HYDROLOGY AND HYDRAULICS STUDY

FOR YESAIR SOLAR ARRAY, MAINTENANCE ACCESS ROAD

140R MAIN STREET, BYFIELD, MA

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WATERSTONE ENGINEERING
INNOVATIVE STORMWATER MANAGEMENT

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1.0 EXECUTIVE SUMMARY

Waterstone Engineering has conducted a hydrology and hydraulics investigation to evaluate the impact of the proposed wetland restoration for the removal of a cart path and replacement with a full span bridge. This is to support the evaluation of the application for Modification to the Special Permit dated May 16, 2018 for a Ground Mounted Solar Photovoltaic Installations situated at 140R Main Street, Byfield, MA. The Applicant proposes to construct an access road along the existing farm road and remove an existing wetland crossing and replace with a bridge to satisfy National Grid (NGRID) requirement for maintenance access to the interconnection via the solar facility. The road length is 1,037 ft and will be widened from approximately 9 ft to 12 ft with clearing both sides totaling 22 ft wide (5 ft on either side). An existing 135 ft cart path across the wetland and perennial stream will be removed restoring 1,485 sf of wetland (Figure 1). This includes the removal of an estimated 4,500 cf of wetland fill. The existing cart path will be removed and replaced with a 12 ft wide 150 ft span truss bridge to eliminate wetland impacts making the project a net plus for wetlands (see Figure 2, Figure 3).

To accomplish this, a hydrology and hydraulics analysis was conducted to examine any changes in water surface elevations or velocity that might be concerning and indicate potential flooding or erosion as a result, and to demonstrate the project will not cause adverse impacts to downstream properties, infrastructure, and aquatic habitat.

The hydrology and hydraulics analysis demonstrates that there is essentially no change in the flow regime for the 2, 5, 10, 25, 50, and 100-Yr storms. This because the existing cart path is only 2+ feet above the water surface elevation and relatively low within the valley (Figure 4, Figure 5), such that flood flows overtop the cart path, and because Interstate 95 is a downstream controlling element. The interstate crosses the wetland 450 feet downstream from the cart path, and has 2 x 36" diameter concrete barrel culverts as outlets (Figure 6). The 2 culverts are controlling the release of the water from this wetland system.

2.0 SITE DESCRIPTION

The project site consists of two parcels of land owned by the Yesair family (Karen E. Yesair Thiel and Kavy N. Yesair, Successor Trustees of the Ruth A. Yesair Trust) totaling approximately 85 acres). The two parcels are identified as R41-42A, 2.907 acres at 136 Main Street, and R41-42, 82.185 acres at 140R Main Street. The primary 85-acre parcel contains about 72 acres of wetlands and critical upland habitat protected by a Conservation Restriction, and a solar facility lease area, and utility and access easements. The parcels consist of a variety of habitat types including forested areas, critical upland habitat, wetlands, hay fields, numerous foot and cart paths. The front portion of the site is developed and consists of a single residence with associated driveways, and landscaped/manicured areas. Interstate Route 95 borders the site to the east and undeveloped forested areas are located to the north that are protected and managed by Greenbelt Land Trust. North Main Street and residences are located to the west of the site and a utility easement/right-of-way (ROW) is to the south.

The proposed project is the final NGRID requirement to complete the interconnection of the 2.795 MW ground-mounted solar facility by providing a maintenance access road to the electric utility transmission corridor through the customer facility. The proposed work would occur by upgrading an existing cart path through the eastern portion of the facility, through the forested wetlands and uplands, and across the large wetland system at the location of the existing cattle crossing, to the point of interconnection within the NGRID transmission corridor. The road length is 1,037 ft and will be widened from approximately 9 ft to 12 ft with clearing both sides totaling 22 ft wide (5 ft on either side).

The existing cart path will be removed and replaced with a 12 ft wide 150 ft span truss bridge with open pervious decking to eliminate wetland impacts making the project a net plus for wetlands. The bridge capacity is H-20 loading with a maximum capacity of 40,000 lbs, 20 tons.

A 20-ft bar gate with signage will control access to the site at the transmission corridor. Traffic usage will be almost zero with annual usage of the roadway expected for inspection and maintenance activities. The maintenance access road will otherwise remain unused with the rare exception of maintenance access.

The site is located along an unnamed brook that is crossed by Interstate 95. Based on the Stream Stats Report (USGS 2022) the contributing watershed drainage area is 0.83 square miles. The mean basin elevation is 77.7 feet with a calculated estimated watershed slope of 4.4%. There is 69.86% of the area covered by forest and 19.74% covered by waterbodies and wetlands. Peak flow statistics for the unnamed brook are listed in Table 1.

Table 1: Watershed Peak Flow Statistics for Unnamed Brook (USGS, Stream Stats, 2022)

Year Storm	% Recurrence	Peak Flow (cfs)
100	1%	97.3
50	2%	82
25	4%	67.6
10	10%	50.1
5	20%	37.9
2	50%	22.7

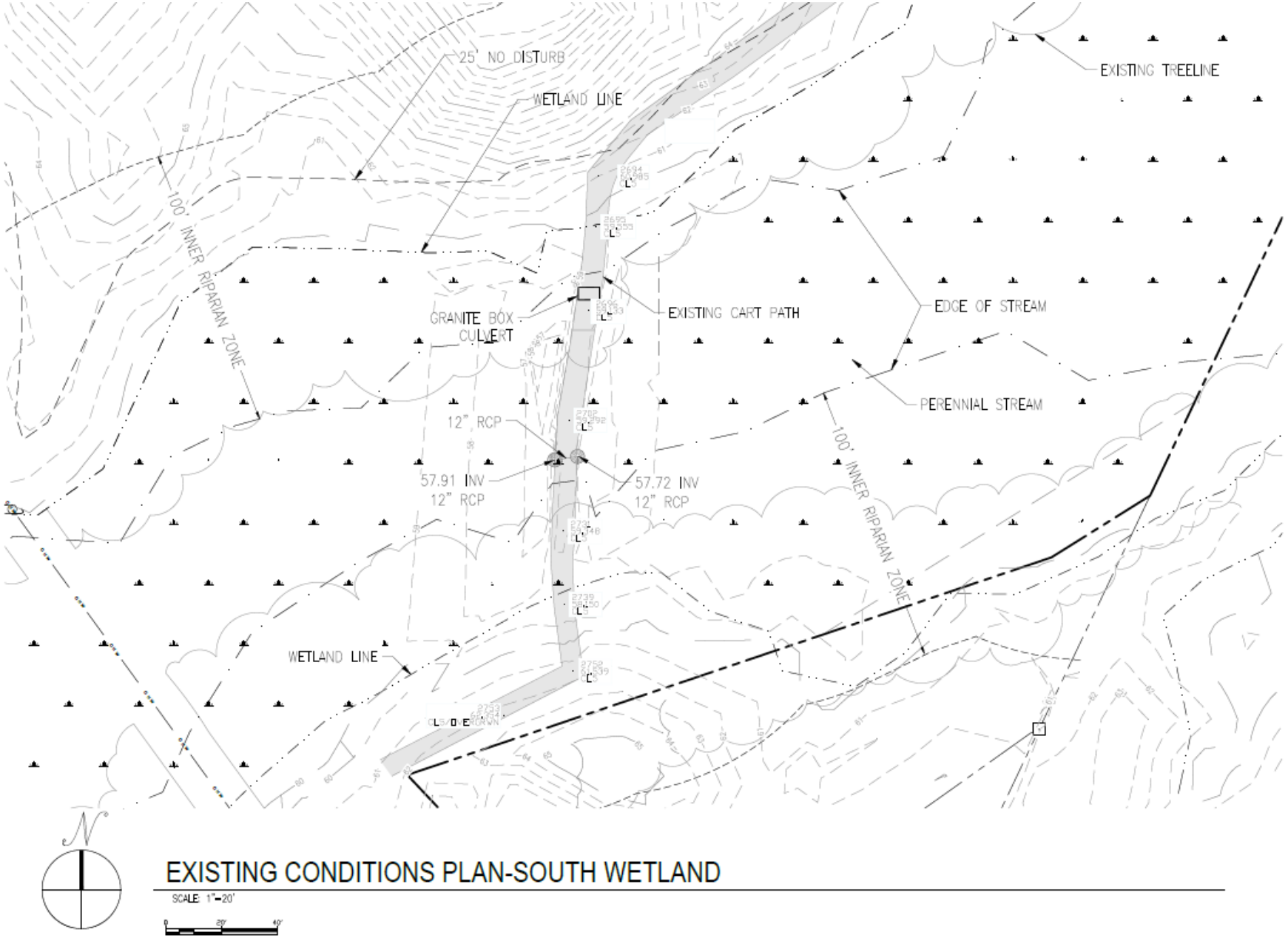


Figure 1: Existing Conditions Watershed Plan

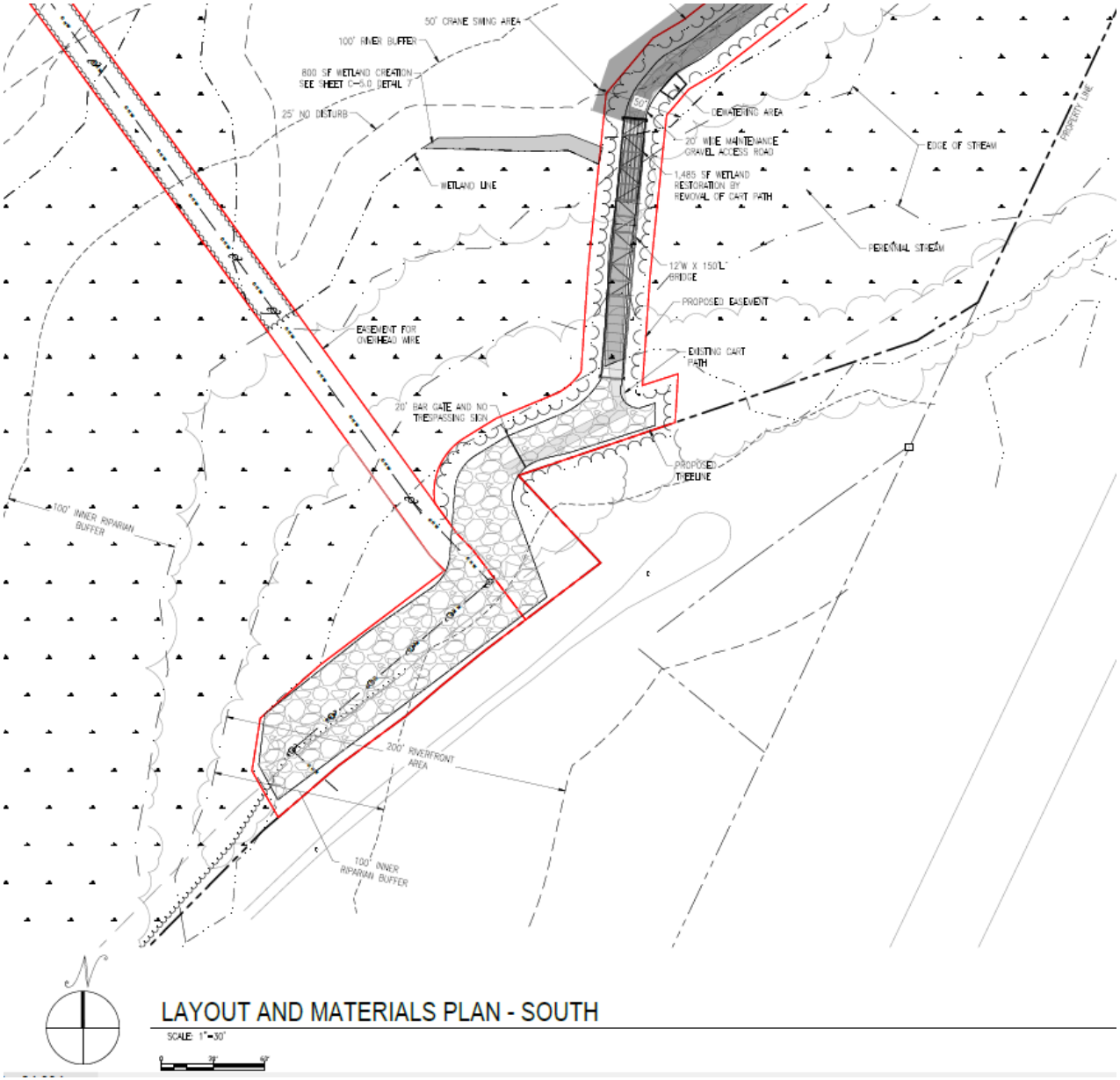


Figure 2: Proposed Conditions Watershed Plan

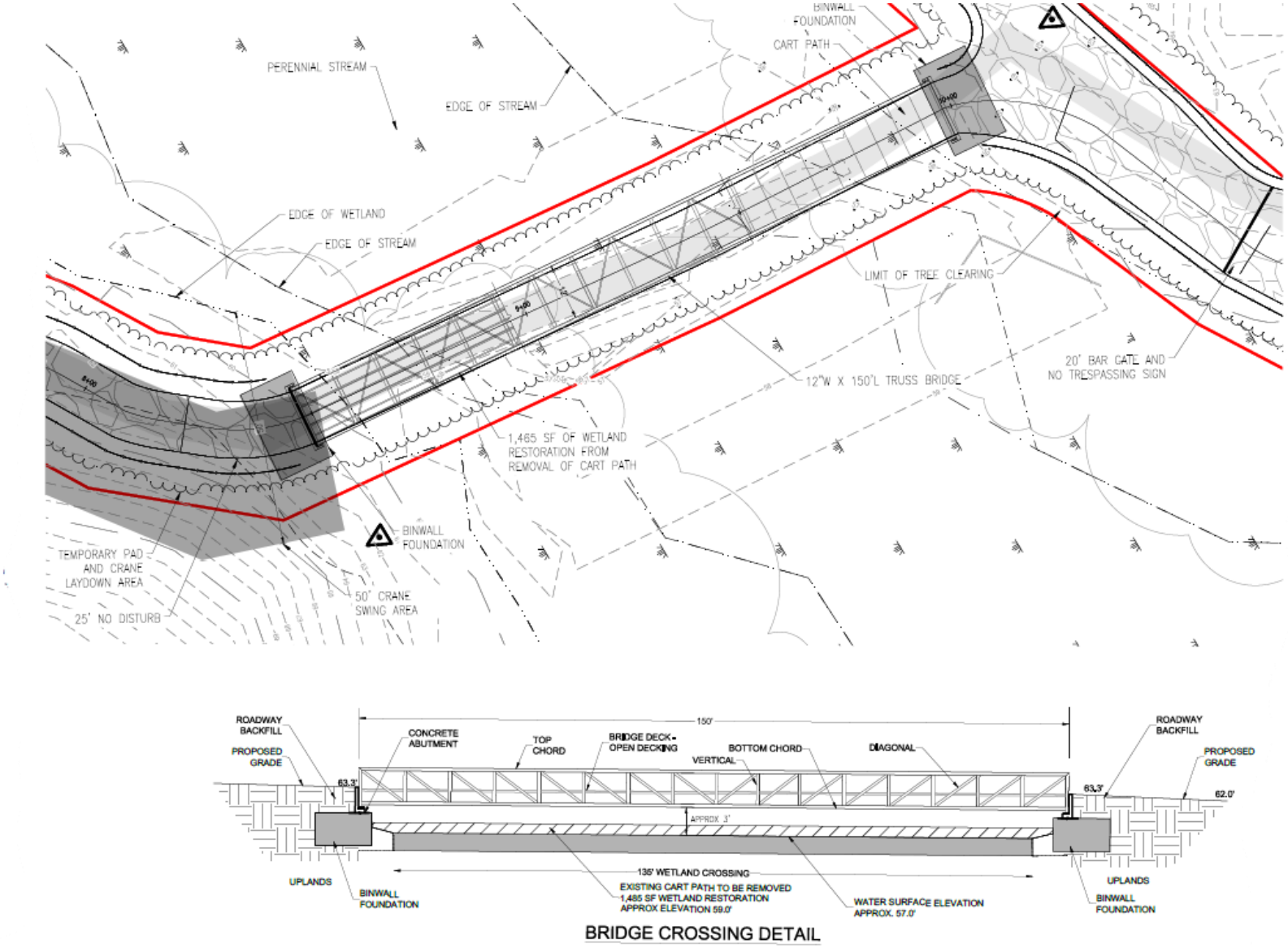


Figure 3: Wetland Crossing and Bridge Plan and Detail

Figure 4: View looking south of cart path at stream bank at wetland crossing #2, location of wetland restoration and proposed bridge, road station 8+50

Figure 5: View of cart path looking north at wetland crossing, location of wetland restoration and proposed bridge, road station 10+00

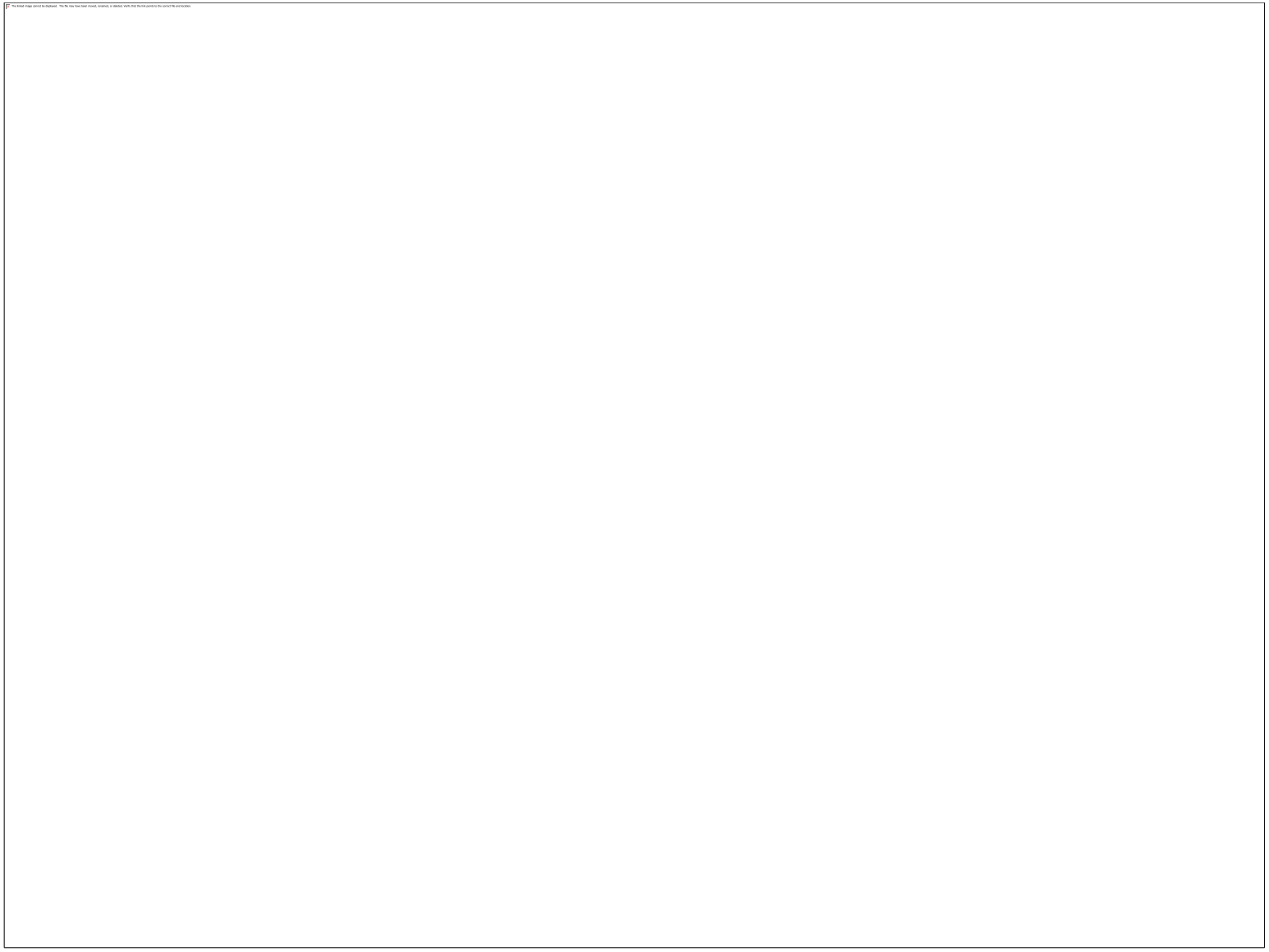


Figure 6: View of the Interstate 95 Culverts: 2x 36" Concrete Barrels

3.0 HYDROLOGIC AND HYDRAULICS MODEL

Floodplain Hydraulics: A one-dimension hydraulic surface water model was developed using GeoHECRAS version 4.0.0.1852, a proprietary software by CivilGeo. GeoHECRAS is built upon the Army Corps HEC-RAS model version 6.2. HEC-RAS is a river analysis model that enables the evaluation of channel hydraulics. HEC-RAS will compute water surface profiles for steady and unsteady flow models, bridge and culvert roadway crossings, FEMA floodplain encroachments, stream restorations, inline reservoir structures, and off-channel storage areas. The Hydrologic Engineering Center's (HEC) River Analysis System (HEC-RAS) software allows you to perform one-dimensional steady and 1D and 2D unsteady flow river hydraulics calculations. HEC-RAS is an integrated system of software designed for interactive use in a multi-tasking, multi-user network environment. The system is comprised of a graphical user interface, separate hydraulic analysis components, data storage and management capabilities, graphics and reporting facilities. The GeoHECRAS summary output is listed in Appendix A and the complete model report for the proposed project can be found in Appendix B.

The HEC-RAS system contains four hydraulic analysis components for: (1) steady flow water surface profile computations; (2) One and two-dimensional unsteady flow simulations; (3) movable boundary sediment transport computations; and (4) water temperature and constituent transport modeling. A key element is that all four components use a common geometric data representation and common geometric and hydraulic computations routines. In addition to the four hydraulic analysis components, the system contains several hydraulic design features that can be invoked once the basic water surface profiles are computed.

The surface water model enables the assessment of:

- Water surface elevations and flow velocities at surveyed cross-sections,
- Evaluate the impact from changes in site hydrology upon the downstream section,
- Predict the effects of the proposed development hydrology for the various design events 2, 5, 10, 25, 50, and 100-YR Storms,
- Assess the potential effects upon neighboring parcels.

Watershed Hydrology: Watershed hydrology was developed using the USGS Stream Stats web application. StreamStats provides access to spatial analytical tools that are useful for water-resources planning and management, and for engineering and design purposes. The map-based user interface is used to delineate drainage areas, get basin characteristics and estimates of flow statistics, and more. StreamStats provides access to an assortment of Geographic Information Systems (GIS) analytical tools that are useful for water-resources planning and management, and for engineering and design purposes. Peak flow estimation is based on a USGS method for flood discharges of streams in NH (Olson, 2008). The StreamStats Report for the unnamed brook watershed can be found in Appendix C.

3.1 Model Construction

Two (2) surface water model scenarios were built representing 1) pre-existing conditions with the cart path, and 2) post-development conditions without the cart path and with the addition of the bridge. 19 model cross-sections were generated every 200' feet along the stream reach and are shown in Figure 8.

Site Topography: Site topography was based on both a combination of field site survey and the use of LIDAR imagery for the coastal region. LIDAR topography was used for areas of the site that were not covered by field survey including the larger watershed basin topography. Site survey did include roads, culverts, and wetland resource delineation. Bridge geometry for the model is a simplified (conservative) representation of the bridge. The bridge is an open truss bridge that is designed for periodic exposure to flood flows. The model

representation of the bridge is a closed bridge and does not consider the openings with the bridge truss. It does include the area below the truss.

4.0 STUDY RESULTS

The HEC-RAS modeled surface water hydrology and hydraulics demonstrates that the reduced peak flows result in lowered water surface elevations and floodwater extent along the unnamed brook at the location of the cart path and upstream of Interstate 95. Table 3 lists the HEC-RAS summary output data for the cross-sections of interest. Waters surface elevations and flow velocity are listed are listed for the 2, 5, 10, 25, 50, and 100-Yr storms with pre- and post- development construction topography. Water surface elevation are listed (column 6) and show **no** changes in water surface elevations (column 7) and no changes in flow velocity (column 9). This is best understood by looking at Figure 10 and Figure 11 which clearly demonstrate how Interstate 95 and the 2 x 36" diameter culverts are restricting flow and are the controlling features for this wetland system. In fact, it is likely that this wetland system would be far smaller without the interstate and with the free flow of the stream.

Flow velocities were examined pre and post conditions and are all well below erosive velocities of approximately 15 centimeters per second (cms) after which erosion becomes a concern. Table 2 lists the flow velocities at the bridge and it can be seen that they do not exceed 5 cms. Figure 7 is a particle stability diagram which is used for determining whether concerns may exist for flow velocity due to changes in hydraulics. The minimum erosive velocity tends to about 15 cms for a sand sized particle.

Table 2: Flow Velocities by Storm Size at the Bridge – No Change from Pre to Post Condition

Column1	Vel (fps)	Vel (cms)
100-Yr	0.14	4.3
50-Yr	0.14	4.3
25-Yr	0.13	4.0
10-Yr	0.11	3.4
5-Yr	0.09	2.7
2-Yr	0.06	1.8

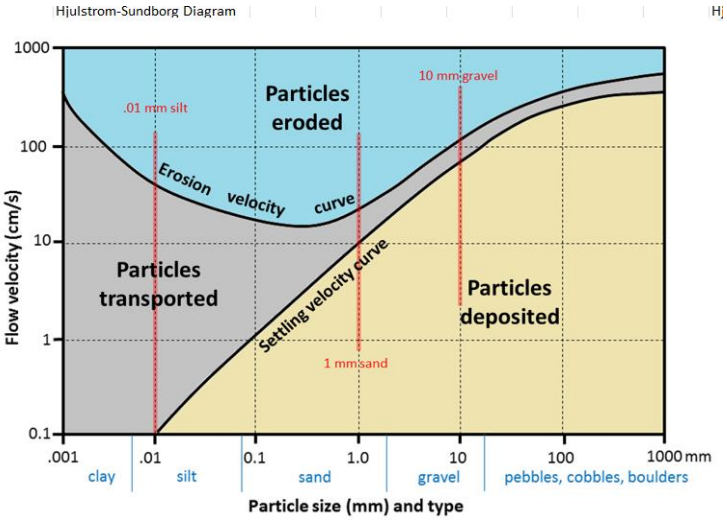


Figure 7: Particle Stability Diagram by Hjultrom and Sundborg

Similarly, the extent of the floodplain can be observed for the 100-Yr storm for both conditions in Figure 12 and Figure 13. There is no difference in the floodplains because of lack of changes due to cart path removal.

Lastly, the flood depths do intersect the proposed bridge. Figure 16 lists the flood elevations, the bridge elevations, and plots the lines over the bridge detail. However, it is worthy of note that the bridge is nearly at the same elevation as the interstate (elevation 64' versus elevation 63.3') and is intended only for rare usage. The bridge manufacturer states the bridge is designed for periodic inundation and is commonly used for this type of application. Lastly, there is no concern about erosion and the bridge abutments and flood waters. The velocity under the bridge will be very low as the bridge opening span is 150'. As mentioned previously flow velocities are not erosive and will rather transport and deposit materials rather than erode them. This is consistent with the observation of the wetland location and the backwater accumulation.

Table 3: HEC-RAS Results Summary Output

River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	ΔWSEL	Vel Chnl	ΔVel
Units			(cfs)	(ft)	(ft)	(ft)	(ft/s)	(ft/s)
1004	100-Yr	I-95 Alt Outlet	97.3	59	63.79	0.00	0.13	0.00
1004	100-Yr	No Cart Path	97.3	59	63.79		0.13	
1004	50-Yr	I-95 Alt Outlet	82	59	63.03	0.00	0.13	0.00
1004	50-Yr	No Cart Path	82	59	63.03		0.13	
1004	25-Yr	I-95 Alt Outlet	67.6	59	62.46	0.00	0.13	0.00
1004	25-Yr	No Cart Path	67.6	59	62.46		0.13	
1004	10-Yr	I-95 Alt Outlet	50.1	59	61.88	0.00	0.12	0.00
1004	10-Yr	No Cart Path	50.1	59	61.88		0.12	
1004	5-Yr	I-95 Alt Outlet	37.9	59	61.48	0.00	0.11	0.00
1004	5-Yr	No Cart Path	37.9	59	61.48		0.11	
1004	2-Yr	I-95 Alt Outlet	22.7	59	60.92	0.00	0.09	0.00
1004	2-Yr	No Cart Path	22.7	59	60.92		0.09	
1003.4	100-Yr	I-95 Alt Outlet	97.3	57	63.79	0.00	0.14	0.00
1003.4	100-Yr	No Cart Path	97.3	57	63.79		0.14	
1003.4	50-Yr	I-95 Alt Outlet	82	57	63.03	0.00	0.14	0.00
1003.4	50-Yr	No Cart Path	82	57	63.03		0.14	
1003.4	25-Yr	I-95 Alt Outlet	67.6	57	62.46	0.00	0.13	0.00
1003.4	25-Yr	No Cart Path	67.6	57	62.46		0.13	
1003.4	10-Yr	I-95 Alt Outlet	50.1	57	61.88	0.00	0.11	0.00
1003.4	10-Yr	No Cart Path	50.1	57	61.88		0.11	
1003.4	5-Yr	I-95 Alt Outlet	37.9	57	61.48	0.00	0.09	0.00
1003.4	5-Yr	No Cart Path	37.9	57	61.48		0.09	
1003.4	2-Yr	I-95 Alt Outlet	22.7	57	60.92	0.00	0.06	0.00
1003.4	2-Yr	No Cart Path	22.7	57	60.92		0.06	
1003.3	CART PATH		Culvert					
1003	100-Yr	I-95 Alt Outlet	97.3	59	63.79	0.00	0.14	0.00
1003	100-Yr	No Cart Path	97.3	59	63.79		0.14	
1003	50-Yr	I-95 Alt Outlet	82	59	63.03	0.00	0.15	0.00
1003	50-Yr	No Cart Path	82	59	63.03		0.15	
1003	25-Yr	I-95 Alt Outlet	67.6	59	62.46	0.00	0.15	0.00
1003	25-Yr	No Cart Path	67.6	59	62.46		0.15	
1003	10-Yr	I-95 Alt Outlet	50.1	59	61.88	0.00	0.14	0.00
1003	10-Yr	No Cart Path	50.1	59	61.88		0.14	
1003	5-Yr	I-95 Alt Outlet	37.9	59	61.48	0.00	0.13	0.00
1003	5-Yr	No Cart Path	37.9	59	61.48		0.13	
1003	2-Yr	I-95 Alt Outlet	22.7	59	60.92	0.00	0.11	0.00
1003	2-Yr	No Cart Path	22.7	59	60.92		0.11	
1002	100-Yr	I-95 Alt Outlet	97.3	59	63.79	0.00	0.25	0.00
1002	100-Yr	No Cart Path	97.3	59	63.79		0.25	
1002	50-Yr	I-95 Alt Outlet	82	59	63.03	0.00	0.26	0.00
1002	50-Yr	No Cart Path	82	59	63.03		0.26	
1002	25-Yr	I-95 Alt Outlet	67.6	59	62.46	0.00	0.25	0.00

1002		25-Yr	No Cart Path	67.6	59	62.46		0.25	
1002		10-Yr	I-95 Alt Outlet	50.1	59	61.88	0.00	0.22	0.00
1002		10-Yr	No Cart Path	50.1	59	61.88		0.22	
1002		5-Yr	I-95 Alt Outlet	37.9	59	61.48	0.00	0.2	0.00
1002		5-Yr	No Cart Path	37.9	59	61.48		0.2	
1002		2-Yr	I-95 Alt Outlet	22.7	59	60.92	0.00	0.16	0.00
1002		2-Yr	No Cart Path	22.7	59	60.92		0.16	
1001	I-95	100-Yr	I-95 Alt Outlet	97.3	59	63.79	0.00	0.12	0.00
1001	I-95	100-Yr	No Cart Path	97.3	59	63.79		0.12	
1001	I-95	50-Yr	I-95 Alt Outlet	82	59	63.03	0.00	0.12	0.00
1001	I-95	50-Yr	No Cart Path	82	59	63.03		0.12	
1001	I-95	25-Yr	I-95 Alt Outlet	67.6	59	62.46	0.00	0.12	0.00
1001	I-95	25-Yr	No Cart Path	67.6	59	62.46		0.12	
1001	I-95	10-Yr	I-95 Alt Outlet	50.1	59	61.88	0.00	0.11	0.00
1001	I-95	10-Yr	No Cart Path	50.1	59	61.88		0.11	
1001	I-95	5-Yr	I-95 Alt Outlet	37.9	59	61.48	0.00	0.11	0.00
1001	I-95	5-Yr	No Cart Path	37.9	59	61.48		0.11	
1001	I-95	2-Yr	I-95 Alt Outlet	22.7	59	60.92	0.00	0.09	0.00
1001	I-95	2-Yr	No Cart Path	22.7	59	60.92		0.09	

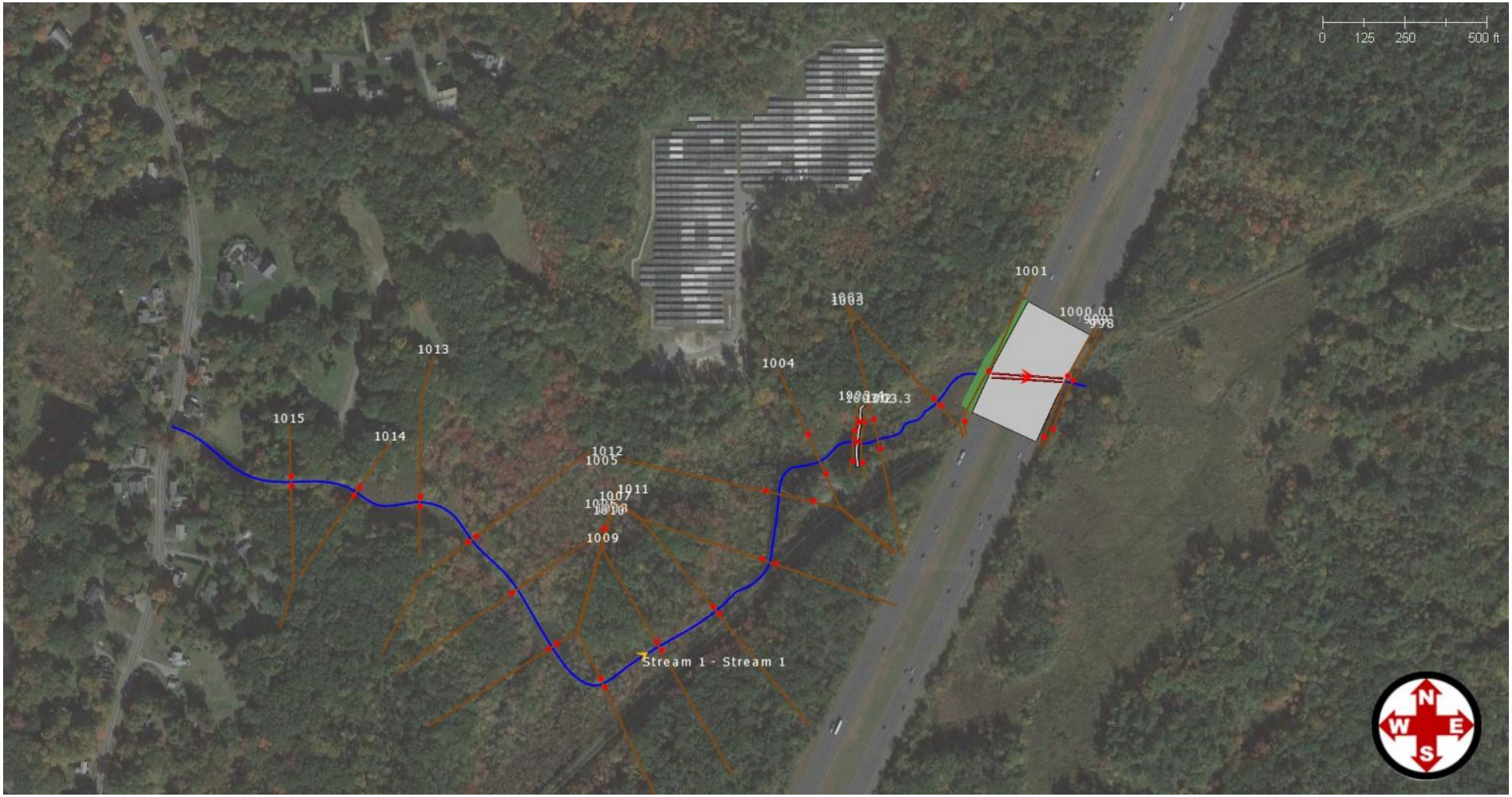


Figure 8: Model Study Area with Cross-Sections

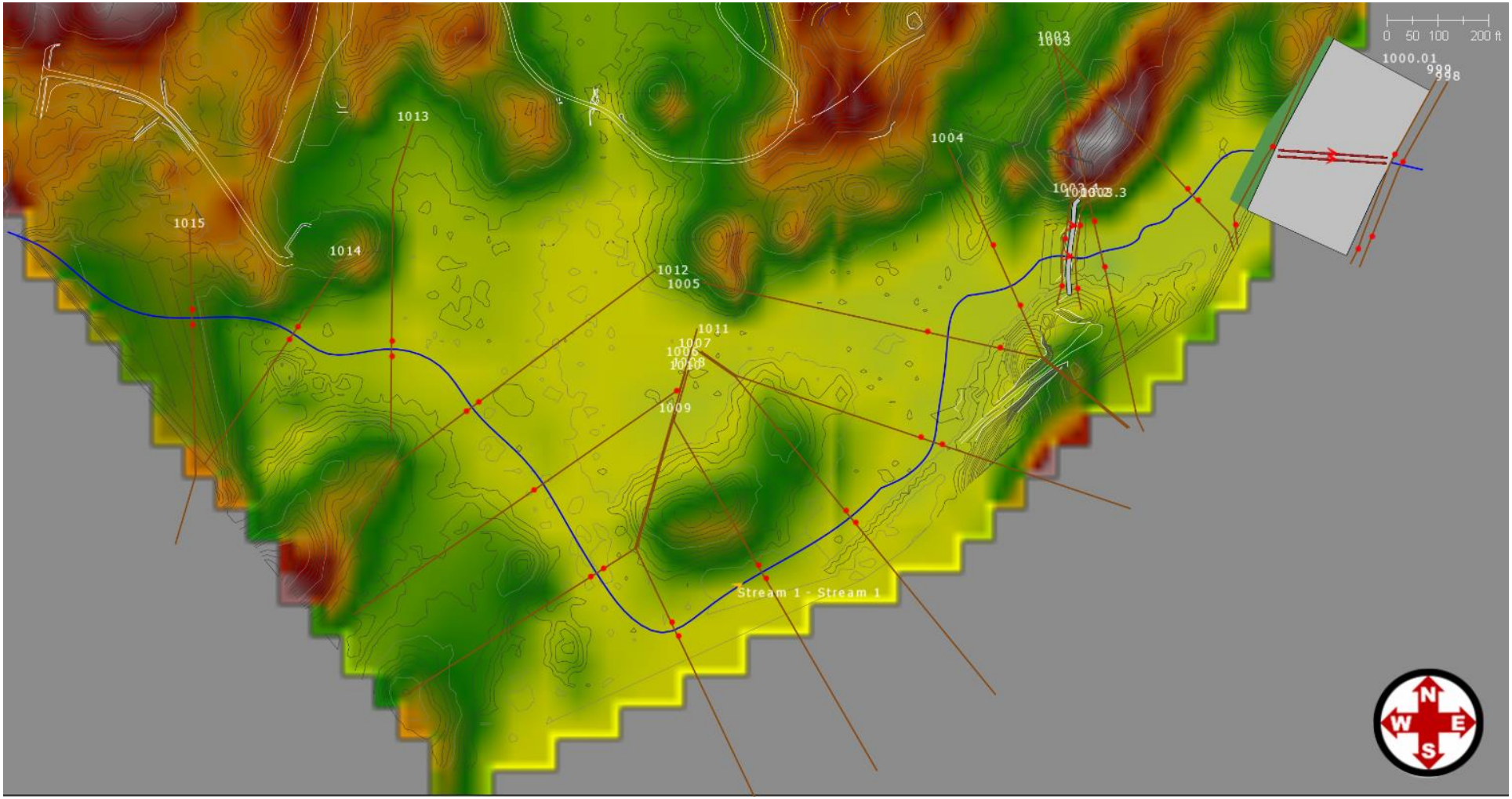


Figure 9: Model Study Area Topography, Cart Path, and Interstate 95

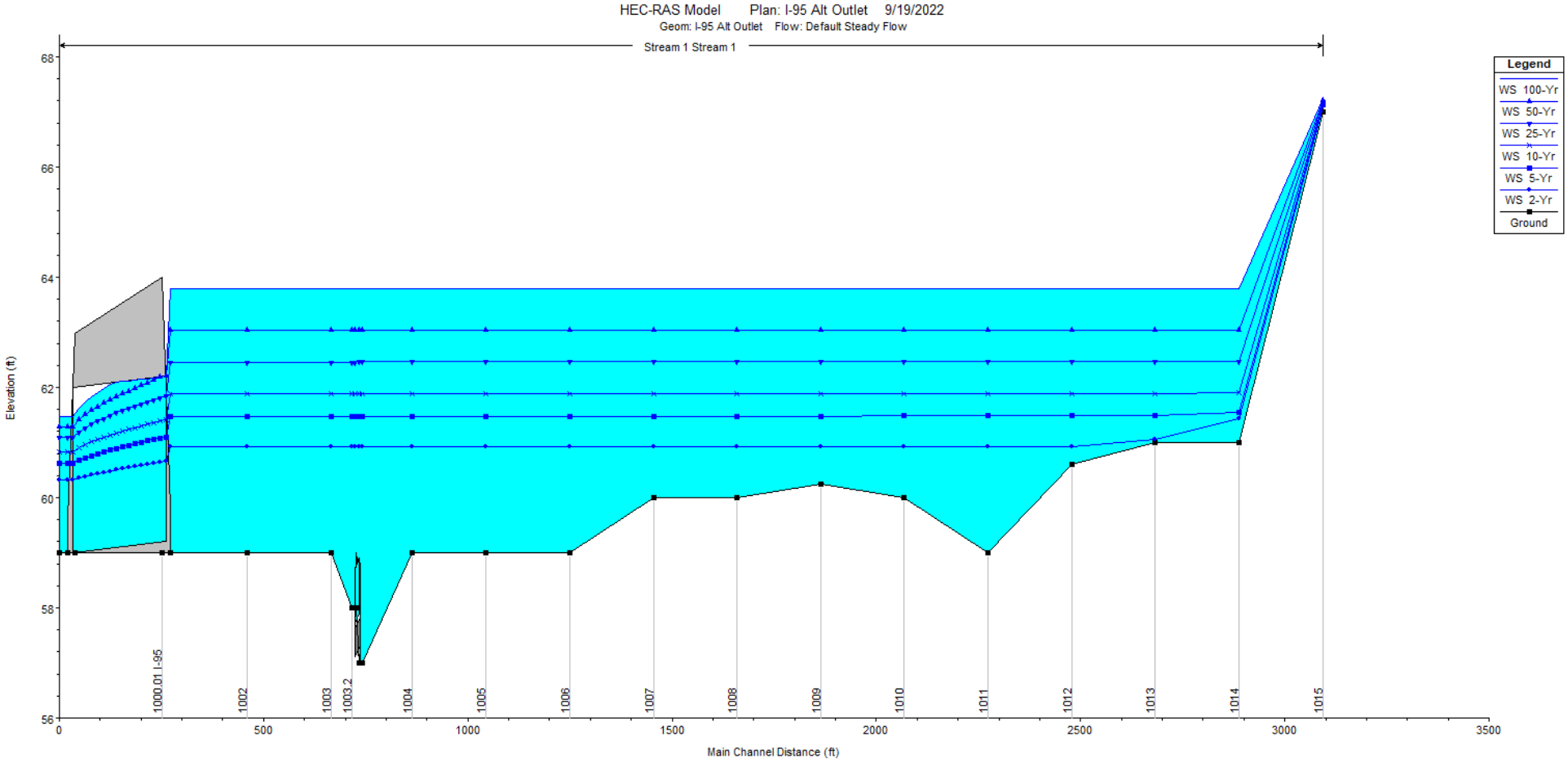


Figure 10: Longitudinal Profile of Existing Conditions with Cart Path for the 2, 5, 10, 25, 50, and 100-Yr WSEL Elevations

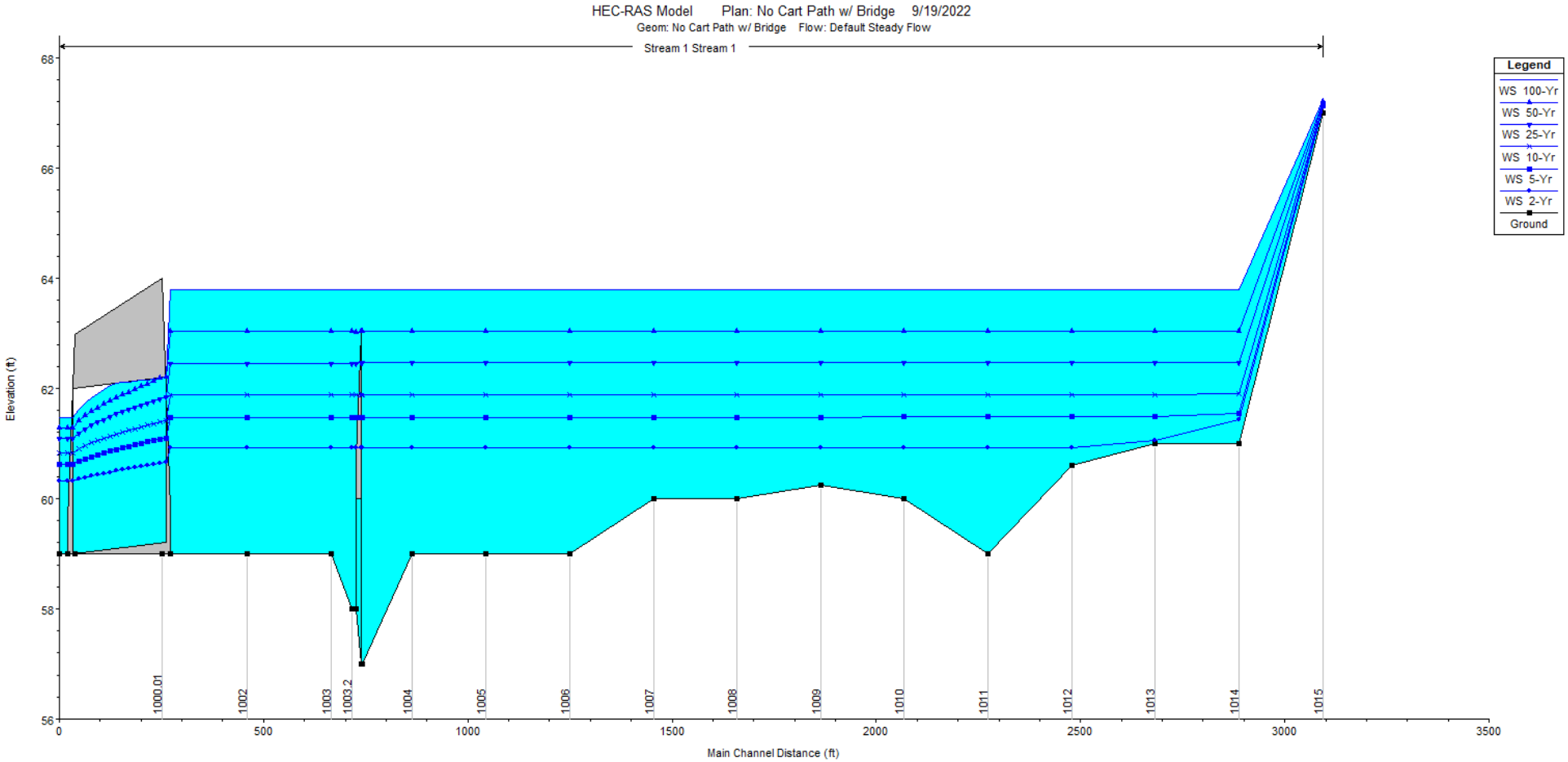


Figure 11: Longitudinal Profile of Proposed Conditions with Bridge Installed and Cart Path Removed for the 2, 5, 10, 25, 50, and 100-Yr WSEL Elevations

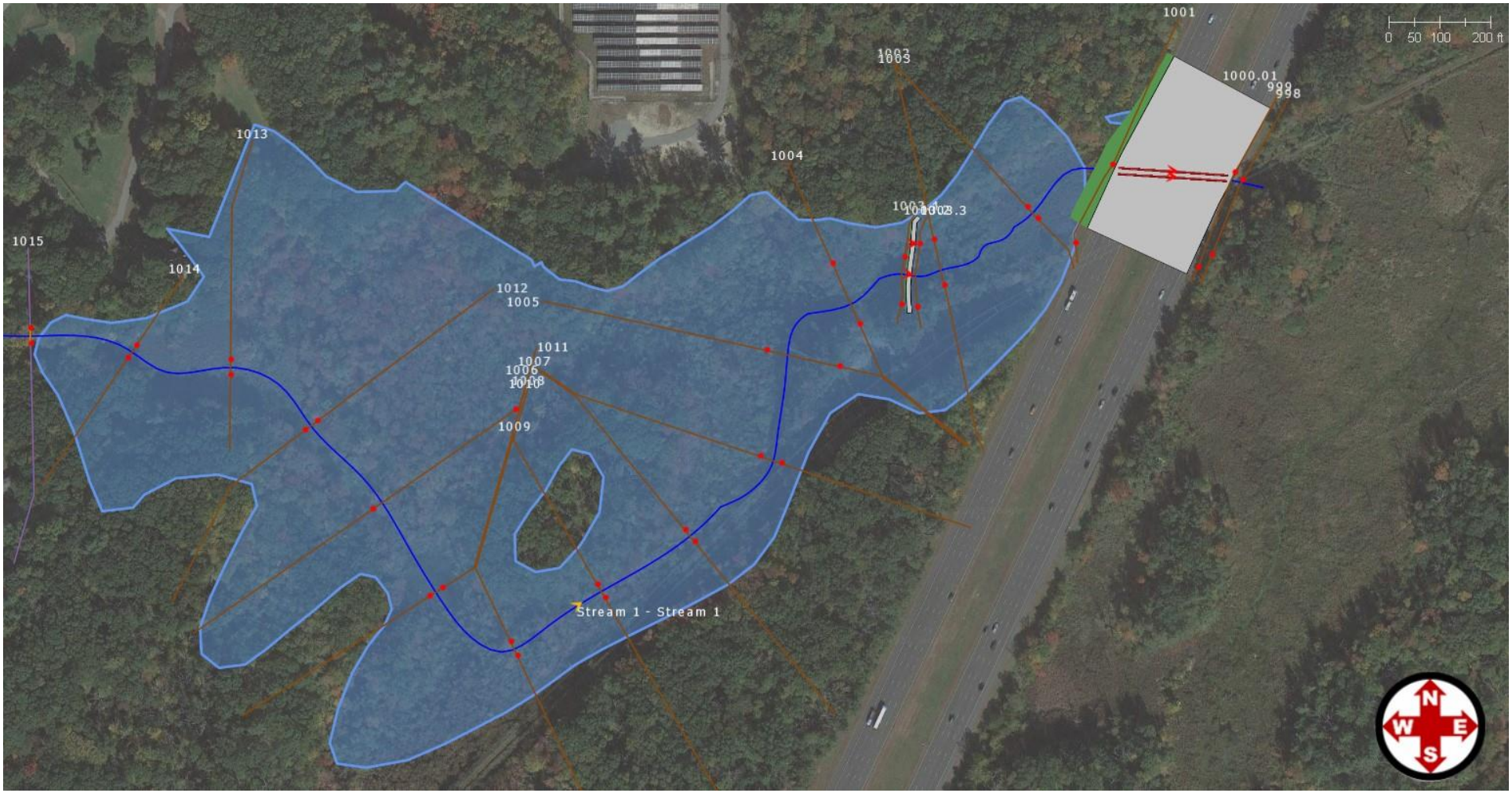


Figure 12: Existing 100-Yr Storm Flood Simulation

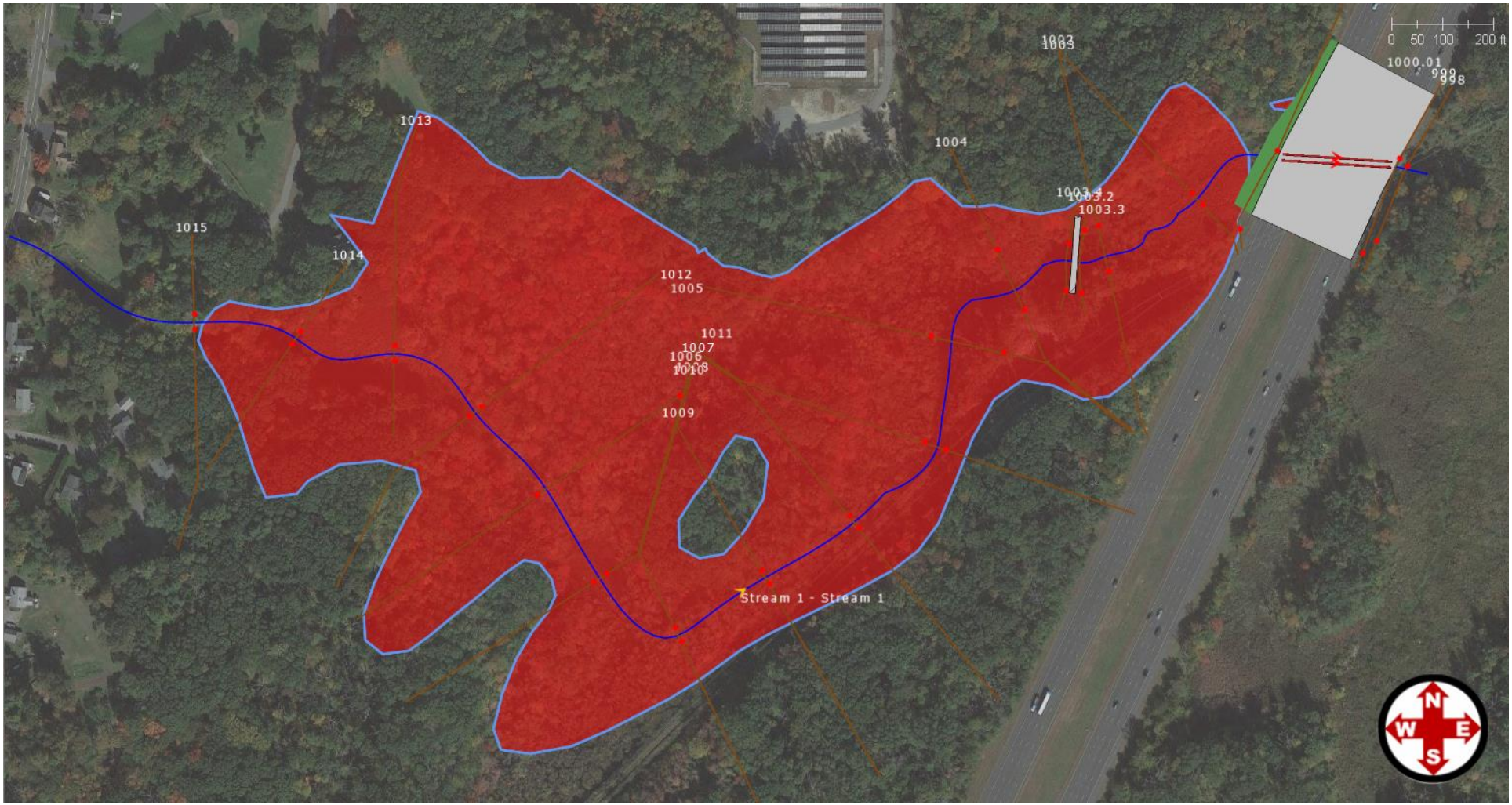


Figure 13: Proposed 100-Yr Storm Flood Simulation

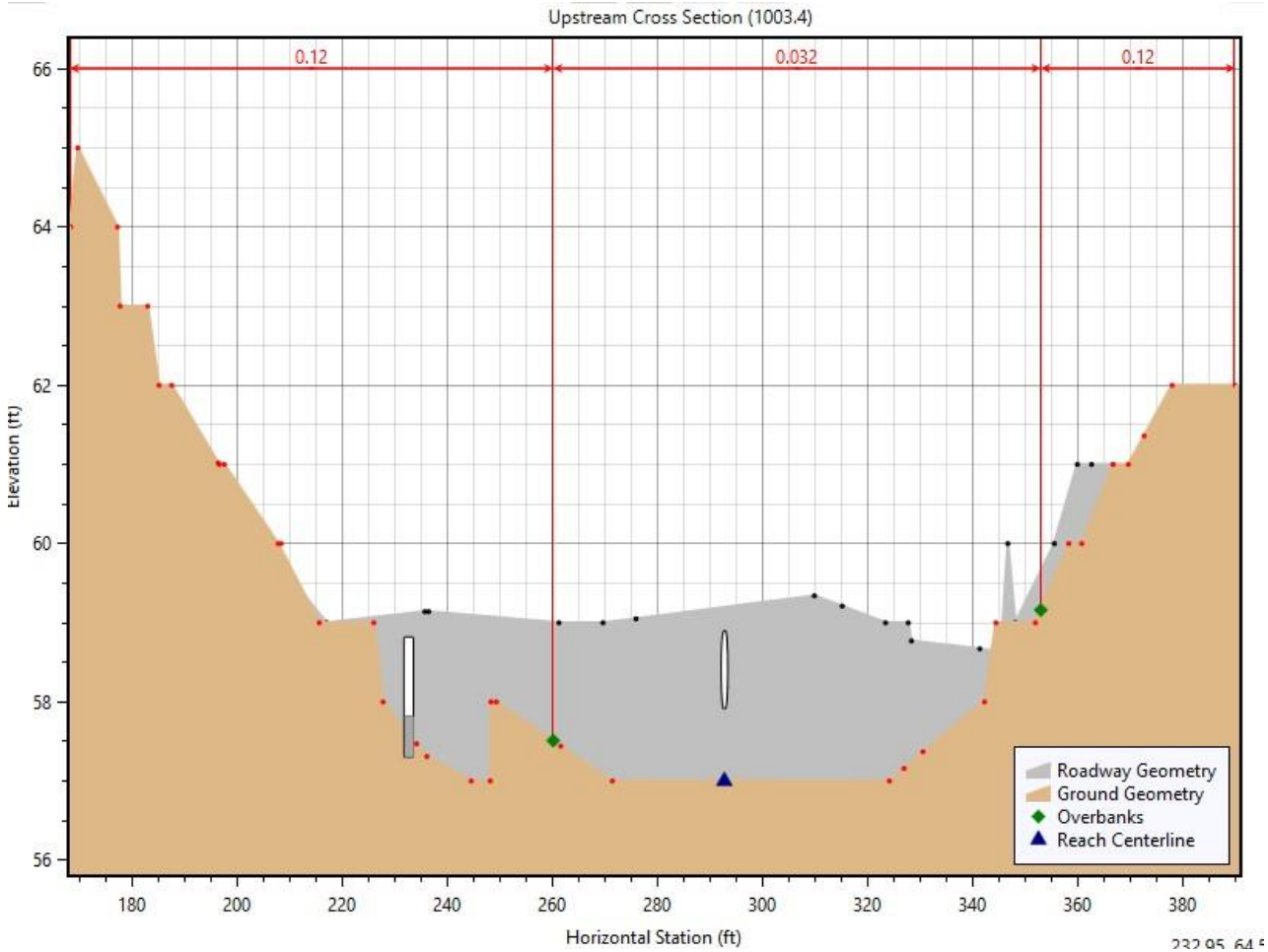


Figure 14: Modeled Cross-Section of the Existing Cart Path with Two Culverts

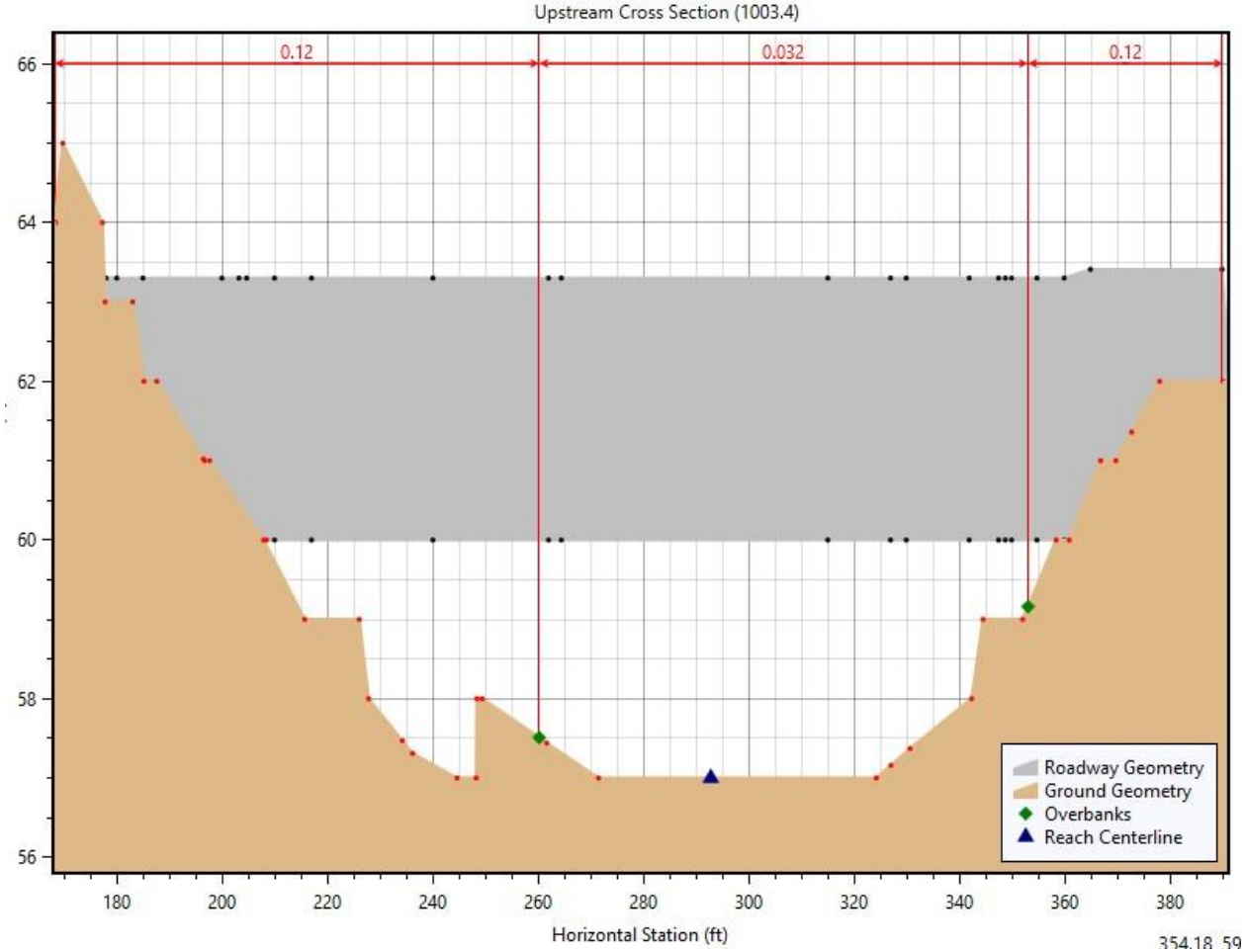


Figure 15: Modeled Cross-Section of the Proposed 150 Ft Span Bridge

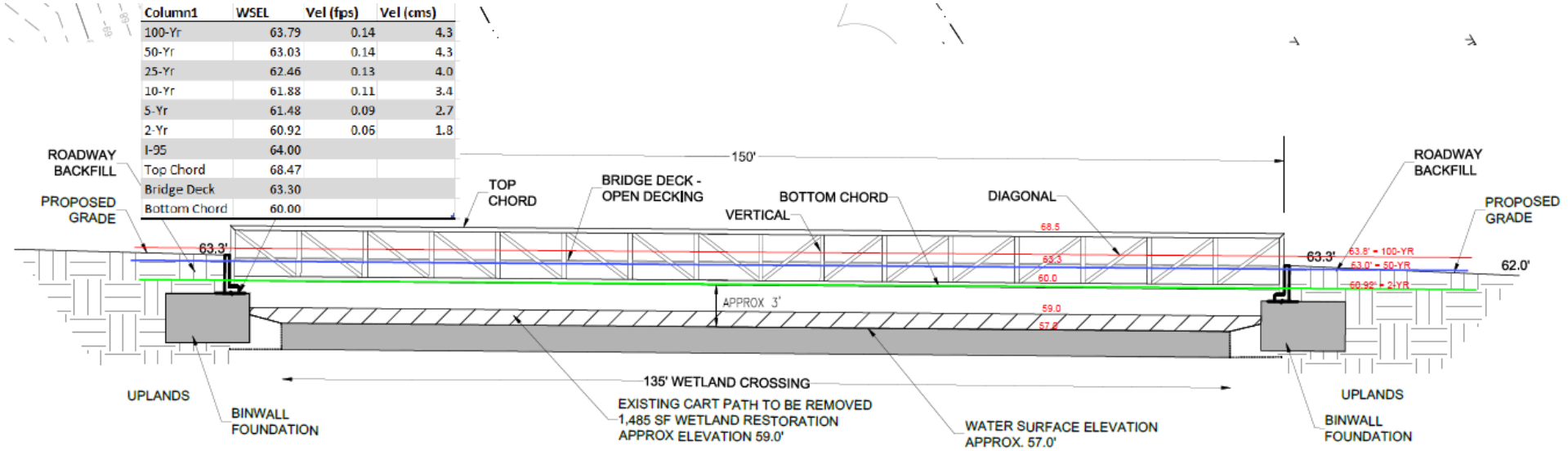


Figure 16: Bridge Crossing Detail and Flood Elevations

5.0 SUMMARY OF FINDINGS

A one-dimension hydraulics surface water model was developed using GeoHECRAS to evaluate the impact of the proposed wetland restoration for the removal of a cart path and replacement with a full span bridge. An existing 135 ft cart path across the wetland and perennial stream will be removed restoring 1,485 sf of wetland (Figure 1). This includes the removal of an estimated 4,500 cf of wetland fill. The existing cart path will be removed and replaced with a 12 ft wide 150 ft span truss bridge to eliminate wetland impacts making the project a net plus for wetlands.

The hydrology and hydraulics analysis demonstrates that there is essentially no change in the flow regime for the 2, 5, 10, 25, 50, and 100-Yr storms. This because the existing cart path is only 2+ feet above the water surface elevation and relatively low within the valley such that flood flows overtop the cart path, and because Interstate 95 is a downstream controlling element. The interstate crosses the wetland 450 feet downstream from the cart path, and has 2 x 36" diameter concrete barrel culverts as outlets. The 2 culverts are controlling the release of the water from this wetland system.

Please feel free to contact me anytime with questions or comments regarding this study.

6.0 LIMITATIONS AND ASSUMPTIONS

The hydrology and hydraulics models presented herein are a mathematical representation of the hydrologic system and watershed setting. Due to the natural complexity of these entities, a model can only achieve a simplified representation of the actual system and therefore must be considered as a generalized screening tool for use in studying this Site. Furthermore, the accuracy, calibration and validation of any model is limited by the study depth, level of resources, availability and accuracy of field data and historical records of site activities. All observations and opinions are limited to the extent of information available at the time of study and review. Special risks occur whenever engineering or related disciplines are applied to identify subsurface conditions. Even a comprehensive monitoring and testing program, implemented with appropriate equipment and experience by personnel who function in accordance with a professional standard of practice, may fail to detect certain conditions. For similar reasons, actual environmental, hydrologic, geological, and geotechnical conditions that were inferred to exist may differ significantly from those that actually exist.

7.0 REFERENCES

1. Olson, S. A. (2008). Estimation of flood discharges at selected recurrence intervals for streams in New Hampshire, Scientific Investigation Report 2008-5206. Pembroke, NH, USGS, New Hampshire. Dept. of Transportation.
2. Ries III, K. G., J. D. Guthrie, et al. (2008). StreamStats: A water resources web application, US Geological Survey.

APPENDIX A: HECRAS DETAILED SUMMARY OUTPUT

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	ΔWSEL	Vel Chnl	ΔVel	Flow Area	Top Width
	Units			(cfs)	(ft)	(ft)	(ft)	(ft/s)	(ft/s)	(sq ft)	(ft)
Stream 1	1015	100-Yr	I-95 Alt Outl	97.3	67	67.24	0.00	3.49	0.00	38.44	177.44
Stream 1	1015	100-Yr	No Cart Patl	97.3	67	67.24		3.49		38.44	177.44
Stream 1	1015	50-Yr	I-95 Alt Outl	82	67	67.21	0.00	3.3	0.00	34.17	174.35
Stream 1	1015	50-Yr	No Cart Patl	82	67	67.21		3.3		34.17	174.35
Stream 1	1015	25-Yr	I-95 Alt Outl	67.6	67	67.19	0.00	3.13	0.00	29.51	170.9
Stream 1	1015	25-Yr	No Cart Patl	67.6	67	67.19		3.13		29.51	170.9
Stream 1	1015	10-Yr	I-95 Alt Outl	50.1	67	67.15	0.00	2.9	0.00	23.33	166.23
Stream 1	1015	10-Yr	No Cart Patl	50.1	67	67.15		2.9		23.33	166.23
Stream 1	1015	5-Yr	I-95 Alt Outl	37.9	67	67.13	0.00	2.56	0.00	19.96	163.62
Stream 1	1015	5-Yr	No Cart Patl	37.9	67	67.13		2.56		19.96	163.62
Stream 1	1015	2-Yr	I-95 Alt Outl	22.7	67	67.09	0.00	2.16	0.00	14.03	158.94
Stream 1	1015	2-Yr	No Cart Patl	22.7	67	67.09		2.16		14.03	158.94
Stream 1	1014	100-Yr	I-95 Alt Outl	97.3	61	63.8	0.00	0.26	0.00	630.27	328.02
Stream 1	1014	100-Yr	No Cart Patl	97.3	61	63.8		0.26		629.64	327.95
Stream 1	1014	50-Yr	I-95 Alt Outl	82	61	63.04	0.00	0.35	0.00	391.2	300.6
Stream 1	1014	50-Yr	No Cart Patl	82	61	63.04		0.35		391.01	300.58
Stream 1	1014	25-Yr	I-95 Alt Outl	67.6	61	62.47	0.00	0.45	0.00	238.54	255.97
Stream 1	1014	25-Yr	No Cart Patl	67.6	61	62.47		0.45		238.44	255.96
Stream 1	1014	10-Yr	I-95 Alt Outl	50.1	61	61.9	0.00	0.63	0.00	109.24	138.29
Stream 1	1014	10-Yr	No Cart Patl	50.1	61	61.9		0.63		109.22	138.29
Stream 1	1014	5-Yr	I-95 Alt Outl	37.9	61	61.54	0.00	0.82	0.00	61.57	124.42
Stream 1	1014	5-Yr	No Cart Patl	37.9	61	61.54		0.82		61.56	124.42
Stream 1	1014	2-Yr	I-95 Alt Outl	22.7	61	61.44	0.00	0.61	0.00	49.57	120.68
Stream 1	1014	2-Yr	No Cart Patl	22.7	61	61.44		0.61		49.57	120.68
Stream 1	1013	100-Yr	I-95 Alt Outl	97.3	61	63.8	0.00	0.11	0.00	1363.39	590.23
Stream 1	1013	100-Yr	No Cart Patl	97.3	61	63.8		0.11		1362.25	590.22
Stream 1	1013	50-Yr	I-95 Alt Outl	82	61	63.04	0.00	0.14	0.00	915.93	585.22
Stream 1	1013	50-Yr	No Cart Patl	82	61	63.04		0.14		915.57	585.22
Stream 1	1013	25-Yr	I-95 Alt Outl	67.6	61	62.47	0.00	0.2	0.00	585.48	579.2
Stream 1	1013	25-Yr	No Cart Patl	67.6	61	62.47		0.2		585.27	579.19
Stream 1	1013	10-Yr	I-95 Alt Outl	50.1	61	61.89	0.00	0.25	0.00	278.64	333.29
Stream 1	1013	10-Yr	No Cart Patl	50.1	61	61.89		0.25		278.59	333.28
Stream 1	1013	5-Yr	I-95 Alt Outl	37.9	61	61.48	0.00	0.36	0.00	147.12	314.79
Stream 1	1013	5-Yr	No Cart Patl	37.9	61	61.48		0.36		147.1	314.78
Stream 1	1013	2-Yr	I-95 Alt Outl	22.7	61	61.06	0.00	1.8	0.00	17.05	295.35
Stream 1	1013	2-Yr	No Cart Patl	22.7	61	61.06		1.8		17.05	295.35
Stream 1	1012	100-Yr	I-95 Alt Outl	97.3	60.6	63.8	0.01	0.07	0.00	1958.66	617.39
Stream 1	1012	100-Yr	No Cart Patl	97.3	60.6	63.79		0.07		1957.47	617.33
Stream 1	1012	50-Yr	I-95 Alt Outl	82	60.6	63.04	0.01	0.07	0.00	1498.89	590.26
Stream 1	1012	50-Yr	No Cart Patl	82	60.6	63.03		0.07		1498.51	590.24
Stream 1	1012	25-Yr	I-95 Alt Outl	67.6	60.6	62.47	0.00	0.07	0.00	1170.74	565.59
Stream 1	1012	25-Yr	No Cart Patl	67.6	60.6	62.47		0.07		1170.53	565.57
Stream 1	1012	10-Yr	I-95 Alt Outl	50.1	60.6	61.89	0.00	0.07	0.00	851.48	537.03
Stream 1	1012	10-Yr	No Cart Patl	50.1	60.6	61.89		0.07		851.41	537.02
Stream 1	1012	5-Yr	I-95 Alt Outl	37.9	60.6	61.48	0.00	0.06	0.00	636.51	521.74
Stream 1	1012	5-Yr	No Cart Patl	37.9	60.6	61.48		0.06		636.48	521.73
Stream 1	1012	2-Yr	I-95 Alt Outl	22.7	60.6	60.93	0.00	0.04	0.00	354.14	487.3
Stream 1	1012	2-Yr	No Cart Patl	22.7	60.6	60.93		0.04		353.73	487.1

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	ΔWSEL	Vel Chnl	ΔVel	Flow Area	Top Width
Stream 1	1011	100-Yr	I-95 Alt Outl	97.3	59	63.8	0.01	0.05	0.00	2657.36	900
Stream 1	1011	100-Yr	No Cart Patl	97.3	59	63.79		0.05		2655.62	900
Stream 1	1011	50-Yr	I-95 Alt Outl	82	59	63.04	0.01	0.05	0.00	1972.04	900
Stream 1	1011	50-Yr	No Cart Patl	82	59	63.03		0.05		1971.48	900
Stream 1	1011	25-Yr	I-95 Alt Outl	67.6	59	62.47	0.00	0.05	0.00	1614.56	606.25
Stream 1	1011	25-Yr	No Cart Patl	67.6	59	62.47		0.05		1614.34	606.25
Stream 1	1011	10-Yr	I-95 Alt Outl	50.1	59	61.89	0.00	0.05	0.00	1267.49	594.47
Stream 1	1011	10-Yr	No Cart Patl	50.1	59	61.89		0.05		1267.4	594.47
Stream 1	1011	5-Yr	I-95 Alt Outl	37.9	59	61.48	0.00	0.04	0.00	1027.65	586.69
Stream 1	1011	5-Yr	No Cart Patl	37.9	59	61.48		0.04		1027.61	586.69
Stream 1	1011	2-Yr	I-95 Alt Outl	22.7	59	60.93	0.00	0.04	0.00	706.05	575.24
Stream 1	1011	2-Yr	No Cart Patl	22.7	59	60.93		0.04		705.57	575.22
Stream 1	1010	100-Yr	I-95 Alt Outl	97.3	60	63.8	0.01	0.2	0.00	1819.15	614.15
Stream 1	1010	100-Yr	No Cart Patl	97.3	60	63.79		0.2		1817.97	614.04
Stream 1	1010	50-Yr	I-95 Alt Outl	82	60	63.04	0.01	0.22	0.00	1369.15	567.66
Stream 1	1010	50-Yr	No Cart Patl	82	60	63.03		0.22		1368.79	567.62
Stream 1	1010	25-Yr	I-95 Alt Outl	67.6	60	62.47	0.00	0.23	0.00	1053.59	544.72
Stream 1	1010	25-Yr	No Cart Patl	67.6	60	62.47		0.23		1053.39	544.7
Stream 1	1010	10-Yr	I-95 Alt Outl	50.1	60	61.89	0.00	0.24	0.00	745.23	520.47
Stream 1	1010	10-Yr	No Cart Patl	50.1	60	61.89		0.24		745.15	520.47
Stream 1	1010	5-Yr	I-95 Alt Outl	37.9	60	61.48	0.00	0.25	0.00	538.28	498.54
Stream 1	1010	5-Yr	No Cart Patl	37.9	60	61.48		0.25		538.24	498.54
Stream 1	1010	2-Yr	I-95 Alt Outl	22.7	60	60.93	0.00	0.27	0.00	276.87	375.61
Stream 1	1010	2-Yr	No Cart Patl	22.7	60	60.93		0.27		276.55	375.47
Stream 1	1009	100-Yr	I-95 Alt Outl	97.3	60.24	63.8	0.01	0.12	0.00	2723.46	813.21
Stream 1	1009	100-Yr	No Cart Patl	97.3	60.24	63.79		0.12		2721.89	813.15
Stream 1	1009	50-Yr	I-95 Alt Outl	82	60.24	63.03	0.00	0.13	0.00	2113.29	788.79
Stream 1	1009	50-Yr	No Cart Patl	82	60.24	63.03		0.13		2112.8	788.77
Stream 1	1009	25-Yr	I-95 Alt Outl	67.6	60.24	62.47	0.00	0.14	0.00	1669.07	775.64
Stream 1	1009	25-Yr	No Cart Patl	67.6	60.24	62.47		0.14		1668.79	775.63
Stream 1	1009	10-Yr	I-95 Alt Outl	50.1	60.24	61.89	0.00	0.13	0.00	1224.21	758.83
Stream 1	1009	10-Yr	No Cart Patl	50.1	60.24	61.89		0.13		1224.1	758.82
Stream 1	1009	5-Yr	I-95 Alt Outl	37.9	60.24	61.48	0.00	0.13	0.00	920.18	736.05
Stream 1	1009	5-Yr	No Cart Patl	37.9	60.24	61.48		0.13		920.13	736.05
Stream 1	1009	2-Yr	I-95 Alt Outl	22.7	60.24	60.93	0.01	0.12	0.00	522.14	665.08
Stream 1	1009	2-Yr	No Cart Patl	22.7	60.24	60.92		0.12		521.57	664.89
Stream 1	1008	100-Yr	I-95 Alt Outl	97.3	60	63.8	0.01	0.13	0.00	2604.28	749.47
Stream 1	1008	100-Yr	No Cart Patl	97.3	60	63.79		0.13		2602.83	749.38
Stream 1	1008	50-Yr	I-95 Alt Outl	82	60	63.03	0.00	0.14	0.00	2047.04	713.31
Stream 1	1008	50-Yr	No Cart Patl	82	60	63.03		0.14		2046.59	713.28
Stream 1	1008	25-Yr	I-95 Alt Outl	67.6	60	62.47	0.00	0.14	0.00	1645.8	699.85
Stream 1	1008	25-Yr	No Cart Patl	67.6	60	62.47		0.14		1645.54	699.84
Stream 1	1008	10-Yr	I-95 Alt Outl	50.1	60	61.89	0.00	0.14	0.00	1244.39	686.15
Stream 1	1008	10-Yr	No Cart Patl	50.1	60	61.89		0.14		1244.3	686.15
Stream 1	1008	5-Yr	I-95 Alt Outl	37.9	60	61.48	0.00	0.13	0.00	967.56	674.02
Stream 1	1008	5-Yr	No Cart Patl	37.9	60	61.48		0.13		967.52	674.02
Stream 1	1008	2-Yr	I-95 Alt Outl	22.7	60	60.92	0.00	0.13	0.00	597.05	657.85
Stream 1	1008	2-Yr	No Cart Patl	22.7	60	60.92		0.13		596.48	657.83
Stream 1	1007	100-Yr	I-95 Alt Outl	97.3	60	63.8	0.01	0.13	0.00	2621.83	770.57
Stream 1	1007	100-Yr	No Cart Patl	97.3	60	63.79		0.13		2620.34	770.49

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	ΔWSEL	Vel Chnl	ΔVel	Flow Area	Top Width
Stream 1	1007	50-Yr	I-95 Alt Outl	82	60	63.03	0.00	0.14	0.00	2046.51	739.37
Stream 1	1007	50-Yr	No Cart Patl	82	60	63.03		0.14		2046.04	739.34
Stream 1	1007	25-Yr	I-95 Alt Outl	67.6	60	62.47	0.01	0.15	0.00	1631.81	720.17
Stream 1	1007	25-Yr	No Cart Patl	67.6	60	62.46		0.15		1631.55	720.16
Stream 1	1007	10-Yr	I-95 Alt Outl	50.1	60	61.89	0.00	0.14	0.00	1220.34	700.3
Stream 1	1007	10-Yr	No Cart Patl	50.1	60	61.89		0.14		1220.24	700.29
Stream 1	1007	5-Yr	I-95 Alt Outl	37.9	60	61.48	0.00	0.14	0.00	938.29	684.69
Stream 1	1007	5-Yr	No Cart Patl	37.9	60	61.48		0.14		938.24	684.68
Stream 1	1007	2-Yr	I-95 Alt Outl	22.7	60	60.92	0.00	0.14	0.00	563.58	649.59
Stream 1	1007	2-Yr	No Cart Patl	22.7	60	60.92		0.14		563.01	649.51
Stream 1	1006	100-Yr	I-95 Alt Outl	97.3	59	63.8	0.01	0.19	0.00	1799.99	573.56
Stream 1	1006	100-Yr	No Cart Patl	97.3	59	63.79		0.19		1798.88	573.55
Stream 1	1006	50-Yr	I-95 Alt Outl	82	59	63.03	0.00	0.21	0.00	1363.85	570.69
Stream 1	1006	50-Yr	No Cart Patl	82	59	63.03		0.21		1363.49	570.69
Stream 1	1006	25-Yr	I-95 Alt Outl	67.6	59	62.46	0.00	0.21	0.00	1066.43	502.05
Stream 1	1006	25-Yr	No Cart Patl	67.6	59	62.46		0.21		1066.25	502.03
Stream 1	1006	10-Yr	I-95 Alt Outl	50.1	59	61.89	0.01	0.2	0.00	787.28	456.79
Stream 1	1006	10-Yr	No Cart Patl	50.1	59	61.88		0.2		787.22	456.78
Stream 1	1006	5-Yr	I-95 Alt Outl	37.9	59	61.48	0.00	0.19	0.00	611.11	407.98
Stream 1	1006	5-Yr	No Cart Patl	37.9	59	61.48		0.19		611.08	407.97
Stream 1	1006	2-Yr	I-95 Alt Outl	22.7	59	60.92	0.00	0.16	0.00	402.11	344.89
Stream 1	1006	2-Yr	No Cart Patl	22.7	59	60.92		0.16		401.81	344.83
Stream 1	1005	100-Yr	I-95 Alt Outl	97.3	59	63.8	0.01	0.09	0.00	2704.98	722.56
Stream 1	1005	100-Yr	No Cart Patl	97.3	59	63.79		0.09		2703.59	722.53
Stream 1	1005	50-Yr	I-95 Alt Outl	82	59	63.03	0.00	0.09	0.00	2159.45	708.66
Stream 1	1005	50-Yr	No Cart Patl	82	59	63.03		0.09		2159	708.65
Stream 1	1005	25-Yr	I-95 Alt Outl	67.6	59	62.46	0.00	0.09	0.00	1761.37	694.38
Stream 1	1005	25-Yr	No Cart Patl	67.6	59	62.46		0.09		1761.11	694.37
Stream 1	1005	10-Yr	I-95 Alt Outl	50.1	59	61.88	0.00	0.08	0.00	1364.18	666.28
Stream 1	1005	10-Yr	No Cart Patl	50.1	59	61.88		0.08		1364.09	666.27
Stream 1	1005	5-Yr	I-95 Alt Outl	37.9	59	61.48	0.00	0.07	0.00	1095.23	654.2
Stream 1	1005	5-Yr	No Cart Patl	37.9	59	61.48		0.07		1095.19	654.19
Stream 1	1005	2-Yr	I-95 Alt Outl	22.7	59	60.92	0.00	0.06	0.00	745.64	504.44
Stream 1	1005	2-Yr	No Cart Patl	22.7	59	60.92		0.06		745.2	504.43
Stream 1	1004	100-Yr	I-95 Alt Outl	97.3	59	63.79	0.00	0.13	0.00	1373.29	435.11
Stream 1	1004	100-Yr	No Cart Patl	97.3	59	63.79		0.13		1372.45	435.04
Stream 1	1004	50-Yr	I-95 Alt Outl	82	59	63.03	0.00	0.13	0.00	1051.67	408.59
Stream 1	1004	50-Yr	No Cart Patl	82	59	63.03		0.13		1051.42	408.57
Stream 1	1004	25-Yr	I-95 Alt Outl	67.6	59	62.46	0.00	0.13	0.00	829.74	381.56
Stream 1	1004	25-Yr	No Cart Patl	67.6	59	62.46		0.13		829.6	381.55
Stream 1	1004	10-Yr	I-95 Alt Outl	50.1	59	61.88	0.00	0.12	0.00	615.45	348.23
Stream 1	1004	10-Yr	No Cart Patl	50.1	59	61.88		0.12		615.4	348.23
Stream 1	1004	5-Yr	I-95 Alt Outl	37.9	59	61.48	0.00	0.11	0.00	475.32	339.96
Stream 1	1004	5-Yr	No Cart Patl	37.9	59	61.48		0.11		475.29	339.95
Stream 1	1004	2-Yr	I-95 Alt Outl	22.7	59	60.92	0.00	0.09	0.00	301.01	176.59
Stream 1	1004	2-Yr	No Cart Patl	22.7	59	60.92		0.09		300.85	176.58
Stream 1	1003.4	100-Yr	I-95 Alt Outl	97.3	57	63.79	0.00	0.14	0.00	1064.13	212.76
Stream 1	1003.4	100-Yr	No Cart Patl	97.3	57	63.79		0.14		1063.72	212.75
Stream 1	1003.4	50-Yr	I-95 Alt Outl	82	57	63.03	0.00	0.14	0.00	902.08	212.37
Stream 1	1003.4	50-Yr	No Cart Patl	82	57	63.03		0.14		901.95	212.37

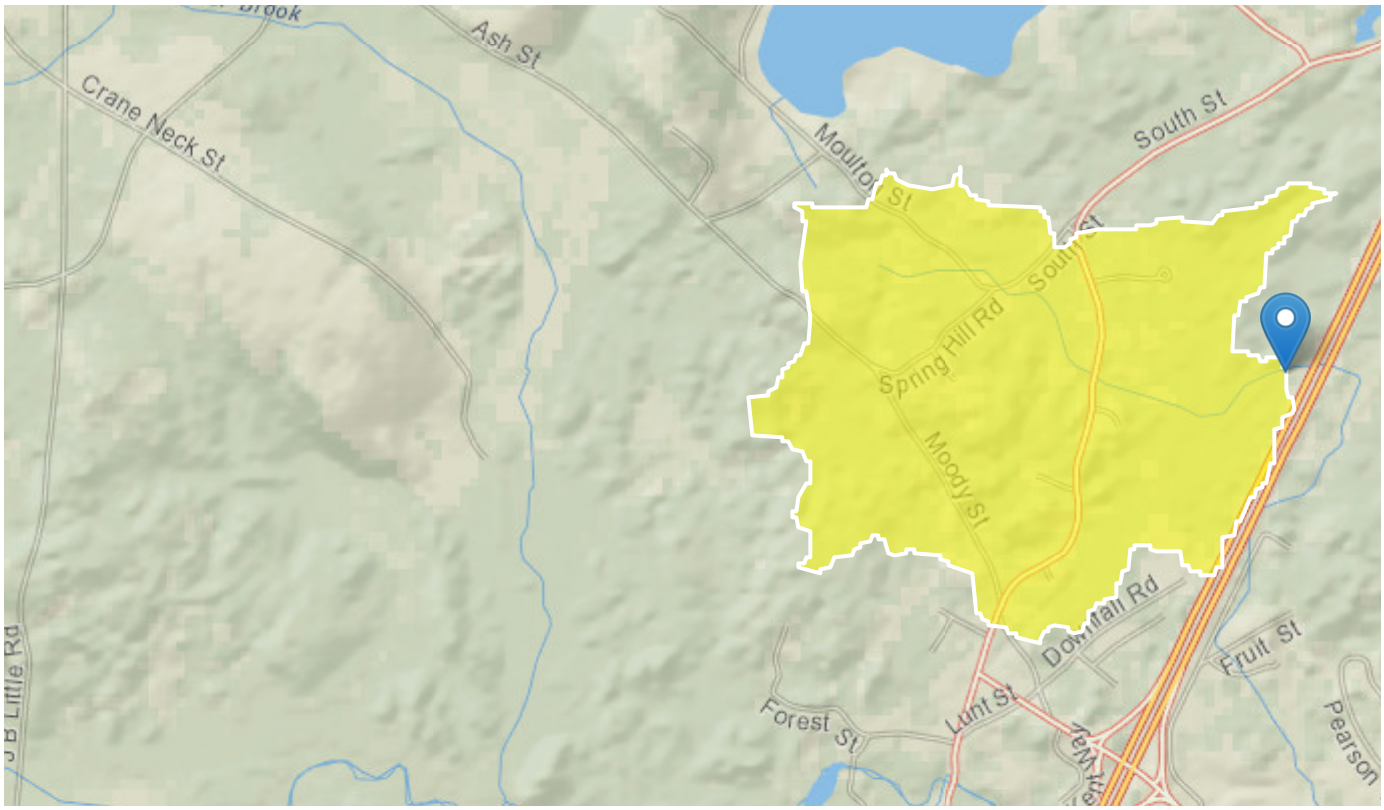
Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	ΔWSEL	Vel Chnl	ΔVel	Flow Area	Top Width
Stream 1	1003.4	25-Yr	I-95 Alt Outl	67.6	57	62.46	0.00	0.13	0.00	784.46	205.97
Stream 1	1003.4	25-Yr	No Cart Patl	67.6	57	62.46		0.13		784.38	205.97
Stream 1	1003.4	10-Yr	I-95 Alt Outl	50.1	57	61.88	0.00	0.11	0.00	667.26	188.5
Stream 1	1003.4	10-Yr	No Cart Patl	50.1	57	61.88		0.11		667.24	188.5
Stream 1	1003.4	5-Yr	I-95 Alt Outl	37.9	57	61.48	0.00	0.09	0.00	591.91	181.42
Stream 1	1003.4	5-Yr	No Cart Patl	37.9	57	61.48		0.09		591.89	181.42
Stream 1	1003.4	2-Yr	I-95 Alt Outl	22.7	57	60.92	0.00	0.06	0.00	493.77	167.97
Stream 1	1003.4	2-Yr	No Cart Patl	22.7	57	60.92		0.06		493.62	167.96
Stream 1	1003.3	CART PATH		Culvert							
Stream 1	1003.2	100-Yr	I-95 Alt Outl	97.3	58	63.79	0.00	0.14	0.00	919.53	205.74
Stream 1	1003.2	100-Yr	No Cart Patl	97.3	58	63.79		0.14		919.53	205.74
Stream 1	1003.2	50-Yr	I-95 Alt Outl	82	58	63.03	0.00	0.14	0.00	765.04	200.11
Stream 1	1003.2	50-Yr	No Cart Patl	82	58	63.03		0.14		765.04	200.11
Stream 1	1003.2	25-Yr	I-95 Alt Outl	67.6	58	62.46	0.00	0.13	0.00	653.37	194.46
Stream 1	1003.2	25-Yr	No Cart Patl	67.6	58	62.46		0.13		653.37	194.46
Stream 1	1003.2	10-Yr	I-95 Alt Outl	50.1	58	61.88	0.00	0.11	0.00	542.28	188.63
Stream 1	1003.2	10-Yr	No Cart Patl	50.1	58	61.88		0.11		542.28	188.63
Stream 1	1003.2	5-Yr	I-95 Alt Outl	37.9	58	61.48	0.00	0.1	0.00	466.2	185.19
Stream 1	1003.2	5-Yr	No Cart Patl	37.9	58	61.48		0.1		466.2	185.19
Stream 1	1003.2	2-Yr	I-95 Alt Outl	22.7	58	60.92	0.00	0.07	0.00	364.42	176.79
Stream 1	1003.2	2-Yr	No Cart Patl	22.7	58	60.92		0.07		364.42	176.79
Stream 1	1003	100-Yr	I-95 Alt Outl	97.3	59	63.79	0.00	0.14	0.00	1657.3	490.67
Stream 1	1003	100-Yr	No Cart Patl	97.3	59	63.79		0.14		1657.3	490.67
Stream 1	1003	50-Yr	I-95 Alt Outl	82	59	63.03	0.00	0.15	0.00	1284.91	487.54
Stream 1	1003	50-Yr	No Cart Patl	82	59	63.03		0.15		1284.91	487.54
Stream 1	1003	25-Yr	I-95 Alt Outl	67.6	59	62.46	0.00	0.15	0.00	1009.52	483.24
Stream 1	1003	25-Yr	No Cart Patl	67.6	59	62.46		0.15		1009.52	483.24
Stream 1	1003	10-Yr	I-95 Alt Outl	50.1	59	61.88	0.00	0.14	0.00	734.49	444.23
Stream 1	1003	10-Yr	No Cart Patl	50.1	59	61.88		0.14		734.49	444.23
Stream 1	1003	5-Yr	I-95 Alt Outl	37.9	59	61.48	0.00	0.13	0.00	560.59	412.56
Stream 1	1003	5-Yr	No Cart Patl	37.9	59	61.48		0.13		560.59	412.56
Stream 1	1003	2-Yr	I-95 Alt Outl	22.7	59	60.92	0.00	0.11	0.00	353.55	217.59
Stream 1	1003	2-Yr	No Cart Patl	22.7	59	60.92		0.11		353.55	217.59
Stream 1	1002	100-Yr	I-95 Alt Outl	97.3	59	63.79	0.00	0.25	0.00	1202.98	295.84
Stream 1	1002	100-Yr	No Cart Patl	97.3	59	63.79		0.25		1202.98	295.84
Stream 1	1002	50-Yr	I-95 Alt Outl	82	59	63.03	0.00	0.26	0.00	979.94	289.96
Stream 1	1002	50-Yr	No Cart Patl	82	59	63.03		0.26		979.94	289.96
Stream 1	1002	25-Yr	I-95 Alt Outl	67.6	59	62.46	0.00	0.25	0.00	818.9	277.92
Stream 1	1002	25-Yr	No Cart Patl	67.6	59	62.46		0.25		818.9	277.92
Stream 1	1002	10-Yr	I-95 Alt Outl	50.1	59	61.88	0.00	0.22	0.00	661.35	266.93
Stream 1	1002	10-Yr	No Cart Patl	50.1	59	61.88		0.22		661.35	266.93
Stream 1	1002	5-Yr	I-95 Alt Outl	37.9	59	61.48	0.00	0.2	0.00	554.05	260.29
Stream 1	1002	5-Yr	No Cart Patl	37.9	59	61.48		0.2		554.05	260.29
Stream 1	1002	2-Yr	I-95 Alt Outl	22.7	59	60.92	0.00	0.16	0.00	411.37	250.79
Stream 1	1002	2-Yr	No Cart Patl	22.7	59	60.92		0.16		411.37	250.79
Stream 1	1001	I-95 100-Yr	I-95 Alt Outl	97.3	59	63.79	0.00	0.12	0.00	1192.59	374.95
Stream 1	1001	I-95 100-Yr	No Cart Patl	97.3	59	63.79		0.12		1192.59	374.95
Stream 1	1001	I-95 50-Yr	I-95 Alt Outl	82	59	63.03	0.00	0.12	0.00	910.09	366.89
Stream 1	1001	I-95 50-Yr	No Cart Patl	82	59	63.03		0.12		910.09	366.89

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	ΔWSEL	Vel Chnl	ΔVel	Flow Area	Top Width
Stream 1	1001	I-95 25-Yr	I-95 Alt Outl	67.6	59	62.46	0.00	0.12	0.00	722.11	313.72
Stream 1	1001	I-95 25-Yr	No Cart Patl	67.6	59	62.46		0.12		722.11	313.72
Stream 1	1001	I-95 10-Yr	I-95 Alt Outl	50.1	59	61.88	0.00	0.11	0.00	549.93	283.14
Stream 1	1001	I-95 10-Yr	No Cart Patl	50.1	59	61.88		0.11		549.93	283.14
Stream 1	1001	I-95 5-Yr	I-95 Alt Outl	37.9	59	61.48	0.00	0.11	0.00	437.77	267.86
Stream 1	1001	I-95 5-Yr	No Cart Patl	37.9	59	61.48		0.11		437.77	267.86
Stream 1	1001	I-95 2-Yr	I-95 Alt Outl	22.7	59	60.92	0.00	0.09	0.00	294.2	245.73
Stream 1	1001	I-95 2-Yr	No Cart Patl	22.7	59	60.92		0.09		294.2	245.73
Stream 1	1000.01	I-95		Culvert							
Stream 1	999	100-Yr	I-95 Alt Outl	97.3	59	61.47	0.00	0.24	0.00	475.39	271.91
Stream 1	999	100-Yr	No Cart Patl	97.3	59	61.47		0.24		475.39	271.91
Stream 1	999	50-Yr	I-95 Alt Outl	82	59	61.28	0.00	0.22	0.00	424.48	267.71
Stream 1	999	50-Yr	No Cart Patl	82	59	61.28		0.22		424.48	267.71
Stream 1	999	25-Yr	I-95 Alt Outl	67.6	59	61.09	0.00	0.21	0.00	373.9	263.48
Stream 1	999	25-Yr	No Cart Patl	67.6	59	61.09		0.21		373.9	263.48
Stream 1	999	10-Yr	I-95 Alt Outl	50.1	59	60.84	0.00	0.18	0.00	306.43	256.49
Stream 1	999	10-Yr	No Cart Patl	50.1	59	60.84		0.18		306.43	256.49
Stream 1	999	5-Yr	I-95 Alt Outl	37.9	59	60.63	0.00	0.16	0.00	254.42	250.39
Stream 1	999	5-Yr	No Cart Patl	37.9	59	60.63		0.16		254.42	250.39
Stream 1	999	2-Yr	I-95 Alt Outl	22.7	59	60.33	0.00	0.13	0.00	179.97	241.4
Stream 1	999	2-Yr	No Cart Patl	22.7	59	60.33		0.13		179.97	241.4
Stream 1	998	100-Yr	I-95 Alt Outl	97.3	59	61.47	0.00	0.24	0.00	475.33	271.9
Stream 1	998	100-Yr	No Cart Patl	97.3	59	61.47		0.24		475.33	271.9
Stream 1	998	50-Yr	I-95 Alt Outl	82	59	61.28	0.00	0.22	0.00	424.42	267.71
Stream 1	998	50-Yr	No Cart Patl	82	59	61.28		0.22		424.42	267.71
Stream 1	998	25-Yr	I-95 Alt Outl	67.6	59	61.09	0.00	0.21	0.00	373.84	263.48
Stream 1	998	25-Yr	No Cart Patl	67.6	59	61.09		0.21		373.84	263.48
Stream 1	998	10-Yr	I-95 Alt Outl	50.1	59	60.83	0.00	0.19	0.00	306.37	256.48
Stream 1	998	10-Yr	No Cart Patl	50.1	59	60.83		0.19		306.37	256.48
Stream 1	998	5-Yr	I-95 Alt Outl	37.9	59	60.63	0.00	0.17	0.00	254.36	250.39
Stream 1	998	5-Yr	No Cart Patl	37.9	59	60.63		0.17		254.36	250.39
Stream 1	998	2-Yr	I-95 Alt Outl	22.7	59	60.33	0.00	0.14	0.00	179.91	241.4
Stream 1	998	2-Yr	No Cart Patl	22.7	59	60.33		0.14		179.91	241.4

APPENDIX B: USGS STREAM STATS REPORT

Yesair Solar Stream Crossing StreamStats Report

Region ID: MA
Workspace ID: MA20220916200642819000
Clicked Point (Latitude, Longitude): 42.76888, -70.93514
Time: 2022-09-16 16:07:08 -0400



Collapse All

Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
BSLDEM10M	Mean basin slope computed from 10 m DEM	4.388	percent
BSLDEM250	Mean basin slope computed from 1:250K DEM	1.037	percent
DRFTPERSTR	Area of stratified drift per unit of stream length	0.0456	square mile per mile
DRNAREA	Area that drains to a point on a stream	0.83	square miles
ELEV	Mean Basin Elevation	77.7	feet

Parameter Code	Parameter Description	Value	Unit
FOREST	Percentage of area covered by forest	69.86	percent
LC06STOR	Percentage of water bodies and wetlands determined from the NLCD 2006	19.74	percent
MAREGION	Region of Massachusetts 0 for Eastern 1 for Western	0	dimensionless
PCTSNDGRV	Percentage of land surface underlain by sand and gravel deposits	7.96	percent

Peak-Flow Statistics

Peak-Flow Statistics Parameters [Peak Statewide 2016 5156]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.83	square miles	0.16	512
ELEV	Mean Basin Elevation	77.7	feet	80.6	1948
LC06STOR	Percent Storage from NLCD2006	19.74	percent	0	32.3

Peak-Flow Statistics Disclaimers [Peak Statewide 2016 5156]

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

Peak-Flow Statistics Flow Report [Peak Statewide 2016 5156]

Statistic	Value	Unit
50-percent AEP flood	22.7	ft^3/s
20-percent AEP flood	37.9	ft^3/s
10-percent AEP flood	50.1	ft^3/s
4-percent AEP flood	67.6	ft^3/s
2-percent AEP flood	82	ft^3/s
1-percent AEP flood	97.3	ft^3/s

Statistic	Value	Unit
0.5-percent AEP flood	114	ft^3/s
0.2-percent AEP flood	137	ft^3/s

Peak-Flow Statistics Citations

Zarriello, P.J.,2017, Magnitude of flood flows at selected annual exceedance probabilities for streams in Massachusetts: U.S. Geological Survey Scientific Investigations Report 2016–5156, 99 p. (https://dx.doi.org/10.3133/sir20165156)

Low-Flow Statistics

Low-Flow Statistics Parameters [Statewide Low Flow WRIR00 4135]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.83	square miles	1.61	149
BSLDEM250	Mean Basin Slope from 250K DEM	1.037	percent	0.32	24.6
DRFTPERSTR	Stratified Drift per Stream Length	0.0456	square mile per mile	0	1.29
MAREGION	Massachusetts Region	0	dimensionless	0	1

Low-Flow Statistics Disclaimers [Statewide Low Flow WRIR00 4135]

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

Low-Flow Statistics Flow Report [Statewide Low Flow WRIR00 4135]

Statistic	Value	Unit
7 Day 2 Year Low Flow	0.0271	ft^3/s
7 Day 10 Year Low Flow	0.00675	ft^3/s

Low-Flow Statistics Citations

Ries, K.G., III,2000, Methods for estimating low-flow statistics for Massachusetts streams: U.S. Geological Survey Water Resources Investigations Report 00-4135, 81 p. (http://pubs.usgs.gov/wri/wri004135/)

Flow-Duration Statistics

Flow-Duration Statistics Parameters [Statewide Low Flow WRIR00 4135]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.83	square miles	1.61	149
DRFTPERSTR	Stratified Drift per Stream Length	0.0456	square mile per mile	0	1.29
MAREGION	Massachusetts Region	0	dimensionless	0	1
BSLDEM250	Mean Basin Slope from 250K DEM	1.037	percent	0.32	24.6

Flow-Duration Statistics Disclaimers [Statewide Low Flow WRIR00 4135]

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

Flow-Duration Statistics Flow Report [Statewide Low Flow WRIR00 4135]

Statistic	Value	Unit
50 Percent Duration	0.79	ft^3/s
60 Percent Duration	0.495	ft^3/s
70 Percent Duration	0.25	ft^3/s
75 Percent Duration	0.181	ft^3/s
80 Percent Duration	0.11	ft^3/s
85 Percent Duration	0.0716	ft^3/s
90 Percent Duration	0.0409	ft^3/s
95 Percent Duration	0.0206	ft^3/s
98 Percent Duration	0.0131	ft^3/s
99 Percent Duration	0.00887	ft^3/s

Flow-Duration Statistics Citations

Ries, K.G., III,2000, Methods for estimating low-flow statistics for Massachusetts streams: U.S. Geological Survey Water Resources Investigations Report 00-4135, 81 p.

(http://pubs.usgs.gov/wri/wri004135/)

August Flow-Duration Statistics

August Flow-Duration Statistics Parameters [Statewide Low Flow WRIR00 4135]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.83	square miles	1.61	149
BSLDEM250	Mean Basin Slope from 250K DEM	1.037	percent	0.32	24.6
DRFTPERSTR	Stratified Drift per Stream Length	0.0456	square mile per mile	0	1.29
MAREGION	Massachusetts Region	0	dimensionless	0	1

August Flow-Duration Statistics Disclaimers [Statewide Low Flow WRIR00 4135]

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

August Flow-Duration Statistics Flow Report [Statewide Low Flow WRIR00 4135]

Statistic	Value	Unit
August 50 Percent Duration	0.0819	ft^3/s

August Flow-Duration Statistics Citations

Ries, K.G., III,2000, Methods for estimating low-flow statistics for Massachusetts streams: U.S. Geological Survey Water Resources Investigations Report 00-4135, 81 p. (http://pubs.usgs.gov/wri/wri004135/)

Bankfull Statistics

Bankfull Statistics Parameters [Bankfull Statewide SIR2013 5155]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.83	square miles	0.6	329
BSLDEM10M	Mean Basin Slope from 10m DEM	4.388	percent	2.2	23.9

Bankfull Statistics Parameters [Appalachian Highlands D Bieger 2015]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.83	square miles	0.07722	940.1535

Bankfull Statistics Parameters [New England P Bieger 2015]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.83	square miles	3.799224	138.999861

Bankfull Statistics Parameters [USA Bieger 2015]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.83	square miles	0.07722	59927.7393

Bankfull Statistics Flow Report [Bankfull Statewide SIR2013 5155]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, ASEp: Average Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	ASEp
Bankfull Width	12.8	ft	21.3
Bankfull Depth	0.844	ft	19.8
Bankfull Area	10.7	ft^2	29
Bankfull Streamflow	22.2	ft^3/s	55

Bankfull Statistics Flow Report [Appalachian Highlands D Bieger 2015]

Statistic	Value	Unit
Bieger_D_channel_width	14.1	ft
Bieger_D_channel_depth	1.06	ft
Bieger_D_channel_cross_sectional_area	15.1	ft^2

Bankfull Statistics Disclaimers [New England P Bieger 2015]

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

Bankfull Statistics Flow Report [New England P Bieger 2015]

Statistic	Value	Unit
Bieger_P_channel_width	24	ft
Bieger_P_channel_depth	1.32	ft
Bieger_P_channel_cross_sectional_area	31.5	ft^2

Bankfull Statistics Flow Report [USA Bieger 2015]

Statistic	Value	Unit
Bieger_USA_channel_width	11.6	ft
Bieger_USA_channel_depth	1.16	ft
Bieger_USA_channel_cross_sectional_area	15.5	ft^2

Bankfull Statistics Flow Report [Area-Averaged]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, ASEp: Average Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	ASEp
Bankfull Width	12.8	ft	21.3
Bankfull Depth	0.844	ft	19.8
Bankfull Area	10.7	ft^2	29
Bankfull Streamflow	22.2	ft^3/s	55
Bieger_D_channel_width	14.1	ft	
Bieger_D_channel_depth	1.06	ft	
Bieger_D_channel_cross_sectional_area	15.1	ft^2	
Bieger_P_channel_width	24	ft	
Bieger_P_channel_depth	1.32	ft	
Bieger_P_channel_cross_sectional_area	31.5	ft^2	
Bieger_USA_channel_width	11.6	ft	
Bieger_USA_channel_depth	1.16	ft	

Statistic	Value	Unit	ASEp
Bieger_USA_channel_cross_sectional_area	15.5	ft^2	

Bankfull Statistics Citations

Bent, G.C., and Waite, A.M.,2013, Equations for estimating bankfull channel geometry and discharge for streams in Massachusetts: U.S. Geological Survey Scientific Investigations Report 2013–5155, 62 p., (http://pubs.usgs.gov/sir/2013/5155/)
Bieger, Katrin; Rathjens, Hendrik; Allen, Peter M.; and Arnold, Jeffrey G.,2015, Development and Evaluation of Bankfull Hydraulic Geometry Relationships for the Physiographic Regions of the United States, Publications from USDA-ARS / UNL Faculty, 17p. (https://digitalcommons.unl.edu/usdaarsfacpub/1515?utm_source=digitalcommons.unl.edu%2Fusdaarsfacpub%2F1515&utm_medium=PDF&utm_

Probability Statistics

Probability Statistics Parameters [Perennial Flow Probability]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.83	square miles	0.01	1.99
PCTSNDGRV	Percent Underlain By Sand And Gravel	7.96	percent	0	100
FOREST	Percent Forest	69.86	percent	0	100
MAREGION	Massachusetts Region	0	dimensionless	0	1

Probability Statistics Flow Report [Perennial Flow Probability]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, ASEp: Average Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PC
Probability Stream Flowing Perennially	0.747	dim	71

Probability Statistics Citations

Bent, G.C., and Steeves, P.A.,2006, A revised logistic regression equation and an automated procedure for mapping the probability of a stream flowing perennially in Massachusetts: U.S. Geological Survey Scientific Investigations Report 2006–5031, 107 p. (http://pubs.usgs.gov/sir/2006/5031/pdfs/SIR_2006-5031rev.pdf)

Application Version: 4.10.1
StreamStats Services Version: 1.2.22
NSS Services Version: 2.2.1