



# LAKE AVENUE CULVERT REPLACEMENT

CITY OF BRISTOL



## HYDROLOGY AND HYDRAULICS ANALYSIS REPORT

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<b>1</b>	<b>EXECUTIVE SUMMARY .....</b>	<b>1</b>
<b>2</b>	<b>PROJECT INFORMATION .....</b>	<b>2</b>
<b>2.1</b>	<b>Existing Structure .....</b>	<b>3</b>
<b>2.2</b>	<b>Proposed Structure .....</b>	<b>3</b>
<b>3</b>	<b>HYDROLOGY .....</b>	<b>3</b>
<b>3.1</b>	<b>Hydrology Context .....</b>	<b>3</b>
<b>3.2</b>	<b>Hydrologic Analysis Methodologies .....</b>	<b>4</b>
3.2.1	HydroCAD Computer Model Analysis .....	4
3.2.2	Average Daily Flow and Average Spring Flow .....	5
<b>4</b>	<b>HYDRAULICS .....</b>	<b>6</b>
<b>4.1</b>	<b>Hydraulic Design Criteria .....</b>	<b>6</b>
<b>4.2</b>	<b>Hydraulic Analysis Methodology .....</b>	<b>6</b>
<b>4.3</b>	<b>Hydraulic Analysis Conclusion .....</b>	<b>6</b>
<b>4.4</b>	<b>Hydraulic Performance for Temporary Conditions .....</b>	<b>11</b>



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## **TABLES**

TABLE 1: HYDROCAD SUMMARY OF DISCHARGES.....	5
TABLE 2: HEC-RAS PLAN SUMMARY .....	6
TABLE 3: COMPARISON TABLE: EXISTING VS. PROPOSED AT 1-YEAR WATER SURFACE ELEVATION.....	7
TABLE 4: COMPARISON TABLE: EXISTING VS. PROPOSED AT 2-YEAR WATER SURFACE ELEVATION .....	7
TABLE 5: COMPARISON TABLE: EXISTING VS. PROPOSED AT 5-YEAR WATER SURFACE ELEVATION.....	8
TABLE 6: COMPARISON TABLE: EXISTING VS. PROPOSED AT 10-YEAR WATER SURFACE ELEVATION.....	8
TABLE 7: COMPARISON TABLE: EXISTING VS. PROPOSED AT 25-YEAR WATER SURFACE ELEVATION .....	9
TABLE 8: COMPARISON TABLE: EXISTING VS. PROPOSED AT 50-YEAR WATER SURFACE ELEVATION.....	9
TABLE 9: COMPARISON TABLE: EXISTING VS. PROPOSED AT 100-YEAR WATER SURFACE ELEVATION .....	10
TABLE 10: TEMPORARY STAGE 1 MODEL: 1-YR, 2-YR, 3-YR, AVG DAILY FLOW, AVG SPRING FLOW.....	12
TABLE 11: TEMPORARY STAGE 2 MODEL: 1-YR, 2-YR, 3-YR, AVG DAILY FLOW, AVG SPRING FLOW.....	13

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## **FIGURES**

FIGURE 1 - LOCATION PLAN .....	2
FIGURE 2 - HEC-RAS PROFILE FOR 50-YEAR AND 5-YEAR .....	11

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## **APPENDICES**

<b>A</b> WATERSHED MAP	
<b>B</b> FIRMETTE AT PROJECT SITE	
<b>C</b> STREAMSTATS REPORT (FLOWS NOT APPLICABLE AT SITE)	
<b>D</b> HYDROLOGIC SOIL GROUP MAP	
<b>E</b> NOAA ATLAS 14 DEPTHS AND INTENSITIES	
<b>F</b> HYDROCAD REPORT	
<b>G</b> HEC-RAS OUTPUT	
<b>H</b> CROSS SECTION SITE PLAN	

# 1 EXECUTIVE SUMMARY

WSP USA Inc. (WSP) was engaged by the City of Bristol (City) to provide engineering services for the complete replacement of the Lake Avenue Culvert which carries Lake Avenue over the Cussgutter Brook.

This report documents the hydrologic and hydraulic design analysis for the replacement of the Lake Avenue culvert over Cussgutter Brook in the City of Bristol, Connecticut in Hartford County. The culvert, originally constructed circa 1920 with a reconstruction circa 1950, is scheduled to be replaced under the Lake Avenue Culvert Replacement (“the Project”).

Since the culvert drainage area is less than 1 square mile, the Connecticut Department of Transportation Drainage Manual (CTDOT Drainage Manual), Chapter 8, Table 8-4, classifies this crossing as a Small Structure. The design frequency for a Small Structure is 50-year with a check frequency of 100-year.

Design Discharges for Cussgutter Brook were developed using the HydroCAD computer program utilizing TR-55 Urban Hydrology for Small Watersheds methodology as described in Chapter 6.14 of the CTDOT Drainage Manual. The peak flows were calculated for the 0.57± square mile watershed at the culvert.

Per the CTDOT Drainage Manual, the hydraulic design requirement for a Small Structure culvert is to provide a minimum freeboard of 1 foot at the design storm. Freeboard is defined as the vertical distance between the design water surface and the upstream control such as the low point of the roadway edge, sill of a building, or other controlling element.

During the 50-year flood event, there is 0.00 foot increase in water surface elevation for the comparisons between the existing and proposed models for all of the cross sections upstream of the culvert, however there is a 1.34 feet increase immediately downstream of the culvert which decreases to 0.00 feet 25 feet downstream of the culvert. The cross section immediately downstream of the undersized existing culvert experiences critical flow velocities and the more appropriately sized proposed culvert does not force the downstream section into critical flow velocity, therefore, there is an increase in water surface elevation immediately downstream of the culvert as the stream’s velocity is sub-critical, but there are no proposed detrimental effects to the surrounding properties by this localized increase in water surface elevation.

The existing culvert, with a 10.5 feet wide x 3.25 feet tall hydraulic opening, does not meet the hydraulic design requirements for a small structure. HEC-RAS calculations indicate that the water surface elevation overtops low point in the grassed shoulder and flows into the road at the existing culvert during a storm event less than a 25-year flood event.

It is proposed to replace the existing culvert with a precast box culvert that will provide a 15 feet wide x 3.5 feet tall hydraulic opening (culvert is 15 feet x 4.5 feet with 1 foot of natural stream bed material placed at the bottom of the culvert). The proposed culvert will improve the hydraulic capacity and will allow for the continuous uninterrupted flow of the 50-year flood event.

The existing hydraulic model indicates that the low point in the grassed shoulder is overtopped which allows flow to flow onto the roadway with approximate 0.01 feet of water during the 50-year storm. During the 50-year flood event the proposed culvert’s approach water surface elevation is 234.58 which will give more than 1 foot for freeboard to the top of the embankment adjacent to the upstream side of the culvert at elevation 235.67. Therefore, no design exception, as discussed in ConnDOT Drainage Manual Section 9.3.9, will be required since this CTDOT hydraulic design criteria can be met. All elevations in this report are NAVD88.

## 2 PROJECT INFORMATION

Lake Avenue runs from Middle Street (Route 229) southerly to Welch Road where Lake Avenue then transitions into Mt Vernon Road. The Project is located immediately north of Lake Compounce Amusement Park; approximately ½ mile south of the intersection with Glenn Street. In the vicinity of the project, the eastern street line is the municipal boundary with the street lying within the City of Bristol on the west and the Town of Southington located to the east. The total project length is 291 feet. It is noted that access will need to be maintained for one residential driveway within these limits throughout construction. The travel way will remain open as the proposed culvert will be constructed with a staged construction approach.

Bridge No. 017005 shall be replaced in its entirety with a precast concrete box culvert. This includes removing the existing 73 feet long substructure and superstructure which is composed of a combination of masonry abutments, a reinforced concrete slab, and steel rail top.

Lake Avenue is the only roadway within the project limits. Lake Avenue is generally a north-south roadway and is classified as an urban minor arterial. For the length of the project, Lake Avenue will be constructed to a 30-foot-wide roadway with one 11-foot lane and 4-foot shoulder in each direction. The width slightly varies at the project limits to tie into the existing roadway geometry. Additionally, bituminous concrete curbing will be installed on either side of the roadway.

The structure is owned by the City. At the Project, the Cussgutter Brook flows generally west to east. This report contains the hydrologic analysis for the flows of the Cussgutter Brook as well as the hydraulic analysis performed for the replacement of the existing culvert at the Cussgutter Brook. A location map of the project site is presented in Figure 1.

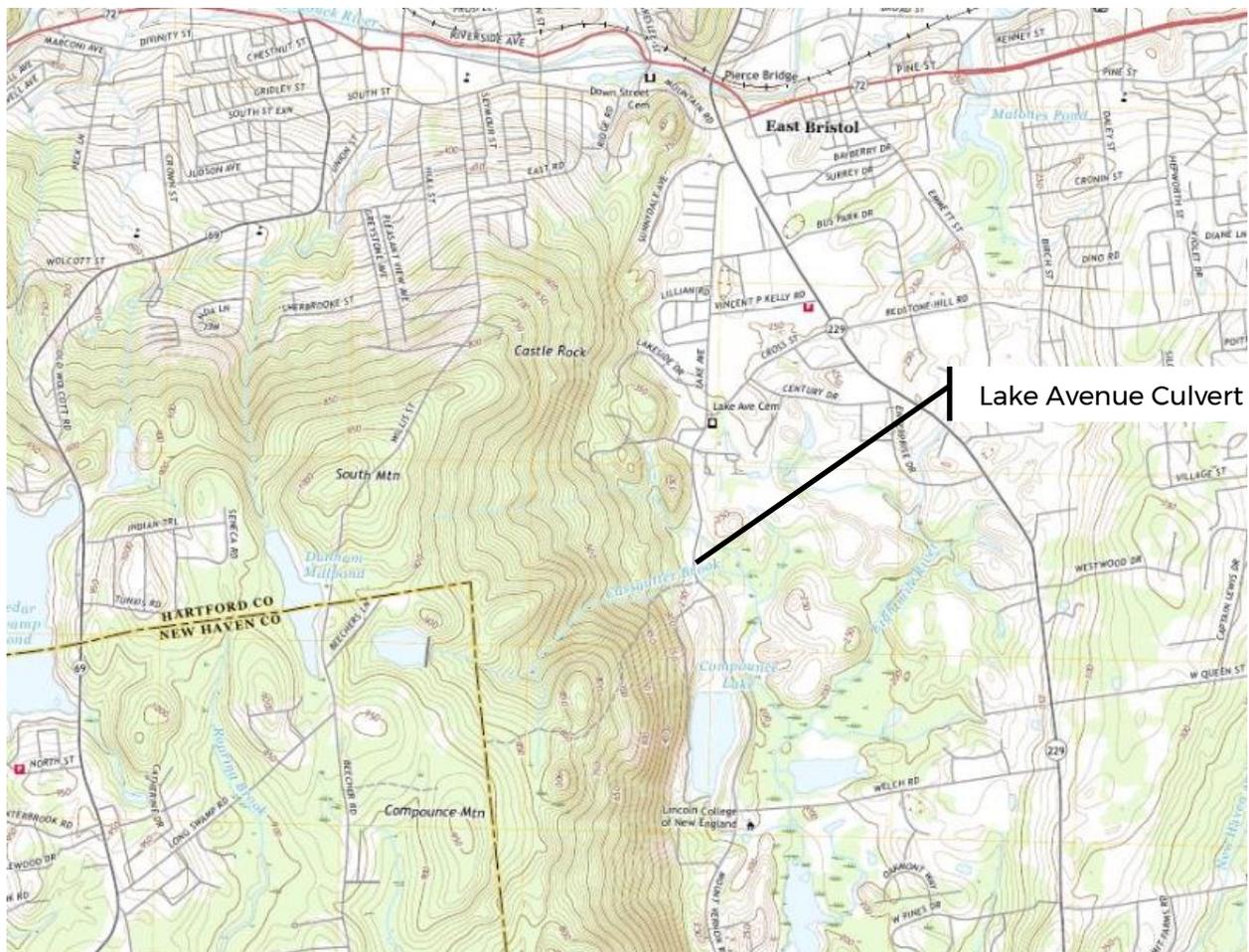


Figure 1 - Location Plan

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## 2.1 EXISTING STRUCTURE

The existing structure is 10.5 feet wide x 3.25 feet tall culvert structure that is approximately 73 feet in length. The culvert carries two lanes of Lake Avenue above with no sidewalk over the culvert. It is estimated that the structure was originally constructed circa 1920 with a reconstruction circa 1950. The inlet and outlet are both constructed of stone masonry. There is no flood of record or any associated high-water marks.

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## 2.2 PROPOSED STRUCTURE

It is proposed to replace the Lake Avenue Culvert with a precast reinforced concrete box culvert with a 5.5 feet tall by 15 feet wide opening. The structure bottom will be buried 2 feet below the stream bed with natural stream bed material placed on the floor of the structure, resulting in a hydraulic opening that is 3.5 feet tall. The culvert is proposed to be 48.5 feet long with cast-in-place reinforced concrete wingwalls on spread footings, approximately 25 feet shorter than the existing culvert.

The precast concrete box culvert provides an accelerated construction phase and simplified construction methods. The culvert ends and wingwalls will have a 42" vertical face parapet mounted on top. The east end of the culvert is placed outside of the clear zone to eliminate safety concerns and the need for guiderail. The west end of the culvert is placed a minimum 4'-3" behind the proposed guiderail for sufficient guiderail deflection.

The proposed road is at a 1.06% longitudinal grade draining towards the north, however, for purposes of the HEC-RAS model an overtopping sag is created in the grassed shoulder adjacent to the road where the overtopping occurs.

During construction temporary water handling will be managed with water handling cofferdams and temporary bypass pipes which will be removed after the proposed culvert is fully installed and operational.

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# 3 HYDROLOGY

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## 3.1 HYDROLOGY CONTEXT

The watershed area for Cussgutter Brook at the Lake Avenue culvert is 0.57± square miles (367± acres). The watershed boundary was delineated utilizing the 1-foot contour lines provided by the 2016 Connecticut LiDAR with consideration of the City of Bristol stormwater drainage network GIS information and field observations. Aerial images of the watershed were also obtained from the 2016 Connecticut LiDAR. Land cover was determined using municipal zoning maps of the City of Bristol along with the aerial imagery. Soil data was obtained from the Natural Resources Conservation Service (NRCS) Web Soil Survey.

The project is in DEEP Basin Number 5201-01-1; Major: South Central Coast; Regional: Quinnipiac; Subregional: Eightmile River. The site is not located within an Aquifer Protection Area.

Cussgutter Brook starts at the west at the Bristol Fish & Game Club Pond and then runs easterly through woods to the Lake Avenue culvert. The topography of the watershed consists mostly of wooded area and bedrock outcroppings with some pockets of pasture and residential land uses. Slopes are variable with steeper areas toward the high points of the watershed.

The Watershed Map is provided in Appendix A.

Since the culvert drainage area is less than 1 square mile, the CTDOT Drainage Manual, Chapter 8, Table 8-4, classifies this crossing as a Small Structure. The design frequency for a Small Structure is 50-year with a check frequency of 100-year.

The CTDOT Drainage Manual, Section 6.15 Hydrology for Temporary Facilities and Appendix F Design Procedure: Hydrology for Temporary Facilities indicate that for the temporary staged construction which will be in place for less than a year the temporary analysis frequency is 2-year.

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## 3.2 HYDROLOGIC ANALYSIS METHODOLOGIES

The CTDOT Drainage Manual Chapter 6 discusses the various hydrologic methodologies available for analysis: Rational method, Stream Gage Data, USGS Regression Equations, Computer Models for Hydrograph Generation, FEMA Flood Insurance Study Discharge Rates, and SCEL Stream Channel Encroachment Discharge Rates.

1. Rational Method: This methodology is applicable for sites less than 200 acres (0.3 square miles) and is therefore not applicable for the Project.
2. Stream Gage Data: There is no stream gage information available for Cussgutter Brook.
3. USGS Regression Equations: This methodology is applicable for sites greater than 1 square mile and is therefore not applicable for the Project.
4. Computer Models for Hydrograph Generation: This methodology utilizing HydroCAD will be discussed further below.
5. FEMA Flood Insurance Study Discharge Rates: Cussgutter Brook is located within Federal Emergency Management Agency (FEMA) Zone X, Area of Minimal Flood Hazard, with no floodplain or floodway. Therefore, there are no FEMA designated flows in the Flood Insurance Study (FIS). The FIRMette of the site indicating the Project location within Zone X is provided in Appendix B.
6. SCEL Stream Channel Encroachment Discharge Rates: There are no SCEL Stream Channel Encroachment Discharge Rates available.
7. USGS StreamStats: The USGS StreamStats application for Connecticut utilizes the multiple linear-regression equations from that were developed to estimate the peak discharges of flood events for non-urban, unregulated stream sites with drainage areas ranging from about 1.7 to 715 square miles. Because the project site is less than 1.7 square miles this methodology is not applicable for the Project, however, the report was still run to confirm the watershed delineation. The StreamStats Report of the site indicating the watershed delineation is provided in Appendix C.

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### 3.2.1 HYDROCAD COMPUTER MODEL ANALYSIS

The watershed was analyzed using HydroCAD software which utilizes the Natural Resources Conservation Service (NRCS) TR-55 Urban Hydrology for Small Watersheds.

The culvert watershed was modeled utilizing two different methodologies and compared.

The first methodology divided the full watershed into two sub-watersheds, one for the portion of the watershed that drains into the Bristol Fish & Game Club Pond and then the portion of the watershed downstream of the pond. Pond geometry was assumed based on available topography and aerial mapping however information on the pond outlet control structure was not available. From aerial imagery, it appears that there is a pond overflow berm which is likely used only during high storm events as well as a horizontal orifice/standpipe type outlet which discharges during smaller storm events, as well as to keep the pond at a level state. Assumptions were made for the pond outlet with the utilization of a pond overflow berm, and a 24"x24" horizontal grate, which was determined to be a conservative assumption. This modeling approach with assumptions reduces the baseflow within Cussgutter Brook as a function of the outlet control structure of the 12-acre pond.

The second methodology utilized one large watershed without considering the pond's effects of its storage volume and outlet flow control and instead treats the 12-acre pond as impervious area.

For each of the sub-watersheds a composite runoff curve number was generated based on TR-55 guidance utilizing the NRCS hydrologic soil groups (HSG) and the land cover type. The hydrologic soil group map is provided in Appendix D. A portion of the soils within the watershed have a HSG of B/D. A conservative approach was taken in modeling these soils as HSG D. Reviewing the soils descriptions and aerial imagery there isn't substantial evidence that would support a HSG B model assumption.

In addition, the hydrologically longest time of concentration path was calculated for each of the sub-watersheds. Time of concentrations were generated consistent with TR-55 guidance for the sum of the sheet-flow travel time, shallow

concentrated flow travel time, and channel flow travel time, as applicable. The maximum length for the sheet-flow travel time was limited to 150 linear feet.

The rainfall distribution for the model was set to the 24-hour “Type III” storm as recommended by the NRCS with rainfall rates as presented by NOAA Atlas 14 which are provided in Appendix E.

The calculated peak discharges from the HydroCAD model are presented in Table 1. The full HydroCAD report is provided in Appendix F.

**Table 1: HydroCAD Summary of Discharges**

Flood Event (Years)	HydroCAD Peak Discharges at culvert accounting for Bristol Fish & Game Club Pond (cfs)	HydroCAD Peak Discharges at culvert as a single watershed (cfs) USED FOR HYDRAULIC MODEL
1	36	<b>49</b>
2	66	<b>86</b>
5	127	<b>158</b>
10	183	<b>225</b>
25	268	<b>323</b>
50	331	<b>398</b>
100	401	<b>483</b>

After comparison of the two model methodologies and without field verification of the pond outlet on private property, it was determined that the second methodology with the model as one watershed and therefore the higher flows would be utilized for the hydraulic analysis.

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### **3.2.2 AVERAGE DAILY FLOW AND AVERAGE SPRING FLOW**

The CTDOT Drainage Manual, Chapter 6.16 provides calculations for determining the average daily flow and average spring flow of unengaged streams. Using these formulas, based on the 0.57 square mile watershed, the average daily flow of Cussgutter Brook is calculated to be 1.1 cfs and the average spring flow of Cussgutter Brook is calculated to be 2.1 cfs.

# 4 HYDRAULICS

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## 4.1 HYDRAULIC DESIGN CRITERIA

Per the CTDOT Drainage Manual, the hydraulic design requirement for a Small Structure culvert is to provide a minimum freeboard of 1 foot for the 50-Year flood event. Freeboard is defined as the vertical distance between the design water surface and the upstream control such as the low point of the roadway edge, sill of a building, or other controlling element.

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## 4.2 HYDRAULIC ANALYSIS METHODOLOGY

The HEC-RAS version 5.0.7 computer modeling software generated by the U.S. Army Corps of Engineers was utilized to perform the hydraulic analysis for this report.

For the hydraulic analysis, two geometry files and one steady flow file were created. These were combined into two different design plans that were run as a Steady Flow model which are summarized in the table below:

**Table 2: HEC-RAS Plan Summary**

Plan	Geometry File	Steady Flow File
Existing Design	Existing	HydroCAD
Proposed Design	Proposed	HydroCAD

A flow file was created utilizing the flows calculated by HydroCAD with the flows applied to the upstream reach of the model. The downstream boundary condition was set to critical depth.

An existing conditions geometry model was created utilizing surveyed channel cross sections of a 347 linear feet section of stream with approximately 160 linear feet downstream of the culvert modeled. The cross sections were supplemented with elevation data from the 2016 Connecticut LiDAR DEM for some of the overbank areas that were beyond the limits of the survey. The Manning's n values were set based on channel and overbank characteristics. Contraction coefficients of 0.3 and expansion coefficients of 0.5 were assigned to the cross sections immediately up and downstream of the culvert.

To generate a proposed conditions model, a 'Save As' was performed on the existing geometry generated above and the Lake Avenue culvert geometry was revised based on the proposed geometry. The geometric data elements revised on the proposed model, with all other elements remaining unchanged, include revised culvert geometry, including revised internal cross sections at the upstream and downstream faces; and revised ineffective flow area stations and elevations in the vicinity of the project to reflect the new culvert geometry.

An Existing Conditions Plan was generated utilizing the HydroCAD flows and the existing conditions geometry model and a Proposed Conditions Plan was generated utilizing the HydroCAD flows and the proposed conditions geometry model. Both models were run in the subcritical steady flow regime.

A full printout of the Existing Conditions Model and Proposed Conditions Model with design flows Standard Table 1 output from HEC-RAS is provided in Appendix G. Also provided in Appendix G are the cross sections as well as a profile of the existing and proposed plans for each of the flood events. Included in Appendix H is the site survey with the HEC-RAS section locations.

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## 4.3 HYDRAULIC ANALYSIS CONCLUSION

The Existing Conditions Plan and Proposed Conditions Plan water surface elevations (WSEL) were compared and are presented in the series of tables below for the 1-Year, 2-Year, 5-Year, 10-Year, 25-Year, 50-Year, and 100-Year flood events.

**Table 3: COMPARISON TABLE: Existing vs. Proposed at 1-Year Water Surface Elevation**

Cross Section	HEC-RAS Existing Plan (NAVD88)	HEC-RAS Proposed Plan (NAVD88)	Existing vs. Proposed WSEL
	1-Year WSEL	1-Year WSEL	1-Year
<b>347</b>	236.51	236.51	0.00
<b>319</b>	235.62	235.62	0.00
<b>292</b>	233.86	233.86	0.00
<b>269</b>	233.19	233.19	0.00
<b>254</b>	232.91	232.71	-0.20
<b>237</b>	232.33	232.24	-0.09
<b>200</b>			
<b>160</b>	229.85	229.82	-0.03
<b>142</b>	229.42	229.42	0.00
<b>124</b>	228.85	228.85	0.00
<b>107</b>	228.50	228.50	0.00
<b>27</b>	224.32	224.32	0.00
<b>0</b>	223.74	223.74	0.00

Shaded cells indicate those with an increase of more than 0.00 foot.

**Table 4: COMPARISON TABLE: Existing vs. Proposed at 2-Year Water Surface Elevation**

Cross Section	HEC-RAS Existing Plan (NAVD88)	HEC-RAS Proposed Plan (NAVD88)	Existing vs. Proposed WSEL
	2-Year WSEL	2-Year WSEL	2-Year
<b>347</b>	236.90	236.90	0.00
<b>319</b>	235.97	235.97	0.00
<b>292</b>	234.25	234.25	0.00
<b>269</b>	233.59	233.59	0.00
<b>254</b>	233.53	233.19	-0.34
<b>237</b>	232.78	232.62	-0.16
<b>200</b>			
<b>160</b>	230.23	230.16	-0.07
<b>142</b>	229.98	229.98	0.00
<b>124</b>	229.32	229.32	0.00
<b>107</b>	228.95	228.95	0.00
<b>27</b>	224.94	224.94	0.00
<b>0</b>	224.11	224.11	0.00

Shaded cells indicate those with an increase of more than 0.00 foot.

**Table 5: COMPARISON TABLE: Existing vs. Proposed at 5-Year Water Surface Elevation**

Cross Section	HEC-RAS Existing Plan (NAVD88)	HEC-RAS Proposed Plan (NAVD88)	Existing vs. Proposed WSEL
	<b>5-Year WSEL</b>	<b>5-Year WSEL</b>	<b>5-Year</b>
<b>347</b>	237.49	237.49	0.00
<b>319</b>	236.50	236.49	-0.01
<b>292</b>	234.82	234.82	0.00
<b>269</b>	234.19	234.19	0.00
<b>254</b>	234.47	233.88	-0.59
<b>237</b>	233.46	233.18	-0.28
<b>200</b>			
<b>160</b>	230.81	230.68	-0.13
<b>142</b>	230.40	230.40	0.00
<b>124</b>	230.04	230.04	0.00
<b>107</b>	229.48	229.48	0.00
<b>27</b>	225.77	225.77	0.00
<b>0</b>	224.68	224.68	0.00

Shaded cells indicate those with an increase of more than 0.00 foot.

**Table 6: COMPARISON TABLE: Existing vs. Proposed at 10-Year Water Surface Elevation**

Cross Section	HEC-RAS Existing Plan (NAVD88)	HEC-RAS Proposed Plan (NAVD88)	Existing vs. Proposed WSEL
	<b>10-Year WSEL</b>	<b>10-Year WSEL</b>	<b>10-Year</b>
<b>347</b>	237.95	237.95	0.00
<b>319</b>	236.88	236.88	0.00
<b>292</b>	235.25	235.25	0.00
<b>269</b>	234.86	234.62	-0.24
<b>254</b>	235.13	234.38	-0.75
<b>237</b>	234.07	233.60	-0.47
<b>200</b>			
<b>160</b>	231.27	231.09	-0.18
<b>142</b>	230.54	230.54	0.00
<b>124</b>	230.38	230.38	0.00
<b>107</b>	229.99	229.99	0.00
<b>27</b>	226.36	226.36	0.00
<b>0</b>	225.13	225.13	0.00

Shaded cells indicate those with an increase of more than 0.00 foot.

**Table 7: COMPARISON TABLE: Existing vs. Proposed at 25-Year Water Surface Elevation**

Cross Section	HEC-RAS Existing Plan (NAVD88)	HEC-RAS Proposed Plan (NAVD88)	Existing vs. Proposed WSEL
	25-Year WSEL	25-Year WSEL	25-Year
<b>347</b>	238.52	238.52	0.00
<b>319</b>	237.36	237.36	0.00
<b>292</b>	235.79	235.79	0.00
<b>269</b>	235.87	235.15	-0.72
<b>254</b>	236.08	234.48	-1.60
<b>237</b>	234.56	234.38	-0.18
<b>200</b>			
<b>160</b>	231.88	232.51	0.63
<b>142</b>	230.89	230.89	0.00
<b>124</b>	230.67	230.67	0.00
<b>107</b>	230.25	230.25	0.00
<b>27</b>	227.11	227.11	0.00
<b>0</b>	225.68	225.68	0.00

Shaded cells indicate those with an increase of more than 0.00 foot.

**Table 8: COMPARISON TABLE: Existing vs. Proposed at 50-Year Water Surface Elevation**

Cross Section	HEC-RAS Existing Plan (NAVD88)	HEC-RAS Proposed Plan (NAVD88)	Existing vs. Proposed WSEL
	50-Year WSEL	50-Year WSEL	50-Year
<b>347</b>	238.93	238.93	0.00
<b>319</b>	237.69	237.69	0.00
<b>292</b>	236.16	236.16	0.00
<b>269</b>	235.64	235.64	0.00
<b>254</b>	235.36	234.60	-0.76
<b>237</b>	235.35	234.58	-0.77
<b>200</b>			
<b>160</b>	232.32	233.66	1.34
<b>142</b>	231.12	231.12	0.00
<b>124</b>	230.84	230.84	0.00
<b>107</b>	230.39	230.39	0.00
<b>27</b>	227.59	227.59	0.00
<b>0</b>	226.07	226.07	0.00

Shaded cells indicate those with an increase of more than 0.00 foot.

**Table 9: COMPARISON TABLE: Existing vs. Proposed at 100-Year Water Surface Elevation**

Cross Section	HEC-RAS Existing Plan (NAVD88)	HEC-RAS Proposed Plan (NAVD88)	Existing vs. Proposed WSEL
	100-Year WSEL	100-Year WSEL	100-Year
<b>347</b>	239.38	239.38	0.00
<b>319</b>	238.05	238.05	0.00
<b>292</b>	236.51	236.51	0.00
<b>269</b>	235.97	235.97	0.00
<b>254</b>	236.31	236.02	-0.29
<b>237</b>	236.31	236.04	-0.27
<b>200</b>			
<b>160</b>	232.77	234.45	1.68
<b>142</b>	231.35	231.35	0.00
<b>124</b>	231.00	231.00	0.00
<b>107</b>	230.54	230.54	0.00
<b>27</b>	228.03	228.03	0.00
<b>0</b>	228.03	228.03	0.00

Shaded cells indicate those with an increase of more than 0.00 foot.

As would be expected between the two models, there are lower water surface elevations at Lake Avenue culvert immediately upstream for all storm events due to the increase in hydraulic waterway opening with the new structure.

There are no increases (0.00 foot) upstream or downstream at the 1-year, 2-year, 5-year, and 10-year flood events.

During the 25-year, 50-year, and 100-year flood events, the cross section immediately downstream of the undersized existing culvert which is in critical depth and the more appropriately sized proposed culvert does not force the downstream cross section into critical depth. As a result of the hydraulic improvement to avoid critical depth, there is an increase in water surface elevation immediately downstream of the culvert but there are no proposed detrimental effects to the surrounding properties by this localized increase.

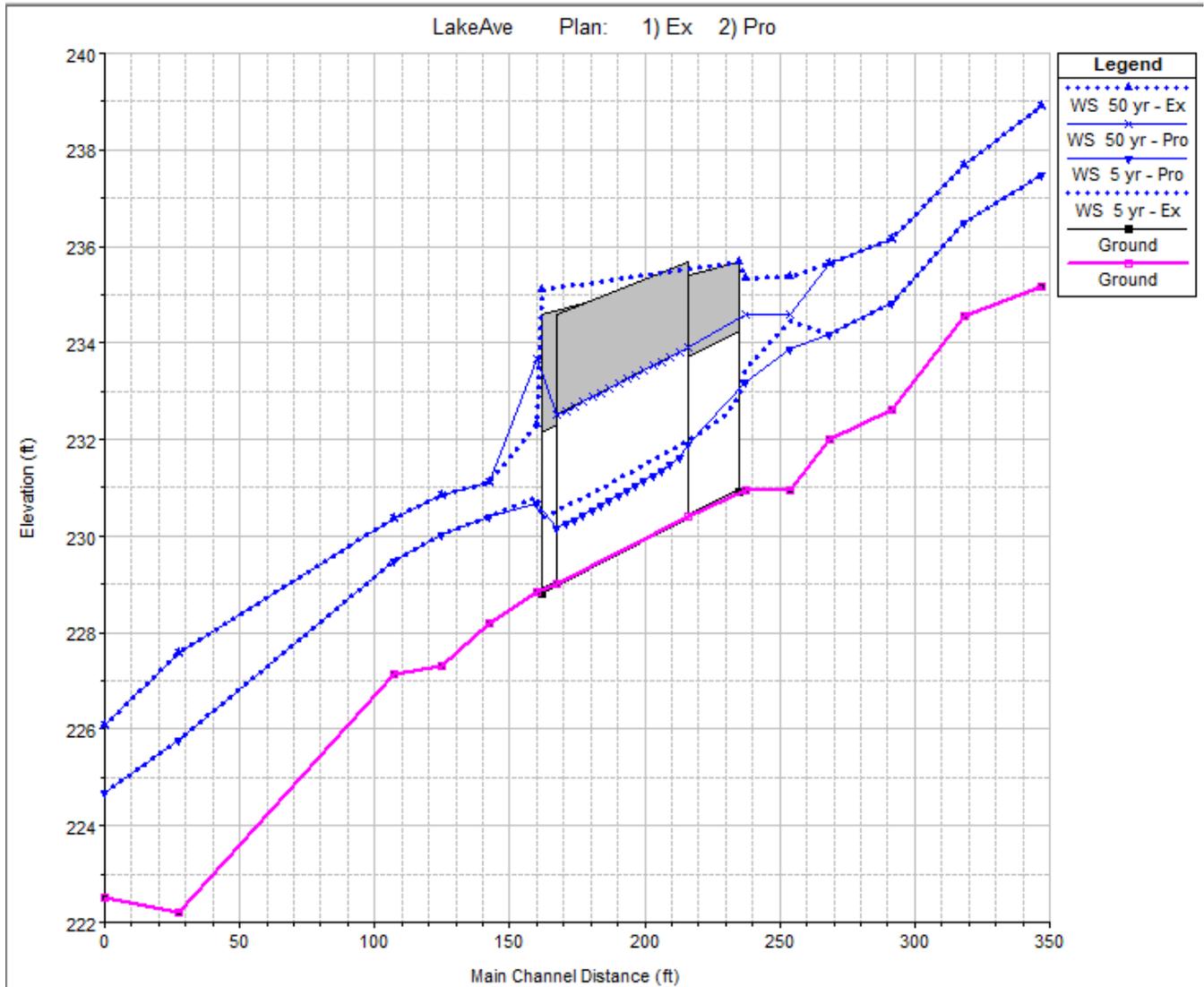
Per the CTDOT Drainage Manual, the hydraulic design requirement for a Small Structure culvert is to provide a minimum freeboard of 1 foot during the 50-year flood event. Freeboard is defined as the vertical distance between the design water surface and the upstream control such as the low point of the roadway edge, sill of a building, or other controlling element.

The existing culvert with a 10.5 feet wide x 3.25 feet tall hydraulic opening does not meet the hydraulic design requirements for a small structure. HEC-RAS calculations indicate that the water surface elevation overtops the road at the existing culvert during a storm event less than a 25-year flood event.

It is proposed to replace the existing culvert with a precast concrete box culvert that will provide a 15 feet wide x 3.5 feet tall hydraulic opening (culvert is 15 feet x 4.5 feet with 1 foot of natural stream bed material placed at the bottom of the culvert). The proposed culvert will improve the hydraulic capacity and will allow for the continuous uninterrupted flow of the 50-year flood event.

The existing hydraulic model indicates that the road is overtopped with approximate 0.01 feet of water during the 50-year storm. During the 50-year flood event the proposed culvert's approach water surface elevation is 234.58 which will give more than 1 foot for freeboard to the top of the embankment adjacent to the upstream side of the culvert at elevation 235.67. Therefore, no design exception, as discussed in ConnDOT Drainage Manual Section 9.3.9, will be required since this CTDOT hydraulic design criteria can be met.

A comparison profile is provided below showing the improvement during the 50-year flood event and also the 5-year flood event as reference. Also of note in the profile below, the slope of the stream is being maintained. Due to the proposed culvert being shorter than the existing culvert, the upstream invert is lowering and the downstream invert is raising.



**Figure 2 - HEC-RAS Profile for 50-Year and 5-Year**

## 4.4 HYDRAULIC PERFORMANCE FOR TEMPORARY CONDITIONS

Water handling and temporary hydraulic facility design shall be provided to the Contractor such that the base stream flows shall be maintained to the maximum extent feasible at all times during construction. As previously discussed, per the Temporary Hydraulic Facilities calculation in Appendix F of the CTDOT Drainage Manual, the temporary design frequency should be a 2-year flood for an anticipated use of up to 12 months.

Due to the topography of the existing site and the requirement to keep the road open to traffic to the maximum extent possible, it is proposed that temporary hydraulics be handled with a combination of temporary water handling cofferdams and temporary bypass pipes.

In Stage 1, temporary water handling cofferdams will be installed on the embankment, blocking less than 25% of the stream width which will allow the temporary bypass pipes to be installed while the existing culvert is still otherwise being utilized. After the temporary bypass pipes are installed the temporary water handling cofferdams will both be removed. In Stage 2, temporary water handling cofferdams will be installed across the stream downstream of the inlet to the temporary bypass pipes and upstream of the outlet to the temporary bypass pipes allowing the bypass pipes to carry the Cussgutter Brook temporary flows.

The temporary water surface elevations for the portion of the reach from Cross Section 485 to Cross Section 1129 for Stage 1 and Stage 2 are shown in the tables below.

During Stage 1, a save as of the HEC-RAS existing model was performed and blocked obstructions on the left embankment to minimum elevation 234.2 were added at Cross Section 254 and to minimum elevation 231.4 at Cross Section 142 which allows for 12” of freeboard to the 2-year WSEL representing the locations of the upstream and downstream cofferdams at the embankment. Bolded values represent the temporary design water surface elevation at the cofferdams.

**Table 10: Temporary Stage 1 Model: 1-Yr, 2-Yr, 3-Yr, Avg Daily Flow, Avg Spring Flow**

HEC-RAS Temporary Stage 1 Model with Design Flows (NAVD88)					
Cross Section	1-Year WS El. (49 cfs)	2-Year WS El. (86 cfs)	3-Year WS El. (118 cfs)	Avg Daily Flow WS El. (1.1 cfs)	Avg Spring Flow WS El. (2.1 cfs)
347	236.51	236.90	237.18	235.48	235.54
319	235.62	235.97	236.22	234.75	234.82
292	233.86	234.25	234.52	232.88	232.96
269	233.19	233.90	234.47	232.18	232.24
254	232.68	<b>233.20</b>	233.57	231.50	231.61
237	232.33	232.78	233.10	231.22	231.29
200					
160	230.50	231.26	231.76	229.04	229.09
142	229.76	<b>230.39</b>	230.78	228.42	228.50
124	228.85	229.32	229.68	227.65	227.74
107	228.50	228.95	229.20	227.33	227.41
27	224.32	224.94	225.35	222.93	223.07
0	223.74	224.11	224.39	222.77	222.84

During Stage 2, the existing culvert will be replaced with the two temporary 36” bypass pipes with an upstream invert of 231.0 and a downstream invert of 228.0. The upstream temporary water handling cofferdam will be set to a minimum top elevation of 235.5 and the downstream temporary water handling cofferdam will be set to a minimum top elevation of 231.0

which allows for more than 12” of freeboard to the 2-year WSEL. Bolded values represent the temporary design water surface elevation at the cofferdams.

**Table 11: Temporary Stage 2 Model: 1-Yr, 2-Yr, 3-Yr, Avg Daily Flow, Avg Spring Flow**

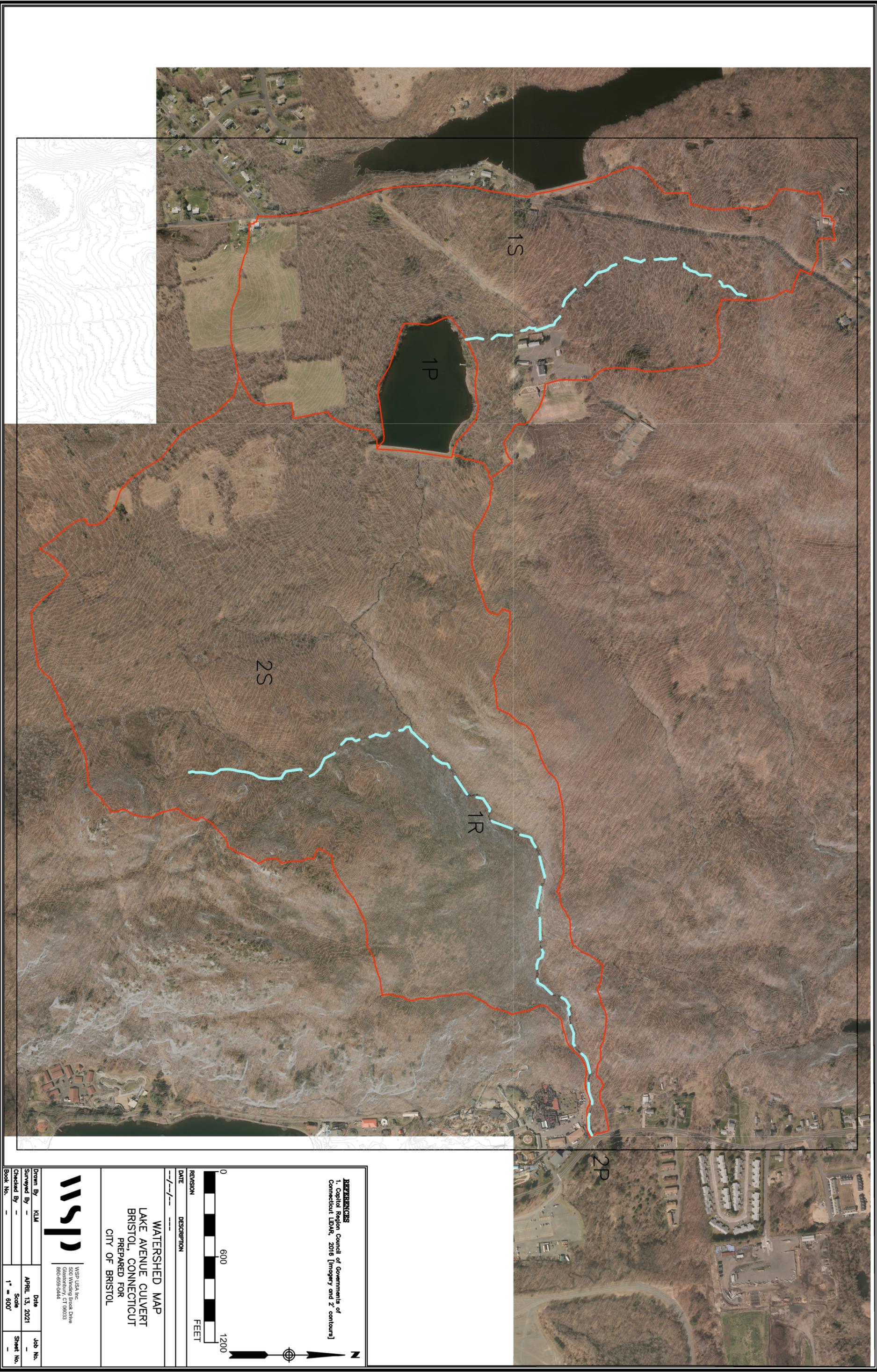
HEC-RAS Temporary Stage 2 Model with Design Flows (NAVD88)					
Cross Section	1-Year WS El. (49 cfs)	2-Year WS El. (86 cfs)	3-Year WS El. (118 cfs)	Avg Daily Flow WS El. (1.1 cfs)	Avg Spring Flow WS El. (2.1 cfs)
<b>347</b>	236.51	236.90	237.18	235.48	235.54
<b>319</b>	235.62	235.97	236.22	234.75	234.82
<b>292</b>	233.86	234.25	235.62	232.88	232.96
<b>269</b>	233.19	234.34	235.64	232.18	232.24
<b>254</b>	233.37	<b>234.41</b>	235.67	231.31	231.43
<b>200</b>					
<b>124</b>	228.85	<b>229.32</b>	229.68	227.65	227.74
<b>107</b>	228.50	228.95	229.20	227.33	227.41
<b>27</b>	224.32	224.94	225.35	222.93	223.07
<b>0</b>	223.74	224.11	224.39	222.77	222.84

A full printout of the Temporary Conditions Stage 1 Model and Temporary Conditions Stage 2 Model with design flows Standard Table 1 output from HEC-RAS are provided in Appendix G.

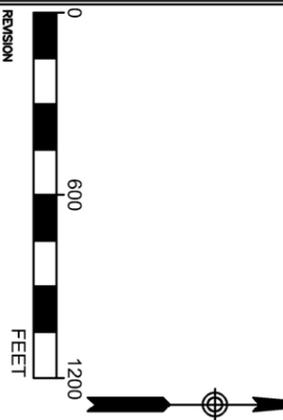
# APPENDIX

# A WATERSHED MAP





**REFERENCES**  
 1. Capitol Region Council of Governments of Connecticut (IDAR, 2016 [Imagery and 2' contours])



DATE	DESCRIPTION

**WATERSHED MAP**  
**LAKE AVENUE CULVERT**  
**BRISTOL, CONNECTICUT**  
**PREPARED FOR**  
**CITY OF BRISTOL**



WSP USA Inc.  
 500 Winding Brook Drive  
 Bristol, CT 06033  
 860-459-4444

Drawn By	KLM	Date	APRIL 13, 2021	Job No.	
Surveyed By		Scale	1" = 600'	Sheet No.	
Checked By					
Book No.					

# APPENDIX

## **B** FIRMETTE AT PROJECT SITE



# National Flood Hazard Layer FIRMMette



72°55'44"W 41°38'54"N



## Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS		Without Base Flood Elevation (BFE) Zone A, V, A99
		With BFE or Depth Zone AE, AO, AH, VE, AR
		Regulatory Floodway
OTHER AREAS OF FLOOD HAZARD		0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile Zone X
		Future Conditions 1% Annual Chance Flood Hazard Zone X
		Area with Reduced Flood Risk due to Levee. See Notes. Zone X
		Area with Flood Risk due to Levee Zone D
OTHER AREAS		NO SCREEN Area of Minimal Flood Hazard Zone X
		Effective LOMRs
		Area of Undetermined Flood Hazard Zone D
GENERAL STRUCTURES		Channel, Culvert, or Storm Sewer
		Levee, Dike, or Floodwall
OTHER FEATURES		20.2 Cross Sections with 1% Annual Chance Water Surface Elevation 17.5
		Coastal Transect
		Base Flood Elevation Line (BFE)
		Limit of Study
		Jurisdiction Boundary
		Coastal Transect Baseline Profile Baseline Hydrographic Feature
MAP PANELS		Digital Data Available
		No Digital Data Available
		Unmapped
		The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.



This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on **3/30/2021 at 2:29 PM** and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.

0 250 500 1,000 1,500 2,000 Feet 1:6,000

72°55'7"W 41°38'27"N

Basemap: USGS National Map: Orthoimagery: Data refreshed October, 2020

# APPENDIX

## C STREAMSTATS REPORT (FLOWS NOT APPLICABLE AT SITE)



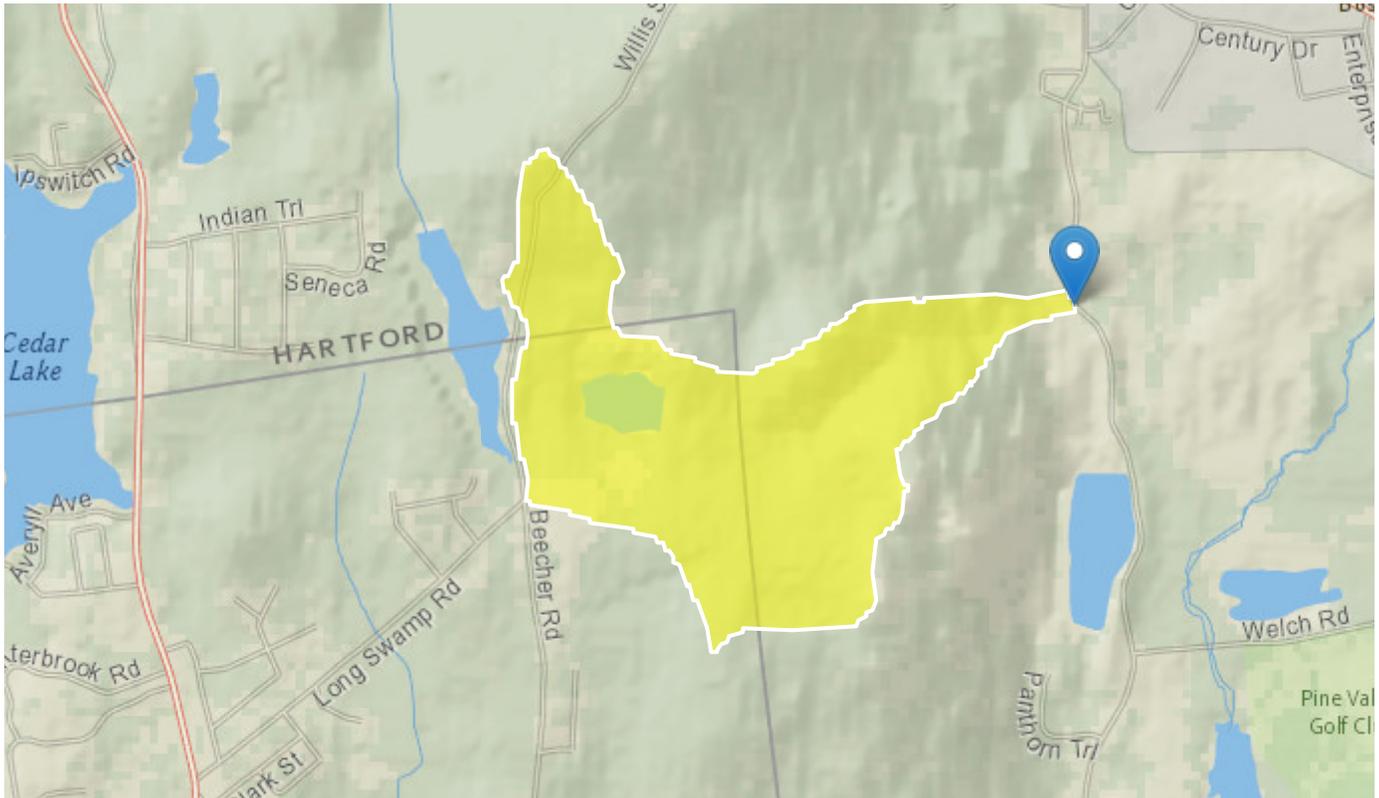
# Lake Ave StreamStats Report

Region ID: CT

Workspace ID: CT20210330184807474000

Clicked Point (Latitude, Longitude): 41.64431, -72.92354

Time: 2021-03-30 14:48:29 -0400



## Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	0.58	square miles
I24H2Y	Maximum 24-hour precipitation that occurs on average once in 2 years - Equivalent to precipitation intensity index	3.25	inches
SSURGOCCDD	Percentage of area with hydrologic soil types C, D, or C/D from SSURGO	0.4042	percent
I24H5Y	Maximum 24-hour precipitation that occurs on average once in 5 years	4.62	inches

Parameter Code	Parameter Description	Value	Unit
I24H10Y	Maximum 24-hour precipitation that occurs on average once in 10 years	5.66	inches
I24H25Y	Maximum 24-hour precipitation that occurs on average once in 25 years	7.04	inches
I24H50Y	Maximum 24-hour precipitation that occurs on average once in 50 years	8.08	inches
I24H100Y	Maximum 24-hour precipitation that occurs on average once in 100 years	9.11	inches
I24H200Y	Maximum 24-hour precipitation that occurs on average once in 200 years	10.75	inches
I24H500Y	Maximum 24-hour precipitation that occurs on average once in 500 years	12.9	inches
ELEV	Mean Basin Elevation	828	feet
CRSDFT	Percentage of area of coarse-grained stratified drift	0.36	percent
PRCWINTER	Mean annual precipitation for December through February	3.9	inches
WETLAND	Percentage of Wetlands	0	percent
NOVAVPRE	Mean November Precipitation	4.5	inches

## Peak-Flow Statistics Parameters [Statewide DA only SIR 2020 5054]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.58	square miles	0.69	325

## Peak-Flow Statistics Parameters [Statewide Multiparameter SIR 2020 5054]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.58	square miles	0.69	325
I24H2Y	24 Hour 2 Year Precipitation	3.25	inches	2.77	3.32
SSURGOCCDD	Percent soil type C or D from SSURGO	0.4042	percent	0.118	0.945
I24H5Y	24 Hour 5 Year Precipitation	4.62	inches	4	4.7
I24H10Y	24 Hour 10 Year Precipitation	5.66	inches	4.86	5.79

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
I24H25Y	24 Hour 25 Year Precipitation	7.04	inches	5.99	7.22
I24H50Y	24 Hour 50 Year Precipitation	8.08	inches	6.81	8.3
I24H100Y	24 Hour 100 Year Precipitation	9.11	inches	7.62	9.38
I24H200Y	24 Hour 200 Year Precipitation	10.75	inches	8.7	11.22
I24H500Y	24 Hour 500 Year Precipitation	12.9	inches	10.1	13.64

Peak-Flow Statistics Disclaimers [Statewide DA only SIR 2020 5054]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

Peak-Flow Statistics Flow Report [Statewide DA only SIR 2020 5054]

Statistic	Value	Unit
Drainage Area Only 50-percent AEP flood	42	ft <sup>3</sup> /s
Drainage Area Only 20-percent AEP flood	74.4	ft <sup>3</sup> /s
Drainage Area Only 10-percent AEP flood	101	ft <sup>3</sup> /s
Drainage Area Only 4-percent AEP flood	141	ft <sup>3</sup> /s
Drainage Area Only 2-percent AEP flood	175	ft <sup>3</sup> /s
Drainage Area Only 1-percent AEP flood	213	ft <sup>3</sup> /s
Drainage Area Only 0.5-percent AEP flood	254	ft <sup>3</sup> /s
Drainage Area Only 0.2-percent AEP flood	316	ft <sup>3</sup> /s

Peak-Flow Statistics Disclaimers [Statewide Multiparameter SIR 2020 5054]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

Peak-Flow Statistics Flow Report [Statewide Multiparameter SIR 2020 5054]

Statistic	Value	Unit
50-percent AEP flood	41.9	ft <sup>3</sup> /s
20-percent AEP flood	90.1	ft <sup>3</sup> /s
10-percent AEP flood	128	ft <sup>3</sup> /s
4-percent AEP flood	186	ft <sup>3</sup> /s

<b>Statistic</b>	<b>Value</b>	<b>Unit</b>
2-percent AEP flood	235	ft <sup>3</sup> /s
1-percent AEP flood	287	ft <sup>3</sup> /s
0.5-percent AEP flood	338	ft <sup>3</sup> /s
0.2-percent AEP flood	419	ft <sup>3</sup> /s

Peak-Flow Statistics Flow Report [Area-Averaged]

<b>Statistic</b>	<b>Value</b>	<b>Unit</b>
Drainage Area Only 50-percent AEP flood	42	ft <sup>3</sup> /s
Drainage Area Only 20-percent AEP flood	74.4	ft <sup>3</sup> /s
Drainage Area Only 10-percent AEP flood	101	ft <sup>3</sup> /s
Drainage Area Only 4-percent AEP flood	141	ft <sup>3</sup> /s
Drainage Area Only 2-percent AEP flood	175	ft <sup>3</sup> /s
Drainage Area Only 1-percent AEP flood	213	ft <sup>3</sup> /s
Drainage Area Only 0.5-percent AEP flood	254	ft <sup>3</sup> /s
Drainage Area Only 0.2-percent AEP flood	316	ft <sup>3</sup> /s
50-percent AEP flood	41.9	ft <sup>3</sup> /s
20-percent AEP flood	90.1	ft <sup>3</sup> /s
10-percent AEP flood	128	ft <sup>3</sup> /s
4-percent AEP flood	186	ft <sup>3</sup> /s
2-percent AEP flood	235	ft <sup>3</sup> /s
1-percent AEP flood	287	ft <sup>3</sup> /s
0.5-percent AEP flood	338	ft <sup>3</sup> /s
0.2-percent AEP flood	419	ft <sup>3</sup> /s

*Peak-Flow Statistics Citations*

**Ahearn, E.A., and Hodgkins, G.A., 2020, Estimating flood magnitude and frequency on streams and rivers in Connecticut, based on data through water year 2015: U.S. Geological Survey Scientific Investigations Report 2020–5054, 42 p. (<https://doi.org/10.3133/sir20205054>)**

USGS Data Disclaimer: Unless otherwise stated, all data, metadata and related materials are considered to satisfy the quality standards relative to the purpose for which the data were collected. Although these data and associated metadata have been reviewed for accuracy and completeness and approved for release by the U.S. Geological Survey (USGS), no warranty expressed or implied is made regarding the display or utility of the data for other purposes, nor on all computer systems, nor shall the act of distribution constitute any such warranty.

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USGS Product Names Disclaimer: Any use of trade, firm, or product names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

Application Version: 4.5.1

StreamStats Services Version: 1.2.22

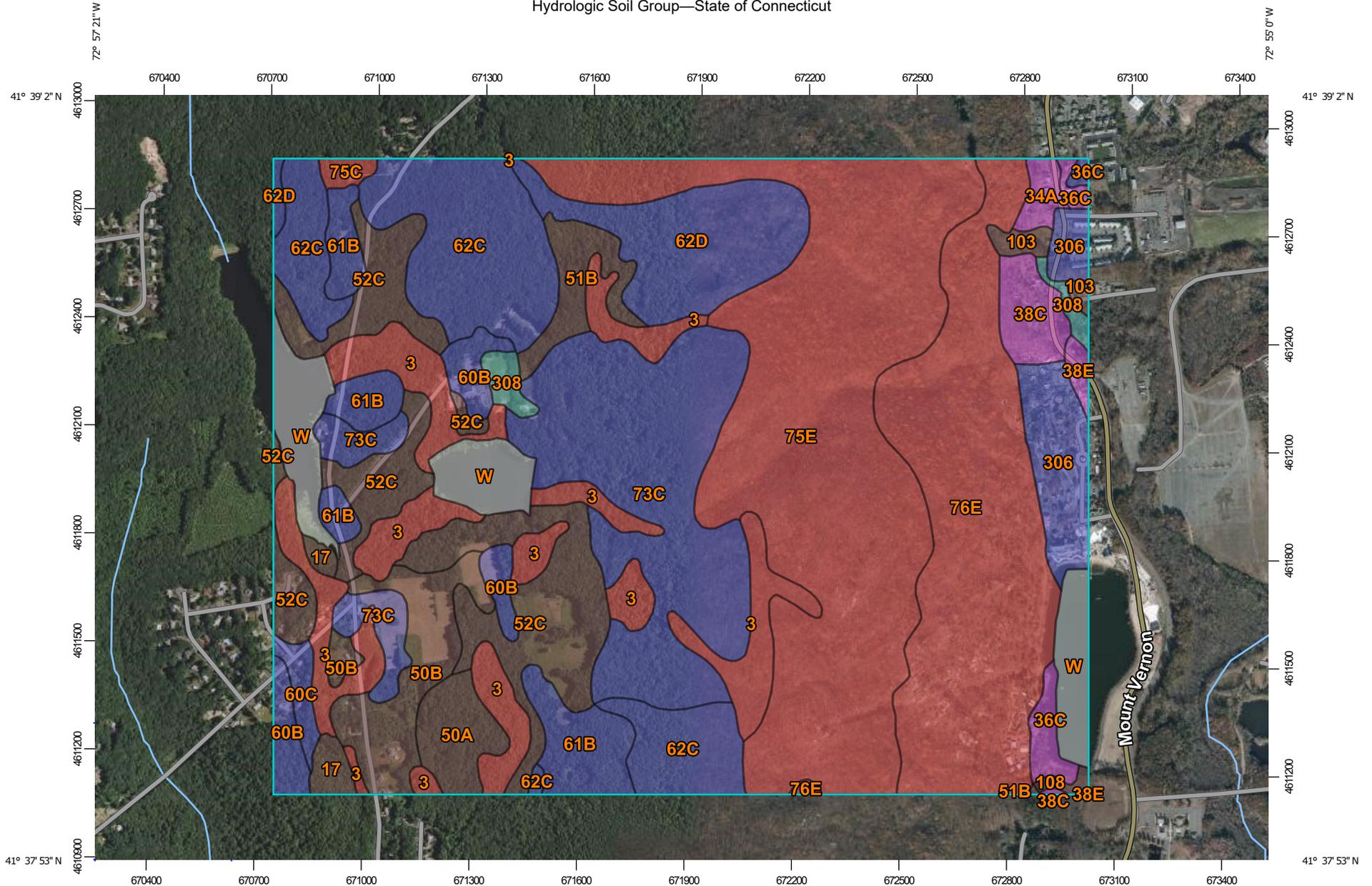
NSS Services Version: 2.1.0

# APPENDIX

# D HYDROLOGIC SOIL GROUP MAP



Hydrologic Soil Group—State of Connecticut



Map Scale: 1:15,000 if printed on A landscape (11" x 8.5") sheet.



Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 18N WGS84



## MAP LEGEND

### Area of Interest (AOI)

 Area of Interest (AOI)

### Soils

#### Soil Rating Polygons

 A  
 A/D  
 B  
 B/D  
 C  
 C/D  
 D  
 Not rated or not available

#### Soil Rating Lines

 A  
 A/D  
 B  
 B/D  
 C  
 C/D  
 D  
 Not rated or not available

#### Soil Rating Points

 A  
 A/D  
 B  
 B/D

 C  
 C/D  
 D  
 Not rated or not available

### Water Features

 Streams and Canals

### Transportation

 Rails  
 Interstate Highways  
 US Routes  
 Major Roads  
 Local Roads

### Background

 Aerial Photography

## MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:12,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service  
 Web Soil Survey URL:  
 Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: State of Connecticut  
 Survey Area Data: Version 20, Jun 9, 2020

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Sep 25, 2019—Sep 15, 2020

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

## Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
3	Ridgebury, Leicester, and Whitman soils, 0 to 8 percent slopes, extremely stony	D	84.9	8.5%
17	Timakwa and Natchaug soils, 0 to 2 percent slopes	B/D	5.8	0.6%
23A	Sudbury sandy loam, 0 to 5 percent slopes	B	0.8	0.1%
34A	Merrimac fine sandy loam, 0 to 3 percent slopes	A	4.7	0.5%
36C	Windsor loamy sand, 8 to 15 percent slopes	A	7.5	0.8%
38C	Hinckley loamy sand, 3 to 15 percent slopes	A	12.0	1.2%
38E	Hinckley loamy sand, 15 to 45 percent slopes	A	2.4	0.2%
50A	Sutton fine sandy loam, 0 to 3 percent slopes	B/D	14.4	1.4%
50B	Sutton fine sandy loam, 3 to 8 percent slopes	B/D	31.4	3.2%
51B	Sutton fine sandy loam, 0 to 8 percent slopes, very stony	B/D	14.1	1.4%
52C	Sutton fine sandy loam, 2 to 15 percent slopes, extremely stony	B/D	83.5	8.4%
60B	Canton and Charlton fine sandy loams, 3 to 8 percent slopes	B	17.1	1.7%
60C	Canton and Charlton fine sandy loams, 8 to 15 percent slopes	B	5.2	0.5%
61B	Canton and Charlton fine sandy loams, 0 to 8 percent slopes, very stony	B	33.0	3.3%
62C	Canton and Charlton fine sandy loams, 3 to 15 percent slopes, extremely stony	B	85.7	8.6%
62D	Canton and Charlton fine sandy loams, 15 to 35 percent slopes, extremely stony	B	45.8	4.6%

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
73C	Charlton-Chatfield complex, 0 to 15 percent slopes, very rocky	B	118.9	11.9%
75C	Hollis-Chatfield-Rock outcrop complex, 3 to 15 percent slopes	D	2.7	0.3%
75E	Hollis-Chatfield-Rock outcrop complex, 15 to 45 percent slopes	D	216.1	21.7%
76E	Rock outcrop-Hollis complex, 3 to 45 percent slopes	D	132.7	13.3%
103	Rippowam fine sandy loam	B/D	4.1	0.4%
108	Saco silt loam	B/D	1.5	0.2%
306	Udorthents-Urban land complex	B	26.5	2.7%
308	Udorthents, smoothed	C	6.4	0.6%
W	Water		39.0	3.9%
<b>Totals for Area of Interest</b>			<b>996.3</b>	<b>100.0%</b>

## Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

## Rating Options

*Aggregation Method:* Dominant Condition

*Component Percent Cutoff:* None Specified

*Tie-break Rule:* Higher

# APPENDIX

# E NOAA ATLAS 14 DEPTHS AND INTENSITIES





**NOAA Atlas 14, Volume 10, Version 3**  
**Location name: Bristol, Connecticut, USA\***  
**Latitude: 41.6434°, Longitude: -72.9305°**  
**Elevation: 519.46 ft\*\***  
 \* source: ESRI Maps  
 \*\* source: USGS



**POINT PRECIPITATION FREQUENCY ESTIMATES**

Sanja Perica, Sandra Pavlovic, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Orlan Wilhite

NOAA, National Weather Service, Silver Spring, Maryland

[PF\\_tabular](#) | [PF\\_graphical](#) | [Maps & aeriels](#)

**PF tabular**

<b>PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)<sup>1</sup></b>										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
<b>5-min</b>	<b>0.357</b> (0.275-0.462)	<b>0.428</b> (0.329-0.554)	<b>0.544</b> (0.416-0.705)	<b>0.639</b> (0.487-0.835)	<b>0.771</b> (0.570-1.05)	<b>0.871</b> (0.631-1.21)	<b>0.975</b> (0.686-1.41)	<b>1.09</b> (0.730-1.61)	<b>1.24</b> (0.805-1.92)	<b>1.37</b> (0.866-2.15)
<b>10-min</b>	<b>0.506</b> (0.389-0.654)	<b>0.606</b> (0.466-0.784)	<b>0.770</b> (0.589-1.00)	<b>0.906</b> (0.690-1.18)	<b>1.09</b> (0.807-1.49)	<b>1.24</b> (0.893-1.72)	<b>1.38</b> (0.972-1.99)	<b>1.54</b> (1.03-2.29)	<b>1.76</b> (1.14-2.71)	<b>1.94</b> (1.23-3.05)
<b>15-min</b>	<b>0.595</b> (0.458-0.769)	<b>0.713</b> (0.548-0.923)	<b>0.906</b> (0.693-1.18)	<b>1.07</b> (0.812-1.39)	<b>1.29</b> (0.949-1.75)	<b>1.45</b> (1.05-2.02)	<b>1.63</b> (1.14-2.35)	<b>1.81</b> (1.22-2.69)	<b>2.07</b> (1.34-3.19)	<b>2.28</b> (1.44-3.59)
<b>30-min</b>	<b>0.810</b> (0.623-1.05)	<b>0.969</b> (0.744-1.25)	<b>1.23</b> (0.941-1.60)	<b>1.45</b> (1.10-1.89)	<b>1.74</b> (1.29-2.38)	<b>1.97</b> (1.43-2.74)	<b>2.20</b> (1.55-3.18)	<b>2.45</b> (1.65-3.64)	<b>2.81</b> (1.82-4.32)	<b>3.09</b> (1.96-4.86)
<b>60-min</b>	<b>1.02</b> (0.788-1.32)	<b>1.23</b> (0.941-1.59)	<b>1.55</b> (1.19-2.02)	<b>1.82</b> (1.39-2.38)	<b>2.20</b> (1.62-3.00)	<b>2.48</b> (1.80-3.46)	<b>2.77</b> (1.95-4.01)	<b>3.10</b> (2.08-4.59)	<b>3.54</b> (2.29-5.45)	<b>3.91</b> (2.47-6.14)
<b>2-hr</b>	<b>1.35</b> (1.04-1.73)	<b>1.60</b> (1.23-2.05)	<b>2.01</b> (1.55-2.59)	<b>2.35</b> (1.80-3.05)	<b>2.82</b> (2.09-3.82)	<b>3.17</b> (2.31-4.40)	<b>3.54</b> (2.51-5.10)	<b>3.95</b> (2.66-5.83)	<b>4.52</b> (2.94-6.93)	<b>4.98</b> (3.16-7.80)
<b>3-hr</b>	<b>1.56</b> (1.21-2.00)	<b>1.86</b> (1.44-2.38)	<b>2.34</b> (1.80-3.01)	<b>2.73</b> (2.10-3.54)	<b>3.28</b> (2.44-4.44)	<b>3.69</b> (2.70-5.11)	<b>4.12</b> (2.93-5.93)	<b>4.61</b> (3.11-6.79)	<b>5.29</b> (3.44-8.09)	<b>5.86</b> (3.72-9.14)
<b>6-hr</b>	<b>1.99</b> (1.55-2.53)	<b>2.38</b> (1.85-3.04)	<b>3.03</b> (2.35-3.87)	<b>3.56</b> (2.75-4.58)	<b>4.30</b> (3.22-5.80)	<b>4.85</b> (3.56-6.70)	<b>5.43</b> (3.89-7.82)	<b>6.11</b> (4.14-8.97)	<b>7.12</b> (4.64-10.8)	<b>7.95</b> (5.07-12.4)
<b>12-hr</b>	<b>2.45</b> (1.92-3.11)	<b>2.99</b> (2.34-3.79)	<b>3.88</b> (3.02-4.93)	<b>4.61</b> (3.57-5.90)	<b>5.62</b> (4.24-7.57)	<b>6.36</b> (4.71-8.79)	<b>7.17</b> (5.19-10.3)	<b>8.15</b> (5.53-11.9)	<b>9.65</b> (6.31-14.6)	<b>10.9</b> (7.00-16.9)
<b>24-hr</b>	<b>2.88</b> (2.26-3.62)	<b>3.58</b> (2.82-4.51)	<b>4.74</b> (3.71-5.99)	<b>5.70</b> (4.44-7.25)	<b>7.02</b> (5.33-9.44)	<b>7.99</b> (5.97-11.0)	<b>9.06</b> (6.63-13.1)	<b>10.4</b> (7.09-15.2)	<b>12.6</b> (8.24-19.0)	<b>14.5</b> (9.28-22.3)
<b>2-day</b>	<b>3.23</b> (2.55-4.03)	<b>4.10</b> (3.24-5.13)	<b>5.52</b> (4.35-6.93)	<b>6.70</b> (5.25-8.47)	<b>8.33</b> (6.37-11.2)	<b>9.51</b> (7.16-13.1)	<b>10.8</b> (8.02-15.8)	<b>12.6</b> (8.59-18.3)	<b>15.5</b> (10.2-23.3)	<b>18.1</b> (11.6-27.7)
<b>3-day</b>	<b>3.51</b> (2.78-4.37)	<b>4.47</b> (3.54-5.57)	<b>6.04</b> (4.77-7.56)	<b>7.34</b> (5.77-9.24)	<b>9.14</b> (7.01-12.2)	<b>10.4</b> (7.89-14.4)	<b>11.9</b> (8.85-17.3)	<b>13.9</b> (9.48-20.1)	<b>17.1</b> (11.3-25.7)	<b>20.0</b> (12.9-30.7)
<b>4-day</b>	<b>3.77</b> (2.99-4.68)	<b>4.79</b> (3.80-5.96)	<b>6.47</b> (5.12-8.07)	<b>7.86</b> (6.18-9.87)	<b>9.77</b> (7.51-13.1)	<b>11.2</b> (8.45-15.4)	<b>12.7</b> (9.48-18.5)	<b>14.8</b> (10.1-21.4)	<b>18.3</b> (12.1-27.4)	<b>21.4</b> (13.8-32.7)
<b>7-day</b>	<b>4.50</b> (3.59-5.56)	<b>5.64</b> (4.50-6.98)	<b>7.52</b> (5.98-9.34)	<b>9.08</b> (7.17-11.3)	<b>11.2</b> (8.65-14.9)	<b>12.8</b> (9.70-17.5)	<b>14.5</b> (10.8-20.9)	<b>16.8</b> (11.6-24.2)	<b>20.6</b> (13.6-30.7)	<b>23.9</b> (15.5-36.4)
<b>10-day</b>	<b>5.23</b> (4.19-6.44)	<b>6.44</b> (5.15-7.94)	<b>8.42</b> (6.71-10.4)	<b>10.1</b> (7.97-12.5)	<b>12.3</b> (9.50-16.3)	<b>14.0</b> (10.6-19.0)	<b>15.8</b> (11.7-22.6)	<b>18.2</b> (12.5-26.0)	<b>22.0</b> (14.6-32.7)	<b>25.3</b> (16.4-38.5)
<b>20-day</b>	<b>7.54</b> (6.06-9.23)	<b>8.80</b> (7.07-10.8)	<b>10.9</b> (8.70-13.4)	<b>12.6</b> (10.0-15.6)	<b>14.9</b> (11.6-19.5)	<b>16.7</b> (12.7-22.3)	<b>18.6</b> (13.7-26.0)	<b>20.9</b> (14.5-29.7)	<b>24.4</b> (16.3-36.1)	<b>27.4</b> (17.8-41.5)
<b>30-day</b>	<b>9.46</b> (7.63-11.5)	<b>10.7</b> (8.66-13.1)	<b>12.8</b> (10.3-15.7)	<b>14.6</b> (11.6-18.0)	<b>17.0</b> (13.1-21.9)	<b>18.8</b> (14.2-24.9)	<b>20.7</b> (15.2-28.5)	<b>22.8</b> (15.9-32.4)	<b>26.0</b> (17.4-38.3)	<b>28.7</b> (18.7-43.2)
<b>45-day</b>	<b>11.8</b> (9.56-14.4)	<b>13.1</b> (10.6-16.0)	<b>15.3</b> (12.3-18.7)	<b>17.1</b> (13.7-21.0)	<b>19.5</b> (15.1-25.0)	<b>21.4</b> (16.2-28.1)	<b>23.3</b> (17.0-31.7)	<b>25.3</b> (17.7-35.7)	<b>28.0</b> (18.8-41.2)	<b>30.2</b> (19.7-45.4)
<b>60-day</b>	<b>13.8</b> (11.2-16.7)	<b>15.1</b> (12.2-18.3)	<b>17.3</b> (14.0-21.1)	<b>19.2</b> (15.4-23.5)	<b>21.7</b> (16.8-27.7)	<b>23.7</b> (17.9-30.8)	<b>25.6</b> (18.6-34.5)	<b>27.5</b> (19.2-38.6)	<b>29.8</b> (20.1-43.7)	<b>31.6</b> (20.6-47.4)

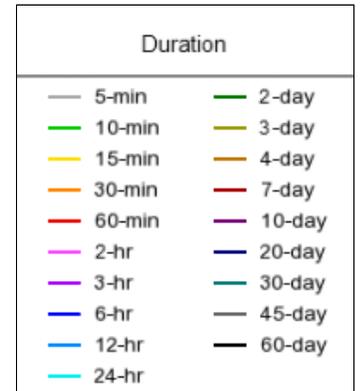
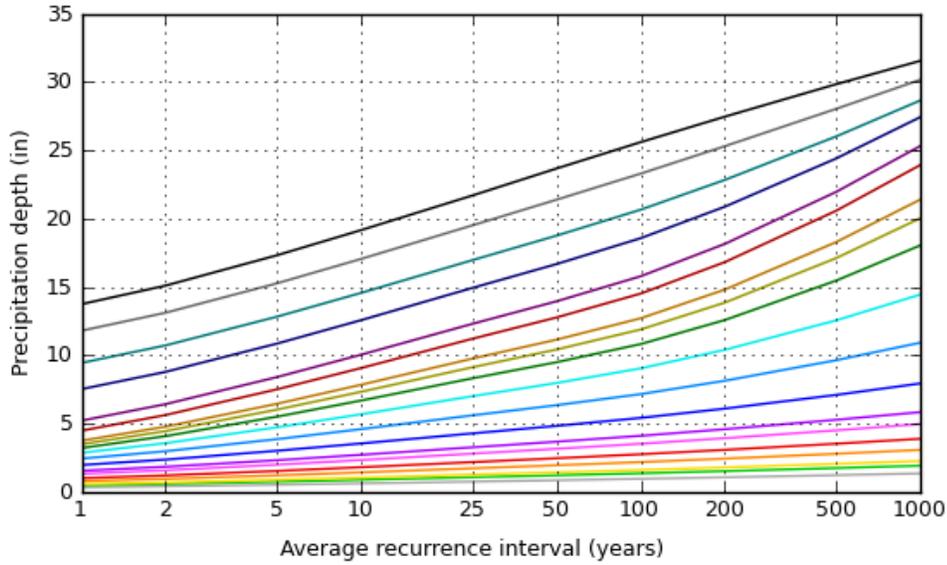
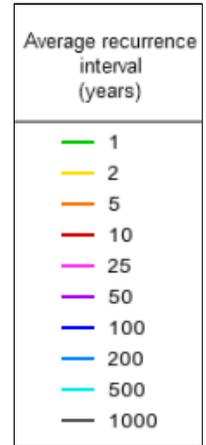
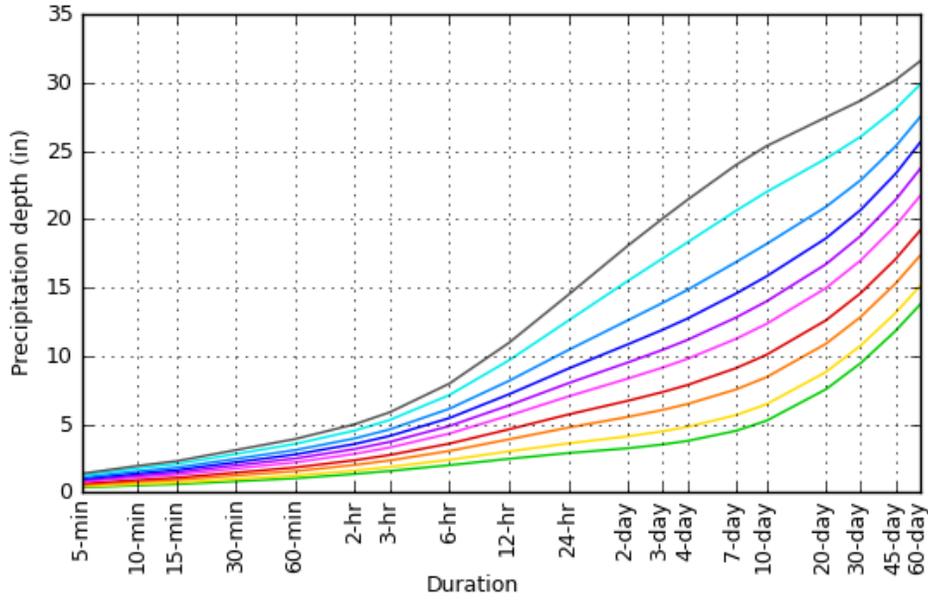
<sup>1</sup> Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS). Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values. Please refer to NOAA Atlas 14 document for more information.

[Back to Top](#)

**PF graphical**

### PDS-based depth-duration-frequency (DDF) curves

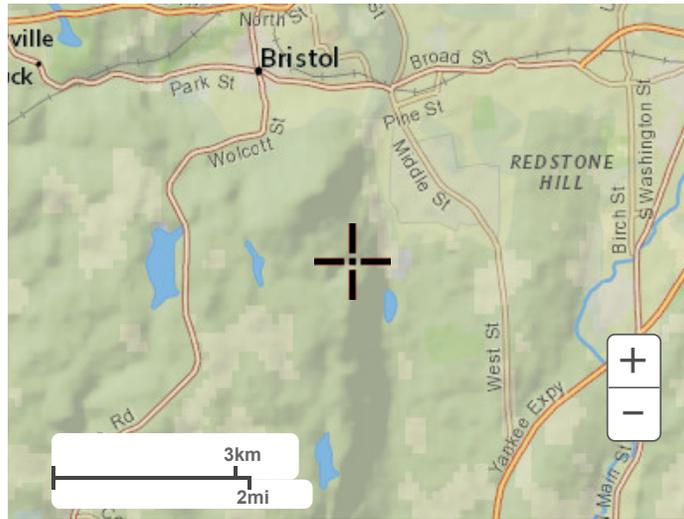
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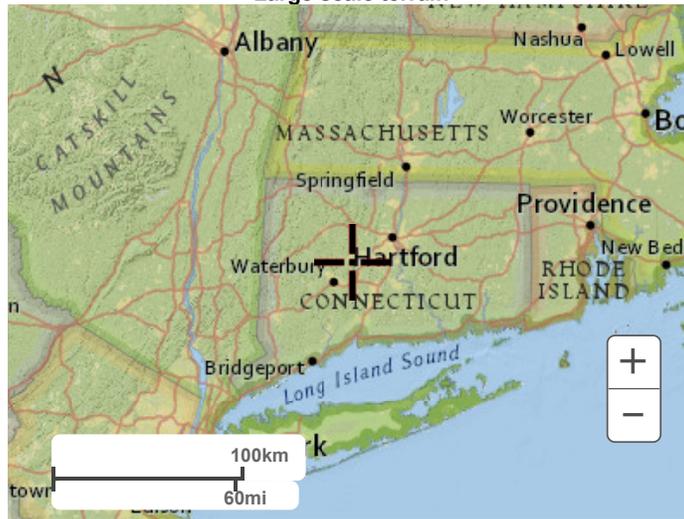
[Back to Top](#)

## Maps & aerials

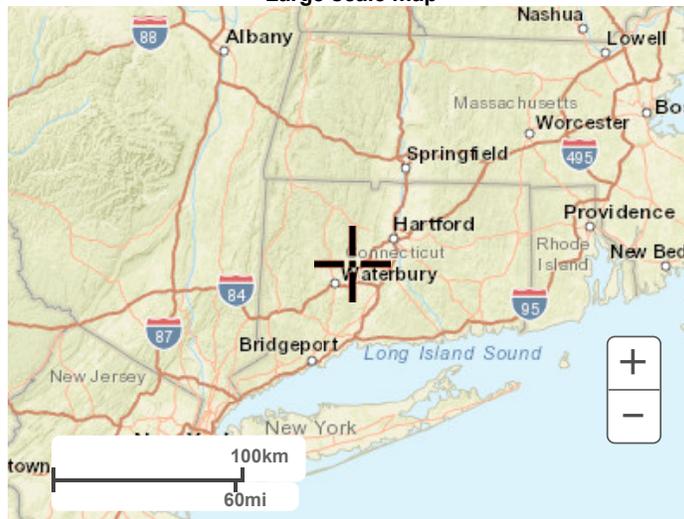
Small scale terrain



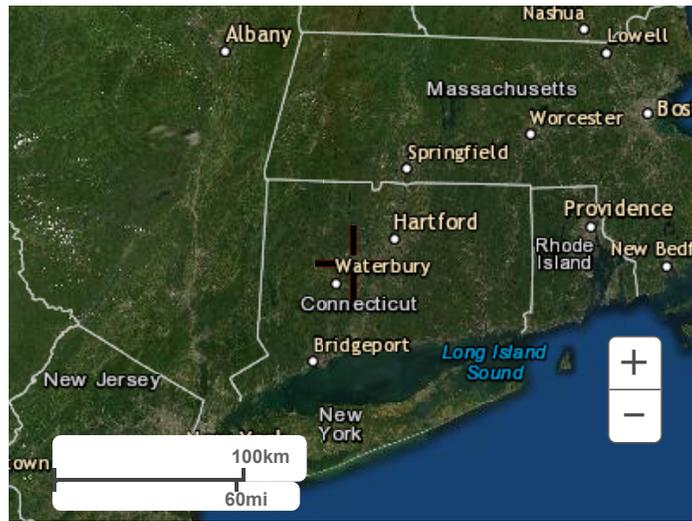
Large scale terrain



Large scale map



Large scale aerial



[Back to Top](#)

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**NOAA Atlas 14, Volume 10, Version 3**  
**Location name: Bristol, Connecticut, USA\***  
**Latitude: 41.6434°, Longitude: -72.9305°**  
**Elevation: 519.46 ft\*\***  
 \* source: ESRI Maps  
 \*\* source: USGS



**POINT PRECIPITATION FREQUENCY ESTIMATES**

Sanja Perica, Sandra Pavlovic, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Orlan Wilhite

NOAA, National Weather Service, Silver Spring, Maryland

[PF\\_tabular](#) | [PF\\_graphical](#) | [Maps & aeriels](#)

**PF tabular**

<b>PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches/hour)<sup>1</sup></b>										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	4.28 (3.30-5.54)	5.14 (3.95-6.65)	6.53 (4.99-8.46)	7.67 (5.84-10.0)	9.25 (6.84-12.6)	10.5 (7.57-14.6)	11.7 (8.23-16.9)	13.0 (8.76-19.4)	14.9 (9.66-23.0)	16.4 (10.4-25.8)
10-min	3.04 (2.33-3.92)	3.64 (2.80-4.70)	4.62 (3.53-6.00)	5.44 (4.14-7.10)	6.56 (4.84-8.95)	7.41 (5.36-10.3)	8.29 (5.83-12.0)	9.24 (6.20-13.7)	10.6 (6.85-16.3)	11.6 (7.36-18.3)
15-min	2.38 (1.83-3.08)	2.85 (2.19-3.69)	3.62 (2.77-4.70)	4.26 (3.25-5.57)	5.14 (3.80-7.02)	5.81 (4.20-8.10)	6.50 (4.57-9.38)	7.25 (4.86-10.8)	8.29 (5.37-12.8)	9.12 (5.78-14.3)
30-min	1.62 (1.25-2.09)	1.94 (1.49-2.51)	2.46 (1.88-3.19)	2.89 (2.20-3.77)	3.48 (2.57-4.75)	3.93 (2.85-5.48)	4.40 (3.10-6.35)	4.91 (3.29-7.28)	5.62 (3.64-8.64)	6.19 (3.92-9.72)
60-min	1.02 (0.788-1.32)	1.23 (0.941-1.59)	1.55 (1.19-2.02)	1.82 (1.39-2.38)	2.20 (1.62-3.00)	2.48 (1.80-3.46)	2.77 (1.95-4.01)	3.10 (2.08-4.59)	3.54 (2.29-5.45)	3.91 (2.47-6.14)
2-hr	0.672 (0.520-0.864)	0.798 (0.616-1.03)	1.00 (0.772-1.30)	1.17 (0.898-1.53)	1.41 (1.05-1.91)	1.59 (1.15-2.20)	1.77 (1.25-2.55)	1.97 (1.33-2.92)	2.26 (1.47-3.46)	2.49 (1.58-3.90)
3-hr	0.521 (0.404-0.667)	0.618 (0.479-0.793)	0.778 (0.600-1.00)	0.910 (0.699-1.18)	1.09 (0.813-1.48)	1.23 (0.898-1.70)	1.37 (0.975-1.97)	1.53 (1.03-2.26)	1.76 (1.15-2.69)	1.95 (1.24-3.04)
6-hr	0.332 (0.259-0.423)	0.398 (0.309-0.507)	0.506 (0.392-0.646)	0.595 (0.459-0.765)	0.718 (0.538-0.969)	0.810 (0.595-1.12)	0.907 (0.650-1.31)	1.02 (0.691-1.50)	1.19 (0.775-1.81)	1.33 (0.847-2.06)
12-hr	0.204 (0.159-0.258)	0.249 (0.194-0.315)	0.322 (0.251-0.409)	0.383 (0.297-0.489)	0.466 (0.352-0.628)	0.528 (0.391-0.729)	0.595 (0.431-0.859)	0.677 (0.459-0.989)	0.801 (0.524-1.22)	0.908 (0.581-1.40)
24-hr	0.120 (0.094-0.151)	0.149 (0.117-0.188)	0.197 (0.155-0.249)	0.237 (0.185-0.302)	0.293 (0.222-0.393)	0.333 (0.249-0.460)	0.377 (0.276-0.547)	0.434 (0.295-0.632)	0.524 (0.343-0.791)	0.602 (0.387-0.928)
2-day	0.067 (0.053-0.084)	0.085 (0.067-0.107)	0.115 (0.091-0.144)	0.140 (0.109-0.176)	0.173 (0.133-0.233)	0.198 (0.149-0.274)	0.226 (0.167-0.329)	0.262 (0.179-0.381)	0.322 (0.212-0.485)	0.376 (0.242-0.577)
3-day	0.049 (0.039-0.061)	0.062 (0.049-0.077)	0.084 (0.066-0.105)	0.102 (0.080-0.128)	0.127 (0.097-0.170)	0.145 (0.110-0.200)	0.165 (0.123-0.241)	0.193 (0.132-0.279)	0.238 (0.157-0.357)	0.278 (0.180-0.426)
4-day	0.039 (0.031-0.049)	0.050 (0.040-0.062)	0.067 (0.053-0.084)	0.082 (0.064-0.103)	0.102 (0.078-0.136)	0.116 (0.088-0.160)	0.133 (0.099-0.192)	0.154 (0.106-0.223)	0.191 (0.126-0.285)	0.223 (0.144-0.341)
7-day	0.027 (0.021-0.033)	0.034 (0.027-0.042)	0.045 (0.036-0.056)	0.054 (0.043-0.068)	0.067 (0.051-0.089)	0.076 (0.058-0.104)	0.086 (0.064-0.124)	0.100 (0.069-0.144)	0.123 (0.081-0.183)	0.142 (0.092-0.217)
10-day	0.022 (0.017-0.027)	0.027 (0.021-0.033)	0.035 (0.028-0.043)	0.042 (0.033-0.052)	0.051 (0.040-0.068)	0.058 (0.044-0.079)	0.066 (0.049-0.094)	0.076 (0.052-0.108)	0.092 (0.061-0.136)	0.106 (0.068-0.160)
20-day	0.016 (0.013-0.019)	0.018 (0.015-0.022)	0.023 (0.018-0.028)	0.026 (0.021-0.032)	0.031 (0.024-0.041)	0.035 (0.026-0.047)	0.039 (0.029-0.054)	0.044 (0.030-0.062)	0.051 (0.034-0.075)	0.057 (0.037-0.086)
30-day	0.013 (0.011-0.016)	0.015 (0.012-0.018)	0.018 (0.014-0.022)	0.020 (0.016-0.025)	0.024 (0.018-0.030)	0.026 (0.020-0.035)	0.029 (0.021-0.040)	0.032 (0.022-0.045)	0.036 (0.024-0.053)	0.040 (0.026-0.060)
45-day	0.011 (0.009-0.013)	0.012 (0.010-0.015)	0.014 (0.011-0.017)	0.016 (0.013-0.019)	0.018 (0.014-0.023)	0.020 (0.015-0.026)	0.022 (0.016-0.029)	0.023 (0.016-0.033)	0.026 (0.017-0.038)	0.028 (0.018-0.042)
60-day	0.010 (0.008-0.012)	0.010 (0.009-0.013)	0.012 (0.010-0.015)	0.013 (0.011-0.016)	0.015 (0.012-0.019)	0.016 (0.012-0.021)	0.018 (0.013-0.024)	0.019 (0.013-0.027)	0.021 (0.014-0.030)	0.022 (0.014-0.033)

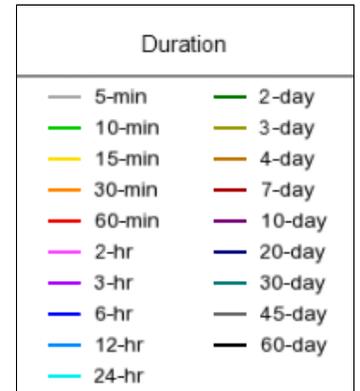
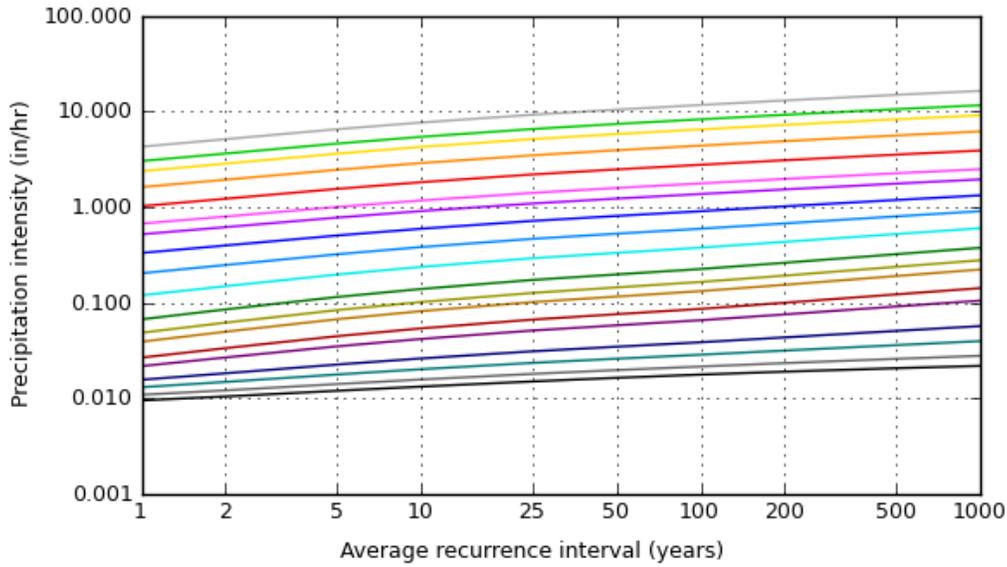
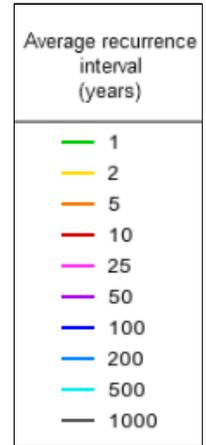
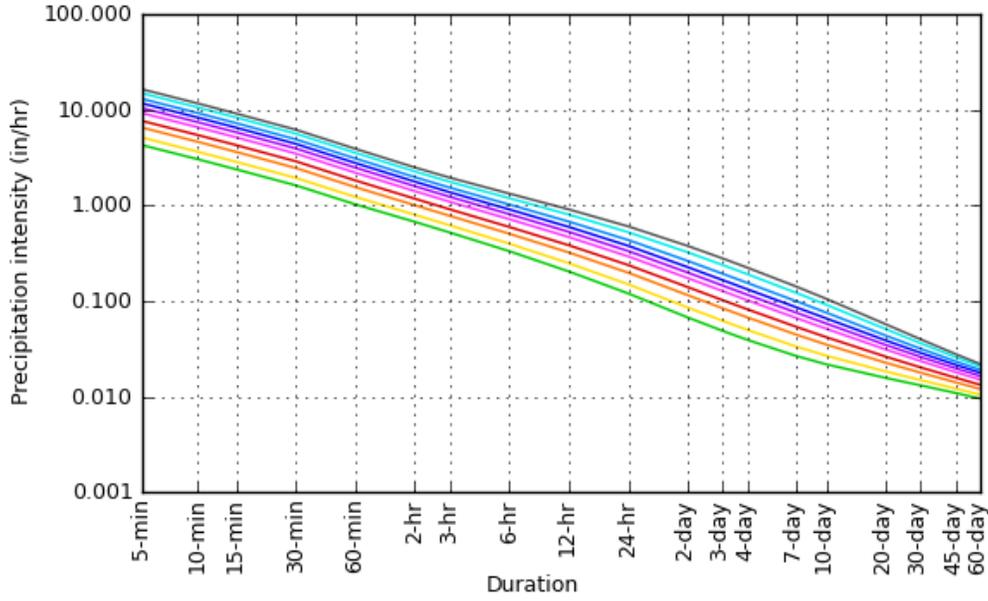
<sup>1</sup> Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS). Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values. Please refer to NOAA Atlas 14 document for more information.

[Back to Top](#)

**PF graphical**

### PDS-based intensity-duration-frequency (IDF) curves

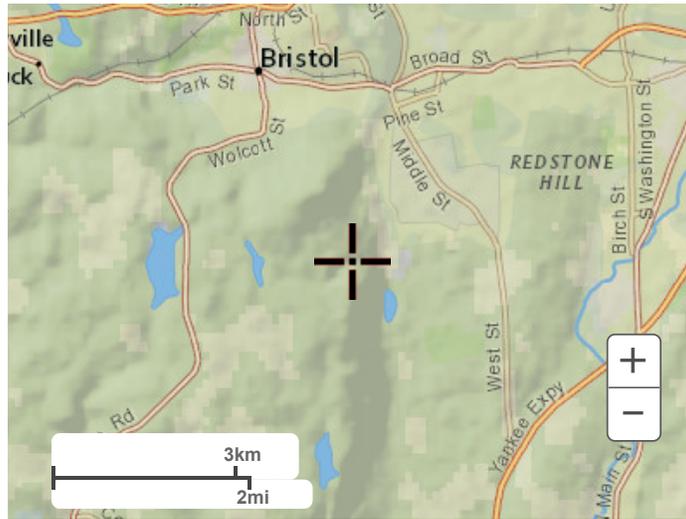
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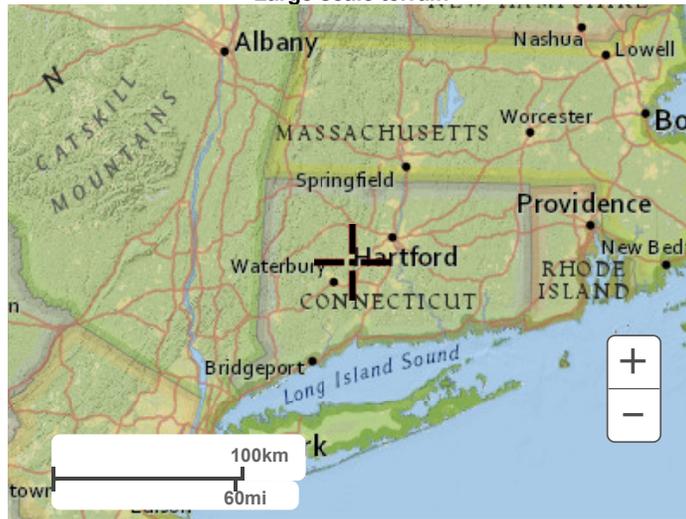
[Back to Top](#)

### Maps & arials

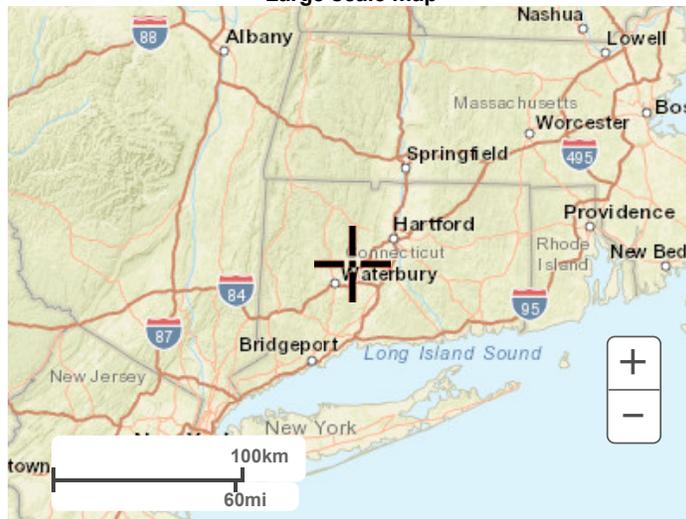
Small scale terrain



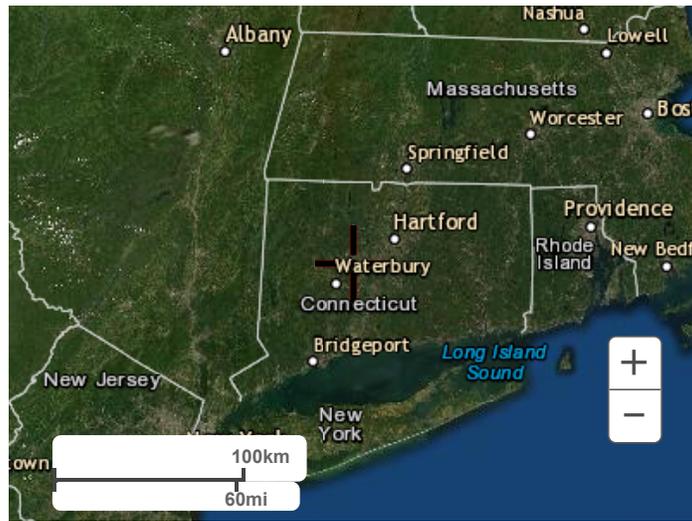
Large scale terrain



Large scale map



Large scale aerial



[Back to Top](#)

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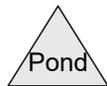
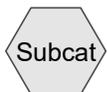
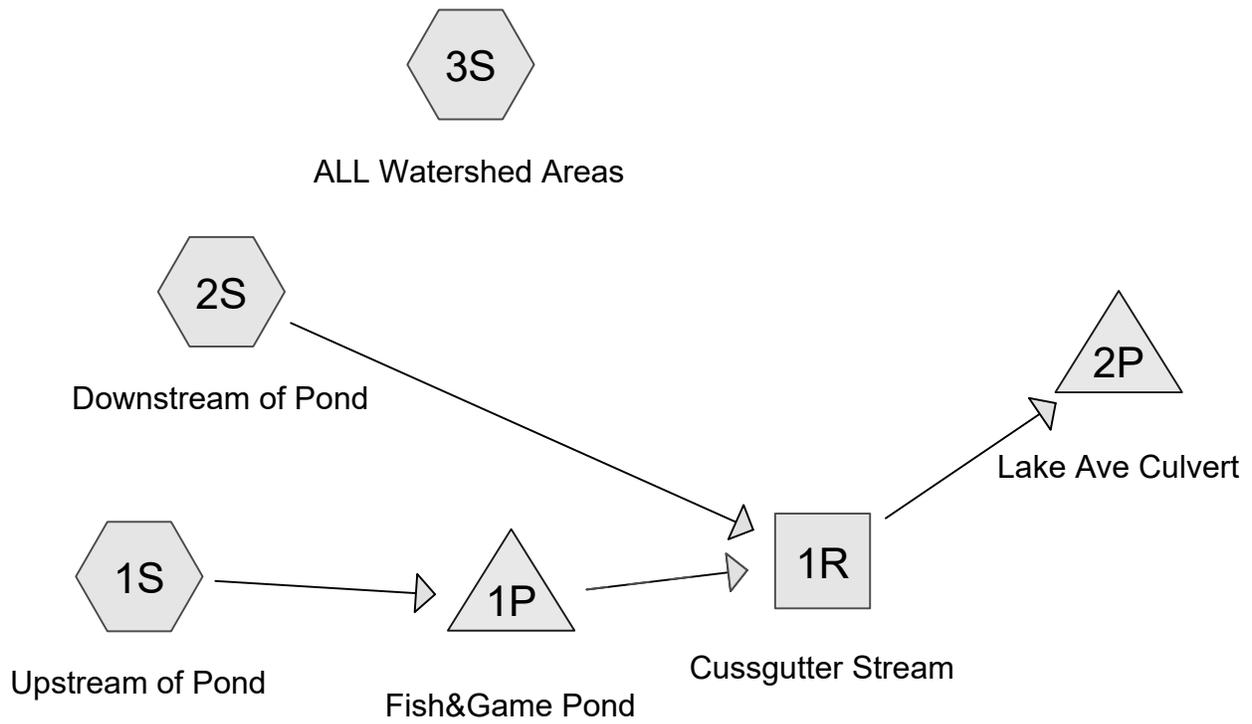
[US Department of Commerce](#)  
[National Oceanic and Atmospheric Administration](#)  
[National Weather Service](#)  
[National Water Center](#)  
1325 East West Highway  
Silver Spring, MD 20910  
Questions?: [HDSC.Questions@noaa.gov](mailto:HDSC.Questions@noaa.gov)

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# APPENDIX

# F HYDROCAD REPORT





**Lake Ave Culvert\_20210317**

Type III 24-hr 1-yr Rainfall=2.88"

Prepared by WSP

Printed 3/30/2021

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Page 2

Time span=0.00-48.00 hrs, dt=0.03 hrs, 1601 points  
Runoff by SCS TR-20 method, UH=SCS  
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

**Subcatchment1S: Upstream of Pond** Runoff Area=115.624 ac 2.96% Impervious Runoff Depth=0.65"  
Flow Length=2,373' Tc=116.5 min CN=70 Runoff=18.92 cfs 6.250 af

**Subcatchment2S: Downstream of Pond** Runoff Area=239.514 ac 0.00% Impervious Runoff Depth=0.61"  
Flow Length=6,730' Tc=113.7 min CN=69 Runoff=36.42 cfs 12.104 af

**Subcatchment3S: ALL Watershed Areas** Runoff Area=367.422 ac 0.93% Impervious Runoff Depth=0.65"  
Flow Length=9,182' Tc=155.0 min CN=70 Runoff=49.33 cfs 19.860 af

**Reach 1R: Cussgutter Stream** Avg. Flow Depth=0.88' Max Vel=7.15 fps Inflow=37.25 cfs 17.540 af  
n=0.050 L=5,896.0' S=0.1048 '/ Capacity=414.79 cfs Outflow=36.47 cfs 17.502 af

**Pond 1P: Fish&Game Pond** Peak Elev=872.28' Storage=3.613 af Inflow=18.92 cfs 6.250 af  
Primary=3.91 cfs 5.436 af Secondary=0.00 cfs 0.000 af Outflow=3.91 cfs 5.436 af

**Pond 2P: Lake Ave Culvert** Inflow=36.47 cfs 17.502 af  
Primary=36.47 cfs 17.502 af

**Total Runoff Area = 722.560 ac Runoff Volume = 38.214 af Average Runoff Depth = 0.63"**  
**99.05% Pervious = 715.713 ac 0.95% Impervious = 6.847 ac**

**Summary for Subcatchment 1S: Upstream of Pond**

Runoff = 18.92 cfs @ 13.75 hrs, Volume= 6.250 af, Depth= 0.65"

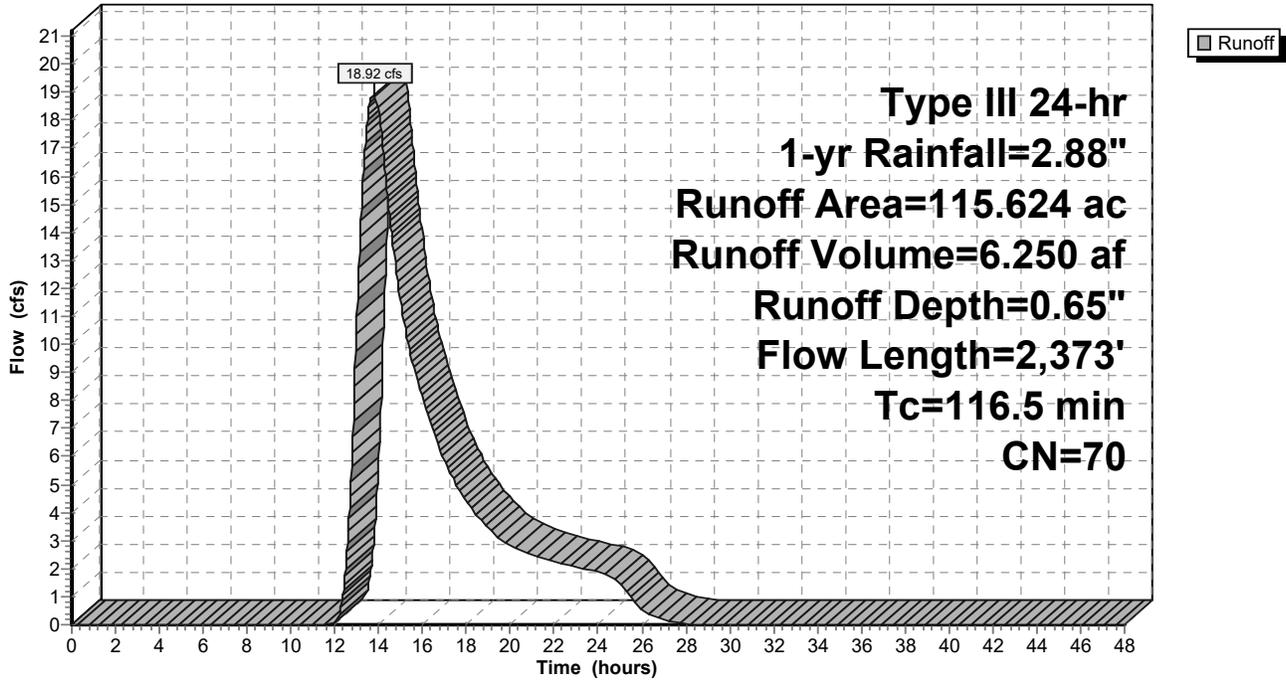
Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.03 hrs  
 Type III 24-hr 1-yr Rainfall=2.88"

Area (ac)	CN	Description
0.000	30	Woods, Good, HSG A
35.573	55	Woods, Good, HSG B
4.135	61	Pasture/grassland/range, Good, HSG B
2.710	92	Urban commercial, 85% imp, HSG B
0.437	74	Pasture/grassland/range, Good, HSG C
62.876	77	Woods, Good, HSG D
8.054	80	Pasture/grassland/range, Good, HSG D
1.124	95	Urban commercial, 85% imp, HSG D
0.658	85	1/2 acre lots, 25% imp, HSG D
0.057	98	Water Surface, 0% imp, HSG B
115.624	70	Weighted Average
112.201		97.04% Pervious Area
3.423		2.96% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
85.1	150	0.0050	0.03		<b>Sheet Flow,</b> Woods: Dense underbrush n= 0.800 P2= 3.58"
4.9	234	0.0256	0.80		<b>Shallow Concentrated Flow,</b> Woodland Kv= 5.0 fps
10.2	818	0.0709	1.33		<b>Shallow Concentrated Flow,</b> Woodland Kv= 5.0 fps
15.1	543	0.0143	0.60		<b>Shallow Concentrated Flow,</b> Woodland Kv= 5.0 fps
0.2	85	0.0200	9.11	16.09	<b>Pipe Channel, Information Unknown</b> 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.012 Concrete pipe, finished
1.0	543	0.0368	9.38	150.09	<b>Trap/Vee/Rect Channel Flow,</b> Bot.W=4.00' D=2.00' Z= 2.0 '/' Top.W=12.00' n= 0.035 Earth, dense weeds
116.5	2,373	Total			

### Subcatchment 1S: Upstream of Pond

Hydrograph



**Summary for Subcatchment 2S: Downstream of Pond**

Runoff = 36.42 cfs @ 13.76 hrs, Volume= 12.104 af, Depth= 0.61"

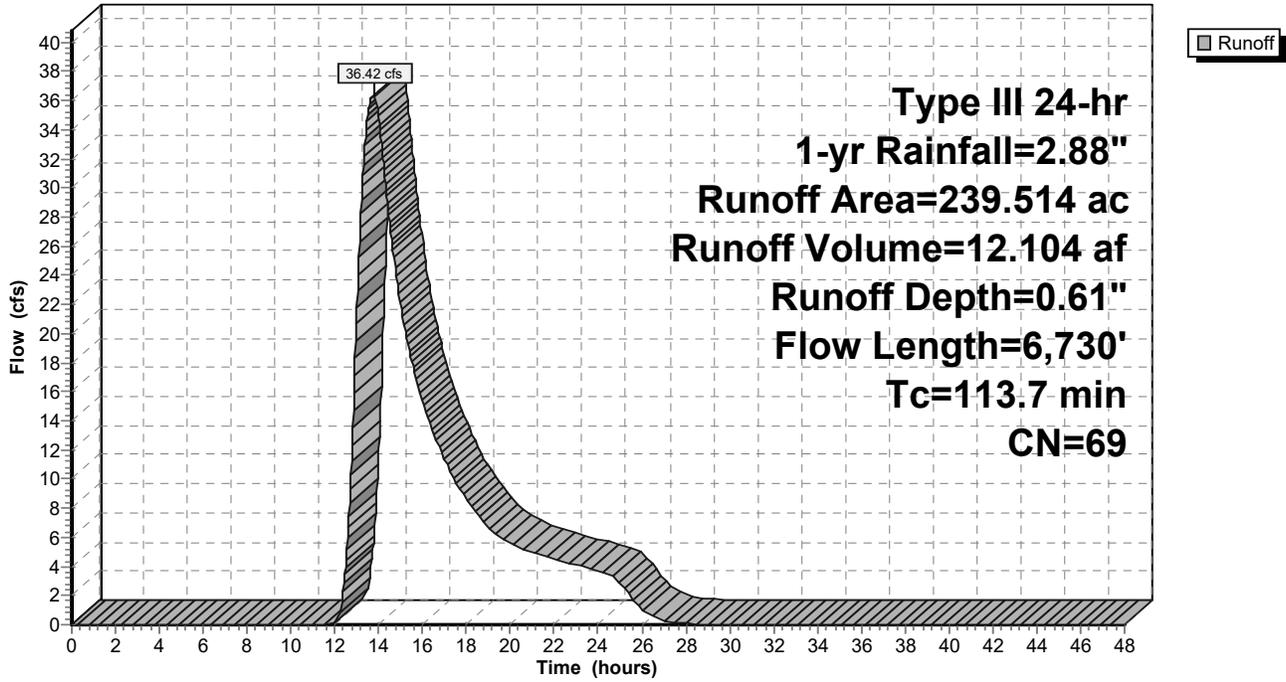
Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.03 hrs  
 Type III 24-hr 1-yr Rainfall=2.88"

Area (ac)	CN	Description
1.120	30	Woods, Good, HSG A
89.189	55	Woods, Good, HSG B
0.000	61	Pasture/grassland/range, Good, HSG B
0.000	92	Urban commercial, 85% imp, HSG B
0.000	74	Pasture/grassland/range, Good, HSG C
138.271	77	Woods, Good, HSG D
10.934	80	Pasture/grassland/range, Good, HSG D
0.000	95	Urban commercial, 85% imp, HSG D
0.000	85	1/2 acre lots, 25% imp, HSG D
0.000	98	Water Surface, 0% imp, HSG B
239.514	69	Weighted Average
239.514		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
85.1	150	0.0050	0.03		<b>Sheet Flow,</b> Woods: Dense underbrush n= 0.800 P2= 3.58"
1.6	131	0.3050	1.38		<b>Shallow Concentrated Flow,</b> Forest w/Heavy Litter Kv= 2.5 fps
3.8	202	0.1287	0.90		<b>Shallow Concentrated Flow,</b> Forest w/Heavy Litter Kv= 2.5 fps
15.5	221	0.0090	0.24		<b>Shallow Concentrated Flow,</b> Forest w/Heavy Litter Kv= 2.5 fps
0.9	340	0.0176	6.18	259.45	<b>Trap/Vee/Rect Channel Flow,</b> Bot.W=8.00' D=3.00' Z= 2.0 '/' Top.W=20.00' n= 0.050 Mountain streams w/large boulders
1.0	757	0.1340	12.90	232.16	<b>Trap/Vee/Rect Channel Flow,</b> Bot.W=5.00' D=2.00' Z= 2.0 '/' Top.W=13.00' n= 0.050 Mountain streams w/large boulders
5.8	4,929	0.1089	14.09	422.79	<b>Trap/Vee/Rect Channel Flow, Cussgutter Reach</b> Bot.W=4.00' D=3.00' Z= 2.0 '/' Top.W=16.00' n= 0.050 Mountain streams w/large boulders
113.7	6,730	Total			

**Subcatchment 2S: Downstream of Pond**

Hydrograph



**Summary for Subcatchment 3S: ALL Watershed Areas**

Runoff = 49.33 cfs @ 14.31 hrs, Volume= 19.860 af, Depth= 0.65"

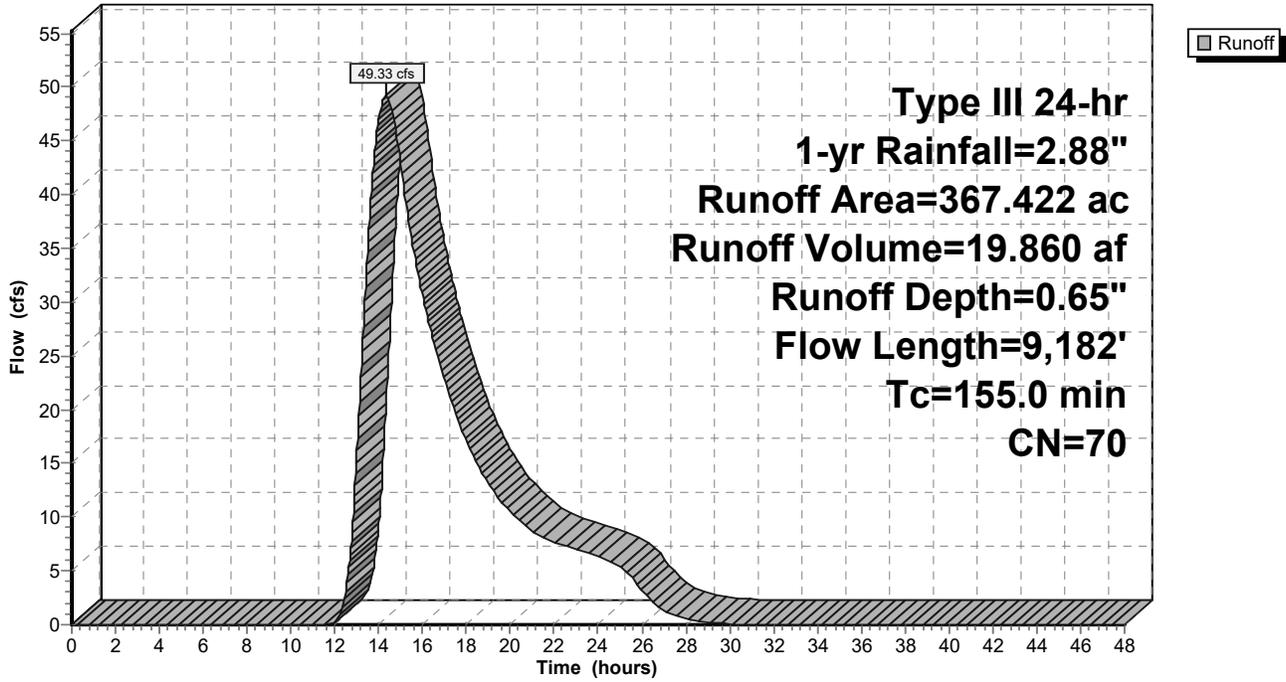
Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.03 hrs  
 Type III 24-hr 1-yr Rainfall=2.88"

Area (ac)	CN	Description
1.120	30	Woods, Good, HSG A
124.762	55	Woods, Good, HSG B
4.135	61	Pasture/grassland/range, Good, HSG B
2.710	92	Urban commercial, 85% imp, HSG B
0.437	74	Pasture/grassland/range, Good, HSG C
201.147	77	Woods, Good, HSG D
18.989	80	Pasture/grassland/range, Good, HSG D
1.124	95	Urban commercial, 85% imp, HSG D
0.658	85	1/2 acre lots, 25% imp, HSG D
12.340	98	Water Surface, 0% imp, HSG B
367.422	70	Weighted Average
363.999		99.07% Pervious Area
3.423		0.93% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
85.1	150	0.0050	0.03		<b>Sheet Flow,</b> Woods: Dense underbrush n= 0.800 P2= 3.58"
9.7	234	0.0256	0.40		<b>Shallow Concentrated Flow,</b> Forest w/Heavy Litter Kv= 2.5 fps
20.5	818	0.0709	0.67		<b>Shallow Concentrated Flow,</b> Forest w/Heavy Litter Kv= 2.5 fps
30.3	543	0.0143	0.30		<b>Shallow Concentrated Flow,</b> Forest w/Heavy Litter Kv= 2.5 fps
0.2	85	0.0200	9.11	16.09	<b>Pipe Channel,</b> 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.012 Concrete pipe, finished
1.0	543	0.0368	9.38	150.09	<b>Trap/Vee/Rect Channel Flow,</b> Bot.W=4.00' D=2.00' Z= 2.0 '/' Top.W=12.00' n= 0.035 Earth, dense weeds
1.1	913		13.90		<b>Lake or Reservoir, Fish and Game Pond</b> Mean Depth= 6.00'
7.0	5,896	0.1089	14.09	422.79	<b>Trap/Vee/Rect Channel Flow, Cussgutter Stream</b> Bot.W=4.00' D=3.00' Z= 2.0 '/' Top.W=16.00' n= 0.050 Mountain streams w/large boulders
155.0	9,182	Total			

Subcatchment 3S: ALL Watershed Areas

Hydrograph



### Summary for Reach 1R: Cussgutter Stream

Inflow Area = 355.138 ac, 0.96% Impervious, Inflow Depth > 0.59" for 1-yr event  
 Inflow = 37.25 cfs @ 13.77 hrs, Volume= 17.540 af  
 Outflow = 36.47 cfs @ 13.94 hrs, Volume= 17.502 af, Atten= 2%, Lag= 10.3 min

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.03 hrs  
 Max. Velocity= 7.15 fps, Min. Travel Time= 13.7 min  
 Avg. Velocity = 3.27 fps, Avg. Travel Time= 30.0 min

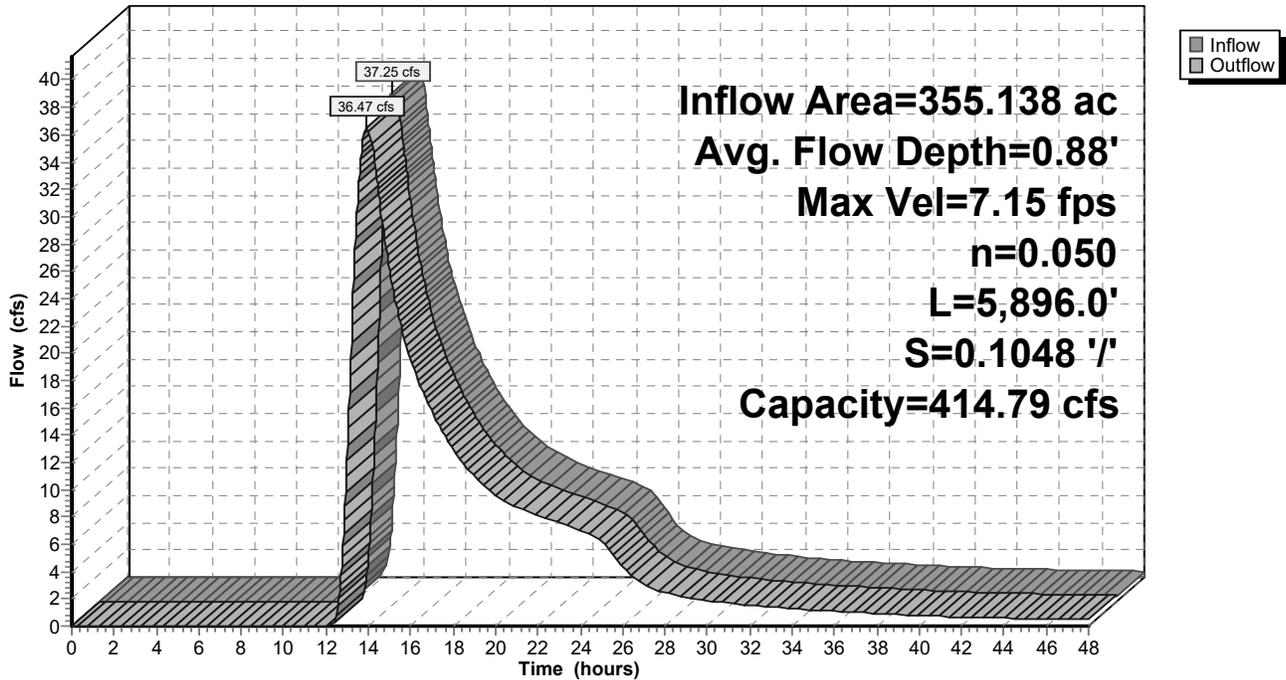
Peak Storage= 30,053 cf @ 13.94 hrs  
 Average Depth at Peak Storage= 0.88'  
 Bank-Full Depth= 3.00' Flow Area= 30.0 sf, Capacity= 414.79 cfs

4.00' x 3.00' deep channel, n= 0.050 Mountain streams w/large boulders  
 Side Slope Z-value= 2.0 '/' Top Width= 16.00'  
 Length= 5,896.0' Slope= 0.1048 '/'  
 Inlet Invert= 854.00', Outlet Invert= 236.00'



### Reach 1R: Cussgutter Stream

Hydrograph



**Summary for Pond 1P: Fish&Game Pond**

Inflow Area = 115.624 ac, 2.96% Impervious, Inflow Depth = 0.65" for 1-yr event  
 Inflow = 18.92 cfs @ 13.75 hrs, Volume= 6.250 af  
 Outflow = 3.91 cfs @ 18.48 hrs, Volume= 5.436 af, Atten= 79%, Lag= 283.7 min  
 Primary = 3.91 cfs @ 18.48 hrs, Volume= 5.436 af  
 Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.03 hrs  
 Peak Elev= 872.28' @ 18.48 hrs Surf.Area= 12.172 ac Storage= 3.613 af

Plug-Flow detention time= 589.7 min calculated for 5.433 af (87% of inflow)  
 Center-of-Mass det. time= 529.3 min ( 1,516.0 - 986.7 )

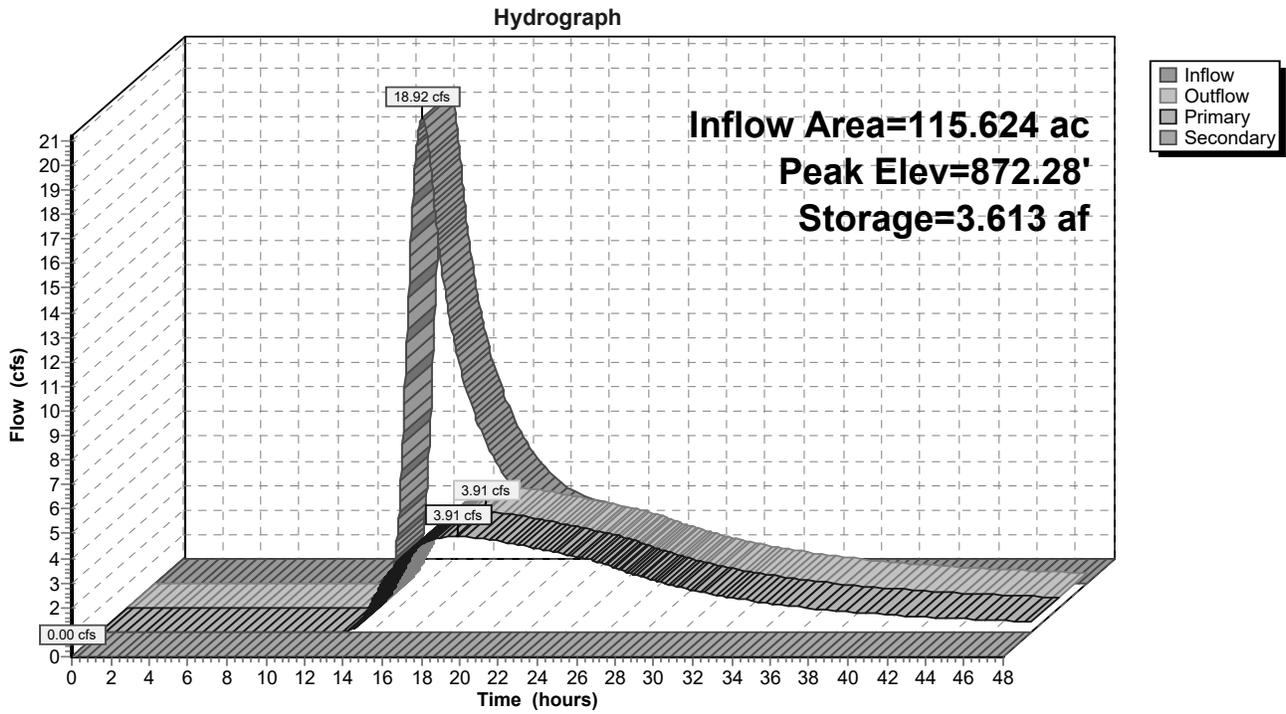
Volume	Invert	Avail.Storage	Storage Description
#1	872.00'	55.716 af	<b>Custom Stage Data (Prismatic)</b> Listed below
Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
872.00	11.910	0.000	0.000
874.00	13.769	25.679	25.679
876.00	16.268	30.037	55.716

Device	Routing	Invert	Outlet Devices
#1	Primary	872.00'	<b>24.0" x 24.0" Horiz. Orifice/Grate</b> C= 0.600 Limited to weir flow at low heads
#2	Secondary	874.00'	<b>24.0' long x 560.0' breadth Broad-Crested Rectangular Weir</b> Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

**Primary OutFlow** Max=3.90 cfs @ 18.48 hrs HW=872.28' (Free Discharge)  
 ↑1=Orifice/Grate (Weir Controls 3.90 cfs @ 1.73 fps)

**Secondary OutFlow** Max=0.00 cfs @ 0.00 hrs HW=872.00' (Free Discharge)  
 ↑2=Broad-Crested Rectangular Weir ( Controls 0.00 cfs)

### Pond 1P: Fish&Game Pond



### Summary for Pond 2P: Lake Ave Culvert

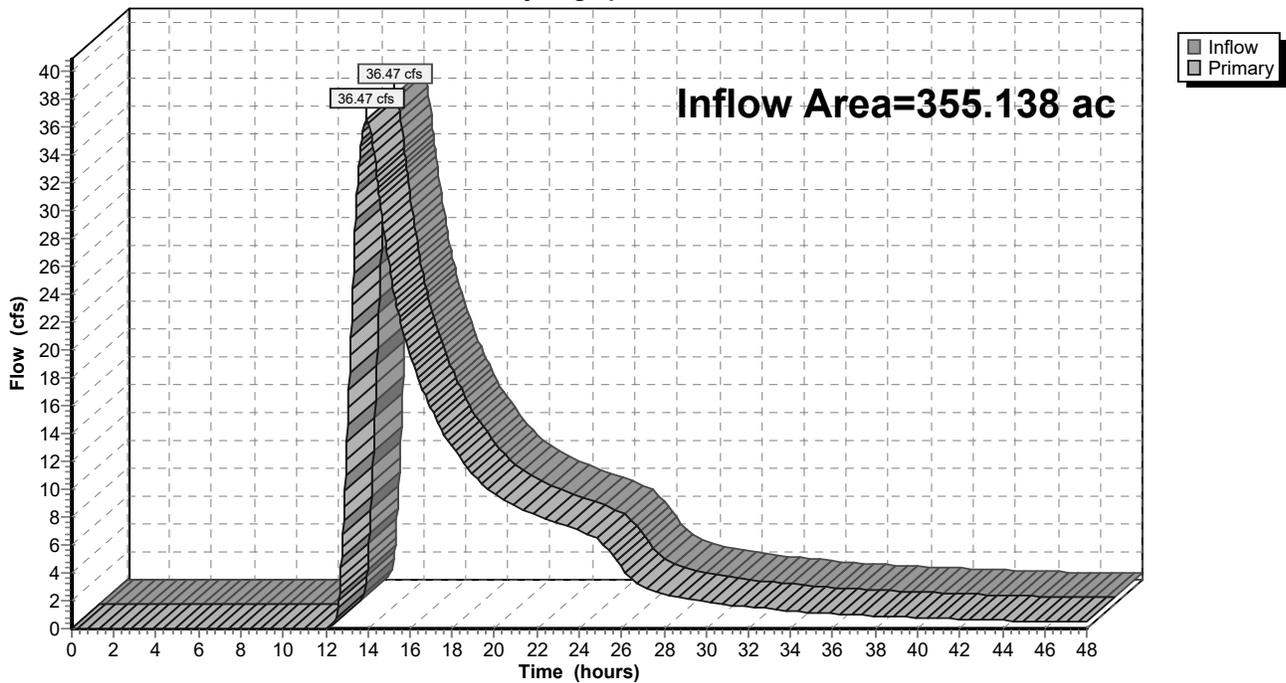
[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 355.138 ac, 0.96% Impervious, Inflow Depth > 0.59" for 1-yr event  
Inflow = 36.47 cfs @ 13.94 hrs, Volume= 17.502 af  
Primary = 36.47 cfs @ 13.94 hrs, Volume= 17.502 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.03 hrs

### Pond 2P: Lake Ave Culvert

Hydrograph



**Lake Ave Culvert\_20210317**

Type III 24-hr 2-yr Rainfall=3.58"

Prepared by WSP

Printed 3/30/2021

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Page 13

Time span=0.00-48.00 hrs, dt=0.03 hrs, 1601 points  
Runoff by SCS TR-20 method, UH=SCS  
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

**Subcatchment1S: Upstream of Pond** Runoff Area=115.624 ac 2.96% Impervious Runoff Depth=1.06"  
Flow Length=2,373' Tc=116.5 min CN=70 Runoff=33.31 cfs 10.193 af

**Subcatchment2S: Downstream of Pond** Runoff Area=239.514 ac 0.00% Impervious Runoff Depth=1.00"  
Flow Length=6,730' Tc=113.7 min CN=69 Runoff=65.41 cfs 20.004 af

**Subcatchment3S: ALL Watershed Areas** Runoff Area=367.422 ac 0.93% Impervious Runoff Depth=1.06"  
Flow Length=9,182' Tc=155.0 min CN=70 Runoff=86.16 cfs 32.389 af

**Reach 1R: Cussgutter Stream** Avg. Flow Depth=1.22' Max Vel=8.49 fps Inflow=67.18 cfs 29.241 af  
n=0.050 L=5,896.0' S=0.1048 '/ Capacity=414.79 cfs Outflow=66.32 cfs 29.197 af

**Pond 1P: Fish&Game Pond** Peak Elev=872.44' Storage=5.629 af Inflow=33.31 cfs 10.193 af  
Primary=7.60 cfs 9.237 af Secondary=0.00 cfs 0.000 af Outflow=7.60 cfs 9.237 af

**Pond 2P: Lake Ave Culvert** Inflow=66.32 cfs 29.197 af  
Primary=66.32 cfs 29.197 af

**Total Runoff Area = 722.560 ac Runoff Volume = 62.586 af Average Runoff Depth = 1.04"**  
**99.05% Pervious = 715.713 ac 0.95% Impervious = 6.847 ac**

**Summary for Subcatchment 1S: Upstream of Pond**

Runoff = 33.31 cfs @ 13.68 hrs, Volume= 10.193 af, Depth= 1.06"

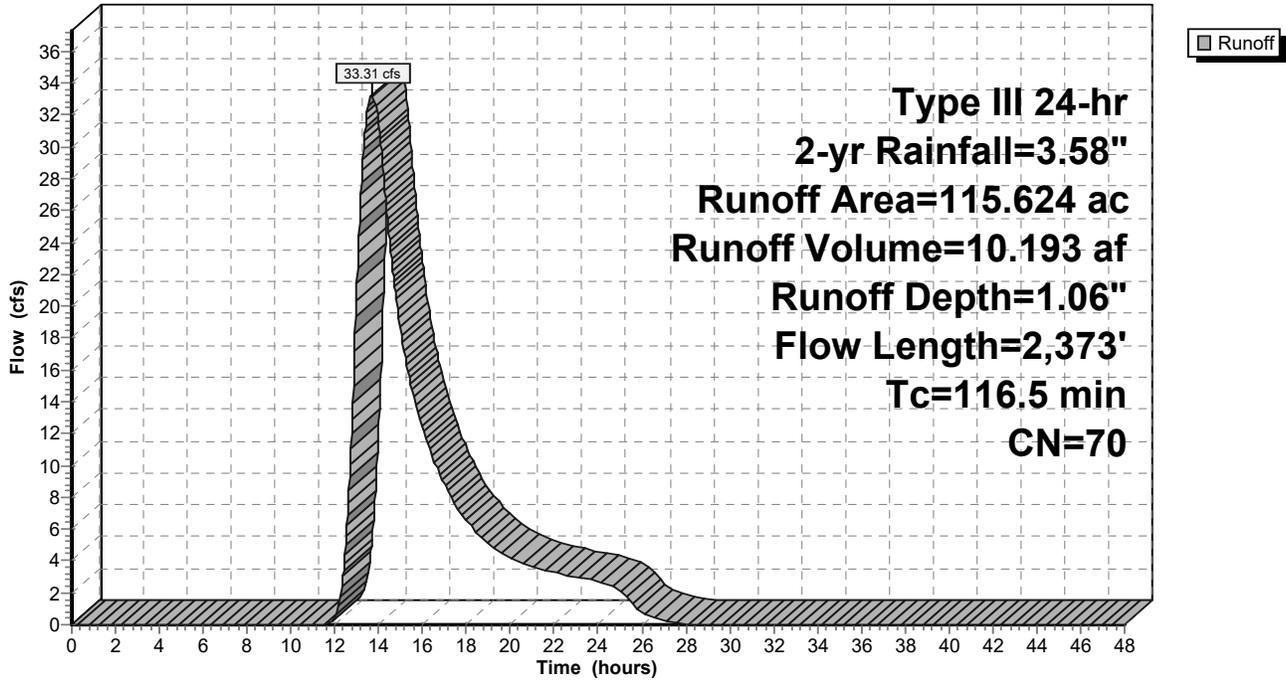
Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.03 hrs  
Type III 24-hr 2-yr Rainfall=3.58"

Area (ac)	CN	Description
0.000	30	Woods, Good, HSG A
35.573	55	Woods, Good, HSG B
4.135	61	Pasture/grassland/range, Good, HSG B
2.710	92	Urban commercial, 85% imp, HSG B
0.437	74	Pasture/grassland/range, Good, HSG C
62.876	77	Woods, Good, HSG D
8.054	80	Pasture/grassland/range, Good, HSG D
1.124	95	Urban commercial, 85% imp, HSG D
0.658	85	1/2 acre lots, 25% imp, HSG D
0.057	98	Water Surface, 0% imp, HSG B
115.624	70	Weighted Average
112.201		97.04% Pervious Area
3.423		2.96% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
85.1	150	0.0050	0.03		<b>Sheet Flow,</b> Woods: Dense underbrush n= 0.800 P2= 3.58"
4.9	234	0.0256	0.80		<b>Shallow Concentrated Flow,</b> Woodland Kv= 5.0 fps
10.2	818	0.0709	1.33		<b>Shallow Concentrated Flow,</b> Woodland Kv= 5.0 fps
15.1	543	0.0143	0.60		<b>Shallow Concentrated Flow,</b> Woodland Kv= 5.0 fps
0.2	85	0.0200	9.11	16.09	<b>Pipe Channel, Information Unknown</b> 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.012 Concrete pipe, finished
1.0	543	0.0368	9.38	150.09	<b>Trap/Vee/Rect Channel Flow,</b> Bot.W=4.00' D=2.00' Z= 2.0 '/' Top.W=12.00' n= 0.035 Earth, dense weeds
116.5	2,373	Total			

### Subcatchment 1S: Upstream of Pond

Hydrograph



**Summary for Subcatchment 2S: Downstream of Pond**

Runoff = 65.41 cfs @ 13.65 hrs, Volume= 20.004 af, Depth= 1.00"

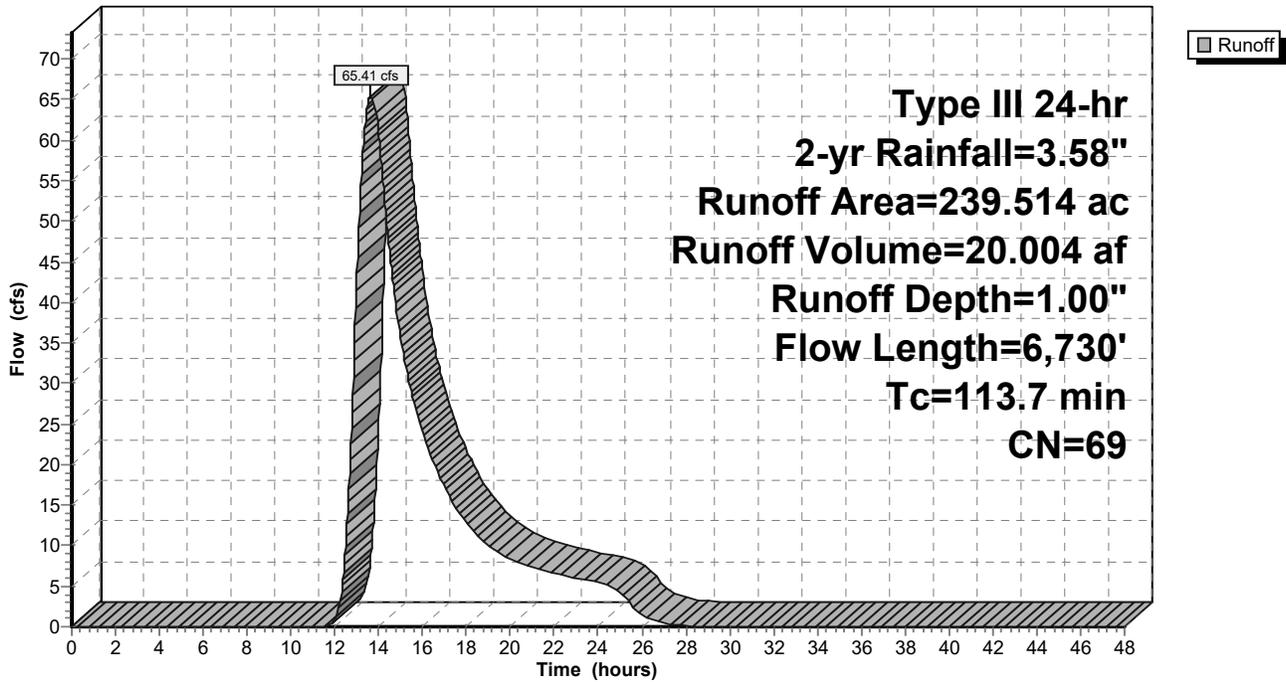
Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.03 hrs  
 Type III 24-hr 2-yr Rainfall=3.58"

Area (ac)	CN	Description
1.120	30	Woods, Good, HSG A
89.189	55	Woods, Good, HSG B
0.000	61	Pasture/grassland/range, Good, HSG B
0.000	92	Urban commercial, 85% imp, HSG B
0.000	74	Pasture/grassland/range, Good, HSG C
138.271	77	Woods, Good, HSG D
10.934	80	Pasture/grassland/range, Good, HSG D
0.000	95	Urban commercial, 85% imp, HSG D
0.000	85	1/2 acre lots, 25% imp, HSG D
0.000	98	Water Surface, 0% imp, HSG B
239.514	69	Weighted Average
239.514		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
85.1	150	0.0050	0.03		<b>Sheet Flow,</b> Woods: Dense underbrush n= 0.800 P2= 3.58"
1.6	131	0.3050	1.38		<b>Shallow Concentrated Flow,</b> Forest w/Heavy Litter Kv= 2.5 fps
3.8	202	0.1287	0.90		<b>Shallow Concentrated Flow,</b> Forest w/Heavy Litter Kv= 2.5 fps
15.5	221	0.0090	0.24		<b>Shallow Concentrated Flow,</b> Forest w/Heavy Litter Kv= 2.5 fps
0.9	340	0.0176	6.18	259.45	<b>Trap/Vee/Rect Channel Flow,</b> Bot.W=8.00' D=3.00' Z= 2.0 '/' Top.W=20.00' n= 0.050 Mountain streams w/large boulders
1.0	757	0.1340	12.90	232.16	<b>Trap/Vee/Rect Channel Flow,</b> Bot.W=5.00' D=2.00' Z= 2.0 '/' Top.W=13.00' n= 0.050 Mountain streams w/large boulders
5.8	4,929	0.1089	14.09	422.79	<b>Trap/Vee/Rect Channel Flow, Cussgutter Reach</b> Bot.W=4.00' D=3.00' Z= 2.0 '/' Top.W=16.00' n= 0.050 Mountain streams w/large boulders
113.7	6,730	Total			

Subcatchment 2S: Downstream of Pond

Hydrograph



**Summary for Subcatchment 3S: ALL Watershed Areas**

Runoff = 86.16 cfs @ 14.28 hrs, Volume= 32.389 af, Depth= 1.06"

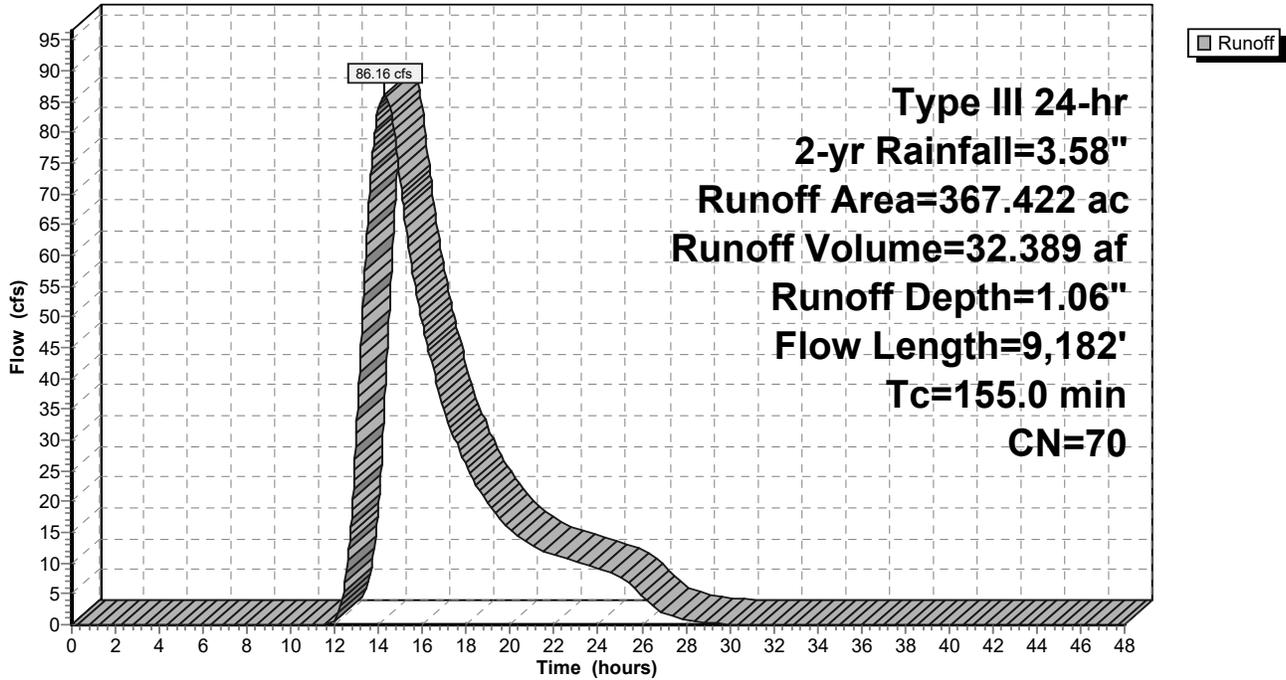
Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.03 hrs  
 Type III 24-hr 2-yr Rainfall=3.58"

Area (ac)	CN	Description
1.120	30	Woods, Good, HSG A
124.762	55	Woods, Good, HSG B
4.135	61	Pasture/grassland/range, Good, HSG B
2.710	92	Urban commercial, 85% imp, HSG B
0.437	74	Pasture/grassland/range, Good, HSG C
201.147	77	Woods, Good, HSG D
18.989	80	Pasture/grassland/range, Good, HSG D
1.124	95	Urban commercial, 85% imp, HSG D
0.658	85	1/2 acre lots, 25% imp, HSG D
12.340	98	Water Surface, 0% imp, HSG B
367.422	70	Weighted Average
363.999		99.07% Pervious Area
3.423		0.93% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
85.1	150	0.0050	0.03		<b>Sheet Flow,</b> Woods: Dense underbrush n= 0.800 P2= 3.58"
9.7	234	0.0256	0.40		<b>Shallow Concentrated Flow,</b> Forest w/Heavy Litter Kv= 2.5 fps
20.5	818	0.0709	0.67		<b>Shallow Concentrated Flow,</b> Forest w/Heavy Litter Kv= 2.5 fps
30.3	543	0.0143	0.30		<b>Shallow Concentrated Flow,</b> Forest w/Heavy Litter Kv= 2.5 fps
0.2	85	0.0200	9.11	16.09	<b>Pipe Channel,</b> 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.012 Concrete pipe, finished
1.0	543	0.0368	9.38	150.09	<b>Trap/Vee/Rect Channel Flow,</b> Bot.W=4.00' D=2.00' Z= 2.0 '/' Top.W=12.00' n= 0.035 Earth, dense weeds
1.1	913		13.90		<b>Lake or Reservoir, Fish and Game Pond</b> Mean Depth= 6.00'
7.0	5,896	0.1089	14.09	422.79	<b>Trap/Vee/Rect Channel Flow, Cussgutter Stream</b> Bot.W=4.00' D=3.00' Z= 2.0 '/' Top.W=16.00' n= 0.050 Mountain streams w/large boulders
155.0	9,182	Total			

**Subcatchment 3S: ALL Watershed Areas**

Hydrograph



### Summary for Reach 1R: Cussgutter Stream

Inflow Area = 355.138 ac, 0.96% Impervious, Inflow Depth > 0.99" for 2-yr event  
 Inflow = 67.18 cfs @ 13.74 hrs, Volume= 29.241 af  
 Outflow = 66.32 cfs @ 13.84 hrs, Volume= 29.197 af, Atten= 1%, Lag= 6.1 min

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.03 hrs  
 Max. Velocity= 8.49 fps, Min. Travel Time= 11.6 min  
 Avg. Velocity = 3.74 fps, Avg. Travel Time= 26.2 min

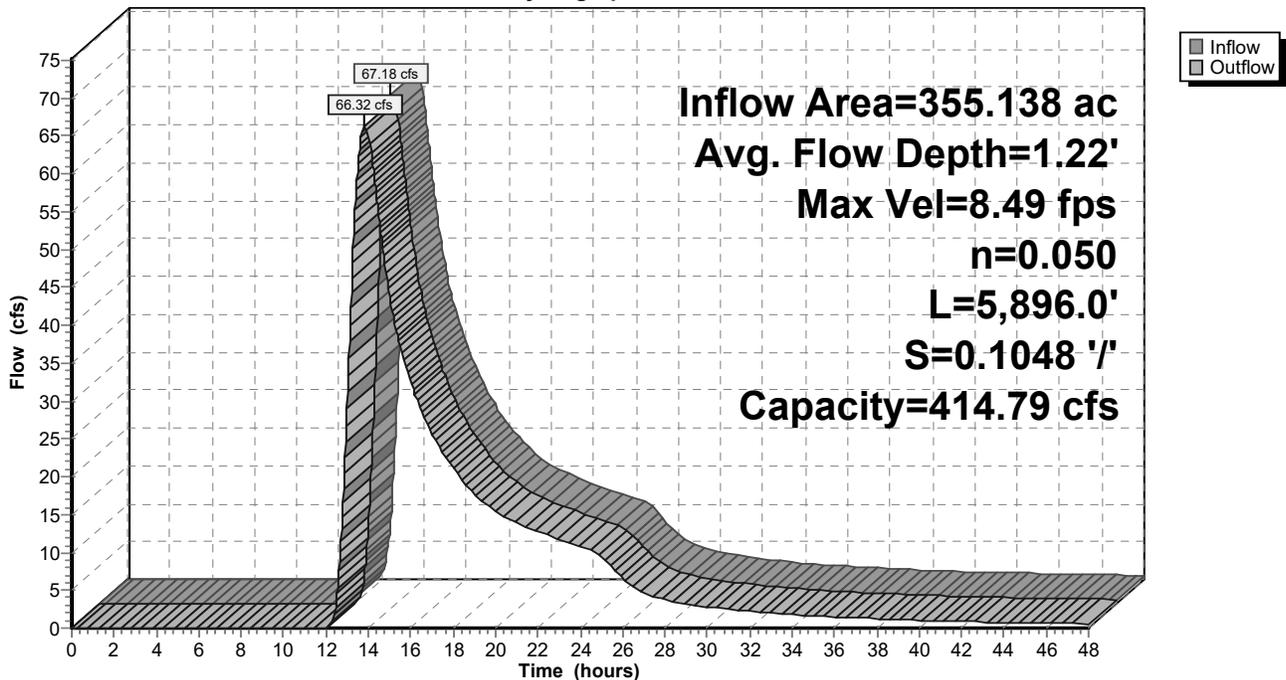
Peak Storage= 46,073 cf @ 13.84 hrs  
 Average Depth at Peak Storage= 1.22'  
 Bank-Full Depth= 3.00' Flow Area= 30.0 sf, Capacity= 414.79 cfs

4.00' x 3.00' deep channel, n= 0.050 Mountain streams w/large boulders  
 Side Slope Z-value= 2.0 '/' Top Width= 16.00'  
 Length= 5,896.0' Slope= 0.1048 '/'  
 Inlet Invert= 854.00', Outlet Invert= 236.00'



### Reach 1R: Cussgutter Stream

Hydrograph



**Summary for Pond 1P: Fish&Game Pond**

Inflow Area = 115.624 ac, 2.96% Impervious, Inflow Depth = 1.06" for 2-yr event  
 Inflow = 33.31 cfs @ 13.68 hrs, Volume= 10.193 af  
 Outflow = 7.60 cfs @ 17.48 hrs, Volume= 9.237 af, Atten= 77%, Lag= 227.9 min  
 Primary = 7.60 cfs @ 17.48 hrs, Volume= 9.237 af  
 Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.03 hrs  
 Peak Elev= 872.44' @ 17.48 hrs Surf.Area= 12.318 ac Storage= 5.629 af

Plug-Flow detention time= 519.4 min calculated for 9.231 af (91% of inflow)  
 Center-of-Mass det. time= 473.4 min ( 1,443.7 - 970.3 )

Volume	Invert	Avail.Storage	Storage Description
#1	872.00'	55.716 af	<b>Custom Stage Data (Prismatic)</b> Listed below
Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
872.00	11.910	0.000	0.000
874.00	13.769	25.679	25.679
876.00	16.268	30.037	55.716

Device	Routing	Invert	Outlet Devices
#1	Primary	872.00'	<b>24.0" x 24.0" Horiz. Orifice/Grate</b> C= 0.600 Limited to weir flow at low heads
#2	Secondary	874.00'	<b>24.0' long x 560.0' breadth Broad-Crested Rectangular Weir</b> Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

**Primary OutFlow** Max=7.59 cfs @ 17.48 hrs HW=872.44' (Free Discharge)

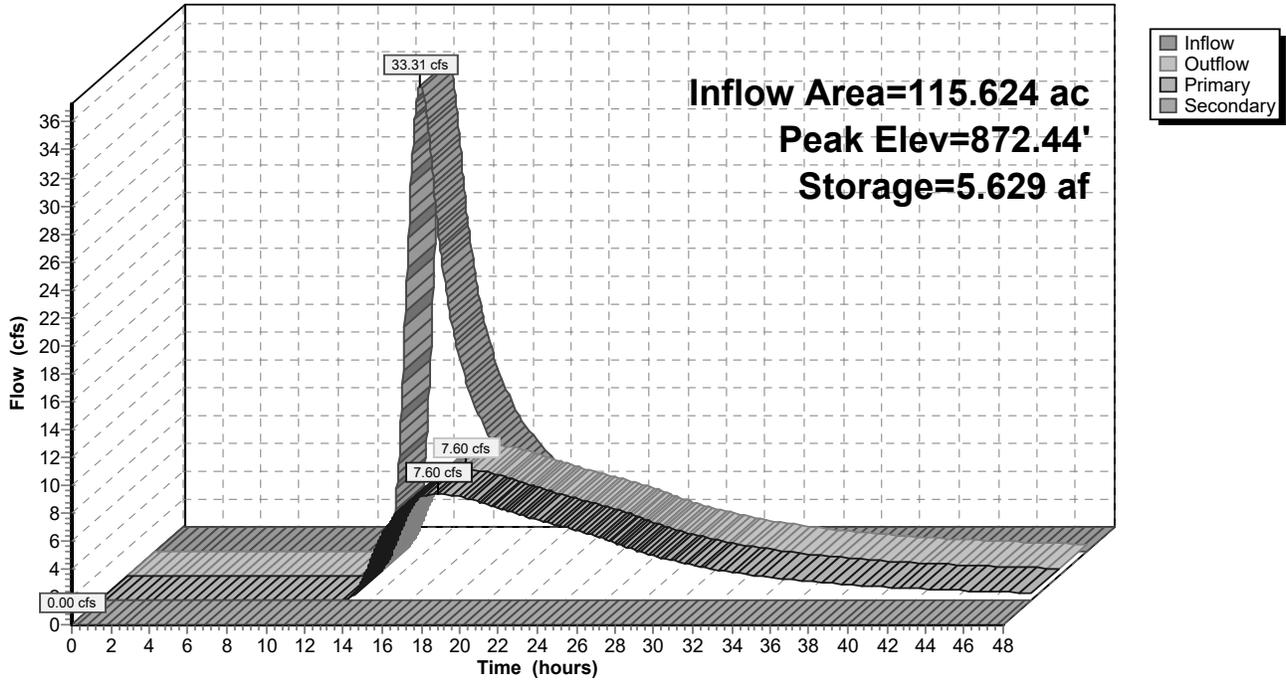
↑1=**Orifice/Grate** (Weir Controls 7.59 cfs @ 2.17 fps)

**Secondary OutFlow** Max=0.00 cfs @ 0.00 hrs HW=872.00' (Free Discharge)

↑2=**Broad-Crested Rectangular Weir** ( Controls 0.00 cfs)

### Pond 1P: Fish&Game Pond

Hydrograph



### Summary for Pond 2P: Lake Ave Culvert

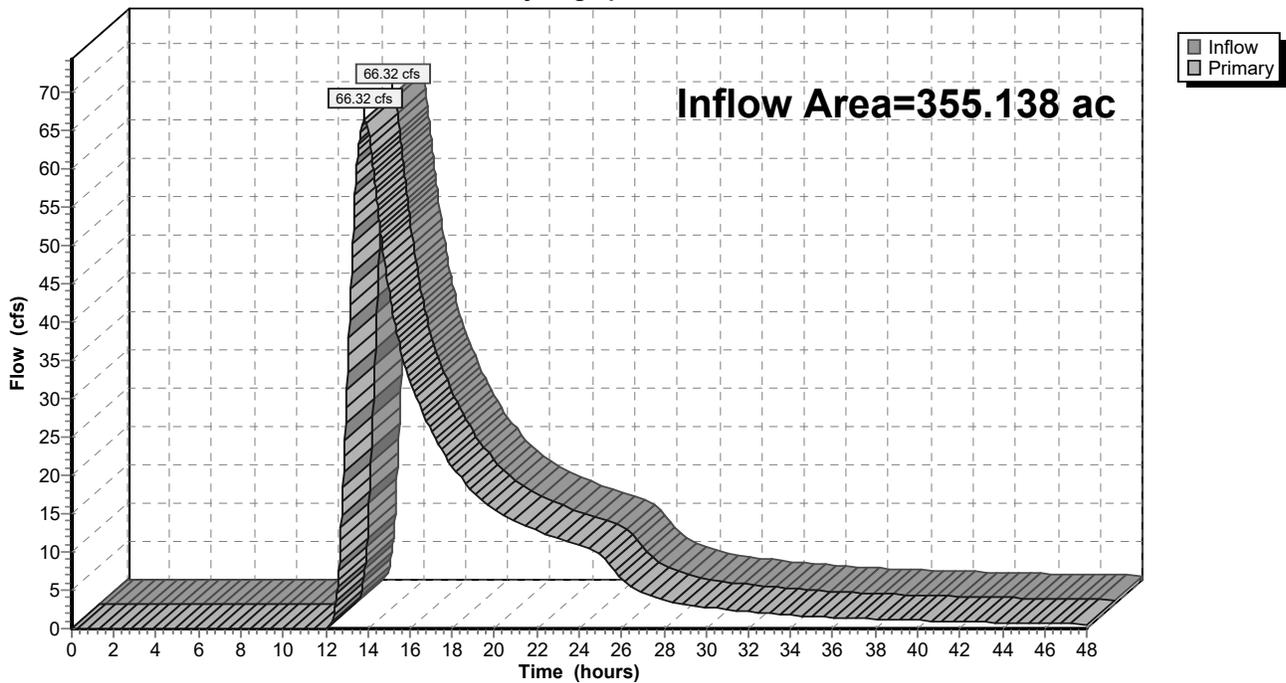
[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 355.138 ac, 0.96% Impervious, Inflow Depth > 0.99" for 2-yr event  
Inflow = 66.32 cfs @ 13.84 hrs, Volume= 29.197 af  
Primary = 66.32 cfs @ 13.84 hrs, Volume= 29.197 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.03 hrs

### Pond 2P: Lake Ave Culvert

Hydrograph



**Lake Ave Culvert\_20210317**

Type III 24-hr 5-yr Rainfall=4.74"

Prepared by WSP

Printed 3/30/2021

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Page 24

Time span=0.00-48.00 hrs, dt=0.03 hrs, 1601 points  
Runoff by SCS TR-20 method, UH=SCS  
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

**Subcatchment1S: Upstream of Pond** Runoff Area=115.624 ac 2.96% Impervious Runoff Depth=1.85"  
Flow Length=2,373' Tc=116.5 min CN=70 Runoff=61.70 cfs 17.784 af

**Subcatchment2S: Downstream of Pond** Runoff Area=239.514 ac 0.00% Impervious Runoff Depth=1.77"  
Flow Length=6,730' Tc=113.7 min CN=69 Runoff=123.27 cfs 35.341 af

**Subcatchment3S: ALL Watershed Areas** Runoff Area=367.422 ac 0.93% Impervious Runoff Depth=1.85"  
Flow Length=9,182' Tc=155.0 min CN=70 Runoff=158.18 cfs 56.512 af

**Reach 1R: Cussgutter Stream** Avg. Flow Depth=1.69' Max Vel=10.13 fps Inflow=127.78 cfs 52.012 af  
n=0.050 L=5,896.0' S=0.1048 1/ Capacity=414.79 cfs Outflow=126.53 cfs 51.961 af

**Pond 1P: Fish&Game Pond** Peak Elev=872.73' Storage=9.332 af Inflow=61.70 cfs 17.784 af  
Primary=16.12 cfs 16.671 af Secondary=0.00 cfs 0.000 af Outflow=16.12 cfs 16.671 af

**Pond 2P: Lake Ave Culvert** Inflow=126.53 cfs 51.961 af  
Primary=126.53 cfs 51.961 af

**Total Runoff Area = 722.560 ac Runoff Volume = 109.637 af Average Runoff Depth = 1.82"**  
**99.05% Pervious = 715.713 ac 0.95% Impervious = 6.847 ac**

**Summary for Subcatchment 1S: Upstream of Pond**

Runoff = 61.70 cfs @ 13.60 hrs, Volume= 17.784 af, Depth= 1.85"

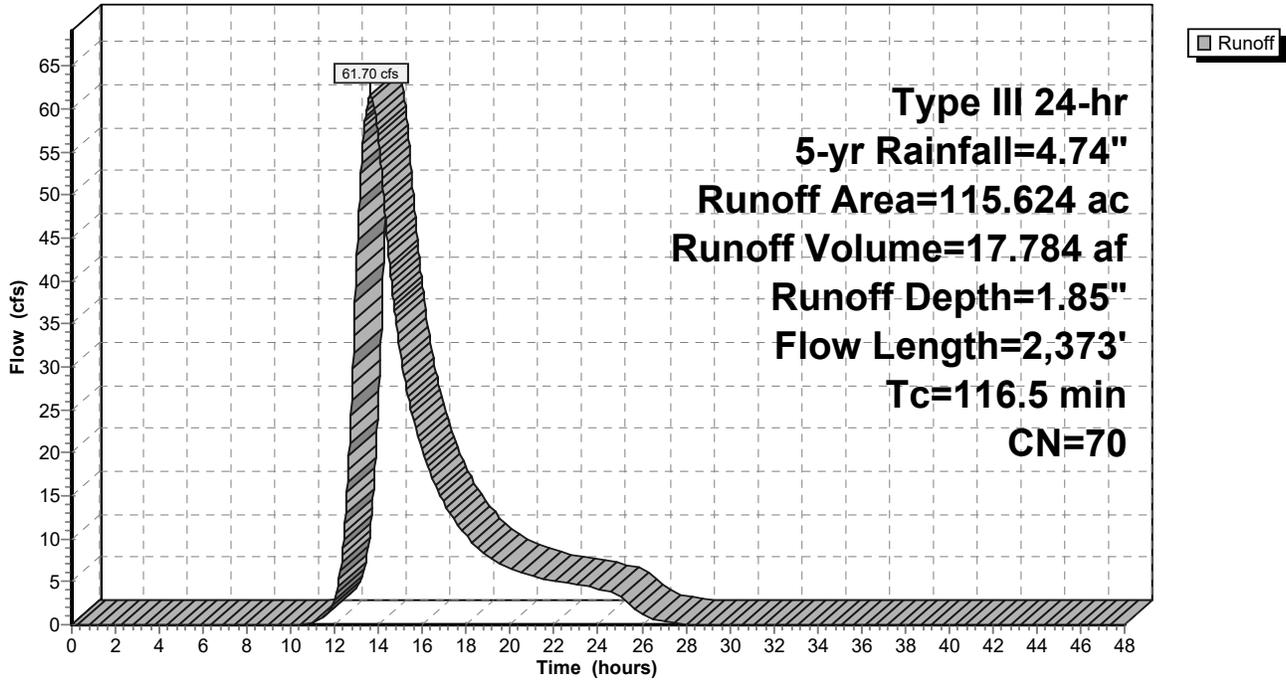
Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.03 hrs  
 Type III 24-hr 5-yr Rainfall=4.74"

Area (ac)	CN	Description
0.000	30	Woods, Good, HSG A
35.573	55	Woods, Good, HSG B
4.135	61	Pasture/grassland/range, Good, HSG B
2.710	92	Urban commercial, 85% imp, HSG B
0.437	74	Pasture/grassland/range, Good, HSG C
62.876	77	Woods, Good, HSG D
8.054	80	Pasture/grassland/range, Good, HSG D
1.124	95	Urban commercial, 85% imp, HSG D
0.658	85	1/2 acre lots, 25% imp, HSG D
0.057	98	Water Surface, 0% imp, HSG B
115.624	70	Weighted Average
112.201		97.04% Pervious Area
3.423		2.96% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
85.1	150	0.0050	0.03		<b>Sheet Flow,</b> Woods: Dense underbrush n= 0.800 P2= 3.58"
4.9	234	0.0256	0.80		<b>Shallow Concentrated Flow,</b> Woodland Kv= 5.0 fps
10.2	818	0.0709	1.33		<b>Shallow Concentrated Flow,</b> Woodland Kv= 5.0 fps
15.1	543	0.0143	0.60		<b>Shallow Concentrated Flow,</b> Woodland Kv= 5.0 fps
0.2	85	0.0200	9.11	16.09	<b>Pipe Channel, Information Unknown</b> 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.012 Concrete pipe, finished
1.0	543	0.0368	9.38	150.09	<b>Trap/Vee/Rect Channel Flow,</b> Bot.W=4.00' D=2.00' Z= 2.0 '/' Top.W=12.00' n= 0.035 Earth, dense weeds
116.5	2,373	Total			

Subcatchment 1S: Upstream of Pond

Hydrograph



**Summary for Subcatchment 2S: Downstream of Pond**

Runoff = 123.27 cfs @ 13.54 hrs, Volume= 35.341 af, Depth= 1.77"

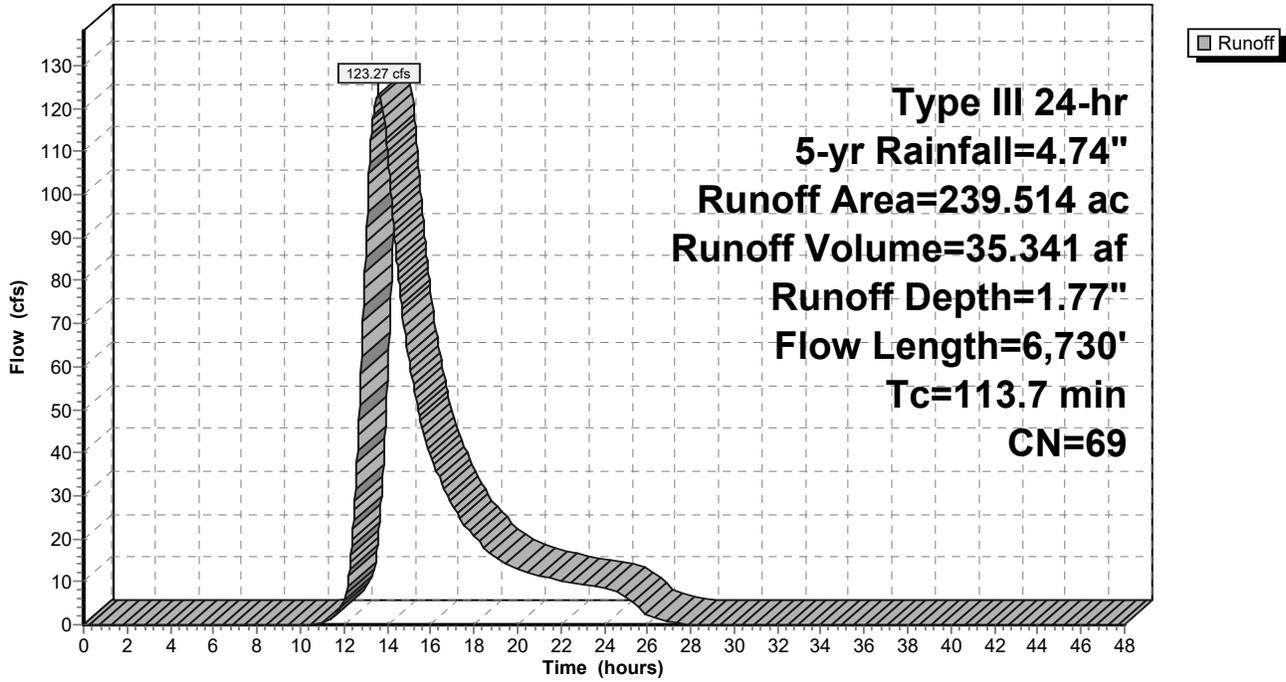
Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.03 hrs  
 Type III 24-hr 5-yr Rainfall=4.74"

Area (ac)	CN	Description
1.120	30	Woods, Good, HSG A
89.189	55	Woods, Good, HSG B
0.000	61	Pasture/grassland/range, Good, HSG B
0.000	92	Urban commercial, 85% imp, HSG B
0.000	74	Pasture/grassland/range, Good, HSG C
138.271	77	Woods, Good, HSG D
10.934	80	Pasture/grassland/range, Good, HSG D
0.000	95	Urban commercial, 85% imp, HSG D
0.000	85	1/2 acre lots, 25% imp, HSG D
0.000	98	Water Surface, 0% imp, HSG B
239.514	69	Weighted Average
239.514		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
85.1	150	0.0050	0.03		<b>Sheet Flow,</b> Woods: Dense underbrush n= 0.800 P2= 3.58"
1.6	131	0.3050	1.38		<b>Shallow Concentrated Flow,</b> Forest w/Heavy Litter Kv= 2.5 fps
3.8	202	0.1287	0.90		<b>Shallow Concentrated Flow,</b> Forest w/Heavy Litter Kv= 2.5 fps
15.5	221	0.0090	0.24		<b>Shallow Concentrated Flow,</b> Forest w/Heavy Litter Kv= 2.5 fps
0.9	340	0.0176	6.18	259.45	<b>Trap/Vee/Rect Channel Flow,</b> Bot.W=8.00' D=3.00' Z= 2.0 '/' Top.W=20.00' n= 0.050 Mountain streams w/large boulders
1.0	757	0.1340	12.90	232.16	<b>Trap/Vee/Rect Channel Flow,</b> Bot.W=5.00' D=2.00' Z= 2.0 '/' Top.W=13.00' n= 0.050 Mountain streams w/large boulders
5.8	4,929	0.1089	14.09	422.79	<b>Trap/Vee/Rect Channel Flow, Cussgutter Reach</b> Bot.W=4.00' D=3.00' Z= 2.0 '/' Top.W=16.00' n= 0.050 Mountain streams w/large boulders
113.7	6,730	Total			

Subcatchment 2S: Downstream of Pond

Hydrograph



**Summary for Subcatchment 3S: ALL Watershed Areas**

Runoff = 158.18 cfs @ 14.14 hrs, Volume= 56.512 af, Depth= 1.85"

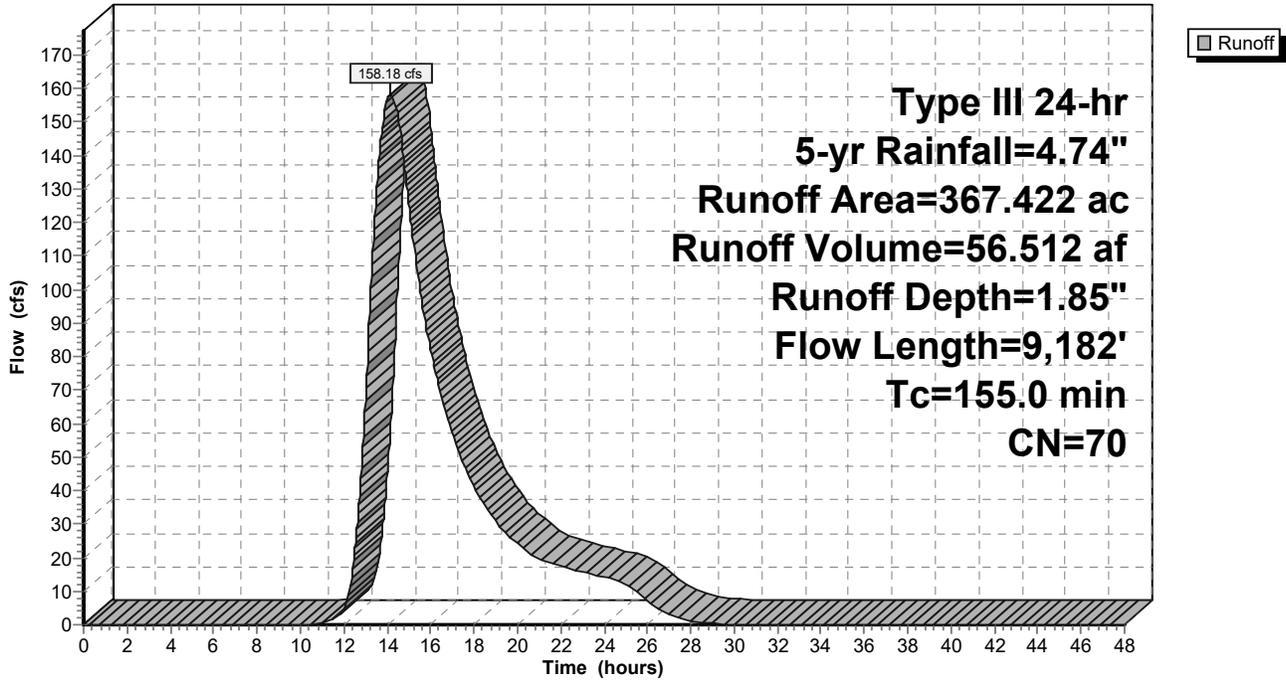
Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.03 hrs  
Type III 24-hr 5-yr Rainfall=4.74"

Area (ac)	CN	Description
1.120	30	Woods, Good, HSG A
124.762	55	Woods, Good, HSG B
4.135	61	Pasture/grassland/range, Good, HSG B
2.710	92	Urban commercial, 85% imp, HSG B
0.437	74	Pasture/grassland/range, Good, HSG C
201.147	77	Woods, Good, HSG D
18.989	80	Pasture/grassland/range, Good, HSG D
1.124	95	Urban commercial, 85% imp, HSG D
0.658	85	1/2 acre lots, 25% imp, HSG D
12.340	98	Water Surface, 0% imp, HSG B
367.422	70	Weighted Average
363.999		99.07% Pervious Area
3.423		0.93% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
85.1	150	0.0050	0.03		<b>Sheet Flow,</b> Woods: Dense underbrush n= 0.800 P2= 3.58"
9.7	234	0.0256	0.40		<b>Shallow Concentrated Flow,</b> Forest w/Heavy Litter Kv= 2.5 fps
20.5	818	0.0709	0.67		<b>Shallow Concentrated Flow,</b> Forest w/Heavy Litter Kv= 2.5 fps
30.3	543	0.0143	0.30		<b>Shallow Concentrated Flow,</b> Forest w/Heavy Litter Kv= 2.5 fps
0.2	85	0.0200	9.11	16.09	<b>Pipe Channel,</b> 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.012 Concrete pipe, finished
1.0	543	0.0368	9.38	150.09	<b>Trap/Vee/Rect Channel Flow,</b> Bot.W=4.00' D=2.00' Z= 2.0 '/' Top.W=12.00' n= 0.035 Earth, dense weeds
1.1	913		13.90		<b>Lake or Reservoir, Fish and Game Pond</b> Mean Depth= 6.00'
7.0	5,896	0.1089	14.09	422.79	<b>Trap/Vee/Rect Channel Flow, Cussgutter Stream</b> Bot.W=4.00' D=3.00' Z= 2.0 '/' Top.W=16.00' n= 0.050 Mountain streams w/large boulders
155.0	9,182	Total			

**Subcatchment 3S: ALL Watershed Areas**

Hydrograph



**Summary for Reach 1R: Cussgutter Stream**

Inflow Area = 355.138 ac, 0.96% Impervious, Inflow Depth > 1.76" for 5-yr event  
 Inflow = 127.78 cfs @ 13.64 hrs, Volume= 52.012 af  
 Outflow = 126.53 cfs @ 13.77 hrs, Volume= 51.961 af, Atten= 1%, Lag= 7.9 min

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.03 hrs  
 Max. Velocity= 10.13 fps, Min. Travel Time= 9.7 min  
 Avg. Velocity = 4.31 fps, Avg. Travel Time= 22.8 min

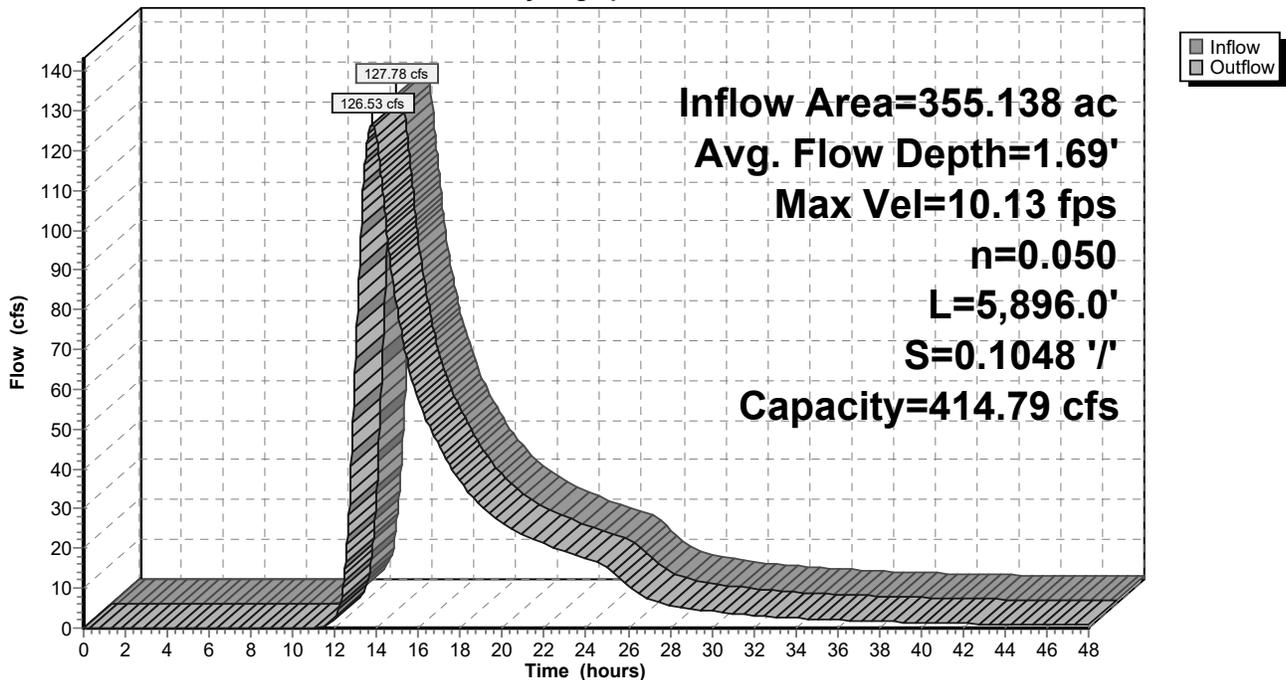
Peak Storage= 73,651 cf @ 13.77 hrs  
 Average Depth at Peak Storage= 1.69'  
 Bank-Full Depth= 3.00' Flow Area= 30.0 sf, Capacity= 414.79 cfs

4.00' x 3.00' deep channel, n= 0.050 Mountain streams w/large boulders  
 Side Slope Z-value= 2.0 '/' Top Width= 16.00'  
 Length= 5,896.0' Slope= 0.1048 '/'  
 Inlet Invert= 854.00', Outlet Invert= 236.00'



**Reach 1R: Cussgutter Stream**

Hydrograph



**Summary for Pond 1P: Fish&Game Pond**

Inflow Area = 115.624 ac, 2.96% Impervious, Inflow Depth = 1.85" for 5-yr event  
 Inflow = 61.70 cfs @ 13.60 hrs, Volume= 17.784 af  
 Outflow = 16.12 cfs @ 16.60 hrs, Volume= 16.671 af, Atten= 74%, Lag= 180.3 min  
 Primary = 16.12 cfs @ 16.60 hrs, Volume= 16.671 af  
 Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.03 hrs  
 Peak Elev= 872.73' @ 16.60 hrs Surf.Area= 12.586 ac Storage= 9.332 af

Plug-Flow detention time= 443.3 min calculated for 16.661 af (94% of inflow)  
 Center-of-Mass det. time= 410.7 min ( 1,363.9 - 953.2 )

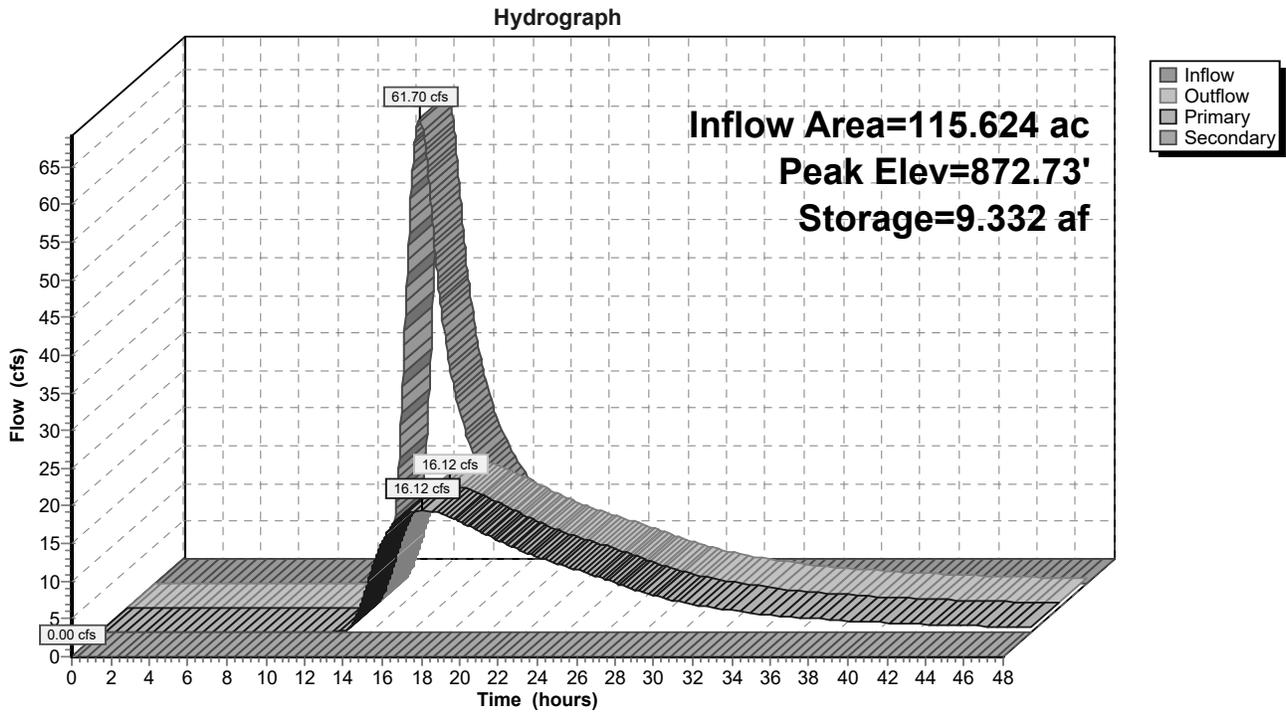
Volume	Invert	Avail.Storage	Storage Description
#1	872.00'	55.716 af	<b>Custom Stage Data (Prismatic)</b> Listed below
Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
872.00	11.910	0.000	0.000
874.00	13.769	25.679	25.679
876.00	16.268	30.037	55.716

Device	Routing	Invert	Outlet Devices
#1	Primary	872.00'	<b>24.0" x 24.0" Horiz. Orifice/Grate</b> C= 0.600 Limited to weir flow at low heads
#2	Secondary	874.00'	<b>24.0' long x 560.0' breadth Broad-Crested Rectangular Weir</b> Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

**Primary OutFlow** Max=16.21 cfs @ 16.60 hrs HW=872.73' (Free Discharge)  
 ↑1=**Orifice/Grate** (Weir Controls 16.21 cfs @ 2.79 fps)

**Secondary OutFlow** Max=0.00 cfs @ 0.00 hrs HW=872.00' (Free Discharge)  
 ↑2=**Broad-Crested Rectangular Weir** ( Controls 0.00 cfs)

### Pond 1P: Fish&Game Pond



### Summary for Pond 2P: Lake Ave Culvert

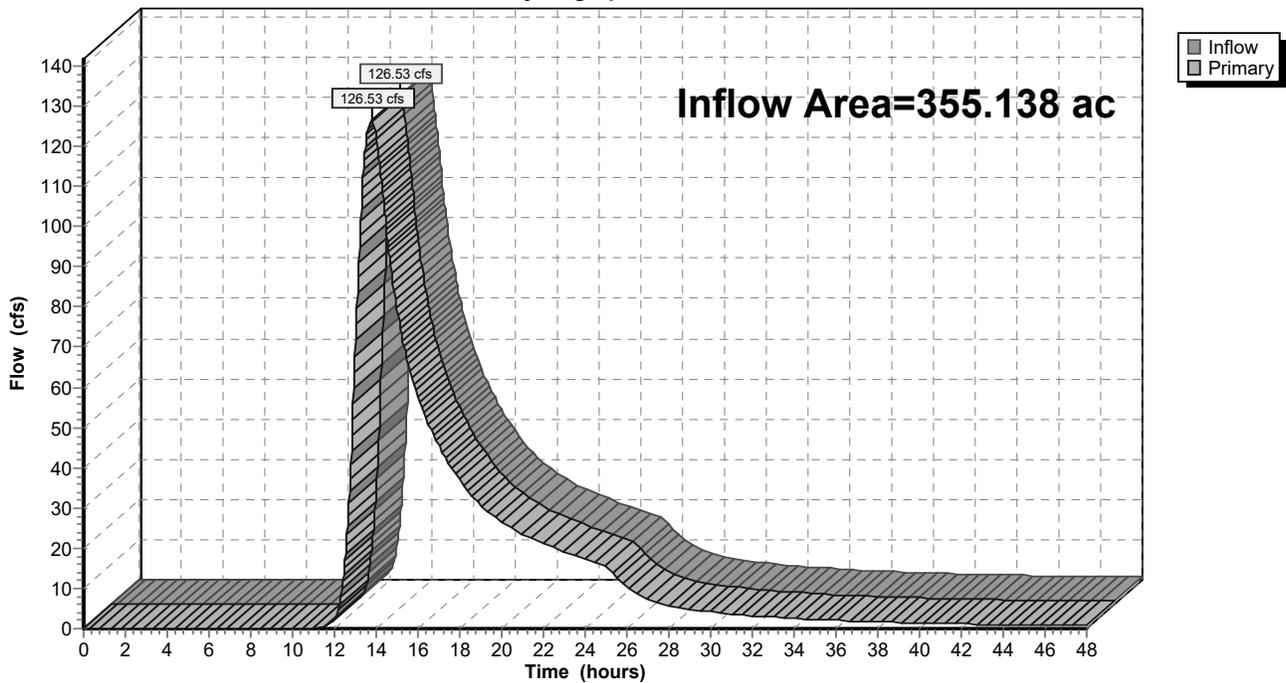
[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 355.138 ac, 0.96% Impervious, Inflow Depth > 1.76" for 5-yr event  
Inflow = 126.53 cfs @ 13.77 hrs, Volume= 51.961 af  
Primary = 126.53 cfs @ 13.77 hrs, Volume= 51.961 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.03 hrs

### Pond 2P: Lake Ave Culvert

Hydrograph



**Lake Ave Culvert\_20210317**

Type III 24-hr 10-yr Rainfall=5.70"

Prepared by WSP

Printed 3/30/2021

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Page 35

Time span=0.00-48.00 hrs, dt=0.03 hrs, 1601 points  
Runoff by SCS TR-20 method, UH=SCS  
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

**Subcatchment1S: Upstream of Pond** Runoff Area=115.624 ac 2.96% Impervious Runoff Depth=2.57"  
Flow Length=2,373' Tc=116.5 min CN=70 Runoff=87.67 cfs 24.755 af

**Subcatchment2S: Downstream of Pond** Runoff Area=239.514 ac 0.00% Impervious Runoff Depth=2.48"  
Flow Length=6,730' Tc=113.7 min CN=69 Runoff=177.01 cfs 49.509 af

**Subcatchment3S: ALL Watershed Areas** Runoff Area=367.422 ac 0.93% Impervious Runoff Depth=2.57"  
Flow Length=9,182' Tc=155.0 min CN=70 Runoff=224.84 cfs 78.666 af

**Reach 1R: Cussgutter Stream** Avg. Flow Depth=2.03' Max Vel=11.18 fps Inflow=184.74 cfs 73.010 af  
n=0.050 L=5,896.0' S=0.1048 '/ Capacity=414.79 cfs Outflow=183.27 cfs 72.954 af

**Pond 1P: Fish&Game Pond** Peak Elev=873.05' Storage=13.432 af Inflow=87.67 cfs 24.755 af  
Primary=19.70 cfs 23.502 af Secondary=0.00 cfs 0.000 af Outflow=19.70 cfs 23.502 af

**Pond 2P: Lake Ave Culvert** Inflow=183.27 cfs 72.954 af  
Primary=183.27 cfs 72.954 af

**Total Runoff Area = 722.560 ac Runoff Volume = 152.930 af Average Runoff Depth = 2.54"**  
**99.05% Pervious = 715.713 ac 0.95% Impervious = 6.847 ac**

**Summary for Subcatchment 1S: Upstream of Pond**

Runoff = 87.67 cfs @ 13.59 hrs, Volume= 24.755 af, Depth= 2.57"

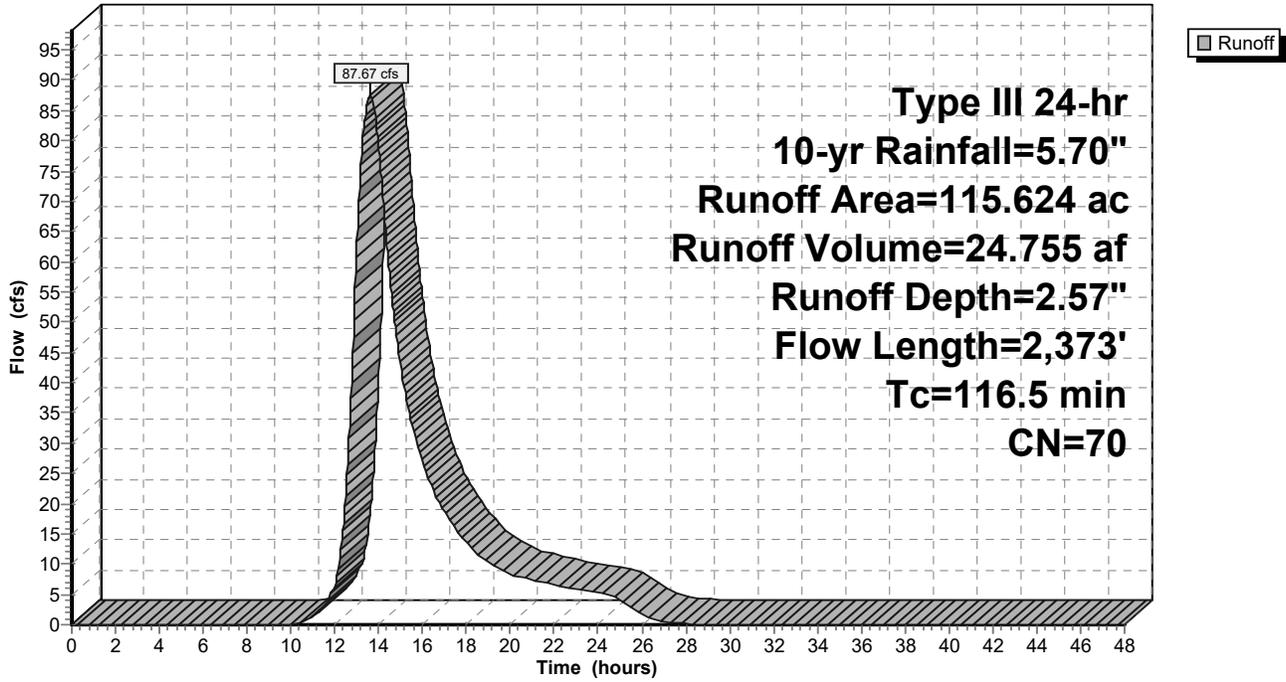
Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.03 hrs  
 Type III 24-hr 10-yr Rainfall=5.70"

Area (ac)	CN	Description
0.000	30	Woods, Good, HSG A
35.573	55	Woods, Good, HSG B
4.135	61	Pasture/grassland/range, Good, HSG B
2.710	92	Urban commercial, 85% imp, HSG B
0.437	74	Pasture/grassland/range, Good, HSG C
62.876	77	Woods, Good, HSG D
8.054	80	Pasture/grassland/range, Good, HSG D
1.124	95	Urban commercial, 85% imp, HSG D
0.658	85	1/2 acre lots, 25% imp, HSG D
0.057	98	Water Surface, 0% imp, HSG B
115.624	70	Weighted Average
112.201		97.04% Pervious Area
3.423		2.96% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
85.1	150	0.0050	0.03		<b>Sheet Flow,</b> Woods: Dense underbrush n= 0.800 P2= 3.58"
4.9	234	0.0256	0.80		<b>Shallow Concentrated Flow,</b> Woodland Kv= 5.0 fps
10.2	818	0.0709	1.33		<b>Shallow Concentrated Flow,</b> Woodland Kv= 5.0 fps
15.1	543	0.0143	0.60		<b>Shallow Concentrated Flow,</b> Woodland Kv= 5.0 fps
0.2	85	0.0200	9.11	16.09	<b>Pipe Channel, Information Unknown</b> 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.012 Concrete pipe, finished
1.0	543	0.0368	9.38	150.09	<b>Trap/Vee/Rect Channel Flow,</b> Bot.W=4.00' D=2.00' Z= 2.0 '/' Top.W=12.00' n= 0.035 Earth, dense weeds
116.5	2,373	Total			

### Subcatchment 1S: Upstream of Pond

Hydrograph



**Summary for Subcatchment 2S: Downstream of Pond**

Runoff = 177.01 cfs @ 13.53 hrs, Volume= 49.509 af, Depth= 2.48"

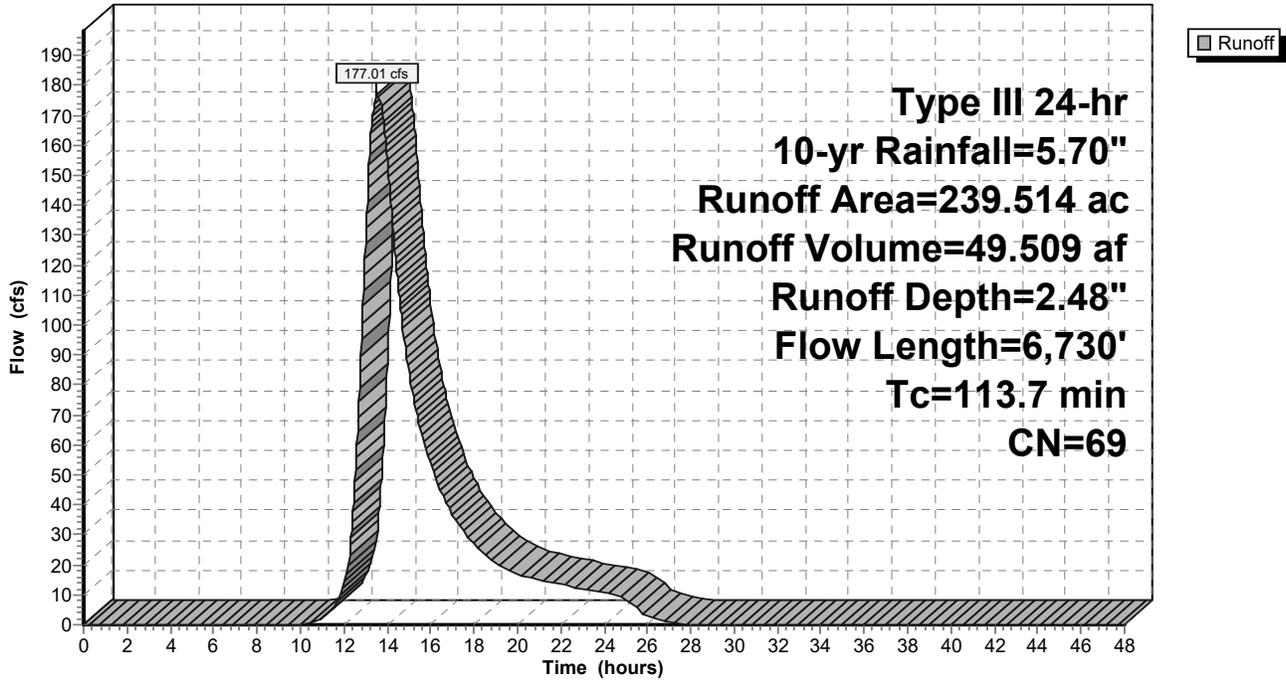
Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.03 hrs  
 Type III 24-hr 10-yr Rainfall=5.70"

Area (ac)	CN	Description
1.120	30	Woods, Good, HSG A
89.189	55	Woods, Good, HSG B
0.000	61	Pasture/grassland/range, Good, HSG B
0.000	92	Urban commercial, 85% imp, HSG B
0.000	74	Pasture/grassland/range, Good, HSG C
138.271	77	Woods, Good, HSG D
10.934	80	Pasture/grassland/range, Good, HSG D
0.000	95	Urban commercial, 85% imp, HSG D
0.000	85	1/2 acre lots, 25% imp, HSG D
0.000	98	Water Surface, 0% imp, HSG B
239.514	69	Weighted Average
239.514		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
85.1	150	0.0050	0.03		<b>Sheet Flow,</b> Woods: Dense underbrush n= 0.800 P2= 3.58"
1.6	131	0.3050	1.38		<b>Shallow Concentrated Flow,</b> Forest w/Heavy Litter Kv= 2.5 fps
3.8	202	0.1287	0.90		<b>Shallow Concentrated Flow,</b> Forest w/Heavy Litter Kv= 2.5 fps
15.5	221	0.0090	0.24		<b>Shallow Concentrated Flow,</b> Forest w/Heavy Litter Kv= 2.5 fps
0.9	340	0.0176	6.18	259.45	<b>Trap/Vee/Rect Channel Flow,</b> Bot.W=8.00' D=3.00' Z= 2.0 '/' Top.W=20.00' n= 0.050 Mountain streams w/large boulders
1.0	757	0.1340	12.90	232.16	<b>Trap/Vee/Rect Channel Flow,</b> Bot.W=5.00' D=2.00' Z= 2.0 '/' Top.W=13.00' n= 0.050 Mountain streams w/large boulders
5.8	4,929	0.1089	14.09	422.79	<b>Trap/Vee/Rect Channel Flow, Cussgutter Reach</b> Bot.W=4.00' D=3.00' Z= 2.0 '/' Top.W=16.00' n= 0.050 Mountain streams w/large boulders
113.7	6,730	Total			

Subcatchment 2S: Downstream of Pond

Hydrograph



**Summary for Subcatchment 3S: ALL Watershed Areas**

Runoff = 224.84 cfs @ 14.12 hrs, Volume= 78.666 af, Depth= 2.57"

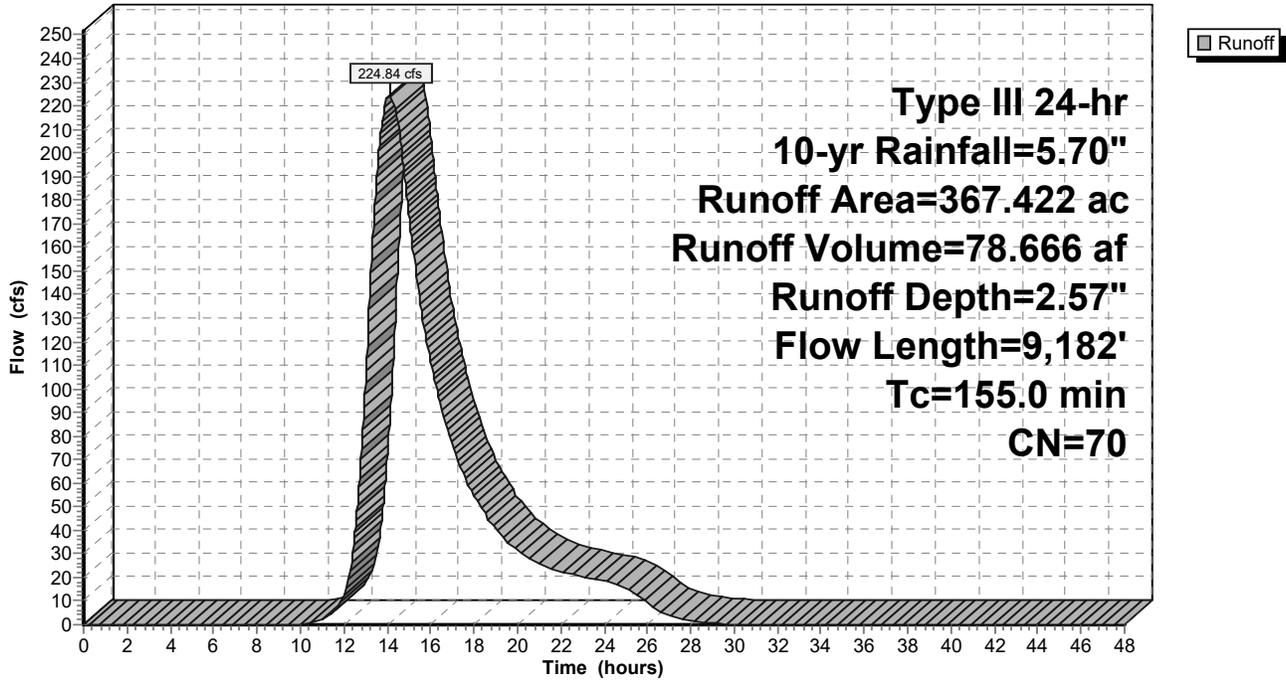
Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.03 hrs  
 Type III 24-hr 10-yr Rainfall=5.70"

Area (ac)	CN	Description
1.120	30	Woods, Good, HSG A
124.762	55	Woods, Good, HSG B
4.135	61	Pasture/grassland/range, Good, HSG B
2.710	92	Urban commercial, 85% imp, HSG B
0.437	74	Pasture/grassland/range, Good, HSG C
201.147	77	Woods, Good, HSG D
18.989	80	Pasture/grassland/range, Good, HSG D
1.124	95	Urban commercial, 85% imp, HSG D
0.658	85	1/2 acre lots, 25% imp, HSG D
12.340	98	Water Surface, 0% imp, HSG B
367.422	70	Weighted Average
363.999		99.07% Pervious Area
3.423		0.93% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
85.1	150	0.0050	0.03		<b>Sheet Flow,</b> Woods: Dense underbrush n= 0.800 P2= 3.58"
9.7	234	0.0256	0.40		<b>Shallow Concentrated Flow,</b> Forest w/Heavy Litter Kv= 2.5 fps
20.5	818	0.0709	0.67		<b>Shallow Concentrated Flow,</b> Forest w/Heavy Litter Kv= 2.5 fps
30.3	543	0.0143	0.30		<b>Shallow Concentrated Flow,</b> Forest w/Heavy Litter Kv= 2.5 fps
0.2	85	0.0200	9.11	16.09	<b>Pipe Channel,</b> 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.012 Concrete pipe, finished
1.0	543	0.0368	9.38	150.09	<b>Trap/Vee/Rect Channel Flow,</b> Bot.W=4.00' D=2.00' Z= 2.0 '/' Top.W=12.00' n= 0.035 Earth, dense weeds
1.1	913		13.90		<b>Lake or Reservoir, Fish and Game Pond</b> Mean Depth= 6.00'
7.0	5,896	0.1089	14.09	422.79	<b>Trap/Vee/Rect Channel Flow, Cussgutter Stream</b> Bot.W=4.00' D=3.00' Z= 2.0 '/' Top.W=16.00' n= 0.050 Mountain streams w/large boulders
155.0	9,182	Total			

Subcatchment 3S: ALL Watershed Areas

Hydrograph



### Summary for Reach 1R: Cussgutter Stream

Inflow Area = 355.138 ac, 0.96% Impervious, Inflow Depth > 2.47" for 10-yr event  
 Inflow = 184.74 cfs @ 13.61 hrs, Volume= 73.010 af  
 Outflow = 183.27 cfs @ 13.73 hrs, Volume= 72.954 af, Atten= 1%, Lag= 7.1 min

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.03 hrs  
 Max. Velocity= 11.18 fps, Min. Travel Time= 8.8 min  
 Avg. Velocity = 4.73 fps, Avg. Travel Time= 20.8 min

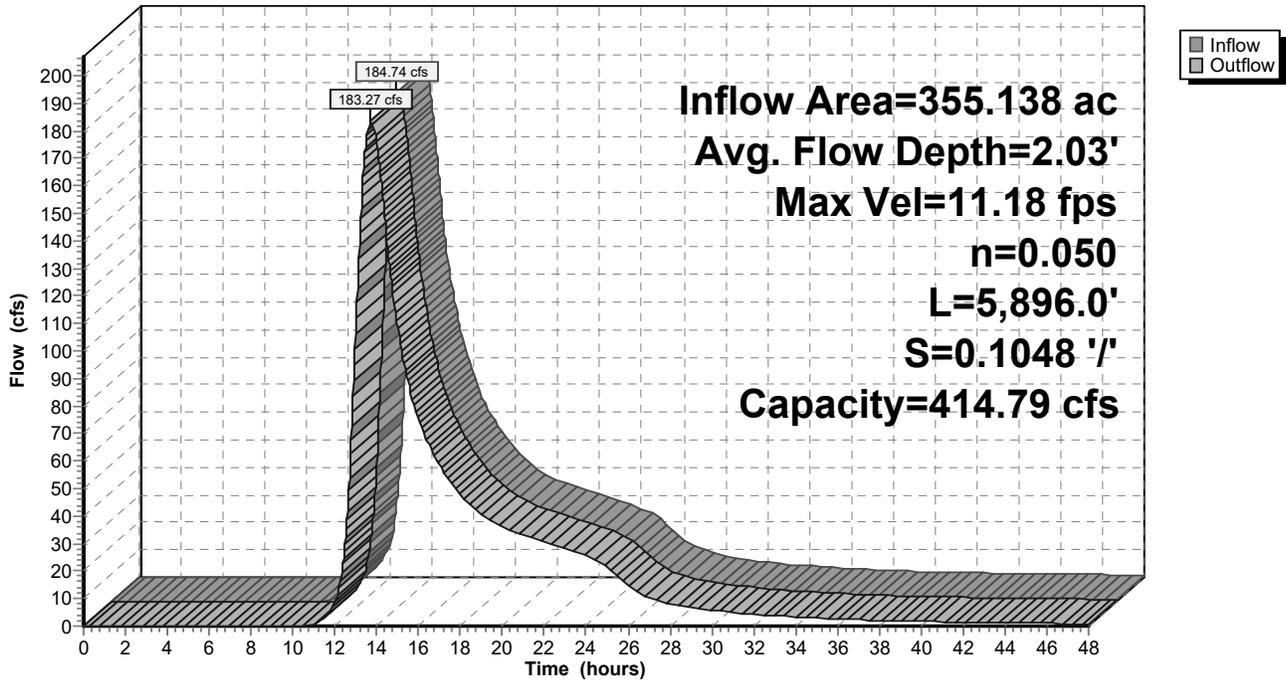
Peak Storage= 96,654 cf @ 13.73 hrs  
 Average Depth at Peak Storage= 2.03'  
 Bank-Full Depth= 3.00' Flow Area= 30.0 sf, Capacity= 414.79 cfs

4.00' x 3.00' deep channel, n= 0.050 Mountain streams w/large boulders  
 Side Slope Z-value= 2.0 '/' Top Width= 16.00'  
 Length= 5,896.0' Slope= 0.1048 '/'  
 Inlet Invert= 854.00', Outlet Invert= 236.00'



### Reach 1R: Cussgutter Stream

Hydrograph



**Summary for Pond 1P: Fish&Game Pond**

Inflow Area = 115.624 ac, 2.96% Impervious, Inflow Depth = 2.57" for 10-yr event  
 Inflow = 87.67 cfs @ 13.59 hrs, Volume= 24.755 af  
 Outflow = 19.70 cfs @ 16.83 hrs, Volume= 23.502 af, Atten= 78%, Lag= 194.3 min  
 Primary = 19.70 cfs @ 16.83 hrs, Volume= 23.502 af  
 Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.03 hrs  
 Peak Elev= 873.05' @ 16.83 hrs Surf.Area= 12.882 ac Storage= 13.432 af

Plug-Flow detention time= 442.1 min calculated for 23.487 af (95% of inflow)  
 Center-of-Mass det. time= 414.9 min ( 1,358.3 - 943.4 )

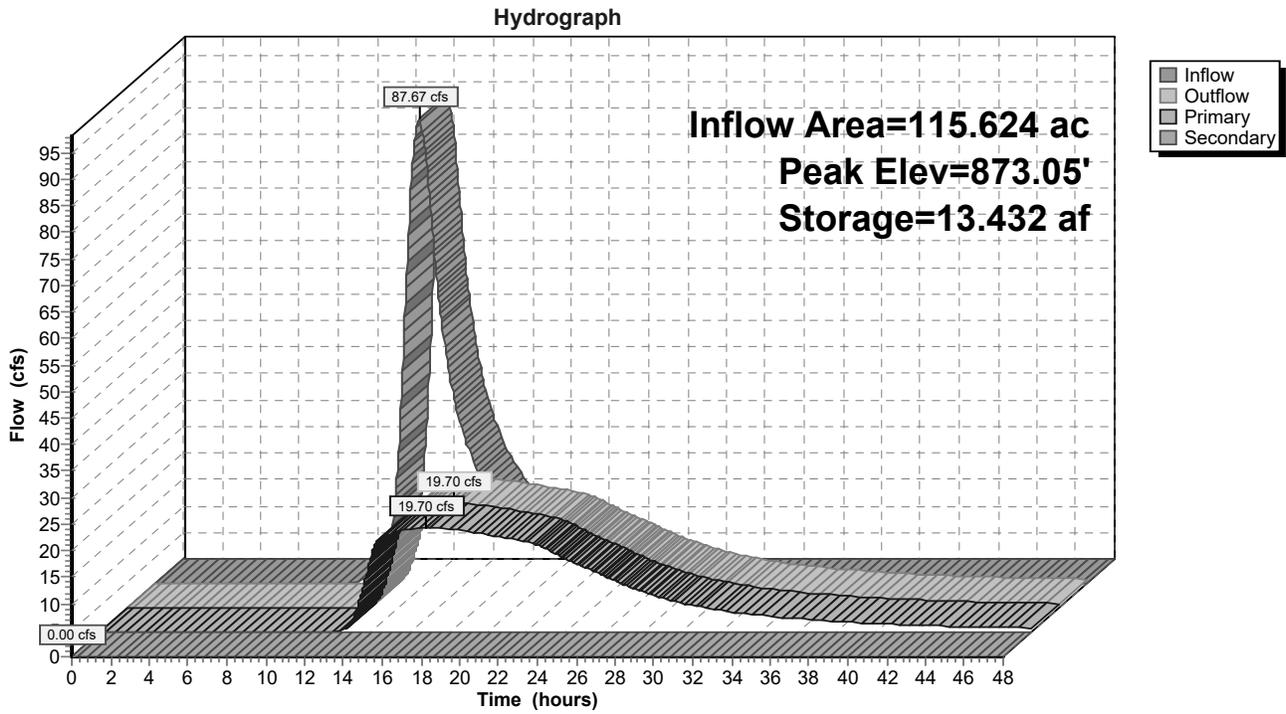
Volume	Invert	Avail.Storage	Storage Description
#1	872.00'	55.716 af	<b>Custom Stage Data (Prismatic)</b> Listed below
Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
872.00	11.910	0.000	0.000
874.00	13.769	25.679	25.679
876.00	16.268	30.037	55.716

Device	Routing	Invert	Outlet Devices
#1	Primary	872.00'	<b>24.0" x 24.0" Horiz. Orifice/Grate</b> C= 0.600 Limited to weir flow at low heads
#2	Secondary	874.00'	<b>24.0' long x 560.0' breadth Broad-Crested Rectangular Weir</b> Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

**Primary OutFlow** Max=19.70 cfs @ 16.83 hrs HW=873.05' (Free Discharge)  
 ↑1=**Orifice/Grate** (Orifice Controls 19.70 cfs @ 4.92 fps)

**Secondary OutFlow** Max=0.00 cfs @ 0.00 hrs HW=872.00' (Free Discharge)  
 ↑2=**Broad-Crested Rectangular Weir** ( Controls 0.00 cfs)

### Pond 1P: Fish&Game Pond



### Summary for Pond 2P: Lake Ave Culvert

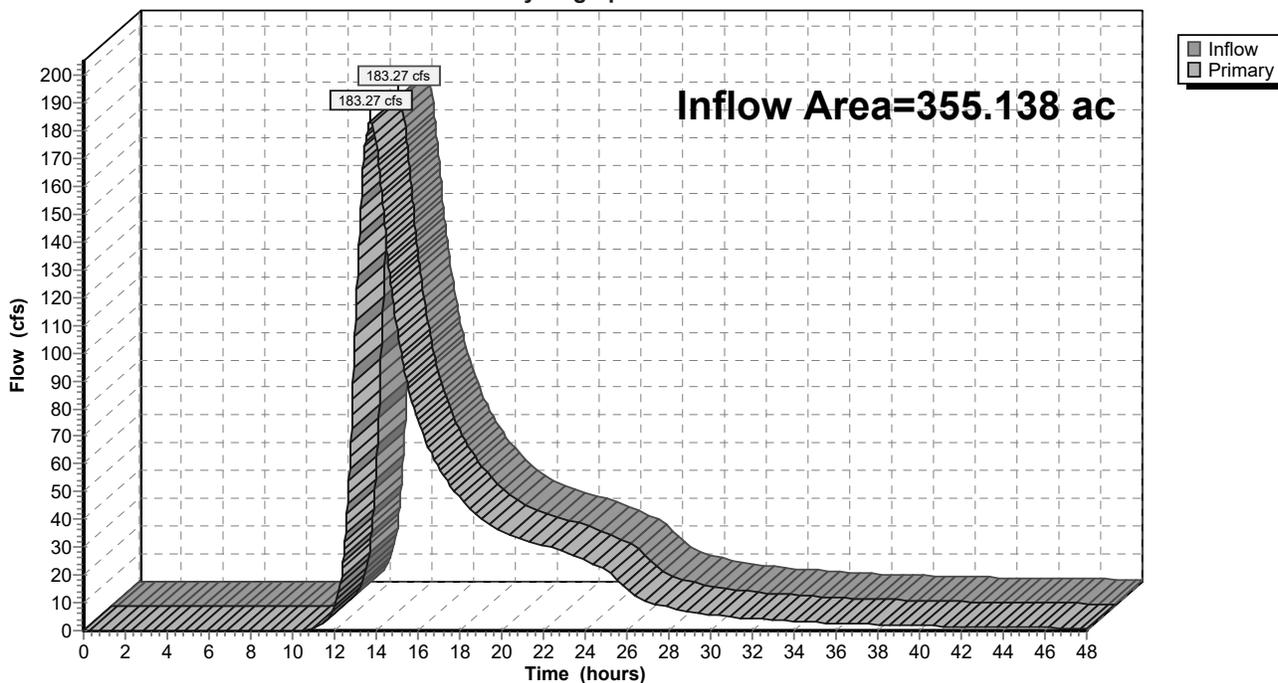
[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 355.138 ac, 0.96% Impervious, Inflow Depth > 2.47" for 10-yr event  
Inflow = 183.27 cfs @ 13.73 hrs, Volume= 72.954 af  
Primary = 183.27 cfs @ 13.73 hrs, Volume= 72.954 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.03 hrs

### Pond 2P: Lake Ave Culvert

Hydrograph



**Lake Ave Culvert\_20210317**

Type III 24-hr 25-yr Rainfall=7.02"

Prepared by WSP

Printed 3/30/2021

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Page 46

Time span=0.00-48.00 hrs, dt=0.03 hrs, 1601 points  
Runoff by SCS TR-20 method, UH=SCS  
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

**Subcatchment1S: Upstream of Pond** Runoff Area=115.624 ac 2.96% Impervious Runoff Depth=3.64"  
Flow Length=2,373' Tc=116.5 min CN=70 Runoff=125.64 cfs 35.025 af

**Subcatchment2S: Downstream of Pond** Runoff Area=239.514 ac 0.00% Impervious Runoff Depth=3.53"  
Flow Length=6,730' Tc=113.7 min CN=69 Runoff=255.99 cfs 70.465 af

**Subcatchment3S: ALL Watershed Areas** Runoff Area=367.422 ac 0.93% Impervious Runoff Depth=3.64"  
Flow Length=9,182' Tc=155.0 min CN=70 Runoff=322.56 cfs 111.299 af

**Reach 1R: Cussgutter Stream** Avg. Flow Depth=2.44' Max Vel=12.35 fps Inflow=270.57 cfs 103.942 af  
n=0.050 L=5,896.0' S=0.1048 '/ Capacity=414.79 cfs Outflow=268.12 cfs 103.873 af

**Pond 1P: Fish&Game Pond** Peak Elev=873.57' Storage=20.164 af Inflow=125.64 cfs 35.025 af  
Primary=24.14 cfs 33.478 af Secondary=0.00 cfs 0.000 af Outflow=24.14 cfs 33.478 af

**Pond 2P: Lake Ave Culvert** Inflow=268.12 cfs 103.873 af  
Primary=268.12 cfs 103.873 af

**Total Runoff Area = 722.560 ac Runoff Volume = 216.788 af Average Runoff Depth = 3.60"**  
**99.05% Pervious = 715.713 ac 0.95% Impervious = 6.847 ac**

**Summary for Subcatchment 1S: Upstream of Pond**

Runoff = 125.64 cfs @ 13.59 hrs, Volume= 35.025 af, Depth= 3.64"

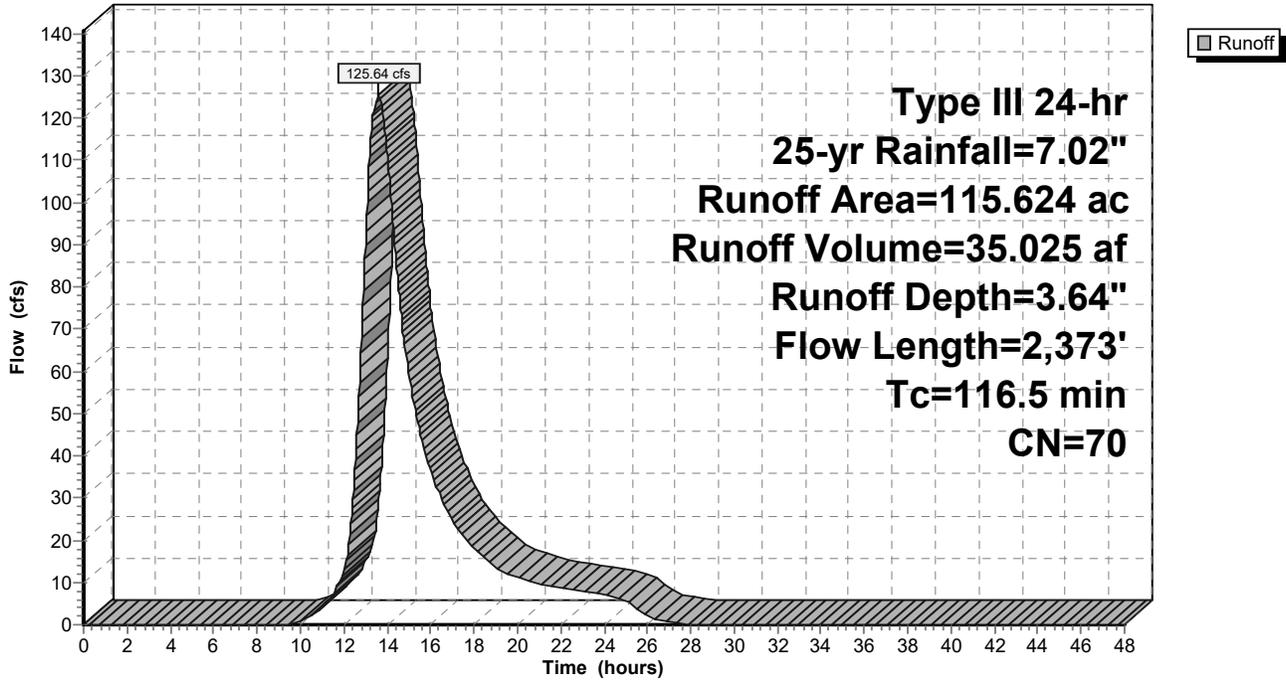
Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.03 hrs  
Type III 24-hr 25-yr Rainfall=7.02"

Area (ac)	CN	Description
0.000	30	Woods, Good, HSG A
35.573	55	Woods, Good, HSG B
4.135	61	Pasture/grassland/range, Good, HSG B
2.710	92	Urban commercial, 85% imp, HSG B
0.437	74	Pasture/grassland/range, Good, HSG C
62.876	77	Woods, Good, HSG D
8.054	80	Pasture/grassland/range, Good, HSG D
1.124	95	Urban commercial, 85% imp, HSG D
0.658	85	1/2 acre lots, 25% imp, HSG D
0.057	98	Water Surface, 0% imp, HSG B
115.624	70	Weighted Average
112.201		97.04% Pervious Area
3.423		2.96% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
85.1	150	0.0050	0.03		<b>Sheet Flow,</b> Woods: Dense underbrush n= 0.800 P2= 3.58"
4.9	234	0.0256	0.80		<b>Shallow Concentrated Flow,</b> Woodland Kv= 5.0 fps
10.2	818	0.0709	1.33		<b>Shallow Concentrated Flow,</b> Woodland Kv= 5.0 fps
15.1	543	0.0143	0.60		<b>Shallow Concentrated Flow,</b> Woodland Kv= 5.0 fps
0.2	85	0.0200	9.11	16.09	<b>Pipe Channel, Information Unknown</b> 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.012 Concrete pipe, finished
1.0	543	0.0368	9.38	150.09	<b>Trap/Vee/Rect Channel Flow,</b> Bot.W=4.00' D=2.00' Z= 2.0 '/' Top.W=12.00' n= 0.035 Earth, dense weeds
116.5	2,373	Total			

Subcatchment 1S: Upstream of Pond

Hydrograph



**Summary for Subcatchment 2S: Downstream of Pond**

Runoff = 255.99 cfs @ 13.52 hrs, Volume= 70.465 af, Depth= 3.53"

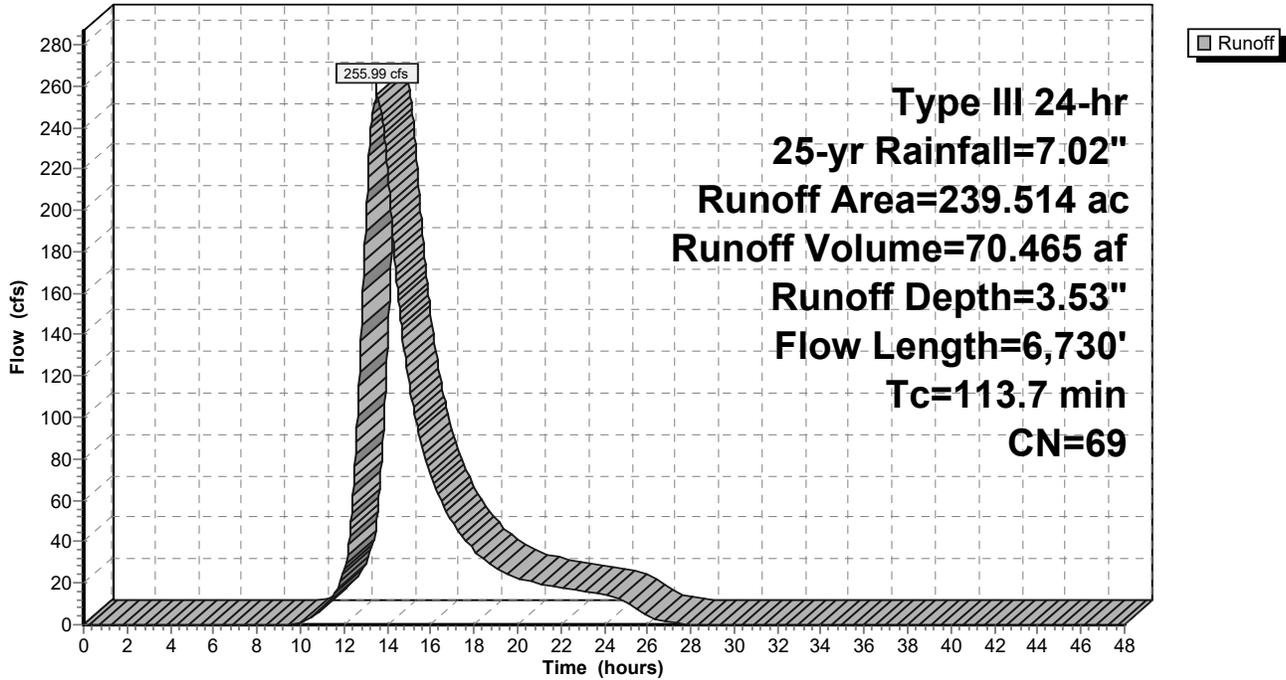
Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.03 hrs  
Type III 24-hr 25-yr Rainfall=7.02"

Area (ac)	CN	Description
1.120	30	Woods, Good, HSG A
89.189	55	Woods, Good, HSG B
0.000	61	Pasture/grassland/range, Good, HSG B
0.000	92	Urban commercial, 85% imp, HSG B
0.000	74	Pasture/grassland/range, Good, HSG C
138.271	77	Woods, Good, HSG D
10.934	80	Pasture/grassland/range, Good, HSG D
0.000	95	Urban commercial, 85% imp, HSG D
0.000	85	1/2 acre lots, 25% imp, HSG D
0.000	98	Water Surface, 0% imp, HSG B
239.514	69	Weighted Average
239.514		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
85.1	150	0.0050	0.03		<b>Sheet Flow,</b> Woods: Dense underbrush n= 0.800 P2= 3.58"
1.6	131	0.3050	1.38		<b>Shallow Concentrated Flow,</b> Forest w/Heavy Litter Kv= 2.5 fps
3.8	202	0.1287	0.90		<b>Shallow Concentrated Flow,</b> Forest w/Heavy Litter Kv= 2.5 fps
15.5	221	0.0090	0.24		<b>Shallow Concentrated Flow,</b> Forest w/Heavy Litter Kv= 2.5 fps
0.9	340	0.0176	6.18	259.45	<b>Trap/Vee/Rect Channel Flow,</b> Bot.W=8.00' D=3.00' Z= 2.0 '/' Top.W=20.00' n= 0.050 Mountain streams w/large boulders
1.0	757	0.1340	12.90	232.16	<b>Trap/Vee/Rect Channel Flow,</b> Bot.W=5.00' D=2.00' Z= 2.0 '/' Top.W=13.00' n= 0.050 Mountain streams w/large boulders
5.8	4,929	0.1089	14.09	422.79	<b>Trap/Vee/Rect Channel Flow, Cussgutter Reach</b> Bot.W=4.00' D=3.00' Z= 2.0 '/' Top.W=16.00' n= 0.050 Mountain streams w/large boulders
113.7	6,730	Total			

Subcatchment 2S: Downstream of Pond

Hydrograph



**Summary for Subcatchment 3S: ALL Watershed Areas**

Runoff = 322.56 cfs @ 13.98 hrs, Volume= 111.299 af, Depth= 3.64"

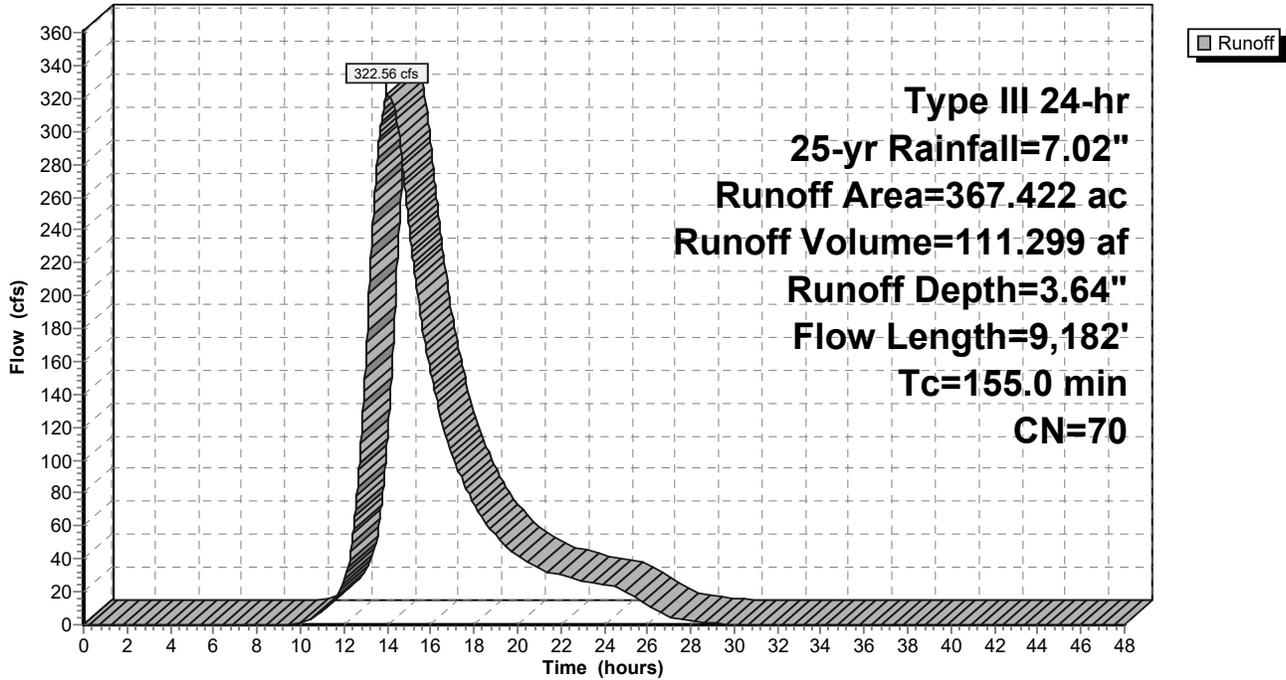
Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.03 hrs  
Type III 24-hr 25-yr Rainfall=7.02"

Area (ac)	CN	Description
1.120	30	Woods, Good, HSG A
124.762	55	Woods, Good, HSG B
4.135	61	Pasture/grassland/range, Good, HSG B
2.710	92	Urban commercial, 85% imp, HSG B
0.437	74	Pasture/grassland/range, Good, HSG C
201.147	77	Woods, Good, HSG D
18.989	80	Pasture/grassland/range, Good, HSG D
1.124	95	Urban commercial, 85% imp, HSG D
0.658	85	1/2 acre lots, 25% imp, HSG D
12.340	98	Water Surface, 0% imp, HSG B
367.422	70	Weighted Average
363.999		99.07% Pervious Area
3.423		0.93% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
85.1	150	0.0050	0.03		<b>Sheet Flow,</b> Woods: Dense underbrush n= 0.800 P2= 3.58"
9.7	234	0.0256	0.40		<b>Shallow Concentrated Flow,</b> Forest w/Heavy Litter Kv= 2.5 fps
20.5	818	0.0709	0.67		<b>Shallow Concentrated Flow,</b> Forest w/Heavy Litter Kv= 2.5 fps
30.3	543	0.0143	0.30		<b>Shallow Concentrated Flow,</b> Forest w/Heavy Litter Kv= 2.5 fps
0.2	85	0.0200	9.11	16.09	<b>Pipe Channel,</b> 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.012 Concrete pipe, finished
1.0	543	0.0368	9.38	150.09	<b>Trap/Vee/Rect Channel Flow,</b> Bot.W=4.00' D=2.00' Z= 2.0 '/' Top.W=12.00' n= 0.035 Earth, dense weeds
1.1	913		13.90		<b>Lake or Reservoir, Fish and Game Pond</b> Mean Depth= 6.00'
7.0	5,896	0.1089	14.09	422.79	<b>Trap/Vee/Rect Channel Flow, Cussgutter Stream</b> Bot.W=4.00' D=3.00' Z= 2.0 '/' Top.W=16.00' n= 0.050 Mountain streams w/large boulders
155.0	9,182	Total			

**Subcatchment 3S: ALL Watershed Areas**

Hydrograph



Summary for Reach 1R: Cussgutter Stream

Inflow Area = 355.138 ac, 0.96% Impervious, Inflow Depth > 3.51" for 25-yr event
Inflow = 270.57 cfs @ 13.54 hrs, Volume= 103.942 af
Outflow = 268.12 cfs @ 13.67 hrs, Volume= 103.873 af, Atten= 1%, Lag= 8.0 min

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.03 hrs
Max. Velocity= 12.35 fps, Min. Travel Time= 8.0 min
Avg. Velocity = 5.31 fps, Avg. Travel Time= 18.5 min

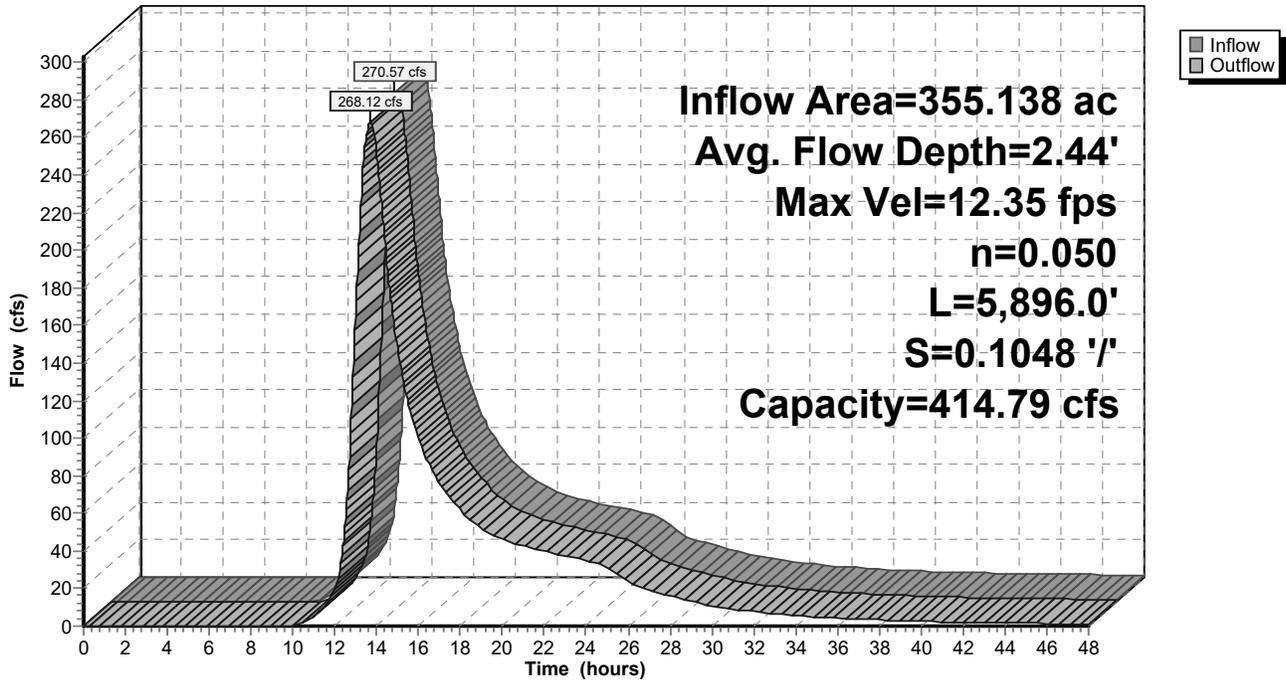
Peak Storage= 127,983 cf @ 13.67 hrs
Average Depth at Peak Storage= 2.44'
Bank-Full Depth= 3.00' Flow Area= 30.0 sf, Capacity= 414.79 cfs

4.00' x 3.00' deep channel, n= 0.050 Mountain streams w/large boulders
Side Slope Z-value= 2.0 '/' Top Width= 16.00'
Length= 5,896.0' Slope= 0.1048 '/'
Inlet Invert= 854.00', Outlet Invert= 236.00'



Reach 1R: Cussgutter Stream

Hydrograph



**Summary for Pond 1P: Fish&Game Pond**

Inflow Area = 115.624 ac, 2.96% Impervious, Inflow Depth = 3.64" for 25-yr event  
 Inflow = 125.64 cfs @ 13.59 hrs, Volume= 35.025 af  
 Outflow = 24.14 cfs @ 17.08 hrs, Volume= 33.478 af, Atten= 81%, Lag= 209.9 min  
 Primary = 24.14 cfs @ 17.08 hrs, Volume= 33.478 af  
 Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.03 hrs  
 Peak Elev= 873.57' @ 17.08 hrs Surf.Area= 13.370 ac Storage= 20.164 af

Plug-Flow detention time= 491.1 min calculated for 33.478 af (96% of inflow)  
 Center-of-Mass det. time= 466.3 min ( 1,399.6 - 933.4 )

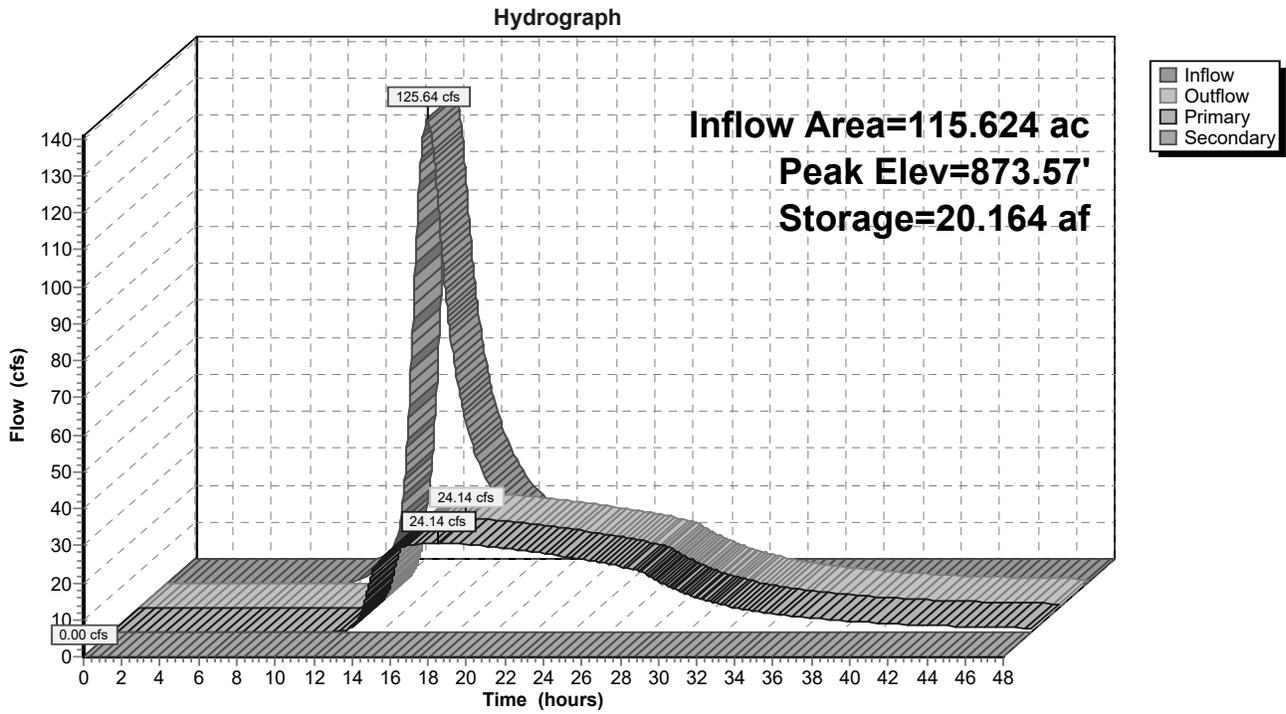
Volume	Invert	Avail.Storage	Storage Description
#1	872.00'	55.716 af	<b>Custom Stage Data (Prismatic)</b> Listed below
Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
872.00	11.910	0.000	0.000
874.00	13.769	25.679	25.679
876.00	16.268	30.037	55.716

Device	Routing	Invert	Outlet Devices
#1	Primary	872.00'	<b>24.0" x 24.0" Horiz. Orifice/Grate</b> C= 0.600 Limited to weir flow at low heads
#2	Secondary	874.00'	<b>24.0' long x 560.0' breadth Broad-Crested Rectangular Weir</b> Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

**Primary OutFlow** Max=24.14 cfs @ 17.08 hrs HW=873.57' (Free Discharge)  
 ↑1=**Orifice/Grate** (Orifice Controls 24.14 cfs @ 6.03 fps)

**Secondary OutFlow** Max=0.00 cfs @ 0.00 hrs HW=872.00' (Free Discharge)  
 ↑2=**Broad-Crested Rectangular Weir** ( Controls 0.00 cfs)

### Pond 1P: Fish&Game Pond



### Summary for Pond 2P: Lake Ave Culvert

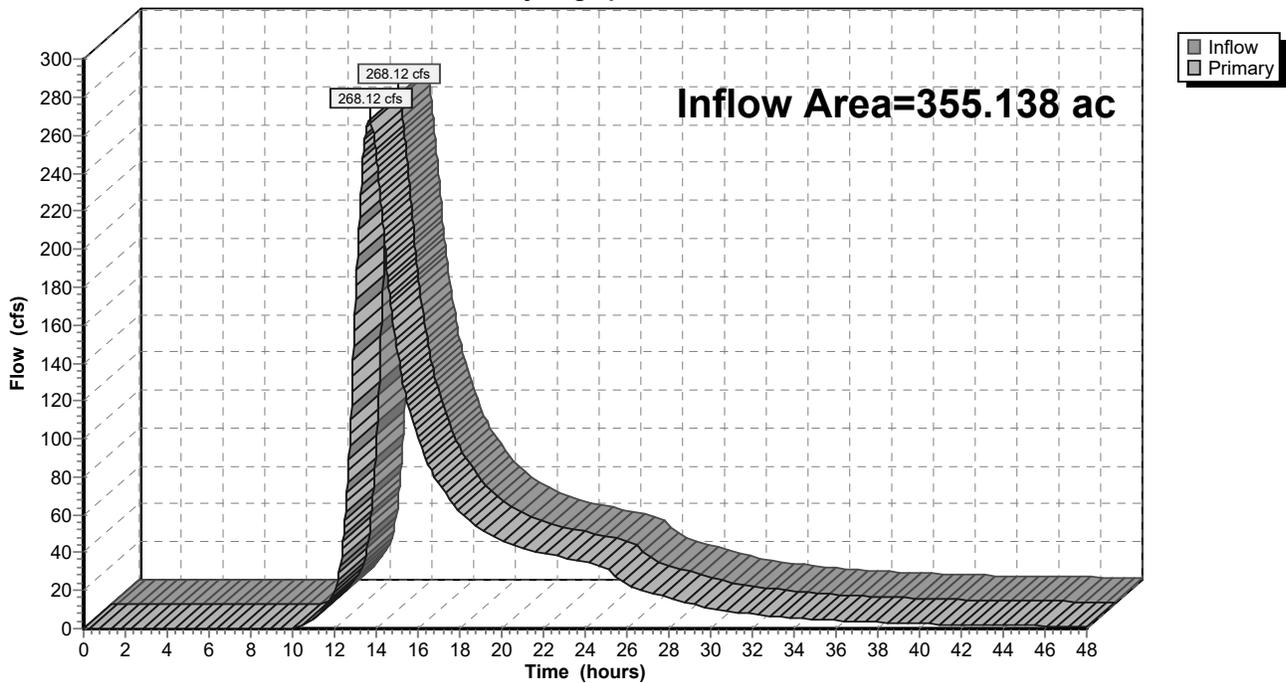
[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 355.138 ac, 0.96% Impervious, Inflow Depth > 3.51" for 25-yr event  
Inflow = 268.12 cfs @ 13.67 hrs, Volume= 103.873 af  
Primary = 268.12 cfs @ 13.67 hrs, Volume= 103.873 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.03 hrs

### Pond 2P: Lake Ave Culvert

Hydrograph



**Lake Ave Culvert\_20210317**

Type III 24-hr 50-yr Rainfall=7.99"

Prepared by WSP

Printed 3/30/2021

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Page 57

Time span=0.00-48.00 hrs, dt=0.03 hrs, 1601 points  
Runoff by SCS TR-20 method, UH=SCS  
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

**Subcatchment1S: Upstream of Pond** Runoff Area=115.624 ac 2.96% Impervious Runoff Depth=4.46"  
Flow Length=2,373' Tc=116.5 min CN=70 Runoff=154.62 cfs 42.932 af

**Subcatchment2S: Downstream of Pond** Runoff Area=239.514 ac 0.00% Impervious Runoff Depth=4.34"  
Flow Length=6,730' Tc=113.7 min CN=69 Runoff=316.51 cfs 86.647 af

**Subcatchment3S: ALL Watershed Areas** Runoff Area=367.422 ac 0.93% Impervious Runoff Depth=4.46"  
Flow Length=9,182' Tc=155.0 min CN=70 Runoff=398.01 cfs 136.427 af

**Reach 1R: Cussgutter Stream** Avg. Flow Depth=2.70' Max Vel=13.04 fps Inflow=334.33 cfs 127.756 af  
n=0.050 L=5,896.0' S=0.1048 '/ Capacity=414.79 cfs Outflow=330.97 cfs 127.675 af

**Pond 1P: Fish&Game Pond** Peak Elev=873.99' Storage=25.572 af Inflow=154.62 cfs 42.932 af  
Primary=27.18 cfs 41.109 af Secondary=0.00 cfs 0.000 af Outflow=27.18 cfs 41.109 af

**Pond 2P: Lake Ave Culvert** Inflow=330.97 cfs 127.675 af  
Primary=330.97 cfs 127.675 af

**Total Runoff Area = 722.560 ac Runoff Volume = 266.006 af Average Runoff Depth = 4.42"**  
**99.05% Pervious = 715.713 ac 0.95% Impervious = 6.847 ac**

**Summary for Subcatchment 1S: Upstream of Pond**

Runoff = 154.62 cfs @ 13.58 hrs, Volume= 42.932 af, Depth= 4.46"

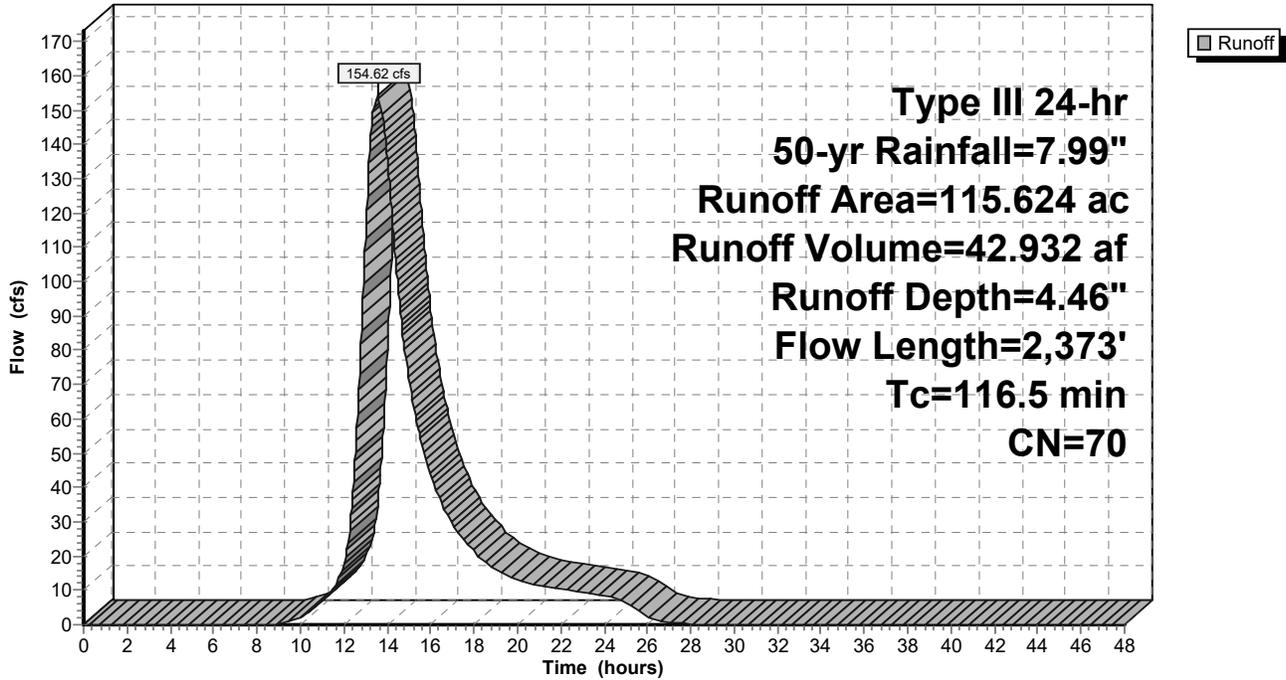
Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.03 hrs  
 Type III 24-hr 50-yr Rainfall=7.99"

Area (ac)	CN	Description
0.000	30	Woods, Good, HSG A
35.573	55	Woods, Good, HSG B
4.135	61	Pasture/grassland/range, Good, HSG B
2.710	92	Urban commercial, 85% imp, HSG B
0.437	74	Pasture/grassland/range, Good, HSG C
62.876	77	Woods, Good, HSG D
8.054	80	Pasture/grassland/range, Good, HSG D
1.124	95	Urban commercial, 85% imp, HSG D
0.658	85	1/2 acre lots, 25% imp, HSG D
0.057	98	Water Surface, 0% imp, HSG B
115.624	70	Weighted Average
112.201		97.04% Pervious Area
3.423		2.96% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
85.1	150	0.0050	0.03		<b>Sheet Flow,</b> Woods: Dense underbrush n= 0.800 P2= 3.58"
4.9	234	0.0256	0.80		<b>Shallow Concentrated Flow,</b> Woodland Kv= 5.0 fps
10.2	818	0.0709	1.33		<b>Shallow Concentrated Flow,</b> Woodland Kv= 5.0 fps
15.1	543	0.0143	0.60		<b>Shallow Concentrated Flow,</b> Woodland Kv= 5.0 fps
0.2	85	0.0200	9.11	16.09	<b>Pipe Channel, Information Unknown</b> 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.012 Concrete pipe, finished
1.0	543	0.0368	9.38	150.09	<b>Trap/Vee/Rect Channel Flow,</b> Bot.W=4.00' D=2.00' Z= 2.0 '/' Top.W=12.00' n= 0.035 Earth, dense weeds
116.5	2,373	Total			

### Subcatchment 1S: Upstream of Pond

Hydrograph



**Summary for Subcatchment 2S: Downstream of Pond**

Runoff = 316.51 cfs @ 13.52 hrs, Volume= 86.647 af, Depth= 4.34"

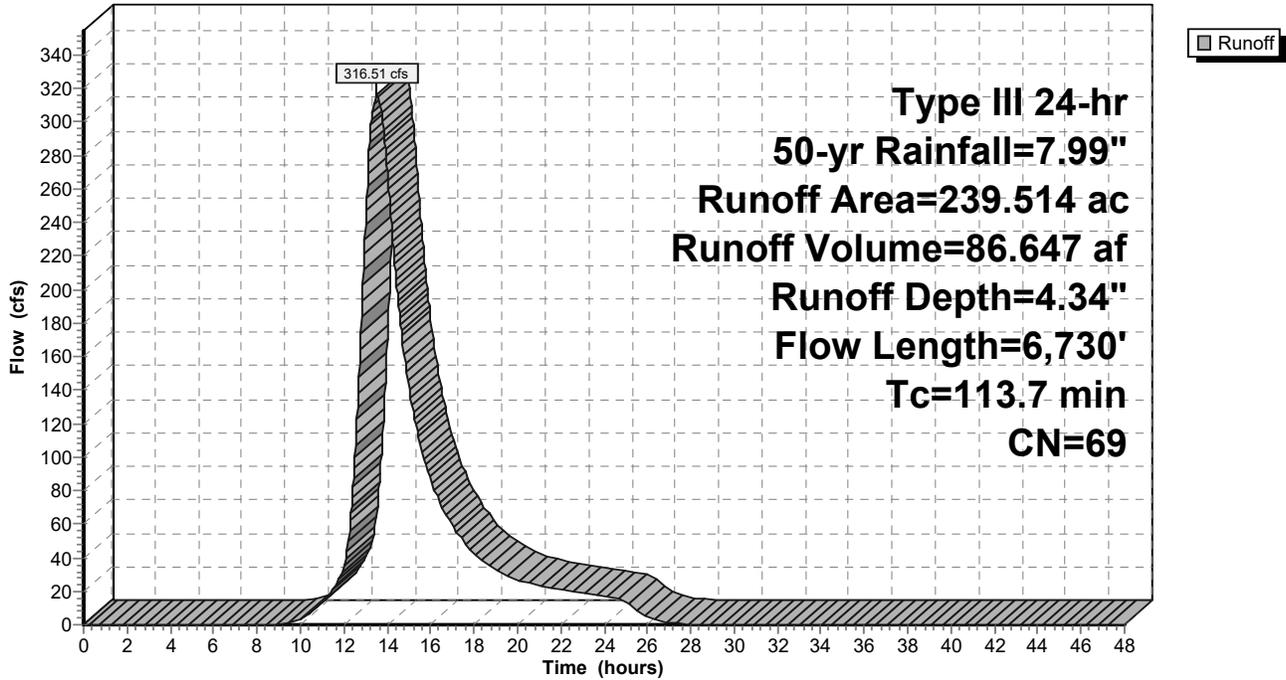
Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.03 hrs  
 Type III 24-hr 50-yr Rainfall=7.99"

Area (ac)	CN	Description
1.120	30	Woods, Good, HSG A
89.189	55	Woods, Good, HSG B
0.000	61	Pasture/grassland/range, Good, HSG B
0.000	92	Urban commercial, 85% imp, HSG B
0.000	74	Pasture/grassland/range, Good, HSG C
138.271	77	Woods, Good, HSG D
10.934	80	Pasture/grassland/range, Good, HSG D
0.000	95	Urban commercial, 85% imp, HSG D
0.000	85	1/2 acre lots, 25% imp, HSG D
0.000	98	Water Surface, 0% imp, HSG B
239.514	69	Weighted Average
239.514		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
85.1	150	0.0050	0.03		<b>Sheet Flow,</b> Woods: Dense underbrush n= 0.800 P2= 3.58"
1.6	131	0.3050	1.38		<b>Shallow Concentrated Flow,</b> Forest w/Heavy Litter Kv= 2.5 fps
3.8	202	0.1287	0.90		<b>Shallow Concentrated Flow,</b> Forest w/Heavy Litter Kv= 2.5 fps
15.5	221	0.0090	0.24		<b>Shallow Concentrated Flow,</b> Forest w/Heavy Litter Kv= 2.5 fps
0.9	340	0.0176	6.18	259.45	<b>Trap/Vee/Rect Channel Flow,</b> Bot.W=8.00' D=3.00' Z= 2.0 '/' Top.W=20.00' n= 0.050 Mountain streams w/large boulders
1.0	757	0.1340	12.90	232.16	<b>Trap/Vee/Rect Channel Flow,</b> Bot.W=5.00' D=2.00' Z= 2.0 '/' Top.W=13.00' n= 0.050 Mountain streams w/large boulders
5.8	4,929	0.1089	14.09	422.79	<b>Trap/Vee/Rect Channel Flow, Cussgutter Reach</b> Bot.W=4.00' D=3.00' Z= 2.0 '/' Top.W=16.00' n= 0.050 Mountain streams w/large boulders
113.7	6,730	Total			

**Subcatchment 2S: Downstream of Pond**

Hydrograph



**Summary for Subcatchment 3S: ALL Watershed Areas**

Runoff = 398.01 cfs @ 13.98 hrs, Volume= 136.427 af, Depth= 4.46"

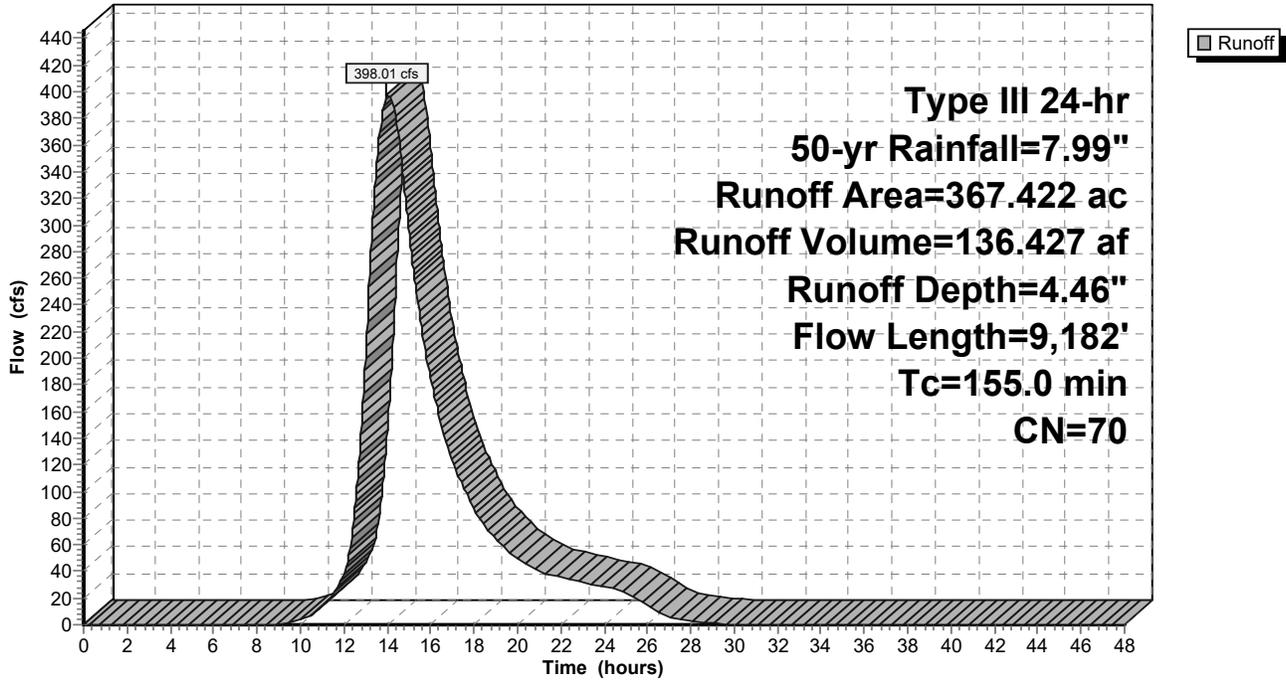
Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.03 hrs  
Type III 24-hr 50-yr Rainfall=7.99"

Area (ac)	CN	Description
1.120	30	Woods, Good, HSG A
124.762	55	Woods, Good, HSG B
4.135	61	Pasture/grassland/range, Good, HSG B
2.710	92	Urban commercial, 85% imp, HSG B
0.437	74	Pasture/grassland/range, Good, HSG C
201.147	77	Woods, Good, HSG D
18.989	80	Pasture/grassland/range, Good, HSG D
1.124	95	Urban commercial, 85% imp, HSG D
0.658	85	1/2 acre lots, 25% imp, HSG D
12.340	98	Water Surface, 0% imp, HSG B
367.422	70	Weighted Average
363.999		99.07% Pervious Area
3.423		0.93% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
85.1	150	0.0050	0.03		<b>Sheet Flow,</b> Woods: Dense underbrush n= 0.800 P2= 3.58"
9.7	234	0.0256	0.40		<b>Shallow Concentrated Flow,</b> Forest w/Heavy Litter Kv= 2.5 fps
20.5	818	0.0709	0.67		<b>Shallow Concentrated Flow,</b> Forest w/Heavy Litter Kv= 2.5 fps
30.3	543	0.0143	0.30		<b>Shallow Concentrated Flow,</b> Forest w/Heavy Litter Kv= 2.5 fps
0.2	85	0.0200	9.11	16.09	<b>Pipe Channel,</b> 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.012 Concrete pipe, finished
1.0	543	0.0368	9.38	150.09	<b>Trap/Vee/Rect Channel Flow,</b> Bot.W=4.00' D=2.00' Z= 2.0 '/' Top.W=12.00' n= 0.035 Earth, dense weeds
1.1	913		13.90		<b>Lake or Reservoir, Fish and Game Pond</b> Mean Depth= 6.00'
7.0	5,896	0.1089	14.09	422.79	<b>Trap/Vee/Rect Channel Flow, Cussgutter Stream</b> Bot.W=4.00' D=3.00' Z= 2.0 '/' Top.W=16.00' n= 0.050 Mountain streams w/large boulders
155.0	9,182	Total			

### Subcatchment 3S: ALL Watershed Areas

Hydrograph



### Summary for Reach 1R: Cussgutter Stream

Inflow Area = 355.138 ac, 0.96% Impervious, Inflow Depth > 4.32" for 50-yr event  
 Inflow = 334.33 cfs @ 13.53 hrs, Volume= 127.756 af  
 Outflow = 330.97 cfs @ 13.63 hrs, Volume= 127.675 af, Atten= 1%, Lag= 6.4 min

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.03 hrs  
 Max. Velocity= 13.04 fps, Min. Travel Time= 7.5 min  
 Avg. Velocity = 5.71 fps, Avg. Travel Time= 17.2 min

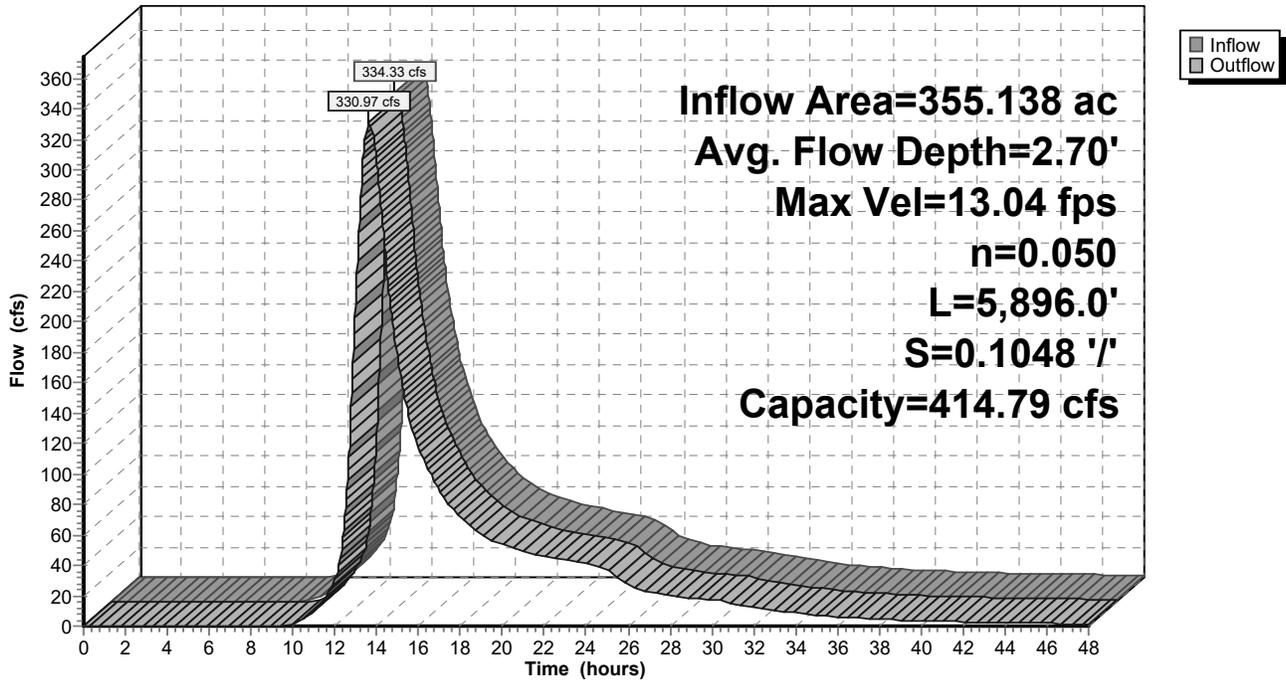
Peak Storage= 149,589 cf @ 13.63 hrs  
 Average Depth at Peak Storage= 2.70'  
 Bank-Full Depth= 3.00' Flow Area= 30.0 sf, Capacity= 414.79 cfs

4.00' x 3.00' deep channel, n= 0.050 Mountain streams w/large boulders  
 Side Slope Z-value= 2.0 '/' Top Width= 16.00'  
 Length= 5,896.0' Slope= 0.1048 '/'  
 Inlet Invert= 854.00', Outlet Invert= 236.00'



### Reach 1R: Cussgutter Stream

Hydrograph



**Summary for Pond 1P: Fish&Game Pond**

Inflow Area = 115.624 ac, 2.96% Impervious, Inflow Depth = 4.46" for 50-yr event  
 Inflow = 154.62 cfs @ 13.58 hrs, Volume= 42.932 af  
 Outflow = 27.18 cfs @ 17.24 hrs, Volume= 41.109 af, Atten= 82%, Lag= 219.4 min  
 Primary = 27.18 cfs @ 17.24 hrs, Volume= 41.109 af  
 Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.03 hrs  
 Peak Elev= 873.99' @ 17.24 hrs Surf.Area= 13.761 ac Storage= 25.572 af

Plug-Flow detention time= 531.9 min calculated for 41.083 af (96% of inflow)  
 Center-of-Mass det. time= 508.4 min ( 1,435.9 - 927.5 )

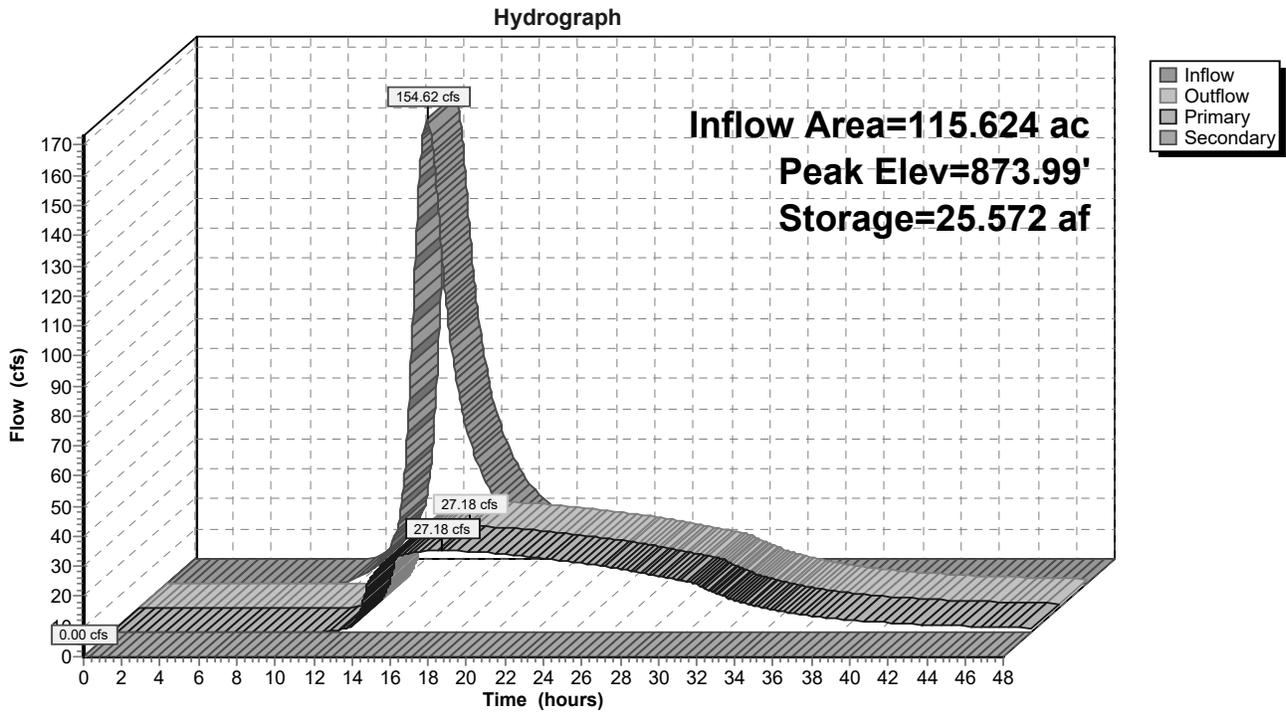
Volume	Invert	Avail.Storage	Storage Description
#1	872.00'	55.716 af	<b>Custom Stage Data (Prismatic)</b> Listed below
Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
872.00	11.910	0.000	0.000
874.00	13.769	25.679	25.679
876.00	16.268	30.037	55.716

Device	Routing	Invert	Outlet Devices
#1	Primary	872.00'	<b>24.0" x 24.0" Horiz. Orifice/Grate</b> C= 0.600 Limited to weir flow at low heads
#2	Secondary	874.00'	<b>24.0' long x 560.0' breadth Broad-Crested Rectangular Weir</b> Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

**Primary OutFlow** Max=27.18 cfs @ 17.24 hrs HW=873.99' (Free Discharge)  
 ↑1=**Orifice/Grate** (Orifice Controls 27.18 cfs @ 6.80 fps)

**Secondary OutFlow** Max=0.00 cfs @ 0.00 hrs HW=872.00' (Free Discharge)  
 ↑2=**Broad-Crested Rectangular Weir** ( Controls 0.00 cfs)

### Pond 1P: Fish&Game Pond



### Summary for Pond 2P: Lake Ave Culvert

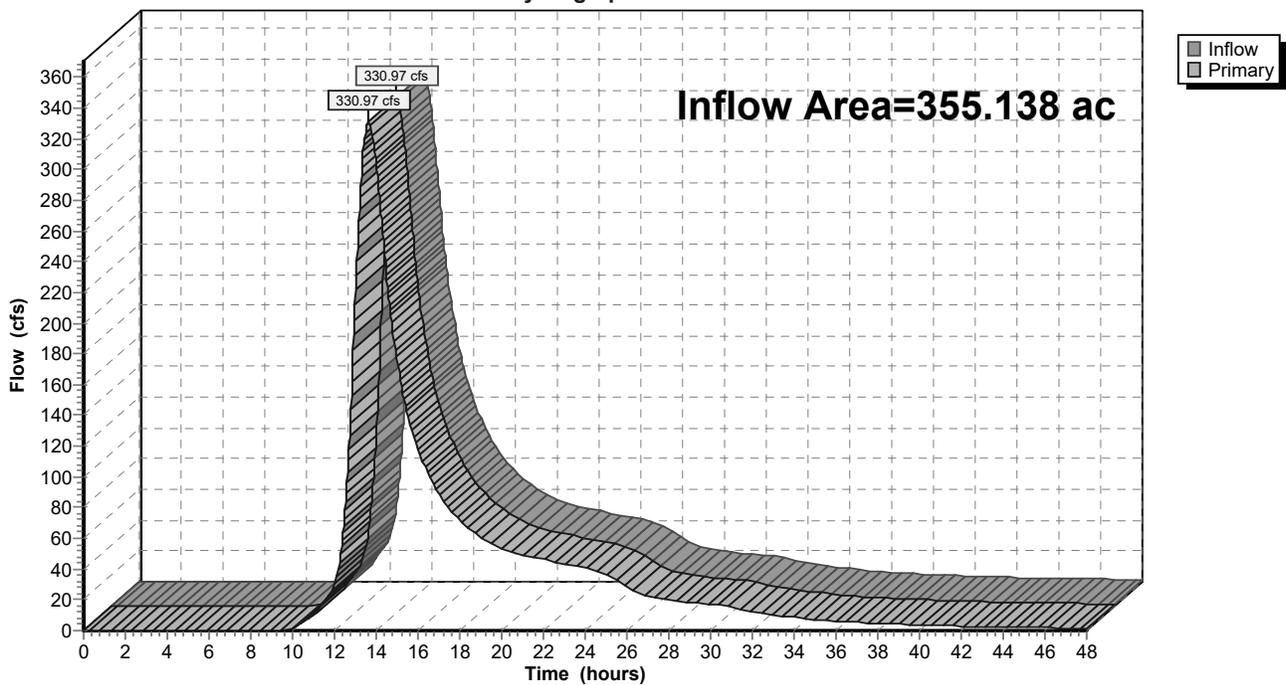
[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 355.138 ac, 0.96% Impervious, Inflow Depth > 4.31" for 50-yr event  
Inflow = 330.97 cfs @ 13.63 hrs, Volume= 127.675 af  
Primary = 330.97 cfs @ 13.63 hrs, Volume= 127.675 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.03 hrs

### Pond 2P: Lake Ave Culvert

Hydrograph



**Lake Ave Culvert\_20210317**

Type III 24-hr 100-yr Rainfall=9.06"

Prepared by WSP

Printed 3/30/2021

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Page 68

Time span=0.00-48.00 hrs, dt=0.03 hrs, 1601 points  
Runoff by SCS TR-20 method, UH=SCS  
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

**Subcatchment1S: Upstream of Pond** Runoff Area=115.624 ac 2.96% Impervious Runoff Depth=5.39"  
Flow Length=2,373' Tc=116.5 min CN=70 Runoff=187.27 cfs 51.914 af

**Subcatchment2S: Downstream of Pond** Runoff Area=239.514 ac 0.00% Impervious Runoff Depth=5.26"  
Flow Length=6,730' Tc=113.7 min CN=69 Runoff=384.87 cfs 105.063 af

**Subcatchment3S: ALL Watershed Areas** Runoff Area=367.422 ac 0.93% Impervious Runoff Depth=5.39"  
Flow Length=9,182' Tc=155.0 min CN=70 Runoff=483.50 cfs 164.969 af

**Reach 1R: Cussgutter Stream** Avg. Flow Depth=2.95' Max Vel=13.71 fps Inflow=404.81 cfs 154.938 af  
n=0.050 L=5,896.0' S=0.1048 '/ Capacity=414.79 cfs Outflow=401.15 cfs 154.849 af

**Pond 1P: Fish&Game Pond** Peak Elev=874.32' Storage=30.417 af Inflow=187.27 cfs 51.914 af  
Primary=29.31 cfs 46.550 af Secondary=11.45 cfs 3.325 af Outflow=40.76 cfs 49.875 af

**Pond 2P: Lake Ave Culvert** Inflow=401.15 cfs 154.849 af  
Primary=401.15 cfs 154.849 af

**Total Runoff Area = 722.560 ac Runoff Volume = 321.946 af Average Runoff Depth = 5.35"**  
**99.05% Pervious = 715.713 ac 0.95% Impervious = 6.847 ac**

**Summary for Subcatchment 1S: Upstream of Pond**

Runoff = 187.27 cfs @ 13.58 hrs, Volume= 51.914 af, Depth= 5.39"

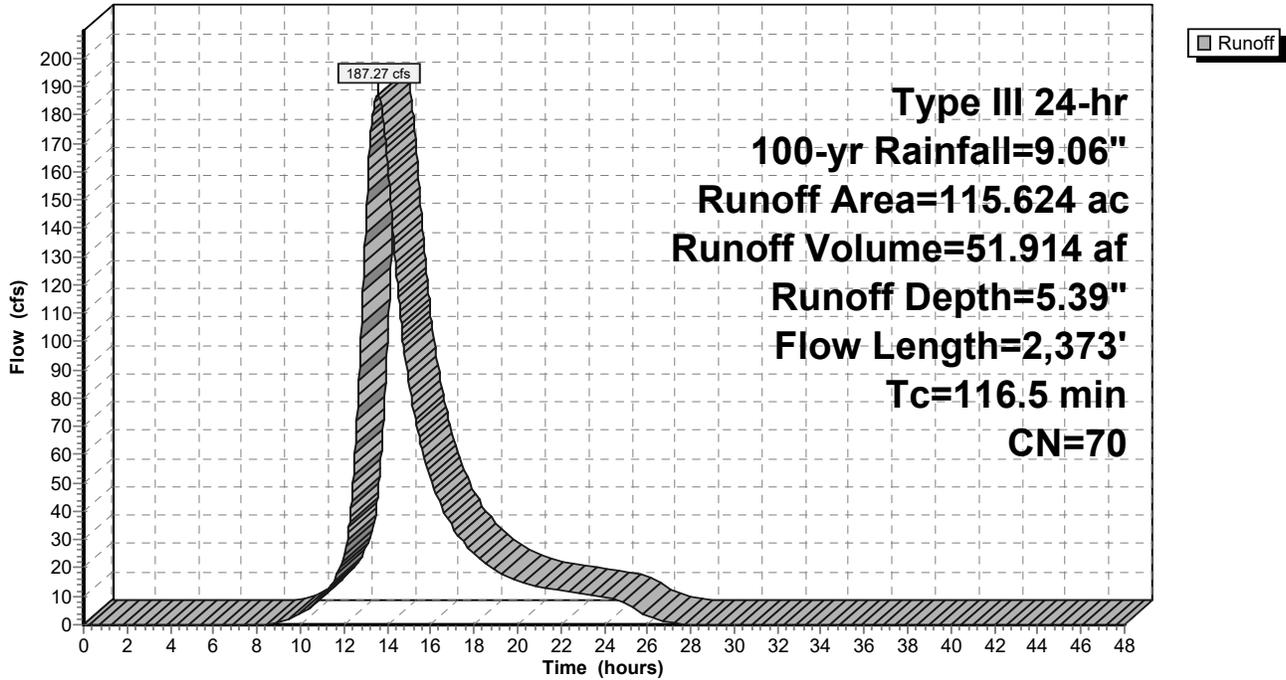
Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.03 hrs  
 Type III 24-hr 100-yr Rainfall=9.06"

Area (ac)	CN	Description
0.000	30	Woods, Good, HSG A
35.573	55	Woods, Good, HSG B
4.135	61	Pasture/grassland/range, Good, HSG B
2.710	92	Urban commercial, 85% imp, HSG B
0.437	74	Pasture/grassland/range, Good, HSG C
62.876	77	Woods, Good, HSG D
8.054	80	Pasture/grassland/range, Good, HSG D
1.124	95	Urban commercial, 85% imp, HSG D
0.658	85	1/2 acre lots, 25% imp, HSG D
0.057	98	Water Surface, 0% imp, HSG B
115.624	70	Weighted Average
112.201		97.04% Pervious Area
3.423		2.96% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
85.1	150	0.0050	0.03		<b>Sheet Flow,</b> Woods: Dense underbrush n= 0.800 P2= 3.58"
4.9	234	0.0256	0.80		<b>Shallow Concentrated Flow,</b> Woodland Kv= 5.0 fps
10.2	818	0.0709	1.33		<b>Shallow Concentrated Flow,</b> Woodland Kv= 5.0 fps
15.1	543	0.0143	0.60		<b>Shallow Concentrated Flow,</b> Woodland Kv= 5.0 fps
0.2	85	0.0200	9.11	16.09	<b>Pipe Channel, Information Unknown</b> 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.012 Concrete pipe, finished
1.0	543	0.0368	9.38	150.09	<b>Trap/Vee/Rect Channel Flow,</b> Bot.W=4.00' D=2.00' Z= 2.0 '/' Top.W=12.00' n= 0.035 Earth, dense weeds
116.5	2,373	Total			

**Subcatchment 1S: Upstream of Pond**

Hydrograph



**Summary for Subcatchment 2S: Downstream of Pond**

Runoff = 384.87 cfs @ 13.52 hrs, Volume= 105.063 af, Depth= 5.26"

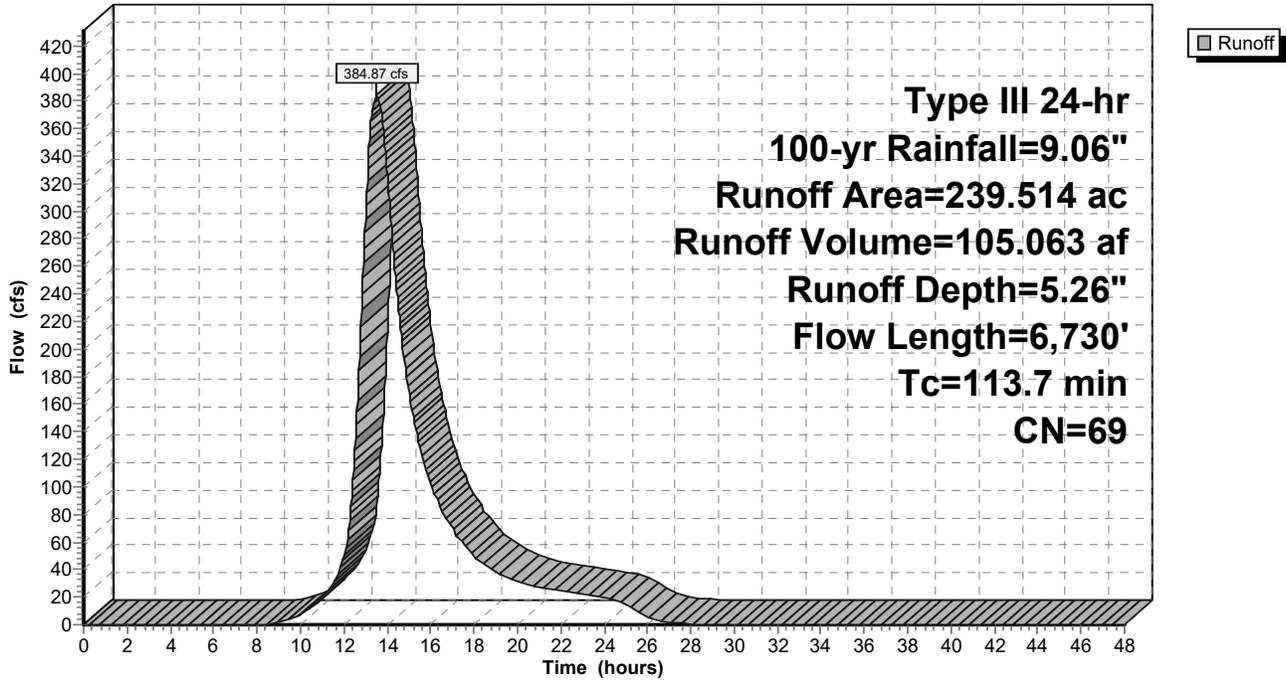
Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.03 hrs  
 Type III 24-hr 100-yr Rainfall=9.06"

Area (ac)	CN	Description
1.120	30	Woods, Good, HSG A
89.189	55	Woods, Good, HSG B
0.000	61	Pasture/grassland/range, Good, HSG B
0.000	92	Urban commercial, 85% imp, HSG B
0.000	74	Pasture/grassland/range, Good, HSG C
138.271	77	Woods, Good, HSG D
10.934	80	Pasture/grassland/range, Good, HSG D
0.000	95	Urban commercial, 85% imp, HSG D
0.000	85	1/2 acre lots, 25% imp, HSG D
0.000	98	Water Surface, 0% imp, HSG B
239.514	69	Weighted Average
239.514		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
85.1	150	0.0050	0.03		<b>Sheet Flow,</b> Woods: Dense underbrush n= 0.800 P2= 3.58"
1.6	131	0.3050	1.38		<b>Shallow Concentrated Flow,</b> Forest w/Heavy Litter Kv= 2.5 fps
3.8	202	0.1287	0.90		<b>Shallow Concentrated Flow,</b> Forest w/Heavy Litter Kv= 2.5 fps
15.5	221	0.0090	0.24		<b>Shallow Concentrated Flow,</b> Forest w/Heavy Litter Kv= 2.5 fps
0.9	340	0.0176	6.18	259.45	<b>Trap/Vee/Rect Channel Flow,</b> Bot.W=8.00' D=3.00' Z= 2.0 '/' Top.W=20.00' n= 0.050 Mountain streams w/large boulders
1.0	757	0.1340	12.90	232.16	<b>Trap/Vee/Rect Channel Flow,</b> Bot.W=5.00' D=2.00' Z= 2.0 '/' Top.W=13.00' n= 0.050 Mountain streams w/large boulders
5.8	4,929	0.1089	14.09	422.79	<b>Trap/Vee/Rect Channel Flow, Cussgutter Reach</b> Bot.W=4.00' D=3.00' Z= 2.0 '/' Top.W=16.00' n= 0.050 Mountain streams w/large boulders
113.7	6,730	Total			

Subcatchment 2S: Downstream of Pond

Hydrograph



**Summary for Subcatchment 3S: ALL Watershed Areas**

Runoff = 483.50 cfs @ 13.96 hrs, Volume= 164.969 af, Depth= 5.39"

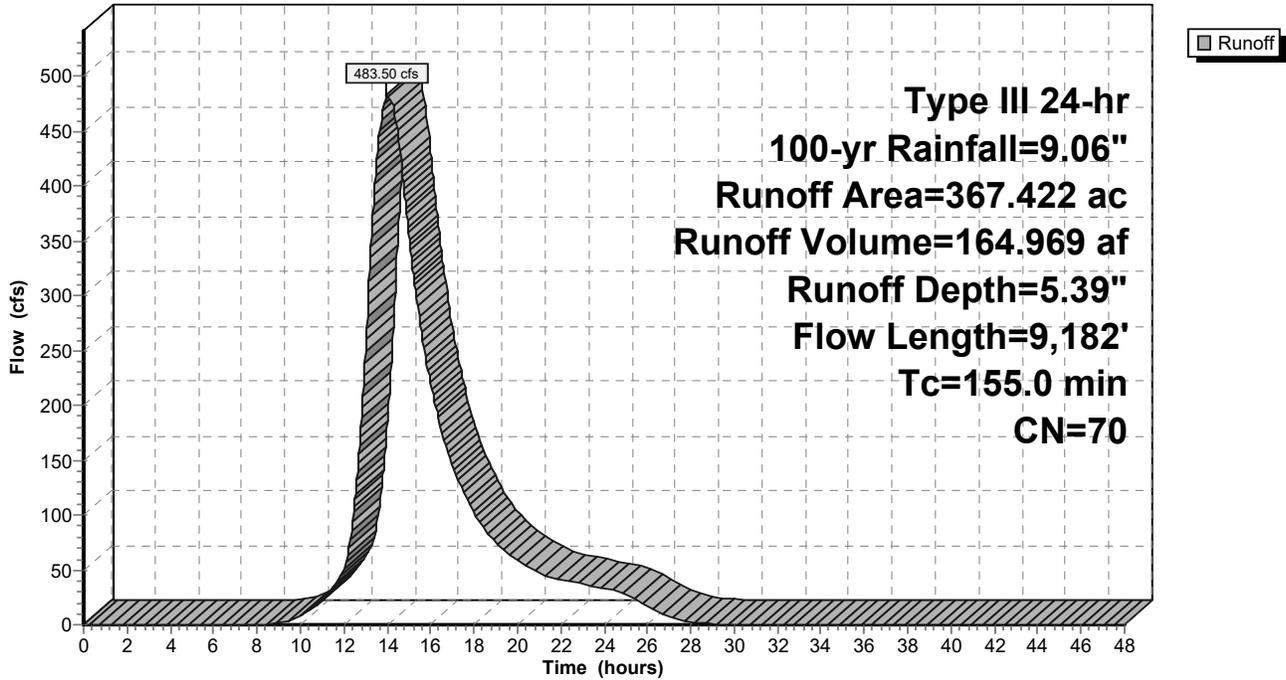
Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.03 hrs  
 Type III 24-hr 100-yr Rainfall=9.06"

Area (ac)	CN	Description
1.120	30	Woods, Good, HSG A
124.762	55	Woods, Good, HSG B
4.135	61	Pasture/grassland/range, Good, HSG B
2.710	92	Urban commercial, 85% imp, HSG B
0.437	74	Pasture/grassland/range, Good, HSG C
201.147	77	Woods, Good, HSG D
18.989	80	Pasture/grassland/range, Good, HSG D
1.124	95	Urban commercial, 85% imp, HSG D
0.658	85	1/2 acre lots, 25% imp, HSG D
12.340	98	Water Surface, 0% imp, HSG B
367.422	70	Weighted Average
363.999		99.07% Pervious Area
3.423		0.93% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
85.1	150	0.0050	0.03		<b>Sheet Flow,</b> Woods: Dense underbrush n= 0.800 P2= 3.58"
9.7	234	0.0256	0.40		<b>Shallow Concentrated Flow,</b> Forest w/Heavy Litter Kv= 2.5 fps
20.5	818	0.0709	0.67		<b>Shallow Concentrated Flow,</b> Forest w/Heavy Litter Kv= 2.5 fps
30.3	543	0.0143	0.30		<b>Shallow Concentrated Flow,</b> Forest w/Heavy Litter Kv= 2.5 fps
0.2	85	0.0200	9.11	16.09	<b>Pipe Channel,</b> 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.012 Concrete pipe, finished
1.0	543	0.0368	9.38	150.09	<b>Trap/Vee/Rect Channel Flow,</b> Bot.W=4.00' D=2.00' Z= 2.0 '/' Top.W=12.00' n= 0.035 Earth, dense weeds
1.1	913		13.90		<b>Lake or Reservoir, Fish and Game Pond</b> Mean Depth= 6.00'
7.0	5,896	0.1089	14.09	422.79	<b>Trap/Vee/Rect Channel Flow, Cussgutter Stream</b> Bot.W=4.00' D=3.00' Z= 2.0 '/' Top.W=16.00' n= 0.050 Mountain streams w/large boulders
155.0	9,182	Total			

Subcatchment 3S: ALL Watershed Areas

Hydrograph



### Summary for Reach 1R: Cussgutter Stream

Inflow Area = 355.138 ac, 0.96% Impervious, Inflow Depth > 5.24" for 100-yr event  
 Inflow = 404.81 cfs @ 13.52 hrs, Volume= 154.938 af  
 Outflow = 401.15 cfs @ 13.61 hrs, Volume= 154.849 af, Atten= 1%, Lag= 5.2 min

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.03 hrs  
 Max. Velocity= 13.71 fps, Min. Travel Time= 7.2 min  
 Avg. Velocity = 6.03 fps, Avg. Travel Time= 16.3 min

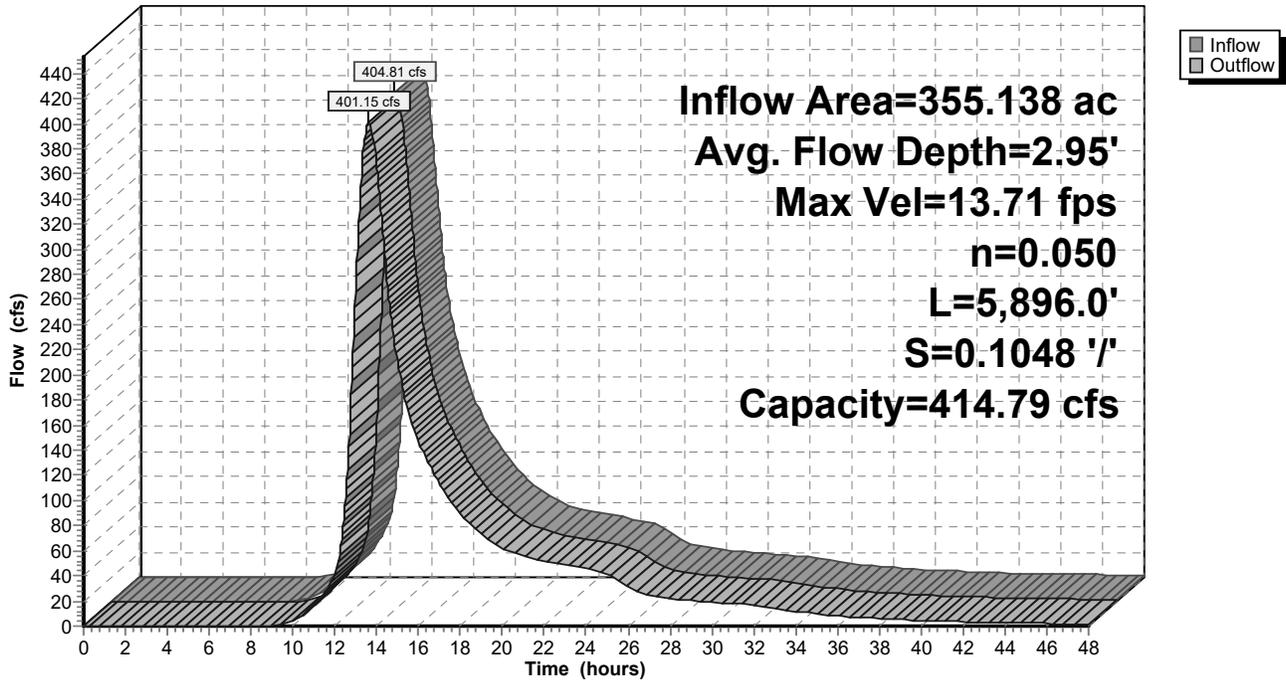
Peak Storage= 172,537 cf @ 13.61 hrs  
 Average Depth at Peak Storage= 2.95'  
 Bank-Full Depth= 3.00' Flow Area= 30.0 sf, Capacity= 414.79 cfs

4.00' x 3.00' deep channel, n= 0.050 Mountain streams w/large boulders  
 Side Slope Z-value= 2.0 '/' Top Width= 16.00'  
 Length= 5,896.0' Slope= 0.1048 '/'  
 Inlet Invert= 854.00', Outlet Invert= 236.00'



### Reach 1R: Cussgutter Stream

Hydrograph



**Summary for Pond 1P: Fish&Game Pond**

Inflow Area = 115.624 ac, 2.96% Impervious, Inflow Depth = 5.39" for 100-yr event  
 Inflow = 187.27 cfs @ 13.58 hrs, Volume= 51.914 af  
 Outflow = 40.76 cfs @ 16.58 hrs, Volume= 49.875 af, Atten= 78%, Lag= 179.6 min  
 Primary = 29.31 cfs @ 16.58 hrs, Volume= 46.550 af  
 Secondary = 11.45 cfs @ 16.58 hrs, Volume= 3.325 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.03 hrs  
 Peak Elev= 874.32' @ 16.58 hrs Surf.Area= 14.163 ac Storage= 30.417 af

Plug-Flow detention time= 528.2 min calculated for 49.875 af (96% of inflow)  
 Center-of-Mass det. time= 505.6 min ( 1,427.7 - 922.1 )

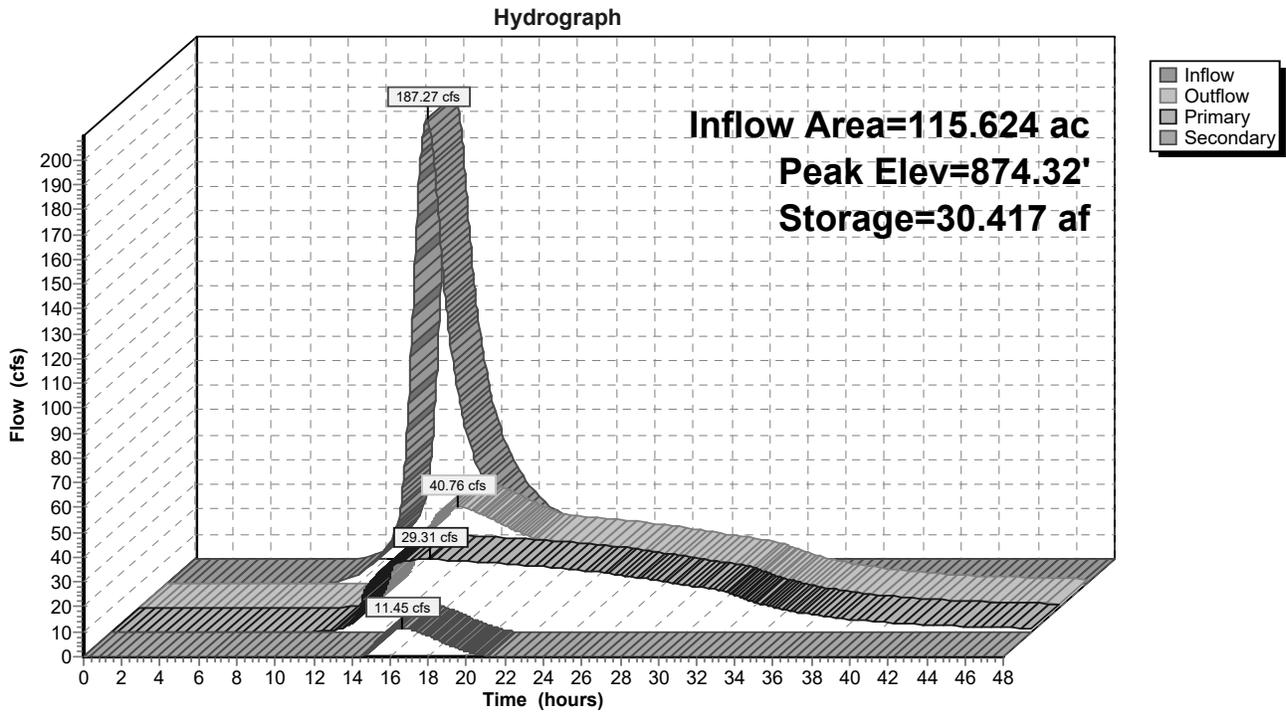
Volume	Invert	Avail.Storage	Storage Description
#1	872.00'	55.716 af	<b>Custom Stage Data (Prismatic)</b> Listed below
Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
872.00	11.910	0.000	0.000
874.00	13.769	25.679	25.679
876.00	16.268	30.037	55.716

Device	Routing	Invert	Outlet Devices
#1	Primary	872.00'	<b>24.0" x 24.0" Horiz. Orifice/Grate</b> C= 0.600 Limited to weir flow at low heads
#2	Secondary	874.00'	<b>24.0' long x 560.0' breadth Broad-Crested Rectangular Weir</b> Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

**Primary OutFlow** Max=29.31 cfs @ 16.58 hrs HW=874.32' (Free Discharge)  
 ↑1=**Orifice/Grate** (Orifice Controls 29.31 cfs @ 7.33 fps)

**Secondary OutFlow** Max=11.44 cfs @ 16.58 hrs HW=874.32' (Free Discharge)  
 ↑2=**Broad-Crested Rectangular Weir**(Weir Controls 11.44 cfs @ 1.51 fps)

### Pond 1P: Fish&Game Pond



### Summary for Pond 2P: Lake Ave Culvert

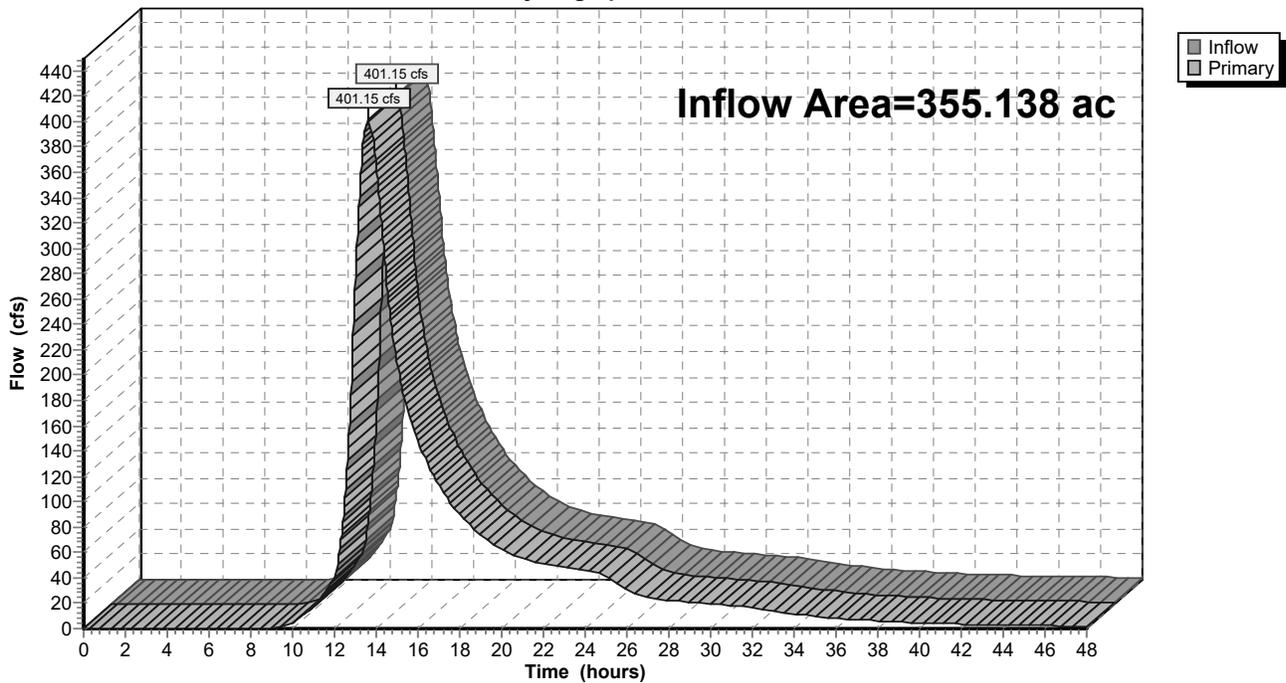
[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 355.138 ac, 0.96% Impervious, Inflow Depth > 5.23" for 100-yr event  
Inflow = 401.15 cfs @ 13.61 hrs, Volume= 154.849 af  
Primary = 401.15 cfs @ 13.61 hrs, Volume= 154.849 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.03 hrs

### Pond 2P: Lake Ave Culvert

Hydrograph



# APPENDIX

# G HEC-RAS OUTPUT



HEC-RAS River: CussgutterBrook Reach: CussgutterBrook

Reach	River Sta	Profile	Plan	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
CussgutterBrook	347	1 yr	Ex	49.00	235.16	236.51	236.51	236.93	0.021291	5.18	9.45	11.63	1.01
CussgutterBrook	347	1 yr	Pro	49.00	235.16	236.51	236.51	236.93	0.021291	5.18	9.45	11.63	1.01
CussgutterBrook	347	2 yr	Ex	86.00	235.16	236.90	236.90	237.48	0.019457	6.10	14.10	12.49	1.01
CussgutterBrook	347	2 yr	Pro	86.00	235.16	236.90	236.90	237.48	0.019464	6.10	14.10	12.49	1.01
CussgutterBrook	347	5 yr	Ex	158.00	235.16	237.49	237.49	238.30	0.017858	7.21	21.90	13.81	1.01
CussgutterBrook	347	5 yr	Pro	158.00	235.16	237.49	237.49	238.30	0.017855	7.21	21.91	13.81	1.01
CussgutterBrook	347	10 yr	Ex	225.00	235.16	237.95	237.95	238.92	0.017077	7.92	28.40	14.83	1.01
CussgutterBrook	347	10 yr	Pro	225.00	235.16	237.95	237.95	238.92	0.017077	7.92	28.40	14.83	1.01
CussgutterBrook	347	25 yr	Ex	323.00	235.16	238.52	238.52	239.68	0.016317	8.64	37.36	16.32	1.01
CussgutterBrook	347	25 yr	Pro	323.00	235.16	238.52	238.52	239.68	0.016317	8.64	37.36	16.32	1.01
CussgutterBrook	347	50 yr	Ex	398.00	235.16	238.93	238.93	240.18	0.015925	8.99	44.28	17.90	1.01
CussgutterBrook	347	50 yr	Pro	398.00	235.16	238.93	238.93	240.18	0.015925	8.99	44.28	17.90	1.01
CussgutterBrook	347	100 yr	Ex	483.00	235.16	239.38	239.38	240.67	0.013498	9.15	54.43	25.50	0.95
CussgutterBrook	347	100 yr	Pro	483.00	235.16	239.38	239.38	240.67	0.013498	9.15	54.43	25.50	0.95
CussgutterBrook	319	1 yr	Ex	49.00	234.54	235.62	235.62	235.99	0.020784	4.89	10.03	13.80	1.01
CussgutterBrook	319	1 yr	Pro	49.00	234.54	235.62	235.62	235.99	0.020784	4.89	10.03	13.80	1.01
CussgutterBrook	319	2 yr	Ex	86.00	234.54	235.97	235.97	236.47	0.018949	5.67	15.16	15.44	1.01
CussgutterBrook	319	2 yr	Pro	86.00	234.54	235.97	235.97	236.47	0.018953	5.67	15.16	15.44	1.01
CussgutterBrook	319	5 yr	Ex	158.00	234.54	236.50	236.50	237.17	0.017109	6.59	23.98	17.92	1.00
CussgutterBrook	319	5 yr	Pro	158.00	234.54	236.49	236.49	237.17	0.017113	6.59	23.98	17.92	1.00
CussgutterBrook	319	10 yr	Ex	225.00	234.54	236.88	236.88	237.69	0.016414	7.20	31.25	19.73	1.01
CussgutterBrook	319	10 yr	Pro	225.00	234.54	236.88	236.88	237.69	0.016414	7.20	31.25	19.73	1.01
CussgutterBrook	319	25 yr	Ex	323.00	234.54	237.36	237.36	238.31	0.015561	7.83	41.23	21.93	1.01
CussgutterBrook	319	25 yr	Pro	323.00	234.54	237.36	237.36	238.31	0.015561	7.83	41.23	21.93	1.01
CussgutterBrook	319	50 yr	Ex	398.00	234.54	237.69	237.69	238.73	0.013954	8.19	49.16	28.26	0.98
CussgutterBrook	319	50 yr	Pro	398.00	234.54	237.69	237.69	238.73	0.013954	8.19	49.16	28.26	0.98
CussgutterBrook	319	100 yr	Ex	483.00	234.54	238.05	238.05	239.14	0.012048	8.43	60.49	32.98	0.93
CussgutterBrook	319	100 yr	Pro	483.00	234.54	238.05	238.05	239.14	0.012048	8.43	60.49	32.98	0.93
CussgutterBrook	292	1 yr	Ex	49.00	232.60	233.86	233.86	234.27	0.020524	5.12	9.57	12.00	1.01
CussgutterBrook	292	1 yr	Pro	49.00	232.60	233.86	233.86	234.27	0.020524	5.12	9.57	12.00	1.01
CussgutterBrook	292	2 yr	Ex	86.00	232.60	234.25	234.25	234.79	0.018800	5.93	14.50	13.54	1.01
CussgutterBrook	292	2 yr	Pro	86.00	232.60	234.25	234.25	234.79	0.018804	5.93	14.50	13.54	1.01
CussgutterBrook	292	5 yr	Ex	158.00	232.60	234.82	234.82	235.56	0.017174	6.88	22.95	15.83	1.01
CussgutterBrook	292	5 yr	Pro	158.00	232.60	234.82	234.82	235.56	0.017180	6.89	22.95	15.83	1.01
CussgutterBrook	292	10 yr	Ex	225.00	232.60	235.25	235.25	236.11	0.016219	7.44	30.24	18.09	1.00
CussgutterBrook	292	10 yr	Pro	225.00	232.60	235.25	235.25	236.11	0.016219	7.44	30.24	18.09	1.00
CussgutterBrook	292	25 yr	Ex	323.00	232.60	235.79	235.79	236.78	0.013373	8.03	41.87	25.65	0.95
CussgutterBrook	292	25 yr	Pro	323.00	232.60	235.79	235.79	236.78	0.013373	8.03	41.87	25.65	0.95
CussgutterBrook	292	50 yr	Ex	398.00	232.60	236.16	236.16	237.21	0.011738	8.33	52.29	31.29	0.91
CussgutterBrook	292	50 yr	Pro	398.00	232.60	236.16	236.16	237.21	0.011738	8.33	52.29	31.29	0.91
CussgutterBrook	292	100 yr	Ex	483.00	232.60	236.51	236.51	237.62	0.010689	8.66	64.15	35.14	0.89
CussgutterBrook	292	100 yr	Pro	483.00	232.60	236.51	236.51	237.62	0.010689	8.66	64.15	35.14	0.89
CussgutterBrook	269	1 yr	Ex	49.00	232.01	233.19	233.19	233.60	0.019882	5.18	9.46	11.31	1.00
CussgutterBrook	269	1 yr	Pro	49.00	232.01	233.19	233.19	233.60	0.019882	5.18	9.46	11.31	1.00
CussgutterBrook	269	2 yr	Ex	86.00	232.01	233.59	233.59	234.15	0.018606	5.96	14.43	13.20	1.00
CussgutterBrook	269	2 yr	Pro	86.00	232.01	233.59	233.59	234.15	0.018606	5.96	14.43	13.20	1.00
CussgutterBrook	269	5 yr	Ex	158.00	232.01	234.19	234.19	234.91	0.017175	6.84	23.09	16.02	1.01
CussgutterBrook	269	5 yr	Pro	158.00	232.01	234.19	234.19	234.91	0.017175	6.84	23.09	16.02	1.01
CussgutterBrook	269	10 yr	Ex	225.00	232.01	234.62	234.62	235.50	0.011254	6.44	34.96	19.25	0.84
CussgutterBrook	269	10 yr	Pro	225.00	232.01	234.62	234.62	235.46	0.016299	7.36	30.58	18.24	1.00
CussgutterBrook	269	25 yr	Ex	323.00	232.01	235.87	235.15	236.32	0.005383	5.44	68.40	48.48	0.61
CussgutterBrook	269	25 yr	Pro	323.00	232.01	235.15	235.15	236.12	0.015418	7.92	40.78	20.79	1.00
CussgutterBrook	269	50 yr	Ex	398.00	232.01	235.64	235.64	236.52	0.011725	7.59	57.32	44.15	0.89
CussgutterBrook	269	50 yr	Pro	398.00	232.01	235.64	235.64	236.52	0.011725	7.59	57.32	44.15	0.89
CussgutterBrook	269	100 yr	Ex	483.00	232.01	235.97	235.97	236.86	0.010403	7.75	73.16	52.11	0.85
CussgutterBrook	269	100 yr	Pro	483.00	232.01	235.97	235.97	236.86	0.010403	7.75	73.16	52.11	0.85
CussgutterBrook	254	1 yr	Ex	49.00	230.95	232.91	232.23	233.01	0.002876	2.53	19.39	15.83	0.40
CussgutterBrook	254	1 yr	Pro	49.00	230.95	232.71	232.23	232.85	0.004678	3.00	16.35	14.99	0.51
CussgutterBrook	254	2 yr	Ex	86.00	230.95	233.53	232.62	233.66	0.002585	2.87	30.01	18.42	0.40
CussgutterBrook	254	2 yr	Pro	86.00	230.95	233.19	232.62	233.39	0.004871	3.59	23.95	17.01	0.53
CussgutterBrook	254	5 yr	Ex	158.00	230.95	234.47	233.17	234.63	0.002211	3.22	49.27	25.81	0.38
CussgutterBrook	254	5 yr	Pro	158.00	230.95	233.88	233.17	234.17	0.004980	4.30	36.71	19.85	0.56
CussgutterBrook	254	10 yr	Ex	225.00	230.95	235.13	233.57	235.30	0.001901	3.38	72.42	59.13	0.36
CussgutterBrook	254	10 yr	Pro	225.00	230.95	234.38	233.58	234.74	0.005003	4.77	47.25	22.63	0.57
CussgutterBrook	254	25 yr	Ex	323.00	230.95	236.08	234.06	236.18	0.000883	2.82	158.80	108.30	0.26
CussgutterBrook	254	25 yr	Pro	323.00	230.95	234.48	234.07	235.14	0.009154	6.55	49.52	26.82	0.77
CussgutterBrook	254	50 yr	Ex	398.00	230.95	235.36	234.41	235.73	0.003912	5.12	92.22	62.48	0.53
CussgutterBrook	254	50 yr	Pro	398.00	230.95	234.60	234.40	235.50	0.011973	7.63	53.05	31.95	0.89
CussgutterBrook	254	100 yr	Ex	483.00	230.95	236.31	234.88	236.48	0.001458	3.77	182.86	108.30	0.34
CussgutterBrook	254	100 yr	Pro	483.00	230.95	236.02	235.03	236.26	0.002166	4.36	151.72	108.30	0.41
CussgutterBrook	237	1 yr	Ex	49.00	230.95	232.33	232.33	232.80	0.020031	5.51	8.90	9.47	1.00
CussgutterBrook	237	1 yr	Pro	49.00	230.95	232.24	232.24	232.63	0.020245	5.02	9.76	12.47	1.00
CussgutterBrook	237	2 yr	Ex	86.00	230.95	232.78	232.78	233.41	0.018335	6.39	13.45	10.61	1.00
CussgutterBrook	237	2 yr	Pro	86.00	230.95	232.62	232.62	233.15	0.018486	5.82	14.77	13.99	1.00
CussgutterBrook	237	5 yr	Ex	158.00	230.95	233.46	233.46	234.34	0.016611	7.53	20.99	12.65	1.00
CussgutterBrook	237	5 yr	Pro	158.00	230.95	233.18	233.18	233.90	0.017046	6.80	23.23	16.23	1.00
CussgutterBrook	237	10 yr	Ex	225.00	230.95	234.07	233.98	235.00	0.014201	7.77	28.96	44.83	0.95
CussgutterBrook	237	10 yr	Pro	225.00	230.95	233.60	233.60	234.45	0.016152	7.39	30.44	18.22	1.00
CussgutterBrook	237	25 yr	Ex	323.00	230.95	234.56	234.56	235.80	0.014849	8.95	36.11	56.04	1.00
CussgutterBrook	237	25 yr	Pro	323.00	230.95	234.38	234.38	234.95	0.008528	6.34	60.33	55.66	0.76

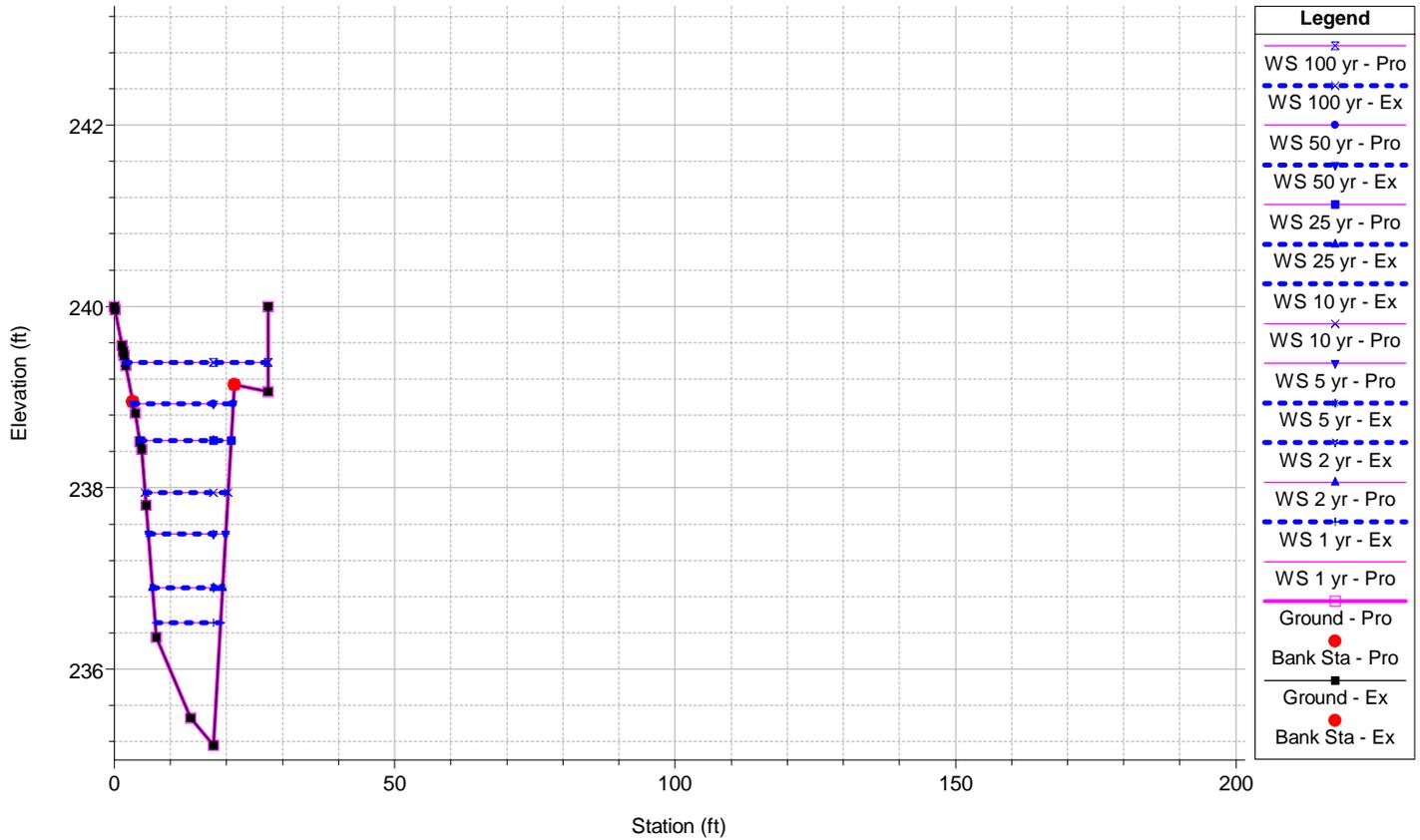
HEC-RAS River: CussgutterBrook Reach: CussgutterBrook (Continued)

Reach	River Sta	Profile	Plan	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
CussgutterBrook	237	50 yr	Ex	398.00	230.95	235.35	234.93	235.61	0.003209	4.75	107.31	69.55	0.47
CussgutterBrook	237	50 yr	Pro	398.00	230.95	234.58	234.58	235.19	0.008593	6.74	71.33	56.07	0.77
CussgutterBrook	237	100 yr	Ex	483.00	230.95	236.31	235.25	236.43	0.001071	3.28	220.25	128.60	0.29
CussgutterBrook	237	100 yr	Pro	483.00	230.95	236.04	234.76	236.19	0.001230	3.51	195.78	128.60	0.32
CussgutterBrook	200			Culvert									
CussgutterBrook	160	1 yr	Ex	49.00	228.84	229.85	229.85	230.26	0.020842	5.11	9.60	12.00	1.00
CussgutterBrook	160	1 yr	Pro	49.00	228.84	229.82	229.82	230.18	0.020523	4.83	10.14	13.87	1.00
CussgutterBrook	160	2 yr	Ex	86.00	228.84	230.23	230.23	230.81	0.018677	6.11	14.08	12.68	0.99
CussgutterBrook	160	2 yr	Pro	86.00	228.84	230.16	230.16	230.66	0.019033	5.68	15.14	15.24	1.00
CussgutterBrook	160	5 yr	Ex	158.00	228.84	230.81	230.81	231.68	0.017152	7.45	21.21	13.51	1.00
CussgutterBrook	160	5 yr	Pro	158.00	228.84	230.68	230.68	231.38	0.017465	6.68	23.65	17.33	1.01
CussgutterBrook	160	10 yr	Ex	225.00	228.84	231.27	231.27	232.36	0.016479	8.36	26.92	14.20	1.00
CussgutterBrook	160	10 yr	Pro	225.00	228.84	231.09	231.09	231.91	0.016303	7.26	31.00	18.95	1.00
CussgutterBrook	160	25 yr	Ex	323.00	228.84	231.88	231.88	233.24	0.015733	9.35	34.54	15.13	1.00
CussgutterBrook	160	25 yr	Pro	323.00	228.84	232.51	231.59	232.93	0.004804	5.21	61.99	24.57	0.58
CussgutterBrook	160	50 yr	Ex	398.00	228.84	232.32	232.32	233.84	0.015235	9.90	40.20	16.06	1.00
CussgutterBrook	160	50 yr	Pro	398.00	228.84	233.66	231.91	233.95	0.002218	4.29	94.99	108.48	0.41
CussgutterBrook	160	100 yr	Ex	483.00	228.84	232.77	232.77	234.46	0.014808	10.43	46.32	79.68	1.00
CussgutterBrook	160	100 yr	Pro	483.00	228.84	234.45	232.24	234.71	0.001618	4.16	121.37	179.87	0.36
CussgutterBrook	142	1 yr	Ex	49.00	228.19	229.42	229.42	229.78	0.021162	4.80	10.21	14.22	1.00
CussgutterBrook	142	1 yr	Pro	49.00	228.19	229.42	229.42	229.78	0.021162	4.80	10.21	14.22	1.00
CussgutterBrook	142	2 yr	Ex	86.00	228.19	229.98	229.81	230.22	0.011714	3.98	21.62	25.96	0.77
CussgutterBrook	142	2 yr	Pro	86.00	228.19	229.98	229.81	230.22	0.011714	3.98	21.62	25.96	0.77
CussgutterBrook	142	5 yr	Ex	158.00	228.19	230.40	230.20	230.75	0.010791	4.73	33.41	29.07	0.78
CussgutterBrook	142	5 yr	Pro	158.00	228.19	230.40	230.20	230.75	0.010791	4.73	33.41	29.07	0.78
CussgutterBrook	142	10 yr	Ex	225.00	228.19	230.54	230.49	231.10	0.015624	6.04	37.26	30.02	0.95
CussgutterBrook	142	10 yr	Pro	225.00	228.19	230.54	230.49	231.10	0.015624	6.04	37.26	30.02	0.95
CussgutterBrook	142	25 yr	Ex	323.00	228.19	230.89	230.89	231.57	0.013826	6.65	51.49	69.18	0.93
CussgutterBrook	142	25 yr	Pro	323.00	228.19	230.89	230.89	231.57	0.013826	6.65	51.49	69.18	0.93
CussgutterBrook	142	50 yr	Ex	398.00	228.19	231.12	231.12	231.86	0.012957	7.04	61.56	72.67	0.92
CussgutterBrook	142	50 yr	Pro	398.00	228.19	231.12	231.12	231.86	0.012957	7.04	61.56	72.67	0.92
CussgutterBrook	142	100 yr	Ex	483.00	228.19	231.35	231.35	232.17	0.012301	7.43	72.09	76.70	0.91
CussgutterBrook	142	100 yr	Pro	483.00	228.19	231.35	231.35	232.17	0.012301	7.43	72.09	76.70	0.91
CussgutterBrook	124	1 yr	Ex	49.00	227.32	228.85	228.71	229.26	0.014767	5.12	9.57	8.49	0.85
CussgutterBrook	124	1 yr	Pro	49.00	227.32	228.85	228.71	229.26	0.014767	5.12	9.57	8.49	0.85
CussgutterBrook	124	2 yr	Ex	86.00	227.32	229.32	229.32	229.87	0.019730	5.92	14.52	13.32	1.00
CussgutterBrook	124	2 yr	Pro	86.00	227.32	229.32	229.32	229.87	0.019730	5.92	14.52	13.32	1.00
CussgutterBrook	124	5 yr	Ex	158.00	227.32	230.04	229.93	230.50	0.013850	5.43	29.12	24.52	0.87
CussgutterBrook	124	5 yr	Pro	158.00	227.32	230.04	229.93	230.50	0.013850	5.43	29.12	24.52	0.87
CussgutterBrook	124	10 yr	Ex	225.00	227.32	230.38	230.38	230.81	0.010253	5.50	53.41	82.34	0.78
CussgutterBrook	124	10 yr	Pro	225.00	227.32	230.38	230.38	230.81	0.010253	5.50	53.41	82.34	0.78
CussgutterBrook	124	25 yr	Ex	323.00	227.32	230.67	230.67	231.14	0.009775	6.02	77.93	91.75	0.79
CussgutterBrook	124	25 yr	Pro	323.00	227.32	230.67	230.67	231.14	0.009775	6.02	77.93	91.75	0.79
CussgutterBrook	124	50 yr	Ex	398.00	227.32	230.84	230.84	231.34	0.009757	6.38	93.81	94.57	0.80
CussgutterBrook	124	50 yr	Pro	398.00	227.32	230.84	230.84	231.34	0.009757	6.38	93.81	94.57	0.80
CussgutterBrook	124	100 yr	Ex	483.00	227.32	231.00	231.00	231.54	0.009888	6.77	109.69	100.67	0.81
CussgutterBrook	124	100 yr	Pro	483.00	227.32	231.00	231.00	231.54	0.009888	6.77	109.69	100.67	0.81
CussgutterBrook	107	1 yr	Ex	49.00	227.15	228.50	228.50	228.95	0.020146	5.37	9.12	10.24	1.00
CussgutterBrook	107	1 yr	Pro	49.00	227.15	228.50	228.50	228.95	0.020146	5.37	9.12	10.24	1.00
CussgutterBrook	107	2 yr	Ex	86.00	227.15	228.95	228.95	229.46	0.019156	5.72	15.02	14.73	1.00
CussgutterBrook	107	2 yr	Pro	86.00	227.15	228.95	228.95	229.46	0.019156	5.72	15.02	14.73	1.00
CussgutterBrook	107	5 yr	Ex	158.00	227.15	229.48	229.48	230.20	0.017427	6.84	23.11	15.83	1.00
CussgutterBrook	107	5 yr	Pro	158.00	227.15	229.48	229.48	230.20	0.017427	6.84	23.11	15.83	1.00
CussgutterBrook	107	10 yr	Ex	225.00	227.15	229.99	229.99	230.37	0.008064	5.55	66.78	96.85	0.71
CussgutterBrook	107	10 yr	Pro	225.00	227.15	229.99	229.99	230.37	0.008064	5.55	66.78	96.85	0.71
CussgutterBrook	107	25 yr	Ex	323.00	227.15	230.25	230.25	230.66	0.008279	6.11	92.84	107.59	0.73
CussgutterBrook	107	25 yr	Pro	323.00	227.15	230.25	230.25	230.66	0.008279	6.11	92.84	107.59	0.73
CussgutterBrook	107	50 yr	Ex	398.00	227.15	230.39	230.39	230.84	0.008899	6.60	107.99	114.17	0.76
CussgutterBrook	107	50 yr	Pro	398.00	227.15	230.39	230.39	230.84	0.008899	6.60	107.99	114.17	0.76
CussgutterBrook	107	100 yr	Ex	483.00	227.15	230.54	230.54	231.01	0.008967	6.92	126.64	121.50	0.78
CussgutterBrook	107	100 yr	Pro	483.00	227.15	230.54	230.54	231.01	0.008967	6.92	126.64	121.50	0.78
CussgutterBrook	27	1 yr	Ex	49.00	222.20	224.32	224.32	224.94	0.022111	6.30	7.78	6.40	1.01
CussgutterBrook	27	1 yr	Pro	49.00	222.20	224.32	224.32	224.94	0.022111	6.30	7.78	6.40	1.01
CussgutterBrook	27	2 yr	Ex	86.00	222.20	224.94	224.94	225.70	0.020633	7.00	12.28	8.17	1.01
CussgutterBrook	27	2 yr	Pro	86.00	222.20	224.94	224.94	225.70	0.020633	7.00	12.28	8.17	1.01
CussgutterBrook	27	5 yr	Ex	158.00	222.20	225.77	225.77	226.73	0.019212	7.88	20.04	10.60	1.01
CussgutterBrook	27	5 yr	Pro	158.00	222.20	225.77	225.77	226.73	0.019215	7.88	20.04	10.60	1.01
CussgutterBrook	27	10 yr	Ex	225.00	222.20	226.35	226.35	227.45	0.018022	8.40	26.78	12.25	1.00
CussgutterBrook	27	10 yr	Pro	225.00	222.20	226.36	226.36	227.45	0.018022	8.40	26.78	12.25	1.00
CussgutterBrook	27	25 yr	Ex	323.00	222.20	227.11	227.11	228.30	0.017074	8.74	36.97	15.59	1.00
CussgutterBrook	27	25 yr	Pro	323.00	222.20	227.11	227.11	228.30	0.017074	8.74	36.97	15.59	1.00
CussgutterBrook	27	50 yr	Ex	398.00	222.20	227.59	227.59	228.78	0.016715	8.75	45.47	20.00	1.01
CussgutterBrook	27	50 yr	Pro	398.00	222.20	227.59	227.59	228.78	0.016715	8.75	45.47	20.00	1.01
CussgutterBrook	27	100 yr	Ex	483.00	222.20	228.03	228.03	229.26	0.013731	8.90	56.17	31.03	0.94
CussgutterBrook	27	100 yr	Pro	483.00	222.20	228.03	228.03	229.26	0.013731	8.90	56.17	31.03	0.94
CussgutterBrook	0	1 yr	Ex	49.00	222.50	223.74	223.74	224.14	0.020525	5.10	9.61	12.17	1.01
CussgutterBrook	0	1 yr	Pro	49.00	222.50	223.74	223.74	224.14	0.020525	5.10	9.61	12.17	1.01
CussgutterBrook	0	2 yr	Ex	86.00	222.50	224.11	224.11	224.67	0.018814	5.98	14.37	13.17	1.01

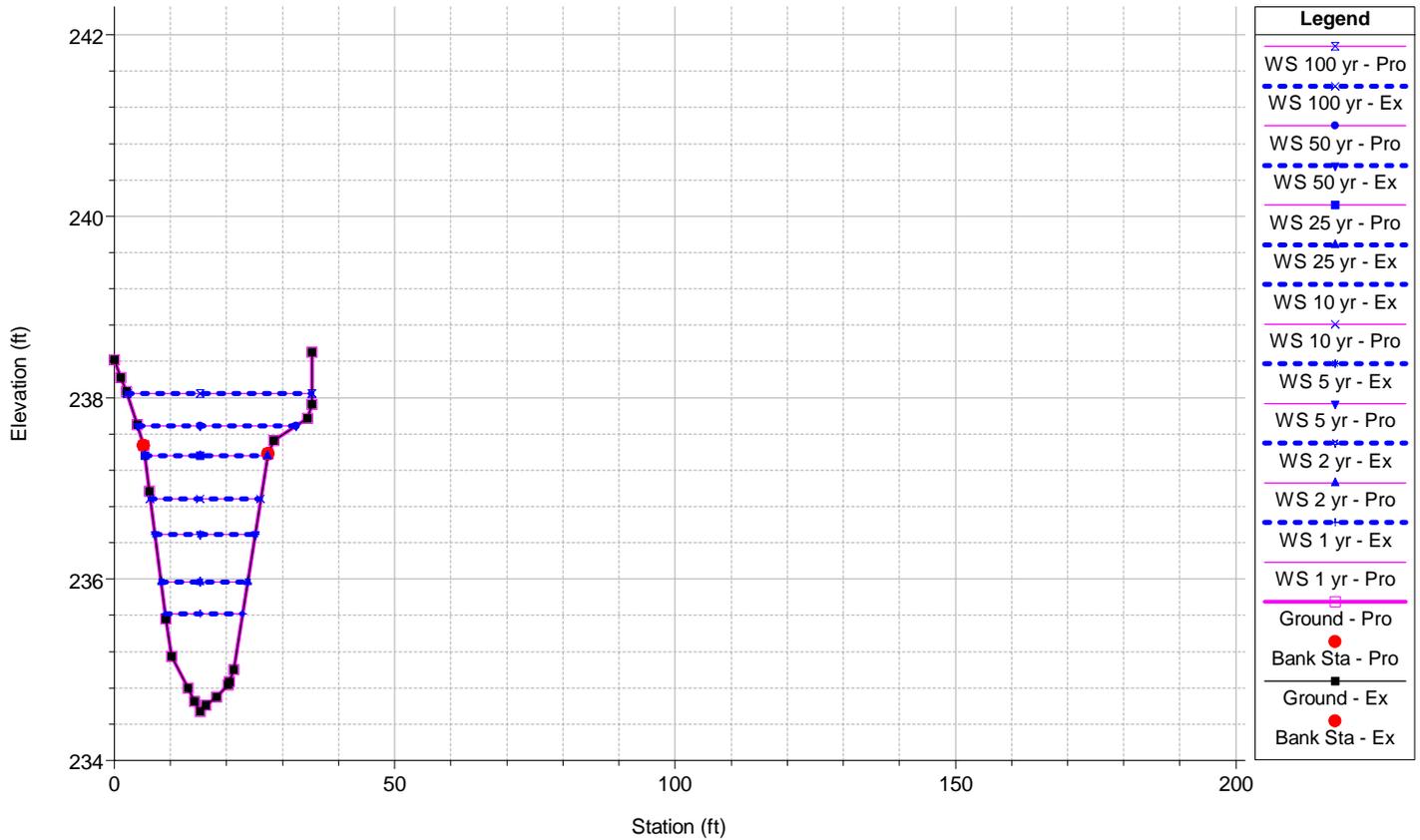
HEC-RAS River: CussgutterBrook Reach: CussgutterBrook (Continued)

Reach	River Sta	Profile	Plan	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
CussgutterBrook	0	2 yr	Pro	86.00	222.50	224.11	224.11	224.67	0.018814	5.98	14.37	13.17	1.01
CussgutterBrook	0	5 yr	Ex	158.00	222.50	224.68	224.68	225.47	0.017340	7.12	22.19	14.35	1.01
CussgutterBrook	0	5 yr	Pro	158.00	222.50	224.68	224.68	225.47	0.017339	7.12	22.19	14.35	1.01
CussgutterBrook	0	10 yr	Ex	225.00	222.50	225.12	225.12	226.08	0.016453	7.83	28.74	15.21	1.00
CussgutterBrook	0	10 yr	Pro	225.00	222.50	225.13	225.13	226.08	0.016450	7.83	28.74	15.21	1.00
CussgutterBrook	0	25 yr	Ex	323.00	222.50	225.68	225.68	226.83	0.015906	8.59	37.59	16.62	1.01
CussgutterBrook	0	25 yr	Pro	323.00	222.50	225.68	225.68	226.83	0.015906	8.59	37.59	16.62	1.01
CussgutterBrook	0	50 yr	Ex	398.00	222.50	226.07	226.07	227.33	0.015779	8.99	44.29	18.17	1.01
CussgutterBrook	0	50 yr	Pro	398.00	222.50	226.07	226.07	227.33	0.015779	8.99	44.29	18.17	1.01
CussgutterBrook	0	100 yr	Ex	483.00	222.50	226.86	226.86	227.70	0.008066	7.64	82.06	70.43	0.76
CussgutterBrook	0	100 yr	Pro	483.00	222.50	226.86	226.86	227.70	0.008066	7.64	82.06	70.43	0.76

LakeAve Plan: 1) Ex 2) Pro  
RS = 347

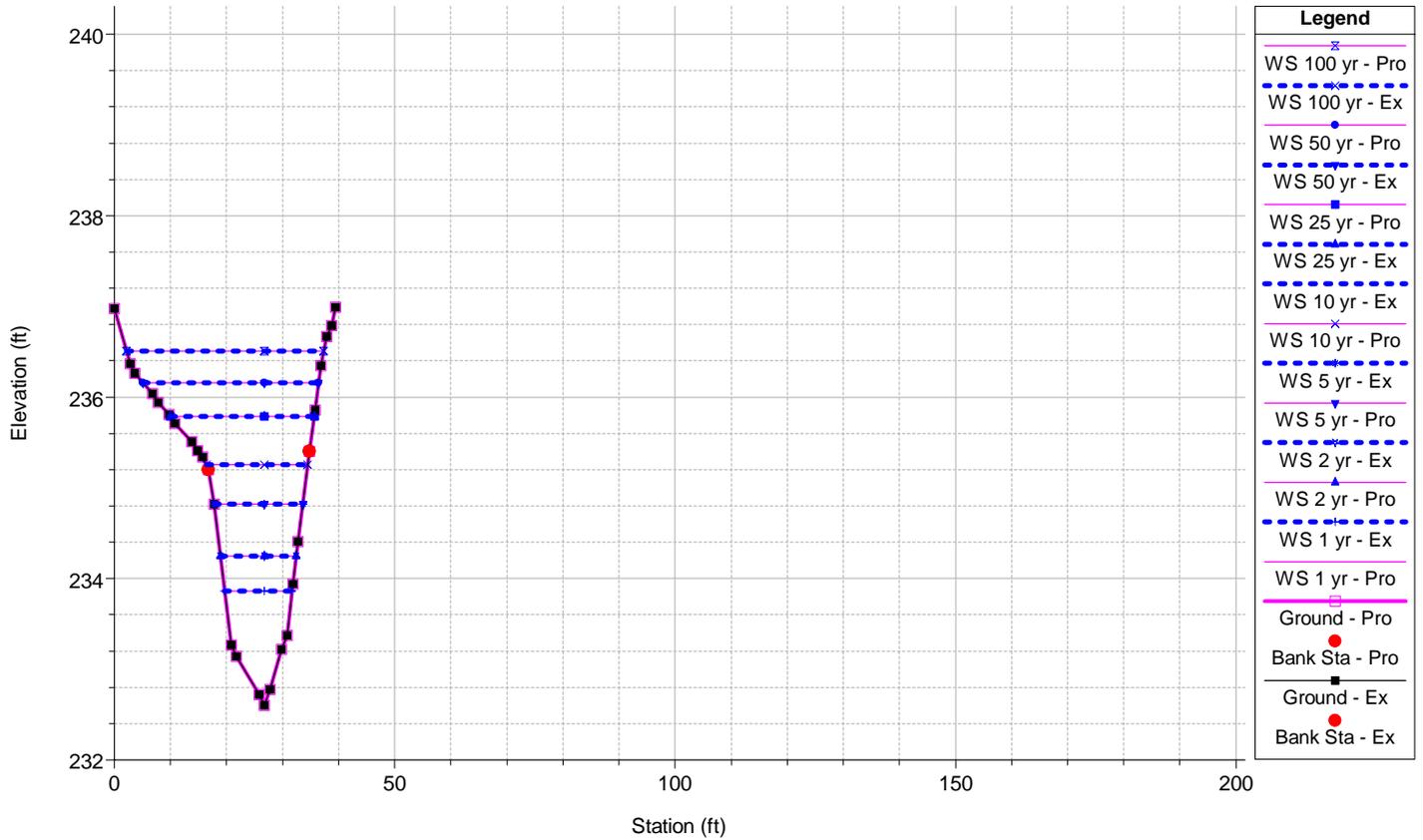


LakeAve Plan: 1) Ex 2) Pro  
RS = 319

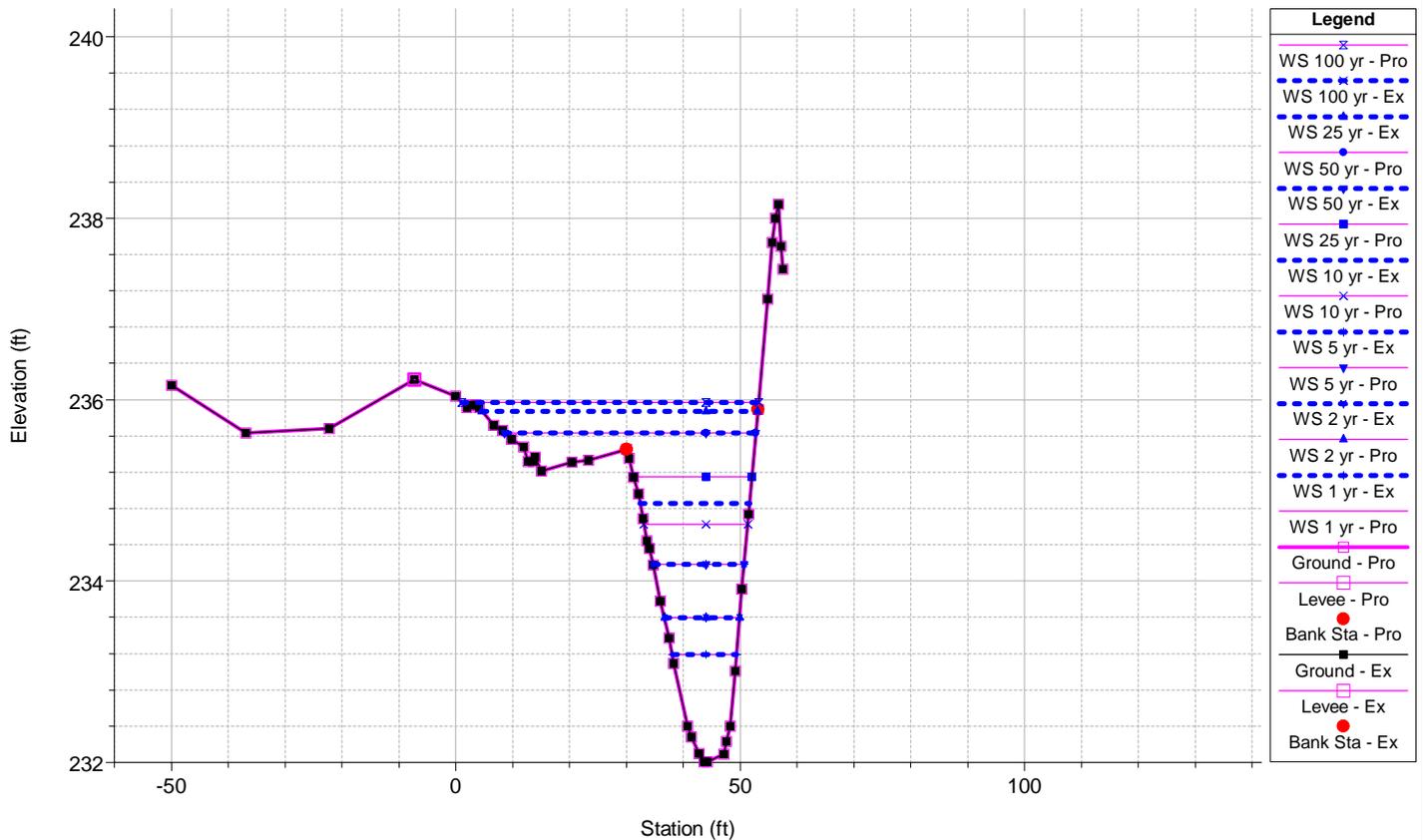


1 in Horiz. = 34 ft 1 in Vert. = 2.1 ft

LakeAve Plan: 1) Ex 2) Pro  
RS = 292

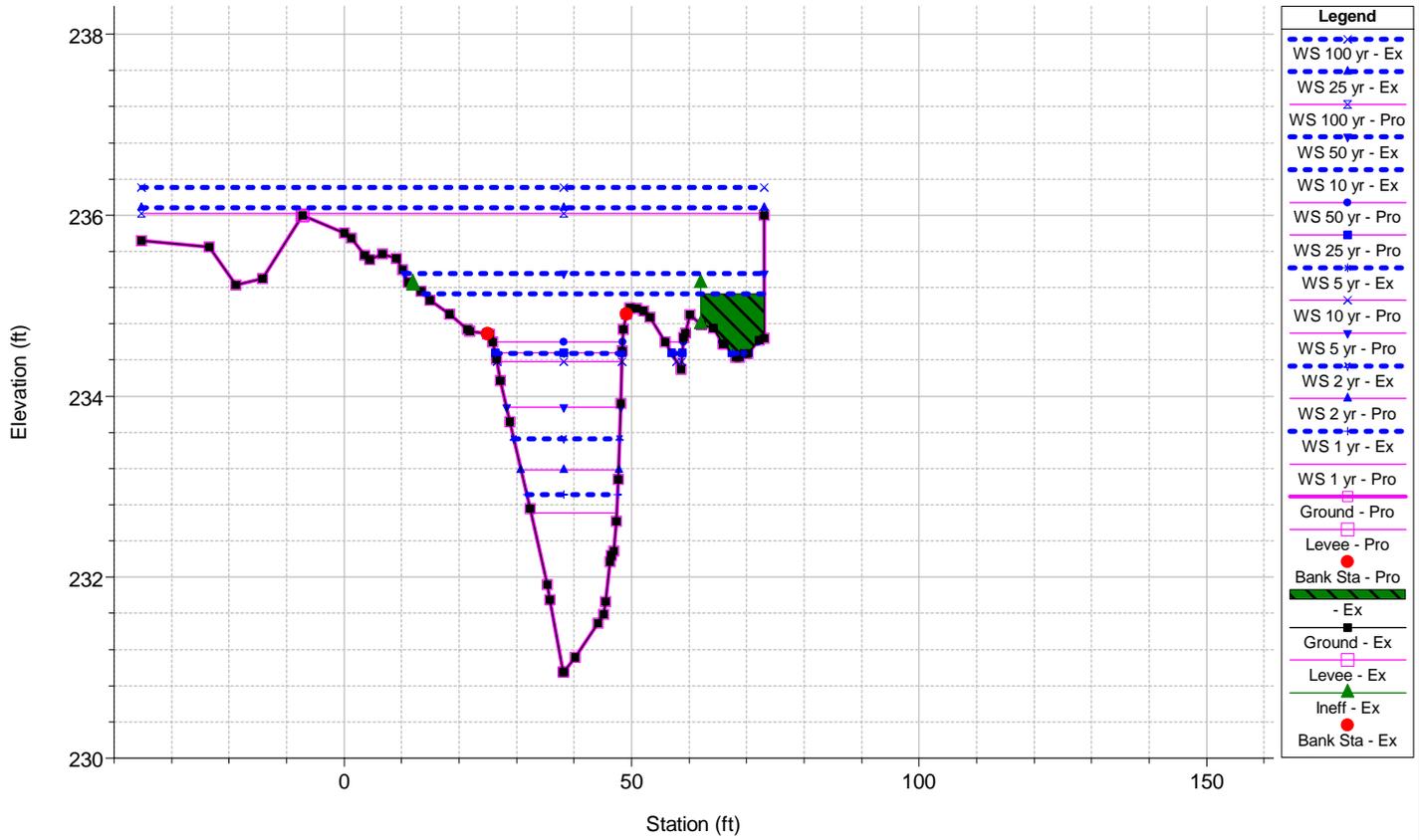


LakeAve Plan: 1) Ex 2) Pro  
RS = 269

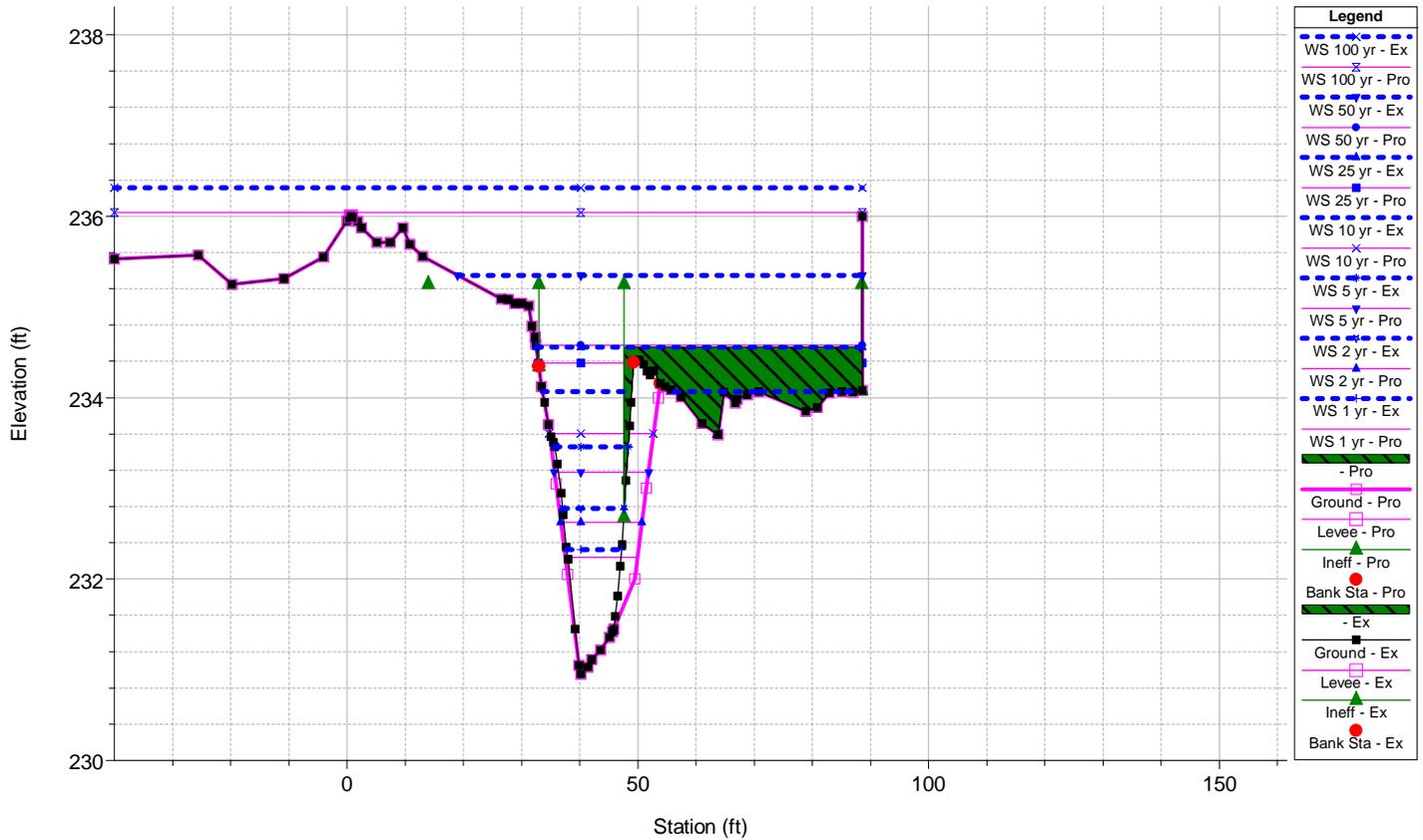


1 in Horiz. = 34 ft 1 in Vert. = 2.1 ft

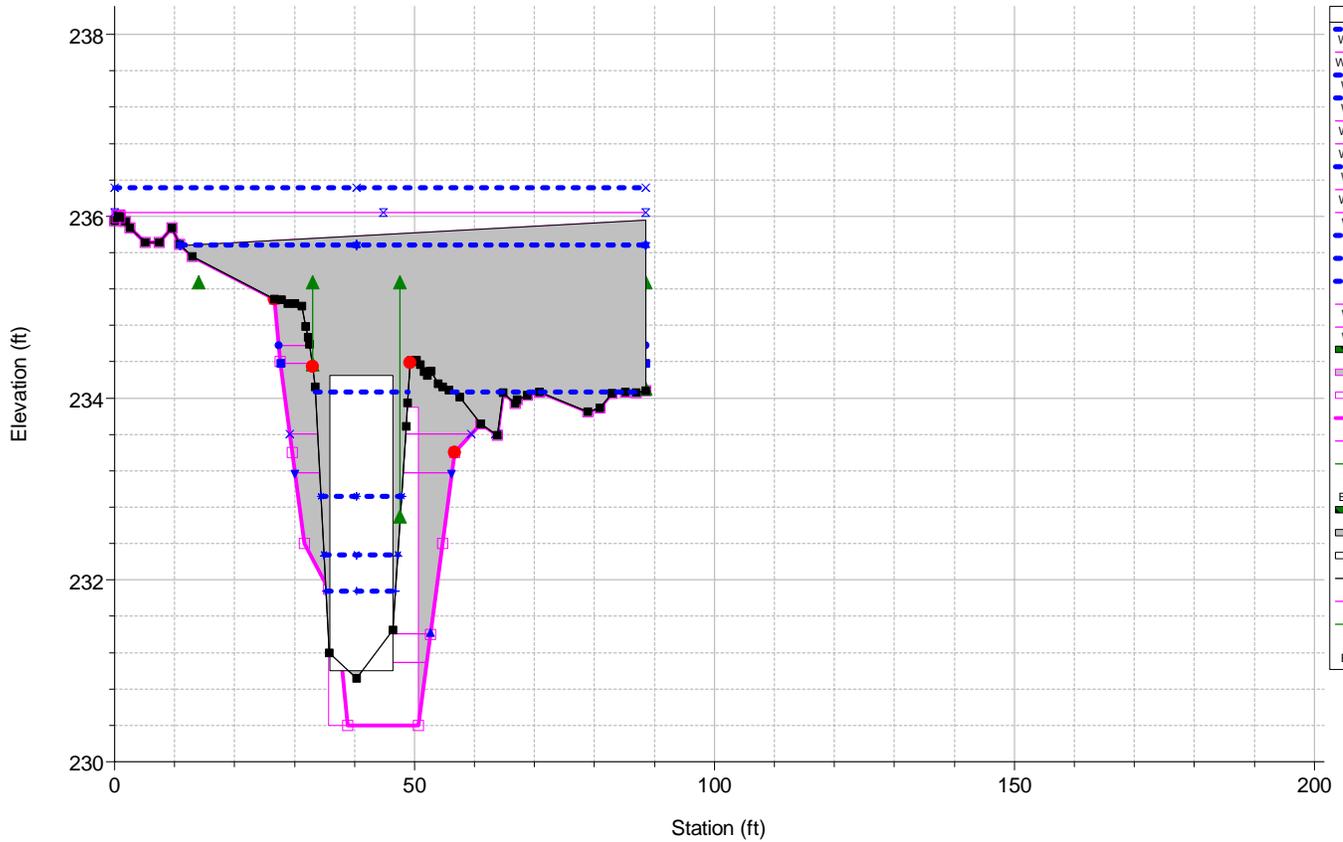
LakeAve Plan: 1) Ex 2) Pro  
RS = 254



LakeAve Plan: 1) Ex 2) Pro  
RS = 237

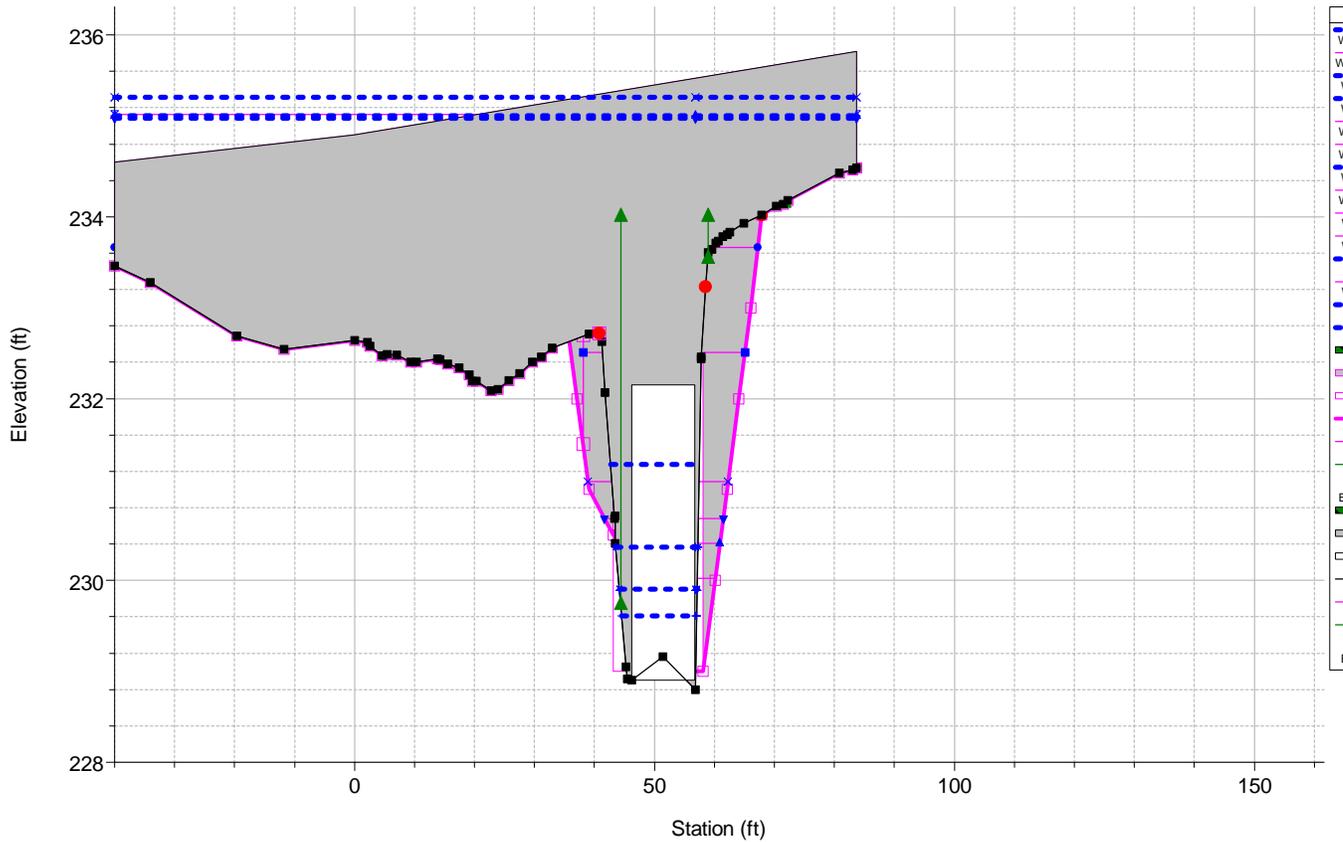


LakeAve Plan: 1) Ex 2) Pro  
RS = 200 Culv



- Legend**
- WS 100 yr - Ex
  - WS 100 yr - Pro
  - WS 25 yr - Ex
  - WS 25 yr - Pro
  - WS 50 yr - Ex
  - WS 50 yr - Pro
  - WS 2 yr - Ex
  - WS 2 yr - Pro
  - WS 10 yr - Ex
  - WS 10 yr - Pro
  - WS 5 yr - Ex
  - WS 5 yr - Pro
  - WS 1 yr - Ex
  - WS 1 yr - Pro
  - Pro
  - Pro
  - Ground - Pro
  - Levee - Pro
  - Ineff - Pro
  - Bank Sta - Pro
  - Ex
  - Ex
  - Ex
  - Ground - Ex
  - Levee - Ex
  - Ineff - Ex
  - Bank Sta - Ex

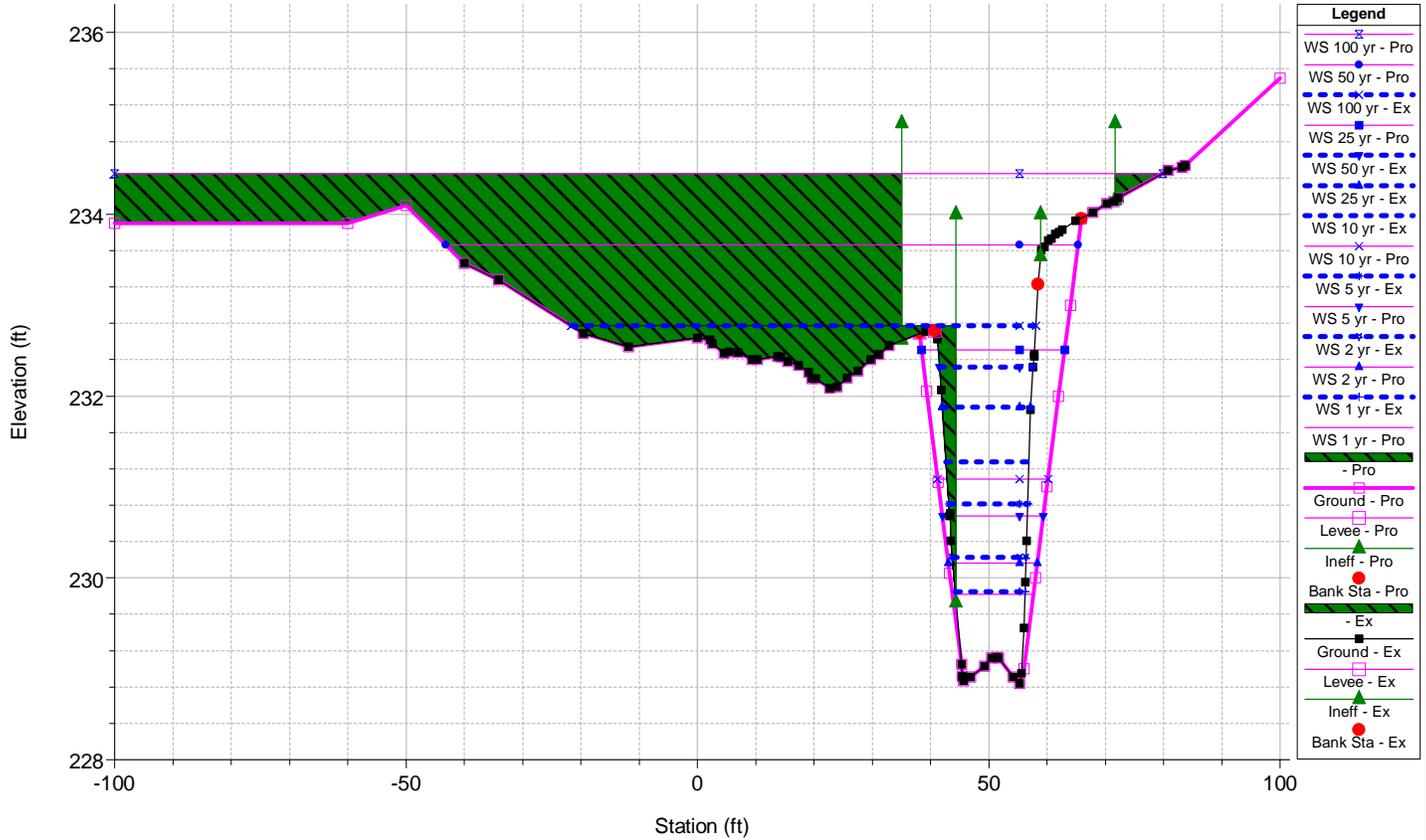
LakeAve Plan: 1) Ex 2) Pro  
RS = 200 Culv



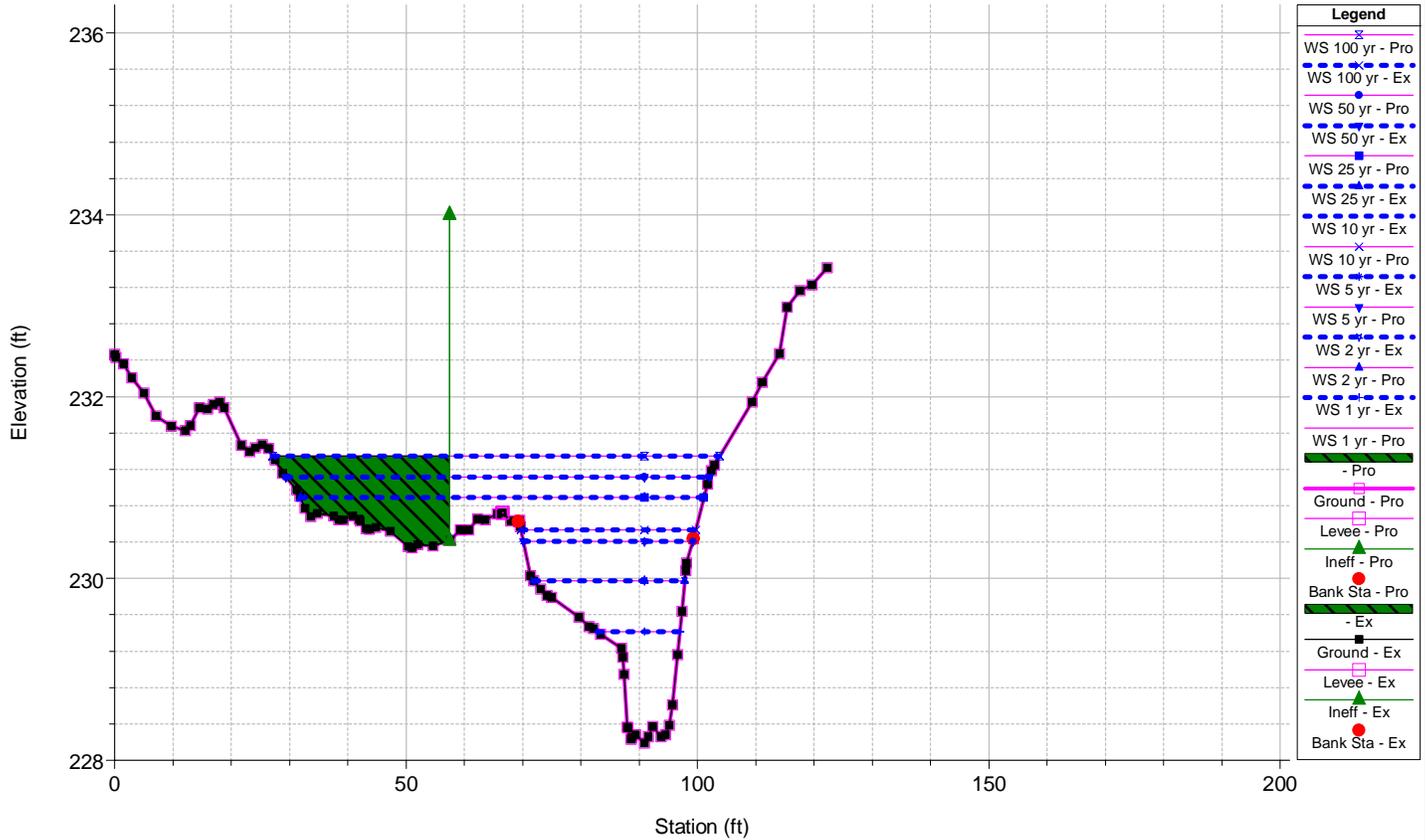
- Legend**
- WS 100 yr - Ex
  - WS 100 yr - Pro
  - WS 25 yr - Ex
  - WS 25 yr - Pro
  - WS 50 yr - Ex
  - WS 50 yr - Pro
  - WS 2 yr - Ex
  - WS 2 yr - Pro
  - WS 10 yr - Ex
  - WS 10 yr - Pro
  - WS 5 yr - Ex
  - WS 5 yr - Pro
  - WS 1 yr - Ex
  - WS 1 yr - Pro
  - Pro
  - Pro
  - Ground - Pro
  - Levee - Pro
  - Ineff - Pro
  - Bank Sta - Pro
  - Ex
  - Ex
  - Ex
  - Ground - Ex
  - Levee - Ex
  - Ineff - Ex
  - Bank Sta - Ex

1 in Horiz. = 34 ft 1 in Vert. = 2.1 ft

LakeAve Plan: 1) Ex 2) Pro  
RS = 160

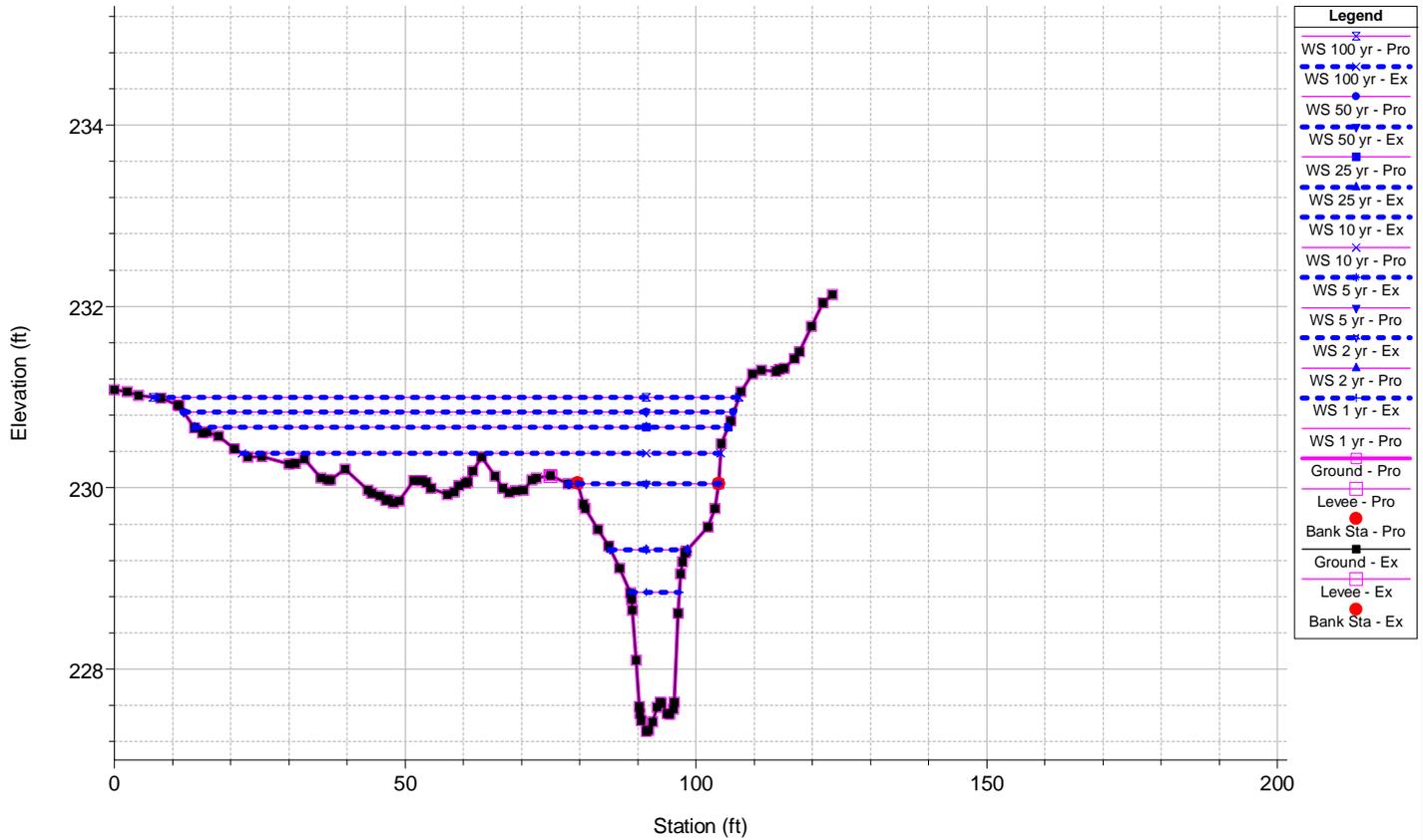


LakeAve Plan: 1) Ex 2) Pro  
RS = 142

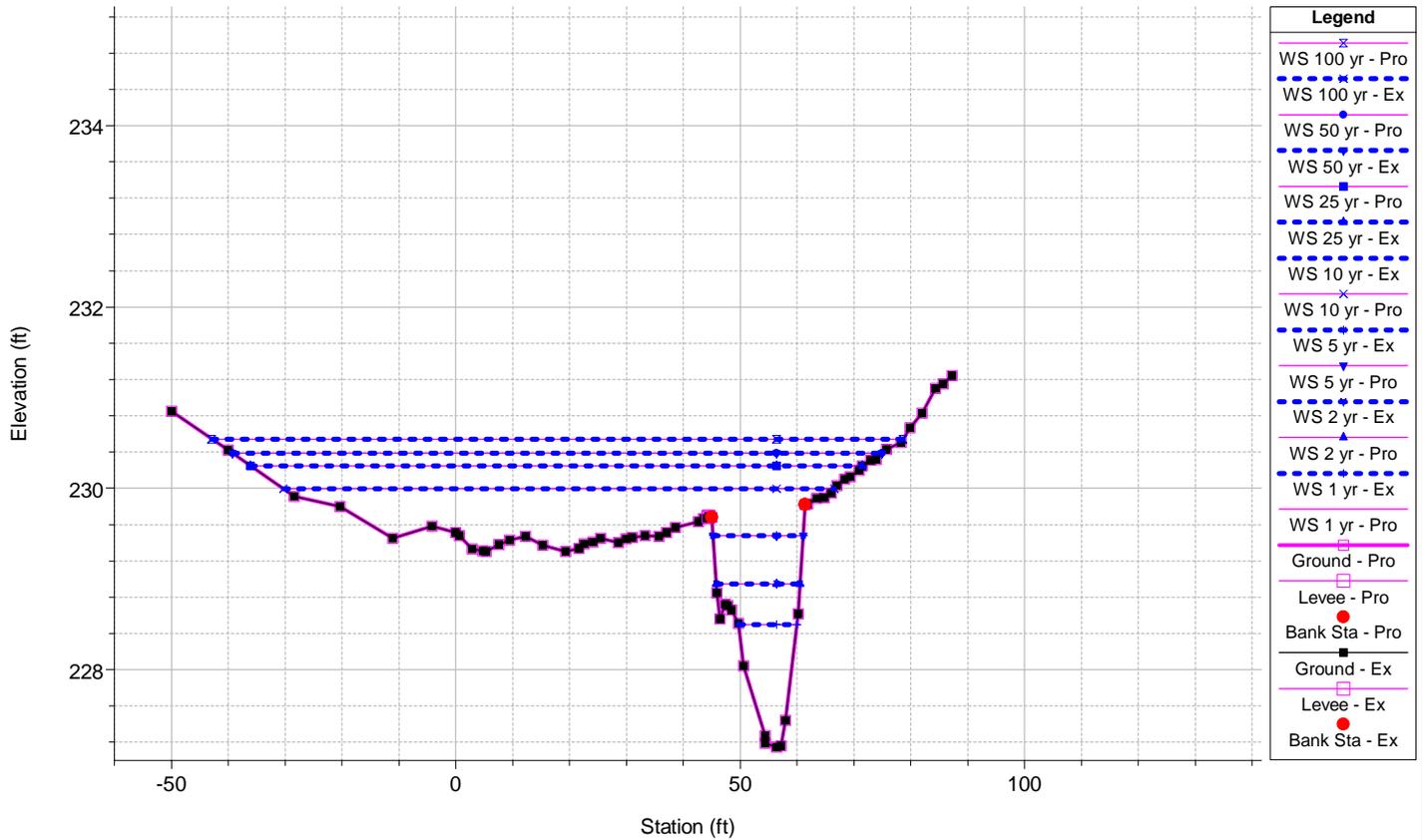


1 in Horiz. = 34 ft 1 in Vert. = 2.1 ft

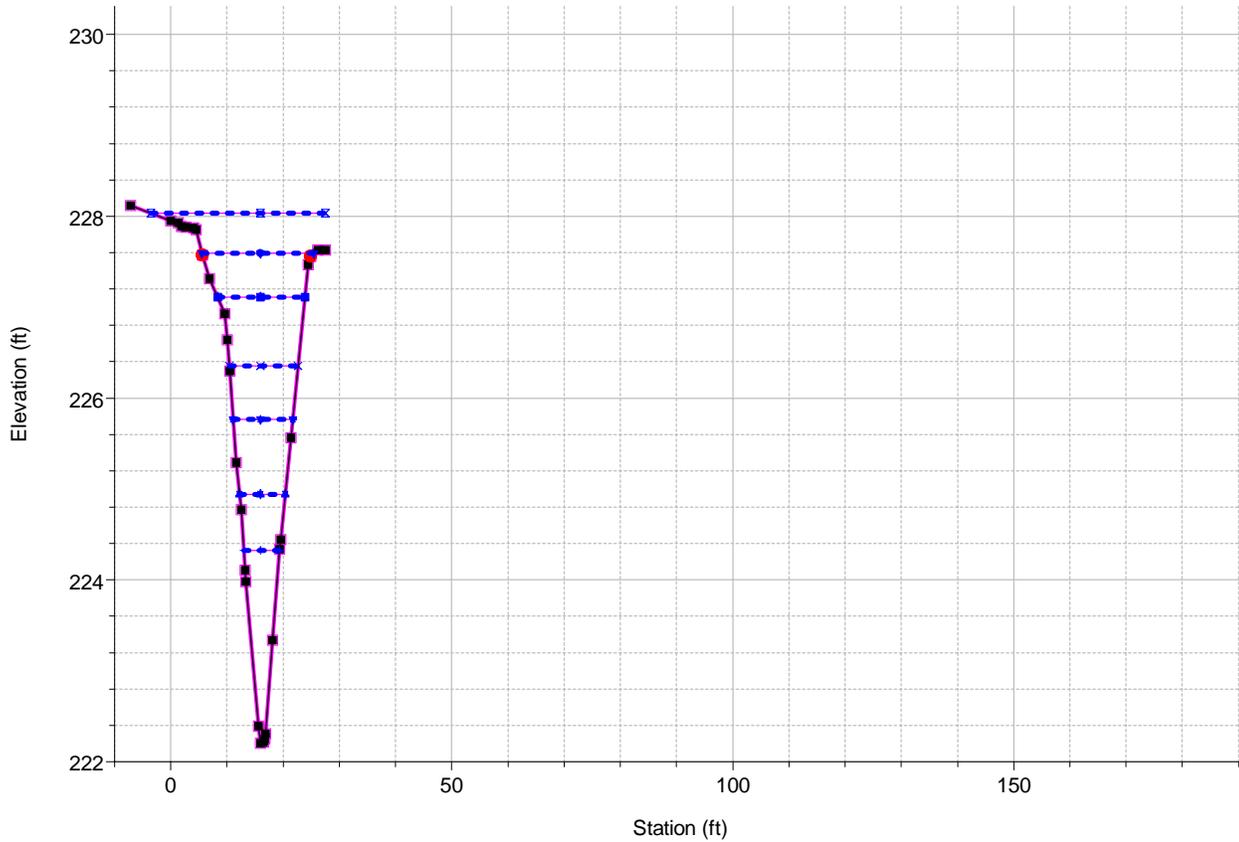
LakeAve Plan: 1) Ex 2) Pro  
RS = 124



LakeAve Plan: 1) Ex 2) Pro  
RS = 107

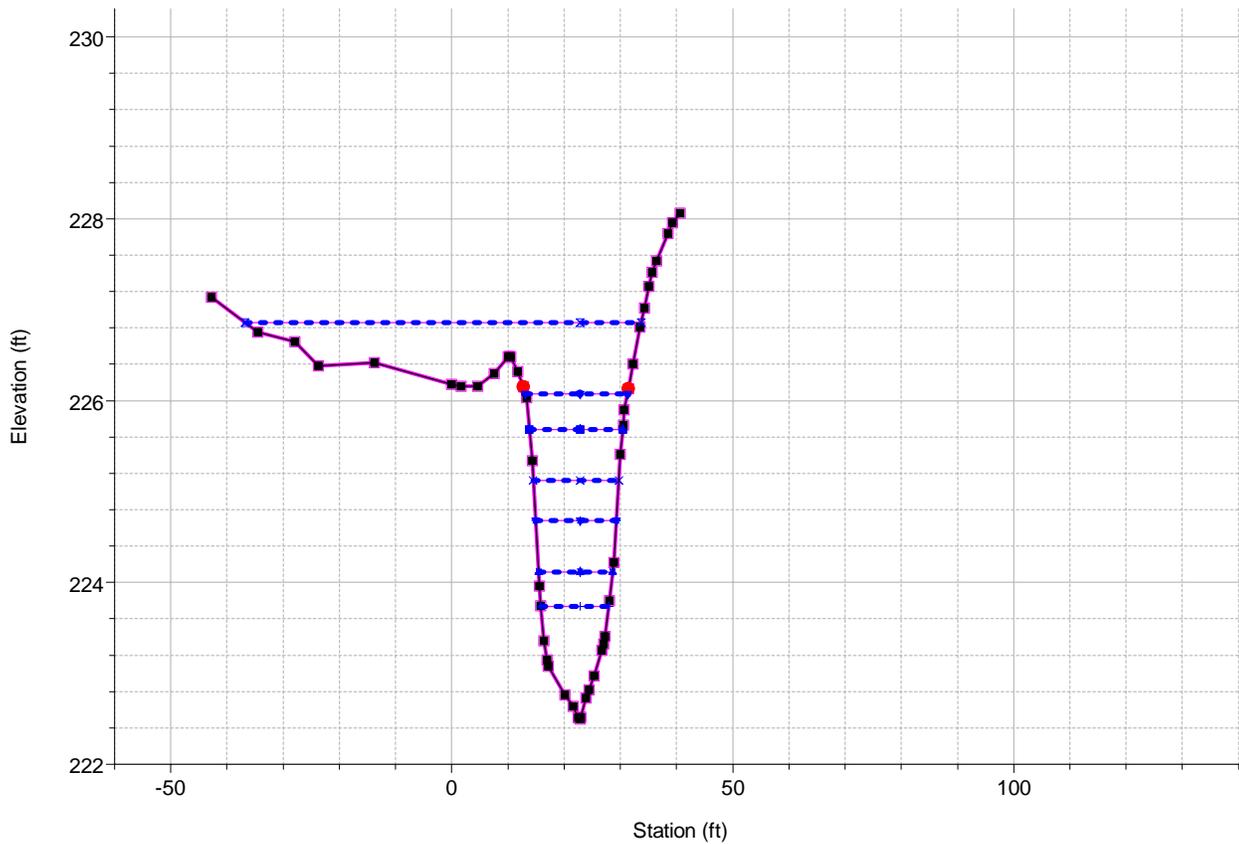


LakeAve Plan: 1) Ex 2) Pro  
RS = 27



Legend	
—x—	WS 100 yr - Pro
- - -x- - -	WS 100 yr - Ex
—●—	WS 50 yr - Pro
- - -●- - -	WS 50 yr - Ex
—■—	WS 25 yr - Pro
- - -■- - -	WS 25 yr - Ex
—x—	WS 10 yr - Pro
- - -x- - -	WS 10 yr - Ex
—●—	WS 5 yr - Ex
—▼—	WS 5 yr - Pro
- - -▼- - -	WS 2 yr - Ex
—▲—	WS 2 yr - Pro
- - -▲- - -	WS 1 yr - Pro
- - -▲- - -	WS 1 yr - Ex
—□—	Ground - Pro
—●—	Bank Sta - Pro
—■—	Ground - Ex
—●—	Bank Sta - Ex

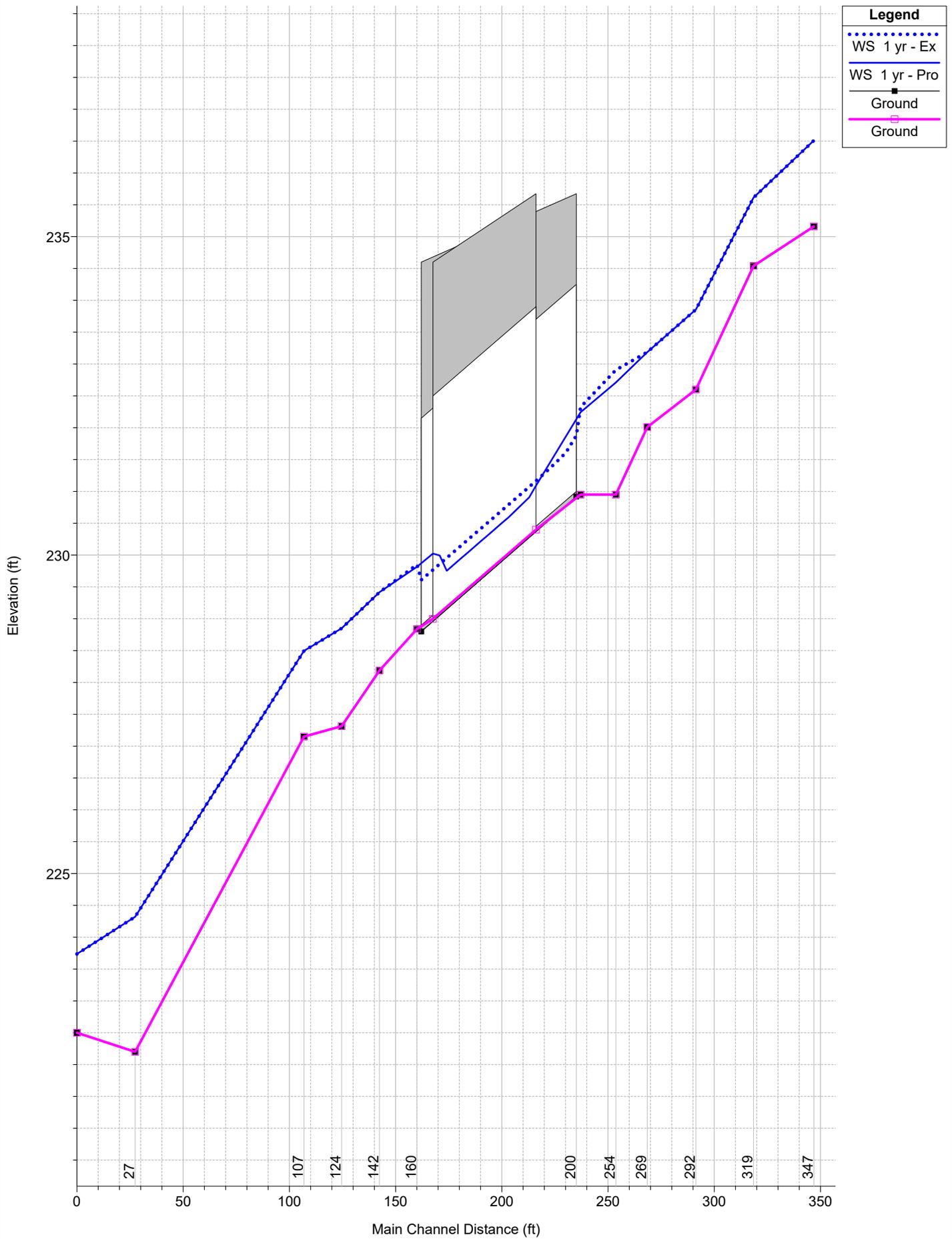
LakeAve Plan: 1) Ex 2) Pro  
RS = 0



Legend	
—x—	WS 100 yr - Pro
- - -x- - -	WS 100 yr - Ex
—●—	WS 50 yr - Pro
- - -●- - -	WS 50 yr - Ex
—■—	WS 25 yr - Pro
- - -■- - -	WS 25 yr - Ex
—x—	WS 10 yr - Pro
- - -x- - -	WS 10 yr - Ex
—▼—	WS 5 yr - Pro
- - -▼- - -	WS 5 yr - Ex
—▲—	WS 2 yr - Pro
- - -▲- - -	WS 2 yr - Ex
- - -▲- - -	WS 1 yr - Pro
- - -▲- - -	WS 1 yr - Ex
—□—	Ground - Pro
—●—	Bank Sta - Pro
—■—	Ground - Ex
—●—	Bank Sta - Ex

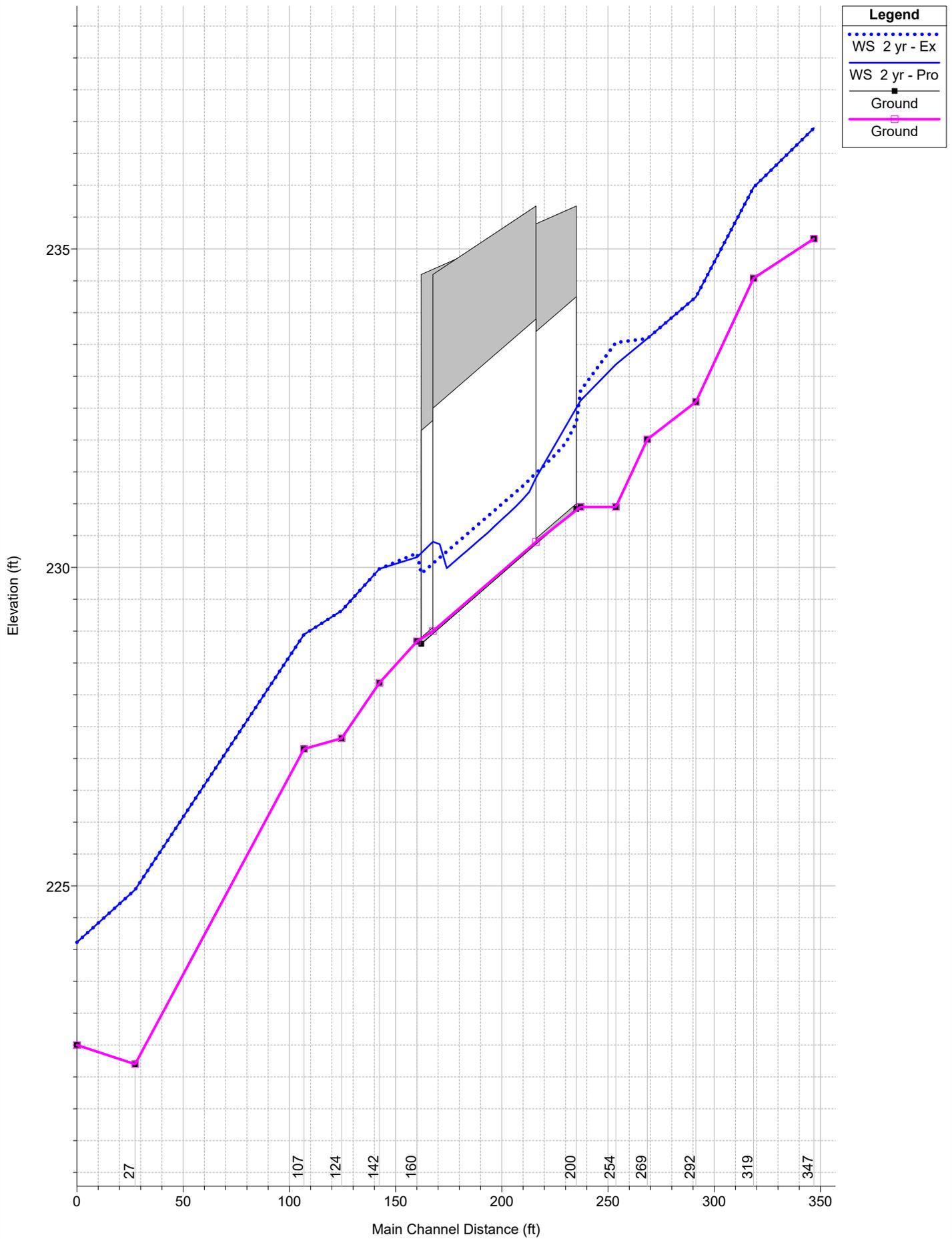
1 in Horiz. = 34 ft 1 in Vert. = 2.1 ft

LakeAve Plan: 1) Ex 2) Pro



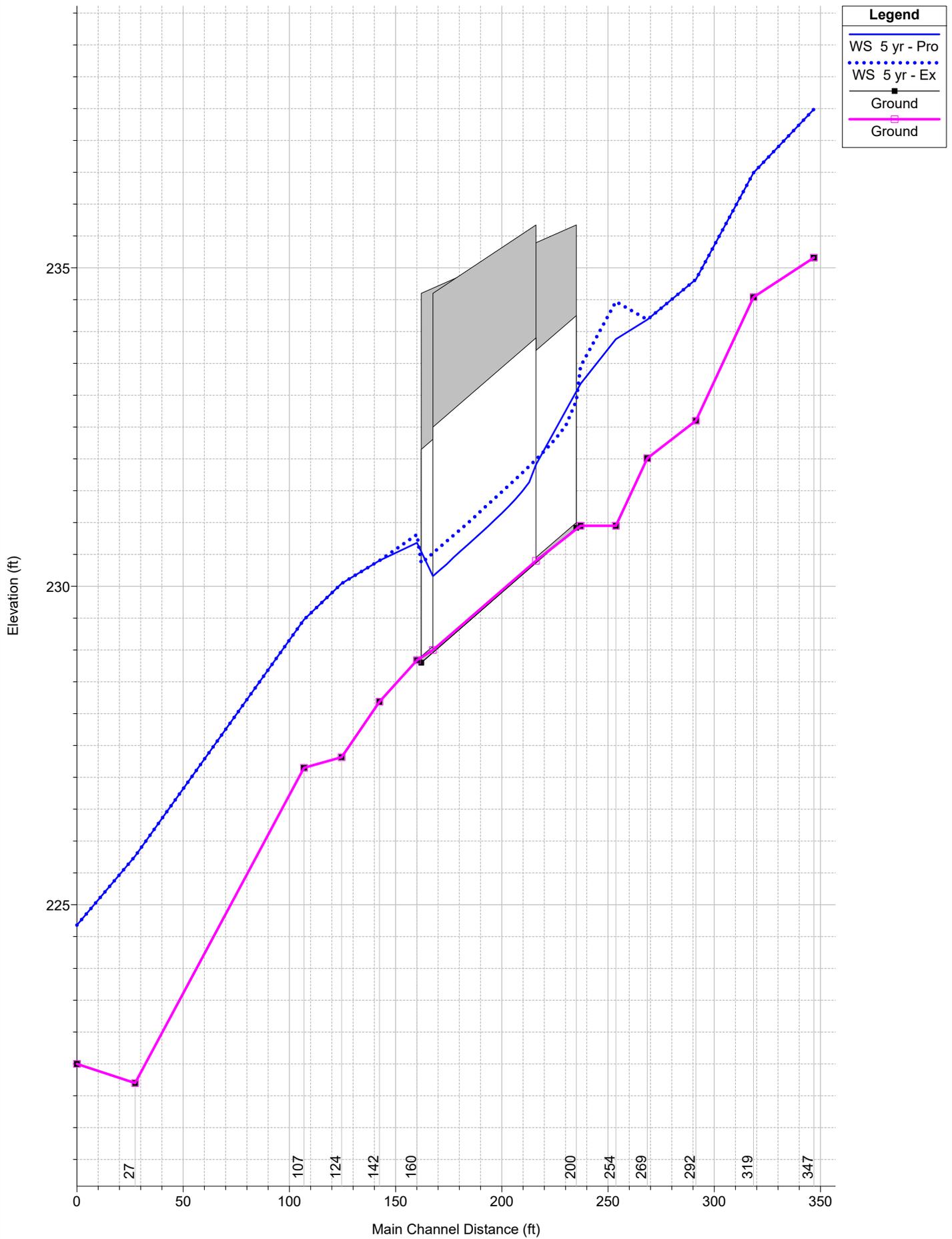
1 in Horiz. = 60 ft 1 in Vert. = 2 ft

LakeAve Plan: 1) Ex 2) Pro



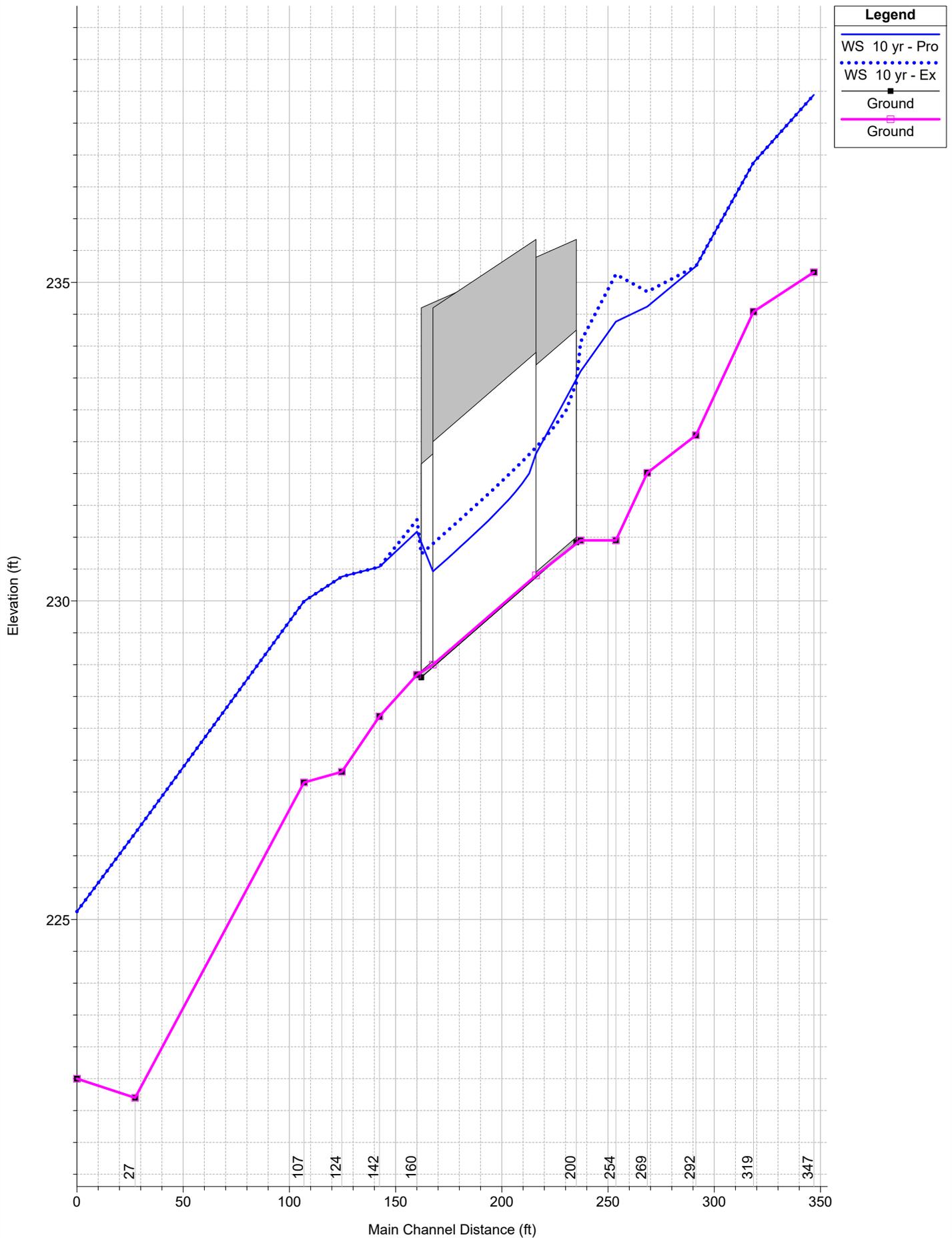
1 in Horiz. = 60 ft 1 in Vert. = 2 ft

LakeAve Plan: 1) Ex 2) Pro



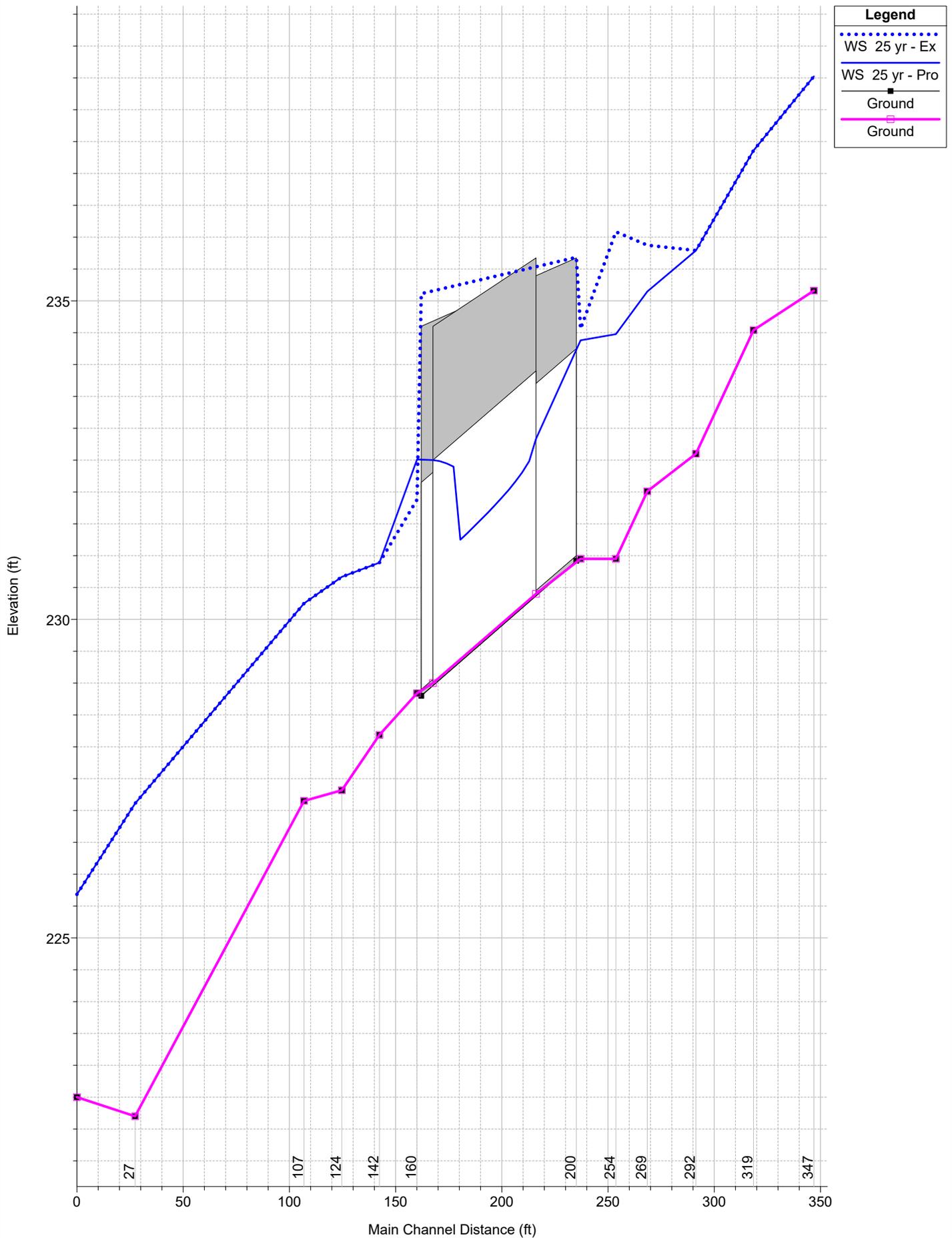
1 in Horiz. = 60 ft 1 in Vert. = 2 ft

LakeAve Plan: 1) Ex 2) Pro



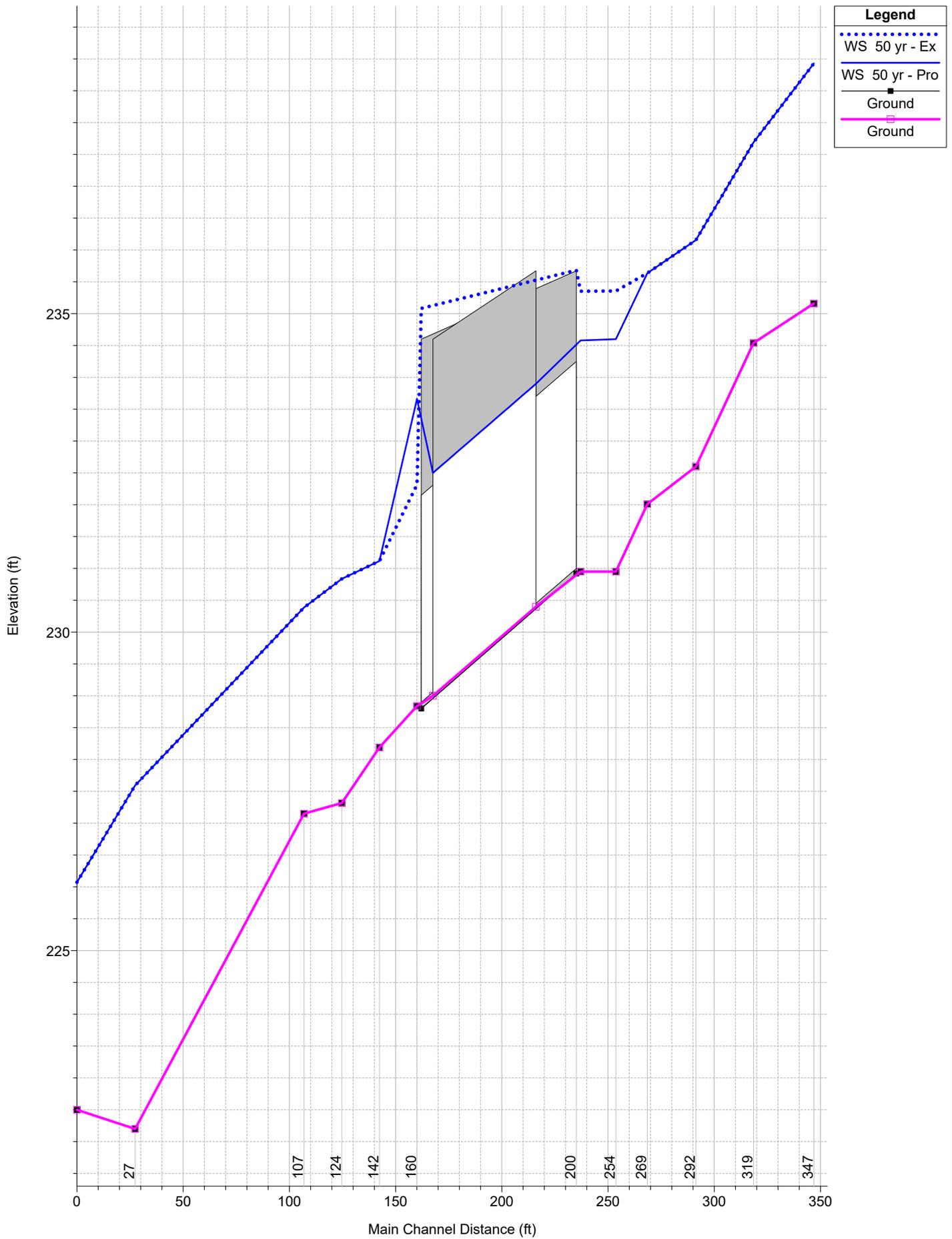
1 in Horiz. = 60 ft 1 in Vert. = 2 ft

LakeAve Plan: 1) Ex 2) Pro



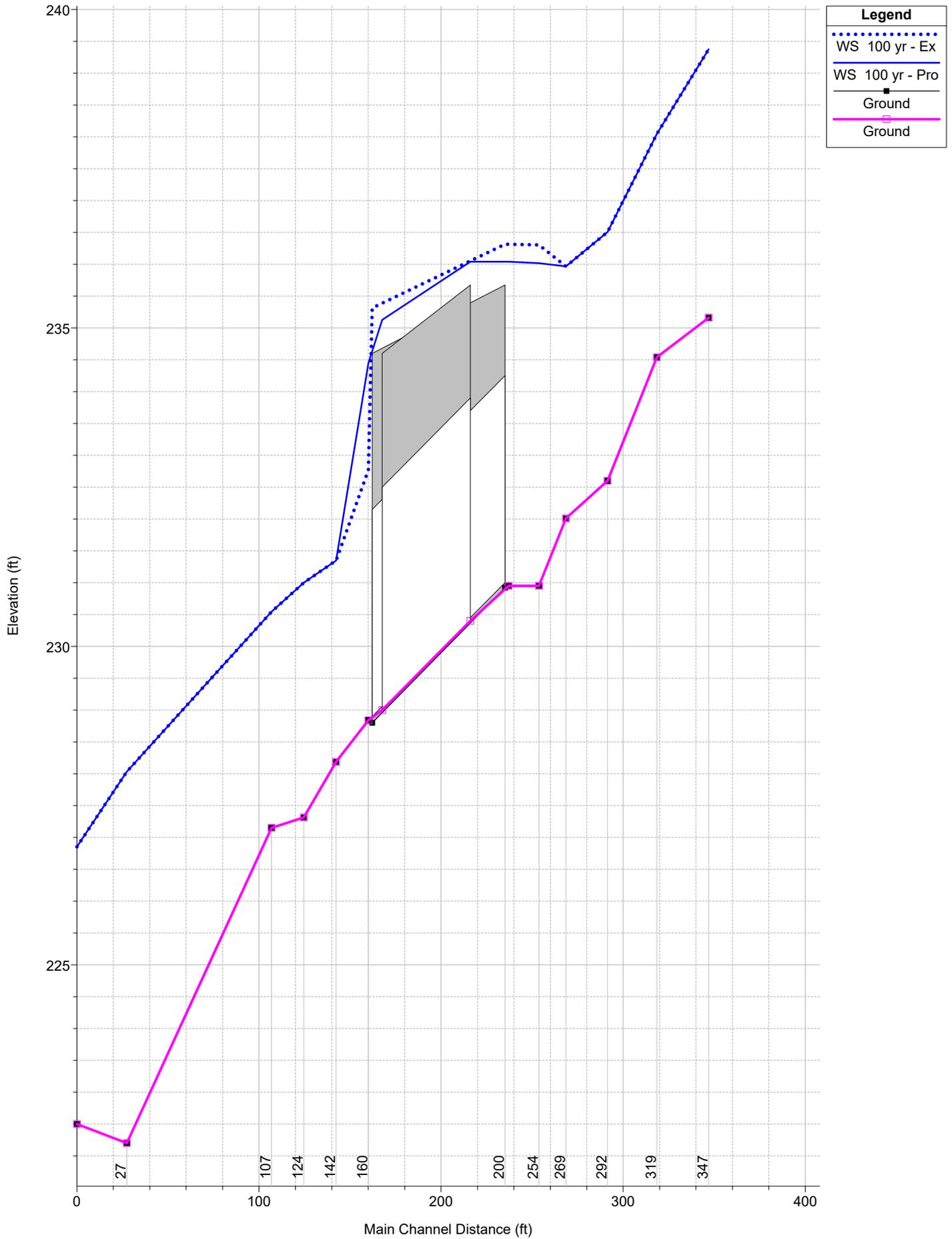
1 in Horiz. = 60 ft 1 in Vert. = 2 ft

LakeAve Plan: 1) Ex 2) Pro



1 in Horiz. = 60 ft 1 in Vert. = 2 ft

LakeAve Plan: 1) Ex 2) Pro



1 in Horiz. = 70 ft 1 in Vert. = 2 ft

HEC-RAS HEC-RAS 5.0.7 March 2019  
 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
XXXXXXXX XXXX     X           XXX XXXX     XXXXXX     XXXX
X      X  X       X           X  X       X  X       X
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PROJECT DATA

Project Title: LakeAve  
 Project File : LakeAve.prj  
 Run Date and Time: 5/5/2022 10:42:39 PM

Project in English units

PLAN DATA

Plan Title: Proposed  
 Plan File : j:\52862 Bristol-Bridge Replacement Design Services\_Culvert  
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 Hydraulics\HECRAS\LakeAve.p02

Geometry Title: Proposed\_Riparian  
 Geometry File : j:\52862 Bristol-Bridge Replacement Design  
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Flow Title : HydroCAD  
 Flow File : j:\52862 Bristol-Bridge Replacement Design  
 Services\_Culvert Replacement\7.0 Project Deliverables\7.13 Hydraulics &  
 Hydrology\Lake Ave Hydrology Hydraulics\HECRAS\LakeAve.f01

Plan Summary Information:

Number of:	Cross Sections =	12	Multiple Openings =	0
	Culverts =	1	Inline Structures =	0
	Bridges =	0	Lateral Structures =	0

Computational Information

Water surface calculation tolerance = 0.01  
 Critical depth calculation tolerance = 0.01  
 Maximum number of iterations = 40  
 Maximum difference tolerance = 0.3  
 Flow tolerance factor = 0.001

Computation Options

Critical depth computed only where necessary  
 Conveyance Calculation Method: Between every coordinate point (HEC2 Style)  
 Friction Slope Method: Average Conveyance  
 Computational Flow Regime: Subcritical Flow

FLOW DATA

Flow Title: HydroCAD

Flow File : j:\52862 Bristol-Bridge Replacement Design Services\_Culvert  
 Replacement\7.0 Project Deliverables\7.13 Hydraulics & Hydrology\Lake Ave Hydrology  
 Hydraulics\HECRAS\LakeAve.f01

Flow Data (cfs)

River	Reach	RS	1 yr	2 yr
5 yr	10 yr	25 yr	50 yr	100 yr
CussgutterBrook	CussgutterBrook	347	49	86
158	225	323	398	483

Boundary Conditions

River	Reach	Profile	Upstream
Downstream			
CussgutterBrook	CussgutterBrook	1 yr	Critical
Critical			
CussgutterBrook	CussgutterBrook	2 yr	Critical
Critical			
CussgutterBrook	CussgutterBrook	5 yr	Critical
Critical			
CussgutterBrook	CussgutterBrook	10 yr	Critical
Critical			
CussgutterBrook	CussgutterBrook	25 yr	Critical
Critical			
CussgutterBrook	CussgutterBrook	50 yr	Critical
Critical			



Manning's n Values num= 3  
 Sta n Val Sta n Val Sta n Val  
 0 .06 5.2 .035 27.4 .05

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.  
 5.2 27.4 27.1 27.1 27.1 .1 .3

CROSS SECTION

RIVER: CussgutterBrook  
 REACH: CussgutterBrook RS: 292

INPUT

Description:

Station Elevation Data num= 27  
 Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev  
 0 236.98 2.8 236.37 3.6 236.26 6.8 236.04 7.8 235.94  
 9.8 235.81 10.8 235.71 13.8 235.51 14.8 235.41 15.8 235.34  
 16.8 235.2 17.8 234.82 20.8 233.27 21.8 233.14 25.8 232.72  
 26.8 232.6 27.8 232.78 29.8 233.22 30.8 233.37 31.8 233.94  
 32.8 234.41 34.8 235.4 35.8 235.86 36.8 236.35 37.8 236.67  
 38.8 236.79 39.4 236.99

Manning's n Values num= 3  
 Sta n Val Sta n Val Sta n Val  
 0 .06 16.8 .035 34.8 .05

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.  
 16.8 34.8 22.9 22.9 22.9 .1 .3

CROSS SECTION

RIVER: CussgutterBrook  
 REACH: CussgutterBrook RS: 269

INPUT

Description:

Station Elevation Data num= 48  
 Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev  
 -50 236.16 -36.9 235.63 -22.3 235.68 -7.3 236.22 0 236.04  
 2 235.91 2.9 235.94 3.6 235.94 4.1 235.91 6.7 235.72  
 8.2 235.66 9.8 235.56 11.9 235.48 12.7 235.32 13.6 235.32  
 14 235.37 15.1 235.21 20.4 235.31 23.3 235.33 30 235.45  
 30.5 235.35 31.3 235.14 32.1 234.96 32.9 234.69 33.6 234.44  
 34 234.36 34.7 234.18 36 233.78 37.5 233.37 38.3 233.09  
 40.7 232.4 41.4 232.28 42.8 232.1 43.7 232.01 44.2 232.01  
 47.1 232.09 47.6 232.23 48.2 232.4 49.1 233.01 50.3 233.91  
 51.5 234.74 53.1 235.89 54.8 237.11 55.6 237.73 56.2 238

56.7 238.15 57.2 237.69 57.5 237.44

Manning's n Values num= 3  
Sta n Val Sta n Val Sta n Val  
-50 .06 30 .035 53.1 .05

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.  
30 53.1 14.8 14.8 14.8 .1 .3  
Left Levee Station= -7.32 Elevation= 236.22

CROSS SECTION

RIVER: CussgutterBrook  
REACH: CussgutterBrook RS: 254

INPUT

Description:

Station Elevation Data num= 62

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-35.3	235.72	-23.5	235.65	-18.8	235.23	-14.2	235.3	-7.2	236
0	235.8	1.2	235.75	3.6	235.56	4.4	235.51	6.7	235.57
9.1	235.52	10.2	235.4	11.2	235.26	13.4	235.16	14.9	235.06
18.4	234.91	21.4	234.74	21.9	234.72	25	234.69	25.3	234.68
25.8	234.6	26.5	234.41	27.2	234.17	28.8	233.72	32.3	232.76
35.3	231.92	35.8	231.75	38.1	230.95	38.2	230.95	40.2	231.11
44.2	231.49	45.1	231.59	45.5	231.73	46.2	232.17	46.5	232.24
46.9	232.29	47.4	232.62	47.7	233.08	48.1	233.92	48.4	234.5
48.6	234.74	49.1	234.91	49.7	234.98	50.9	234.97	52.1	234.94
53.2	234.87	55.9	234.6	58.6	234.3	59.1	234.65	59.4	234.7
60.1	234.9	62.1	234.79	64.2	234.75	65.9	234.58	66.1	234.58
68.1	234.43	68.7	234.43	69.5	234.47	70.2	234.47	72.2	234.62
73	234.64	73	236						

Manning's n Values num= 3  
Sta n Val Sta n Val Sta n Val  
-35.3 .06 25 .035 49.1 .035

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.  
25 49.1 16.6 16.6 16.6 .3 .5  
Left Levee Station= -7.2 Elevation= 236

CROSS SECTION

RIVER: CussgutterBrook  
REACH: CussgutterBrook RS: 237

INPUT

Description:

Station Elevation Data num= 57

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-40	235.53	-25.6	235.57	-19.8	235.25	-10.8	235.31	-4	235.55
0	235.95	.6	236	1	235.99	1.8	235.94	2.5	235.87
5.1	235.71	7.4	235.71	9.6	235.87	10.8	235.69	13	235.56
26.6	235.09	27.8	235.08	28.9	235.04	30	235.04	31.2	235.01
31.8	234.79	32.3	234.67	32.5	234.59	33	234.35	33.4	234.12
34.6	233.7	35.9	233.05	37.9	232.05	39.9	231.05	40.2	230.95
41.4	231.03	42.1	231.11	43.6	231.22	45.1	231.36	45.7	231.42
45.9	231.45	49.5	232	51.5	233	53.5	234	53.9	234.16
54.7	234.12	55.7	234.09	57.5	234.01	61.1	233.72	63.8	233.59
64.8	234.06	66.8	233.94	67.1	233.98	68.8	234.03	70.8	234.07
78.9	233.85	80.9	233.89	82.9	234.05	85.1	234.07	87	234.06
88.6	234.08	88.6	236						

Manning's n Values

Sta	n Val	Sta	n Val	Sta	n Val
-40	.06	33	.035	53.9	.035

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.

Left	Right	Left	Channel	Right	Coeff	Contr.	Expan.
33	53.9	77	77	77		.3	.5

Ineffective Flow num= 2

Sta L	Sta R	Elev	Permanent
-40	14	235.25	F
88.5	88.6	235.25	F

Left Levee Station= .6 Elevation= 236

CULVERT

RIVER: CussgutterBrook  
 REACH: CussgutterBrook RS: 200

INPUT

Description:  
 Distance from Upstream XS = 21  
 Deck/Roadway Width = 48.5  
 Weir Coefficient = 2.6

Upstream Deck/Roadway Coordinates

num=	Sta	Hi	Cord	Lo	Cord	Sta	Hi	Cord	Lo	Cord
2	10	235.67				100	236			

Upstream Bridge Cross Section Data

Station	Elevation	num=	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	235.95	34	.6	236	1	235.99	1.8	235.94	2.5	235.87
5.1	235.71		7.4	235.71	9.6	235.87	10.8	235.69	13	235.56
26.6	235.09		27.65	234.4	29.65	233.4	31.65	232.4	35.65	231.9
36.65	231.9		38.9	230.4	50.65	230.4	52.65	231.4	54.65	232.4
56.65	233.4		61.1	233.72	63.8	233.59	64.8	234.06	66.8	233.94
67.1	233.98		68.8	234.03	70.8	234.07	78.9	233.85	80.9	233.89

82.9 234.05 85.1 234.07 87 234.06 88.6 234.08

Manning's n Values num= 3  
 Sta n Val Sta n Val Sta n Val  
 0 .06 26.6 .035 56.65 .04

Bank Sta: Left Right Coeff Contr. Expan.  
 26.6 56.65 .3 .5

Ineffective Flow num= 2  
 Sta L Sta R Elev Permanent  
 0 14 235.25 F  
 88.5 88.6 235.25 F

Left Levee Station= .6 Elevation= 236

Downstream Deck/Roadway Coordinates

num= 3  
 Sta Hi Cord Lo Cord Sta Hi Cord Lo Cord Sta Hi Cord Lo Cord  
 -40 234.6 0 234.9 100 236

Downstream Bridge Cross Section Data

Station Elevation Data num= 44  

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-40	233.46	-34.1	233.28	-19.6	232.69	-11.8	232.54	0	232.64
2.2	232.62	2.6	232.58	4.6	232.47	5.4	232.49	7	232.48
9.4	232.4	10.3	232.4	13.8	232.44	14.3	232.43	15.5	232.38
17.4	232.34	19.1	232.26	19.7	232.19	20.3	232.19	22.7	232.09
23.9	232.1	25.7	232.2	27.5	232.28	29.7	232.4	31.1	232.46
32.9	232.56	35.1	233	37.1	232	39.1	231	43.1	230.5
44.1	230.5	46.35	229	58.1	229	60.1	230	62.1	231
64.1	232	66.1	233	67.9	234.02	70.3	234.12	71.5	234.14
72.2	234.18	80.8	234.48	83.1	234.52	83.7	234.54		

Manning's n Values num= 3  
 Sta n Val Sta n Val Sta n Val  
 -40 .06 35.1 .035 66.1 .03

Bank Sta: Left Right Coeff Contr. Expan.  
 35.1 67.9 .3 .5

Ineffective Flow num= 2  
 Sta L Sta R Elev Permanent  
 -40 35.1 235 F  
 71.7 83.7 235 F

Left Levee Station= 38.1 Elevation= 232.7

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          Box      3.5      15  
 FHWA Chart # 8 - flared wingwalls  
 FHWA Scale # 3 - Wingwall flared 0 deg. (sides extended straight)  
 Solution Criteria = Highest U. S. EG  
 Culvert Upstrm Dist Length      Top n      Bottom n      Depth Blocked      Entrance Loss Coef  
 Exit Loss Coef

1  
 Upstream Elevation = 230.4  
           Centerline Station = 43.15  
 Downstream Elevation = 229  
           Centerline Station = 50.6

CROSS SECTION

RIVER: CussgutterBrook  
 REACH: CussgutterBrook      RS: 160

INPUT

Description:

Station Elevation Data      num=      57

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-100	233.9	-60	233.9	-50	234.1	-40	233.46	-34.1	233.28
-19.6	232.69	-11.8	232.54	0	232.64	2.2	232.62	2.6	232.58
4.6	232.47	5.4	232.49	7	232.48	9.4	232.4	10.3	232.4
13.8	232.44	14.3	232.43	15.5	232.38	17.4	232.34	19.1	232.26
19.7	232.19	20.3	232.19	22.7	232.09	23.9	232.1	25.7	232.2
27.5	232.28	29.7	232.4	31.1	232.46	32.9	232.56	38.1	232.7
39.3	232.05	41.3	231.05	43.3	230.05	45.3	229.05	45.5	228.92
45.7	228.87	46.9	228.91	49.3	229.03	50.5	229.12	51.3	229.13
51.7	229.12	54.2	228.91	55.3	228.84	56	229	58	230
60	231	62	232	64	233	65.9	233.95	67.9	234.02
70.3	234.12	71.5	234.14	72.2	234.18	80.8	234.48	83.1	234.52
83.7	234.54	100	235.5						

Manning's n Values      num=      3

Sta	n Val	Sta	n Val	Sta	n Val
-100	.06	38.1	.035	65.9	.035

Bank Sta: Left      Right      Lengths: Left Channel      Right      Coeff Contr.      Expan.  
                   38.1      65.9                   23417.73      17.73      17.73                   .3                   .5

Ineffective Flow      num=      2  
 Sta L      Sta R      Elev      Permanent  
 -100      35.1      235      F  
 71.7      100      235      F  
 Left Levee      Station=      38.1      Elevation=      232.7

CROSS SECTION

RIVER: CussgutterBrook  
 REACH: CussgutterBrook RS: 142

INPUT

Description:

Station Elevation Data num= 91

Sta	Elev								
0	232.464	.228	232.432	1.484	232.364	2.929	232.208	5.004	232.038
7.069	231.79	9.78	231.674	12.168	231.626	13.045	231.68	14.556	231.879
15.936	231.864	16.944	231.915	18.049	231.942	18.826	231.878	21.721	231.468
23.161	231.394	24.109	231.436	25.37	231.469	26.497	231.43	27.497	231.305
28.885	231.159	31.273	230.974	31.832	230.908	32.69	230.771	33.661	230.681
34.723	230.715	37.613	230.686	38.437	230.648	39.255	230.648	40.825	230.688
41.948	230.651	42.2	230.631	43.213	230.551	43.67	230.543	44.839	230.564
47.33	230.523	50.377	230.354	50.99	230.337	52.064	230.37	54.65	230.362
57.541	230.419	59.29	230.531	59.47	230.532	60.735	230.537	62.317	230.65
63.626	230.649	65.631	230.712	66.516	230.72	67.961	230.634	69.291	230.623
69.482	230.636	69.603	230.568	71.34	230.028	71.868	229.977	73.062	229.882
74.192	229.814	74.953	229.793	79.682	229.577	81.456	229.47	82.179	229.452
83.342	229.387	87.002	229.229	87.237	229.137	87.39	228.947	87.96	228.362
88.119	228.354	88.584	228.233	88.682	228.255	89.405	228.278	90.972	228.188
91.573	228.258	92.295	228.373	93.74	228.259	94.555	228.277	95.185	228.388
95.749	228.612	96.631	229.159	97.353	229.637	97.982	230.084	98.137	230.167
99.331	230.436	101.719	231.037	102.411	231.184	102.913	231.25	109.376	231.938
111.13	232.155	114.061	232.475	115.402	232.981	117.618	233.169	119.678	233.232
122.272	233.42								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.06	69.291	.035	99.331	.035

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.

69.291	99.331	17.73	17.73	17.73	.3	.5
--------	--------	-------	-------	-------	----	----

Ineffective Flow num= 1

Sta L	Sta R	Elev	Permanent
0	57.5	234	F

Left Levee Station= 66.5 Elevation= 230.72

CROSS SECTION

RIVER: CussgutterBrook  
 REACH: CussgutterBrook RS: 124

INPUT

Description:

Station Elevation Data num= 91

Sta	Elev								
0	231.08	2.17	231.063	4.098	231.021	7.973	230.99	10.874	230.915
11.183	230.904	13.775	230.664	15.226	230.607	15.906	230.61	17.904	230.567
20.629	230.432	22.991	230.342	25.353	230.345	30.076	230.259	31.183	230.268
32.634	230.315	35.535	230.111	36.707	230.088	37.161	230.09	39.622	230.207
43.6	229.975	44.246	229.937	45.69	229.915	46.608	229.862	47.141	229.869
47.989	229.836	48.969	229.859	51.493	230.078	52.943	230.082	53.693	230.059
54.394	229.997	57.295	229.924	58.416	229.957	59.271	230.023	60.43	230.053
60.778	230.063	61.647	230.183	63.139	230.338	65.501	230.127	66.793	229.994
67.863	229.946	68.901	229.969	70.351	229.976	71.802	230.089	72.586	230.111
74.948	230.136	78.075	230.042	79.671	230.053	80.624	229.823	80.997	229.774
83.11	229.539	84.991	229.359	86.871	229.116	88.751	228.842	88.975	228.77
89.116	228.655	89.701	228.101	90.297	227.586	90.426	227.51	90.632	227.433
91.478	227.316	91.877	227.329	92.512	227.418	93.327	227.582	93.839	227.634
94.053	227.622	95.02	227.51	95.503	227.507	96.201	227.56	96.273	227.638
96.954	228.62	97.382	229.052	97.679	229.187	98.153	229.28	98.405	229.306
102.105	229.566	103.286	229.773	103.969	230.043	104.4	230.489	105.948	230.735
107.717	231.063	109.742	231.254	111.214	231.296	113.791	231.281	114.276	231.306
115.188	231.319	116.936	231.427	117.841	231.501	119.866	231.782	121.891	232.037
123.465	232.128								

Manning's n Values num= 3  
 Sta n Val Sta n Val Sta n Val  
 0 .06 79.671 .035 103.969 .035

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.  
 79.671 103.969 17.73 17.73 17.73 .1 .3  
 Ineffective Flow num= 0  
 Sta L Sta R Elev Permanent  
 Left Levee Station= 74.95 Elevation= 230.13

CROSS SECTION

RIVER: CussgutterBrook  
 REACH: CussgutterBrook RS: 107

INPUT

Description:

Station Elevation Data num= 63

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-50	230.85	-40	230.42	-28.4	229.91	-20.4	229.8	-11.1	229.45
-4.1	229.58	0	229.51	.6	229.48	2.9	229.33	4.8	229.31
5.3	229.3	7.6	229.38	9.5	229.43	12.3	229.47	15.3	229.37
19.3	229.3	21.6	229.34	22.6	229.39	24.1	229.41	25.5	229.45
28.6	229.4	29.9	229.44	31	229.46	33.3	229.48	35.7	229.47
37.1	229.51	38.6	229.57	42.7	229.63	43.5	229.67	44.4	229.69
45	229.68	45.9	228.85	46.4	228.56	47.3	228.72	47.8	228.71
48.5	228.66	49.7	228.51	50.6	228.04	54.4	227.27	54.4	227.19
56.4	227.15	57.2	227.16	58	227.44	60.2	228.62	61.4	229.82
61.9	229.83	63.4	229.89	64.8	229.9	66	229.95	67	230.03

68.3	230.1	69.4	230.13	70.9	230.2	71.5	230.25	72.9	230.31
73.9	230.32	75.7	230.43	78.3	230.51	79.9	230.67	82	230.83
84.3	231.1	85.7	231.15	87.2	231.24				

Manning's n Values num= 3  
 Sta n Val Sta n Val Sta n Val  
 -50 .06 45 .035 61.4 .035

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.  
 45 61.4 79.52 79.52 79.52 .1 .3  
 Left Levee Station= 44.4 Elevati on= 229.69

CROSS SECTION

RIVER: CussgutterBrook  
 REACH: CussgutterBrook RS: 27

INPUT

Descripti on:

Station Elevati on Data num= 29

Sta	Elev								
-7.2	228.12	0	227.95	1.3	227.93	1.9	227.89	2.7	227.88
4.1	227.87	4.5	227.85	5.6	227.57	6.9	227.31	9.6	226.93
10.1	226.64	10.5	226.3	11.7	225.29	12.5	224.77	13.2	224.11
13.3	223.98	15.6	222.39	16	222.2	16.5	222.22	16.7	222.25
16.9	222.31	18.1	223.34	19.4	224.34	19.6	224.44	21.4	225.56
24.5	227.47	24.9	227.56	26.2	227.63	27.5	227.63		

Manning's n Values num= 3  
 Sta n Val Sta n Val Sta n Val  
 -7.2 .06 5.6 .035 24.9 .05

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.  
 5.6 24.9 27.4 27.4 27.4 .1 .3

CROSS SECTION

RIVER: CussgutterBrook  
 REACH: CussgutterBrook RS: 0

INPUT

Descripti on:

Station Elevati on Data num= 47

Sta	Elev								
-42.8	227.14	-34.5	226.75	-27.9	226.65	-23.7	226.38	-13.8	226.42
0	226.18	1.7	226.16	4.6	226.16	7.6	226.3	10	226.48
10.3	226.49	10.5	226.48	11.7	226.32	12.8	226.15	13.3	226.03
14.3	225.34	15.6	223.96	15.8	223.74	16.4	223.36	17	223.15
17.2	223.08	20.1	222.76	21.6	222.64	22.5	222.51	22.8	222.5

23	222.52	23.9	222.73	24.4	222.82	25.3	222.97	26.7	223.25
27	223.32	27.3	223.41	28.1	223.8	28.8	224.22	30	225.41
30.5	225.73	30.7	225.9	31.5	226.13	32.3	226.4	33.5	226.81
34.3	227.02	35.1	227.26	35.7	227.41	36.4	227.54	38.5	227.84
39.3	227.96	40.6	228.06						

Manning's n Values			num=	3					
Station Val	Station Val	Station Val	Station Val	Station Val	Station Val	Station Val	Station Val	Station Val	Station Val
-42.8	.06	12.8	.035	31.5	.05				

Bank Sta:	Left	Right	Coeff	Contr.	Expan.
	12.8	31.5		.1	.3

### SUMMARY OF MANNING'S N VALUES

River: CussgutterBrook

Reach	River Sta.	n1	n2	n3
CussgutterBrook	347	.06	.035	.05
CussgutterBrook	319	.06	.035	.05
CussgutterBrook	292	.06	.035	.05
CussgutterBrook	269	.06	.035	.05
CussgutterBrook	254	.06	.035	.035
CussgutterBrook	237	.06	.035	.035
CussgutterBrook	200	Culvert		
CussgutterBrook	160	.06	.035	.035
CussgutterBrook	142	.06	.035	.035
CussgutterBrook	124	.06	.035	.035
CussgutterBrook	107	.06	.035	.035
CussgutterBrook	27	.06	.035	.05
CussgutterBrook	0	.06	.035	.05

### SUMMARY OF REACH LENGTHS

River: CussgutterBrook

Reach	River Sta.	Left	Channel	Right
CussgutterBrook	347	28.4	28.4	28.4
CussgutterBrook	319	27.1	27.1	27.1
CussgutterBrook	292	22.9	22.9	22.9
CussgutterBrook	269	14.8	14.8	14.8
CussgutterBrook	254	16.6	16.6	16.6
CussgutterBrook	237	77	77	77
CussgutterBrook	200	Culvert		

CussgutterBrook	160	23417.73	17.73	17.73
CussgutterBrook	142	17.73	17.73	17.73
CussgutterBrook	124	17.73	17.73	17.73
CussgutterBrook	107	79.52	79.52	79.52
CussgutterBrook	27	27.4	27.4	27.4
CussgutterBrook	0			

SUMMARY OF CONTRACTION AND EXPANSION COEFFICIENTS

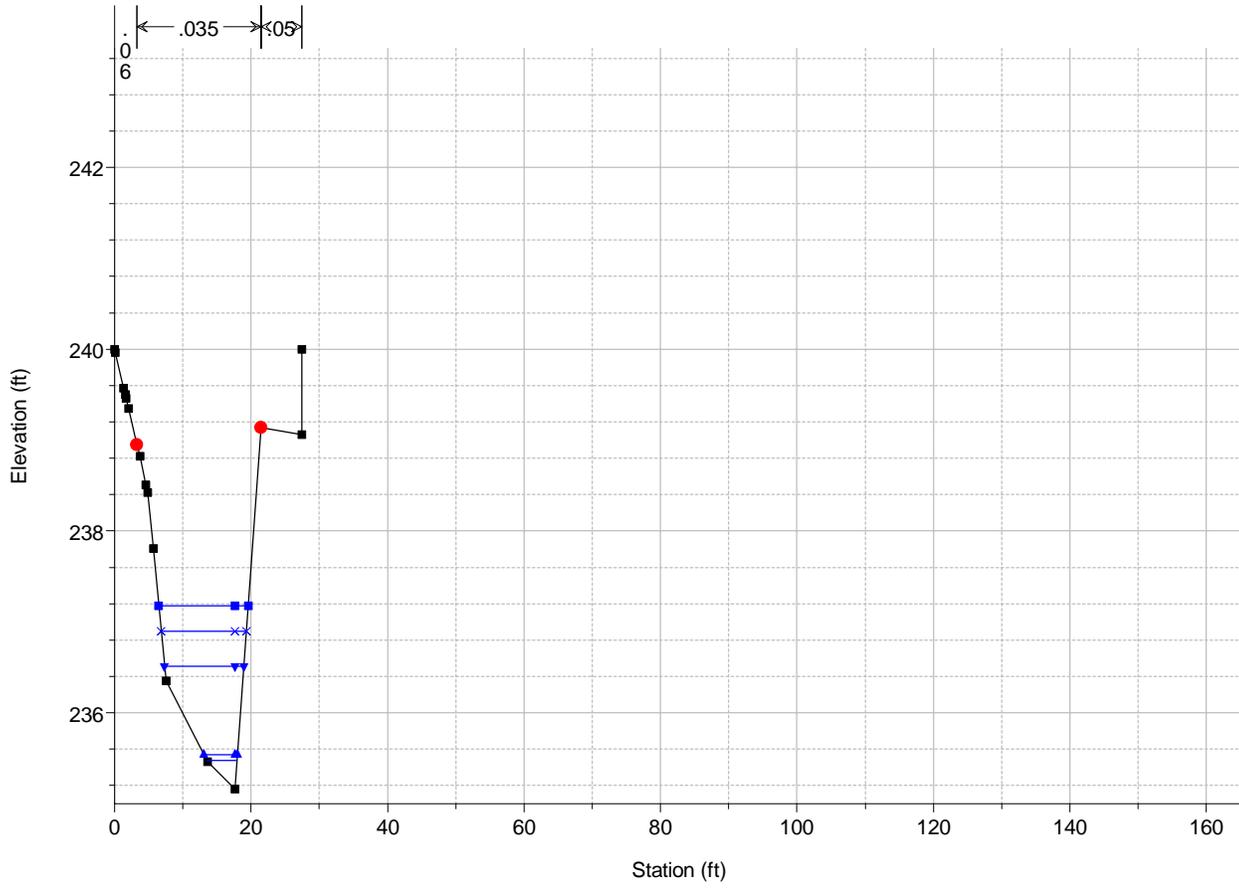
Ri ver: CussgutterBrook

Reach	Ri ver Sta.	Contr.	Expan.
CussgutterBrook	347	.1	.3
CussgutterBrook	319	.1	.3
CussgutterBrook	292	.1	.3
CussgutterBrook	269	.1	.3
CussgutterBrook	254	.3	.5
CussgutterBrook	237	.3	.5
CussgutterBrook	200	Cul vert	
CussgutterBrook	160	.3	.5
CussgutterBrook	142	.3	.5
CussgutterBrook	124	.1	.3
CussgutterBrook	107	.1	.3
CussgutterBrook	27	.1	.3
CussgutterBrook	0	.1	.3

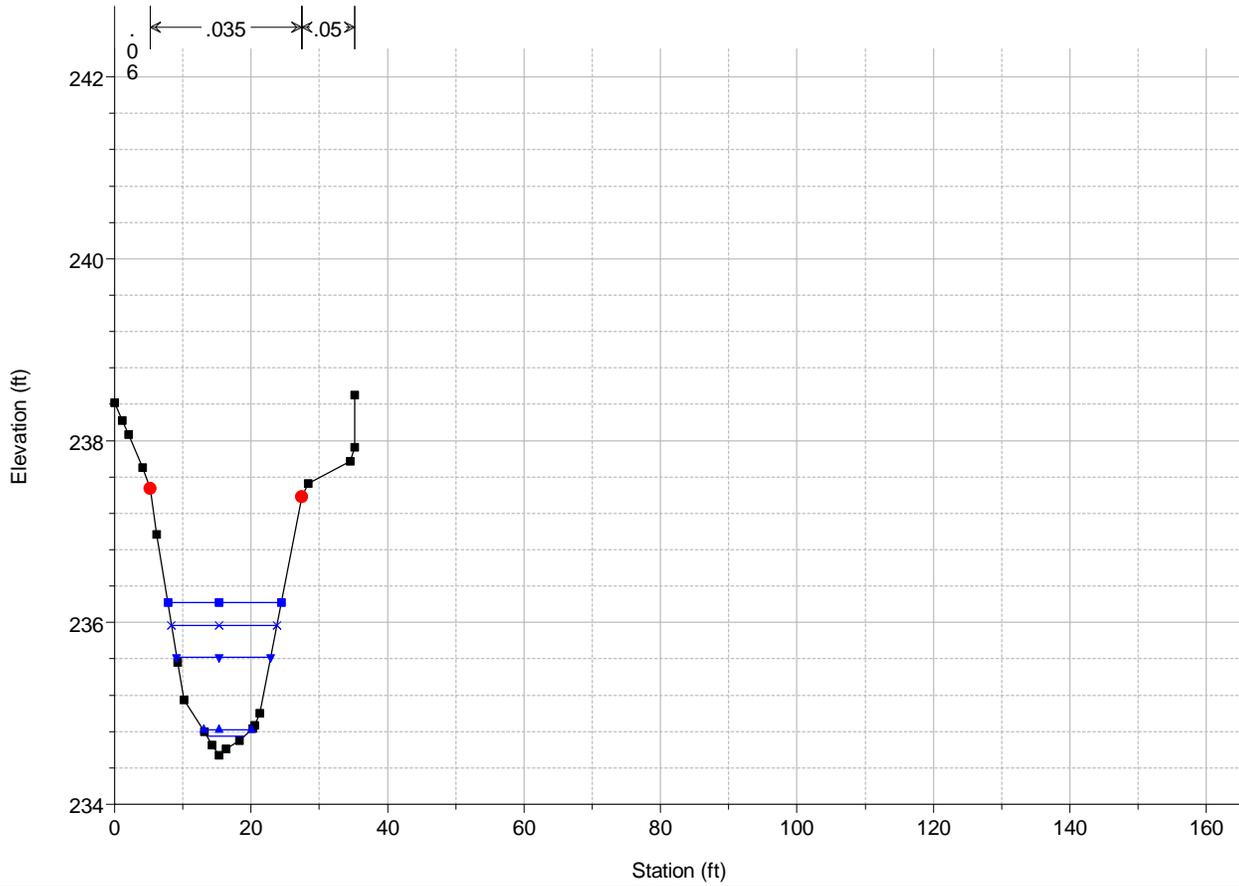
HEC-RAS Plan: TempStage1 River: CussgutterBrook Reach: CussgutterBrook

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
CussgutterBrook	347	Avg Daily	1.10	235.16	235.48		235.51	0.015431	1.53	0.72	4.46	0.67
CussgutterBrook	347	Avg Spring	2.10	235.16	235.54	235.51	235.61	0.019752	2.04	1.03	4.97	0.79
CussgutterBrook	347	1yr	49.00	235.16	236.51	236.51	236.93	0.021285	5.18	9.45	11.63	1.01
CussgutterBrook	347	2yr	86.00	235.16	236.90	236.90	237.48	0.019464	6.10	14.10	12.49	1.01
CussgutterBrook	347	3yr	118.00	235.16	237.18	237.18	237.87	0.018583	6.66	17.71	13.12	1.01
CussgutterBrook	319	Avg Daily	1.10	234.54	234.75	234.75	234.81	0.046065	1.99	0.55	5.41	1.10
CussgutterBrook	319	Avg Spring	2.10	234.54	234.82	234.82	234.89	0.034475	2.13	0.99	7.02	1.00
CussgutterBrook	319	1yr	49.00	234.54	235.62	235.62	235.99	0.020774	4.88	10.03	13.80	1.01
CussgutterBrook	319	2yr	86.00	234.54	235.97	235.97	236.47	0.018953	5.67	15.16	15.44	1.01
CussgutterBrook	319	3yr	118.00	234.54	236.22	236.22	236.81	0.018037	6.15	19.19	16.62	1.01
CussgutterBrook	292	Avg Daily	1.10	232.60	232.88	232.87	232.94	0.029867	1.96	0.56	4.00	0.93
CussgutterBrook	292	Avg Spring	2.10	232.60	232.96	232.95	233.04	0.030923	2.34	0.90	5.04	0.98
CussgutterBrook	292	1yr	49.00	232.60	233.86	233.86	234.27	0.020515	5.12	9.57	12.00	1.01
CussgutterBrook	292	2yr	86.00	232.60	234.25	234.25	234.79	0.018810	5.93	14.50	13.54	1.01
CussgutterBrook	292	3yr	118.00	232.60	234.52	234.52	235.16	0.017966	6.42	18.38	14.65	1.01
CussgutterBrook	269	Avg Daily	1.10	232.01	232.18	232.18	232.23	0.032572	1.82	0.61	5.23	0.94
CussgutterBrook	269	Avg Spring	2.10	232.01	232.24	232.24	232.32	0.032988	2.25	0.93	5.90	1.00
CussgutterBrook	269	1yr	49.00	232.01	233.19	233.19	233.60	0.019882	5.18	9.46	11.31	1.00
CussgutterBrook	269	2yr	86.00	232.01	233.90	233.59	234.23	0.009135	4.61	18.67	14.67	0.72
CussgutterBrook	269	3yr	118.00	232.01	234.47	233.89	234.75	0.005859	4.25	27.79	17.58	0.60
CussgutterBrook	254	Avg Daily	1.10	231.09	231.50	231.40	231.53	0.007674	1.22	0.90	4.33	0.47
CussgutterBrook	254	Avg Spring	2.10	231.09	231.61	231.49	231.64	0.008285	1.51	1.39	5.15	0.51
CussgutterBrook	254	1yr	49.00	231.09	232.68	232.68	233.23	0.023506	5.97	8.21	7.44	1.00
CussgutterBrook	254	2yr	86.00	231.09	233.20	233.20	233.98	0.022951	7.09	12.12	7.75	1.00
CussgutterBrook	254	3yr	118.00	231.09	233.57	233.57	234.52	0.023013	7.83	15.08	7.93	1.00
CussgutterBrook	237	Avg Daily	1.10	230.95	231.22	231.22	231.28	0.032441	2.02	0.55	3.96	0.96
CussgutterBrook	237	Avg Spring	2.10	230.95	231.29	231.29	231.38	0.034520	2.45	0.86	4.85	1.03
CussgutterBrook	237	1yr	49.00	230.95	232.33	232.33	232.80	0.020031	5.51	8.90	9.47	1.00
CussgutterBrook	237	2yr	86.00	230.95	232.78	232.78	233.41	0.018335	6.39	13.45	10.61	1.00
CussgutterBrook	237	3yr	118.00	230.95	233.10	233.10	233.86	0.017449	6.99	16.87	11.48	1.00
CussgutterBrook	200		Culvert									
CussgutterBrook	160	Avg Daily	1.10	228.84	229.04	229.02	229.08	0.026761	1.50	0.73	7.20	0.83
CussgutterBrook	160	Avg Spring	2.10	228.84	229.09	229.08	229.15	0.029296	1.86	1.13	8.58	0.90
CussgutterBrook	160	1yr	49.00	228.84	230.50	229.85	230.62	0.003080	2.81	17.41	13.07	0.41
CussgutterBrook	160	2yr	86.00	228.84	231.26	230.23	231.42	0.002457	3.22	26.74	14.18	0.39
CussgutterBrook	160	3yr	118.00	228.84	231.76	230.49	231.96	0.002408	3.57	33.02	14.93	0.39
CussgutterBrook	142	Avg Daily	1.10	228.19	228.42	228.42	228.49	0.039745	2.04	0.54	4.28	1.01
CussgutterBrook	142	Avg Spring	2.10	228.19	228.50	228.50	228.59	0.032566	2.43	0.86	4.46	0.98
CussgutterBrook	142	1yr	49.00	228.19	229.76	229.76	230.36	0.024025	6.24	7.85	6.52	1.00
CussgutterBrook	142	2yr	86.00	228.19	230.39	230.39	231.14	0.022872	6.98	12.31	8.10	1.00
CussgutterBrook	142	3yr	118.00	228.19	230.78	230.78	231.66	0.020852	7.53	15.86	9.71	0.97
CussgutterBrook	124	Avg Daily	1.10	227.32	227.65	227.58	227.67	0.008104	1.12	0.98	6.06	0.49
CussgutterBrook	124	Avg Spring	2.10	227.32	227.74	227.65	227.77	0.007589	1.40	1.50	6.22	0.50
CussgutterBrook	124	1yr	49.00	227.32	228.85	228.71	229.26	0.014767	5.12	9.57	8.49	0.85
CussgutterBrook	124	2yr	86.00	227.32	229.32	229.32	229.87	0.019730	5.92	14.52	13.32	1.00
CussgutterBrook	124	3yr	118.00	227.32	229.68	229.68	230.18	0.019413	5.65	20.88	20.97	1.00
CussgutterBrook	107	Avg Daily	1.10	227.15	227.33	227.33	227.40	0.034278	2.12	0.52	3.60	0.98
CussgutterBrook	107	Avg Spring	2.10	227.15	227.41	227.41	227.51	0.031420	2.50	0.84	4.24	0.99
CussgutterBrook	107	1yr	49.00	227.15	228.50	228.50	228.95	0.020146	5.37	9.12	10.24	1.00
CussgutterBrook	107	2yr	86.00	227.15	228.95	228.95	229.46	0.019156	5.72	15.02	14.73	1.00
CussgutterBrook	107	3yr	118.00	227.15	229.20	229.20	229.81	0.018151	6.28	18.80	15.26	1.00
CussgutterBrook	27	Avg Daily	1.10	222.20	222.93		222.94	0.001298	0.84	1.32	2.80	0.22
CussgutterBrook	27	Avg Spring	2.10	222.20	223.07		223.09	0.002260	1.21	1.73	3.16	0.29
CussgutterBrook	27	1yr	49.00	222.20	224.32	224.32	224.94	0.022111	6.30	7.78	6.40	1.01
CussgutterBrook	27	2yr	86.00	222.20	224.94	224.94	225.70	0.020635	7.00	12.28	8.17	1.01
CussgutterBrook	27	3yr	118.00	222.20	225.35	225.35	226.21	0.019857	7.42	15.89	9.44	1.01
CussgutterBrook	0	Avg Daily	1.10	222.50	222.77	222.77	222.83	0.035228	2.05	0.54	4.08	1.00
CussgutterBrook	0	Avg Spring	2.10	222.50	222.84	222.84	222.93	0.032521	2.35	0.89	5.21	1.00
CussgutterBrook	0	1yr	49.00	222.50	223.74	223.74	224.14	0.020525	5.10	9.61	12.17	1.01
CussgutterBrook	0	2yr	86.00	222.50	224.11	224.11	224.67	0.018808	5.98	14.37	13.17	1.01
CussgutterBrook	0	3yr	118.00	222.50	224.39	224.39	225.05	0.017962	6.55	18.03	13.77	1.01

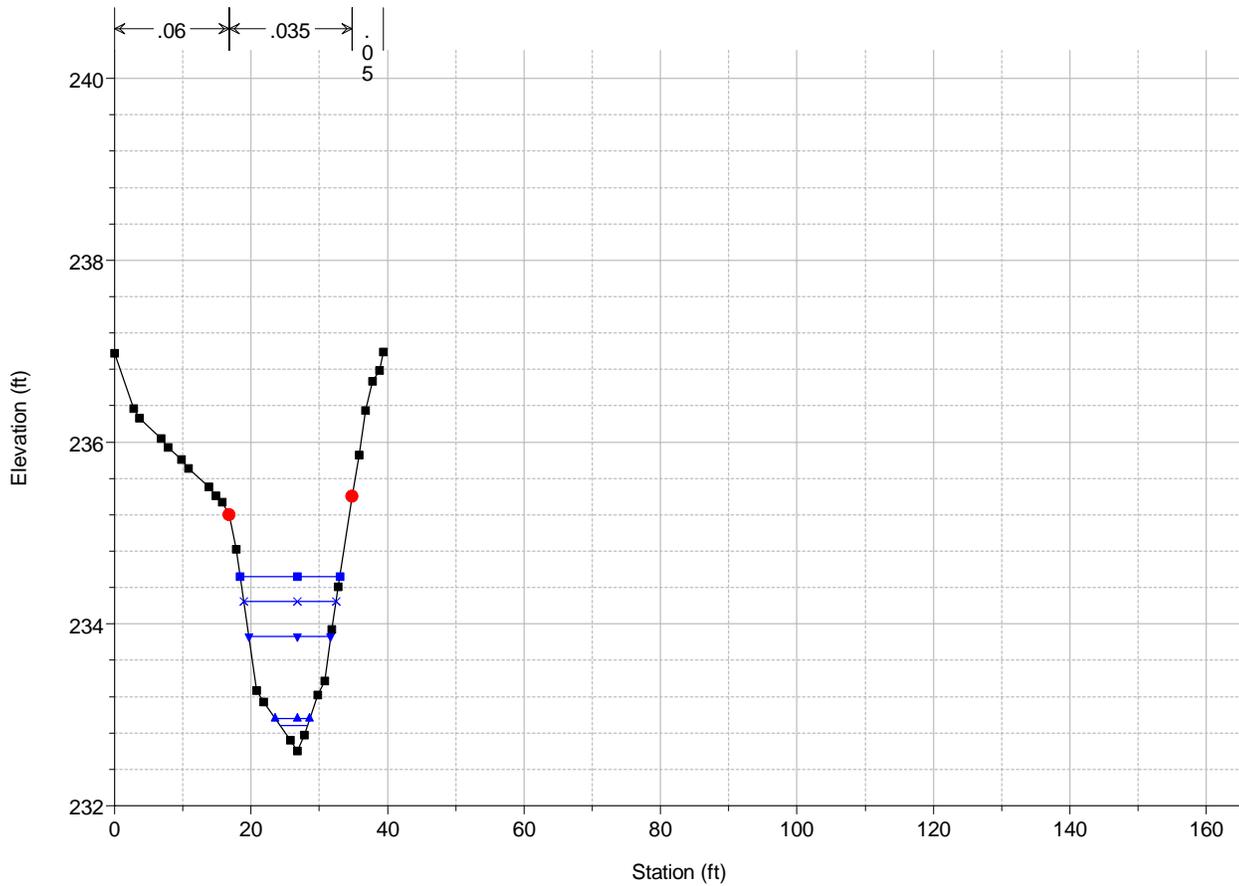
LakeAve Plan: TempStage1LowFlow  
RS = 347



LakeAve Plan: TempStage1LowFlow  
RS = 319

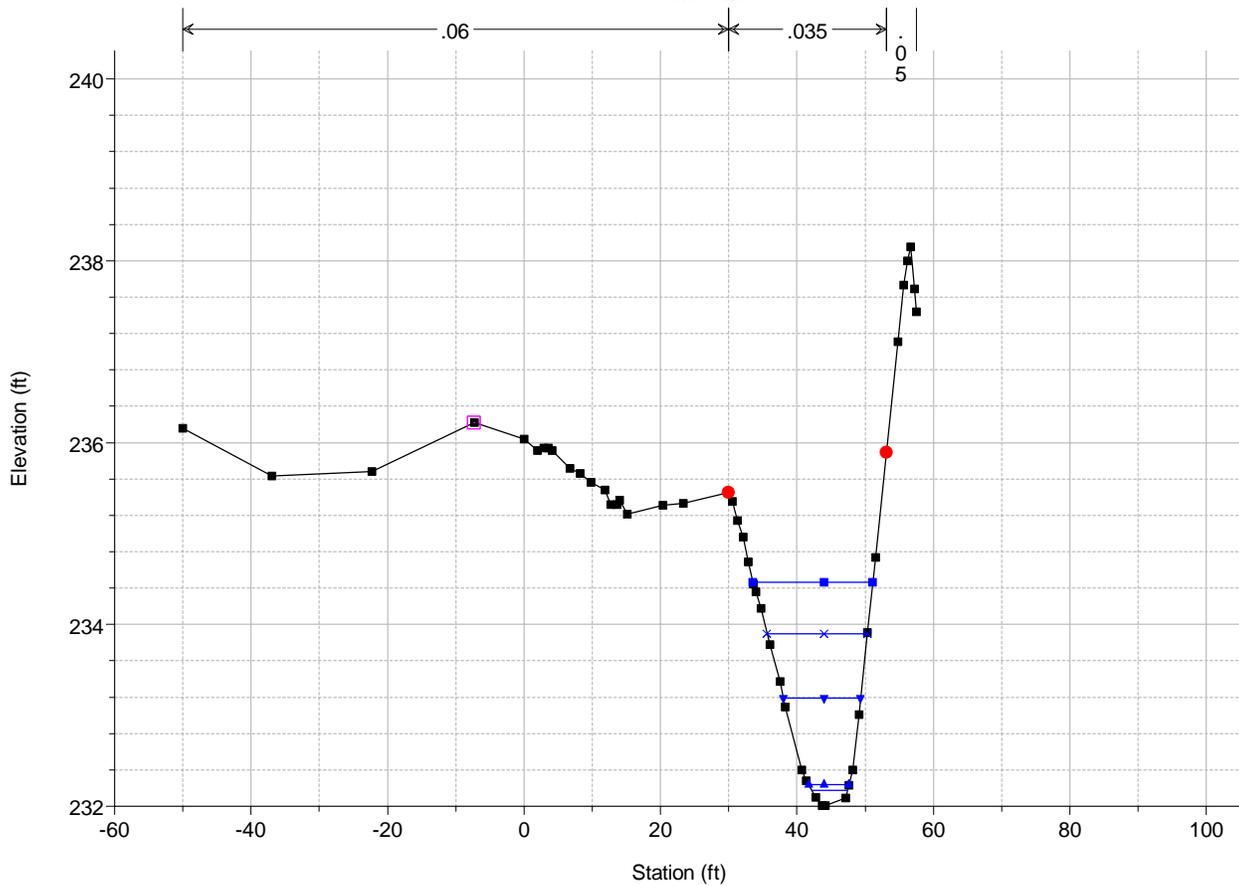


LakeAve Plan: TempStage1LowFlow  
RS = 292



Legend	
■	WS 3yr
×	WS 2yr
▼	WS 1yr
▲	WS Avg Spring
—	WS Avg Daily
■	Ground
●	Bank Sta

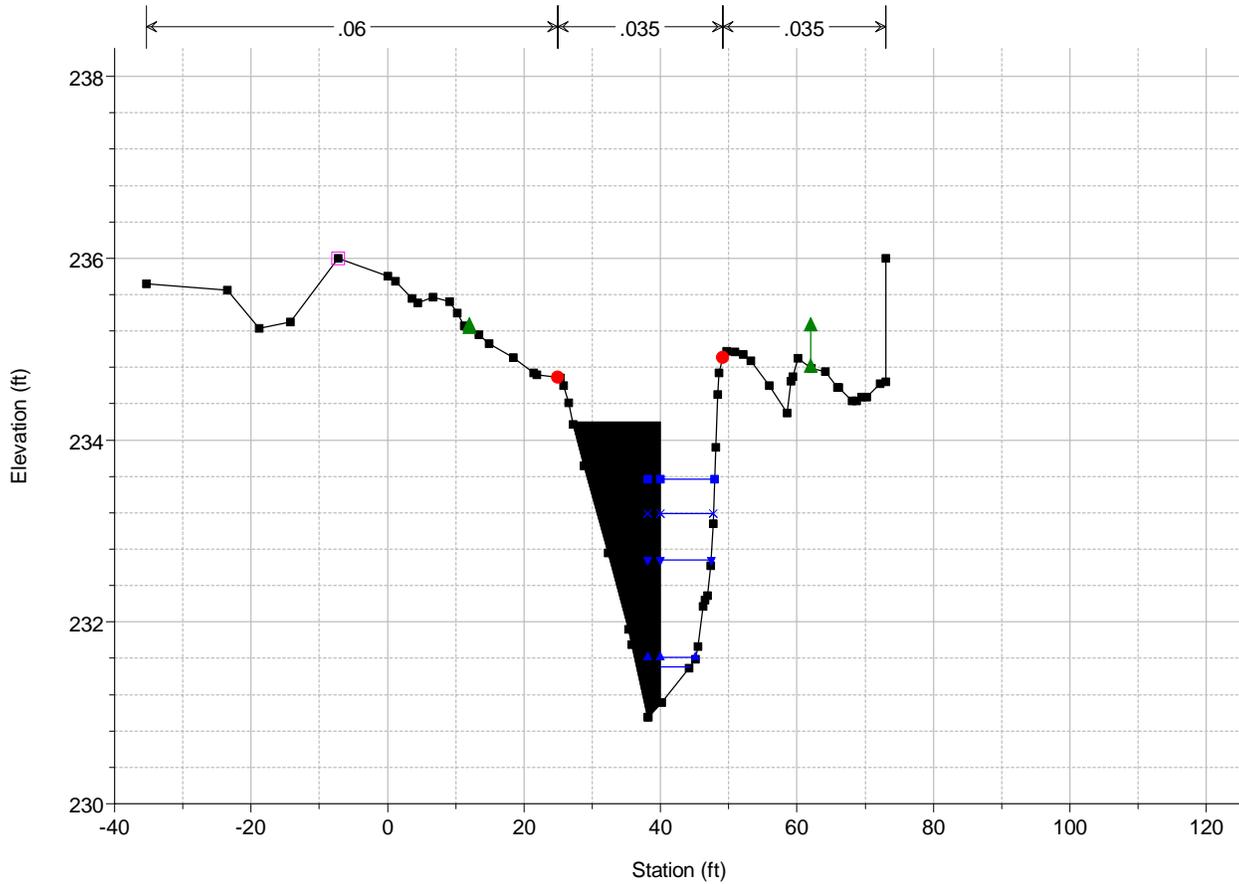
LakeAve Plan: TempStage1LowFlow  
RS = 269



Legend	
■	WS 3yr
×	WS 2yr
▼	WS 1yr
▲	WS Avg Spring
—	WS Avg Daily
■	Ground
□	Levee
●	Bank Sta

LakeAve Plan: TempStage1LowFlow

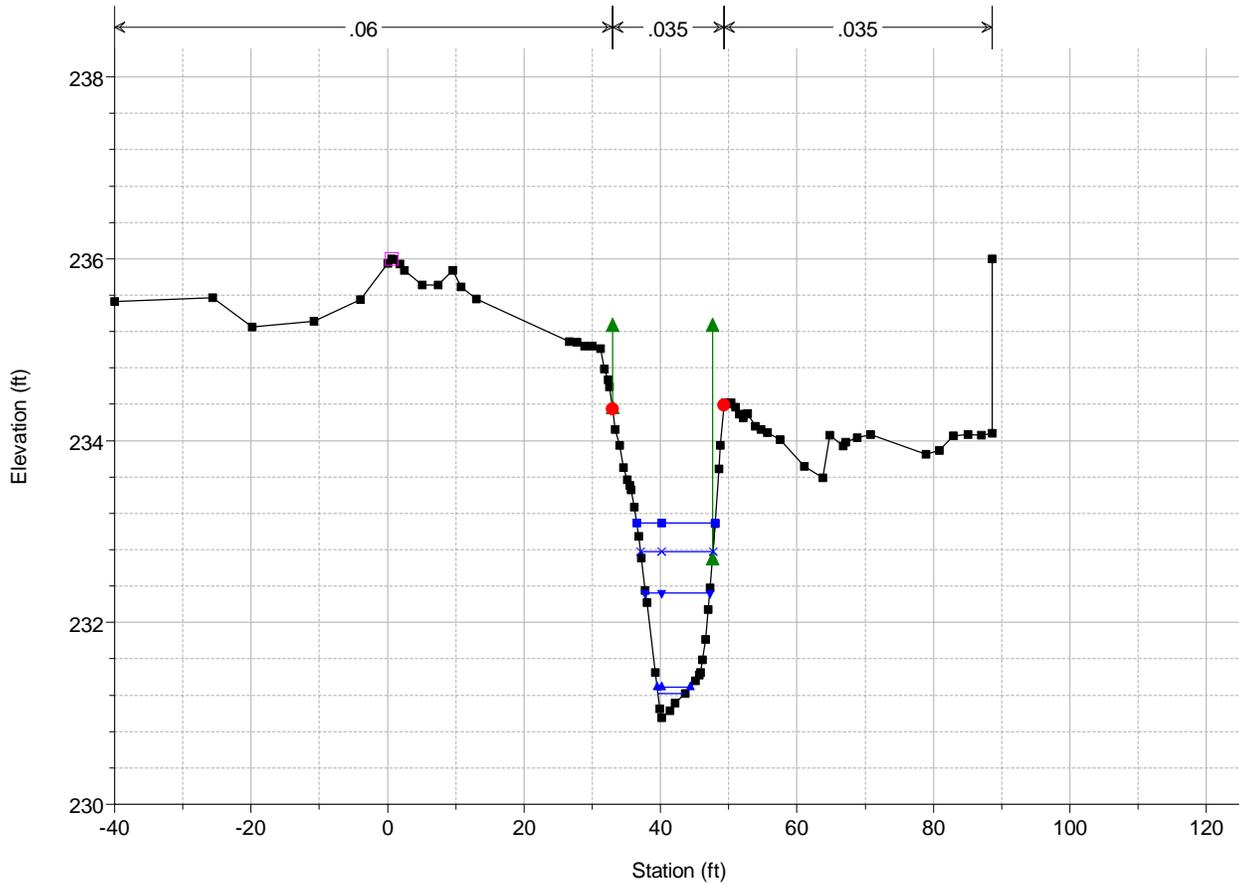
RS = 254



Legend	
■	WS 3yr
×	WS 2yr
▼	WS 1yr
▲	WS Avg Spring
—	WS Avg Daily
■	Ground
□	Levee
▲	Ineff
●	Bank Sta

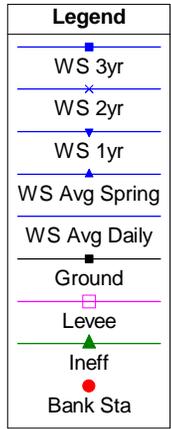
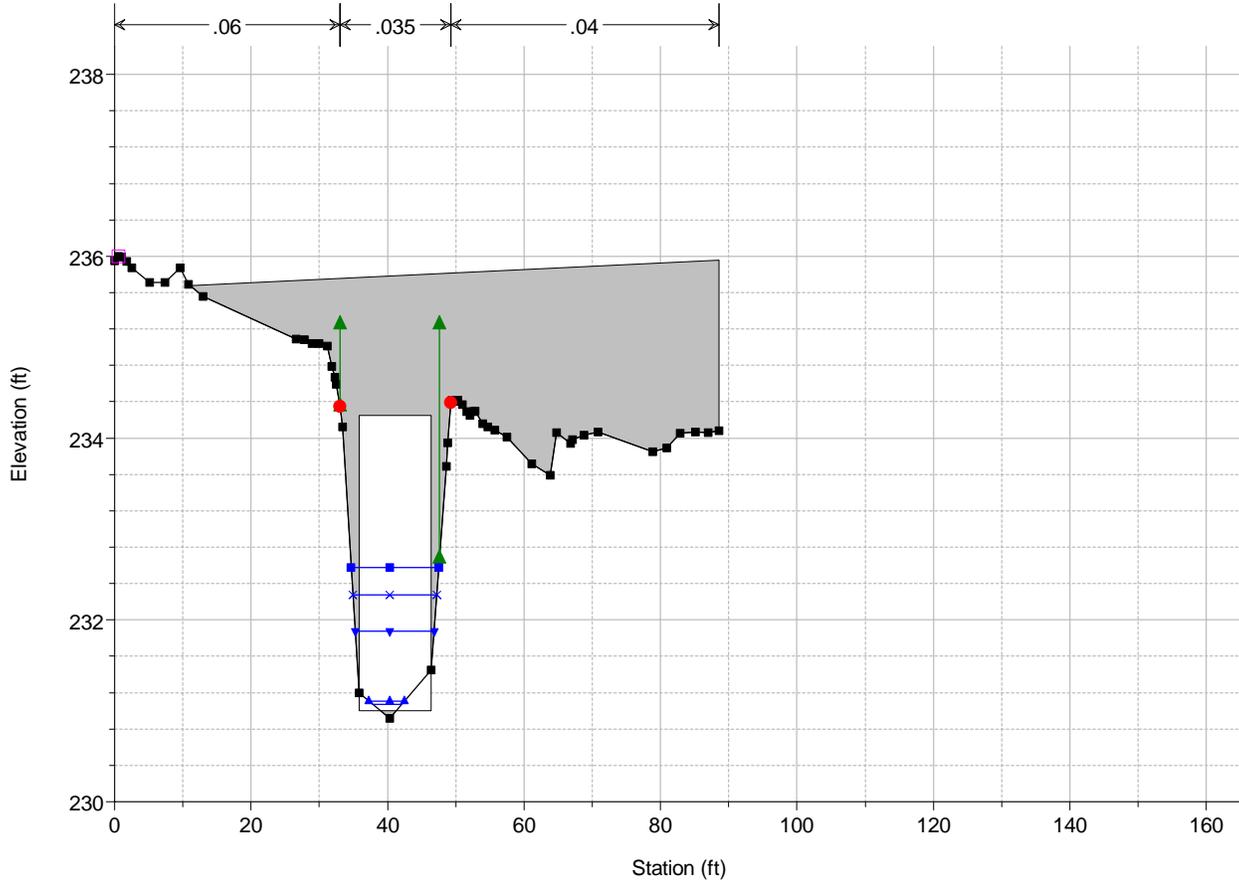
LakeAve Plan: TempStage1LowFlow

RS = 237

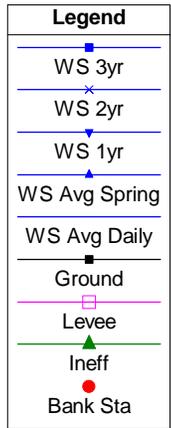
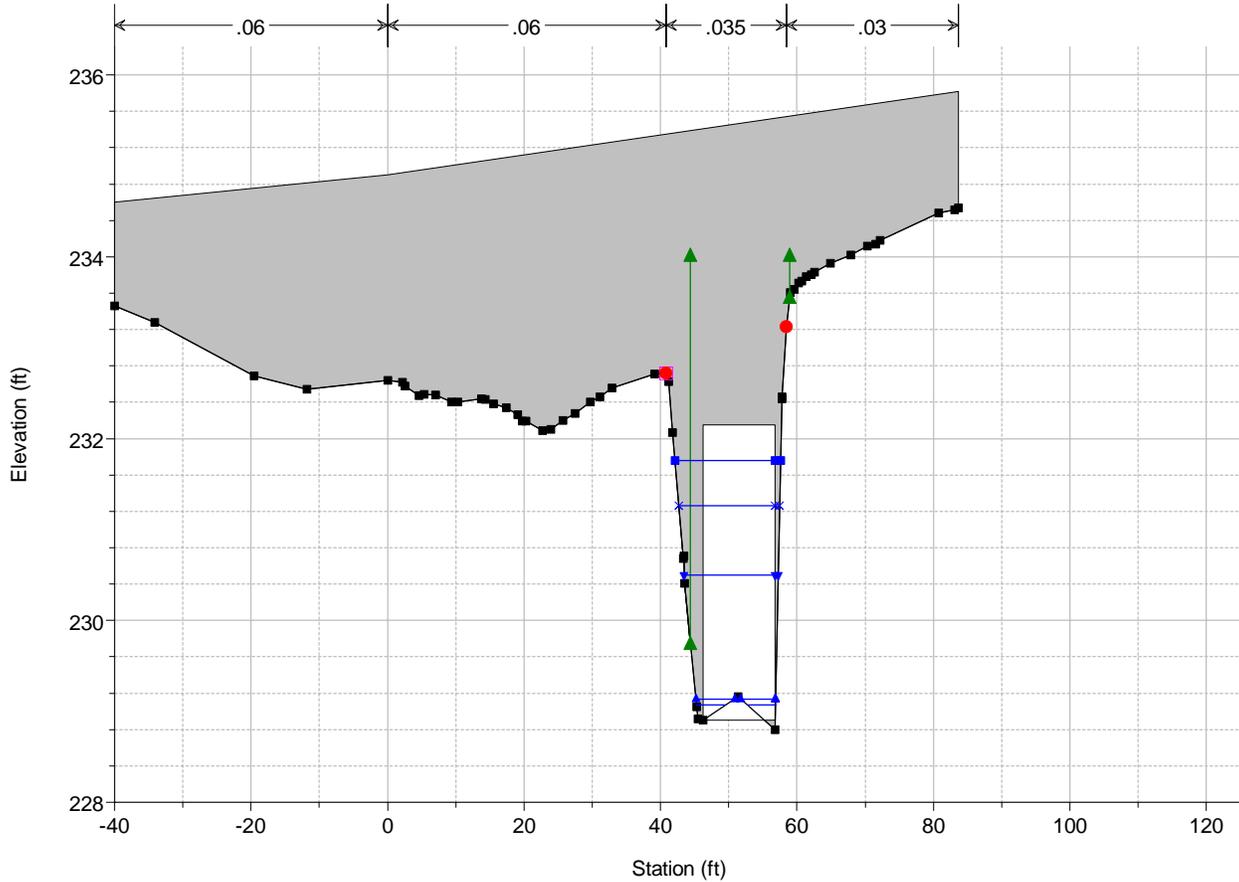


Legend	
■	WS 3yr
×	WS 2yr
▼	WS 1yr
▲	WS Avg Spring
—	WS Avg Daily
■	Ground
□	Levee
▲	Ineff
●	Bank Sta

LakeAve Plan: TempStage1LowFlow  
RS = 200 Culv

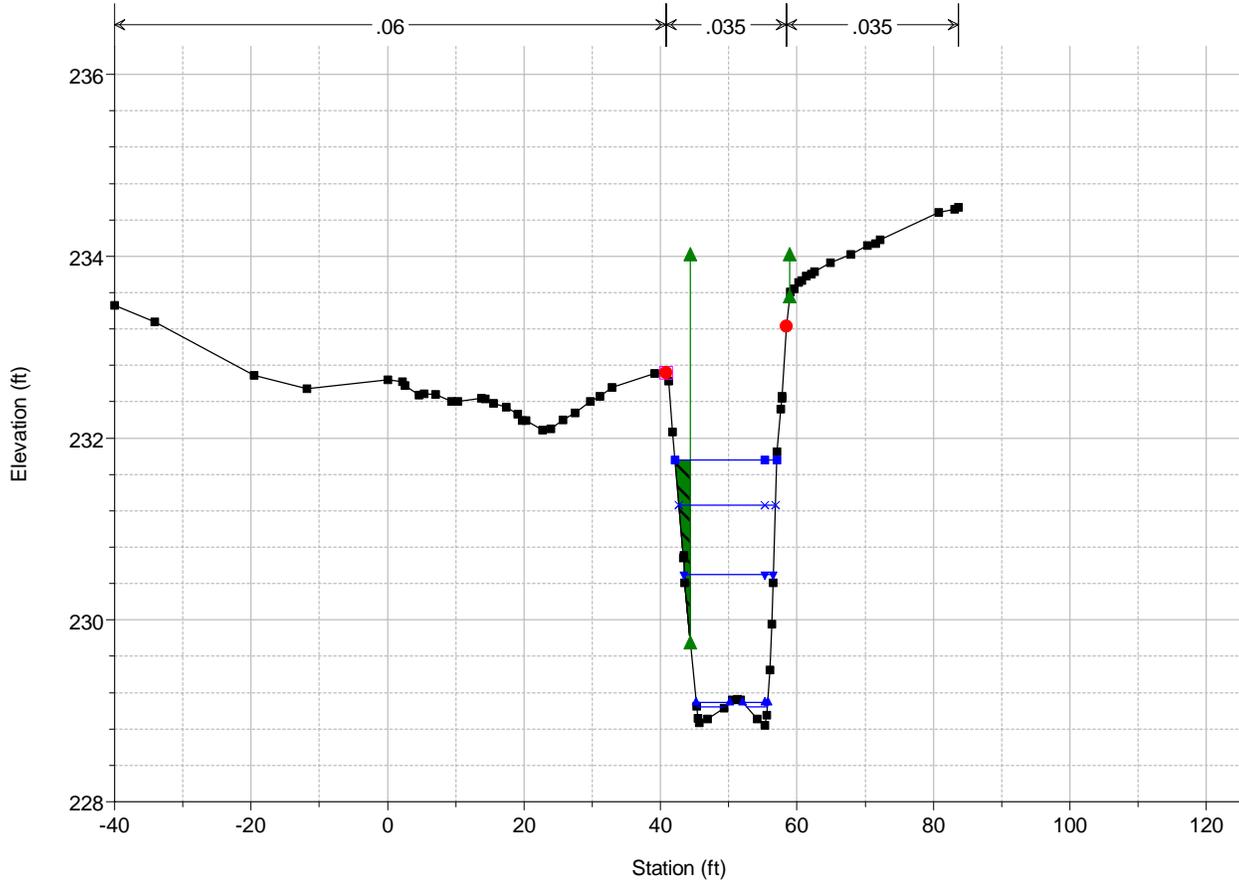


LakeAve Plan: TempStage1LowFlow  
RS = 200 Culv



LakeAve Plan: TempStage1LowFlow

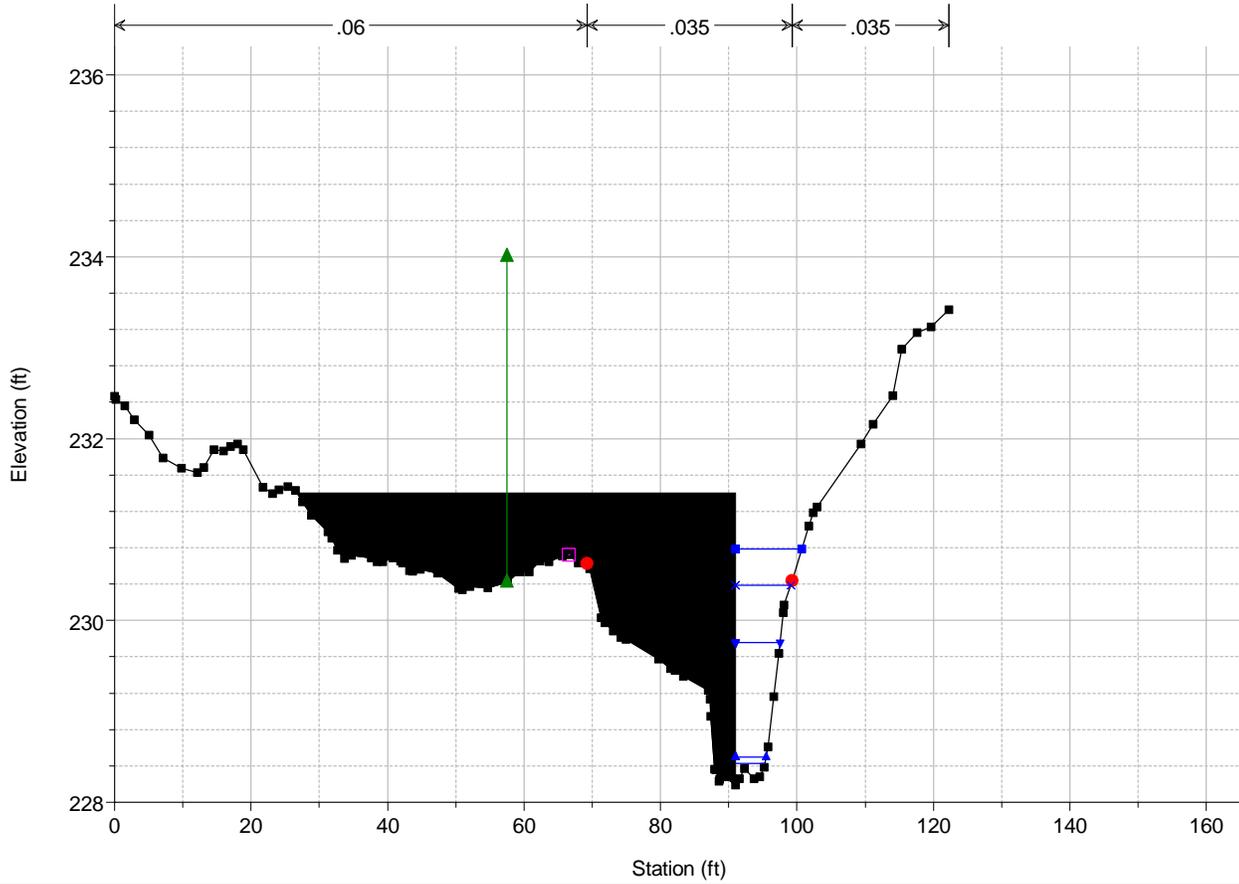
RS = 160



Legend	
■	WS 3yr
×	WS 2yr
▼	WS 1yr
▲	WS Avg Spring
▲	WS Avg Daily
■	Ground
□	Levee
▲	Ineff
●	Bank Sta

LakeAve Plan: TempStage1LowFlow

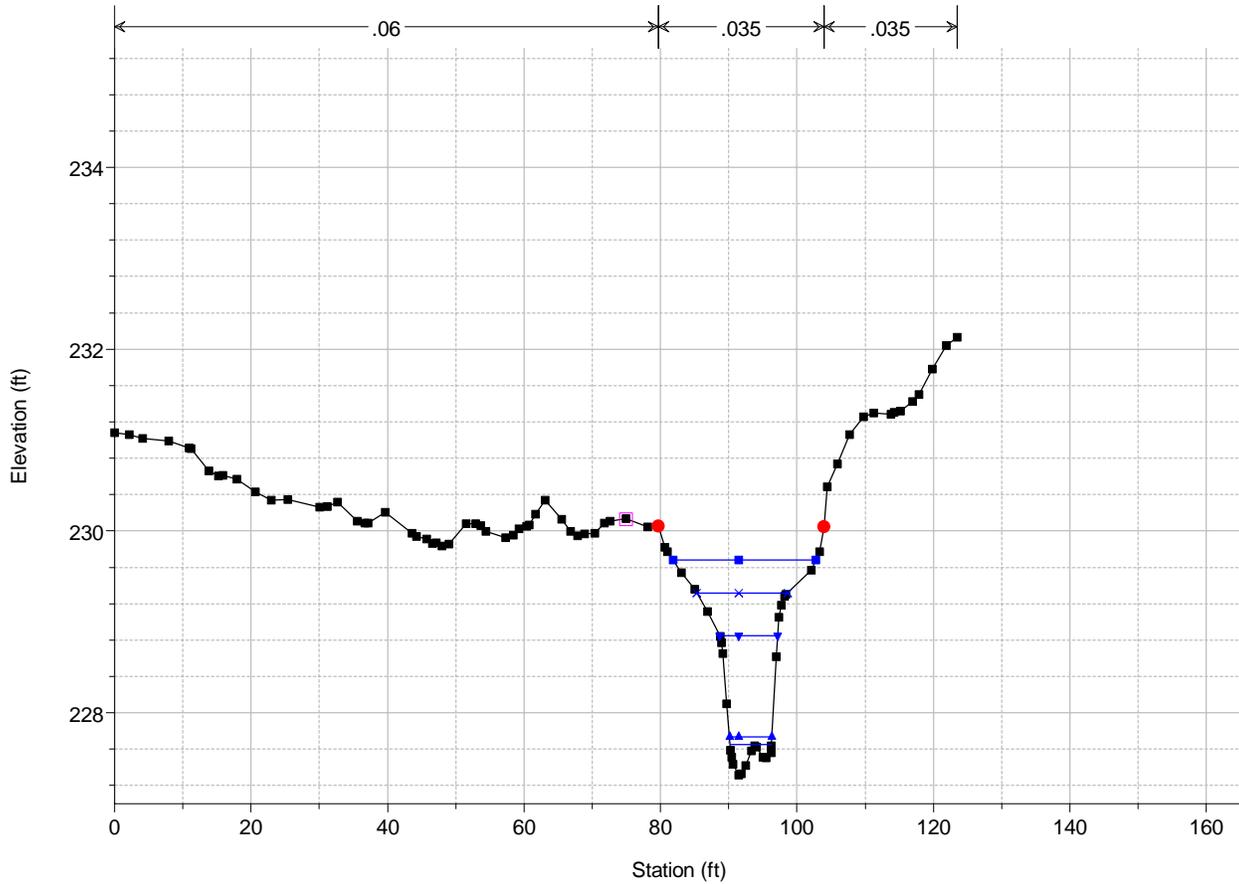
RS = 142



Legend	
■	WS 3yr
×	WS 2yr
▼	WS 1yr
▲	WS Avg Spring
▲	WS Avg Daily
■	Ground
□	Levee
▲	Ineff
●	Bank Sta

LakeAve Plan: TempStage1LowFlow

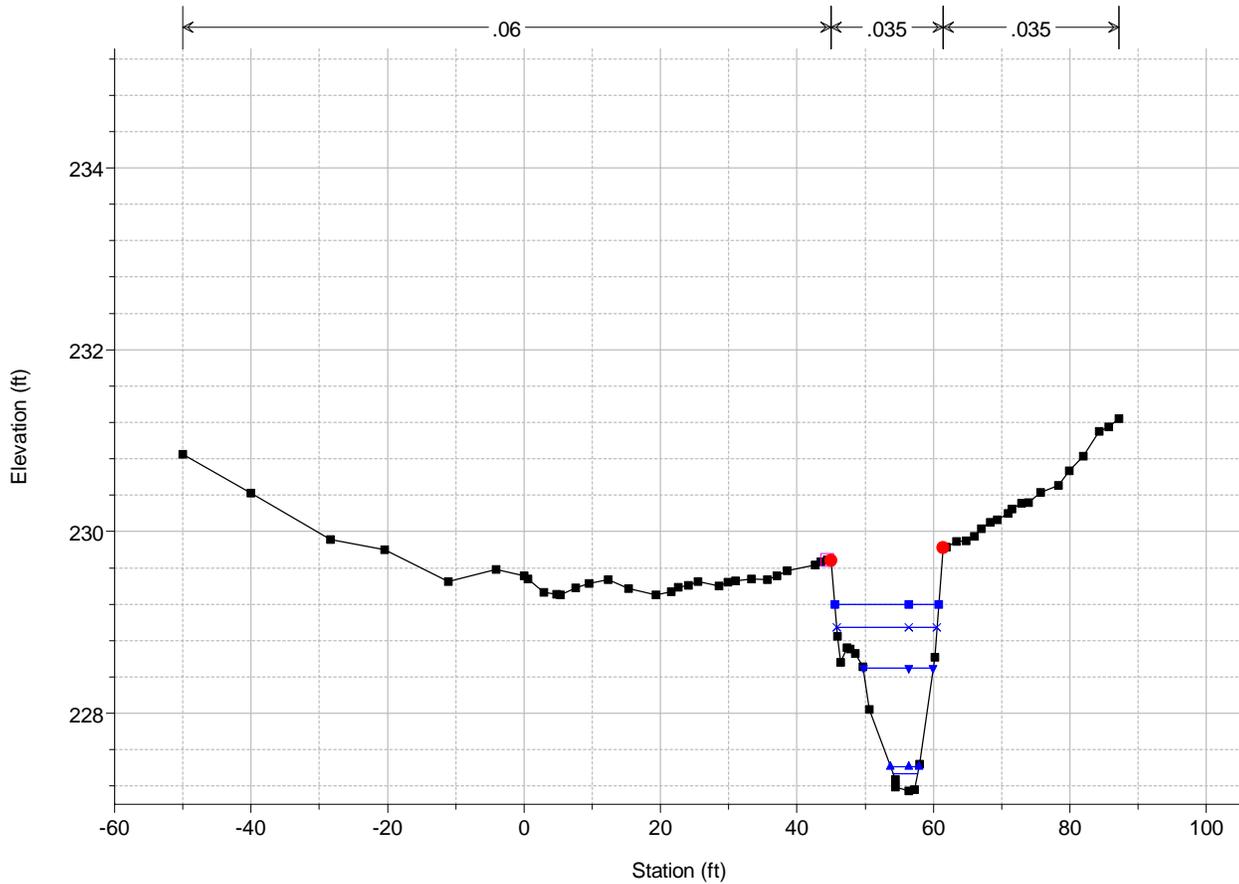
RS = 124



Legend	
■	WS 3yr
×	WS 2yr
▼	WS 1yr
▲	WS Avg Spring
▲	WS Avg Daily
■	Ground
□	Levee
●	Bank Sta

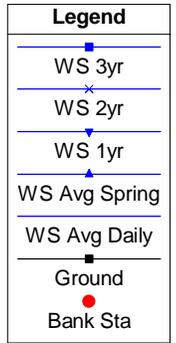
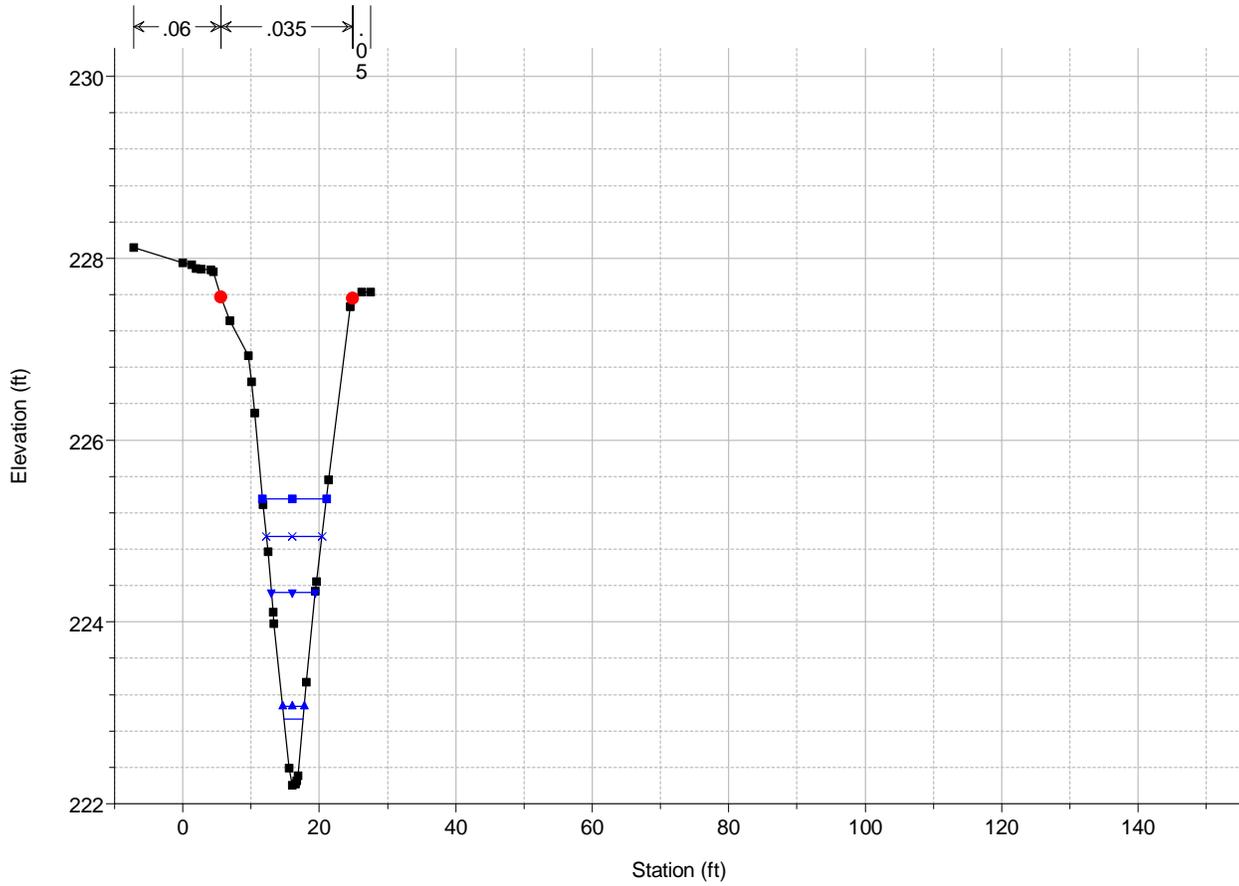
LakeAve Plan: TempStage1LowFlow

RS = 107

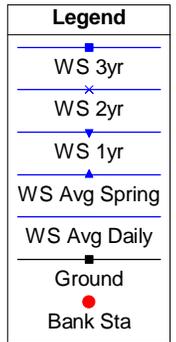
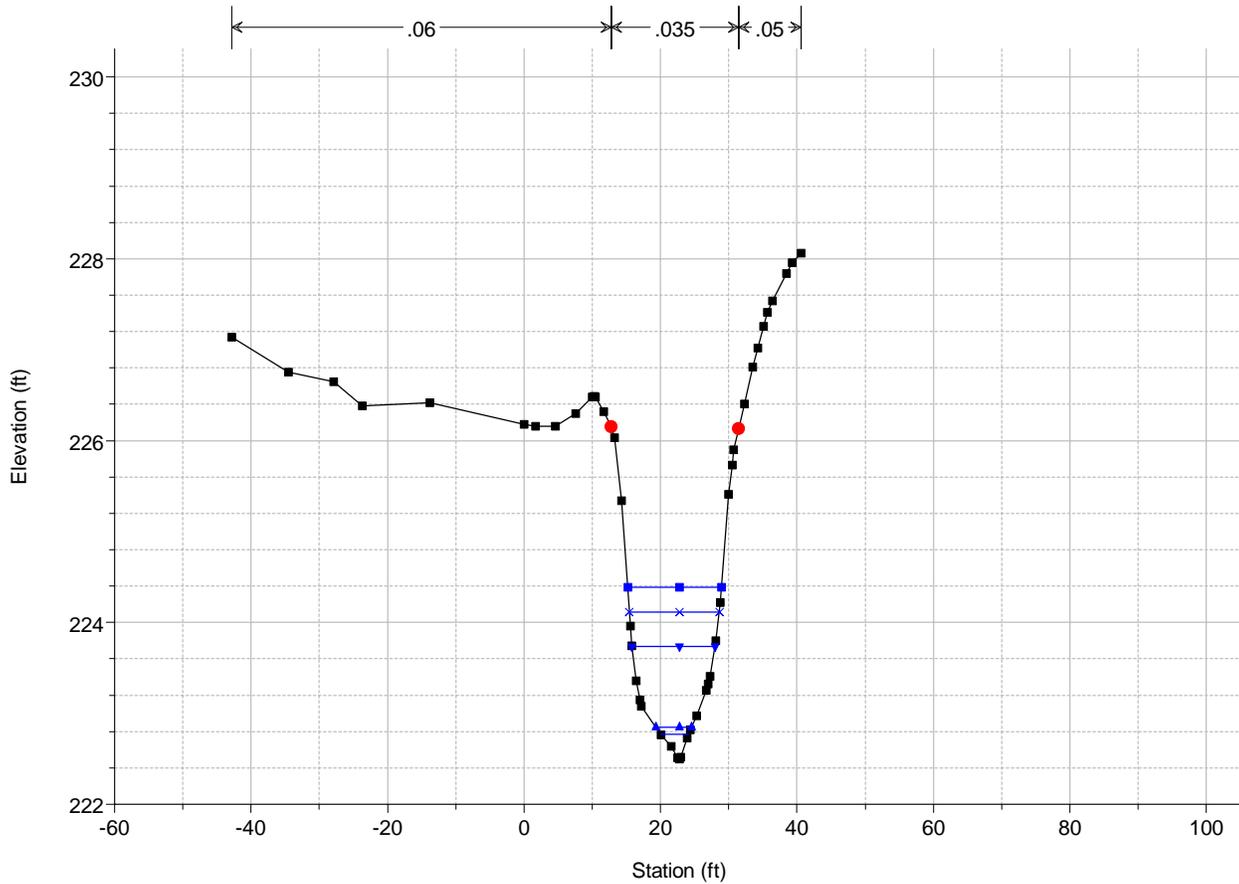


Legend	
■	WS 3yr
×	WS 2yr
▼	WS 1yr
▲	WS Avg Spring
▲	WS Avg Daily
■	Ground
□	Levee
●	Bank Sta

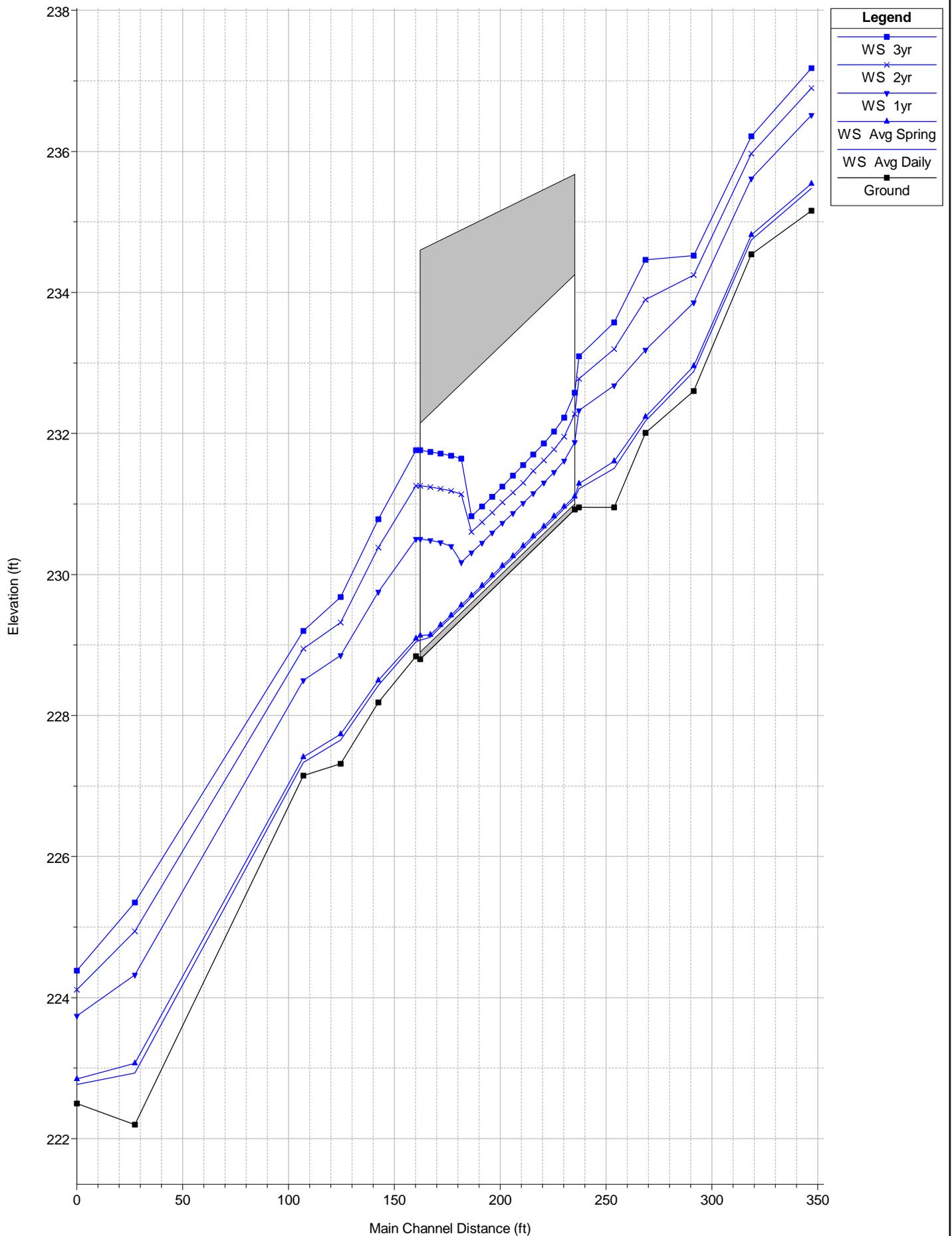
LakeAve Plan: TempStage1LowFlow  
RS = 27



LakeAve Plan: TempStage1LowFlow  
RS = 0



LakeAve Plan: TempStage1LowFlow

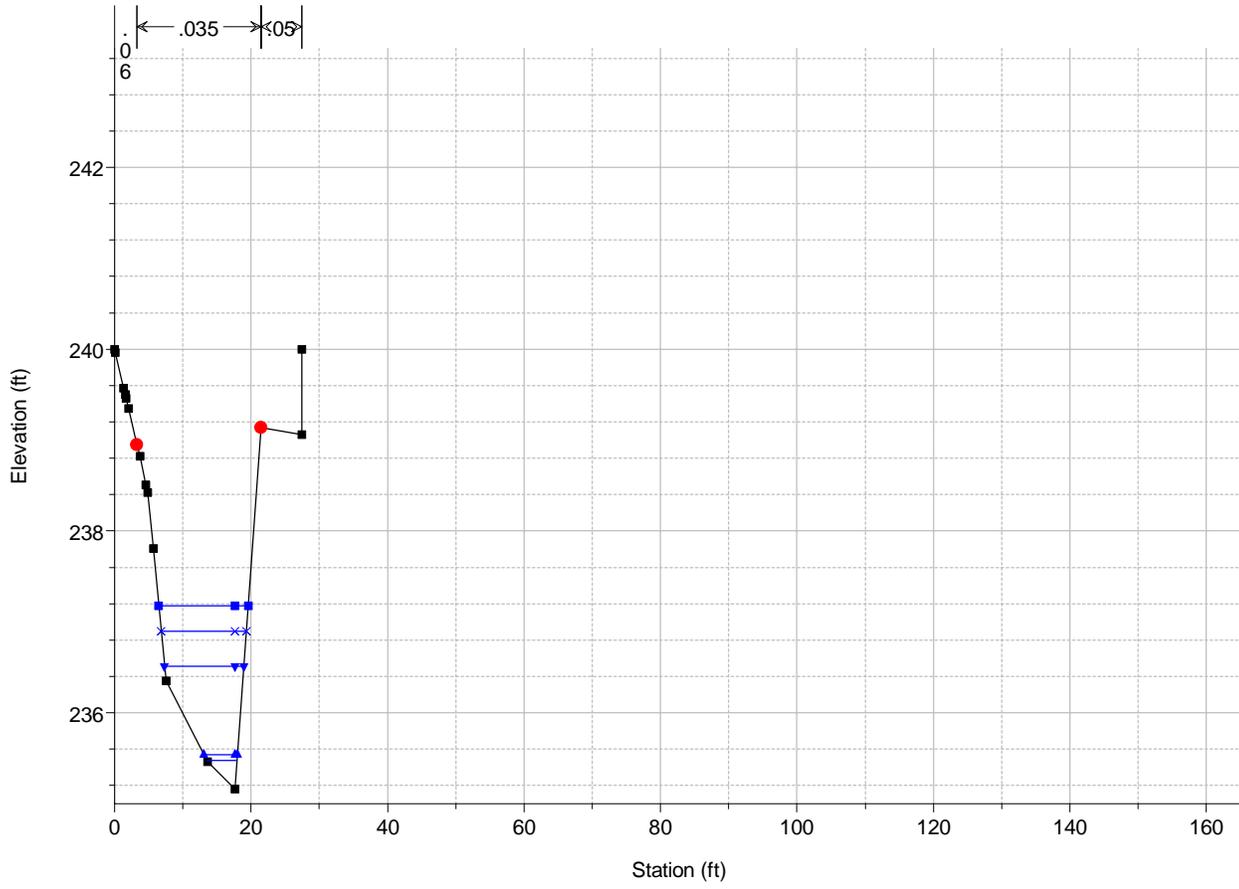


1 in Horiz. = 60 ft 1 in Vert. = 1.8 ft

HEC-RAS Plan: TempStage2 River: CussgutterBrook Reach: CussgutterBrook

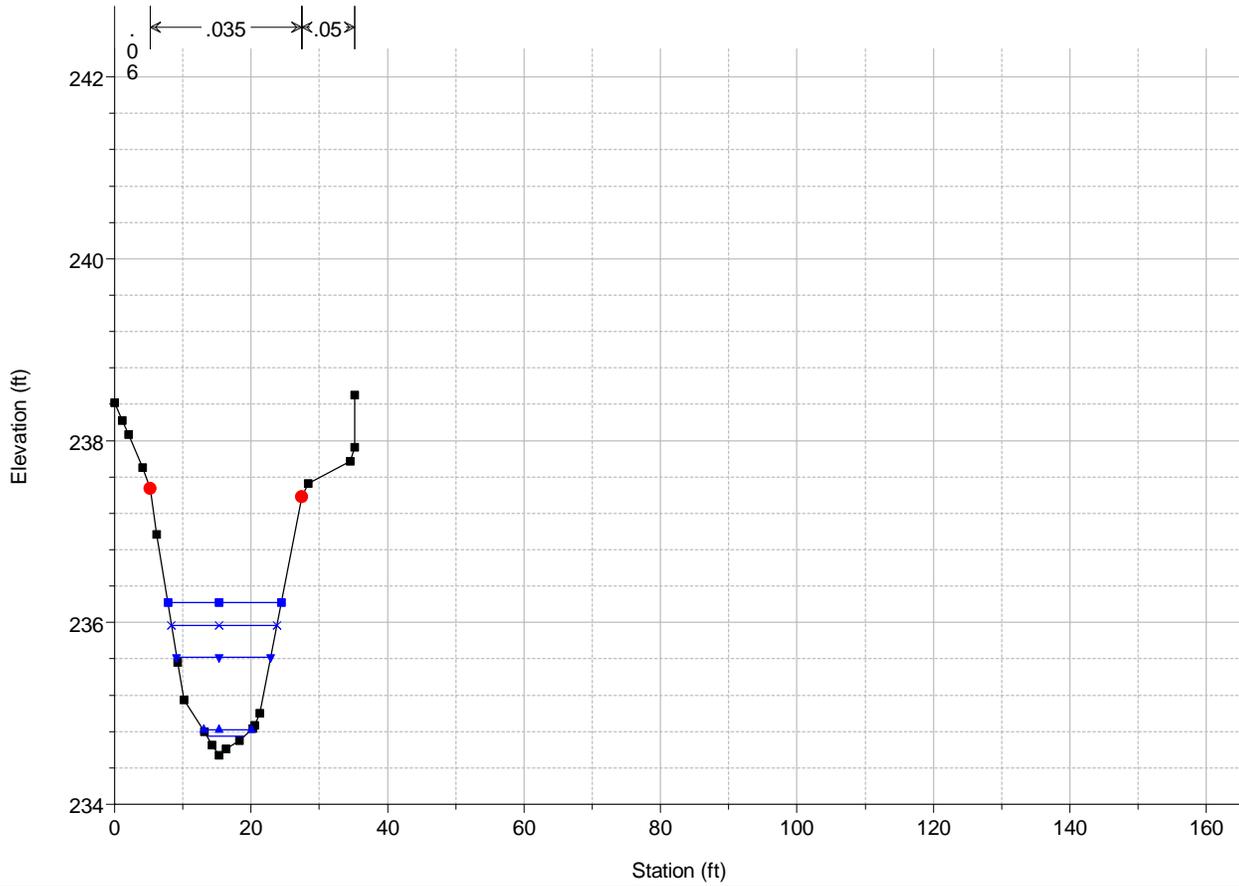
Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
CussgutterBrook	347	Avg Daily	1.10	235.16	235.48		235.51	0.015431	1.53	0.72	4.46	0.67
CussgutterBrook	347	Avg Spring	2.10	235.16	235.54	235.51	235.61	0.019752	2.04	1.03	4.97	0.79
CussgutterBrook	347	1yr	49.00	235.16	236.51	236.51	236.93	0.021285	5.18	9.45	11.63	1.01
CussgutterBrook	347	2yr	86.00	235.16	236.90	236.90	237.48	0.019459	6.10	14.10	12.49	1.01
CussgutterBrook	347	3yr	118.00	235.16	237.18	237.18	237.87	0.018583	6.66	17.71	13.12	1.01
CussgutterBrook	319	Avg Daily	1.10	234.54	234.75	234.75	234.81	0.046065	1.99	0.55	5.41	1.10
CussgutterBrook	319	Avg Spring	2.10	234.54	234.82	234.82	234.89	0.034475	2.13	0.99	7.02	1.00
CussgutterBrook	319	1yr	49.00	234.54	235.62	235.62	235.99	0.020776	4.88	10.03	13.80	1.01
CussgutterBrook	319	2yr	86.00	234.54	235.97	235.97	236.47	0.018948	5.67	15.16	15.44	1.01
CussgutterBrook	319	3yr	118.00	234.54	236.22	236.22	236.81	0.018037	6.15	19.19	16.62	1.01
CussgutterBrook	292	Avg Daily	1.10	232.60	232.88	232.87	232.94	0.029867	1.96	0.56	4.00	0.93
CussgutterBrook	292	Avg Spring	2.10	232.60	232.96	232.95	233.04	0.030923	2.34	0.90	5.04	0.98
CussgutterBrook	292	1yr	49.00	232.60	233.86	233.86	234.27	0.020522	5.12	9.57	12.00	1.01
CussgutterBrook	292	2yr	86.00	232.60	234.25	234.25	234.79	0.018587	5.91	14.56	13.56	1.00
CussgutterBrook	292	3yr	118.00	232.60	235.62		235.78	0.002353	3.20	37.70	23.13	0.39
CussgutterBrook	269	Avg Daily	1.10	232.01	232.18	232.18	232.23	0.032572	1.82	0.61	5.23	0.94
CussgutterBrook	269	Avg Spring	2.10	232.01	232.24	232.24	232.32	0.032988	2.25	0.93	5.90	1.00
CussgutterBrook	269	1yr	49.00	232.01	233.19	233.19	233.60	0.019882	5.18	9.46	11.31	1.00
CussgutterBrook	269	2yr	86.00	232.01	234.34	233.59	234.51	0.003853	3.36	25.62	16.84	0.48
CussgutterBrook	269	3yr	118.00	232.01	235.64	233.89	235.72	0.001019	2.24	57.64	44.27	0.26
CussgutterBrook	254	Avg Daily	1.10	230.95	231.31	231.21	231.33	0.006544	1.12	0.98	5.22	0.45
CussgutterBrook	254	Avg Spring	2.10	230.95	231.43	231.29	231.46	0.005191	1.21	1.74	6.88	0.42
CussgutterBrook	254	1yr	49.00	230.95	233.37	232.23	233.43	0.001103	1.80	27.22	17.78	0.26
CussgutterBrook	254	2yr	86.00	230.95	234.41	232.62	234.46	0.000709	1.80	47.78	22.95	0.21
CussgutterBrook	254	3yr	118.00	230.95	235.67	232.88	235.70	0.000215	1.29	113.26	70.84	0.13
CussgutterBrook	200		Culvert									
CussgutterBrook	124	Avg Daily	1.10	227.32	227.65	227.58	227.67	0.008104	1.12	0.98	6.06	0.49
CussgutterBrook	124	Avg Spring	2.10	227.32	227.74	227.65	227.77	0.007589	1.40	1.50	6.22	0.50
CussgutterBrook	124	1yr	49.00	227.32	228.85	228.71	229.26	0.014767	5.12	9.57	8.49	0.85
CussgutterBrook	124	2yr	86.00	227.32	229.32	229.32	229.87	0.019730	5.92	14.52	13.32	1.00
CussgutterBrook	124	3yr	118.00	227.32	229.68	229.68	230.18	0.019413	5.65	20.88	20.97	1.00
CussgutterBrook	107	Avg Daily	1.10	227.15	227.33	227.33	227.40	0.034278	2.12	0.52	3.60	0.98
CussgutterBrook	107	Avg Spring	2.10	227.15	227.41	227.41	227.51	0.031420	2.50	0.84	4.24	0.99
CussgutterBrook	107	1yr	49.00	227.15	228.50	228.50	228.95	0.020146	5.37	9.12	10.24	1.00
CussgutterBrook	107	2yr	86.00	227.15	228.95	228.95	229.46	0.019156	5.72	15.02	14.73	1.00
CussgutterBrook	107	3yr	118.00	227.15	229.20	229.20	229.81	0.018151	6.28	18.80	15.26	1.00
CussgutterBrook	27	Avg Daily	1.10	222.20	222.93		222.94	0.001298	0.84	1.32	2.80	0.22
CussgutterBrook	27	Avg Spring	2.10	222.20	223.07		223.09	0.002260	1.21	1.73	3.16	0.29
CussgutterBrook	27	1yr	49.00	222.20	224.32	224.32	224.94	0.022111	6.30	7.78	6.40	1.01
CussgutterBrook	27	2yr	86.00	222.20	224.94	224.94	225.70	0.020635	7.00	12.28	8.17	1.01
CussgutterBrook	27	3yr	118.00	222.20	225.35	225.35	226.21	0.019857	7.42	15.89	9.44	1.01
CussgutterBrook	0	Avg Daily	1.10	222.50	222.77	222.77	222.83	0.035228	2.05	0.54	4.08	1.00
CussgutterBrook	0	Avg Spring	2.10	222.50	222.84	222.84	222.93	0.032521	2.35	0.89	5.21	1.00
CussgutterBrook	0	1yr	49.00	222.50	223.74	223.74	224.14	0.020525	5.10	9.61	12.17	1.01
CussgutterBrook	0	2yr	86.00	222.50	224.11	224.11	224.67	0.018808	5.98	14.37	13.17	1.01
CussgutterBrook	0	3yr	118.00	222.50	224.39	224.39	225.05	0.017965	6.55	18.02	13.77	1.01

LakeAve Plan: TempStage2LowFlow  
RS = 347



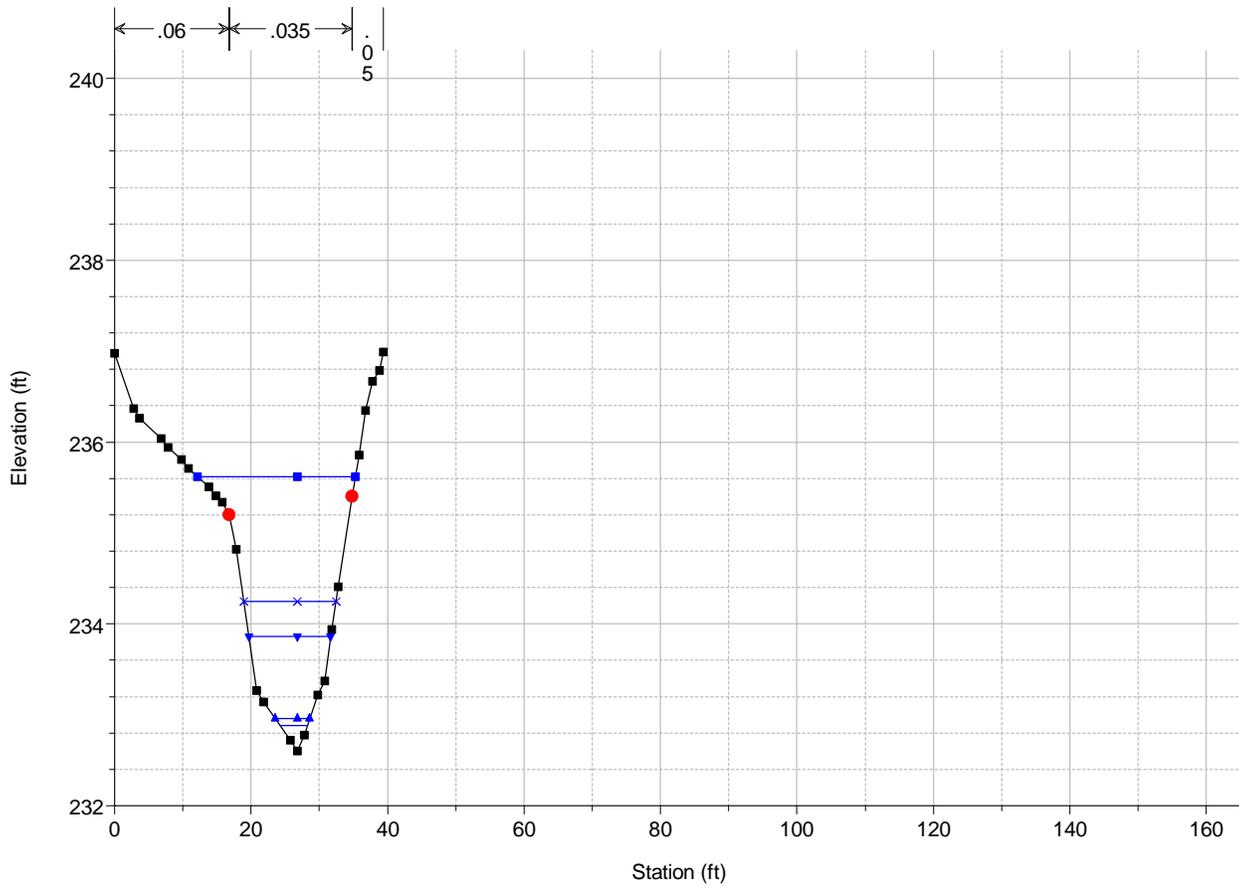
Legend	
■	WS 3yr
×	WS 2yr
▼	WS 1yr
▲	WS Avg Spring
—	WS Avg Daily
■	Ground
●	Bank Sta

LakeAve Plan: TempStage2LowFlow  
RS = 319



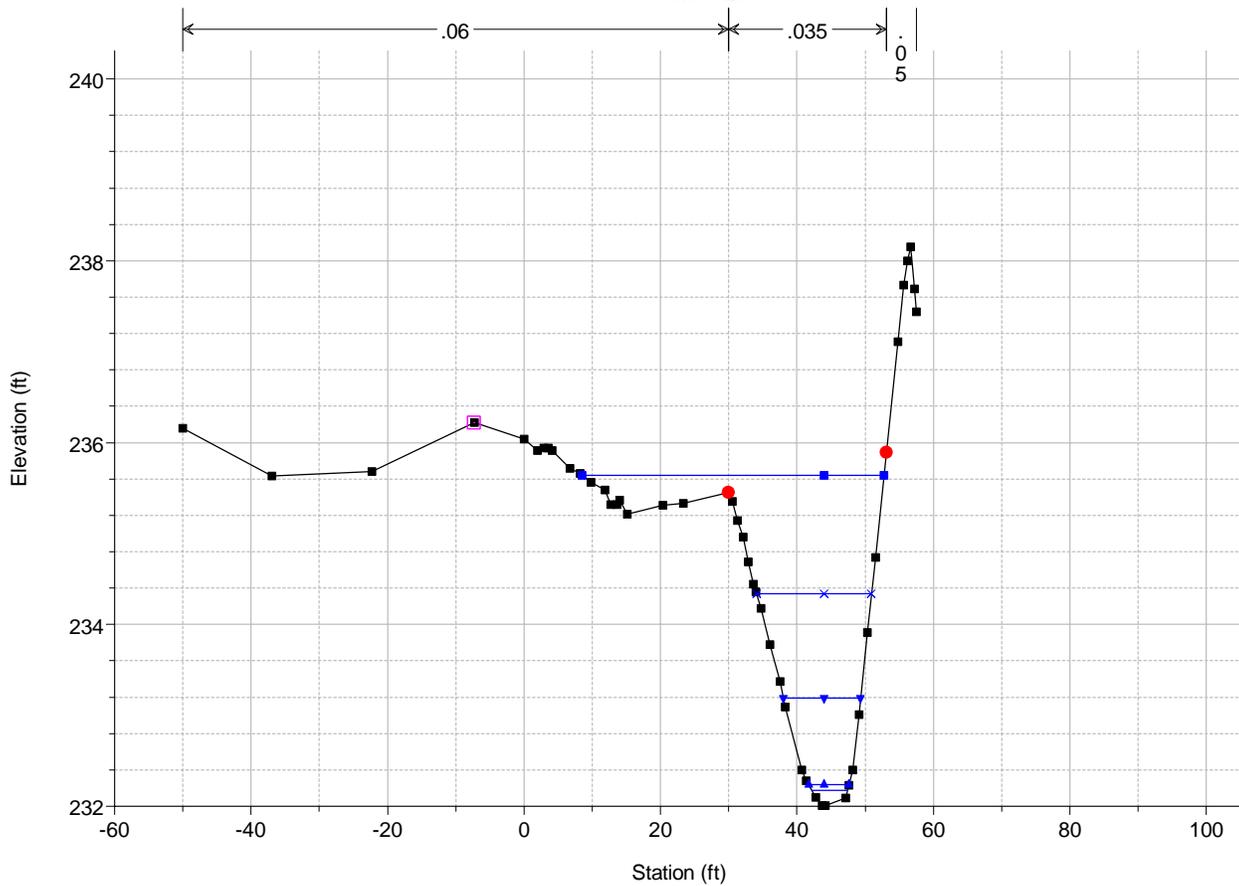
Legend	
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×	WS 2yr
▼	WS 1yr
▲	WS Avg Spring
—	WS Avg Daily
■	Ground
●	Bank Sta

LakeAve Plan: TempStage2LowFlow  
RS = 292



Legend	
■	WS 3yr
×	WS 2yr
▼	WS 1yr
▲	WS Avg Spring
▲	WS Avg Daily
■	Ground
●	Bank Sta

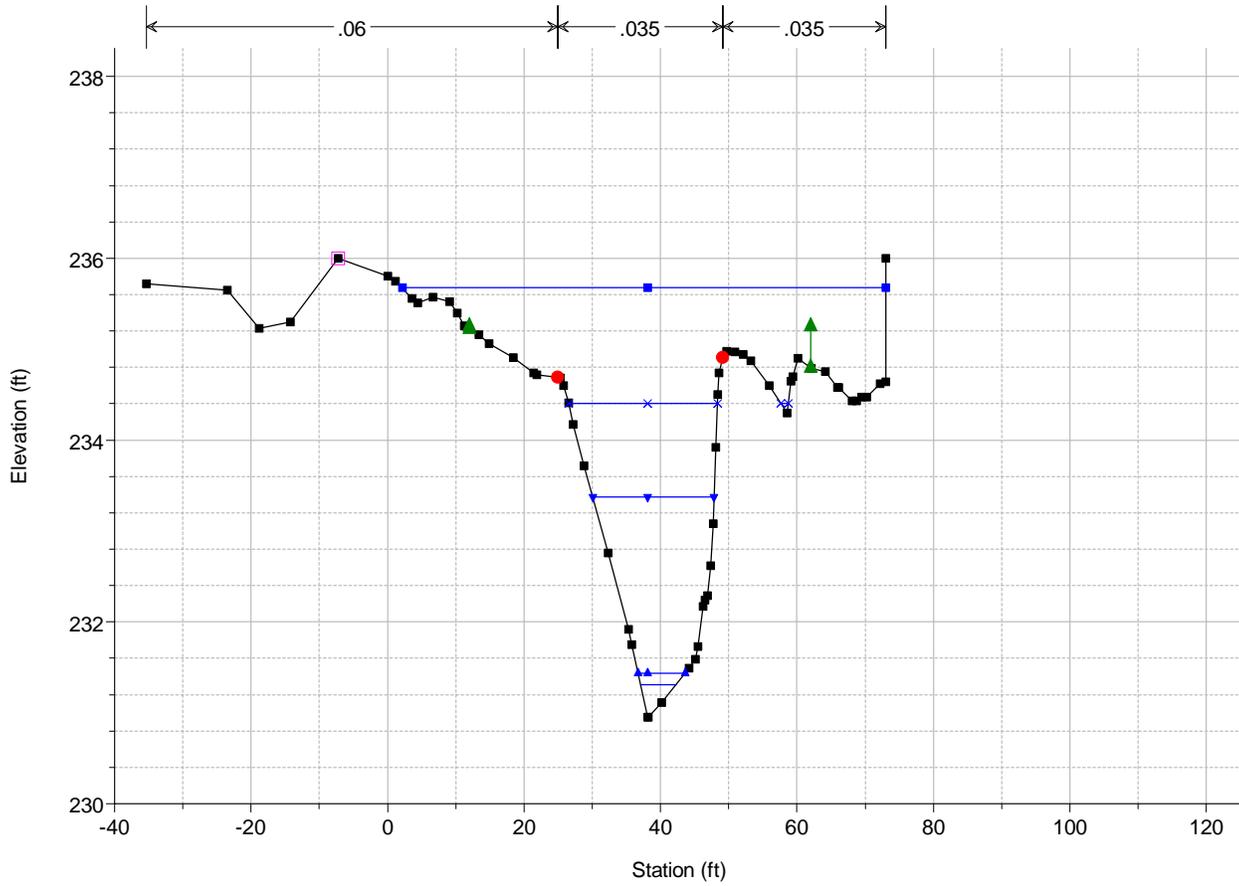
LakeAve Plan: TempStage2LowFlow  
RS = 269



Legend	
■	WS 3yr
×	WS 2yr
▼	WS 1yr
▲	WS Avg Spring
▲	WS Avg Daily
■	Ground
□	Levee
●	Bank Sta

LakeAve Plan: TempStage2LowFlow

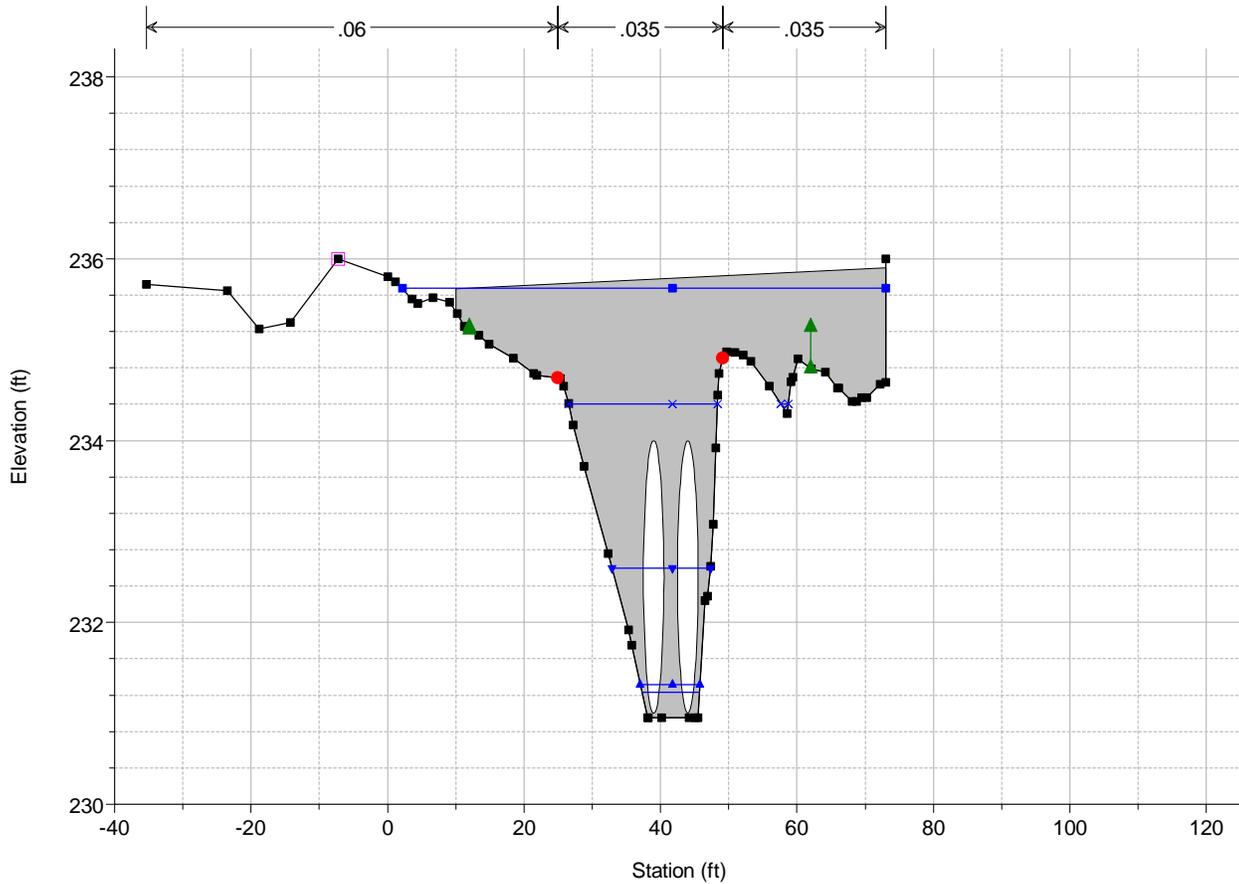
RS = 254



Legend	
■	WS 3yr
×	WS 2yr
▼	WS 1yr
▲	WS Avg Spring
—	WS Avg Daily
■	Ground
□	Levee
▲	Ineff
●	Bank Sta

LakeAve Plan: TempStage2LowFlow

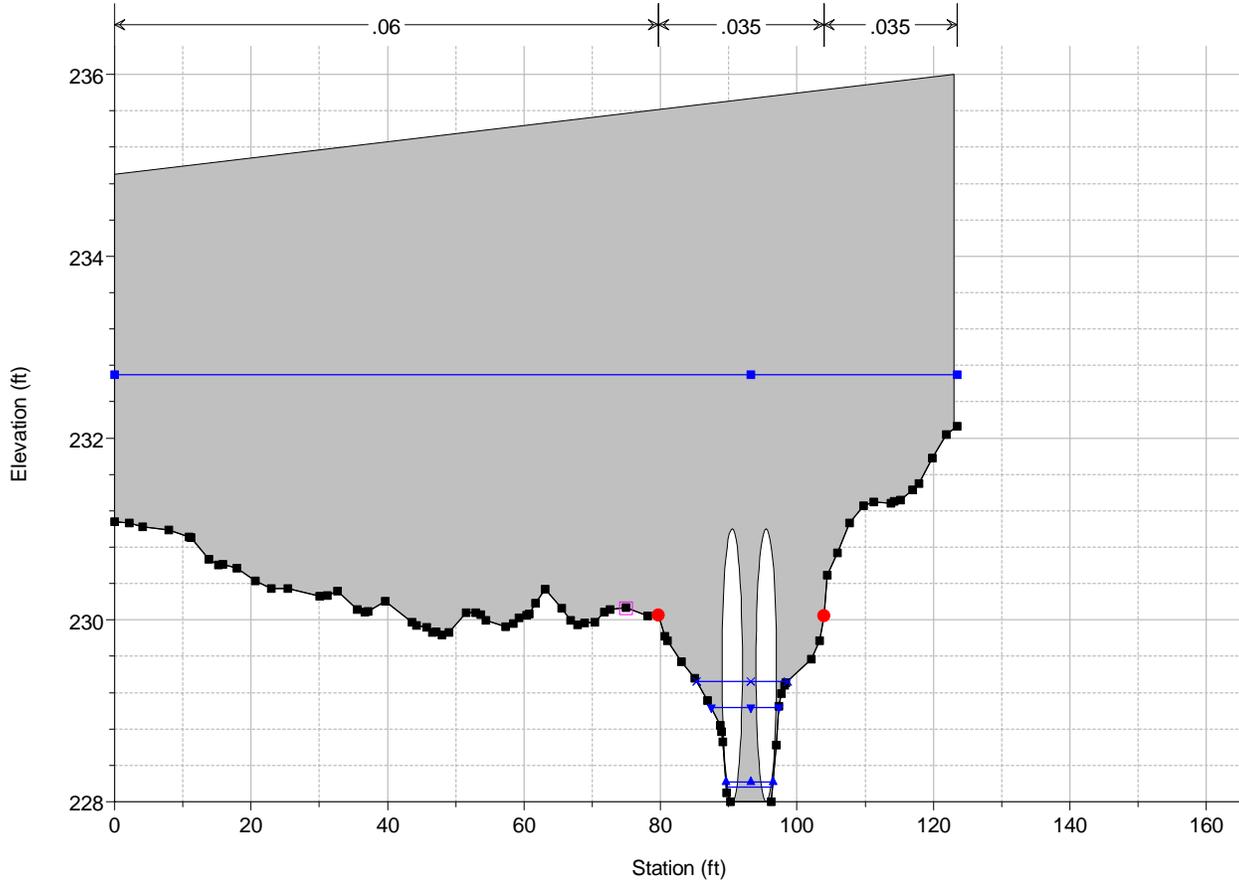
RS = 200 Culv



Legend	
■	WS 3yr
×	WS 2yr
▼	WS 1yr
▲	WS Avg Spring
—	WS Avg Daily
■	Ground
□	Levee
▲	Ineff
●	Bank Sta

LakeAve Plan: TempStage2LowFlow

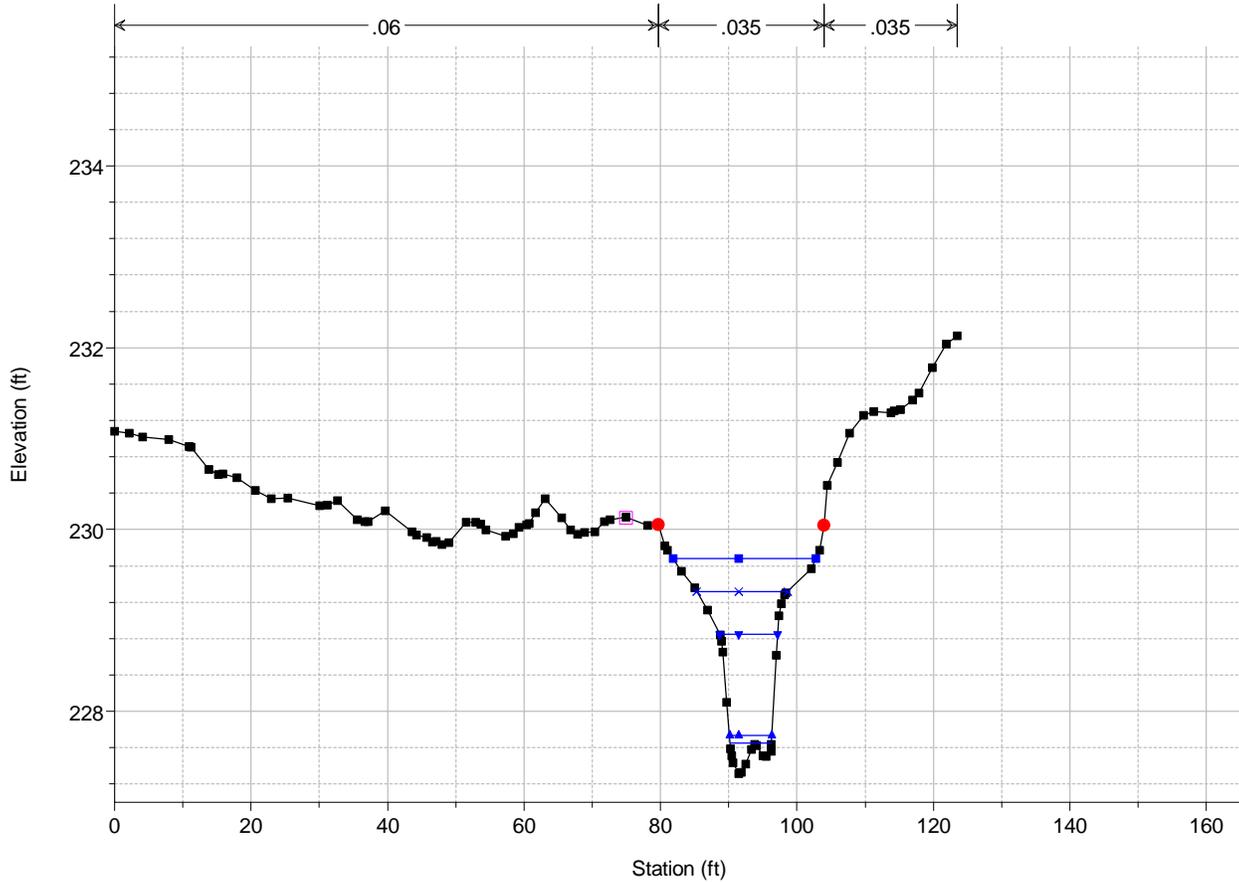
RS = 200 Culv



Legend	
■	WS 3yr
×	WS 2yr
▲	WS 1yr
—	WS Avg Spring
—	WS Avg Daily
■	Ground
□	Levee
●	Bank Sta

LakeAve Plan: TempStage2LowFlow

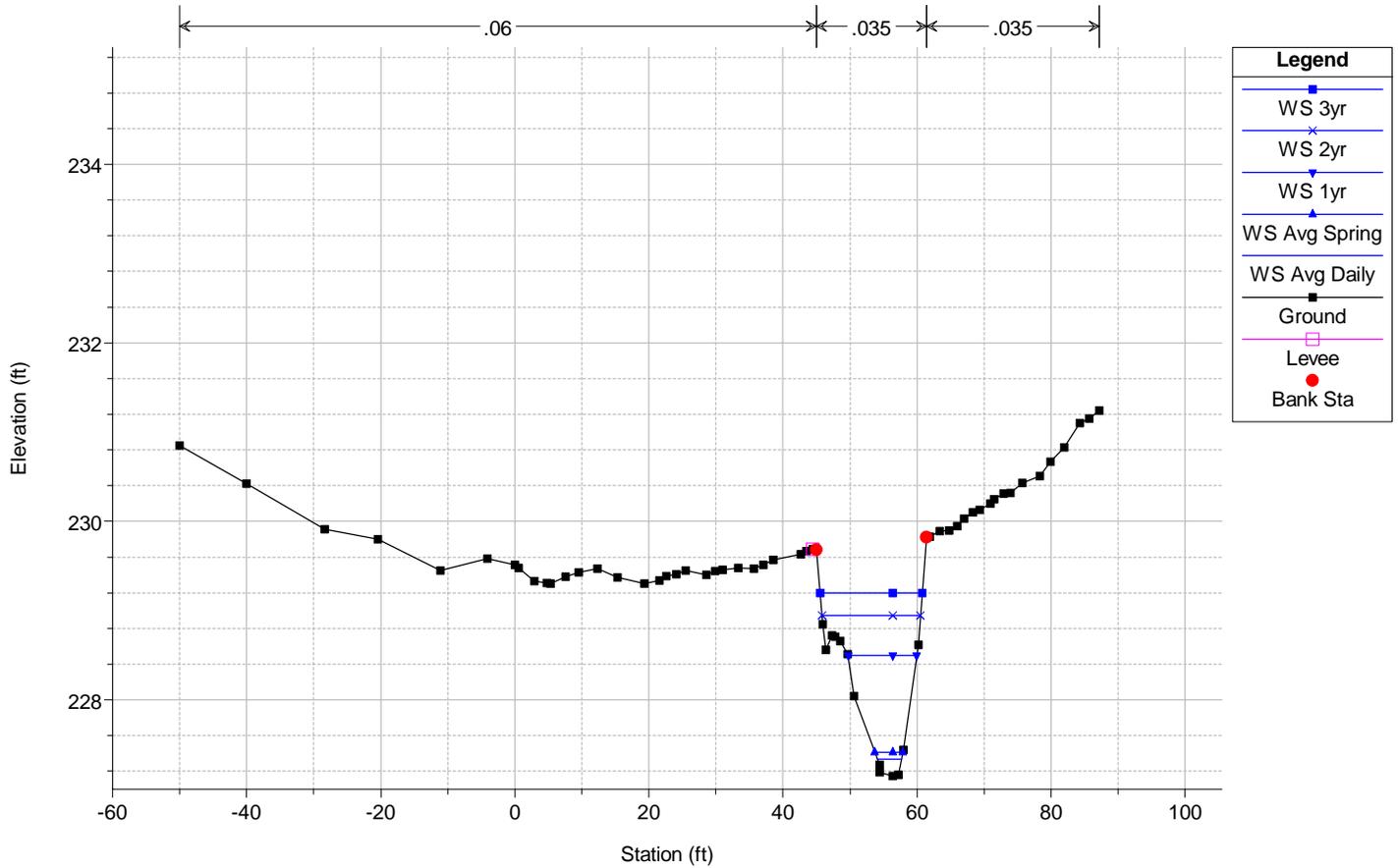
RS = 124



Legend	
■	WS 3yr
×	WS 2yr
▲	WS 1yr
—	WS Avg Spring
—	WS Avg Daily
■	Ground
□	Levee
●	Bank Sta

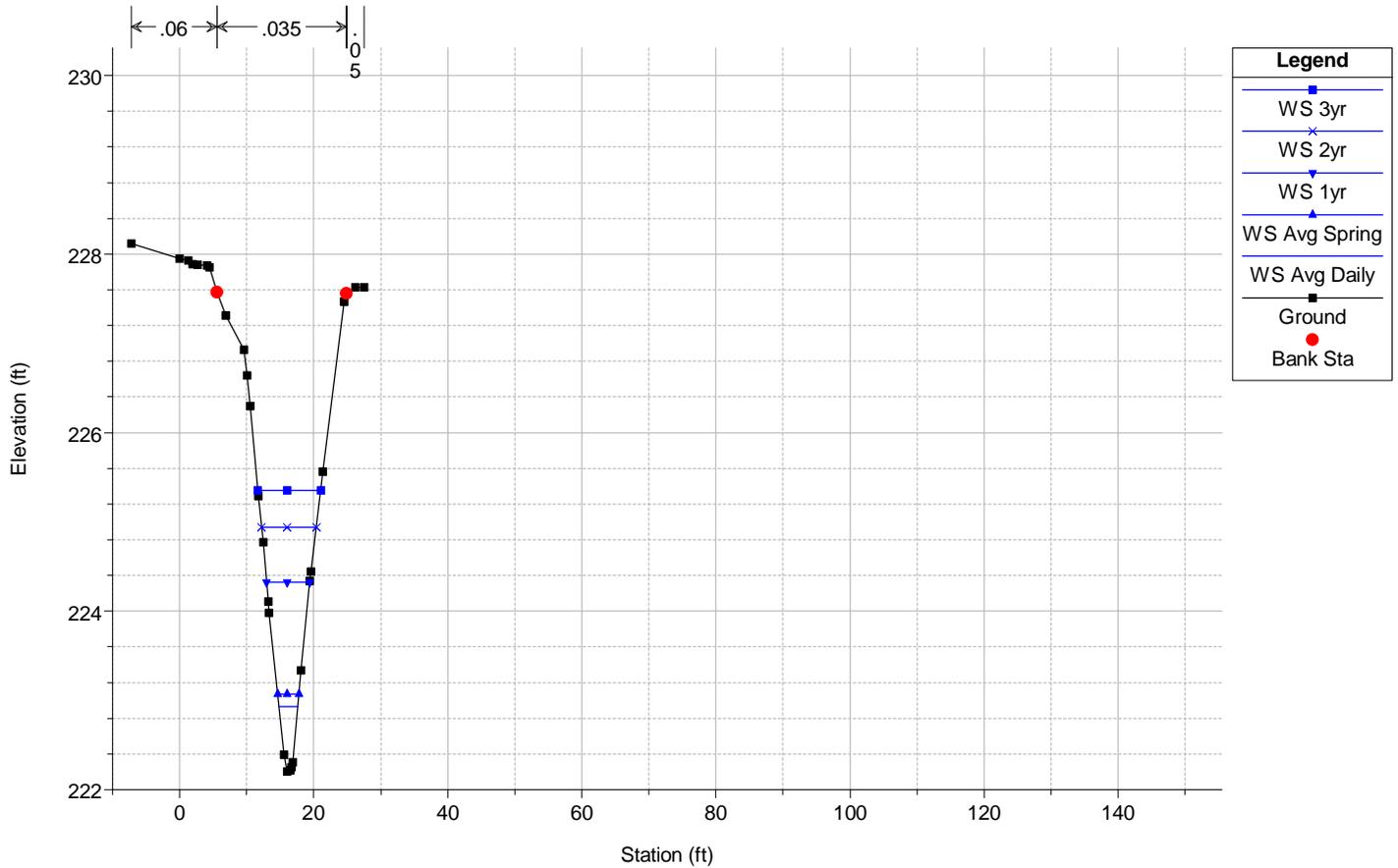
LakeAve Plan: TempStage2LowFlow

RS = 107



LakeAve Plan: TempStage2LowFlow

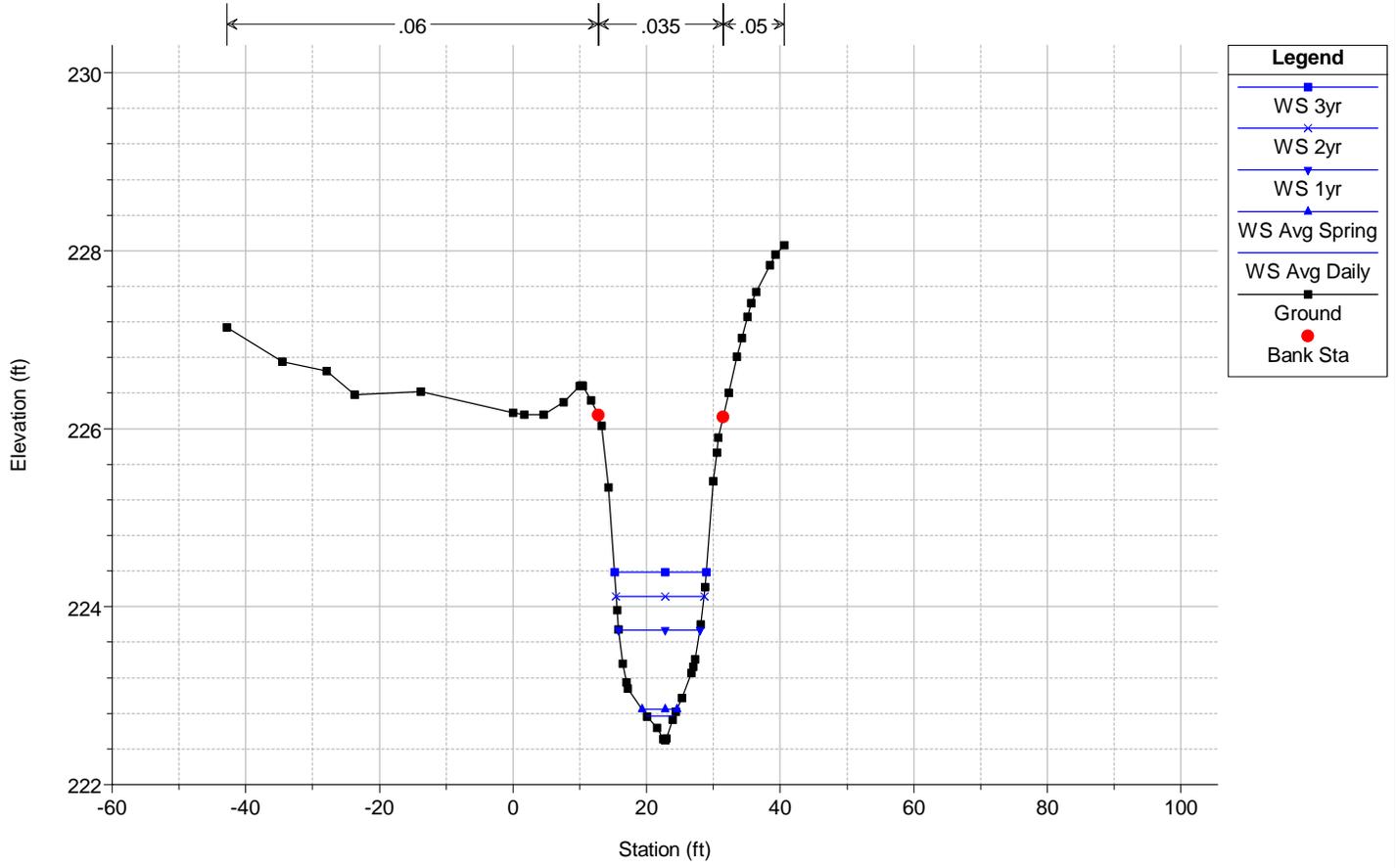
RS = 27



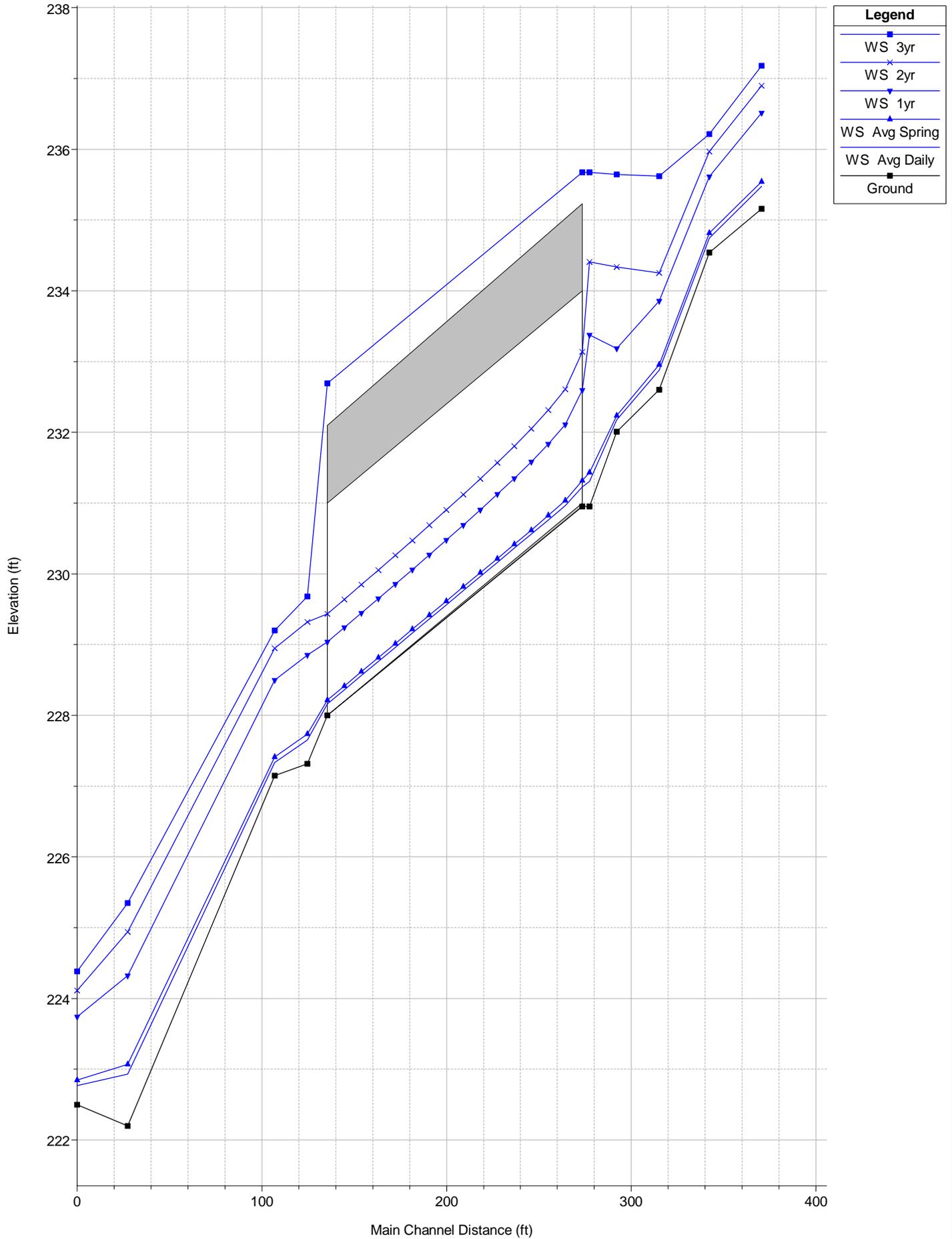
1 in Horiz. = 28 ft 1 in Vert. = 2.1 ft

LakeAve Plan: TempStage2LowFlow

RS = 0



LakeAve Plan: TempStage2LowFlow

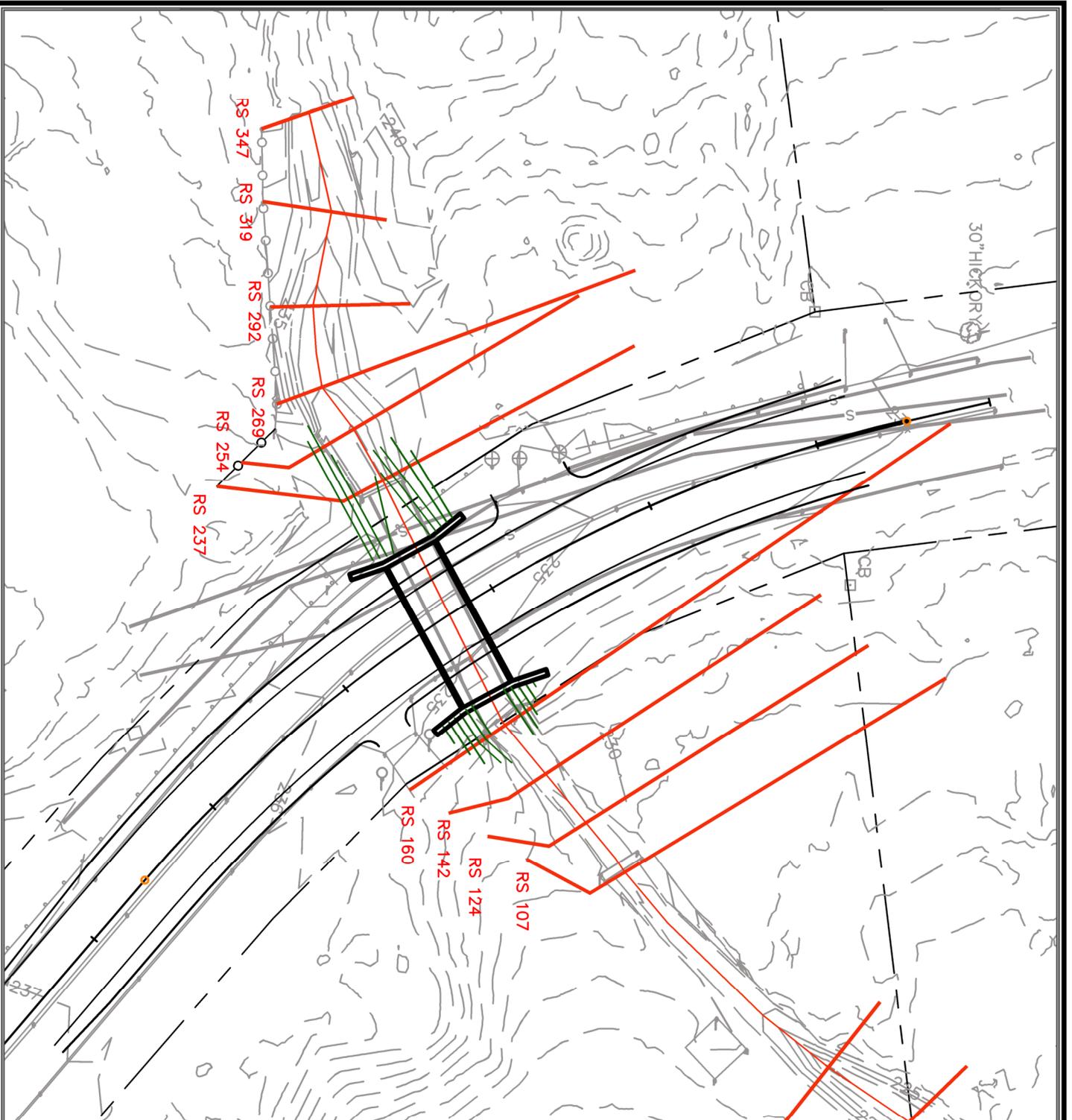


1 in Horiz. = 69 ft 1 in Vert. = 1.8 ft

# APPENDIX

# H CROSS SECTION SITE PLAN





		WSP USA Inc. 1100 Albany Road Albany, NY 12203 518-452-3545	
Drawn By	KLM	Date	APRIL 22, 2021
Surveyed By	-	Scale	1" = 50'
Checked By	-	Job No.	-
Book No.	-	Sheet No.	-

REVISION	DATE	DESCRIPTION

**CROSS SECTION PLAN**  
**LAKE AVENUE CULVERT**  
**BRISTOL, CONNECTICUT**  
 PREPARED FOR  
**CITY OF BRISTOL**