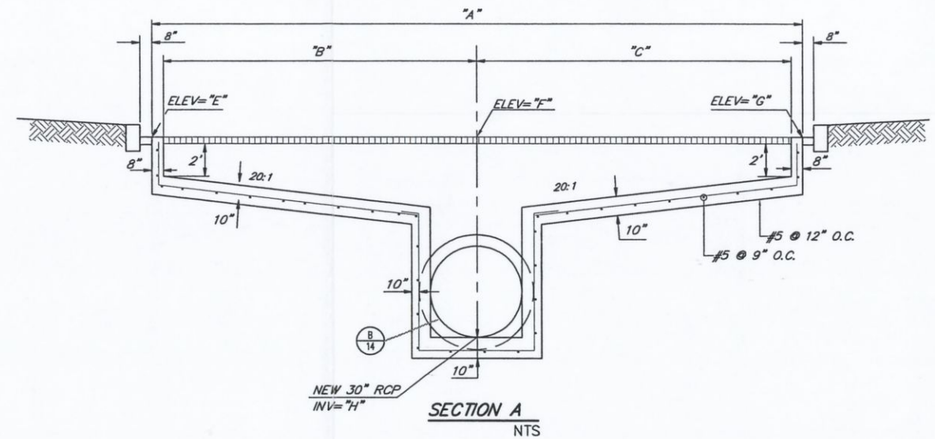


SECTION B
NTS

CIVANO SIDE DRAINAGE INLET DATA TABLE				
DIMENSION	CB #14	CB #15	CB #16	CB #17
NUMBER OF EF-1 GRATES	1	2	2	2
A	2831.35	2833.12	2834.89	2835.46
B	2831.85	2833.62	2835.39	2835.96
C	2831.35	2833.12	2834.89	2835.46
D	2832.35	2834.12	2835.89	2836.46

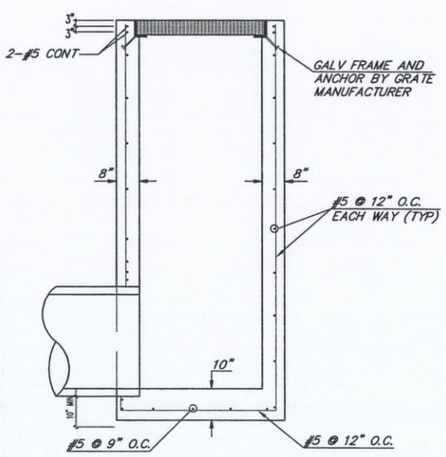


TYPICAL TRNASVERSE GRATE – PLAN VIEW
NTS



SECTION A
NTS

TRANSVERSE GRATE DATA TABLE		
DIMENSION	CB #5	CB #12
A	33'-4"	16'-8"
B	16'-8"	7'-8"
C	16'-8"	7'-8"
D	3'-0"	2'-0"
E	2791.78	2820.42
F	2792.56	2820.42
G	2793.34	2820.432
H	2784.54	2814.56



SECTION B
NTS

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SD14 OF SD14

OUTLET PROTECTION CALCULATION SHEETS

MMLA
McGovern MacVittie Lodge & Associates, Inc.

Project Name: Houghton Road
Project Number: 7TED069904 Made by: JCO Date: 2/10/2010 14:24
Reference: Checked By: Date:

Calculation of Culvert Parameters

Equations taken from U.S Department of Transportation Federal Highway Administration, Hydraulic Engineering Circular No. 14, Third Edition: Hydraulic Design of Energy Dissapators for Culverts and Channels

Flare 3:1, Width at outlet is 3D

Class	D_{50}(mm)	D_{50}(in)	Apron Length[1]	Apron Depth
1	125	5	4D	$3.5D_{50}$
2	150	6	4D	$3.3D_{50}$
3	250	10	5D	$2.4D_{50}$
4	350	14	6D	$2.2D_{50}$
5	500	20	7D	$2.0D_{50}$
6	550	22	8D	$2.0D_{50}$
[1]D is the culvert rise				

General Equation:

$D_{50}=0.2D(Q/(g^{1/2}D^{2.5}))^{4/3}(D/TW)$ Eq 10.4

D_{50}=RipRap Size(m, ft)
Q=Design Discharge(m^3/s, ft^3/s)
D=Culvert Diameter(circular)(m, ft)
TW= Tailwater Depth(m, ft)
g=(Acceleration Due to Gravity, ($9.81 m/s^2$, $32.2 ft/s^2$)

Whenever Flow is Supercritical in the culvert, the culvert diameter is adjusted as follows:

$D' = (D+y_n)/2$ Eq 10.5
D'= Adjusted culvert rise(m, ft)
y_n= normal (supercritical) depth in the culvert(m, ft)

MMLA
McGovern MacVittie Lodge & Associates, Inc.

Project Name:	Houghton Road				
Project Number:	7TED069904	Made by:	JCO	Date:	2/10/2010 14:24
Reference:		Checked By:		Date:	0

Assumptions for Calculations

Gravity is a constant **g= [ft/s^2]** 32.2
Tailwater is assumed to be **0.4*D**

One value for apron length and depth calculations is used to reduce the number of classes of riprap required.
This value is based on the greatest D_{50} value obtained using Equation 10.4

Using the above assumptions the following values are used in the calculations:

Class of riprap for this project is:	3	2	4	5	3
Apron length multiplier for this project is:	5	4	6	7	5
Apron Depth multiplier for this project is:	2.4	3.3	2.2	2.0	2.4

Apron Length calculated using D
Apron Depth calculated using Supercritical D_{50}
I

Summary of Calculations

Detail Location	D10/CP17	D11/CP18A	D12/CP18B	D01/CP12A	D03/CP13A
D= [ft]	7.14	7.14	7.14	8.74	2
Q= [ft^3/s]	127.17	96.67	171.83	378	19
TW= [ft]	2.856	2.856	2.856	3.496	0.8
y_n	1.37	1.09	1.55	3.05	0.96
D' (from Equation 10.5)	4.255	4.115	4.345	5.895	1.48
Minimum Supercritical D_{50}= [ft]	0.64	0.47	0.93	1.45	0.74
MinimumSupercritical D_{50}= [in]	7.70	5.59	11.19	17.41	8.91
# of Pipes	6	6	6	2	2
Spacing Between Pipes [ft]	0.92	0.92	0.92	0.92	1.15
Width at Opening [ft]	64.6	64.6	76.6	20.92	14.33
Apron Length [ft]	36	29	43	61	10
Width at End [ft]	88.40	83.64	105.16	61.71	21.00
Apron Depth [ft]	1.54	1.54	2.05	2.90	1.78

MMLA
McGovern MacVittie Lodge & Associates, Inc.

Project Name:	Houghton Road		
Project Number:	7TED069904	Made by: JCO	Date: 2/17/2010 9:17
Reference:		Checked By:	Date: 0

Assumptions for Calculations

Gravity is a constant **g= [ft/s^2]** 32.2
Tailwater is assumed to be **0.4*D**

One value for apron length and depth calculations is used to reduce the number of classes of riprap required.
This value is based on the greatest D_{50} value obtained using Equation 10.4

Using the above assumptions the following values are used in the calculations:

Class of riprap for this project is:	1	4
Apron length multiplier for this project is:	4	6
Apron Depth multiplier for this project is:	3.5	2.2

Apron Length calculated using D
Apron Depth calculated using Supercritical D_{50}
I

Summary of Calculations

Detail Location	D09/CP16	D13/CP19
D= [ft]	2.5	4
Q= [ft^3/s]	16.33	88
TW= [ft]	1	1.6
y_n	1.02	2.45
D' (from Equation 10.5)	1.76	3.225
Minimum Supercritical D_{50}= [ft]	0.39	1.01
MinimumSupercritical D_{50}= [in]	4.62	12.17
# of Pipes	2	3
Spacing Between Pipes [ft]	0.92	0.92
Width at Opening [ft]	20.92	13.84
Apron Length [ft]	10	24
Width at End [ft]	27.59	29.84
Apron Depth [ft]	1.35	2.23

D02

DISCHARGE	CULVERT DIAM	TAILWATER DEPTH	DURATION
14.00CFS	2.00FT	0.36FT	5.00MIN

MAX SCOUR LGT	MAX SCOUR DEPTH	MAX SCOUR WIDTH	SCOUR VOLUME
11.2FT	2.6FT	11.7FT	65.4FT3

MAX DEPTH OCCURS 4.5 FT DOWNSTREAM OF THE CULVERT OUTLET

SCOUR PROFILE		SCOUR X-SECT AT LOC MAX DEPTH	
LENGTH	DEPTH	DIST FROM CL	DEPTH
0.0	1.85	0.0	2.64
1.1	2.03	0.6	2.48
2.2	2.27	1.2	1.77
3.4	2.51	1.8	1.03
4.5	2.64	2.3	0.71
5.6	2.53	2.9	0.53
6.7	2.22	3.5	0.37
7.8	1.74	4.1	0.24
8.9	1.11	4.7	0.13
10.1	0.40	5.3	0.05
11.2	0.00	5.8	0.00

STONE DIAM(D50) REQUIRED TO PREVENT SCOUR UNDER ALL TAILWATER CONDITION ==> 8.90 INCHES ON A HORIZONTAL BLANKET 2D50 THICK.

LENGTH OF HORIZONTAL STONE PROTECTION BLANKET REQUIRED TO PREVENT SCOUR UNDER ALL TAILWATER CONDITIONS = 22.9FT

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.

D04

DISCHARGE	CULVERT DIAM	TAILWATER DEPTH	DURATION
19.00CFS	2.00FT	0.56FT	5.00MIN

MAX SCOUR LGT	MAX SCOUR DEPTH	MAX SCOUR WIDTH	SCOUR VOLUME
13.9FT	3.0FT	15.4FT	120.5FT3

MAX DEPTH OCCURS 5.5 FT DOWNSTREAM OF THE CULVERT OUTLET

SCOUR PROFILE		SCOUR X-SECT AT LOC MAX DEPTH	
LENGTH	DEPTH	DIST FROM CL	DEPTH
0.0	2.07	0.0	2.96
1.4	2.28	0.8	2.78
2.8	2.55	1.5	1.98
4.2	2.81	2.3	1.15
5.5	2.96	3.1	0.80
6.9	2.84	3.9	0.59
8.3	2.49	4.6	0.41
9.7	1.95	5.4	0.27
11.1	1.24	6.2	0.15
12.5	0.44	6.9	0.06
13.9	0.00	7.7	0.00

STONE DIAM(D50) REQUIRED TO PREVENT SCOUR UNDER ALL TAILWATER CONDITION ==> 8.59 INCHES ON A HORIZONTAL BLANKET 2D50 THICK.

LENGTH OF HORIZONTAL STONE PROTECTION BLANKET REQUIRED TO PREVENT SCOUR UNDER ALL TAILWATER CONDITIONS = 26.1FT

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.

D05

DISCHARGE	CULVERT DIAM	TAILWATER DEPTH	DURATION
17.00CFS	2.00FT	1.12FT	5.00MIN

MAX SCOUR LGT	MAX SCOUR DEPTH	MAX SCOUR WIDTH	SCOUR VOLUME
21.9FT	2.6FT	10.0FT	81.9FT3

MAX DEPTH OCCURS 8.8 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	2.63
2.2	0.84	0.5	2.55
4.4	1.97	1.0	2.39
6.6	2.47	1.5	2.05
8.8	2.63	2.0	1.34
11.0	2.52	2.5	0.60
13.1	2.26	3.0	0.24
15.3	1.84	3.5	0.11
17.5	1.31	4.0	0.05
19.7	0.68	4.5	0.03
21.9	0.00	5.0	0.00

STONE DIAM(D50) REQUIRED TO PREVENT SCOUR UNDER ALL TAILWATER CONDITION
==> 3.70 INCHES ON A HORIZONTAL BLANKET 2D50 THICK.

LENGTH OF HORIZONTAL STONE PROTECTION BLANKET REQUIRED TO PREVENT SCOUR UNDER ALL TAILWATER CONDITIONS = 18.0FT

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.

D06

DISCHARGE	CULVERT DIAM	TAILWATER DEPTH	DURATION
50.67CFS	3.00FT	0.93FT	5.00MIN

MAX SCOUR LGT	MAX SCOUR DEPTH	MAX SCOUR WIDTH	SCOUR VOLUME
20.3FT	4.4FT	22.5FT	380.8FT3

MAX DEPTH OCCURS 8.1 FT DOWNSTREAM OF THE CULVERT OUTLET

SCOUR PROFILE		SCOUR X-SECT AT LOC MAX DEPTH	
LENGTH	DEPTH	DIST FROM CL	DEPTH
0.0	3.07	0.0	4.39
2.0	3.38	1.1	4.12
4.1	3.77	2.2	2.94
6.1	4.17	3.4	1.71
8.1	4.39	4.5	1.18
10.2	4.21	5.6	0.88
12.2	3.68	6.7	0.61
14.2	2.89	7.9	0.39
16.3	1.84	9.0	0.22
18.3	0.66	10.1	0.09
20.3	0.00	11.2	0.00

STONE DIAM(D50) REQUIRED TO PREVENT SCOUR UNDER ALL TAILWATER CONDITION ==> 11.14 INCHES ON A HORIZONTAL BLANKET 2D50 THICK.

LENGTH OF HORIZONTAL STONE PROTECTION BLANKET REQUIRED TO PREVENT SCOUR UNDER ALL TAILWATER CONDITIONS = 38.6FT

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.

D07

DISCHARGE	CULVERT DIAM	TAILWATER DEPTH	DURATION
37.00CFS	2.50FT	1.81FT	5.00MIN

MAX SCOUR LGT	MAX SCOUR DEPTH	MAX SCOUR WIDTH	SCOUR VOLUME
32.0FT	3.6FT	15.3FT	248.3FT3

MAX DEPTH OCCURS 12.8 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	3.57
3.2	1.14	0.8	3.46
6.4	2.67	1.5	3.24
9.6	3.35	2.3	2.78
12.8	3.57	3.1	1.82
16.0	3.42	3.8	0.82
19.2	3.07	4.6	0.32
22.4	2.50	5.4	0.14
25.6	1.78	6.1	0.07
28.8	0.93	6.9	0.04
32.0	0.00	7.7	0.00

STONE DIAM(D50) REQUIRED TO PREVENT SCOUR UNDER ALL TAILWATER CONDITION ==> 4.80 INCHES ON A HORIZONTAL BLANKET 2D50 THICK.

LENGTH OF HORIZONTAL STONE PROTECTION BLANKET REQUIRED TO PREVENT SCOUR UNDER ALL TAILWATER CONDITIONS = 28.1FT

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.

D08

DISCHARGE	CULVERT DIAM	TAILWATER DEPTH	DURATION
19.67CFS	2.00FT	1.28FT	5.00MIN

MAX SCOUR LGT	MAX SCOUR DEPTH	MAX SCOUR WIDTH	SCOUR VOLUME
24.3FT	2.8FT	11.5FT	109.7FT3

MAX DEPTH OCCURS 9.7 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	2.77
2.4	0.89	0.6	2.69
4.9	2.08	1.1	2.52
7.3	2.61	1.7	2.16
9.7	2.77	2.3	1.41
12.1	2.66	2.9	0.64
14.6	2.39	3.4	0.25
17.0	1.94	4.0	0.11
19.4	1.39	4.6	0.06
21.9	0.72	5.2	0.03
24.3	0.00	5.7	0.00

STONE DIAM(D50) REQUIRED TO PREVENT SCOUR UNDER ALL TAILWATER CONDITION
==> 3.93 INCHES ON A HORIZONTAL BLANKET 2D50 THICK.

LENGTH OF HORIZONTAL STONE PROTECTION BLANKET REQUIRED TO PREVENT SCOUR UNDER ALL TAILWATER CONDITIONS = 20.9FT

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.

PSOMAS	Project Name:	Houghton Road-Irvington to Valencia			
	Project Number # :	7TED069904	Made by:	jco	Date: 2/10/10
	Reference:	HEC-14	Checked By:		Date:

HEC14 Eq. 10.1 $h_s/y_e = 0.86*(D_{50}/y_e)^{-0.55}(V_o/(gy_e)^{0.5})-C_o$

Irvington Crossing

y_e	2.45	ft
D_{50}	1	ft
V_o	10.69	ft/sec
g	32.2	
C_o(Eq. 10.3)	2	
Wo	4	ft

	0.86	
	1.64	
	1.20	
	-0.31	
h_s=	**-0.75**	ft
L_s=10h_s=	-7.49	ft
L_a=5h_s=	-3.74	ft
L_b=15h_s=	-11.23	ft
$3W_o$	12	ft
W_o	4	ft
$4W_o$	16	ft

Dissapator pool length is greater os L_s or $3W_o$ = **12.00** ft

Apron length is greater of L_a or W_o = **4.00** ft

Total basin length is greater of L_b or $4W_o$ = **16.00** ft