



Picture Spring Branch Hydrologic and Hydraulic Analysis Report

Prepared for:
Anne Arundel County

Final

Date: November 30, 2017

LimnoTech 
Water | Scientists
Environment | Engineers

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TABLE OF CONTENTS

1 Introduction	1
2 Hydrology	2
3 Hydraulics	6
4 Results	8
1 year Recurrence Interval Event	8
2 year Recurrence Interval Event	9
10 year Recurrence Interval Event	9
100 year Recurrence Interval Event	10
5 References	12

LIST OF FIGURES

Figure 1. Picture Spring Branch Existing Conditions	3
Figure 2. Picture Spring Branch Model Inputs	4
Figure 3. Picture Spring Branch Modeled Cross Sections	7

LIST OF TABLES

Table 1. HEC-RAS Discharges (cfs)	6
Table 2. HEC-RAS Results for 1-Year Recurrence Interval	8
Table 3. HEC-RAS Results for 2-Year Recurrence Interval	9
Table 4. HEC-RAS Results for 10-Year Recurrence Interval	10
Table 5. HEC-RAS Results for 100-Year Recurrence Interval	10

APPENDICES

- Appendix A. SWMM Model Files**
- Appendix B. HEC-RAS Files**



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1 Introduction

As part of its National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permit, Anne Arundel County is required to characterize the geomorphological conditions of the Picture Spring Branch Subwatershed. The goal of this monitoring effort is to assess the implementation of best management practice (BMP) design criteria from the 2000 Maryland Stormwater Design Manual approved by Maryland Department of the Environment (MDE). The BMP design criteria were applied to the stormwater management system constructed at the West County Library site, located in Odenton, Maryland, just west of the intersection of State Highways 170 (Telegraph Road) and 175 (Annapolis Road). Physical condition and habitat monitoring for Picture Spring Branch began in 2003 and is conducted on an annual basis. Biological monitoring to measure overall stream health is also performed.

The Picture Spring Branch watershed is mostly residential but contains the Odenton MARC Station and the West County Library. Although it is developed and has a high percentage of impervious surfaces, it contains a large forested area east of the MARC station. The stream flows through this forested area towards the Library and then under Piney Orchard Parkway.

The purpose of this report is to determine the effect of the 1-, 2-, 10-, and 100-year design storms on the stream bed. This was done by using SWMM to model the hydrology of the watershed, and HEC-RAS to model the stream hydraulics. Key results of the model include stream flow, shear stress, and stream velocity. The modeling results were evaluated to determine the stability of the stream during the four modeled design storms.

Several studies have been performed on this site to determine the effectiveness of BMP implementation in the watershed, including a Stormwater Management report for the Library performed by McCrone in 2002 (McCrone, 2002), and a hydrologic and hydraulic analysis done by KCI in 2010 (KCI Technologies, Inc. 2010). This report serves as a supplement to these reports, and includes both hydrologic and hydraulic analysis of the creek and its watershed. This report is also required to be included with Anne Arundel County's MS4 Annual Report.



2 Hydrology

The Picture Spring Branch watershed is generally sloped from southwest to northeast. Flows reach the stream through a combination of overland flow and a storm sewer system. Picture Spring Branch has two flow paths in this area; one along Annapolis Road carrying flows from the MARC station east towards the library, and one smaller branch carrying flows from the residential neighborhoods north towards the library. These two paths meet east of the library and flow further east under Piney Orchard Parkway (Figure 1).

The hydrologic modeling was done in PCSWMM using the 2014 impervious surfaces layer provided by the County and the current SSURGO soils layer as inputs (USDA 2016). In order to be conservative, the system was modeled such that runoff from the watersheds flows directly to the outfall or BMP that captures it. Typically, a collection system is not designed to convey very large runoff events (e.g. 100-year event), and therefore water will pond locally before flowing to the outfall or stream. However, because the size and elevations for the storm system were not known, oversized pipes were modeled to convey the flows to each outfall and BMP. Because the model directs flow to the outfall or stream through an enlarged pipe, the resulting peak flows and intensities are likely higher than would be seen during an actual precipitation event. Although additional information on conduit the storm system could be useful to further refine these results, this conservative approach is considered appropriate for this model application.

Thirty two (32) BMPs were identified in the Picture Spring Branch watershed (Figure 1). These BMPs were identified either from the KCI report completed in 2010, or from the Anne Arundel County BMP Record Review and Update project currently being conducted by LimnoTech. Five (5) of these BMPs were identified as having sufficient detention to impact runoff, and were included in the model. The remaining BMPs were either too small to affect the downstream hydrograph (e.g. single family housing infiltration practices) or were designed for water quality and not detention (e.g. Baysavers), and thus they were not included in the model.





Figure 1. Picture Spring Branch Existing Conditions

Of the five (5) identified BMPs, three (3) are dry ponds, one (1) is a wet pond, and one (1) is an infiltration BMP. Drainage areas for each modeled BMP were developed using a combination of GIS data including elevation files and storm drain profiles; previous delineations done by KCI in 2010; and plan documents received from the County through the Anne Arundel County BMP Record Review and Update project. The

modeled BMP locations, their drainage areas, and the hydrologic soil groups are shown in Figure 2 below. The HSGs classifications are used to estimate the runoff potential of various soil types. Soils classified as HSG A soils have low potential for runoff, while soils classified as HSG D have high potential. As Figure 2 shows, most of the Picture Spring Branch Watershed is classified as HSG A and B soils and will generally produce low runoff.

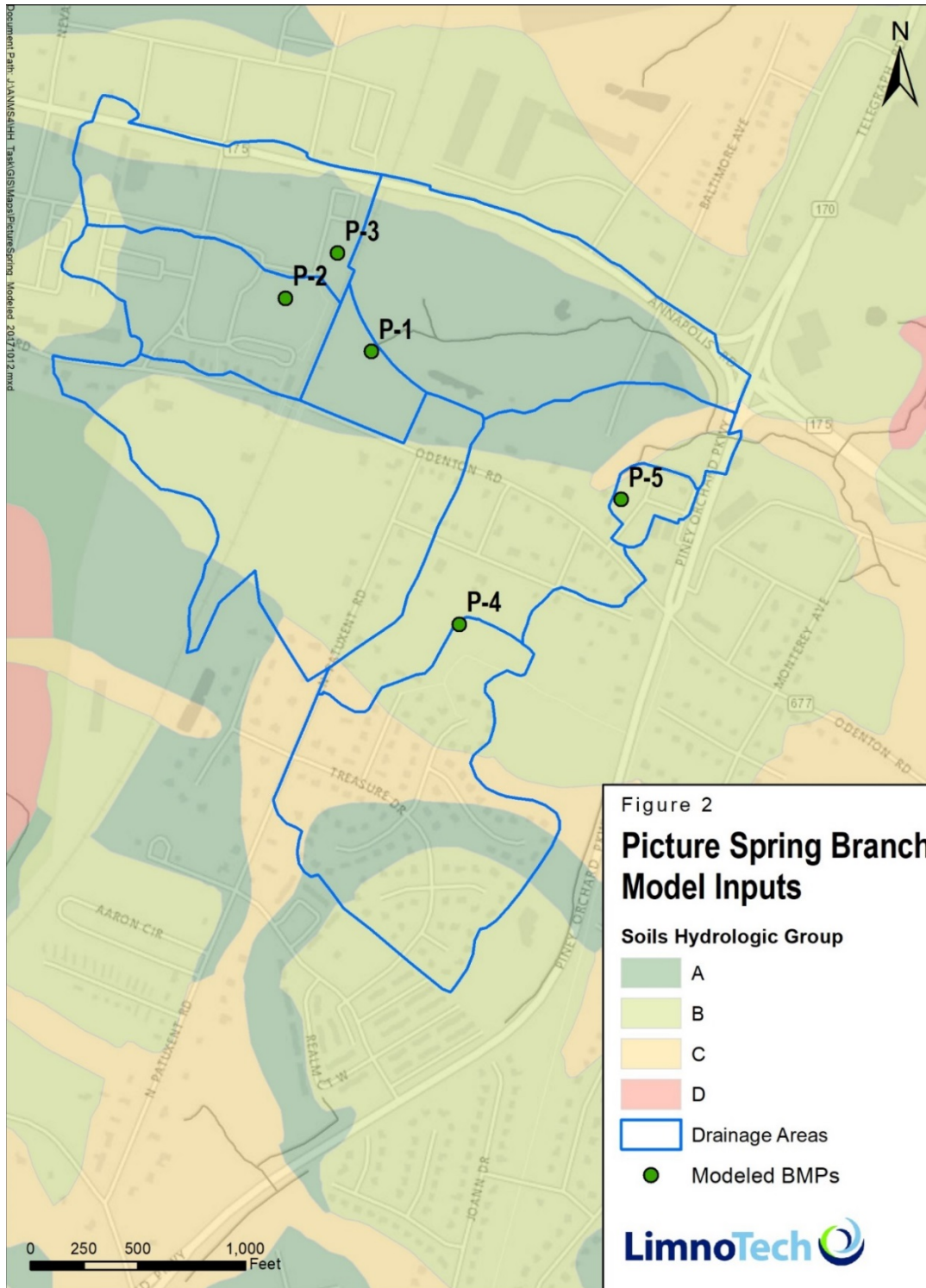


Figure 2. Picture Spring Branch Model Inputs

Available information varied for each BMP, so a breakdown of how each BMP was modeled is provided below:

- BMP PS-1: This infiltration BMP was modeled as a storage unit and outfall using elevation-area and stage-discharge curves previously developed by KCI.
- BMP PS-2: This dry pond was modeled as a storage unit and outfall using elevation-area and stage-discharge curves previously developed by KCI.
- BMP PS-3: This wet pond was modeled as a storage unit and outfall using elevation-area and stage-discharge curves previously developed by KCI.
- BMP PS-4: This dry pond was modeled as a storage unit and outfall using elevation-area and stage-discharge curves previously developed by KCI.
- BMP PS-5: Due to lack of information, this dry pond was assumed to treat the first 1" of rainfall based on stormwater regulations. This was done in the model by increasing depression storage of the subcatchment to 1".



3 Hydraulics

LimnoTech surveyed cross sections along Picture Spring Branch for the HEC-RAS model in September 2017. The focus of the survey was on defining the main channel flow path and the immediate floodplain. The elevation for the extended floodplains and overbank areas were taken from the LiDAR derived surface that was received from the County (Anne Arundel County 2017). Versar also has stream cross sections recorded in 2017 for a geomorphic study, and these cross sections were also used for the HEC-RAS model. In order to import the cross sections into HEC-RAS, cross sections were first taken from the LiDAR surface and then compared to the surveyed cross sections from LimnoTech and Versar. The cross sections were then adjusted to reflect the surveyed portion of the channel which helped to define the low flow channel more precisely. Generally, there was little difference between the LiDAR cross sections and the surveyed cross sections. In areas where the low flow channel was not picked up by the LiDAR, small modifications were made in HEC-RAS to reflect the low flow channel. Stream crossings were surveyed as part of the KCI study and these elevations and details were used directly in the HEC-RAS model. The final modeled cross sections are shown in Figure 3.

Manning’s n values which describe the flow roughness of the stream were assigned based on field notes and photographs of the site. For the main channel, an “n” value of 0.045, which corresponds to a main channel with vegetation, some pools, and stones/obstructions (Chow 1959), was used. Overbank “n” values of 0.08 - which corresponds to floodplains with light brush and trees - were used (Chow 1959).

A steady flow file was created to define the flows and model boundary condition. The 1, 2, 10, and 100-year peak discharges from the SWMM model were used to develop this steady flow file. The downstream slope of the channel (0.004 ft/ft), was entered into the model as the downstream “normal depth” boundary condition. The “subcritical” flow regime was selected because this is a low gradient stream.

The discharges from SWMM that were modeled in HEC-RAS are shown in Table 1.

Table 1. SWMM discharges used in HEC-RAS (cfs)				
River Station	1-year	2-year	10-year	100-year
2509	85	113	193	312
1483	158	211	363	600

The modeled BMPs provide volume and peak flow reduction, but are much less effective for larger storms. During small storms the BMPs are not at capacity, meaning that they can provide mitigation throughout the storm. Once the BMPs fill, they are effectively taken out of the hydraulic equation; volume in equals volume out and can no longer provide any mitigation. These large 10- and 100-year design storms are so intense that the BMPs fill in minutes, reducing their overall effectiveness.



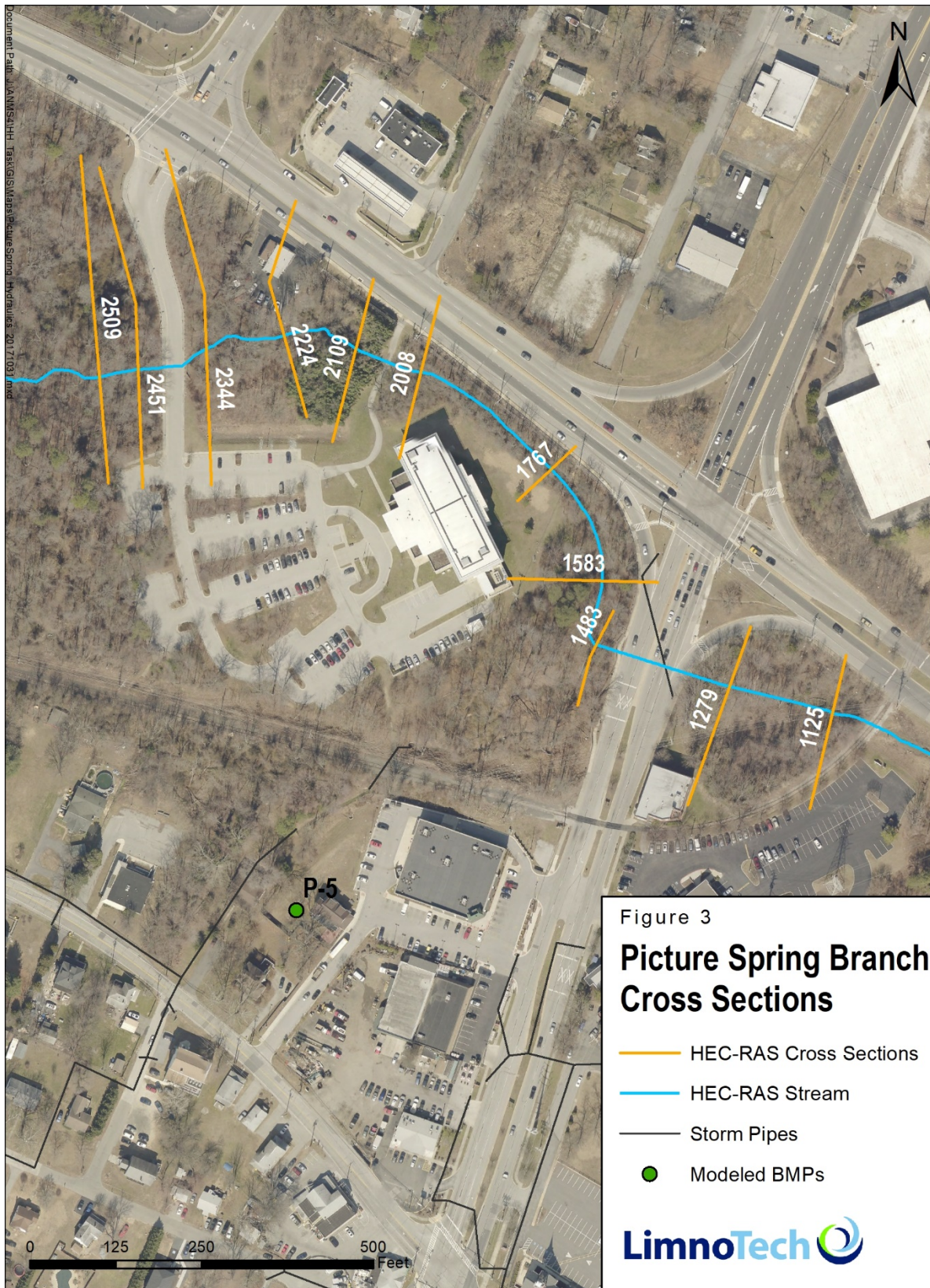


Figure 3. Picture Spring Branch Modeled Cross Sections

4 Results

The KCI report (KCI Technologies Inc., 2010) documents relevant background information on the culverts and stream crossings in the project area. The Winmeyer Avenue culvert was designed to convey the 100-year storm event. The pedestrian walkway culvert, downstream of Winmeyer Ave, was to be removed during the construction of the library, but a fiber optic duct bank was discovered which made the removal not possible. This pedestrian crossing was likely not designed to convey the 100-year storm event. No information is available on the capacity of the Piney Orchard Parkway culvert. Discussion of culvert conveyance and road overtopping for each of the recurrent intervals is discussed below.

With respect to the stream stability, the velocity and shear stress are both key metrics used to evaluate the erosive forces within the stream channel. In the report “Biological and Geomorphological Conditions in the Picture Spring Branch Subwatershed: Severn River Watershed,” the substrate of streams in this area are all dominated by sand (KCI 2009). The maximum permissible velocity of a silty loam stream channel is 3.0 ft/s (ASCE 1926). The critical bed shear stress in the channel should be less than 0.03 lb/ft² (USGS 2008). It is important to note that all results presented below are values for the peak of the hydrograph and do not occur throughout the event. Therefore, if the velocity or shear stress is exceeded it does not necessarily mean the stream is not in equilibrium. If normal sediment transport conditions exist, the eroded areas will be replenished from upstream areas and the stream will remain stable.

1 year Recurrence Interval Event

The 1-year storm does not overtop any of the modeled crossings. The channel velocities range from 3.99 ft/s at the upstream end of the reach where the slope is steepest to less than 2 ft/s at the downstream reach where the channel slope is more gradual. The shear stress in the channel is generally less than 0.5 lb/ft². See Table 2 for hydraulic model results.

Table 2. HEC-RAS Results for 1-Year Recurrence Interval			
River Station	W.S. Elevation	Average Channel Velocity	Shear Stress, Channel
	(ft)	(ft/s)	(lb/sq/ft)
2509	135.03	3.99	1.10
2451	133.79	1.98	0.20
2401	Winmeyer Avenue		
2344	132.72	1.10	0.05
2224	132.61	2.03	0.18
2109	132.55	1.52	0.09
2062	Pedestrian Walkway		
2008	131.03	3.98	0.75
1767	130.83	1.83	0.13
1583	130.78	1.40	0.07
1483	130.76	1.37	0.06



Table 2. HEC-RAS Results for 1-Year Recurrence Interval			
River Station	W.S. Elevation	Average Channel Velocity	Shear Stress, Channel
	(ft)	(ft/s)	(lb/sq/ft)
1395	Piney Orchard Parkway		
1279	127.37	2.87	0.39
1125	126.79	2.99	0.43

2 year Recurrence Interval Event

The 2-year storm also does not overtop any of the modeled crossings. The velocity in the channel has a similar range to the 1-year storm with a slight increase. The water surface elevations do increase for the 2-year recurrence interval as expected although floodplain is not activated.

Table 3. HEC-RAS Results for 2-Year Recurrence Interval			
River Station	W.S. Elevation	Average Channel Velocity	Shear Stress, Channel
	(ft)	(ft/s)	(lb/sq/ft)
2509	135.14	4.26	1.18
2451	134.09	2.04	0.20
2401	Winmeyer Avenue		
2344	133.39	1.09	0.05
2224	133.30	1.98	0.16
2109	133.26	1.42	0.08
2062	Pedestrian Walkway		
2008	131.92	3.69	0.59
1767	131.80	1.85	0.12
1583	131.76	1.44	0.07
1483	131.75	1.38	0.06
1395	Culvert		
1279	127.69	3.23	0.47
1125	127.10	3.34	0.51

10 year Recurrence Interval Event

For the 10-year storm event, all three cross sections are at capacity but the road crossings are not overtopped. The velocities and shear stresses in the channel are much lower in this scenario as flow is backed up behind the crossings, creating slow moving riverine conditions.



Table 4. HEC-RAS Results for 10-Year Recurrence Interval			
River Station	W.S. Elevation	Average Channel Velocity	Shear Stress, Channel
	(ft)	(ft/s)	(lb/sq/ft)
2509	137.69	0.69	0.02
2451	137.68	0.61	0.01
2401	Winmeyer Avenue		
2344	137.41	0.56	0.01
2224	137.39	1.19	0.04
2109	137.4	0.74	0.02
2062	Pedestrian Walkway		
2008	134.93	2.60	0.23
1767	134.88	1.69	0.08
1583	134.87	1.34	0.05
1483	134.87	1.05	0.03
1395	Piney Orchard Parkway		
1279	128.39	4.01	0.65
1125	127.79	4.06	0.68

100 year Recurrence Interval Event

During the 100-year event, all culverts are at their capacity. For this scenario, the backwater from the Piney Orchard culvert is the dominant factor. Although Piney Orchard Parkway is not being overtopped, the backwater is overtopping Winmeyer Avenue and the Pedestrian Bridge. Similar to the 10-year storm, velocities and shear stresses are low in the channel because of the flow conditions.

Table 5. HEC-RAS Results for 100-Year Recurrence Interval			
River Station	W.S. Elevation	Average Channel Velocity	Shear Stress, Channel
	(ft)	(ft/s)	(lb/sq/ft)
2509	142.65	0.27	0.00
2451	142.65	0.29	0.00
2401	Winmeyer Avenue		
2344	142.65	0.30	0.00
2224	142.64	0.76	0.01
2109	142.64	0.50	0.01
2062	Pedestrian Walkway		
2008	142.63	1.00	0.03



Table 5. HEC-RAS Results for 100-Year Recurrence Interval			
River Station	W.S. Elevation	Average Channel Velocity	Shear Stress, Channel
	(ft)	(ft/s)	(lb/sq/ft)
1767	142.62	0.98	0.02
1583	142.62	0.57	0.01
1483	142.62	0.64	0.01
1395	Piney Orchard Parkway		
1279	129.18	4.64	0.81
1125	128.57	4.81	0.87

Although the modeled results do sometimes show the velocity and shear stress thresholds being exceeded in some locations under some scenarios, our field observations indicate that the channel is in equilibrium. From our observations, the channel does not show any channel downcutting, bank erosion, or instability. Likewise in the overbank areas, no major erosion or scour was seen. Geomorphic monitoring has also been performed in the project reach from 2011 to 2017. Results from this monitoring showed similar results to this modeling effort. In most areas, the cross-sectional area has had little noticeable change. In areas where the channel was not channelized, the channel shows some signs of sedimentation and scouring. Considering all of these findings, it appears that the channel is relatively stable and the runoff from the watershed is not causing any erosion in the stream reach.



5 References

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American Society of Civil Engineers 1926. Special Committee on Irrigation Research.

Chow, V.T. 1959. *Open Channel Hydraulics*. McGraw-Hill, New York.

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McCrone. 2002. *West County Library Stormwater Management Report*. July 2002.

USDA. 2016. Soil Survey Map of Anne Arundel County, SSURGO. Accessed through <https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm>.

USGS. 2008. Scientific Investigations Report 2008-5093. Table 7.



Appendix A. SWMM Model Files





Legend

- ▲ Outfalls
- Storages
- Outlets
- Subcatchments



1500 ft

[TITLE]

```
[OPTIONS]
;;Options          Value
;;-----
FLOW_UNITS        CFS
INFILTRATION      HORTON
FLOW_ROUTING      DYNWAVE
START_DATE        01/01/1989
START_TIME        00:00:00
REPORT_START_DATE 01/01/1989
REPORT_START_TIME 00:00:00
END_DATE          01/02/1989
END_TIME          00:00:00
SWEEP_START       01/01
SWEEP_END         12/31
DRY_DAYS          0
REPORT_STEP       00:01:00
WET_STEP          00:05:00
DRY_STEP          00:05:00
ROUTING_STEP      5
ALLOW_PONDING    NO
INERTIAL_DAMPING  PARTIAL
VARIABLE_STEP     0.75
LENGTHENING_STEP 0
MIN_SURFAREA     0
NORMAL_FLOW_LIMITED BOTH
SKIP_STEADY_STATE NO
FORCE_MAIN_EQUATION H-W
LINK_OFFSETS     DEPTH
MIN_SLOPE        0
MAX_TRIALS       8
HEAD_TOLERANCE   0.005
SYS_FLOW_TOL     5
LAT_FLOW_TOL     5
MINIMUM_STEP     0.5
THREADS          4
```

```
[EVAPORATION]
;;Type            Parameters
;;-----
CONSTANT          0.0
DRY_ONLY          NO
```

```
[RAINGAGES]
;;
;;Name            Rain    Time    Snow    Data
;;Type            Type    Intrvl  Catch  Source
;;-----
100yr_24hr       VOLUME 0:05   1.0    TIMESERIES 100yr_24hr
10yr_24hr        VOLUME 0:05   1.0    TIMESERIES 10yr_24hr
1yr_24hr         VOLUME 0:05   1.0    TIMESERIES 1yr_24hr
2yr_24hr         VOLUME 0:05   1.0    TIMESERIES 2yr_24hr
```

```
[SUBCATCHMENTS]
;;
;;Name            Raingage      Outlet          Total    Pcnt.
;;-----          -----          -----          Area    Imperv
;;-----          -----          -----          -----
;Modified Urban Stormwater BMP Review
S10      1yr_24hr      OF12            2.3363  69.844
;Modified Urban Stormwater BMP Review
S13      1yr_24hr      P-1             4.5752  50.567
;Modified KCI Drainage Area
S18      1yr_24hr      P-2             13.8974 69.735
;Modified KCI Drainage Area
S19      1yr_24hr      P-3             16.0272 60.088
;Modified KCI Drainage Area
;(Matt Zelin - 2017.10.04) For PSB, can we factor in the bioretention area in the library parking lot?
S20      1yr_24hr      OF12            28.3442 21.655
;Modified KCI Drainage Area
S21      1yr_24hr      OF12            26.1788 29.463
;Modified KCI Drainage Area
S22      1yr_24hr      OF9             33.5982 29.616
;Modified Urban Stormwater BMP Review
S9       1yr_24hr      P-4             28.8435 38.452
;;-----          -----          -----          -----
Total Area    Pcnt.  Width  Pcnt.  Curb  Snow
Area    Imperv  Slope  Length Pack
```

```
[SUBAREAS]
;;Subcatchment  N-Imperv  N-Perv  S-Imperv  S-Perv  PctZero  RouteTo  PctRouted
;;-----
S10             0.01     0.1     1         1         0         OUTLET
S13             0.01     0.1     0.05     0.05     25        OUTLET
S18             0.01     0.1     0.05     0.05     25        OUTLET
S19             0.01     0.1     0.05     0.05     25        OUTLET
S20             0.01     0.1     0.05     0.05     25        OUTLET
S21             0.01     0.1     0.05     0.05     25        OUTLET
S22             0.01     0.1     0.05     0.05     25        OUTLET
S9              0.01     0.1     0.05     0.05     25        OUTLET
```

```
[INFILTRATION]
;;Subcatchment  MaxRate  MinRate  Decay  DryTime  MaxInfil
;;-----
S10             3.691   0.294   3.046  5.849   0
S13             3.749   0.3     2.988  5.988   0
S18             3.749   0.3     2.988  5.988   0
S19             3.749   0.3     2.988  5.988   0
```

S20	3.746	0.3	2.991	5.979	0
S21	3.594	0.285	3.143	5.619	0
S22	3.708	0.296	3.029	5.89	0
S9	3.289	0.254	3.451	4.889	0

[OUTFALLS]

```

;;
;;Name      Invert      Outfall      Stage/Table      Tide
            Elev.      Type          Time Series      Gate Route To
-----
OF12       138.89      FREE         NO                NO
OF7        138.219    FREE         NO                NO
OF8        138.219    FREE         NO                NO
OF9        138.219    FREE         NO                NO

```

[STORAGE]

```

;;
;;Name      Invert      Max.      Init.      Storage      Curve      Poned      Evap.
            Elev.      Depth     Depth     Curve        Params     Area      Frac.      Infiltration parameters
-----
;IBAS- Infiltration Basin
P-1        142.2      11.8      0          TABULAR     PS_1       0          0
P-2        147        7         0          TABULAR     PS_2       0          0
P-3        149.4      4.6      0          TABULAR     PS_4       0          0
;XDPD-Detention Structure (Dry Pond) (plain old pond)
P-4        150.3      13.7     0          TABULAR     PS_8       0          0

```

[OUTLETS]

```

;;
;;Name      Inlet      Outlet      Outflow      Outlet      Qcoeff/      Qexpon      Flap
            Node      Node        Height       Type        QTable       Gate
-----
OL1        P-3        OF7         0            TABULAR/DEPTH PSO_4        NO
OL2        P-2        OF9         0            TABULAR/DEPTH PSO_2        NO
OL3        P-1        OF8         0            TABULAR/DEPTH PSO_1        NO
OL4        P-4        OF12        0            TABULAR/DEPTH PSO_8        NO

```

[CURVES]

```

;;
;;Name      Type      X-Value      Y-Value
-----
PSO_1      Rating   0.894407959  1.000108172
PSO_1      Rating   1.747908325  1.999990659
PSO_1      Rating   3.134886475  3.000010808
PSO_1      Rating   3.425223083  7.198129701
PSO_1      Rating   3.476000519  11.93239144
PSO_1      Rating   3.654993896  36.10542747
PSO_1      Rating   3.796950684  61.30856007
PSO_1      Rating   3.922165435  87.0841943
PSO_1      Rating   4.03566864   113.0040308

PSO_2      Rating   0.201464844  0.00013035
PSO_2      Rating   3.771472168  4.998627004
PSO_2      Rating   4.072185425  8.000239655
PSO_2      Rating   4.232526855  10.00070509
PSO_2      Rating   4.585887451  15.00064748
PSO_2      Rating   4.890532189  19.99953232
PSO_2      Rating   5.120456543  30.01222208
PSO_2      Rating   5.215056152  40.01366647
PSO_2      Rating   5.292486387  50.02319012
PSO_2      Rating   5.398541851  60.00472738
PSO_2      Rating   5.66985      69.99833333
PSO_2      Rating   6.93075963   79.99783333
PSO_2      Rating   8.552900741  89.99733333
PSO_2      Rating   10.17504185  99.99683333
PSO_2      Rating   13.42        120
PSO_2      Rating   14.76        140
PSO_2      Rating   16.1         160
PSO_2      Rating   16.14        180
PSO_2      Rating   16.18        200
PSO_2      Rating   16.181      200

PSO_4      Rating   0            0
PSO_4      Rating   0.269373516  1.119033176
PSO_4      Rating   0.386379595  3.293815464
PSO_4      Rating   0.512671596  6.299139122
PSO_4      Rating   0.602355128  8.872743747
PSO_4      Rating   1.102695074  30.33487199
PSO_4      Rating   1.408569419  49.85012538
PSO_4      Rating   2.596437673  178.9660477
PSO_4      Rating   3.300262952  301.0226454
PSO_4      Rating   4.604290009  630.8127629

PSO_8      Rating   1.040732422  5.12062E-05
PSO_8      Rating   1.571154633  1.00002742
PSO_8      Rating   2.036665955  2.000024444
PSO_8      Rating   2.740065613  2.99996683
PSO_8      Rating   3.061309998  3.999936714
PSO_8      Rating   3.298630219  5.000019034
PSO_8      Rating   5.106233521  9.999995334
PSO_8      Rating   7.725875244  14.99618218
PSO_8      Rating   7.793244898  20.00295938
PSO_8      Rating   7.846019135  25.00121884
PSO_8      Rating   7.892076416  29.99029725
PSO_8      Rating   7.934116821  34.99620504
PSO_8      Rating   7.973799744  39.99999088
PSO_8      Rating   8.022834473  44.99158152
PSO_8      Rating   8.695        50

```

PSO_8		11.350108	60.001
PSO_8		12.430108	70.001
PSO_8		13.51	80
PSO_8		13.55	90
PSO_8		13.59	100

PS_1	Storage	0	0
PS_1		1.8	7300
PS_1		3.8	37850
PS_1		5.8	51490
PS_1		7.8	68905
PS_1		9.8	99850
PS_1		11.8	131705

PS_2	Storage	0	0
PS_2		1	7670
PS_2		3	22540
PS_2		5	39456
PS_2		7	52551

PS_4	Storage	0	0
PS_4		0.6	8687
PS_4		4.6	22545

PS_8	Storage	0	0
PS_8		3.7	28238
PS_8		5.7	31740
PS_8		7.7	35360
PS_8		9.7	40600
PS_8		11.7	47366
PS_8		13.7	55371

[TIMESERIES]

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100yr_24hr	1/1/1989	0:25	0.0108
100yr_24hr	1/1/1989	0:30	0.0108
100yr_24hr	1/1/1989	0:35	0.0108
100yr_24hr	1/1/1989	0:40	0.0108
100yr_24hr	1/1/1989	0:45	0.0108
100yr_24hr	1/1/1989	0:50	0.0108
100yr_24hr	1/1/1989	0:55	0.0108
100yr_24hr	1/1/1989	1:00	0.0108
100yr_24hr	1/1/1989	1:05	0.0108
100yr_24hr	1/1/1989	1:10	0.0108
100yr_24hr	1/1/1989	1:15	0.0108
100yr_24hr	1/1/1989	1:20	0.0108
100yr_24hr	1/1/1989	1:25	0.0108
100yr_24hr	1/1/1989	1:30	0.0108
100yr_24hr	1/1/1989	1:35	0.0108
100yr_24hr	1/1/1989	1:40	0.0108
100yr_24hr	1/1/1989	1:45	0.0108
100yr_24hr	1/1/1989	1:50	0.0108
100yr_24hr	1/1/1989	1:55	0.0108
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100yr_24hr	1/1/1989	2:05	0.0108
100yr_24hr	1/1/1989	2:10	0.0108
100yr_24hr	1/1/1989	2:15	0.0108
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100yr_24hr	1/1/1989	2:45	0.0108
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100yr_24hr	1/1/1989	2:55	0.0108
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100yr_24hr	1/1/1989	3:45	0.0108
100yr_24hr	1/1/1989	3:50	0.0108
100yr_24hr	1/1/1989	3:55	0.0108
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100yr_24hr	1/1/1989	4:30	0.0108
100yr_24hr	1/1/1989	4:35	0.0108
100yr_24hr	1/1/1989	4:40	0.0108
100yr_24hr	1/1/1989	4:45	0.0108
100yr_24hr	1/1/1989	4:50	0.0108
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10yr_24hr	1/1/1989	4:55	0.0050
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10yr_24hr	1/1/1989	5:05	0.0050
10yr_24hr	1/1/1989	5:10	0.0050
10yr_24hr	1/1/1989	5:15	0.0050
10yr_24hr	1/1/1989	5:20	0.0050
10yr_24hr	1/1/1989	5:25	0.0050
10yr_24hr	1/1/1989	5:30	0.0050
10yr_24hr	1/1/1989	5:35	0.0050
10yr_24hr	1/1/1989	5:40	0.0050
10yr_24hr	1/1/1989	5:45	0.0050
10yr_24hr	1/1/1989	5:50	0.0050
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10yr_24hr	1/1/1989	6:25	0.0100
10yr_24hr	1/1/1989	6:30	0.0100
10yr_24hr	1/1/1989	6:35	0.0100
10yr_24hr	1/1/1989	6:40	0.0100
10yr_24hr	1/1/1989	6:45	0.0100
10yr_24hr	1/1/1989	6:50	0.0100
10yr_24hr	1/1/1989	6:55	0.0100
10yr_24hr	1/1/1989	7:00	0.0100
10yr_24hr	1/1/1989	7:05	0.0100
10yr_24hr	1/1/1989	7:10	0.0100
10yr_24hr	1/1/1989	7:15	0.0100
10yr_24hr	1/1/1989	7:20	0.0100
10yr_24hr	1/1/1989	7:25	0.0100
10yr_24hr	1/1/1989	7:30	0.0100
10yr_24hr	1/1/1989	7:35	0.0100
10yr_24hr	1/1/1989	7:40	0.0100
10yr_24hr	1/1/1989	7:45	0.0100
10yr_24hr	1/1/1989	7:50	0.0100
10yr_24hr	1/1/1989	7:55	0.0100
10yr_24hr	1/1/1989	8:00	0.0100
10yr_24hr	1/1/1989	8:05	0.0100
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10yr_24hr	1/1/1989	8:15	0.0100
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10yr_24hr	1/1/1989	8:25	0.0100
10yr_24hr	1/1/1989	8:30	0.0100
10yr_24hr	1/1/1989	8:35	0.0100
10yr_24hr	1/1/1989	8:40	0.0100
10yr_24hr	1/1/1989	8:45	0.0100
10yr_24hr	1/1/1989	8:50	0.0100
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1yr_24hr	1/1/1989	4:55	0.0025
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[REPORT]
INPUT YES
CONTROLS NO
SUBCATCHMENTS ALL
NODES ALL
LINKS ALL

[TAGS]

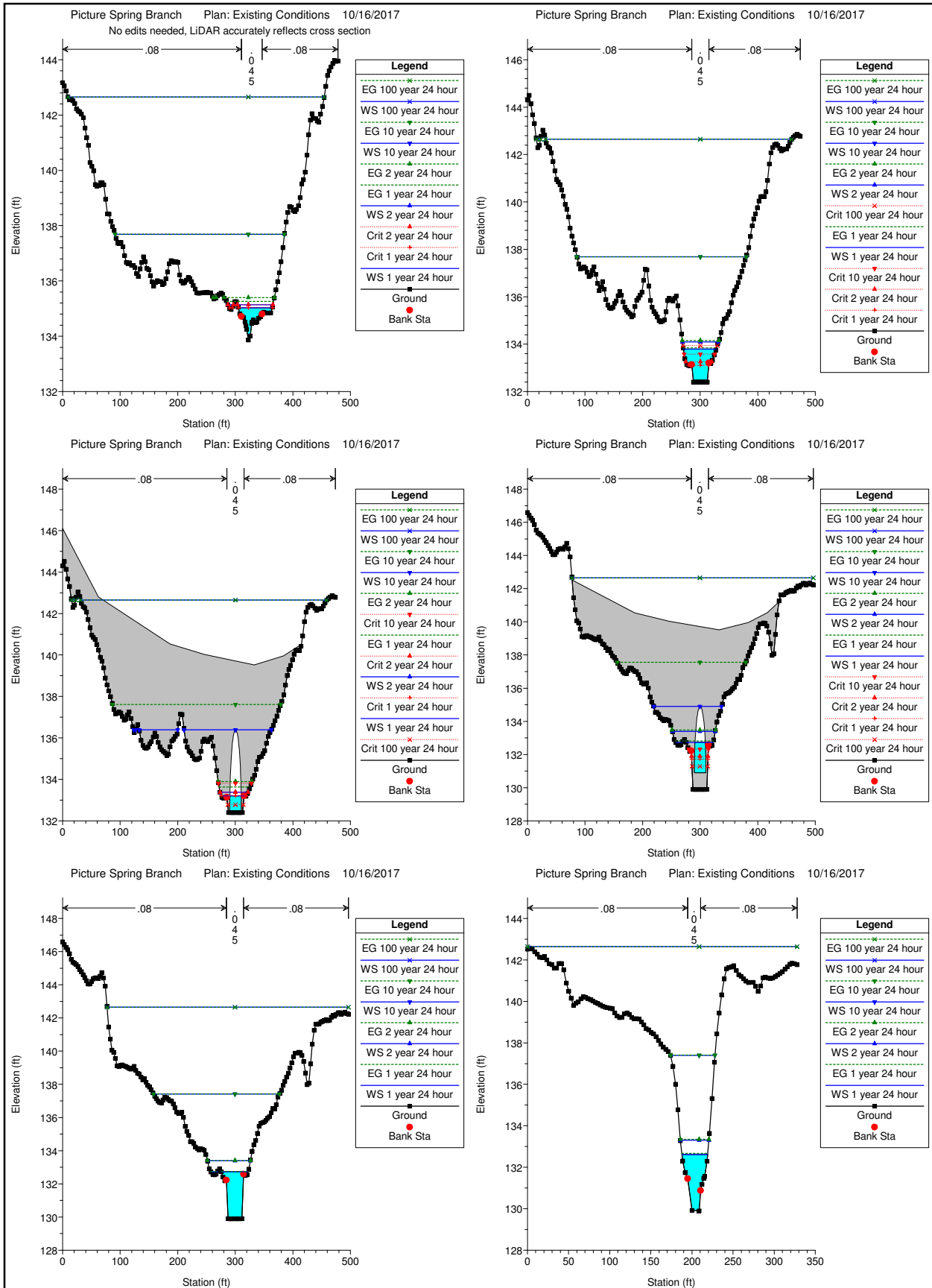
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UNITS Feet

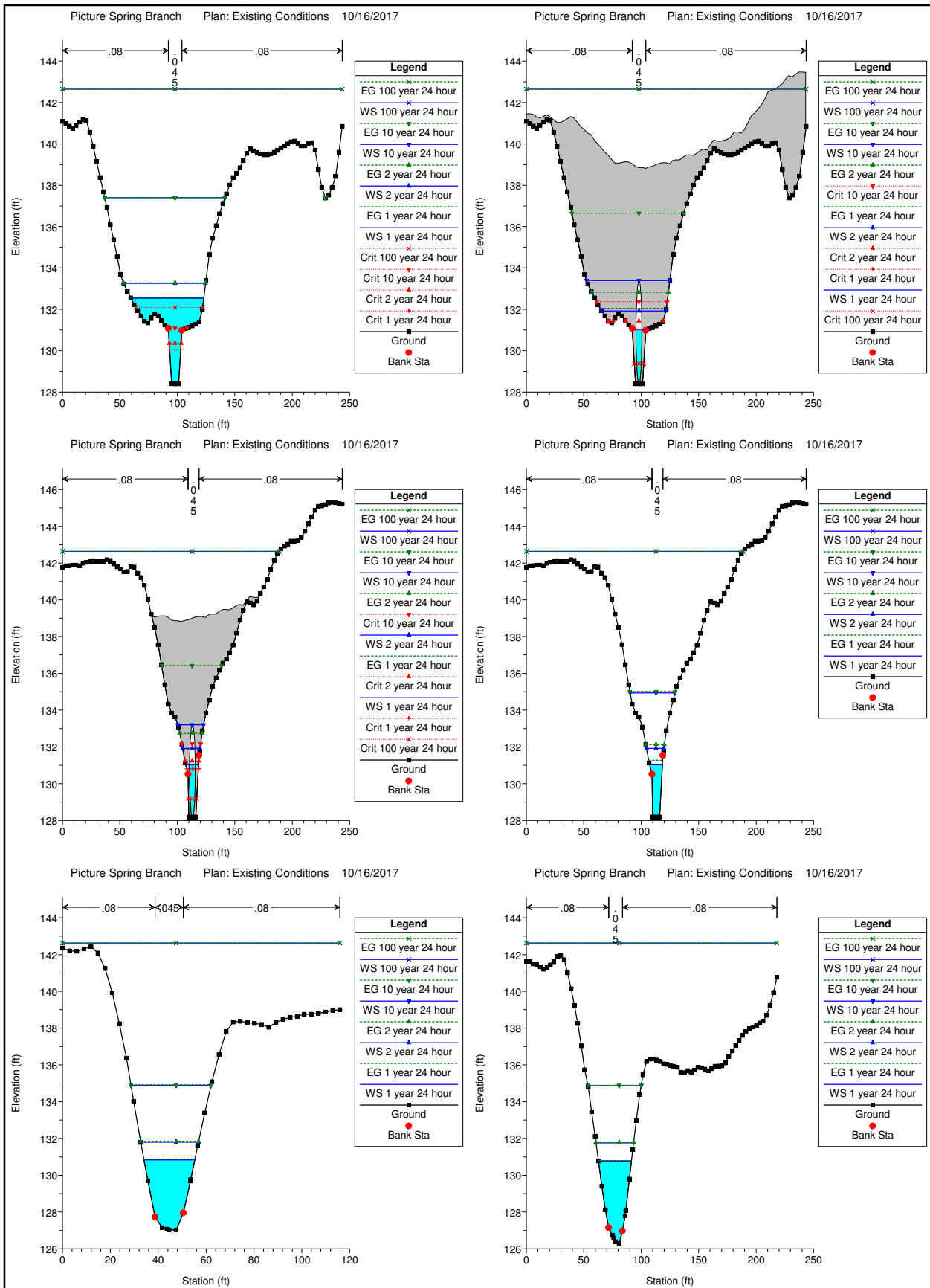
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OF7 1396348.476 517696.101
OF8 1396344.067 517644.432
OF9 1396344 517665.875
P-1 1396040 517605
P-2 1395641.011 517853.195
P-3 1395883.199 518062.83
P-4 1396450.568 516334.646

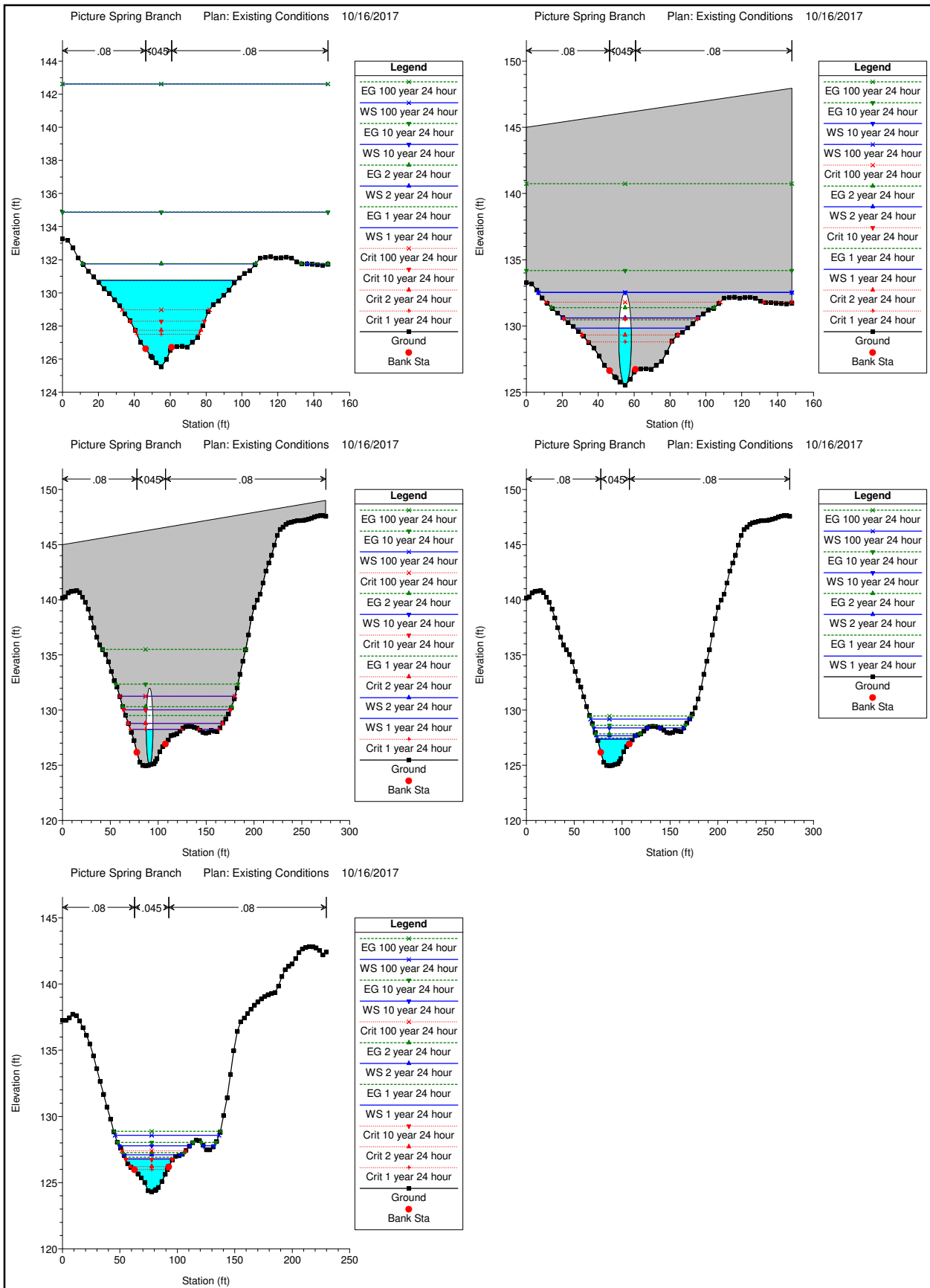
[VERTICES]
; ;Link X-Coord Y-Coord
; ;-----

Appendix B. HEC-RAS Files









HEC-RAS Version 4.1.0 Jan 2010
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
XXXXXXXX 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 XXXXXX XXXX X X X X XXXXX
```

PROJECT DATA

Project Title: PSB_v2
Project File : PSB_v2.prj
Run Date and Time: 10/16/2017 2:13:54 PM

Project in English units

PLAN DATA

Plan Title: Existing Conditions
Plan File : j:\ANMS4\HH_Task\Hydraulics\HECRAS\model\PSB\PSB_v2.p01

Geometry Title: CC GeoRAS
Geometry File : j:\ANMS4\HH_Task\Hydraulics\HECRAS\model\PSB\PSB_v2.g01

Flow Title : SWMM Flows
Flow File : j:\ANMS4\HH_Task\Hydraulics\HECRAS\model\PSB\PSB_v2.f01

Plan Summary Information:

Number of: Cross Sections = 11 Multiple Openings = 0
Culverts = 3 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: SWMM Flows
 Flow File : j:\ANMS4\HH_Task\Hydraulics\HECRAS\model\PSB\PSB_v2.f01

Flow Data (cfs)

River	Reach	RS	1 year 24 hour	2 year 24 hour	10 year 24 hour	100 year 24 hour
PSB	R1	2509	85	113	193	312
PSB	R1	1483	158	211	363	600

Boundary Conditions

River	Reach	Profile	Upstream	Downstream
PSB	R1	1 year 24 hour		Normal S = 0.004
PSB	R1	2 year 24 hour		Normal S = 0.004
PSB	R1	10 year 24 hour		Normal S = 0.004
PSB	R1	100 year 24 hour		Normal S = 0.004

GEOMETRY DATA

Geometry Title: CC GeoRAS
 Geometry File : j:\ANMS4\HH_Task\Hydraulics\HECRAS\model\PSB\PSB_v2.g01

CROSS SECTION

RIVER: PSB
 REACH: R1 RS: 2509

INPUT

Description: No edits needed, LiDAR accurately reflects cross section

Station Elevation Data num= 163

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	143.17	2.99	143.05	5.98	142.87	8.97	142.66	11.96	142.55
14.95	142.57	17.94	142.52	20.92	142.42	23.91	142.22	26.9	142.15
29.89	142.11	32.88	142.03	35.87	141.9	38.86	141.53	41.85	141.19
44.84	140.9	47.83	140.28	50.82	140.14	53.81	139.98	56.79	139.49
59.78	139.43	62.77	139.45	65.76	139.56	68.75	139.56	71.74	139.48
74.73	138.95	77.72	138.43	80.71	138.42	83.7	138.15	86.69	137.97
89.68	137.83	92.66	137.55	95.65	137.37	98.64	137.35	101.63	137.39
104.62	137.24	107.61	136.92	110.6	136.67	113.59	136.62	116.58	136.66

119.57 136.56 122.56 136.56 125.55 136.49 128.53 136.27 131.52 136.17
 134.51 136.44 137.5 136.67 140.49 136.87 143.48 136.7 146.47 136.45
 149.46 136.41 152.45 136.19 155.44 135.97 158.43 135.81 161.42 135.94
 164.41 136.01 167.39 135.98 170.38 135.98 173.37 135.87 176.36 135.91
 179.35 136.08 182.34 136.33 185.33 136.62 188.32 136.74 191.31 136.71
 194.3 136.68 197.29 136.7 200.28 136.67 203.26 136.22 206.25 135.99
 209.24 135.92 212.23 135.95 215.22 136.03 218.21 136.12 221.2 136.09
 224.19 135.98 227.18 135.84 230.17 135.71 233.16 135.57 236.15 135.55
 239.13 135.56 242.12 135.57 245.11 135.58 248.1 135.58 251.09 135.59
 254.08 135.57 257.07 135.57 260.06 135.45 263.05 135.35 266.04 135.38
 269.03 135.47 272.02 135.51 275 135.56 277.99 135.51 280.98 135.37
 283.97 135.29 286.96 135.14 289.95 135 292.94 134.97 295.93 135.08
 298.92 135.25 301.91 135.25 304.9 135.05 307.89 134.81 310.88 134.72
 313.86 134.68 316.85 134.51 318.41 134.38 319.84 134.25 322.83 133.86
 325.82 134.01 328.53 134.46 328.81 134.51 331.8 134.59 334.79 134.5
 337.78 134.51 340.77 134.65 343.76 134.72 346.75 134.8 349.73 134.87
 352.72 134.85 355.71 134.84 358.7 134.84 361.69 134.85 364.68 135.05
 367.67 135.38 370.66 135.68 373.65 135.98 376.64 136.3 379.63 136.69
 382.62 137.2 385.6 137.72 388.59 138.13 391.58 138.48 394.57 138.69
 397.56 138.67 400.55 138.55 403.54 138.51 406.53 138.58 409.52 138.72
 412.51 139.01 415.5 139.51 418.49 139.66 421.48 139.94 424.46 140.55
 427.45 141.29 430.44 141.82 433.43 142.05 436.42 141.88 439.41 141.88
 442.4 141.78 445.39 141.74 448.38 142.03 451.37 142.32 454.36 142.63
 457.35 143.04 460.33 143.43 463.32 143.6 466.31 143.74 469.3 143.86
 472.29 143.97 475.28 143.94 478.27 143.96

Manning's n Values num= 3
 Sta n Val Sta n Val Sta n Val
 0 .08 310.88 .045 346.75 .08

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
 310.88 346.75 58.66 57.98 57.3 .1 .3

CROSS SECTION

RIVER: PSB
 REACH: R1 RS: 2451

INPUT

Description:

Station Elevation Data num= 162
 Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
 0 144.3 2.97 144.5 5.93 144.14 8.9 143.68 11.87 143.31
 14.83 142.71 17.8 142.29 20.77 142.4 23.73 142.78 26.7 143.03
 29.67 142.82 32.63 142.49 35.6 142.33 38.57 142.27 41.53 142.06
 44.5 141.71 47.47 141.31 50.43 140.96 53.4 140.85 56.37 140.74
 59.34 140.51 62.3 140.24 65.27 139.89 68.24 139.7 71.2 139.37
 74.17 138.89 77.14 138.56 80.1 138.27 83.07 137.99 86.04 137.67
 89 137.37 91.97 137.17 94.94 137.19 97.9 137.25 100.87 137.2
 103.84 137.03 106.8 136.85 109.77 136.91 112.74 137.11 115.7 137.26
 118.67 136.94 121.64 136.56 124.6 136.27 127.57 136.43 130.54 136.64
 133.5 136.32 136.47 135.88 139.44 135.64 142.4 135.53 145.37 135.5
 148.34 135.55 151.3 135.71 154.27 135.82 157.24 136.05 160.21 136.23

163.17 136.07 166.14 135.78 169.11 135.55 172.07 135.43 175.04 135.35
 178.01 135.27 180.97 135.15 183.94 135.21 186.91 135.58 189.87 135.85
 192.84 135.95 195.81 136.07 198.77 136.2 201.74 136.69 204.71 137.15
 207.7 137.13 210.69 136.46 213.68 135.84 216.67 135.55 219.67 135.37
 222.66 135.28 225.65 135.14 228.64 134.99 231.63 134.95 234.63 134.97
 237.62 135.02 240.61 135.36 243.6 135.83 246.6 135.94 249.59 135.87
 252.58 135.82 255.57 135.94 258.56 136.03 261.56 135.61 264.55 135.02
 267.54 134.43 270.53 133.84 273.52 133.38 276.52 133.14 279.51 133.1
 282.5 133.09 285.49 133.14 288.48 132.4 291.48 132.4 294.47 132.4
 296.21 132.4 297.46 132.4 300.45 132.4 303.44 132.4 306.21 132.4
 306.44 132.4 309.43 132.4 312.42 132.4 315.41 133.21 318.41 133.19
 321.4 133.32 324.39 133.54 327.38 133.75 330.37 134.01 333.37 134.2
 336.36 134.49 339.35 134.86 342.34 135.06 345.33 135.1 348.33 135.24
 351.32 135.38 354.31 135.74 357.3 136.07 360.29 136.27 363.29 136.42
 366.28 136.6 369.27 136.83 372.26 137.06 375.25 137.32 378.25 137.56
 381.24 137.76 384.23 138.07 387.22 138.54 390.21 139 393.21 139.29
 396.2 139.5 399.19 139.76 402.18 140.04 405.17 140.22 408.17 140.23
 411.16 140.22 414.15 140.42 417.14 140.91 420.14 141.6 423.13 142.07
 426.12 142.3 429.11 142.41 432.1 142.44 435.1 142.38 438.09 142.26
 441.08 142.16 444.07 142.2 447.06 142.24 450.06 142.24 453.05 142.36
 456.04 142.51 459.03 142.65 462.02 142.73 465.02 142.79 468.01 142.86
 471 142.81 473.99 142.78

Manning's n Values num= 3
 Sta n Val Sta n Val Sta n Val
 0 .08 285.49 .045 315.41 .08

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
 285.49 315.41 107.17 107.11 106.83 .1 .3

CULVERT

RIVER: PSB
 REACH: R1 RS: 2401

INPUT
 Description:
 Distance from Upstream XS = 35
 Deck/Roadway Width = 20
 Weir Coefficient = 2.6
 Upstream Deck/Roadway Coordinates
 num= 10

Sta	Hi	Cord	Lo	Cord	Sta	Hi	Cord	Lo	Cord	Sta	Hi	Cord	Lo	Cord
0	146.1	62.18794	142.8	186.5638	140.5363									
246.2018	140.0313	332.9981	139.5225	383.8786	139.9582									
416.8013	140.553	434.7592	141.1444	461.6959	141.9697									
476.6608	142.3155													

Upstream Bridge Cross Section Data
 Station Elevation Data num= 162
 Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
 0 144.3 2.97 144.5 5.93 144.14 8.9 143.68 11.87 143.31
 14.83 142.71 17.8 142.29 20.77 142.4 23.73 142.78 26.7 143.03

29.67 142.82 32.63 142.49 35.6 142.33 38.57 142.27 41.53 142.06
 44.5 141.71 47.47 141.31 50.43 140.96 53.4 140.85 56.37 140.74
 59.34 140.51 62.3 140.24 65.27 139.89 68.24 139.7 71.2 139.37
 74.17 138.89 77.14 138.56 80.1 138.27 83.07 137.99 86.04 137.67
 89 137.37 91.97 137.17 94.94 137.19 97.9 137.25 100.87 137.2
 103.84 137.03 106.8 136.85 109.77 136.91 112.74 137.11 115.7 137.26
 118.67 136.94 121.64 136.56 124.6 136.27 127.57 136.43 130.54 136.64
 133.5 136.32 136.47 135.88 139.44 135.64 142.4 135.53 145.37 135.5
 148.34 135.55 151.3 135.71 154.27 135.82 157.24 136.05 160.21 136.23
 163.17 136.07 166.14 135.78 169.11 135.55 172.07 135.43 175.04 135.35
 178.01 135.27 180.97 135.15 183.94 135.21 186.91 135.58 189.87 135.85
 192.84 135.95 195.81 136.07 198.77 136.2 201.74 136.69 204.71 137.15
 207.7 137.13 210.69 136.46 213.68 135.84 216.67 135.55 219.67 135.37
 222.66 135.28 225.65 135.14 228.64 134.99 231.63 134.95 234.63 134.97
 237.62 135.02 240.61 135.36 243.6 135.83 246.6 135.94 249.59 135.87
 252.58 135.82 255.57 135.94 258.56 136.03 261.56 135.61 264.55 135.02
 267.54 134.43 270.53 133.84 273.52 133.38 276.52 133.14 279.51 133.1
 282.5 133.09 285.49 133.14 288.48 132.4 291.48 132.4 294.47 132.4
 296.21 132.4 297.46 132.4 300.45 132.4 303.44 132.4 306.21 132.4
 306.44 132.4 309.43 132.4 312.42 132.4 315.41 133.21 318.41 133.19
 321.4 133.32 324.39 133.54 327.38 133.75 330.37 134.01 333.37 134.2
 336.36 134.49 339.35 134.86 342.34 135.06 345.33 135.1 348.33 135.24
 351.32 135.38 354.31 135.74 357.3 136.07 360.29 136.27 363.29 136.42
 366.28 136.6 369.27 136.83 372.26 137.06 375.25 137.32 378.25 137.56
 381.24 137.76 384.23 138.07 387.22 138.54 390.21 139 393.21 139.29
 396.2 139.5 399.19 139.76 402.18 140.04 405.17 140.22 408.17 140.23
 411.16 140.22 414.15 140.42 417.14 140.91 420.14 141.6 423.13 142.07
 426.12 142.3 429.11 142.41 432.1 142.44 435.1 142.38 438.09 142.26
 441.08 142.16 444.07 142.2 447.06 142.24 450.06 142.24 453.05 142.36
 456.04 142.51 459.03 142.65 462.02 142.73 465.02 142.79 468.01 142.86
 471 142.81 473.99 142.78

Manning's n Values num= 3
 Sta n Val Sta n Val Sta n Val
 0 .08 285.49 .045 315.41 .08

Bank Sta: Left Right Coeff Contr. Expan.
 285.49 315.41 .1 .3

Downstream Deck/Roadway Coordinates
 num= 10
 Sta Hi Cord Lo Cord Sta Hi Cord Lo Cord Sta Hi Cord Lo Cord
 0 146.1 62.18794 142.8 186.5638140.5363
 246.2018140.0313 332.998139.5225 383.8786139.9582
 416.8013 140.553 434.7592141.1444 461.6959141.9697
 476.6608142.3155

Downstream Bridge Cross Section Data
 Station Elevation Data num= 170
 Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
 0 146.59 2.96 146.42 5.92 146.25 8.88 146.1 11.84 145.87
 14.8 145.52 17.75 145.36 20.71 145.29 23.67 145.23 26.63 145.11
 29.59 144.91 32.55 144.79 35.51 144.61 38.47 144.43 41.43 144.25
 44.39 144.05 47.34 144.04 50.3 144.2 53.26 144.35 56.22 144.42

59.18 144.42 62.14 144.39 65.1 144.52 68.06 144.73 71.02 144.41
73.98 143.91 76.93 142.71 79.89 141.46 82.85 140.72 85.81 140.07
88.77 139.93 91.73 139.56 94.69 139.11 97.65 139.07 100.61 139.15
103.57 139.17 106.53 139.12 109.48 139.09 112.44 139.03 115.4 138.96
118.36 138.92 121.32 138.98 124.28 139.08 127.24 138.84 130.2 138.67
133.16 138.63 136.12 138.44 139.07 138.26 142.03 138.35 144.99 138.12
147.95 137.93 150.91 137.83 153.87 137.68 156.83 137.49 159.79 137.29
162.75 137.13 165.71 136.99 168.66 136.9 171.62 136.88 174.58 137.06
177.54 137.22 180.5 137.2 183.46 137.08 186.42 137.02 189.38 136.99
192.34 136.82 195.3 136.58 198.26 136.32 201.21 136.26 204.17 136.25
207.13 136.31 210.09 136.01 213.05 135.46 216.01 135.16 218.99 134.91
221.98 134.54 224.96 134.54 227.95 134.42 230.93 134.23 233.92 134.14
236.9 134.06 239.89 134.11 242.87 134.08 245.86 134.02 248.84 133.77
251.83 133.38 254.81 132.91 257.8 132.72 260.78 132.57 263.77 132.55
266.75 132.59 269.74 132.77 272.72 132.9 275.71 132.73 278.69 132.42
281.68 132.19 284.66 132.23 287.65 129.9 290.63 129.9 292.45 129.9
293.62 129.9 296.6 129.9 299.59 129.9 302.57 129.9 303.37 129.9
305.56 129.9 308.54 129.9 311.53 129.9 314.51 132.59 317.5 132.5
320.48 132.55 323.47 132.89 326.45 133.44 329.44 133.97 332.42 134.35
335.41 134.62 338.39 135.05 341.38 135.47 344.36 135.65 347.35 135.69
350.33 135.74 353.32 135.83 356.3 135.95 359.29 136.05 362.27 136.28
365.26 136.54 368.24 136.53 371.23 136.77 374.21 137.25 377.2 137.45
380.18 137.65 383.17 137.93 386.15 138.18 389.14 138.44 392.12 138.67
395.11 138.98 398.09 139.3 401.08 139.66 404.06 139.87 407.05 139.87
410.03 139.94 413.02 139.91 416 139.74 418.99 139.38 421.97 138.69
424.96 137.98 427.94 138.07 430.93 139.23 433.91 140.42 436.9 141.26
439.88 141.63 442.87 141.61 445.85 141.64 448.84 141.74 451.82 141.79
454.81 141.85 457.79 141.91 460.78 141.83 463.76 141.86 466.75 142.05
469.73 142.15 472.72 142.11 475.7 142.22 478.69 142.32 481.67 142.32
484.66 142.23 487.64 142.29 490.63 142.35 493.61 142.27 496.6 142.23

Manning's n Values num= 3
Sta n Val Sta n Val Sta n Val
0 .08 284.66 .045 314.51 .08

Bank Sta: Left Right Coeff Contr. Expan.
284.66 314.51 .1 .3

Upstream Embankment side slope = 0 horiz. to 1.0 vertical
Downstream Embankment side slope = 0 horiz. to 1.0 vertical
Maximum allowable submergence for weir flow = .98
Elevation at which weir flow begins =
Energy head used in spillway design =
Spillway height used in design =
Weir crest shape = Broad Crested

Number of Culverts = 1

Culvert Name Shape Rise Span
Culvert #1 Arch 4 20
FHWA Chart # 41- Arch; Corrugated metal
FHWA Scale # 1 - 90 Degree headwall
Solution Criteria = Highest U.S. EG
Culvert Upstrm Dist Length Top n Bottom n Depth Blocked Entrance Loss Coef Exit Loss Coef

34 35 .013 .035 0 .5 1
 Upstream Elevation = 132.39
 Centerline Station = 300.45
 Downstream Elevation = 130.9
 Centerline Station = 300

CROSS SECTION

RIVER: PSB
 REACH: R1 RS: 2344

INPUT
 Description:

Station Elevation Data num= 170

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	146.59	2.96	146.42	5.92	146.25	8.88	146.1	11.84	145.87
14.8	145.52	17.75	145.36	20.71	145.29	23.67	145.23	26.63	145.11
29.59	144.91	32.55	144.79	35.51	144.61	38.47	144.43	41.43	144.25
44.39	144.05	47.34	144.04	50.3	144.2	53.26	144.35	56.22	144.42
59.18	144.42	62.14	144.39	65.1	144.52	68.06	144.73	71.02	144.41
73.98	143.91	76.93	142.71	79.89	141.46	82.85	140.72	85.81	140.07
88.77	139.93	91.73	139.56	94.69	139.11	97.65	139.07	100.61	139.15
103.57	139.17	106.53	139.12	109.48	139.09	112.44	139.03	115.4	138.96
118.36	138.92	121.32	138.98	124.28	139.08	127.24	138.84	130.2	138.67
133.16	138.63	136.12	138.44	139.07	138.26	142.03	138.35	144.99	138.12
147.95	137.93	150.91	137.83	153.87	137.68	156.83	137.49	159.79	137.29
162.75	137.13	165.71	136.99	168.66	136.9	171.62	136.88	174.58	137.06
177.54	137.22	180.5	137.2	183.46	137.08	186.42	137.02	189.38	136.99
192.34	136.82	195.3	136.58	198.26	136.32	201.21	136.26	204.17	136.25
207.13	136.31	210.09	136.01	213.05	135.46	216.01	135.16	218.99	134.91
221.98	134.54	224.96	134.54	227.95	134.42	230.93	134.23	233.92	134.14
236.9	134.06	239.89	134.11	242.87	134.08	245.86	134.02	248.84	133.77
251.83	133.38	254.81	132.91	257.8	132.72	260.78	132.57	263.77	132.55
266.75	132.59	269.74	132.77	272.72	132.9	275.71	132.73	278.69	132.42
281.68	132.19	284.66	132.23	287.65	129.9	290.63	129.9	292.45	129.9
293.62	129.9	296.6	129.9	299.59	129.9	302.57	129.9	303.37	129.9
305.56	129.9	308.54	129.9	311.53	129.9	314.51	132.59	317.5	132.5
320.48	132.55	323.47	132.89	326.45	133.44	329.44	133.97	332.42	134.35
335.41	134.62	338.39	135.05	341.38	135.47	344.36	135.65	347.35	135.69
350.33	135.74	353.32	135.83	356.3	135.95	359.29	136.05	362.27	136.28
365.26	136.54	368.24	136.53	371.23	136.77	374.21	137.25	377.2	137.45
380.18	137.65	383.17	137.93	386.15	138.18	389.14	138.44	392.12	138.67
395.11	138.98	398.09	139.3	401.08	139.66	404.06	139.87	407.05	139.87
410.03	139.94	413.02	139.91	416	139.74	418.99	139.38	421.97	138.69
424.96	137.98	427.94	138.07	430.93	139.23	433.91	140.42	436.9	141.26
439.88	141.63	442.87	141.61	445.85	141.64	448.84	141.74	451.82	141.79
454.81	141.85	457.79	141.91	460.78	141.83	463.76	141.86	466.75	142.05
469.73	142.15	472.72	142.11	475.7	142.22	478.69	142.32	481.67	142.32
484.66	142.23	487.64	142.29	490.63	142.35	493.61	142.27	496.6	142.23

Manning's n Values num= 3

Sta	n	Val	Sta	n	Val	Sta	n	Val
0	.08	284.66	.045	314.51	.08			

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
 284.66 314.51 116.31 119.84 123.58 .1 .3

CROSS SECTION

RIVER: PSB
 REACH: R1 RS: 2224

INPUT

Description:

Station Elevation Data num= 111

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	142.52	2.95	142.57	5.89	142.53	8.84	142.39	11.79	142.27
14.73	142.12	17.68	142.11	20.63	142.17	23.57	142	26.52	141.81
29.47	141.77	32.41	141.61	35.36	141.61	38.31	141.83	41.25	141.83
44.2	141.51	47.15	140.88	50.09	140.49	53.04	140.15	55.99	139.8
58.93	139.92	61.88	139.97	64.83	140.12	67.77	140.21	70.72	140.19
73.67	140.13	76.61	140.08	79.56	140.02	82.51	139.95	85.45	139.89
88.4	139.83	91.35	139.77	94.29	139.72	97.24	139.7	100.19	139.68
103.13	139.64	106.08	139.45	109.03	139.29	111.97	139.21	114.92	139.24
117.87	139.4	120.81	139.45	123.76	139.36	126.72	139.23	129.68	139.16
132.63	139.17	135.59	139.15	138.55	139.01	141.51	138.87	144.46	138.69
147.42	138.63	150.38	138.49	153.34	138.43	156.29	138.29	159.25	138.12
162.21	137.95	165.17	137.8	168.13	137.69	171.08	137.58	174.04	137.4
177	136.87	179.96	136.01	182.91	134.77	185.87	133.28	188.83	132.3
191.79	131.74	194.74	131.45	200.19	129.92	208.91	129.9	210.64	130.88
212.3	131.18	214.29	131.46	215.45	131.55	218.41	132.29	221.36	133.64
224.32	135.32	227.28	137.06	230.24	138.43	233.19	139.43	236.15	140.32
239.11	141.08	242.07	141.57	245.02	141.63	247.98	141.65	250.94	141.72
253.9	141.49	256.86	141.28	259.81	141.21	262.77	141.09	265.73	140.98
268.69	140.91	271.64	140.92	274.6	140.92	277.56	140.72	280.52	140.48
283.47	140.75	286.43	141.14	289.39	141.17	292.35	141.12	295.3	141.11
298.26	141.13	301.22	141.19	304.18	141.27	307.14	141.35	310.09	141.44
313.05	141.55	316.01	141.67	318.97	141.79	321.92	141.84	324.88	141.82
327.84	141.77								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.08	194.74	.045	210.64	.08

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
 194.74 210.64 123.65 115.55 105.42 .1 .3

CROSS SECTION

RIVER: PSB
 REACH: R1 RS: 2109

INPUT

Description:

Station Elevation Data num= 85

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	141.09	2.97	140.99	5.94	140.86	8.91	140.74	11.89	140.88
14.86	141.05	17.83	141.16	20.8	141.13	23.77	140.55	26.74	139.88
29.72	139.15	32.69	138.38	35.66	137.68	38.63	136.92	41.6	136.1
44.57	135.36	47.54	134.56	50.52	133.68	53.49	133.22	56.46	132.88
59.43	132.55	62.4	132.22	65.37	131.95	68.35	131.68	71.32	131.42
74.29	131.35	77.26	131.59	80.23	131.79	83.2	131.68	86.17	131.45
89.15	131.24	92.12	131.08	95.09	128.4	98.06	128.4	98.62	128.4
101.03	128.4	104	130.98	106.98	131.07	109.17	131.11	109.95	131.13
112.92	131.2	115.89	131.28	118.86	131.39	121.83	131.99	124.8	133.39
127.78	134.65	130.75	135.44	133.72	136.04	136.69	136.61	139.66	137.12
142.63	137.58	145.61	138.01	148.58	138.37	151.55	138.57	154.52	138.85
157.49	139.19	160.46	139.54	163.43	139.75	166.41	139.66	169.38	139.57
172.35	139.51	175.32	139.47	178.29	139.47	181.26	139.51	184.24	139.59
187.21	139.69	190.18	139.8	193.15	139.9	196.12	140	199.09	140.1
202.07	140.14	205.04	140.01	208.01	139.91	210.98	139.9	213.95	140.01
216.92	140.06	219.89	139.7	222.87	138.75	225.84	137.88	228.81	137.39
231.78	137.52	234.75	137.88	237.72	138.42	240.7	139.59	243.67	140.85

Manning's n Values num= 3
 Sta n Val Sta n Val Sta n Val
 0 .08 92.12 .045 104 .08

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
 92.12 104 101.21 101.04 100.87 .1 .3

CULVERT

RIVER: PSB
 REACH: R1 RS: 2062

INPUT
 Description:
 Distance from Upstream XS = 36
 Deck/Roadway Width = 16
 Weir Coefficient = 2.6
 Upstream Deck/Roadway Coordinates
 num= 83

Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord
0	141.4459	2.965169	141.4608	5.930337	141.4242			
8.895506	141.3085	11.860671	141.2517	14.825841	141.3335			
17.791011	141.3988	20.756181	141.2961	23.72135	141.154			
26.686521	141.0371	29.651691	141.0292	32.616861	141.1083			
35.582021	141.2123	38.547191	141.3158	41.51236	141.252			
44.477531	141.0298	47.442714	140.8269	50.407871	140.6862			
53.37304	140.513	56.338214	140.4495	59.303381	140.1733			
62.268541	139.9835	65.233711	139.8024	68.198881	139.6077			
71.164051	139.4499	74.12922	139.255	77.094381	139.0813			
80.059561	139.0627	83.024731	139.0964	85.989891	139.1337			
88.955061	139.1273	91.920231	139.0468	94.88541	138.9138			
97.850571	138.8516	100.81571	138.8559	103.78091	138.8181			
106.74611	138.8857	109.71121	138.9192	112.67641	139.0005			
115.64161	139.0594	118.60681	139.0874	121.57191	139.0847			

124.5371139.0331	127.5023139.2056	130.4674139.2305
133.4326 139.222	136.3978139.3682	139.3629139.4651
142.3281139.4729	145.2933139.4499	148.2584139.5501
151.2236139.6798	154.1888139.7462	157.1539 139.697
160.1191139.9731	163.0843140.1781	166.0495140.1347
169.0146140.1221	171.9798140.1724	174.9449140.2143
177.9101140.3452	180.8753140.5563	183.8405140.5862
186.8056 140.513	189.7708 140.674	192.736141.0168
195.7011141.3485	198.6663141.4878	201.6315141.6726
204.5966141.8908	207.5618142.1595	210.527142.5111
213.4921142.5977	216.4573142.6381	219.4225142.7533
222.3876142.8952	225.3528 143.115	228.318143.2987
231.2832143.2383	234.2483143.3584	237.2135143.4731
240.1787143.4668	243.1438143.4613	

Upstream Bridge Cross Section Data

Station Elevation Data num= 85

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	141.09	2.97	140.99	5.94	140.86	8.91	140.74	11.89	140.88
14.86	141.05	17.83	141.16	20.8	141.13	23.77	140.55	26.74	139.88
29.72	139.15	32.69	138.38	35.66	137.68	38.63	136.92	41.6	136.1
44.57	135.36	47.54	134.56	50.52	133.68	53.49	133.22	56.46	132.88
59.43	132.55	62.4	132.22	65.37	131.95	68.35	131.68	71.32	131.42
74.29	131.35	77.26	131.59	80.23	131.79	83.2	131.68	86.17	131.45
89.15	131.24	92.12	131.08	95.09	128.4	98.06	128.4	98.62	128.4
101.03	128.4	104	130.98	106.98	131.07	109.17	131.11	109.95	131.13
112.92	131.2	115.89	131.28	118.86	131.39	121.83	131.99	124.8	133.39
127.78	134.65	130.75	135.44	133.72	136.04	136.69	136.61	139.66	137.12
142.63	137.58	145.61	138.01	148.58	138.37	151.55	138.57	154.52	138.85
157.49	139.19	160.46	139.54	163.43	139.75	166.41	139.66	169.38	139.57
172.35	139.51	175.32	139.47	178.29	139.47	181.26	139.51	184.24	139.59
187.21	139.69	190.18	139.8	193.15	139.9	196.12	140	199.09	140.1
202.07	140.14	205.04	140.01	208.01	139.91	210.98	139.9	213.95	140.01
216.92	140.06	219.89	139.7	222.87	138.75	225.84	137.88	228.81	137.39
231.78	137.52	234.75	137.88	237.72	138.42	240.7	139.59	243.67	140.85

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.08	92.12	.045	104	.08

Bank Sta: Left Right Coeff Contr. Expan.

92.12	104	.1	.3
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Downstream Deck/Roadway Coordinates

num= 83

Sta	Hi	Cord	Lo	Cord	Sta	Hi	Cord	Lo	Cord	Sta	Hi	Cord	Lo	Cord
0	141.4459	2.965169	141.4608	5.930337	141.4242									
8.895506	141.3085	11.860671	141.2517	14.825841	141.3335									
17.791011	141.3988	20.756181	141.2961	23.72135	141.154									
26.686521	141.0371	29.651691	141.0292	32.616861	141.1083									
35.582021	141.2123	38.547191	141.3158	41.51236	141.252									
44.477531	141.0298	47.442714	140.8269	50.407871	140.6862									
53.37304	140.513	56.338214	140.4495	59.303381	140.1733									
62.268541	139.9835	65.233711	139.8024	68.198881	139.6077									

71.16405139.4499	74.12922 139.255	77.09438139.0813
80.05956139.0627	83.02473139.0964	85.98989139.1337
88.95506139.1273	91.92023139.0468	94.8854138.9138
97.85057138.8516	100.8157138.8559	103.7809138.8181
106.7461138.8857	109.7112138.9192	112.6764139.0005
115.6416139.0594	118.6068139.0874	121.5719139.0847
124.5371139.0331	127.5023139.2056	130.4674139.2305
133.4326 139.222	136.3978139.3682	139.3629139.4651
142.3281139.4729	145.2933139.4499	148.2584139.5501
151.2236139.6798	154.1888139.7462	157.1539 139.697
160.1191139.9731	163.0843140.1781	166.0495140.1347
169.0146140.1221	171.9798140.1724	174.9449140.2143
177.9101140.3452	180.8753140.5563	183.8405140.5862
186.8056 140.513	189.7708 140.674	192.736141.0168
195.7011141.3485	198.6663141.4878	201.6315141.6726
204.5966141.8908	207.5618142.1595	210.527142.5111
213.4921142.5977	216.4573142.6381	219.4225142.7533
222.3876142.8952	225.3528 143.115	228.318143.2987
231.2832143.2383	234.2483143.3584	237.2135143.4731
240.1787143.4668	243.1438143.4613	

Downstream Bridge Cross Section Data

Station Elevation Data num= 85

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	141.74	2.97	141.84	5.94	141.86	8.91	141.89	11.89	141.88
14.86	141.84	17.83	141.99	20.8	142.04	23.77	142.07	26.74	142.09
29.72	142.07	32.69	142.07	35.66	142.07	38.63	142.18	41.6	142.1
44.57	141.95	47.54	141.8	50.52	141.68	53.49	141.52	56.46	141.54
59.43	141.81	62.4	141.78	65.37	141.44	68.35	141.21	71.32	140.79
74.29	140.01	77.26	139.2	80.23	138.5	83.2	137.56	86.17	136.48
89.15	135.38	92.12	134.31	95.09	133.84	98.06	133.63	101.03	133.08
104	132.14	106.98	131.13	109.38	130.51	109.95	128.2	112.92	128.2
115.89	128.2	118.86	131.54	119.42	131.79	121.83	132.88	124.8	133.83
127.78	134.55	130.75	135.28	133.72	135.74	136.69	136.16	139.66	136.55
142.63	136.79	145.61	137.12	148.58	137.54	151.55	138.18	154.52	138.88
157.49	139.43	160.46	139.89	163.43	139.83	166.41	139.73	169.38	139.93
172.35	140.35	175.32	140.71	178.29	141.09	181.26	141.65	184.24	142.14
187.21	142.5	190.18	142.77	193.15	142.92	196.12	143.03	199.09	143.19
202.07	143.19	205.04	143.23	208.01	143.39	210.98	143.73	213.95	144.14
216.92	144.51	219.89	144.86	222.87	145.08	225.84	145.11	228.81	145.17
231.78	145.26	234.75	145.3	237.72	145.27	240.7	145.23	243.67	145.2

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.08	109.38	.045	118.86	.08

Bank Sta: Left Right Coeff Contr. Expan.

109.38	118.86	.1	.3
--------	--------	----	----

Upstream Embankment side slope = 0 horiz. to 1.0 vertical
Downstream Embankment side slope = 0 horiz. to 1.0 vertical
Maximum allowable submergence for weir flow = .98
Elevation at which weir flow begins =
Energy head used in spillway design =

Spillway height used in design =
Weir crest shape = Broad Crested

Number of Culverts = 1

Culvert Name Shape Rise Span

Culvert #1 Circular 5

FHWA Chart # 1 - Concrete Pipe Culvert

FHWA Scale # 1 - Square edge entrance with headwall

Solution Criteria = Highest U.S. EG

Culvert	Upstrm	Dist	Length	Top n	Bottom n	Depth	Blocked	Entrance	Loss	Coef	Exit	Loss	Coef
	35	40	.013	.013	0	.5	1						

Upstream Elevation = 128.4

Centerline Station = 98

Downstream Elevation = 128.2

Centerline Station = 113.1

CROSS SECTION

RIVER: PSB

REACH: R1 RS: 2008

INPUT

Description:

Station Elevation Data num= 85

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	141.74	2.97	141.84	5.94	141.86	8.91	141.89	11.89	141.88
14.86	141.84	17.83	141.99	20.8	142.04	23.77	142.07	26.74	142.09
29.72	142.07	32.69	142.07	35.66	142.07	38.63	142.18	41.6	142.1
44.57	141.95	47.54	141.8	50.52	141.68	53.49	141.52	56.46	141.54
59.43	141.81	62.4	141.78	65.37	141.44	68.35	141.21	71.32	140.79
74.29	140.01	77.26	139.2	80.23	138.5	83.2	137.56	86.17	136.48
89.15	135.38	92.12	134.31	95.09	133.84	98.06	133.63	101.03	133.08
104	132.14	106.98	131.13	109.38	130.51	109.95	128.2	112.92	128.2
115.89	128.2	118.86	131.54	119.42	131.79	121.83	132.88	124.8	133.83
127.78	134.55	130.75	135.28	133.72	135.74	136.69	136.16	139.66	136.55
142.63	136.79	145.61	137.12	148.58	137.54	151.55	138.18	154.52	138.88
157.49	139.43	160.46	139.89	163.43	139.83	166.41	139.73	169.38	139.93
172.35	140.35	175.32	140.71	178.29	141.09	181.26	141.65	184.24	142.14
187.21	142.5	190.18	142.77	193.15	142.92	196.12	143.03	199.09	143.19
202.07	143.19	205.04	143.23	208.01	143.39	210.98	143.73	213.95	144.14
216.92	144.51	219.89	144.86	222.87	145.08	225.84	145.11	228.81	145.17
231.78	145.26	234.75	145.3	237.72	145.27	240.7	145.23	243.67	145.2

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.08	109.38	.045	118.86	.08

Bank	Sta: Left	Right	Lengths: Left	Channel	Right	Coeff	Contr.	Expan.
	109.38	118.86	248.81	240.18	231.55	.1	.3	

CROSS SECTION

RIVER: PSB

REACH: R1

RS: 1767

INPUT

Description:

Station Elevation Data num= 42

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	142.34	2.97	142.2	5.94	142.18	8.92	142.3	11.89	142.44
14.86	142.09	17.83	141.25	20.81	139.93	23.78	138.24	26.75	136.36
29.72	134.02	32.7	131.78	35.67	129.7	38.64	127.73	41.61	127.15
43.61	127.07	44.58	127.03	47.56	127.02	50.53	127.96	53.5	129.69
53.62	129.77	56.47	131.59	59.45	133.39	62.42	135.08	65.39	136.56
68.36	137.81	71.34	138.33	74.31	138.37	77.28	138.31	80.25	138.25
83.22	138.2	86.2	138.05	89.17	138.31	92.14	138.48	95.11	138.59
98.09	138.64	101.06	138.76	104.03	138.76	107	138.81	109.98	138.88
112.95	138.97	115.92	139						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.08	38.64	.045	50.53	.08

Bank Sta:	Left	Right	Lengths:	Left Channel	Right	Coeff	Contr.	Expan.
	38.64	50.53	196.34	184.66	172.98	.1	.3	

CROSS SECTION

RIVER: PSB

REACH: R1

RS: 1583

INPUT

Description:

Station Elevation Data num= 76

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	141.63	2.99	141.62	5.98	141.49	8.96	141.48	11.95	141.33
14.94	141.21	17.93	141.29	20.92	141.44	23.9	141.6	26.89	141.91
29.88	141.93	32.87	141.72	35.86	141.01	38.84	140.15	41.83	139.22
44.82	138.26	47.81	137.04	50.8	135.73	53.78	134.81	56.77	133.46
59.76	132.12	62.75	130.78	65.74	129.4	68.72	128.12	71.71	127.15
74.7	126.72	75.92	126.59	77.69	126.39	80.68	126.3	83.66	126.97
85.92	127.8	86.65	128.08	89.64	129.79	92.63	131.39	95.62	132.97
98.6	134.38	101.59	135.46	104.58	136.18	107.57	136.31	110.56	136.32
113.55	136.26	116.53	136.19	119.52	136.05	122.51	136.03	125.5	135.96
128.49	135.93	131.47	135.87	134.46	135.6	137.45	135.58	140.44	135.69
143.43	135.62	146.41	135.72	149.4	135.86	152.39	135.85	155.38	135.77
158.37	135.68	161.35	135.79	164.34	135.93	167.33	135.94	170.32	135.95
173.31	136.1	176.29	136.45	179.28	136.76	182.27	137.07	185.26	137.34
188.25	137.61	191.23	137.81	194.22	137.97	197.21	138.06	200.2	138.14
203.19	138.28	206.17	138.38	209.16	138.7	212.15	139.24	215.14	139.94
218.13	140.76								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val

0 .08 71.71 .045 83.66 .08

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
71.71 83.66 81.78 99.91 118 .1 .3

CROSS SECTION

RIVER: PSB

REACH: R1 RS: 1483

INPUT

Description:

Station Elevation Data num= 54

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	133.26	2.9	133.17	5.79	132.71	8.69	132.11	11.59	131.71
14.48	131.31	17.38	130.96	20.28	130.63	23.17	130.24	26.07	129.96
28.97	129.58	31.86	129.22	34.76	128.73	37.66	128.33	40.55	127.73
43.45	127.01	46.35	126.61	49.24	126.17	49.92	126.08	52.14	125.77
55.04	125.53	57.93	125.97	60.05	126.51	60.83	126.7	63.73	126.75
66.62	126.77	69.52	126.72	72.42	127.01	75.31	127.31	78.22	128.01
81.12	128.86	84.03	129.29	86.93	129.51	89.84	129.85	92.75	130.15
95.65	130.6	98.56	130.9	101.46	131.18	104.37	131.33	107.27	131.69
110.18	132.1	113.08	132.14	115.99	132.18	118.89	132.09	121.8	132.13
124.71	132.15	127.61	132.09	130.52	131.87	133.42	131.75	136.33	131.75
139.23	131.72	142.14	131.69	145.04	131.66	147.95	131.72		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.08	46.35	.045	60.83	.08

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
46.35 60.83 201.54 203.39 205.27 .1 .3

CULVERT

RIVER: PSB

REACH: R1 RS: 1395

INPUT

Description:

Distance from Upstream XS = 7

Deck/Roadway Width = 150

Weir Coefficient = 2.6

Upstream Deck/Roadway Coordinates

num= 2

Sta	Hi	Cord	Lo	Cord	Sta	Hi	Cord	Lo	Cord
0	145		150		148				

Upstream Bridge Cross Section Data

Station Elevation Data num= 54

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	133.26	2.9	133.17	5.79	132.71	8.69	132.11	11.59	131.71

14.48 131.31 17.38 130.96 20.28 130.63 23.17 130.24 26.07 129.96
 28.97 129.58 31.86 129.22 34.76 128.73 37.66 128.33 40.55 127.73
 43.45 127.01 46.35 126.61 49.24 126.17 49.92 126.08 52.14 125.77
 55.04 125.53 57.93 125.97 60.05 126.51 60.83 126.7 63.73 126.75
 66.62 126.77 69.52 126.72 72.42 127.01 75.31 127.31 78.22 128.01
 81.12 128.86 84.03 129.29 86.93 129.51 89.84 129.85 92.75 130.15
 95.65 130.6 98.56 130.9 101.46 131.18 104.37 131.33 107.27 131.69
 110.18 132.1 113.08 132.14 115.99 132.18 118.89 132.09 121.8 132.13
 124.71 132.15 127.61 132.09 130.52 131.87 133.42 131.75 136.33 131.75
 139.23 131.72 142.14 131.69 145.04 131.66 147.95 131.72

Manning's n Values num= 3
 Sta n Val Sta n Val Sta n Val
 0 .08 46.35 .045 60.83 .08

Bank Sta: Left Right Coeff Contr. Expan.
 46.35 60.83 .1 .3

Downstream Deck/Roadway Coordinates
 num= 2
 Sta Hi Cord Lo Cord Sta Hi Cord Lo Cord
 0 145 275 149

Downstream Bridge Cross Section Data
 Station Elevation Data num= 95
 Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
 0 140.14 2.99 140.28 5.98 140.61 8.98 140.75 11.97 140.79
 14.96 140.84 17.95 140.66 20.94 140.23 23.93 139.77 26.93 139.15
 29.92 138.35 32.91 137.47 35.9 136.63 38.89 135.9 41.88 135.49
 44.88 135.04 47.87 134.38 50.86 133.5 53.85 132.67 56.84 132.09
 59.84 131.21 62.83 130.3 65.82 129.54 68.81 128.77 71.8 127.99
 74.79 127.24 77.79 126.16 80.78 125.29 83.77 124.98 86.76 124.95
 87.12 124.96 89.75 124.99 92.75 125.08 95.74 125.13 97.17 125.35
 98.73 125.58 101.72 126.24 104.71 126.68 107.7 126.93 110.7 127.29
 113.69 127.67 116.68 127.75 119.67 127.87 122.66 128.08 125.65 128.35
 128.65 128.49 131.64 128.53 134.63 128.51 137.62 128.44 140.61 128.34
 143.61 128.18 146.6 127.99 149.59 127.92 152.58 127.98 155.57 128.15
 158.56 128.08 161.56 128.06 164.55 128.39 167.54 128.82 170.53 129.2
 173.52 129.65 176.52 130.23 179.51 131.03 182.5 132.02 185.49 133.27
 188.48 134.43 191.47 135.48 194.47 136.82 197.46 138.3 200.45 139.33
 203.44 139.97 206.43 140.5 209.42 141.52 212.42 142.6 215.41 143.34
 218.4 144.04 221.39 144.96 224.38 145.83 227.38 146.37 230.37 146.6
 233.36 146.82 236.35 146.98 239.34 147.03 242.33 147.11 245.33 147.18
 248.32 147.18 251.31 147.19 254.3 147.24 257.29 147.31 260.29 147.4
 263.28 147.49 266.27 147.59 269.26 147.63 272.25 147.62 275.24 147.56

Manning's n Values num= 3
 Sta n Val Sta n Val Sta n Val
 0 .08 77.79 .045 107.7 .08

Bank Sta: Left Right Coeff Contr. Expan.
 77.79 107.7 .1 .3

Upstream Embankment side slope = 0 horiz. to 1.0 vertical

Downstream Embankment side slope = 0 horiz. to 1.0 vertical
 Maximum allowable submergence for weir flow = .98
 Elevation at which weir flow begins =
 Energy head used in spillway design =
 Spillway height used in design =
 Weir crest shape = Broad Crested

Number of Culverts = 1

Culvert Name Shape Rise Span

Culvert #1 Circular 7

FHWA Chart # 2 - Corrugated Metal Pipe Culvert

FHWA Scale # 1 - Headwall

Solution Criteria = Highest U.S. EG

Culvert	Upstrm Dist	Length	Top n	Bottom n	Depth Blocked	Entrance Loss Coef	Exit Loss Coef
1	5	175	.024	.024	0	.5	1

Upstream Elevation = 125.53

Centerline Station = 55

Downstream Elevation = 125

Centerline Station = 91

CROSS SECTION

RIVER: PSB

REACH: R1 RS: 1279

INPUT

Description:

Station Elevation Data num= 95

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	140.14	2.99	140.28	5.98	140.61	8.98	140.75	11.97	140.79
14.96	140.84	17.95	140.66	20.94	140.23	23.93	139.77	26.93	139.15
29.92	138.35	32.91	137.47	35.9	136.63	38.89	135.9	41.88	135.49
44.88	135.04	47.87	134.38	50.86	133.5	53.85	132.67	56.84	132.09
59.84	131.21	62.83	130.3	65.82	129.54	68.81	128.77	71.8	127.99
74.79	127.24	77.79	126.16	80.78	125.29	83.77	124.98	86.76	124.95
87.12	124.96	89.75	124.99	92.75	125.08	95.74	125.13	97.17	125.35
98.73	125.58	101.72	126.24	104.71	126.68	107.7	126.93	110.7	127.29
113.69	127.67	116.68	127.75	119.67	127.87	122.66	128.08	125.65	128.35
128.65	128.49	131.64	128.53	134.63	128.51	137.62	128.44	140.61	128.34
143.61	128.18	146.6	127.99	149.59	127.92	152.58	127.98	155.57	128.15
158.56	128.08	161.56	128.06	164.55	128.39	167.54	128.82	170.53	129.2
173.52	129.65	176.52	130.23	179.51	131.03	182.5	132.02	185.49	133.27
188.48	134.43	191.47	135.48	194.47	136.82	197.46	138.3	200.45	139.33
203.44	139.97	206.43	140.5	209.42	141.52	212.42	142.6	215.41	143.34
218.4	144.04	221.39	144.96	224.38	145.83	227.38	146.37	230.37	146.6
233.36	146.82	236.35	146.98	239.34	147.03	242.33	147.11	245.33	147.18
248.32	147.18	251.31	147.19	254.3	147.24	257.29	147.31	260.29	147.4
263.28	147.49	266.27	147.59	269.26	147.63	272.25	147.62	275.24	147.56

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.08	77.79	.045	107.7	.08

Bank Sta:	Left	Right	Lengths:	Left Channel	Right	Coeff	Contr.	Expan.
	77.79	107.7		153.15	154.79	156.43	.1	.3

CROSS SECTION

RIVER: PSB

REACH: R1 RS: 1125

INPUT

Description:

Station Elevation Data num= 80

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	137.25	2.98	137.26	5.97	137.46	8.95	137.72	11.94	137.62
14.92	137.22	17.9	136.7	20.89	136.12	23.87	135.47	26.86	134.58
29.84	133.6	32.82	132.63	35.81	131.67	38.79	130.71	41.77	129.79
44.76	128.83	47.74	128.06	50.73	127.61	53.71	127.04	56.69	126.42
59.68	126.16	62.66	125.97	65.65	125.66	68.63	125.36	71.61	124.99
74.6	124.38	77.58	124.31	80.57	124.43	81.28	124.48	83.55	124.64
86.53	125.08	89.52	125.62	91.44	125.99	92.5	126.19	95.48	126.71
98.47	126.98	101.45	127.02	104.44	127.13	107.42	127.42	110.4	127.74
113.39	128.01	116.37	128.2	119.36	128.17	122.34	127.83	125.32	127.47
128.31	127.48	131.29	127.69	134.28	128.11	137.26	128.8	140.24	130.07
143.23	131.4	146.21	133.17	149.2	134.97	152.18	136.42	155.16	137.15
158.15	137.44	161.13	137.78	164.11	138.1	167.1	138.4	170.08	138.64
173.07	138.88	176.05	139.06	179.03	139.19	182.02	139.28	185	139.35
187.99	139.84	190.97	140.56	193.95	141.09	196.94	141.33	199.92	141.51
202.91	141.92	205.89	142.38	208.87	142.65	211.86	142.76	214.84	142.82
217.83	142.81	220.81	142.73	223.79	142.53	226.78	142.2	229.76	142.41

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.08	62.66	.045	92.5	.08

Bank Sta:	Left	Right	Lengths:	Left Channel	Right	Coeff	Contr.	Expan.
	62.66	92.5		1091.46	1124.6	1165.97	.1	.3

SUMMARY OF MANNING'S N VALUES

River:PSB

Reach	River Sta.	n1	n2	n3
R1	2509	.08	.045	.08
R1	2451	.08	.045	.08
R1	2401	Culvert		
R1	2344	.08	.045	.08
R1	2224	.08	.045	.08
R1	2109	.08	.045	.08
R1	2062	Culvert		
R1	2008	.08	.045	.08

R1	1767	.08	.045	.08
R1	1583	.08	.045	.08
R1	1483	.08	.045	.08
R1	1395	Culvert		
R1	1279	.08	.045	.08
R1	1125	.08	.045	.08

SUMMARY OF REACH LENGTHS

River: PSB

Reach	River Sta.	Left	Channel	Right
R1	2509	58.66	57.98	57.3
R1	2451	107.17	107.11	106.83
R1	2401	Culvert		
R1	2344	116.31	119.84	123.58
R1	2224	123.65	115.55	105.42
R1	2109	101.21	101.04	100.87
R1	2062	Culvert		
R1	2008	248.81	240.18	231.55
R1	1767	196.34	184.66	172.98
R1	1583	81.78	99.91	118
R1	1483	201.54	203.39	205.27
R1	1395	Culvert		
R1	1279	153.15	154.79	156.43
R1	1125	1091.46	1124.6	1165.97

SUMMARY OF CONTRACTION AND EXPANSION COEFFICIENTS

River: PSB

Reach	River Sta.	Contr.	Expan.
R1	2509	.1	.3
R1	2451	.1	.3
R1	2401	Culvert	
R1	2344	.1	.3
R1	2224	.1	.3
R1	2109	.1	.3
R1	2062	Culvert	
R1	2008	.1	.3
R1	1767	.1	.3
R1	1583	.1	.3
R1	1483	.1	.3
R1	1395	Culvert	
R1	1279	.1	.3
R1	1125	.1	.3

HEC-RAS Version 4.1.0 Jan 2010
 U.S. Army Corps of Engineers
 Hydrologic Engineering Center
 609 Second Street
 Davis, California

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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
XXXXXXXX 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: Picture Spring Branch
 Project File : PSB_v2.prj
 Run Date and Time: 10/31/2017 1:20:08 PM

Project in English units

Profile Output Table - Standard Table 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl
Flow Area	Top Width	Froude # Chl	(ft)	(ft)	(ft)	(ft/ft)	(sq ft)	(ft)	
		(cfs)							
R1	2509	1 year 24 hour	85.00000	133.86	135.03	135.03	135.26	0.031408	3.99
24.46	64.27	0.94							
R1	2509	2 year 24 hour	113.00000	133.86	135.14	135.14	135.40	0.027966	4.26
32.24	72.02	0.91							
R1	2509	10 year 24 hour	193.00000	133.86	137.69		137.69	0.000091	0.69
560.42	294.21	0.07							
R1	2509	100 year 24 hour	312.00000	133.86	142.65		142.65	0.000004	0.27
2372.86	445.30	0.02							
R1	2451	1 year 24 hour	85.00000	132.40	133.79	133.11	133.84	0.002523	1.98
52.20	56.92	0.30							
R1	2451	2 year 24 hour	113.00000	132.40	134.09	133.26	134.15	0.002019	2.04
70.56	62.47	0.28							
R1	2451	10 year 24 hour	193.00000	132.40	137.68	133.58	137.69	0.000038	0.61
687.56	294.20	0.05							
R1	2451	100 year 24 hour	312.00000	132.40	142.65	133.94	142.65	0.000004	0.29
2409.58	435.34	0.02							
R1	2401	Culvert							
R1	2344	1 year 24 hour	85.00000	129.90	132.72		132.74	0.000339	1.10

82.62	57.47	0.12							
R1	2344	2 year 24 hour	113.00000	129.90	133.39		133.40	0.000248	1.09
128.51	74.38	0.11							
R1	2344	10 year 24 hour	193.00000	129.90	137.41		137.42	0.000022	0.56
670.13	218.69	0.04							
R1	2344	100 year 24 hour	312.00000	129.90	142.65		142.65	0.000003	0.30
2363.15	419.52	0.02							
R1	2224	1 year 24 hour	85.00000	129.90	132.61		132.67	0.001235	2.03
51.37	31.21	0.23							
R1	2224	2 year 24 hour	113.00000	129.90	133.30		133.35	0.000839	1.98
74.07	34.78	0.20							
R1	2224	10 year 24 hour	193.00000	129.90	137.39		137.41	0.000098	1.19
251.13	53.93	0.08							
R1	2224	100 year 24 hour	312.00000	129.90	142.64		142.64	0.000019	0.76
1144.77	327.84	0.04							
R1	2109	1 year 24 hour	85.00000	128.40	132.55	130.05	132.57	0.000492	1.52
93.92	63.55	0.14							
R1	2109	2 year 24 hour	113.00000	128.40	133.26	130.36	133.28	0.000334	1.42
142.24	71.31	0.12							
R1	2109	10 year 24 hour	193.00000	128.40	137.40	131.10	137.40	0.000037	0.74
500.73	104.85	0.05							
R1	2109	100 year 24 hour	312.00000	128.40	142.64	132.09	142.64	0.000009	0.50
1484.72	243.67	0.02							
R1	2062		Culvert						
R1	2008	1 year 24 hour	85.00000	128.20	131.03		131.27	0.006823	3.98
21.82	11.03	0.46							
R1	2008	2 year 24 hour	113.00000	128.20	131.92		132.13	0.004062	3.69
33.43	15.08	0.37							
R1	2008	10 year 24 hour	193.00000	128.20	134.93		135.02	0.000825	2.60
111.32	38.93	0.19							
R1	2008	100 year 24 hour	312.00000	128.20	142.63		142.64	0.000041	1.00
771.48	188.65	0.05							
R1	1767	1 year 24 hour	85.00000	127.02	130.83		130.88	0.000572	1.83
56.68	21.24	0.17							
R1	1767	2 year 24 hour	113.00000	127.02	131.80		131.85	0.000425	1.85
78.63	24.15	0.15							
R1	1767	10 year 24 hour	193.00000	127.02	134.88		134.92	0.000179	1.69
167.33	33.45	0.11							
R1	1767	100 year 24 hour	312.00000	127.02	142.62		142.63	0.000023	0.98
714.46	115.92	0.04							
R1	1583	1 year 24 hour	85.00000	126.30	130.78		130.80	0.000272	1.40
83.38	28.74	0.12							
R1	1583	2 year 24 hour	113.00000	126.30	131.76		131.79	0.000216	1.44
113.60	32.78	0.11							
R1	1583	10 year 24 hour	193.00000	126.30	134.87		134.89	0.000101	1.34
235.88	46.38	0.08							
R1	1583	100 year 24 hour	312.00000	126.30	142.62		142.63	0.000008	0.57
1415.57	218.13	0.03							

R1	1483	1 year 24 hour	158.00000	125.53	130.76	127.50	130.78	0.000220	1.37
207.00	78.07	0.11							
R1	1483	2 year 24 hour	211.00000	125.53	131.75	127.74	131.77	0.000173	1.38
294.23	107.90	0.10							
R1	1483	10 year 24 hour	363.00000	125.53	134.87	128.29	134.88	0.000056	1.05
738.34	147.95	0.06							
R1	1483	100 year 24 hour	600.00000	125.53	142.62	128.98	142.63	0.000009	0.64
1885.04	147.95	0.03							
R1	1395	Culvert							
R1	1279	1 year 24 hour	158.00000	124.95	127.37		127.49	0.003433	2.87
57.32	37.04	0.37							
R1	1279	2 year 24 hour	211.00000	124.95	127.69		127.84	0.003527	3.23
69.66	41.25	0.39							
R1	1279	10 year 24 hour	363.00000	124.95	128.39		128.62	0.003712	4.01
111.89	81.56	0.42							
R1	1279	100 year 24 hour	600.00000	124.95	129.18		129.47	0.003582	4.64
189.13	103.19	0.43							
R1	1125	1 year 24 hour	158.00000	124.31	126.79	125.99	126.92	0.004001	2.99
56.61	41.38	0.40							
R1	1125	2 year 24 hour	211.00000	124.31	127.10	126.21	127.26	0.004000	3.34
70.50	50.08	0.41							
R1	1125	10 year 24 hour	363.00000	124.31	127.79	126.73	128.03	0.004002	4.06
111.46	70.78	0.43							
R1	1125	100 year 24 hour	600.00000	124.31	128.57	127.41	128.88	0.004001	4.81
176.64	90.54	0.45							