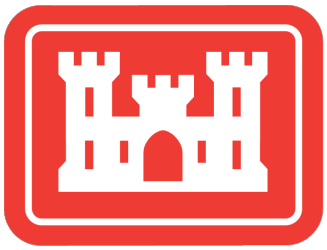
HUDSON RIVER HABITAT RESTORATION

ECOSYSTEM RESTORATION
FINAL INTEGRATED FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT

Appendix B:
Engineering Appendix



U.S. ARMY CORPS OF ENGINEERS
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1. Introduction

This Engineering Appendix presents engineering observations, measurements, and design assumptions for various and distinct portions of the Hudson River Habitat Restoration (HRHR) Feasibility Study. Site-specific discussions regarding field observations and measurements, design calculations and assumptions, and concept designs and quantities are included within this document.

The project area is bounded by the Governor Mario M. Cuomo Bridge (formerly Tappan Zee Bridge) (River Mile 62) and the Troy Lock and Dam (River Mile 153) and generally encompasses 91 miles of Hudson River as well as the immediate tributaries and land east and west of the Hudson River between these two boundaries. Within this project area, six restoration sites were selected including:

- Binnen Kill
- Schodack Island
- Charles Rider Park
- Henry Hudson Park
- Moodna Creek including AOP 1 barrier (Utility Crossing); AOP 2 barrier (Firth Cliff Dam); and AOP 3 barrier (Orr's Mill Dam)
- Rondout Creek – Eddyville Dam

Figure 1 provides a broad overview of the project area including site locations, tide gauge locations and river miles.

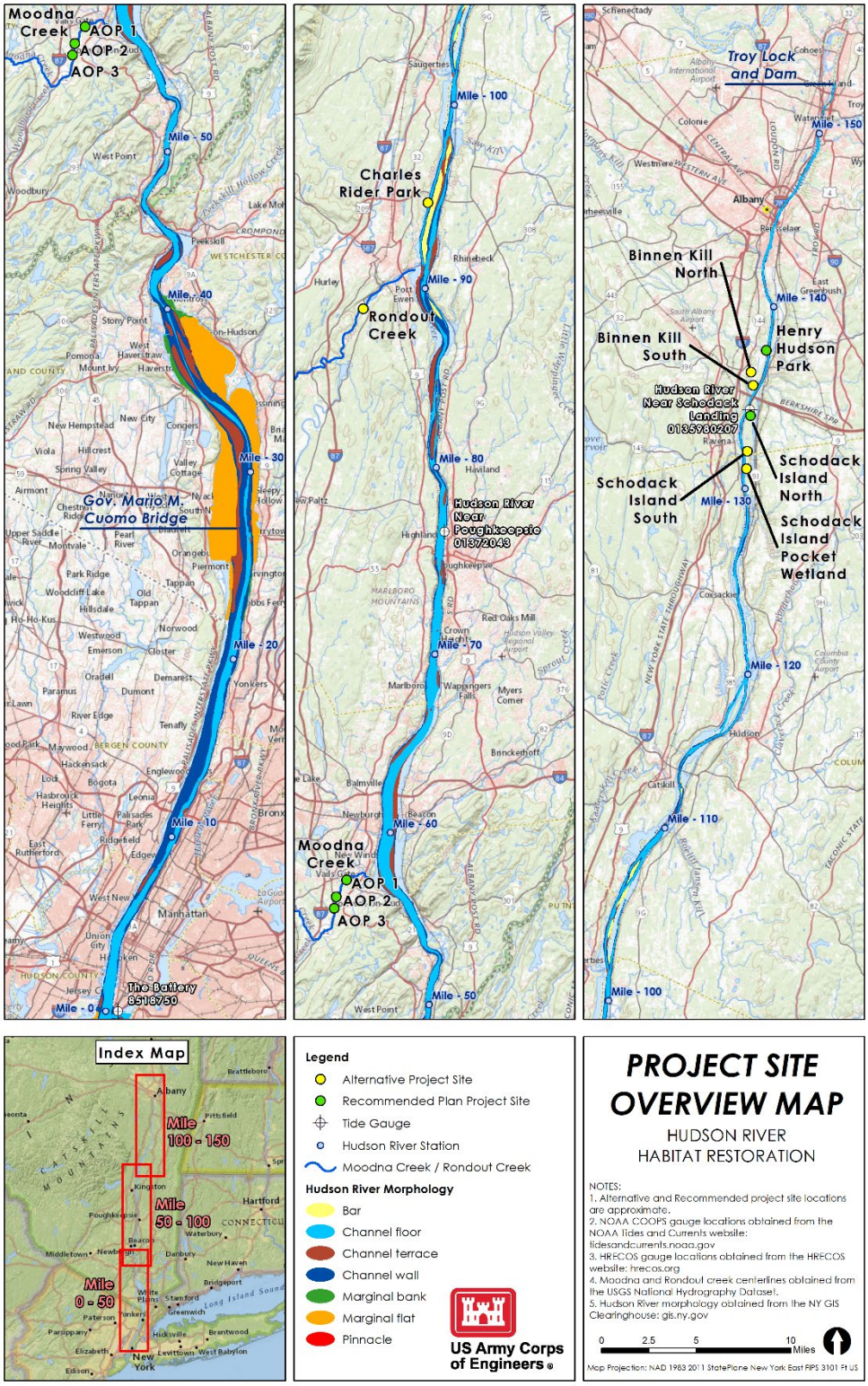

Figure 1: Hudson River Habitat Restoration Project Overview.

The Binnen Kill site is located on the west shore of the Hudson River at river mile 136, on the borders of the Towns of Bethlehem and Coeymans, New York and encompasses approximately 1,000 acres of publicly and privately-owned lands. The eastern edge of the site originally included islands that were separated from the historic shoreline by side channels in the 1800s but that are now contiguous with the site due to infilling. The Binnen Kill proper is a tidal freshwater tributary that is surrounded by a complex of tidal wetlands, upland forests, non-tidal swamps, and farmland. Proposed actions at the site consist of the restoration of wetlands and hydrological connections through the restoration of side channels.

Schodack Island project site is part of the Schodack Island State Park located along the eastern shore of the Hudson River between river mile 131 and 134, just south of Albany. Approximately seven miles of Hudson River and Schodack Creek shoreline bound the park. The park has been designated a State Estuary and a portion of the park shelters a Bird Conservation Area that is home to bald eagles, cerulean warblers, and blue herons. Eight miles of multi-use trails wind through a variety of ecological communities. In addition, the park has 66 campsites for use, an improved bike trail, volleyball nets, horseshoe pit, and a kayak/canoe launch. Interpretive signage highlights the park's historic and environmental significance. Proposed actions at the site consist of the restoration of wetlands and hydrological connections through the restoration of side channels.

Charles Rider Park is located on the west shore of the Hudson River at river mile 95 and encompasses approximately 29.6 acres of public open space owned by the Town of Ulster. The shoreline consists of failed timber cribbing and rock riprap and is largely void of vegetation. Proposed actions at the site focus on shoreline restoration and consist of shoreline stabilization using living shoreline techniques including the establishment of tidal wetlands.

Henry Hudson Park is public open space owned by the Town of Bethlehem and is located on the western shore of the Hudson River at river mile 138. The Hudson River shoreline consists of a dilapidated timber cribbing structure, which has either partially or completely failed along the majority of the structure. Proposed actions at the site focus on shoreline restoration and consist of shoreline stabilization using living shoreline techniques including the establishment of tidal wetlands.

Moodna Creek is a Hudson River Tributary, which drains into the Hudson River from the west at river mile 58. It has three aquatic organism passage barriers including:

- **AOP 1: Utility Crossing** is located along Moodna Creek upstream of the Forge Hill Road (Route 74) crossing. A concrete-encased decommissioned sewer line crosses Moodna Creek forming a weir that creates a vertical drop of water

approximately two feet in height during low flows. This sewer line is a potential barrier to aquatic organism passage (AOP), including both migratory and inland resident fish. Proposed actions at the site seek to restore aquatic organism passage by removing the structure or installing a rock ramp.

AOP 2: Firth Cliff Dam is located along Moodna Creek adjacent to the former textile manufacturing site historically known as Firth Carpet Company. The factory was previously demolished but the nine-foot-high dam remains, acting as a barrier to Aquatic Organism Passage (AOP). Proposed actions at the site seek to restore aquatic organism passage by removing the structure or installing a technical fishway.

- **AOP 3: Orr's Mill Dam** is located along Moodna Creek upstream of the Route 32 bridge crossing. The ten-foot-high dam is in poor condition and a barrier to AOP. Normal river flow passes under the spillway suggesting the structure is substantially undermined. Proposed actions at the site seek to restore aquatic organism passage by removing or breaching the structure.

Eddyville Dam is located on Rondout Creek, a Hudson River tributary which drains into the Hudson River from the west at river mile 90, on the boundary between the Towns of Esopus and Ulster. The 12-foot high dam sits on a bedrock ledge and is the current head of tide. Proposed actions at the site will seek to restore aquatic organism passage by removing or breaching the structure or installing a technical fishway.

2. Existing Conditions

2.1 Topography/Bathymetry

Topographic, bathymetric, and existing feature characteristics (e.g. dams and culverts) were collected to support the development of alternatives. The following section is a discussion of the data collection efforts and summary of findings.

Topographic and bathymetric cross sections and profiles were based on site surveys conducted in 2018 and supplemental elevation data derived from LiDAR (Light Detection and Ranging). All data are referenced to North American Datum 1983 (NAD83) New York State Plane East, North American Vertical Datum 1988 (NAVD88), feet. Profile data were collected for Binnen Kill, Schodack Island, Henry Hudson Park, Charles Rider Park, and three AOP barrier sites along Moodna Creek. Profiles extended landward to at least 100 feet and waterward to a water depth of three feet or to the edge of a sudden drop such as the edge of a bulkhead or other revetment structure. A sufficient number of points were collected to ensure adequate depiction of all topographic and hydrographic features and major breaks in slope.

Site survey spot elevations were collected using a Leica Viva GS14 GNSS receiver and CS20 field controller for Binnen Kill, Schodack Island, Henry Hudson Park, and Charles

Rider Park; a TopCon HiperV receiver and Carlson Surveyor II controller were used for Moodna Creek. NYSNet Real-Time kinematic (RTK) positioning service was used to achieve sub-centimeter (<0.762 cm) position accuracy in optimal conditions during the collection effort. In areas where sub-centimeter accuracy could not be achieved in the field due to tree cover, the profiles were supplemented with topographic data obtained from a 1-meter resolution 2011/2012 LiDAR Digital Elevation Model (DEM) available from the New York State GIS Clearinghouse. The LiDAR has a bare earth vertical accuracy of 15-centimeter root mean square error (RMSE) or better and horizontal accuracy of 50-centimeter RMSE. Refer to Attachment A for existing conditions cross sections and profiles.

Binnen Kill

A two-day field visit was completed to collect topographic and planimetric data at the Binnen Kill site on June 13 and June 14, 2018 (Figure 2). The field survey crew collected topographic and planimetric information at three locations, Crossing #1, Crossing #2, and the shoreline protection area.

Five profiles were measured along the shoreline at the shoreline protection area (Figure 2); each profile began landward of an observed high-water mark along the shoreline and extended waterward to a point along the shoreline where the water depth was four feet or less during low tide. At each shoreline profile, upland forest was present landward of the observed high-water mark, ranging in elevation from 8 to 12 feet. There was a 10 to 25 percent slope at the transition between the upland forest and beach. Over 80 feet of sandy beach occupied the land waterward of the observed high-water mark at shoreline profiles BK-1, BK-2, and BK-3, while only 20 to 40 feet of beach was present along profiles BK-4 and BK-5. Additionally, at shoreline profiles BK-3, BK-4, and BK-5, an existing cribbing structure approximately 5 to 15 feet in width was present waterward of the beach.

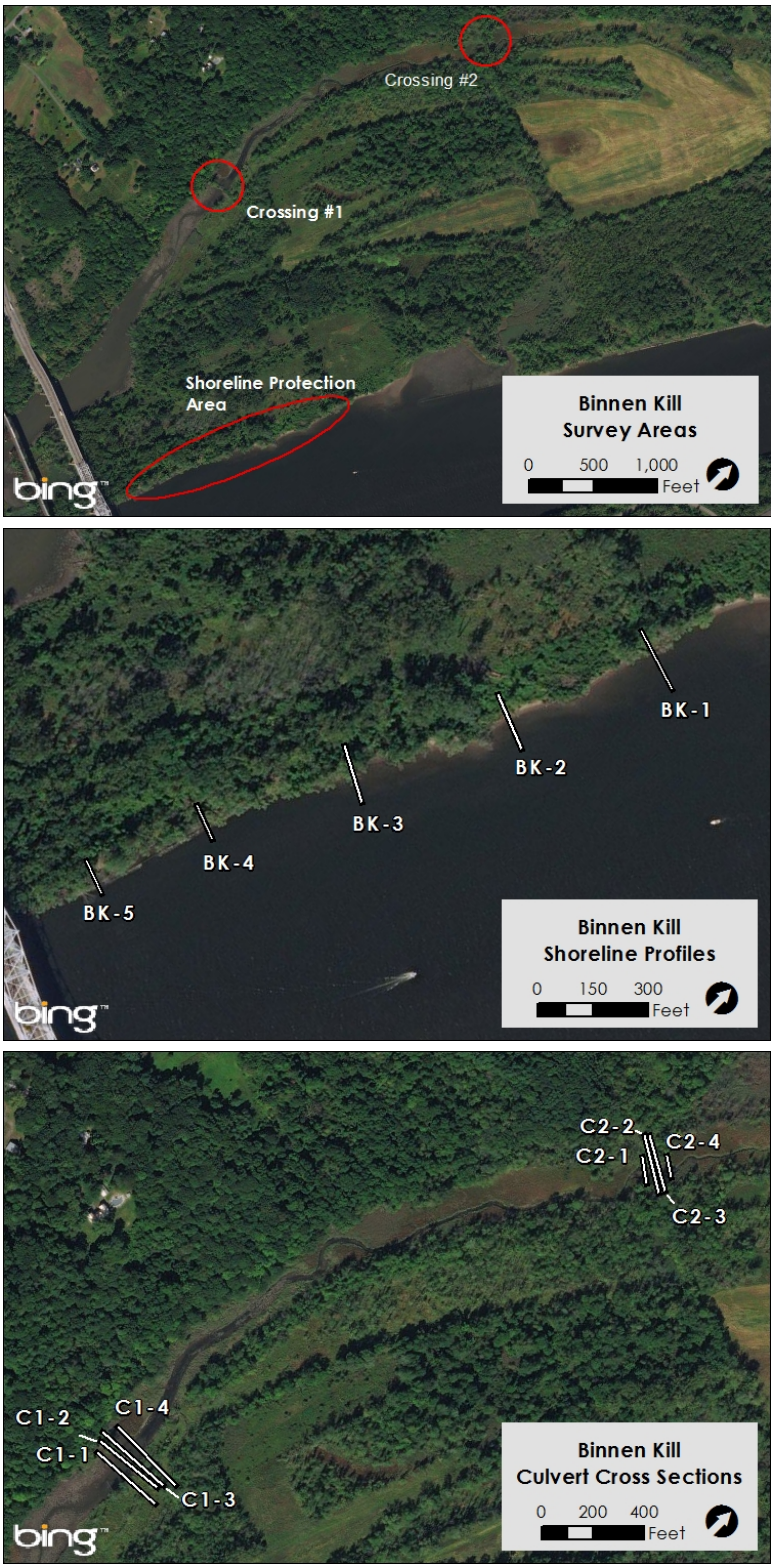

Figure 2: (Top) Three survey areas at Binnen Kill; (Middle) Shoreline profile locations collected along the Hudson River; (Lower) Cross section locations at each stream crossing.

Crossing #1 consisted of an approximately 45-foot wide steel girder supported bridge with a top of road crossing elevation of 4.31 feet. The low chord elevation of the bridge was 2.95 feet, 1.37 feet below the top of road crossing. The minimum elevation of the streambed under the road crossing was 0.00 feet, resulting in an average maximum of a 2.95-foot clearance under the crossing. The average existing stream bank slope was approximately 3.75 feet horizontal to 1 foot vertical while the existing grade upslope of the banks was approximately 20 feet horizontal to 1 foot vertical

Crossing #2 consisted of an approximately 20-foot wide earthen crossing with a top of road crossing elevation of 5.00 feet. The crossing contains a 56-inch diameter culvert with an invert elevation of -0.46 feet. The stream channel in this area was approximately 200 feet wide, measured from the river right and river left top of bank.

Schodack Island

Topographic data was collected at Schodack Island on June 4 and June 5, 2018. The river water level underwent a full tidal cycle during the duration of the visit. In total, data was collected at 20 shoreline profiles oriented perpendicular to the shoreline and spaced approximately 960 feet apart (Figure 3). On average, five data points were collected per profile at a spacing of approximately 10 to 20 feet. While sub-centimeter accuracy was achieved on the off-shore end of all profiles, tree cover interfered with GPS position accuracy on the landward ends of all profiles. The area under this tree cover consisted of dense forest which dominated the interior of the island. No points were collected at profile SI-10 as it was unable to be safely reached at the time of the site visit.

Profiles SI-1, SI-2, and SI-3 contained a sandy/silt beach waterward of upland forest. The upland forest was relatively flat, lying at an elevation of approximately 5 to 8 feet. At the transition between the upland forest and low-lying shoreline area, a 25 percent slope was present. Profile SI-2 also contained riprap reinforcing the beach area.

Profile SI-4 contained an intact timber cribbing structure. Landward of this structure was a low sloping shoreline area of riprap, followed by sandy beach, followed by wetland. A low sloping upland forest area was further landward at an elevation of approximately 5 feet. At the transition between the upland forest and low-lying shoreline area, a 30 percent slope was present. An eight-foot vertical

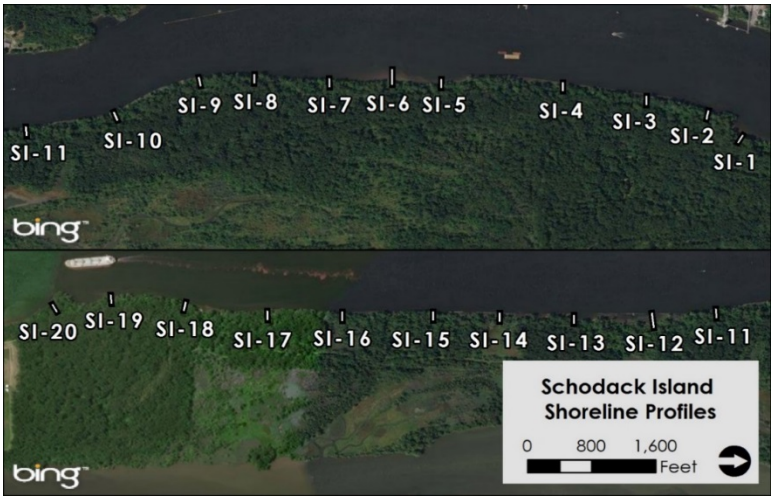

Figure 3: Surveyed Shoreline Profile location at Schodack Island.

drop off was present between the top of the cribbing structure and the Hudson River channel bottom.

Profile SI-5 contained an intact timber cribbing structure. Landward of this structure was a narrow sandy beach, approximately 20 feet wide. A low sloping upland forest area was further landward at an elevation of approximately 7 feet. At the transition between the upland forest and beach, an 80 percent slope was present. Waterward of the cribbing structure was a 15-foot-wide area of riprap, followed by low sloping area of sandy substrate mixed with riprap.

Profile SI-6 contained a 170-foot-wide, low sloping sandy beach area ranging in elevation from -2 to 2 feet. Landward of this beach was a ten percent slope, where the beach transitioned to a 15-foot-wide tidal wetland, and subsequently an upland forest.

Profiles SI-7, SI-8, SI-9, and SI-10 contained an intact timber cribbing structure. Landward of this structure was a 10 to 20-foot-wide area of riprap, followed by upland forest. The upland forest area was at an elevation of approximately 5 to 10 feet. At the transition between the upland forest and riprap, a 25 percent slope was present at SI-7, SI-8, and SI-10 while an 80 percent slope was present at SI-9. A 5 to 6-foot vertical drop off was present between the top of the cribbing structure and the Hudson River channel bottom.

Profile SI-11 contained an intact timber cribbing structure. Landward of this structure was a low sloping shoreline area of riprap, followed by sandy beach. A low sloping upland forest area was further landward at an elevation of approximately 8 feet. At the transition between the upland forest and low-lying shoreline area, a 60 percent slope was present. A vertical drop off of undetermined depth was present between the top of the cribbing structure and the Hudson River channel bottom.

Profile SI-12 contained a failing timber cribbing structure. Landward of this structure was a low sloping shoreline area of riprap, followed by mudflat and emergent wetland, followed by a sandy beach. A low sloping upland forest area was further landward at an elevation of approximately 6 feet. At the transition between the upland forest and low-lying shoreline area, a ten percent slope was present. An eight-foot vertical drop was present between the top of the cribbing structure and the Hudson River channel bottom.

Profile SI-13 contained a failing timber cribbing structure. Landward of this structure was a low sloping shoreline area of sandy beach. A low sloping upland forest area was further landward at an elevation of approximately 6 feet. At the transition between the upland forest and low-lying shoreline area, a 25 percent slope was present. A four-foot vertical drop was present between the top of the cribbing structure and the Hudson River channel bottom.

Profile SI-14 contained an intact timber cribbing structure. Landward of this structure was a low sloping shoreline area of riprap, followed by common reed, followed by a sandy beach. A low sloping upland forest area was further landward at an elevation of approximately 5 feet. There was a smooth transition between the upland forest and shoreline area, with a continuous eight percent slope. A vertical drop off of undermined depth was present between the top of the cribbing structure and the Hudson River channel bottom.

Profiles SI-15 contained an intact timber cribbing structure. Landward of this structure was a 15-foot-wide area of riprap, with a 30 percent slope, followed by low sloping upland forest. The upland forest area was at an elevation of approximately 3 to 5 feet. Further landward of the upland forest, approximately 80 feet from the cribbing structure, was an emergent wetland which appeared to be non-tidal. A vertical drop off of undermined depth was present between the top of the cribbing structure and the Hudson River channel bottom.

Profile SI-16 contained an intact timber cribbing structure. Landward of this structure was a low sloping shoreline area of riprap, followed by common reed. A low sloping upland forest area was further landward at an elevation of approximately 5 feet. At the transition between the upland forest and low-lying shoreline area, a 40 percent slope was present. A 1.5-foot vertical drop was present between the top of the cribbing structure and the Hudson River channel bottom.

Profile SI-17 contained an intact timber cribbing structure. Landward of this structure was a low sloping shoreline area of common reed. A low sloping upland forest area was further landward at an elevation of approximately 5 feet. At the transition between the upland forest and low-lying shoreline area, a 40 percent slope was present. A vertical drop off of undermined depth was present between the top of the cribbing structure and the Hudson River channel bottom.

Profile SI-18 contained an intact timber cribbing structure. Landward of this structure was a low sloping shoreline area of tidal wetland. A low sloping upland forest area was further landward at an elevation of approximately 3 to 8 feet. There was a smooth transition between the upland forest and shoreline area, with a continuous seven percent slope. A vertical drop off of undermined depth was present between the top of the cribbing structure and the Hudson River channel bottom.

Profile SI-19 contained a beach with a sandy substrate mixed with sparse riprap. Landward of this beach was a low sloping shoreline area of tidal wetland, approximately 40 feet wide. A low sloping upland forest area was further landward at an elevation of approximately 5 feet. There was a smooth transition between the upland forest and

shoreline area, with a continuous 12 percent slope. A higher sloping area was present within the upland forest, where elevations reach 10 feet over a 25 percent slope.

Profile SI-20 contained a sandy beach. A low sloping upland forest area was further landward at an elevation of approximately 5 to 10 feet. The upland forest area has a five percent slope while the beach has a 25 percent slope.

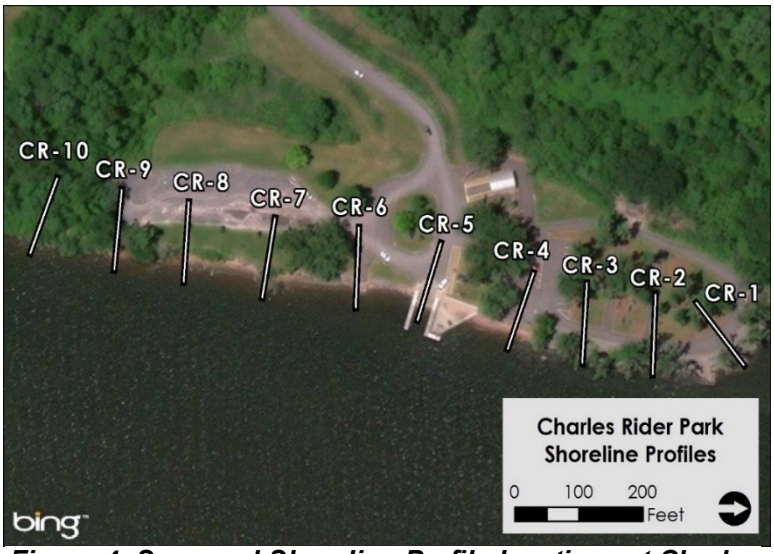

Figure 4: Surveyed Shoreline Profile locations at Charles Rider Park.

Charles Rider Park

Topographic data was collected at Charles Rider Park on June 8, 2018. The river water level was approximately at low tide and rising at the time of arrival. In total, data was collected at ten shoreline profiles oriented perpendicular to the shoreline and spaced approximately 110 feet apart (Figure 4). On average, 11 data points were collected per profile at a spacing of approximately 5 to 10 feet.

Due to the minimal tree cover in Charles Rider Park, sub-centimeter accuracy was achieved throughout most of the shoreline profiles. While sub-centimeter accuracy was achieved on the waterward end of all profiles, tree cover interfered with position accuracy on the landward end of some profiles, in particular profiles CR-9 and CR-10, which crossed into a heavily wooded area.

The landward portions of each shoreline profiles traversed the park's relatively flat upland area, ranging in elevation from approximately 5 to 7 feet. This upland area of profiles CR-1 to CR-8 consisted of parking areas and internal roadways run close to the shoreline, separated from the shoreline edge by 15 to 50 feet of maintained lawn. The upland area of profiles CR-9 and CR-10 consisted of forested habitat.

Shoreline profile CR-1 was located at the northern-most section of the site contained a small cove, partially protected by large rock material. The shoreline had a sandy gravel substrate mixed with riprap and had a slope of 17 percent.

Shoreline profile CR-2 contained a dilapidated timber cribbing and riprap structure. Between this structure and the upland area was an area of riprap set at a slope of 25

percent. A 6.7-foot vertical drop was present between the top of the cribbing structure and the Hudson River channel bottom.

Shoreline profile CR-3 contained a dilapidated timber cribbing and riprap structure. Between this structure and the upland area was an area of sandy cobble beach set at a slope of 20 percent. A 9.7-foot vertical drop was present between the top of the cribbing structure and the Hudson River channel bottom.

Shoreline profile CR-4 contained a sandy cobble beach set at a 17 percent slope. Between this beach and the upland area was a steep four-foot drop off, stabilized with large boulders.

Shoreline profile CR-5 contained the park's active concrete boat ramp, which extended from Charles Rider Road to the Hudson River at a 17 percent slope.

Profile CR-6 contained the park's remnant, degrading, boat ramp structure, which extended from Charles Rider Road to the Hudson River at a 13 percent slope. Waterward of this remnant structure was an area of riprap mixed with a cobble substrate.

Shoreline profiles CR-7 and CR-8 contained a dilapidated timber cribbing and riprap structure. Landward and waterward of this structure was an area of riprap mixed with cobble substrate set at a 15 percent slope. A steep five-foot drop off, stabilized with large boulders separated the upland area from the shoreline area.

Shoreline profile CR-9 contained a dilapidated timber cribbing and riprap structure. The structure and upland area were separated by an area of riprap mixed with cobble substrate set at a 13 percent slope. This riprap/cobble substrate also extended waterward of the structure into the riverbed at a similar slope.

Shoreline profile CR-10 contained a shoreline area with a mix of sandy and cobble substrate, as well as some riprap reinforcement. This shoreline was set at a 25% slope, extending waterward into the river bed and landward until transitioning to the flatter upland forest area.

Henry Hudson Park

Topographic data was collected at Henry Hudson Park on June 7, 2018. The river water level was approximately at high tide and falling at the time of arrival. In total, data was collected at ten shoreline profiles oriented perpendicular to the shoreline and spaced approximately 200 feet apart (Figure 5). On average, 12 data points were collected per profile at a spacing of approximately 5 to 10 feet.

While sub-centimeter accuracy was achieved on the off-shore end of all profiles, tree cover interfered with position accuracy on the landward end of most profiles. The area under this tree cover consisted of maintained grass which ran at a relatively low slope

from Lyons Road to the edge of the revetment structure. Additionally, high water markings from past storms were recorded on an onsite building; recorded flood depths were 1.5 feet in June 2012, 2.3 feet in August 2011, and 3.8 feet in January 1996.

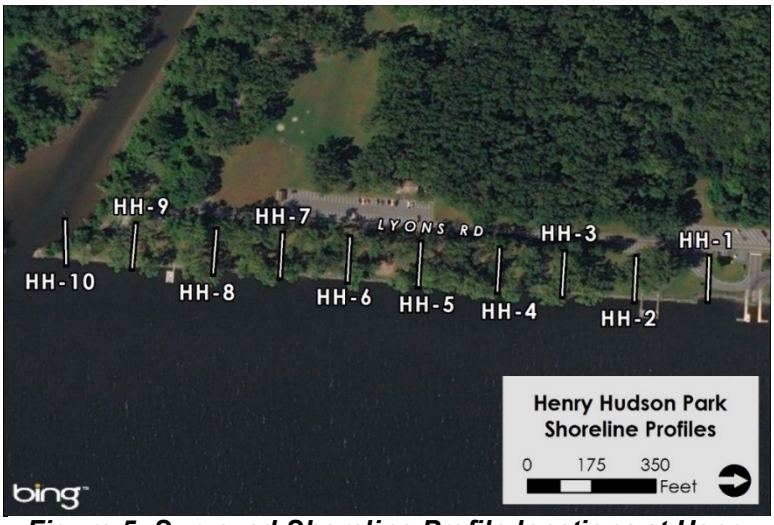

Figure 5: Surveyed Shoreline Profile locations at Henry Hudson Park

Surveyed shoreline profiles HH-2 to HH-10 consisted of a dilapidated timber cribbing structure filled with riprap between two timber crib walls and capped with convex concrete segments. Profile HH-1 was located immediately upstream of this structure where the shoreline was reinforced with only riprap. The majority of the cribbing structure was in varying states of disrepair; where structural failure was visible, landward erosion was also present. The grass area immediately adjacent to the shoreline structure ranged in elevation from 5 to 9 feet with an average slope of four percent. At the shoreline structure, the elevation drops seven feet over a length of 15 to 20 feet, with an additional vertical drop off between the top of the cribbing structure and the Hudson River channel bottom.

Moodna Creek

Investigation of Moodna Creek included three AOP barriers: AOP 1 (Utility Crossing), AOP 2 (Firth Cliff Dam), and AOP 3 (Orr's Mill Dam) in May 2018. The initial visit focused on access to each site, identifying fieldwork safety concerns, as well as initial investigation of potentially critical issues, including bedrock, downstream and upstream channel slopes, and site characteristics compatible for different fish passage alternatives as well as attempting to identify pipe undermining for the Utility Crossing. Flows were high during this initial site investigation.

After review of the FEMA profiles, aerial photos, and discussion after the May site visit, a more detailed site investigation was completed between June 21 and June 22, 2018. These visits included surveying the AOP feature and measuring cross sections and longitudinal profiles of Moodna Creek with a GPS.

AOP 1: Utility Crossing

The AOP 1 barrier was surveyed on June 21, 2018. The site was accessed through the active construction zone on river left (north of channel). The primary goals for this site investigation, informed by the May site visit, included:

- Collect cross-section and structure elevation data;
- Verify bed configuration above and below pipe;
- Assess if pipe might be undermined;
- Assess if there is a significant scour hole downstream;
- Identify where a rock ramp would connect back into grade; and,
- Gather data on the upstream rapids (boulder steps) to assess fish passability and potential for use as a reference reach for a ramp.

Low flow conditions were present and the field crew was able to safely walk across the utility crossing. Cross sections at, above, and below the crossing, and a longitudinal profile of the estimated channel thalweg including the upstream riffle and the boulders downstream where the rock ramp would connect into grade were measured. The sediment was coarse-grained and compact (i.e. bedload), and not manually penetrable in the channel with rebar; sediment depths are negligible.

The utility crossing is encased in concrete, and approximately five feet wide (Photograph 1). The encasement has a vertical downstream face with a 6 to 12-inch lip just below water surface elevation. However, the lip is not continuous across the structure. Based on a visual assessment, there is limited scour undercutting the concrete encasement. The deepest point in the scour hole downstream of the encasement was observed to be four to five feet below water surface elevation.

Minor flow under the utility crossing structure was observed, suggesting the utility crossing was starting to be undermined. During the low flow conditions, a softball sized hole in the river bed sediment was observed; turbid water stirred up at the hole was observed flowing into the hole and thus beneath the concrete encasement.

At the utility crossing, the river left bank is two feet above water surface elevation, while the river right bank is stabilized with large angular rip rap on a slope rising 15 to 20 feet above water surface elevation (Photograph 1).

Photograph 1: AOP #1, view of utility crossing and river right bank.

Large boulder substrate was observed in the scour hole, along the banks, and on the failing downstream slope.

The boulder steps exist upstream of the utility crossing at the location of the upstream landslide. At this feature, the main flow goes through two steep drops (Photograph 2), one of which is about five feet, the other about four feet. These drops are likely not passable for fish passage and rock configuration may need to be adjusted during construction of any alternatives to ensure fish passability. The secondary flow paths have smaller vertical drops but have lower water depths, and thus remain a fish passage concern, at least at low flows.

Downstream of the utility crossing, there are three to four-foot boulders into which the rock ramp grade could be tied (Photograph 3).

There is a destabilized valley wall downstream of the utility crossing which would need to be considered for any design alternative, as it could present long-term channel stability issues.

Photograph 2: View of upstream boulder steps which may be a natural AOP barrier.

Photograph 3: View of boulders to tie into rock ramp downstream from the utility crossing.

AOP 2: Firth Cliff Dam

The AOP 2 barrier was surveyed on June 22, 2018. The site was accessed through the stormwater outflow channel immediately upstream of the factory on river right after receiving permission from the adjacent homeowner. The primary goals for this site investigation, informed by the May site visit, included:

- Collect cross-section and structure elevation data;
- Probe impounded sediments;
- Assess if the dam is fixed on bedrock; and,
- Verify grade control downstream and upstream of the dam.

The impoundment was deep enough that the survey profile and cross sections in this area were completed from a jon boat. While low-flow was evident at the other sites on Moodna Creek, water was spilling over Firth Cliff dam. Water depth was less than an inch over the crest of the dam, suggesting that the dam is not leaking; no evidence of leakage could be seen.

The dam had a crest that was two feet wide. The downstream spillway sloped down an estimated nine feet with an approximate one-foot thick lip at the bottom of the spillway.

A large abutment straddles each side of the dam. On river left, the abutment is about 60-feet long and two-feet wide. River left valley wall near the dam is steeply sloped, nearly vertical in places. River right does not have a steep valley wall, but immediately beyond the impoundment is the factory parking lot. This parking lot is not in use and appears to

be abandoned. Access through the factory to the dam could not be obtained; therefore, detail about the abutment is lacking.

On river right, the abutment also shows evidence of a gate structure which likely included a diversion for a mill race. The gate is on the upstream end of the abutment and was about six-feet wide and with gate guides that are an estimated three-feet high. Silt blocked most of the height of the actual diversion suggesting the gate has not been used recently.

Sediment in the first cross-section above the dam was very coarse sand and small gravel with an estimated D_{35} = 8 mm, D_{50}=12 mm, and D_{85} = 35 mm. Sediment was compact and could only be probed manually with rebar 2 to 5 inches with the exception of a downstream log debris area where fine sediment deposited was approximately 2 feet deep. At the second cross-section upstream of the dam, the material was coarser, with an estimated D_{35} = 14 mm, D_{50} = 24 mm, and D_{85} = 110 mm. The grain size distribution at this cross-section was likely bi-modal; that is, both fine gravel and boulders were the most frequently observed size classes. Throughout the length of the impoundment, localized scour near the boulders was observed along both river banks, so the bi-modal grain size distribution was typical. Near the left bank at this cross-section, unconsolidated gravels were probed approximately 12 to 14 inches in depth. At the third upstream cross-section, sediment grain size was estimated at D_{35} = 3 mm, D_{50} = 12 mm, and D_{85} = 30 mm. Here, large boulders were along the end of bank on both sides. The fourth upstream cross section consisted of mostly large cobble and boulders, with a D_{35} = 100 mm, the D_{50} = 300 mm, and D_{85} = 7500 mm. Upstream, there were bedrock/glacial erratics on the banks (Photograph 4) that would maintain bank stability in the event of dam removal. These were located with the GPS, as well as large boulders in the channel which would likely maintain grade control if the dam was altered or removed.

Photograph 4: View of large glacial erratics on the river left bank.

Downstream, the main channel is along the river right bank. Immediately downstream of the dam, a riffle and pool sequence began, which serves as the grade control downstream of the dam.

It was difficult to determine if the dam was on bedrock. There is bedrock/glacial erratics along this stretch of Moodna Creek, so it is a distinct possibility; however, this could not be confirmed.

AOP 3: Orr's Mill Dam

The AOP 3 barrier was surveyed on June 21 and June 22, 2018. The site was accessed through the dam owner's yard on river left upon obtaining permission. The primary goals for this site investigation, informed by the May site visit, included:

- Collect cross-section and structure elevation data;
- Probe impounded sediment;
- Assess if there would be falls or rapid post dam removal;
- Verify the scour hole; and,
- Verify grade control downstream of the dam.

During both days, the flows were wade-able throughout most of the impoundment. Upstream water surface elevation was about two feet below the crest of the spillway – flow is actively conveyed under the dam spillway. While this low flow condition was in contrast to the May site visit, a land-owner said this water level was typical of the last three to four years.

Survey points of cross sections of the spillway and crest of the dam, above and below the crossing, and a longitudinal profile of the channel thalweg including below the bridge downstream of the dam and upstream to the riffle where the channel bifurcates around the island demarcating the end of the impoundment were collected. The sediment was compact, primarily bedload, and was not penetrable with a manual probe; as such, there are no substantial fine sediment accumulations impounded by this dam.

The dam itself is unique. The spillway is made of boulders with steel I-beams and timbers running longitudinally along the spillway, and capped with a layer of concrete. A historical photo from circa 1900 confirms that the dam at that time was a stone dam and the reinforcement and concrete were added at a later date. There are multiple holes in the concrete cap where timber and stone underneath can be observed (Photographs 5 and 6).

The downstream edge of the spillway is elevated two feet above the downstream river bed. Water can be seen flowing out from below the spillway clearly indicating that the dam is leaking. Additionally, upstream of the dam, water can be seen creating a vortex as it flows into leakage holes (Photographs 7 and 8). Any bypass fishway would necessitate significant improvements and repairs to the dam.

There are large 5 to 10-foot boulders immediately downstream of the dam across the channel. On river left, there is a scour pool with a maximum depth of 5.5 feet. On the downstream side of the bridge, there are boulders that would as channel grade control below the bridge (Photograph 9).

Photograph 5: Boulder embedded in concrete spillway.

Photograph 6: hole in concrete spillway revealing timber.

Photograph 7: Leakage under Spillway Downstream of Dam.

Photograph 8:1 Vortex Forming in Impoundment due to Leakage.

Photograph 9: 2 Looking downstream from bridge.

There are large 5 to 10-foot boulders immediately upstream of the dam as well. It appears as though the historical dam is made from boulders from this stream that were moved from immediately upstream and immediately downstream of the dam location. These boulders from the dam could be re-used in the case of any dam deconstruction. Additionally, a natural boulder cascade or bedrock falls may be present in the vicinity of the current dam location. In addition to the large boulders, the lower impoundment is made of large cobble with limited bedrock outcrop and/or glacial erratics.

On river right above the dam, there is a point bar mostly consisting of sand, gravel, and cobble with some boulders.

Upstream, there are large boulders and glacial erratics that would serve as grade control. The change from the cobble/gravel in the impoundment to these large boulders signifies the end of the impoundment and likely serve as an upstream grade control.

Photograph 10: Point Bar in Lower Impoundment on River Right.

There are two legacy millraces that historically bypassed flow to mill buildings that are now residential. Historically, the river right millraces extended from downstream of the dam, underneath the porch of the existing house, and connected with Moodna Creek upstream. However, the millrace currently extends from downstream of the dam to the brick wall on the side of the house. There is no current millrace from the house to tie into the upstream edge of the river. The elevation of the current millrace is higher than the downstream river channel by approximately five feet. Repurposing this millrace into a fishway would require extensive repair, alteration of the residential buildings, and new construction, thus limiting its feasibility.

Photograph 11: Looking Upstream at Edge of Impoundment.

The legacy millrace on the river left connects upstream of the dam near the dam abutment, and continues into a 15-

foot culvert underneath the abutment and then through a 50-foot-long, 5x5 foot box culvert underneath the road. That culvert and dam spillway each empty into a holding pond approximately four feet deep. The grade continues to drop in elevation, approximately eight feet, until it connects with the river at least 50 feet downstream.

The existing river left millrace would not be feasible as a fishway because it discharges to the main channel too far downstream of the dam. Downstream of the riffle below the bridge, a large landslide can be seen. This will have to be taken into account with any construction for this project since there is a development at the top of the hill.

Photograph 12: River Left Sluiceway under Culvert for Abutment (Left)) and Road (Right).

Photograph 13: River Left Spillway.

Rondout Creek – Eddyville Dam

The lack of Right of Entry access and high-water flow prevented the collection of field data for Eddyville dam on Rondout Creek. However, site data collected in a previous independent project was reviewed; while the topographic data is not summarized as part of this effort, site observations used to develop the alternatives are presented below.

Independent field data collection efforts were conducted to confirm the FEMA profile and gather information regarding channel cross-section geometry. Access was limited to measurements collected directly in the river. Water depths were measured by graduated range rods and a depth sounder upstream and downstream of the dam by jon boat and a larger motorized boat. Where water depths were low enough, water depth readings were taken with probing rods from the water surface to top of sediment and through to refusal, or to solid riverbed when impounded sediment was absent. Little impounded sediment was found upstream of the dam and the stream bed was deeply excavated, reportedly from rock mining. River substrate consisted primarily of bedrock and cobbles.

Photograph 14: Historical Illustration of Eddyville Dam

The irregular profile and deep excavated pools shown on the FEMA profile were confirmed and, in some cases, the pools were significantly deeper than the FEMA profile depicted. Further field investigations are necessary to determine the ledge height below the dam and better assess the dam condition.

The dam seems to be a stone masonry dam capped with concrete although an older timber crib structure might also exist along the upstream side of the visible stone masonry but cannot be confirmed at this time. The dam is stone and cement construction with a wood face.

Photograph 15: Eddyville dam at Low Tide with Low Flows (3 July 2001)

Field observations also confirmed that the Rondout Creek channel where the dam is located is likely not the original channel alignment. The channel was significantly altered during the period when the canal was developed. Historical records and field investigation suggest that the original channel was located on the northern side of what is now a peninsula extending south from the left bank of the former river. Historic records refer to this peninsula as a former island after the canal was constructed. There is clear evidence of bedrock removal from the current channel just downstream of the dam and downstream bridge, suggesting that there was formerly a high ledge that precluded flows from being conveyed down the current channel path (perhaps high flows overtopped this ledge but due to the high ledge height this is not confirmed at this time). Remnants of the former canal still exist along the northern side of the river downstream of the dam and downstream bridge.

2.2 Geotechnical Investigation

Geotechnical and soils data were not collected during this phase of the project. An overview of the geology and geotechnical setting of the study area is provided in the main report (Section 2.4 Geological Setting).

2.3 Hydrologic and Hydraulic Analysis

The Hudson River and its tributaries are subject to both riverine flow and tidal influence where elevations are within the tidal range. Water level gages were installed at multiple locations to collect river stage and tidal fluctuation data to inform the restoration designs. Detailed hydrologic and hydraulic modeling was not completed for this feasibility assessment for the Binnen Kill, Schodack Island, Charles Rider, Rondout Creek, and Henry Hudson Park sites due to the wide array of sites that were considered and the possibility that some sites would be eliminated from consideration due a variety of other factors and constraints. Detailed hydrologic and hydraulic modeling is planned for the PED phase (See Section 11). An initial hydraulic model was developed for the AOP barriers on Moodna Creek and utilized for the Assessment of Hydraulic and Sediment Conditions – see Section 3. Each of the project sites, excluding the Moodna Creek sites, experience semidiurnal tides, two high and two low tides of approximately equal size every lunar day. While riverine discharge and velocity data were not incorporated into the concept designs, tidal datum elevations (mean tide, mean high water, etc.) for the year 2027 informed design elevations.

For each project site, 2018 tidal datum elevations were calculated using tide gauges (Table 2.1). Long-term tide gauge stations were selected based on their proximity to the site and period of observation. The calculated tidal datum elevations then served as the baseline condition in the sea level change analysis, as discussed in Section 3.

Additionally, five pressure transducer data loggers were deployed in the Binnen Kill and Schodack Creek (Figure 6) from June to November 2018 to characterize the hydrological relationship of the tributaries to the Hudson River. Three data loggers were deployed within Binnen Kill, one in the lower portion of the tributary (BK-1), a second upstream of the AOP-1 crossing (BK-2), and a third upstream of the AOP-2 crossing (BK-3). An analysis of the observed water surface elevations confirmed that the crossings do not constrict the tidal datum between Binnen Kill and the Hudson River. The head of tide in Binnen Kill lies upstream of the project area. Tidal datums

Two data loggers were deployed within Schodack Creek, one in a cove approximately midway along Schodack Island (SI-3) and a second towards the upstream end of Schodack Island (SI-2). An analysis of the observed water surface elevations confirmed that there are no constrictions to the tidal datum between Schodack Creek and the Hudson River. The head of tide in Schodack Creek lies upstream of the project area.

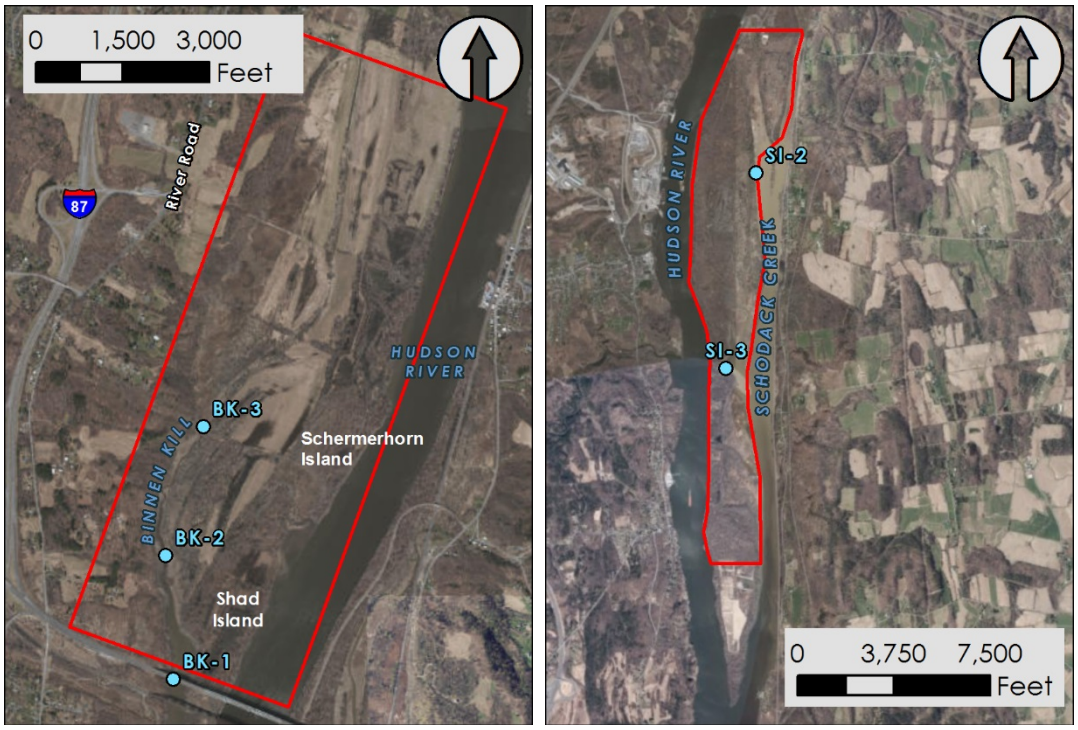

Figure 6: Supplemental data logger locations (blue points) at Binnen Kill (Left) and Schodack Island (Right). Approximate site boundaries in red outline.

Data at all five local gauges were collected in 15-minute intervals from mid-June 2018 through October 2018. Final datum calculations did not include data from the month of October due to time constraints. HEC-DSSVue, version 2.0.1 was used to calculate the tidal datums and the results from some of the data sets were confirmed "by hand" with scripts written in Excel to ensure accuracy.

Datums at the lower end of the tide cycle (MLW and MLLW) were not accurately calculated because in some cases the lowest water surface elevations could not be recorded, producing a truncated signal. Therefore, some of the data collected at the low end of the tide cycles were unreliable and could not be used.

If the MHHW, MHW and Mean Tide Level (MTL) datums can be calculated at a local gauge, the Modified Range Ratio method (NOAA, 2003) can be used to determine MLW and MLLW, but only if a nearby long-term gauge is also available. For greatest accuracy in predicting long-term sea level change trends, datums from local gauges should be correlated to a nearby long-term gauge for which data have been collected for an entire 19-year epoch.

Datums recorded at the NOAA Albany gauge (Station ID# 8518995) are based on data collected from July 1982 to June 1987, far short of an entire 19-year epoch. It is not possible to accurately develop long-term datums for the local tide gauges that are correlated to the NOAA Albany gauge. Additionally, a sea level change trend is not

available for this gauge. The nearest long-term NOAA gauge for which a sea level change trend is recorded on the Hudson River is at The Battery in NY Harbor (Station ID # 8518570), more than 200 miles away.

The next available long-term gauge is the HRECOS gauge (Hudson River Environmental Conditions Observing System (www.hrecos.org), which is located in the Hudson River at Schodack Island. Historic data are available from 2008 to present. Again, a full 19-year epoch of data are not available for accurate correlation with the local gauges. For the purpose of this study, datums for the HRECOS Schodack gauge were calculated from January 2013 through October 2018. The datums resulting from this time period were presented in *Table 2.1: Tide Gauge Data Collection.*

Because it was not possible to properly correlate data from the short-term local gauges with a nearby long-term NOAA gauge, data from the 5 locally-deployed tide gauges were ultimately not used for determining current and future water surface elevations; however, these data from the local gauges have served to confirm the results of longer-term HRECOS datums. Datums calculated from HRECOS Schodack were selected as the design datums for the Henry Hudson Park, Binnen Kill and Schodack Island sites, as this was the best available data in both proximity to sites and length of data collection. The calculated datums were used to develop wetland plant community elevation ranges which are presented in section 7.1. There are no applicable regulatory datums of concern in the Hudson River. The sea level rise trends from The Battery, NY were applied to the HRECOS Schodack Island datums to determine future water surface elevations at these sites. As discussed in section 11, records from HRECOS Schodack shall continue to be the best available data proximate to the site; potential datum uncertainties shall be mitigated through bio-benchmark surveys performed at nearby reference sites.

Table 2.1: Tide Gauge Data Collection and Design Tidal Datums

Site		The Battery (Mile 0)	Charles Rider Park (Mile 95)	Rondout Creek (Mile 90)	Henry Hudson Park (Mile 138), Binnen Kill (Mile 136), & Schodack Island (Mile 134)
Station		NOAA The Battery, NY Station (8518750)	USGS Poughkeepsie (01372058)	NOAA Hyde Park Station (8518951)	HRECOS Schodack Island Station
Datum Source		NOAA Published Datums (1983 – 2001 Epoch)	USACE Analysis 1/1/2013 – 9/25/2018	NOAA Published Datums (1983 – 2001 Epoch)	USACE Analysis 1/1/2013 – 9/25/2018
Station Mile		Mile 0	Mile 77	Mile 81	Mile 134
2018 Tidal Datums	**MHHW**	2.28	2.47	2.32	3.80
	MHW	1.96	2.17	1.93	3.47

(NAVD88 feet)	MTL	-0.30	0.54	0.18	1.12
	MLW	-2.57	-1.19	-1.58	-1.42
	MLLW	-2.77	-1.39	-1.78	-1.63

Notes:
1. This table only includes the prospective project sites that are tidally influenced.

Binnen Kill

Semidiurnal tides at the site range in elevation from 3.80 feet at Mean Higher High Water (MHHW) to -1.63 feet at Mean Lower Low Water (MLLW) (Figure 7) based on HRECOS monitoring station located at Schodack Island approximately 1 mile downstream of the Binnen Kill confluence with the Hudson River.

Binnen Kill proper has both tidal and non-tidal portions. The tidal portion begins at its confluence with the Hudson River below Castleton Bridge and extends upstream for approximately 7,500 feet. A bridge (AOP 1) and culvert crossing (AOP 2) span this segment of the stream. The head of tide is upstream of AOP 2 and outside of the project area.

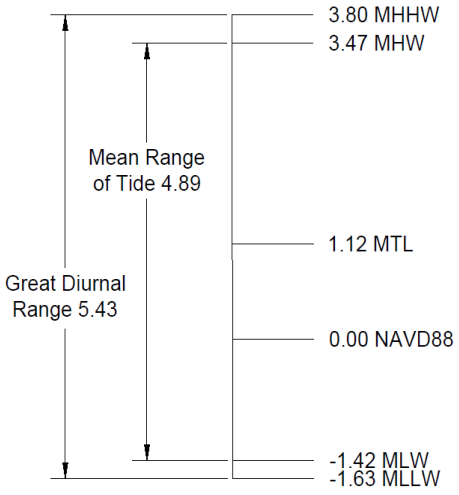

Figure 7: Henry Hudson Park, Binnen Kill, and Schodack Island Tidal Datum Relative to NAVD88, feet.

Schodack Island

Semidiurnal tides at the site range in elevation from 3.80 feet at MHHW to -1.63 feet at MLLW (Figure 7) based on the HRECOS monitoring station located on-site. Tidal influence likewise extends into Schodack Creek based on monitoring of water surface elevations within Schodack Creek from June to November 2018 in the monitored area which included stations at the southern extent of the north and south components. In other words, the tidal elevations in Schodack Creek are comparable to those of the Hudson River.

Henry Hudson Town Park

Semidiurnal tides at the park, range in elevation from 3.80 feet at MHHW to -1.63 feet at MLLW (Figure 7) based on the HRECOS, Schodack Island Station located approximately 4 miles upstream of the park.

Charles Rider Park

No local tide gauges were deployed at Charles Rider Park. The nearest established gauges are the USGS Poughkeepsie gauge (Station ID # 01372058) and the NOAA Hyde Park gauge (Station ID# 8518750). The datums calculated at the USGS Poughkeepsie gauge are based on data collected from January 2106 through August 2018; the datums

calculated at the NOAA Hyde Park gauge are based on data collected from May 2014 through July 2014. The USGS Poughkeepsie gauge data is more recent than that of the NOAA Hyde Park gauge and covers a greater time period, and therefore were used for calculating the datums that will be used for the design of Charles Rider Park. The USGS Poughkeepsie gauge is located approximately 18 miles downstream from the park.

In the absence of a nearby long-term NOAA gauge to which the shorter-term USGS gauge can be correlated, the sea level rise trends from the NOAA gauge at The Battery, NY were applied to the calculated USGS Poughkeepsie gauge datums to determine future water surface elevations.

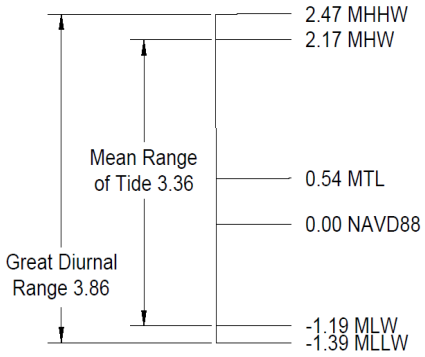

Figure 8: Charles Rider Tidal Datum Relative to NAVD88, feet.

Semidiurnal tides at the Park, range in elevation from 2.47 feet at MHHW to -1.39 feet at MLLW (Figure 8).

Rondout Creek – Eddyville Dam

The Eddyville Dam serves as the upstream limit of tidal influence in Rondout Creek. Semidiurnal tides at the dam, range in elevation from 2.32 feet at MHHW to -1.78 feet at MLLW based on the NOAA Hyde Park Station located approximately downstream of Rondout Creek / Hudson River confluence.

2.4 Discharge, Velocity, and Wave Action

Discharge, velocity, and wave/wake action calculations were not completed during this phase of the project. The need for additional hydrologic and hydraulic analyses is noted in section 11. The risks of this expedited approach are discussed in the risk register and have been considered in the contingencies for these projects.

2.5 Salinity and Water Temperature Observations

Salinity or temperature measurements were not collected during this phase of the project. Salinous water pushes up the Hudson Estuary and is diluted by freshwater flow as it moves north. Under average precipitation patterns, the estuary's salt front usually remains in the Tappan Zee (Tappan Sea), downstream of each of the project sites, during the spring; and pushes northward to Newburgh Bay, upstream of Rondout Creek and downstream of the other project sites, during the summer. For the purposes of this project, it was assumed that the project sites were predominantly freshwater systems.

3. Qualitative Assessment of Hydraulic and Sediment Conditions

An assessment was completed of the anticipated changes in hydraulic conditions and the transport of impounded sediment upon the implementation of the recommended plans (or

optimized alternatives) for the three AOP barriers on Moodna Creek. Refer to Attachment B for the full report. The recommended plans for each AOP barrier are as follows:

- AOP #1, full removal of the Utility Crossing;
- AOP #2, full removal of the Firth Cliff Dam spillway; and
- AOP #3, the breach of the Orr's Mill Spillway, including removal of the central portion of the spillway while retaining and stabilizing the sides of the spillway.

This assessment utilized observations from field investigations, interpretation of river channel survey, and results of preliminary hydraulic modelling that compare existing and anticipated conditions. The primary step in evaluating the changes in sediment transport and subsequent hydraulic conditions involved determining the anticipated equilibrium profile of the river (i.e. the average channel invert) following implementation of the recommended plans. After the removal or breach of a dam/barrier, Moodna Creek will adjust by eroding down vertically into impounded sediment and re-equilibrating at or close to the pre-dam channel profile. This anticipated equilibrium profile represents an average elevation, which the river can be expected to fluctuate above and below gradually through time. Sediment characteristics and probing data and the surveyed longitudinal profile of the river were used to establish the equilibrium profile at each AOP site. The equilibrium profile was in turn used to quantify the volume of impounded sediment, assess the magnitude and extent of channel adjustments, and predict channel dimension, pattern, and profile for modeling hydraulic conditions post-barrier removal. Impounded sediment volume was compared with the average annual watershed sediment yield following broad-level estimating procedures published in the literature.

An existing hydraulic model was updated with in-channel survey for each AOP barrier. The flows modeled for this assessment included the 1 Percent Annual Chance Flood Hazard discharge from the effective 2009 FEMA FIS, and the annual median discharge and the bankfull discharge, calculated using USGS StreamStats. Hydraulic modeling was then completed to compare existing conditions with the anticipated conditions for each recommended plan at each AOP barrier.

At AOP #1 (Utility line), results indicate that its removal would mobilize a volume of impounded sediment that is equivalent to less than 1% of the annual watershed sediment yield volume. In addition, removal of the utility line would create a minor reduction in flood elevations, or approximately 0.8 feet in the 1 Percent Annual Chance Flood. At AOP #2 (Firth Cliff Dam), results indicate that its removal would mobilize a volume of impounded sediment that is equivalent to 4 - 10% of the annual watershed sediment yield volume. In addition, removal of the dam would create a minor reduction in flood elevations, or approximately 5.8 feet in the 1 Percent Annual Chance Flood. At AOP #3 (Orr's Mill Dam), results indicate that its breach would mobilize a volume of impounded sediment that is equivalent to 4 - 10% of the annual watershed sediment yield volume. In addition,

breach of the spillway would create a minor reduction in flood elevations, or approximately 3.5 feet in the 1 Percent Annual Chance Flood.

Implementation of the recommended plans at the three AOP barriers will likely require additional (i) topographic survey and (ii) sediment sampling and analysis for potential pollutants in the Preconstruction Engineering and Design (PED) phase to complete planning, engineering design, and permitting.

4. Relative Sea Level Change Analysis

The Department of the Army Engineering Circular ER-1100-2-8162 (Dec 2013) requires that future sea level change projections must be incorporated into the planning, engineering design, construction and operation of all civil works projects. The project team should evaluate structural and non-structural components of the proposed alternatives in consideration of the "low," "intermediate" and "high" potential rates of future sea level change for both "with" and "without project" conditions. This range of potential rates of change is based on findings by the National Research Council (NRC, 1987) and the Intergovernmental Panel for Climate Change (IPCC, 2007).

The conducted analysis was done consistent with procedures in EP 1100-2-1 (Jun 2019.) The relative sea level trend for the NOAA gauge station at The Battery, NY is 2.84 mm/yr, which was applied to the HRECOS Schodack and USGS Poughkeepsie tidal datums. These RLSC projections did not consider any degree of attenuation, which may be significant given the distance between the NOAA gauge station at The Battery and the project sites (over 130 miles). RSLC projections and project features will be refined in PED phase to account for this consideration. It is noted that designs were developed to deliver benefits both immediately and in future years for a wide range of RLSC scenarios. The risk of the existing uncertainty with regard to the degree of actual RSLC attenuation is therefore considered negligible. Figure 9 shows the sea level trend at The Battery, NY. Estimated relative SLC projections from 1992 to 2100 for the NOAA gauge station at The Battery, calculated with the USACE Sea Level Change Curve Calculator and plotted against the low and high vegetation habitat ranges at Schodack Island and Henry Hudson Park are presented in Figures 10 and 11. Each figure notes the period of analysis for each site as well as the project thresholds of the Low Marsh lower limit and the High Marsh upper limit. Without considering the impact of accretion, conversion of low marsh to mudflat will begin when the magnitude of RSLC reaches the low marsh threshold. This conversion will however be offset in that all habitat ranges are afforded ample room to migrate landward and upward in response to RSLC change. As low marsh converts to mudflat, high marsh converts to low marsh, scrub-shrub converts to high marsh and upland converts to scrub-shrub. The evolution of these habitat ranges is modeled and discussed in detail in Appendix C. The upper threshold, the High Marsh upper limit represents the elevation at which RLSC will overcome all the original design elevations.

Here again, however, the figures and threshold shown do not consider the dynamic interaction between rising sea levels, accretion and landward/vertical migration of wetland habitat communities. Elevation changes due to accretion, which is modeled in the sea level change analysis discussed in this appendix, are not represented here. These elevation changes have a significant impact on project performance as the project thresholds, shown as static in Figures 10 and 11, are projected to rise at rates that will significantly offset the impacts of RLSC. Accretion and its impact on project performance is discussed in detail in Attachment C. The offset of RSLC changes through accretion, along with the fact that the attenuation of RSLC has not been considered at this point of this study, suggest a high probability of success for these projects for the period of analysis and that the thresholds indicated in Figures 10 and 11 will not in fact be exceeded. In the event that the thresholds are in fact reached, Schodack Island provides ample room for the continued landward migration of wetlands. Henry Hudson Park, though somewhat more constrained, also possesses a considerable amount of upland that will allow for upland to high marsh and high marsh to low marsh conversion for the considered period.

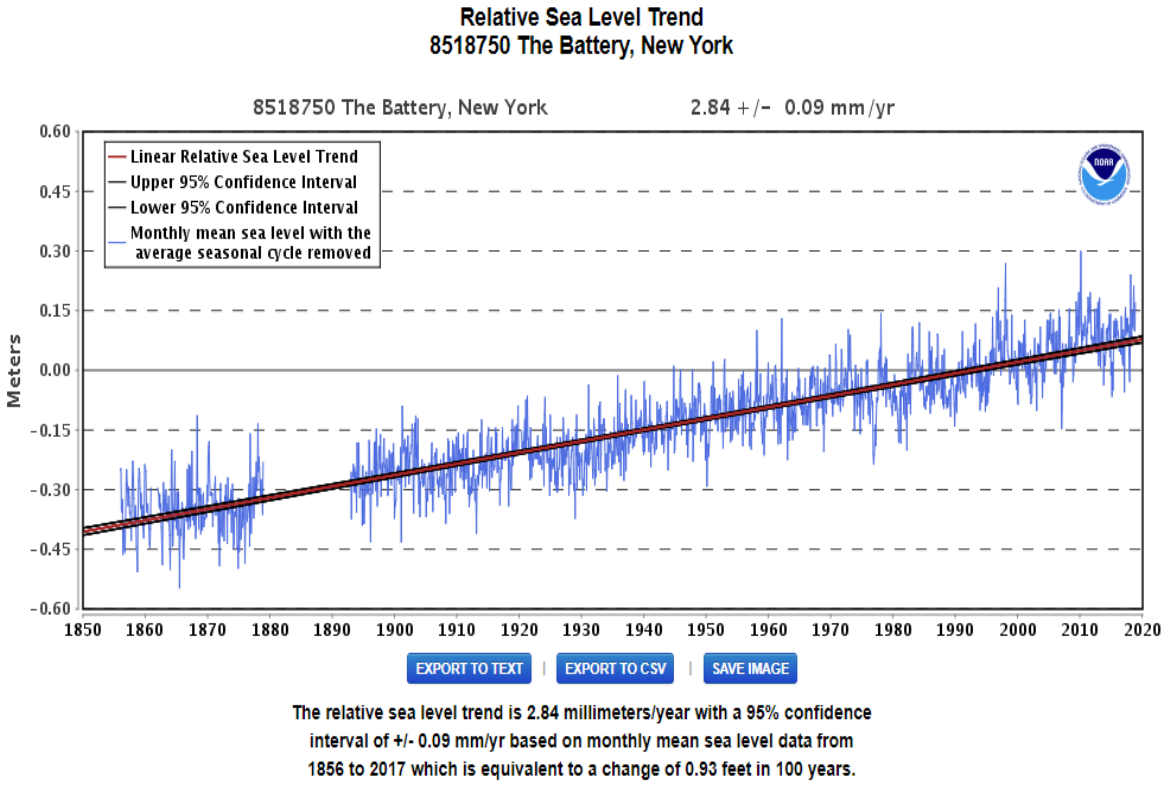

Figure 9. Relative sea level trend for the NOAA gauge station at The Battery, NY

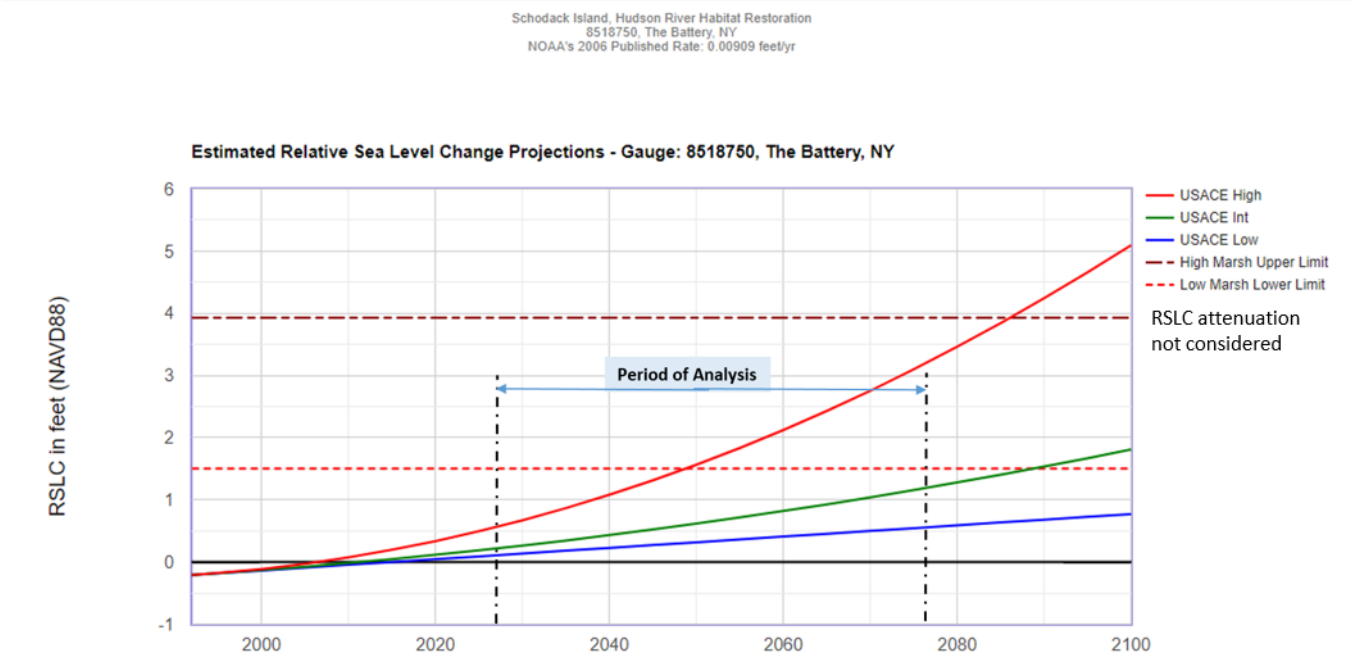

Figure 10. Relative Sea Level Change Projections, 1992-2100, Gauge: The Battery, NY (#8518750) with Schodack Island Thresholds.

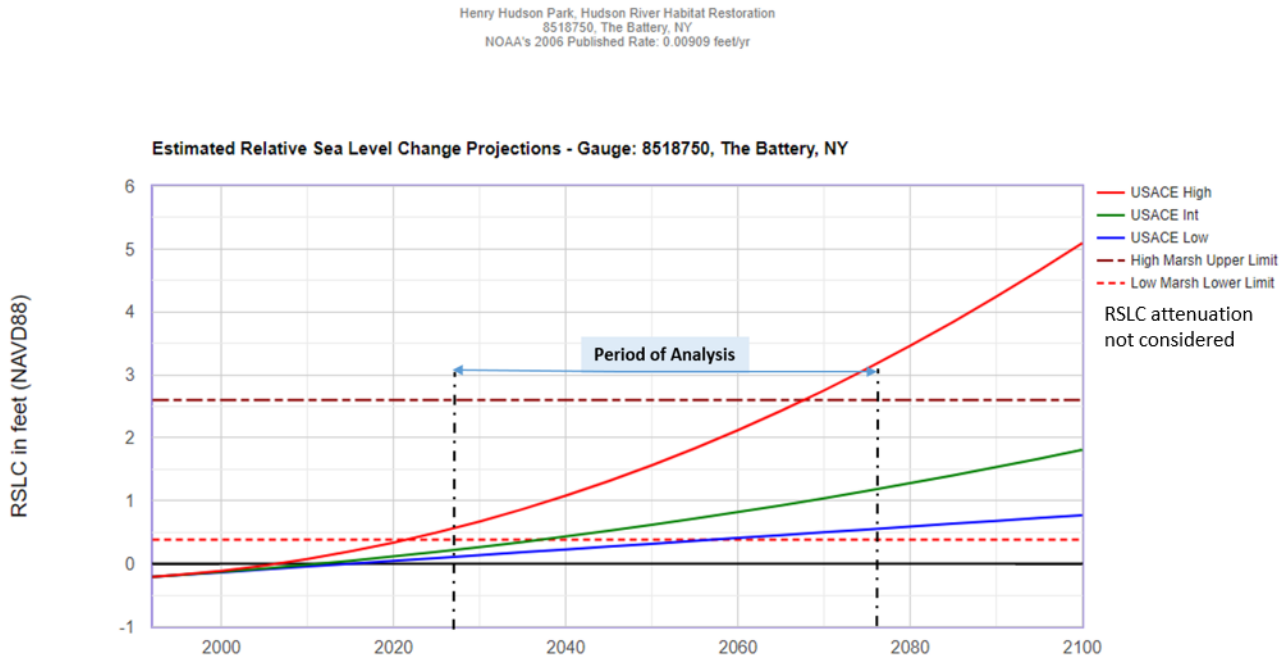

Figure 11. Relative Sea Level Change Projections, 1992-2100, Gauge: The Battery, NY (#8518750) with Henry Hudson Park Thresholds.

Rates of sea level change along New York's coastlines have averaged 1.2 inches per decade since 1900 (NYSERDA, 2011). By the year 2080, it is anticipated that the Hudson

River water surface elevations in the City of Albany could possibly increase between 8 and 18 inches, according to a moderate model-based probability (City of Albany, Albany Climate Change Vulnerability Assessment and Adaptation Plan). These predictions are commensurate with the results of the sea level change analysis conducted for this study.

Table 3-1 shows the low, intermediate and high rates of sea level change from The Battery, NY gauge as applied to the 2018 tidal datums at the HRECOS Schodack Island gauge. These datums are applicable to the Binnen Kill, Henry Hudson Park and Schodack Island restoration sites. The rates of sea level change were calculated using the USACE's Sea Level Change Curve Calculator (USACE, v. 2017.55).

Table 3-2 shows the low, intermediate and high rates of sea level change from The Battery, NY gauge as applied to the 2018 tidal datums at the USGS Poughkeepsie gauge. These datums are applicable to the Charles Rider Park restoration site and were also calculated using the USACE's Sea Level Change Curve Calculator.

It is anticipated that construction on all of these sites will begin in 2025 with a 2-year construction duration (completed in 2027). Calculations for the 20-year and 50-year time horizons are also shown.

Table 4-1 Tidal datum predictions at the HRE-COS Schodack Island gauge for the low, intermediate and high rates of sea level change.

Datum	2018	2027 (ft, NAVD88)			2047 (ft, NAVD88)			2077 (ft, NAVD88)			2127 (ft, NAVD88)		
		LOW	INT	HIGH	LOW	INT	HIGH	LOW	INT	HIGH	LOW	INT	HIGH
MHHW	3.80	3.88	3.93	4.09	4.07	4.28	4.94	4.34	4.92	6.76	4.82	6.44	11.57
MHW	3.47	3.55	3.60	3.76	3.74	3.95	4.61	4.01	4.59	6.43	4.49	6.11	11.24
MTL	1.12	1.20	1.25	1.41	1.39	1.60	2.26	1.66	2.24	4.08	2.14	3.76	8.89
MLW	-1.42	-1.34	-1.29	-1.13	-1.15	-0.94	-0.28	-0.88	-0.30	1.54	0.40	1.22	6.36
MLLW	-1.63	-1.55	-1.50	-1.34	-1.36	-1.15	-0.49	-1.09	-0.51	1.33	-0.61	1.01	6.14

Table 4-2: Tidal datum predictions at the USGS Poughkeepsie gauge for the low, intermediate and high rates of sea level change.

Datum	2018	2027 (ft, NAVD88)			2045 (ft, NAVD88)			2075 (ft, NAVD88)			2125 (ft, NAVD88)		
		LOW	INT	HIGH	LOW	INT	HIGH	LOW	INT	HIGH	LOW	INT	HIGH
MHHW	2.47	2.55	2.6	2.76	2.74	2.95	3.61	3.01	3.59	5.43	3.47	5.04	10.03
MHW	2.17	2.25	2.3	2.46	2.44	2.65	3.31	2.71	3.29	5.13	3.17	4.74	9.73
MTL	0.54	0.62	0.67	0.83	0.81	1.02	1.68	1.08	1.66	3.50	1.54	3.11	8.10
MLW	-1.19	-1.11	-1.06	-0.9	-0.92	-0.71	-0.05	-0.65	-0.07	1.77	-0.19	1.38	6.37
MLLW	-1.39	-1.31	-1.26	-1.1	-1.12	-0.91	-0.25	-0.85	-0.27	1.57	-0.39	1.18	6.17

The results of these sea level change predictions were used in the development of conceptual designs for each of the sites, and during the Evaluation of Planned Wetlands

(EPW) analyses to determine baseline and projected with and without project conditions (Appendix D).

Habitat zone ranges were evaluated with respect to projected sea level rise for the recommended plans. The proposed design grading and habitat zone ranges were based on the intermediate rate curve projected tidal ranges for 2027, the assumed completion year. Design elevations were established for the five proposed habitats zones (Upland Herbaceous / Upland Scrub, Upper Tidal Wetland, Lower Tidal Wetland, Open Water).

Accretion – the vertical growth of tidal wetland habitats as a result of sediment deposition and the accumulation of plant material – is a critical factor in evaluating the impacts of sea level change. Tidal wetlands with accretion rates higher than SLR rates are able to outpace SLR, while tidal wetlands with accretion rates lower than SLR rates become unsuitable for wetland vegetation and convert to tidal mudflat or open water.

The specific accretion rates of on-site tidal wetlands, at the time of this study, are unknown. Studies focused on Hudson River tidal wetlands have found that, overall, the tidal wetlands of the Hudson River are accreting at a rate equal to or outpacing current SLR rates. While anthropogenic modifications to the Hudson River over the past few centuries resulted in the direct loss of wetlands and side channels due to filling activities, there has been a net expansion of tidal wetlands compared to pre-industrial conditions. This expansion of tidal wetlands has occurred in areas such as coves impounded by railroad lines, and historically sub-tidal channels that were brought up to inter-tidal elevations due to filling activities. Two reasonably conservative rates based on published sources were utilized for this analysis and assumed to be consistent across the project sites.

As the Charles Rider site was removed from consideration, results of the analysis were presented for Henry Hudson Park and Schodack Island. For Henry Hudson Park, predicted habitat zone area changes are expected to be minor. Habitat zone area changes are predicted to not exceed 0.06 acres under all scenarios apart from the high curve - Year 50 scenario. Under the high curve – Year 50 scenario, the greatest predicted change in area occurs in the open water and upland herbaceous areas, which are predicted to increase and decrease, respectively, by 0.33 acres. Under all scenarios, the upper and lower tidal wetland areas are predicted to remain within 12% of their design areas. Open water areas (areas below the intertidal range) are expected to encroach upon the site only under high curve SLC projections.

For Schodack Island, predicted habitat zone area changes are expected to vary greatly depending on the habitat zone and SLC scenario. The upland herbaceous and open water areas are the most stable, remaining relatively close to their design areas except for the high curve - Year 50 scenario. Under the high curve – Year 50 scenario however,

open water increases significantly, approximately 5-fold, at the expense of scrub shrub wetland, which is reduced to 1% of its original area. The lower tidal wetland area is predicted to increase over time under the intermediate and high curve SLC scenarios. The upper tidal wetland area is also predicted to increase over time under the intermediate and high curve SLC scenarios; however, by Year 50 under the high curve scenario upper tidal wetlands begin to decrease in favor of lower tidal wetlands. The total area of wetlands (scrub shrub + upper + lower) is expected to expand under all SLC projections for both Year 20 and Year 50 with the exception of the high curve – Year 50 scenario, where it decreases slightly. See the full report in Attachment C for additional detail and results.

5. Inland Hydrology / Nonstationarity Analysis

A nonstationarity analysis and hydrologic trend analysis using United States Army Corps of Engineers (USACE) Nonstationarity Detection tool (NSD) and Climate Hydrology Assessment Tool (CHAT) were completed to inform the designs for the Hudson River Habitat Restoration project sites: Schodack Island Park, Henry Hudson Park, and Moodna Creek (Project Sites).

Stationarity is the assumption that the statistical characteristics of hydrologic time series data are consistent through time. Hydrologic data analysis, and subsequent hydraulic modeling and engineering design for habitat restoration projects rely on the assumption of stationarity in hydrologic data. Recent studies indicate climate change, impacting temperature, precipitation, and streamflow, and anthropogenic modifications of watersheds are undermining the assumption of stationarity. As a result, the USACE requires that the assumption of stationarity of observed streamflow records be assessed using the NSD tool for the Project Sites to ensure that the recommended plans will be sustainable with respect to climate change. In addition, CHAT detects trends in observed annual maximum daily flow from selected USGS gage(s). CHAT was also used to project future trends in annual maximum monthly flow within Hydrologic Unit Code (HUC) 0202: Upper Hudson, where the Project Sites are located.

The NSD tool was developed to detect nonstationarities in annual instantaneous peak streamflow data series at any United States Geological Survey (USGS) streamflow gage site with more than 30 years of annual instantaneous peak streamflow records through Water Year 2014.

The NSD applies 12 statistical methods to assess nonstationarities in the time series data driven by changes in mean, variance/standard deviation, and in the distributional properties of the dataset. A “strong” nonstationarity meets the following criteria:

1) **Consensus** – Consensus occurs when two or more methods detect statistically significant changes for the same statistical property (e.g. mean or

variance/standard deviation or distribution) at or around the same period of time. If a consensus cannot be found for a given year or short period of time, then it is reasonable to discount the nonstationarity.

2) **Robustness** – Robustness is represented when statistically significant changes are detected for two or more statistical properties (mean, variance/standard deviation, or distribution). This represents a multifaceted change in the data set and should be considered when deciding which portion of the period of record to use in the hydrologic analysis.

3) **Magnitude** – The greater the magnitude of change in a statistical property (mean or variance/standard deviation) before and after the nonstationarity, the more important it is to consider in subsequent hydrologic analysis.

For Schodack Island Park and Henry Hudson Park, the USGS gage 01358000 Hudson River at Green Island, NY was utilized in this analysis. NSD results indicated a lack of consensus, robustness, and magnitude of change and therefore allow for the assumption of stationarity at these sites. In addition, NSD results indicated no statistically significant monotonic trend was detected for this dataset.

As USGS gages are absent in Moodna Creek, USGS gages on three proximal streams were utilized in this analysis:

- USGS 01372500 Wappinger Creek Near Wappingers Falls NY;
- USGS 01367500 Rondout Creek at Rosendale NY; and
- USGS 01371500 Wallkill River at Gardiner NY.

NSD results for the Wappinger Creek gage indicated two points in time that did not meet the criteria for strong nonstationarity. However, NSD results indicated several strong nonstationarities were detected for the Walkill River and Rondout Creek watersheds. These results suggest that Moodna Creek hydrology is also subject to nonstationarity.

For the Schodack Island Park and Henry Hudson Park, the USACE CHAT was used to assess historical trends in peak instantaneous stream flow at USGS 01358000 Hudson River at Green Island, New York. Results indicated that there may be an increasing trend in the historically observed peak flow data over the period of record 1946-2014, but the trend is not statistically significant.

For Moodna Creek, the USACE CHAT was used to assess the historical trends in peak instantaneous stream flow at the three proximal streams. Results indicated that the gages on Wappinger Creek and Rondout Creek may show an increasing trend in the historically observed peak flow data over the periods of record, but that the trend is not

statistically significant. Results for the gage on the Wallkill River showed a statistically significant increasing trend in the historically observed peak flow data.

The USACE CHAT was used to investigate future changes in mean monthly stream flows in HUC 0202, which encompasses the watersheds of the Project Sites. Analysis of the projected hydrology for 2000-2099 indicated a statistically significant linear trend of increasing mean annual maximum monthly flows, which suggests the potential for future increases in streamflow relative to current conditions. While this possible increase in streamflow should be further investigated during the PED Phase, with particular regard to the possibility of exacerbating known areas of bank failure, it has been tentatively determined that these findings will have no impact on the project designs.

When comparing the historical records and projected models, the USACE CHAT outputs provided differing results for streams proximate to Moodna Creek. While the CHAT identified a significant increasing trend in peak annual streamflow for the Wallkill gage, the other two gages with smaller watershed sizes that are more reflective of the Moodna Creek watershed (Wappinger and Rondout) did not indicate a similar statistically significant trend. Likewise, for the Schodack Island Park and Henry Hudson Park Sites (Hudson River at Green Island, NY gage), the CHAT result did not identify a statistically significant trend in peak annual streamflow. However, for future projections of HUC 0202: Upper Hudson – which encompasses all Project Sites and the subject gages – the CHAT results indicate a statistically significant projected increasing trend of annual maximum monthly flows for 1999-2099. This implies that existing gage data does not capture the hydroclimatic changes that are currently underway, and that could influence the Project Sites over the next century. See the full report in Attachment D for additional detail and results.

6. Vulnerability Assessment Tool

The USACE Vulnerability Assessment (VA) tool provides a nationwide screening-level assessment of climate change vulnerability and how it relates to the USACE mission, operations, programs and projects. Indicators are used to develop a vulnerability score specific to each of 200 watersheds within the contiguous United States and to each USACE business line. The VA tool uses the Weighted Order Weighted Average (WOWA) scoring method, which combines individual vulnerability indicators and their associated datasets to develop watershed-scale vulnerability scores. The WOWA score combines indicators using a weighting technique to control how much an indicator with a small value can influence an indicator with a larger value, thereby affecting a watershed's perceived vulnerability. A watershed having a WOWA score within the top 20% of the national range is considered to be among the most vulnerable to climate change.

6.1 Vulnerability Assessment for Upper Hudson Watershed

A vulnerability assessment for the HUC 0202 (Upper Hudson) watershed was conducted for the USACE New York District (NAN) and for the USACE North Atlantic Division (NAD) as a whole, for both the flood risk reduction and ecosystem restoration business lines.

6.2 Flood Risk Reduction Business Line

Vulnerability scores for the Flood Risk Management business line for HUC 0202, as well as the ranges of scores nationally, and within NAD and NAN are presented in Table 6-1. Further analysis using the VA tool shows that the HUC 0202 watershed is not vulnerable to climate change for any of the wet and dry scenarios for the Flood Risk Reduction Business Line when compared with the rest of the nation. Figures 12 and 13 show the Vulnerability Assessment Tool outputs for NAD and NAN for the Flood Risk Reduction business line for both dry and wet years. Figure 14 shows the summary vulnerabilities for both wet and dry years for the Flood Risk Reduction Business Line for the HUC 0202 watershed.

Table 6-2: Vulnerability scores for HUC 0202 (Upper Hudson), Flood Risk Reduction Business Model

Scenario/Epoch	WOWA Score	National Range	NAD Range	NAN Range	WOWA as % of National Range	Vulnerable? (In top 20% of national range)
Dry 2050	44.364	35.15 to 70.08	40.01 to 53.37	44.364 to 53.373	14.14 %	No
Wet 2050	48.664	39.80 to 92.85	43.12 to 56.91	48.141 to 56.915	16.71 %	No
Dry 2085	45.319	35.15 to 70.08	40.01 to 53.37	44.364 to 53.373	29.11 %	No
Wet 2085	49.687	39.80 to 92.85	43.12 to 56.91	48.141 to 56.915	18.64 %	No

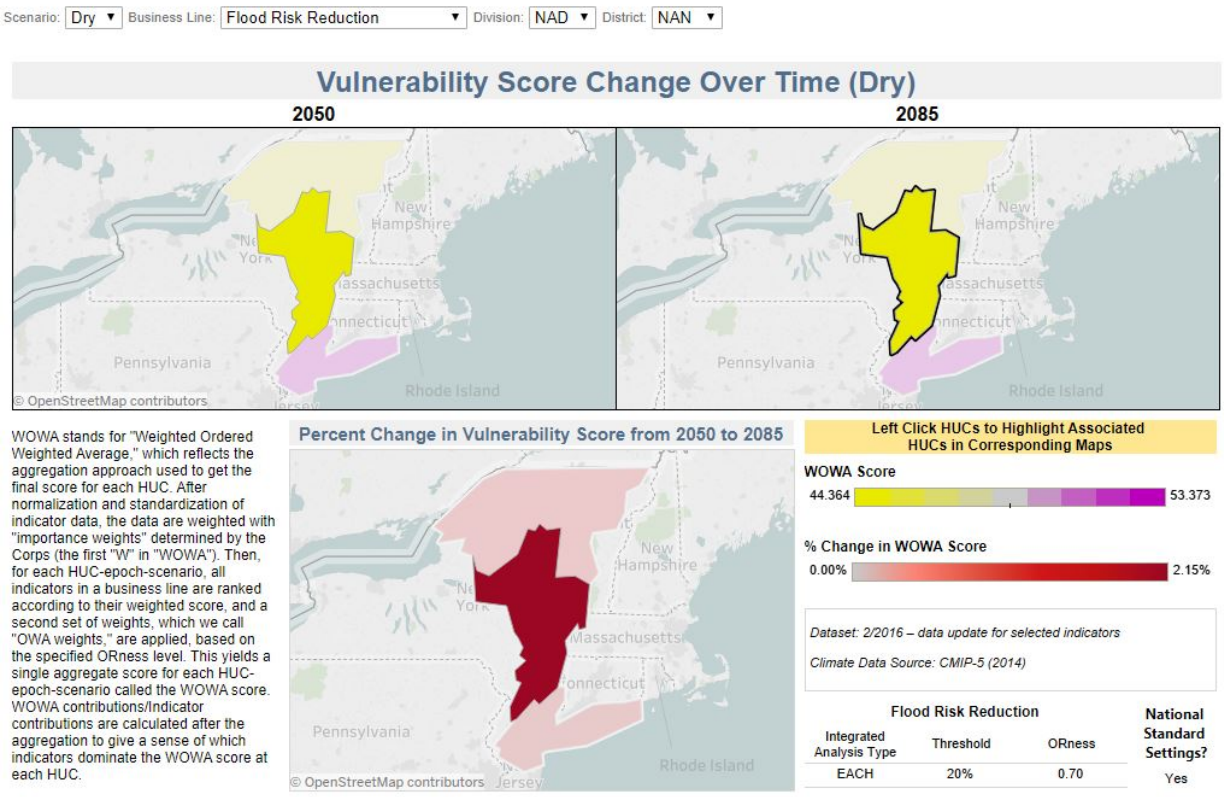

Figure 12: Vulnerability Assessment Tool Output for dry years, HUC 0202, Flood Risk Reduction Business Line

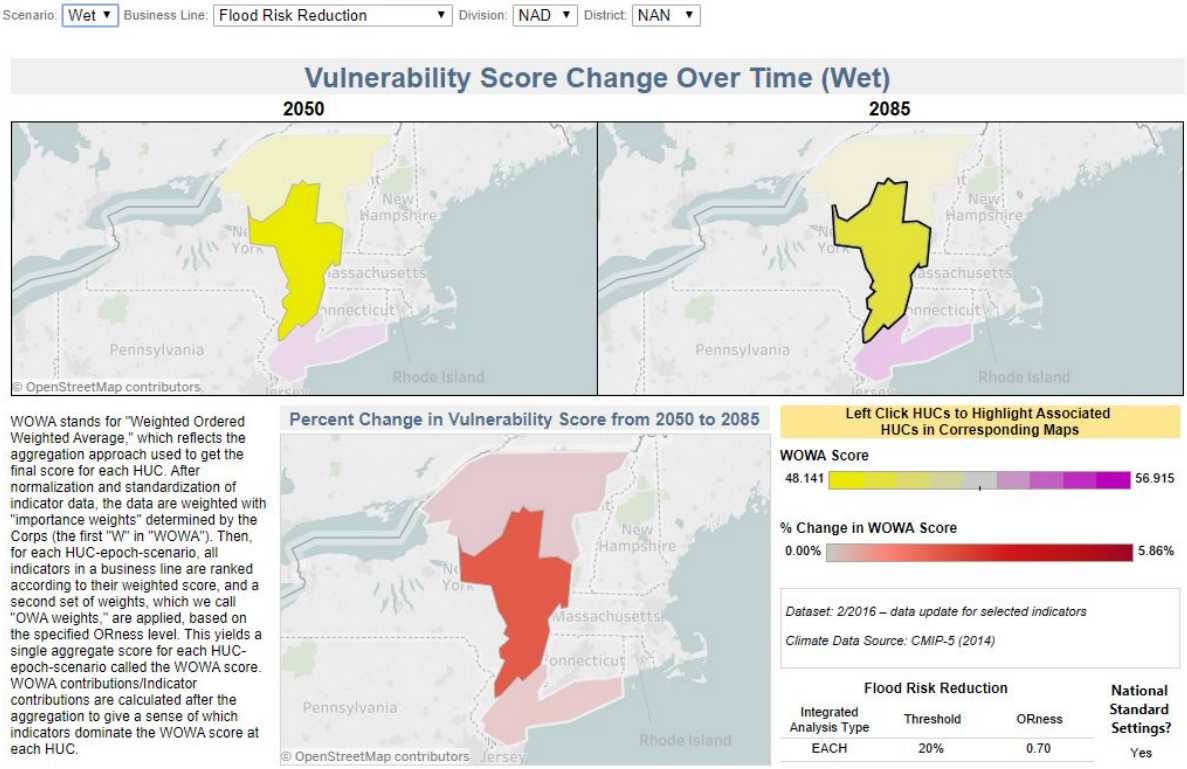

Figure 13: Vulnerability Assessment Tool Output for wet years, HUC 0202, Flood Risk Reduction Business Line

Table 6-2 shows those indicators that have an influence on the WOWAscore for the Flood Risk Reduction business line for HUC 0202.

Table 6-3: Codes and definitions for those indicators affecting the WOWA score in HUC 0202, Flood Risk Reduction Business Line

Code	Description	Indicator Summary
175C	Annual CV of Unregulated Runoff (Cumulative)	Measures the year-to-year variability of hydrology. A higher score suggest a higher variability in runoff when compared with other watersheds. "Cumulative" refers to flow generated within a single HUC-4 watershed in addition to upstream contributing watersheds.
277	% change in runoff divided by % change in Precipitation	Measures the median of the deviation of runoff from the monthly mean times average monthly precipitation, divided by the deviation of precipitation from monthly mean times average monthly runoff. A higher value suggests a higher vulnerability relative to other watersheds.
568C	Flood Magnification Factor (Cumulative)	Represents how flood flow (i.e, monthly flow exceeded 10% of the time) is predicted to change in the future. "Local" refers to flow generated within a single HUC-4 watershed; "Cumulative" refers to flow generated within a single HUC-4 watershed in addition to upstream contributing watersheds.
568L	Flood Magnification Factor (Local)	
590	Acres of Urban Area within 500-Yy Floodplain	Urbanization results in increased impermeable area, leading to increased stormwater runoff volumes and higher peak flows. Higher values suggest a higher vulnerability relative to other watersheds

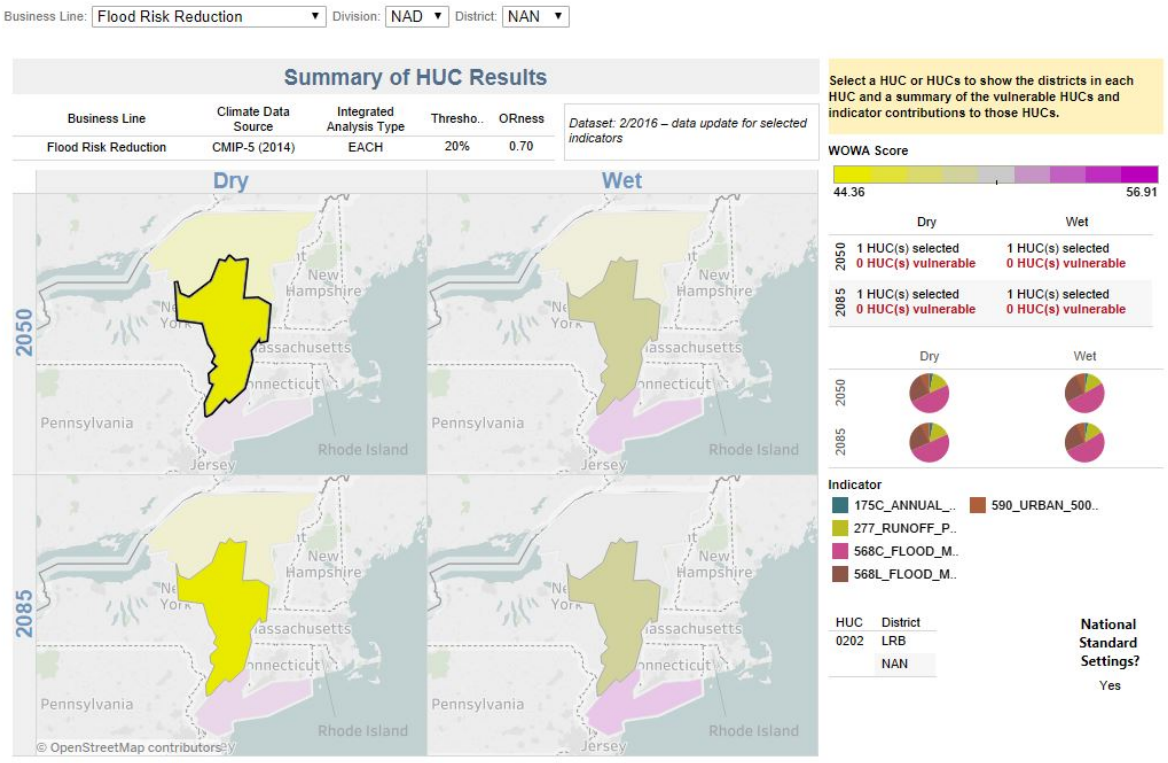

Figure 14: Summary, HUC 0202, Dry & Wet Years for Flood Risk Reduction Business Line (Results show that HUC 0202 is not vulnerable to climate change for any of the evaluated dry or wet years under the flood risk reduction business line.)

Table 6-4: Percent contribution of each indicator value to WOWA score, flood risk business line

Indicator Code	Dry 2050	Wet 2050	Dry 2085	Wet 2085
175C	3.07 %	2.77 %	3.01 %	2.76 %
277	15.13 %	13.77 %	15.06 %	13.41 %
586C	49.41 %	50.95 %	50.01 %	51.67 %
586L	24.96 %	25.74 %	25.28 %	26.11 %
590	7.43 %	6.77 %	6.64 %	6.05 %
Total	**100%**	**100%**	**100%**	**100%**

Table 3 shows that the dominant indicator contributing to the WOWA score for each scenario within the HUC 0202 watershed for the Flood Risk Reduction Business Line is #568C, cumulative flood magnification.

6.3 Ecosystem Restoration Business Line

Table 6-4 shows the vulnerability scores for the Ecosystem Restoration business line for HUC 0202, as well as the ranges of scores nationally, and within NAD and NAN. Further analysis using the VA tool shows that the HUC 0202 watershed is not vulnerable to climate change for any of the wet and dry scenarios for the Ecosystem Restoration Business Line when compared with the rest of the nation. Figures 15 and 16 show the Vulnerability Assessment Tool outputs for NAD and NAN for the Ecosystem Restoration business line for both dry and wet years. Figure 17 shows the summary vulnerabilities for both wet and dry years for the Ecosystem Restoration business line for the HUC 0202 watershed.

Table 6-5: WOWA vulnerability scores for HUC 0202 (Upper Hudson), Ecosystem Restoration Business Model

Scenario/Epoch	WOWA Score	National Range	NAD Range	NAN Range	WOWA as % of National Range	Vulnerable? (In top 20% of national range)
Dry 2050	63.165	55.84 to 81.85	55.84 to 69.81	61.939 to 65.065	28.16 %	No
Wet 2050	63.301	54.69 to 89.84	54.69 to 70.41	62.251 to 65.624	24.49 %	No
Dry 2085	63.346	55.84 to 81.85	55.84 to 69.81	61.939 to 65.065	28.86 %	No
Wet 2085	63.703	54.69 to 89.84	54.69 to 70.41	62.251 to 65.624	25.64 %	No

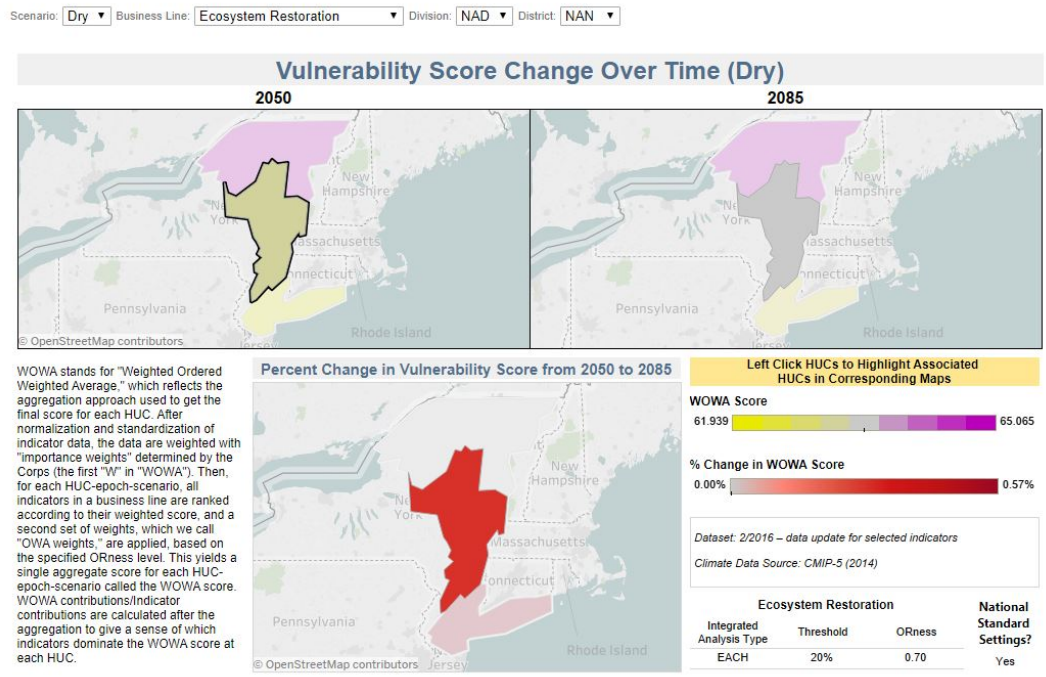

Figure 15: Vulnerability Assessment Tool Output for dry years, HUC 0202, Ecosystem Restoration Business Line

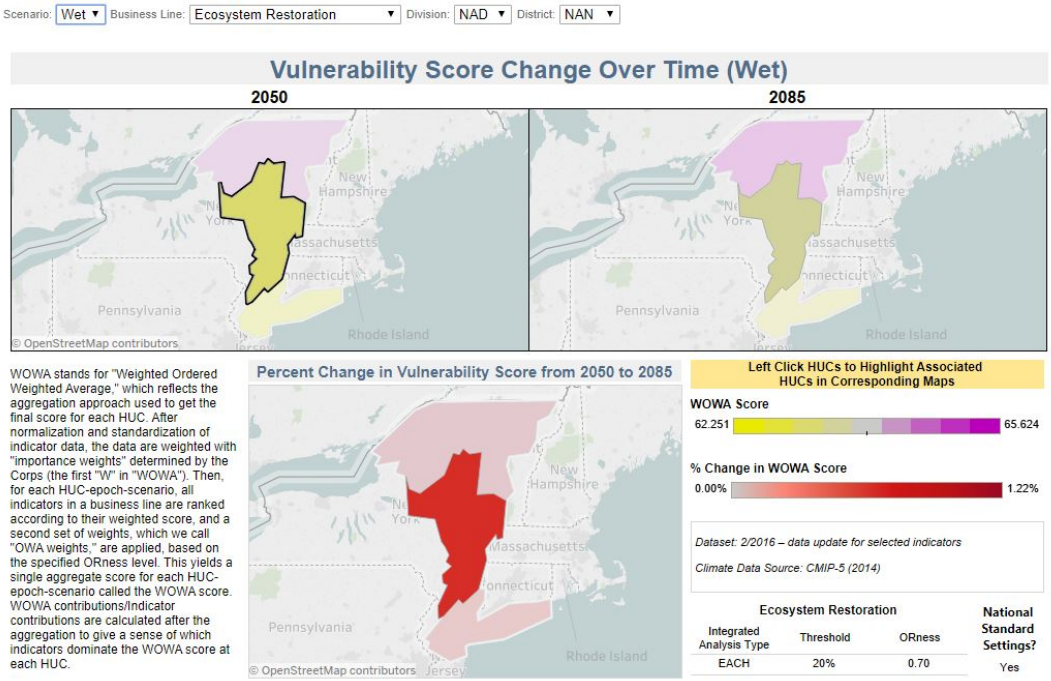

Figure 16: Vulnerability Assessment Tool Output for wet years, HUC 0202, Ecosystem Restoration Business Line

Table 6-5 shows those indicators that have an influence on the WOWA score for the Ecosystem Restoration business line for HUC 0202.

Table 6-5: Codes and definitions for those indicators affecting the WOWA score in HUC 0202, Ecosystem Restoration Business Line

Code	Description	Indicator Summary
156	Change in sediment load due to change in future precipitation	Measures changes in the average annual sediment load in response to future changes in precipitation. A higher value suggests higher vulnerability relative to other watersheds.
221C	Monthly CV of Runoff (Cumulative)	Measures the short-term variability in a region's hydrology. It is the 75th percentile of annual ratios of the standard deviation of monthly runoff to the mean of monthly runoff. "Cumulative" refers to flow generated within a single HUC-4 watershed in addition to upstream contributing watersheds.
277	% change in runoff divided by % change in Precipitation	Measures the median of the deviation of runoff from the monthly mean times average monthly precipitation, divided by the deviation of precipitation from monthly mean times average monthly runoff. A higher value suggests a higher vulnerability relative to other watersheds.
297	Macroinvertebrate Index of Biotic Conditions	Associated with the overall biologic health of a stream. Measures the sum of 6 metrics that characterize macroinvertebrate assemblages, including taxonomic richness, diversity, composition, feeding groups, habits and pollution tolerance. A lower value suggests higher vulnerability relative to other streams.
568C	Flood Magnification Factor (Cumulative)	Represents how flood flow (i.e, monthly flow exceeded 10% of the time) is predicted to change in the future. "Local" refers to flow generated within a single HUC-4 watershed; "Cumulative" refers to flow generated within a single HUC-4 watershed in addition to upstream contributing watersheds.
568L	Flood Magnification Factor (Local)	
65L	Mean Annual Runoff	Reflects the renewable freshwater supply within a single HUC-4 watershed
700C	Low flood reduction factor (Cumulative)	Represents how low flow (i.e, monthly flow exceeded 90% of the time) is predicted to change in the future. "Cumulative" refers to all flow generated within a single HUC-4 watershed in addition to upstream contributing watersheds.
8	Percent of freshwater communities at risk	Areas with a higher diversity of plant communities may provide unique ecosystem services and support distinct species combination

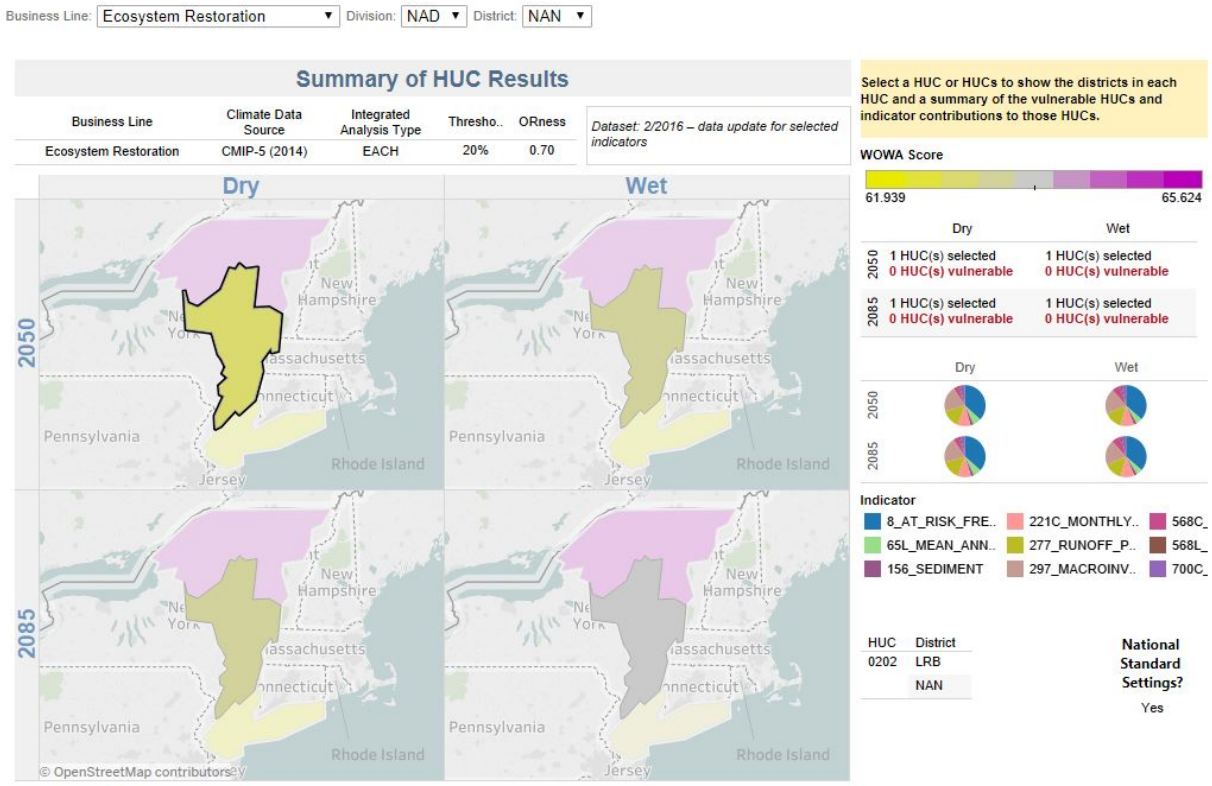

Figure 17: Summary, HUC 0202, Dry & Wet Years for Ecosystem Restoration Business Line (Results show that HUC 0202 is not vulnerable to climate change for any of the evaluated dry or wet years under the ecosystem restoration business line.)

Table 6-6 shows that the dominant indicator contributing to the WOWA score for each scenario within the HUC 0202 watershed for the Ecosystem Restoration Business Line is #8, Percent of Freshwater Communities at Risk.

Table 6-6: Percent contribution of each indicator value to WOWA score, ecosystem restoration business line

Indicator	Dry 2050	Wet 2050	Dry 2085	Wet 2085
156	2.42 %	2.40 %	2.40 %	2.38 %
221C	10.16 %	10.33 %	10.37 %	10.60 %
277	14.77 %	14.62 %	14.91 %	14.44 %
297	20.18 %	20.00 %	20.02 %	19.87 %
568C	3.40 %	6.44 %	4.54 %	6.63 %
568L	1.34 %	1.51 %	1.38 %	1.55 %
65L	6.36 %	4.79 %	6.29 %	4.75 %
700C	4.46 %	3.35 %	3.46 %	3.45 %
8	36.91 %	36.56 %	36.63 %	36.33 %
Total	**100%**	**100%**	**100%**	**100%**

6.4 Conclusions

Based on the results of the Vulnerability Assessment Tool, the HUC 0202 watershed is not considered vulnerable for the Flood Risk Management or Ecosystem Restoration Business Lines when compared with other watersheds throughout the nation. The indicator most affecting the vulnerability (WOWA) score under the Flood Risk Reduction business line is the cumulative flood magnification factor, which tries to predict how flood flow will change in the future. The indicator most affecting the WOWA score under the Ecosystem Restoration Business Line is the percent of freshwater plant communities that are at risk of future extinction within the watershed. These concerns should be incorporated into the project design such that their affects due to climate change are mitigated to the extent possible.

7. Analysis and Design of Restoration Plans

7.1 Design Criteria and Assumptions

General

Concept design alternatives were developed for each site using a combination of site-specific data and professional expertise. Specifically, historical investigations, data derived from site survey, field observations, and digital spatial data, such as topography derived from LiDAR and habitat community mapping, in conjunction with scientific and engineering expertise and professional judgment coalesced to form the alternatives presented. Design criteria and assumptions made as part of the alternatives development process are discussed below.

A general assumption that was applied to the establishment of tidal wetlands is the relationship between wetland plant community and tidal datum elevation. Specifically, a wetland plant community, or marsh zone, is largely dependent on topographic elevation relative to tidal stage. For example, low marsh is dominant between the lower limit of the upper third of the tidal range up to MHW while high marsh spans from MHW up to MHHW levels. This relationship using 2027 tidal datum elevations was the basis for tidal wetland design elevations (Figure 18). With sea level change, wetland plant communities are expected to shift with the rising seas; consequently, when appropriate, high marsh elevations were specified in the design such that high marsh would transition to low marsh by 2075 while still maintaining a wetland plant community.

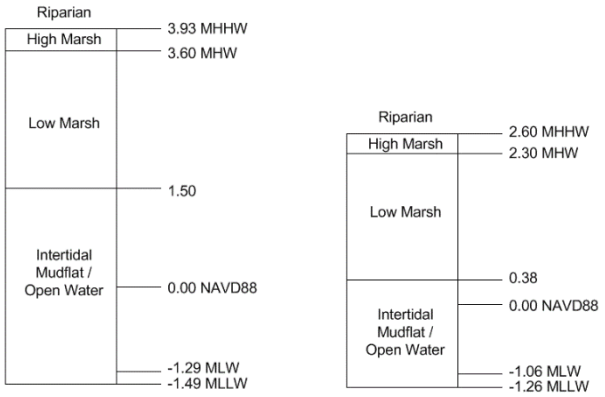

Figure 18: Relationship between wetland plant community and tidal datum elevation for Schodack Island, Binnen Kill, and Henry Hudson (left) and Charles Rider Park (left).

Discussion of Measures

The implementation of side channel restoration, wetland restoration, and shoreline restoration as well as the removal of aquatic organism passage barriers are the primary methods proposed to achieve the project goals. See the full concept alternative design plans in Attachment E and recommended design plans in Attachment F for additional detail and results.

Side Channel Restoration

The four primary objectives of side channel restoration include 1) an increase in habitat diversity, 2) the creation of a velocity refuge for aquatic organisms, 3) the creation of

additional connectivity to wetlands and/or adjacent channels, and 4) the maximization of ecological benefits. Proposed side channels were located in low-lying areas, proximate to the historical side channel location to the maximum extent practicable. The locations were also selected to generally align with existing flow paths, thus reducing the overall excavation effort.

Maintaining pedestrian and vehicular access across the channel was considered a necessity, thus a road crossing was proposed which would include a culvert appropriately sized for AOP. The AOP culverts within the side channels were sized to span the vertical tidal flux with two feet of natural stream substrate. In addition to the AOP culvert, floodplain culvert connections were proposed, where appropriate, which would provide additional tidal connections and hydraulic capacity in order to maximize the tidal exchange with minimal backwater conditions. The floodplain culverts would be tall enough to span the tidal flux and large enough to minimize clogging and other maintenance intensive issues typical with a smaller pipe.

The road crossings consist of a box culvert, floodplain culvert(s), earthwork, and accessory components associated with the culverts and crossing. The box culvert item includes compaction, backfill, excavation, headwalls, wingwalls, a crane crew, mobilization and demobilization of the crane crew, a guard rail, guard rail posts, a base coarse drainage layer, and the concrete box culvert. Box culverts for the draft plan were 10-feet high with a 12-foot span, a 1-foot concrete thickness, and prefabricated in 8-foot sections. The culvert design was later optimized in development of the recommended plan to 14-ft rise, 20-ft span, and 35-ft total length. The culvert and wing wingwalls will be prefabricated sections. The use of prefabricated concrete requires a footing design and geotechnical investigation during the PED phase. Assumptions for the footings are based on concrete volume and reinforcement. The design specifications were quantified based on 1) the existing berm elevation, 2) the required culvert top and invert elevations, and 3) a maximum proposed slope of 3 feet horizontal to 1 foot vertical between the top of the berm/roadway surface and top of headwall, wingwalls or the floodplain elevations. In addition, a temporary bridge would be temporarily installed for intermediate stages, where necessary.

The floodplain culverts would consist of piping, end sections, gaskets, backfill, compaction, excavating, and a base coarse drainage layer. The floodplain culverts were assumed to be 48-inch x 76-inch concrete elliptical pipe design or 60-inch diameter circular pipe equivalent. This sizing was selected to be large enough to accommodate the anticipated 2075 tide range, from elevation zero to MHHW, approximately 57 inches. Thus, the closest standard size pipe diameter was selected. In some locations elliptical pipe would be required to obtain minimum pipe cover. The larger connection pipes were also selected to reduce maintenance and potential for clogging.

Channel and culvert invert elevations varied depending on the proposed channel flow regime; proposed side channel and riparian corridor restoration was designed to provide flow during large precipitation events and high tides while side channel and tidal wetland corridor restoration was designed to maximize flow during mean low tide.

Side Channel and Riparian Corridor

This feature is proposed at Binnen Kill South Alternative 1, Schodack Island North Alternative 1, and Schodack Island South Alternative 1. At each of these sites, a side channel would be excavated in areas of historic fill placement to hydrologically connect the Binnen Kill or Schodack Creek to the Hudson River. The channel would convey flow during large precipitation events and high tides based on 2027 tide levels and provide refuge to aquatic species during increased river velocities. The same tidal datum elevations were used for both Binnen Kill and Schodack Island sites, therefore channel invert elevations and vegetation community elevations are consistent between the sites.

The channel would have a 20-foot width and an invert elevation of 3.00 feet and transition to the riparian corridor which would vary in elevation from 4.00 to 6.00 feet. The riparian corridor would transition to existing grade at a maximum slope of 3 feet horizontal to 1 foot vertical. The width of the riparian corridor varied across the sites depending on the location of the historic shoreline or existing grade elevations. By 2075, with sea level change, it's anticipated that the channels would convey flow at mean tide water levels and the riparian corridor would transition to tidal wetlands.

Side Channel and Tidal Wetland Corridor

This feature is proposed at Binnen Kill South Alternative 2, Schodack Island North Alternative 2, and Schodack Island South Alternative 2. A side channel would be excavated in areas of historic fill placement to hydrologically connect the Binnen Kill or Schodack Creek to the Hudson River. The channel would convey flow during high and low tides and provide velocity refuge to aquatic species during high flow events. The same tidal datum elevations were used for both Binnen Kill and Schodack Island sites, therefore channel invert elevations and vegetation community elevations are consistent between the sites.

The channel would have a 20-foot width and an invert elevation of -2.50 feet based on 2027 tide levels and transition to tidal wetland which would range in elevation from elevation 1.5 to 4.00 feet and then transition to riparian vegetation. The riparian vegetation would transition to existing grade at a maximum slope of 3 feet horizontal to 1 foot vertical. The width of the tidal wetland varied across the sites depending on the location of the historic shoreline or existing grade elevations. By 2075, with sea level change, it's anticipated that low marsh would transition to mudflat, high marsh would transition to low marsh, and riparian vegetation would transition to high marsh.

The recommended plan was optimized to raise the channel invert to elevation -2.0 feet from the proposed channel invert of elevation -2.5. In addition, the connection to the Hudson River involves excavation of the existing wetland in order to optimize exposure to the tidal range. A similar approach was applied to the existing Schodack Creek wetland complex. The connection elevation at the Hudson is at elevation -2.0 feet and is elevation 0.0 feet at the tributary to the Schodack Creek. The channel dimensions remain the same. The tidal wetland is recommended to transition to elevation 4.0 over 30 to 40 feet from the channel bottom. The remainder of the wetland will be graded to have microtopography between elevations 4.0 and 5.0 feet which will sustain a scrub shrub wetland community. The total width of the proposed wetland remains approximately 400 feet. The wetlands transition to existing grade at a maximum slope of 3 feet horizontal to 1 foot vertical.

Wetland Restoration

Wetlands provide significant ecological benefits including the provision of aquatic organism habitat, the improvement of water quality, and the abatement of wave velocity. Therefore, wetland restoration would be critical to meeting project goals. Both tidal and non-tidal wetlands were proposed at the project sites, the designs of which vary based on hydrologic conditions. During pre-construction engineering and design, site hydrology would need to be studied comprehensively where non-tidal wetlands are proposed to ensure wetland hydrology conditions would be met. Tidal wetland hydrology is predicated on tidal datum elevations which were therefore integrated into this phase of the project using the information presented in the Sea Level Change Analysis section. Specifically, 2027 tide levels were utilized to determine marsh platform elevations, and subsequently, required excavation depths and volumes. Furthermore, it was assumed that tidal wetlands would require stabilization at the land-water interface to dissipate energy originating from waves and boat wake. Three to four-foot diameter rock was assumed to meet this stabilization criterion. This diameter material was considered conservative in the absence of design calculations and would be larger than rock material currently present on the sites.

Wetland Restoration

This feature is proposed at Schodack Island Pocket Wetlands Alternative 1, and Binnen Kill North and South Alternatives 1 and 2. Restoration would occur in areas that are currently dominated by invasive vegetation such as common reed or reed canary grass. Restoration would consist of invasive vegetation treatment followed by native vegetation planting.

Forested Wetland Restoration

This feature is proposed at Binnen Kill North Alternative 2. A portion of the existing hay field would be converted to forested wetland through the excavation of soil. Target ground elevations would need to be one foot above the groundwater table for two weeks during

the growing season to ensure wetland hydrology is achieved. It is assumed that twelve inches of material shall be excavated, on average. Microtopographic variations would be incorporated within the proposed wetland resulting in hummocks and hollows with elevations plus or minus six inches from the proposed average grade. After soil grading, the area would be planted with native woody vegetation.

Emergent Wetland Restoration

This feature is proposed at Binnen Kill North Alternative 2. Emergent wetland would be created through the treatment of invasive plant species and excavation of soil. Target ground elevations would need to be within 12 inches of the groundwater table or contain ponded water for at least two weeks during the growing season to ensure wetland hydrology is achieved. After soil excavation is complete, the area would be planted with native vegetation. It is assumed that twelve inches of material shall be excavated, on average, based on existing upland grade elevations and adjacent wetland elevations.

Tidal Wetland Restoration

This feature is proposed at Schodack Island Pocket Wetlands Alternative 1, Schodack Island North and South Alternatives 1 and 2, and Binnen Kill South Alternatives 1 and 2. Restoration would occur in areas that are currently dominated by invasive vegetation such as common reed or reed canary grass. Restoration would consist of Invasive vegetation treatment followed by native vegetation planting. In areas where tidal wetlands connect to the Hudson River, rock stabilization would be installed.

Tidal Wetland Restoration & Conversion to Side Channel Connection

This feature is proposed at Schodack Island North Alternatives 1 and 2. This feature would consist of the treatment of invasive vegetation and planting of native vegetation within existing tidal habitat currently dominated by invasive species such as common reed. Additionally, this feature would include the expansion of the existing tidal channel to accommodate increased flows with the proposed side channel connection. The grading associated with the connection would maintain the slope of the proposed channel and tie into the existing channel. LiDAR derived elevation data was used to approximate the location of this channel and estimate the required grading area and excavation volumes. Fringe wetlands would be graded as necessary to stabilize the channel. The shoreline would be stabilized with rock as necessary to accommodate new flows.

Cove Tidal Wetland Restoration

This feature is proposed at Henry Hudson Park Alternatives 1 and 2. Tidal wetland restoration would occur within an existing mudflat. A 20-inch coir log toe protection would be installed along the northern bank of the Vloman Kill, at the toe of the slope around the existing mudflat. This diameter coir log was selected to allow six inches to be embedded into the existing substrate and at least 12 inches above grade to retain the substrate,

assuming that the coir log will flatten by approximately two inches during installation. 36-inch boulders would be installed along the upland edge of the wetland at the toe of the currently eroded bank to stabilize existing scour. These boulders would be embedded a minimum of six inches into the ground. This diameter rock was selected because it is consistent with the size of existing material in stable bank areas. Native wetland vegetation would be planted within the intertidal area.

Pocket Wetland Restoration – Henry Hudson Park

This feature is proposed at Henry Hudson Park Alternative 2. A pocket wetland would be constructed landward of the northern tidal wetland restoration area. The wetland would be connected to the Hudson River approximately midway along the proposed concrete cribbing structure. The pocket wetland would be established through grading, which would allow tidal flushing, the addition of suitable substrate material, and native vegetation plantings. 36-inch boulders would be installed along the upland edge of the wetland and would be embedded a minimum of six inches into the ground. This diameter rock was selected because it is consistent with the size of existing material in stable bank areas.

Tidal Wetland Restoration

This feature is proposed at Charles Rider Park Alternative 1, Henry Hudson Park Alternatives 1 and 2, and Schodack Island Pocket Wetlands Alternative 1. Tidal wetlands would be created through the treatment of invasive plant species, excavation of soil, and addition of soil amendments to provide a suitable substrate for native vegetation planting. Target ground elevations would be set to allow daily tidal flushing.

Emergent Wetland Restoration and Channel Restoration

This feature is proposed at Binnen Kill North Alternative 2. Restoration would occur in areas that are currently dominated by invasive vegetation such as common reed or reed canary grass. Restoration would consist of invasive vegetation treatment followed by native vegetation planting. Diffuse pools would be graded into the wetland to provide microtopographic variations, resulting in hummocks and hollows with elevations plus or minus six inches from the proposed average grade. An approximately 3,700 linear foot channel of varied width would be created via excavation and provide hydrologic connections to the diffuse pools. After soil grading, the area would be planted with native vegetation.

Shoreline Restoration

Restoring a shoreline can provide numerous benefits including bank stabilization, increased opportunity for vegetation growth, reduced erosion potential, and protection from the impacts associated with sea level rise and storm surge. The shoreline restoration techniques proposed vary from hard armoring with vegetated riprap or

concrete cribbing to softening bank slopes and establishing vegetation. The type of technique ultimately depends on the topography and bathymetry of the immediate area. Dramatic changes in elevation over a short distance require a hard engineering approach, such as concrete cribbing, to span the elevation change, while riprap or other vegetative approaches can be utilized when the elevation change is less dramatic or there is space available to move landward to soften the slope. Riprap and concrete cribbing can be avoided by softening bank slopes to a maximum of five feet horizontal to one foot vertical and establishing vegetation; however, in high energy systems, an energy dissipater should be included along the water's edge. The techniques selected for the project sites were a combination of the three methods discussed above and were selected due to site topography and bathymetry and balancing existing land uses.

Vegetated Riprap Creation

This feature is proposed at Charles Rider Park Alternative 1 and Henry Hudson Park Alternative 1. The portion of land available for shoreline restoration at each Park is limited due to the adjacent park amenities, and the bank slopes are generally steep and require stabilization to transition from the shoreline edge to river channel bottom. Due to these conditions, it was necessary to provide a hard-armoring approach using vegetated riprap while balancing the goal to maximize ecological benefits. To breach the transition from the river channel bottom to shoreline edge, reinforcement of the existing timber cribbing toe protection is proposed. The cribbing would be reinforced with 12-inch riprap which was sized based on existing rock material located at each site. The area of land landward of the reinforced cribbing would be backfilled with soil and planted with native vegetation. It was assumed that the existing timber cribbing is currently stable and would not need to be replaced as the rock and vegetation installed landward of the cribbing would be established and stabilized to withstand the tidal and wave/wake forces if the cribbing further deteriorates. Additionally, stabilization boulders would be placed at the wetland-upland interface. The boulders would be approximately three to four-feet in diameter which is similar in size to boulders on-site that appear to be currently stabilizing the shoreline.

Concrete Cribbing

This feature is proposed at Henry Hudson Park Alternative 2 (Northern Tidal Wetland). In locations where replacing timber cribbing is necessary to maximize wetland establisment and maintain park open space, a concrete cribbing structure would be installed. It was assumed that this concrete cribbing would need to extend below the depth of the waterward ground elevation by approximately three feet. It was also assumed that the area where the concrete cribbing is to be placed would need to be dewatered during crib framing and backfill placement; this would ensure maximum safety and structural stability of the proposed feature. The structure would include anchor supports (i.e. cribbing that is

placed perpendicular to flow) within the excavation landward of the proposed crib wall. The top portion of the concrete cribbing would convey tidal flow to the proposed wetlands.

Softening Bank Slopes

This feature is proposed at Henry Hudson Park Alternative 2 (Southern Tidal Wetland). Wetlands would be established through softening the bank to slopes shallower than ten feet horizontal to one foot vertical and providing toe protection to dissipate wave/wake energy. The toe protection would provide the transition from the shoreline to river channel bottom through the placement of 12-inch riprap, sized based on existing rock material on-site; and would gently slope up to elevations sufficient for tidal wetland establishment.

Rock Revetment Reinforcement

This feature is proposed at Henry Hudson Park Alternatives 1 and 2. The point at the mouth of Vloman Kill, which shelters the cove, would be reinforced with rock. Existing vegetation would be preserved to the maximum extent practicable. As with the vegetated riprap, it was assumed that the existing rock size is adequate for the forces and upsized to three to four feet to be conservative.

Invasive Species Control

The project sites have extensive areas and/or seed banks of invasive or other undesired vegetative species. The control of these species is important to the success of the proposed alternatives. It is assumed that invasive control will primarily be through herbicide applications as approved by the regulatory agencies for use near regulated waters.

Aquatic Organism Passage (AOP)

Dam Removal

Dam or Barrier Removal is a type of AOP which restores free-flowing conditions to a reach of river, transport of sediment and organic material, movement of resident fish and other aquatic organisms, migration of diadromous species, and typically improves water quality including reduced maximum temperatures and increased dissolved oxygen content. Dam removal is often a preferred alternative because it often eliminates a threat to public safety and owner liability and absolves the owner of further regulatory obligations. In addition, the upfront costs for dam removal are typically lower than for dam repair or rebuild, and there are no long-term costs for monitoring, maintenance, and repairs. Dam / Barrier removal was proposed as Alternative 1 for Orr's Mill Dam on Moodna Creek, Alternative 2 for Firth Cliff Dam on Moodna Creek, and Alternative 2 for Eddyville Dam on Rondout Creek.

Dam removal is the recommended plan for Firth Cliff Dam. The refinement of water and sediment control for this alternative removed the use of sheet pile coffer dam and replaced

it with two (2) rock check dams. One of the check dams shall be installed immediately upstream of the dam and will be constructed wide enough to use for construction access. It is assumed that to have a 15 feet top width, be 7 feet high, and have a 1 foot horizontal to one foot vertical slope on the upstream side where the downstream side is assumed to be vertical and abut the upstream face of the dam. It is assumed that A D50 of 12 inches with variation from 6 to 18-inch diameter rock would be used for construction. An impermeable liner is proposed to be installed on the upstream face of the check dam for stability and to eliminate the potential for flow through the rock. The downstream check dam shall be installed such that mobilized sediment will within the existing scour hole. The check dam is proposed to be installed at the head of the riffle immediately downstream of the dam and scour hole. This feature shall be constructed on the same size rock with the dimensions of 3 feet high, a 3 feet top width, and 3 horizonal to 1 vertical side slopes on both sides. The upstream face will have a geotextile filter fabric and a one-foot thick rock layer ranging from ¾ to 6 inches in diameter install. Both rock filter are approximately 200 feet in length to span the entire Moodna Creek.

Crossing Removal

On the Binnen Kill at AOP 2, the culvert, earthen berm and road crossing were proposed as an alternative to be removed as this action would most effectively restore fluvial and tidal flow and aquatic organism passage through the site, and would allow for restoration of tidal wetlands. Removal of this structure would eliminate the need for long-term maintenance and repair due to damage from flooding, etc. This removal alternative does, however, remove the road as an accessway to the adjacent privately-owned lands. The culvert at AOP 2, earthen berm, and road crossing would be removed. The channel would be graded to allow aquatic organism passage and tidal wetlands would be established along the stream banks.

Crossing Enlargement

On the Binnen Kill at AOP 2, the culvert crossing is proposed as an alternative to be enlarged to ensure passage by aquatic organisms. The metal pipe would be replaced with a box culvert with a stream substrate bottom. A box culvert is proposed as it provides larger hydraulic opening, lower vertical rise, longer life-span, greater weight-bearing capacity, and requires less road-cover than the existing metal culvert or a new corrugated metal culvert. The road surface over the culvert would support farm equipment and all-terrain vehicles. Floodplain culverts would be installed on either side of the culvert to increase flow conveyance. Separate floodplain culverts are proposed on the sides as a lower cost option to adding a second primary concrete culvert.

The road crossing consists of a box culvert, floodplain culvert(s), earthwork, and accessory components associated with the culverts and crossing. The box culvert item includes compaction, backfill, excavation, headwalls, wingwalls, a crane crew,

mobilization and demobilization of the crane crew, a guard rail, guard rail posts, a base coarse drainage layer, and the concrete box culvert. Box culverts for the draft plan were 10-feet high with a 12-foot span, a 1-foot concrete thickness, and prefabricated in 8-foot sections. The design specifications were quantified based on 1) the existing berm elevation, 2) the required culvert top and invert elevations, and 3) a maximum proposed slope of 3 feet horizontal to 1 foot vertical between the berm and culvert top elevations. In addition, a temporary bridge would be temporarily installed for intermediate stages, where necessary.

The floodplain culverts would consist of piping, end sections, gaskets, backfill, compaction, excavating, and a base coarse drainage layer. The floodplain culverts were assumed to be 48-inch x 76-inch concrete elliptical pipe design or 60-inch diameter circular pipe equivalent. This sizing was selected to be large enough to accommodate the anticipated 2075 tide range, from elevation zero to MHHW, approximately 57 inches. Thus, the closest standard size pipe diameter was selected. In some locations elliptical pipe would be required to obtain minimum pipe cover. The larger connection pipes were also selected to reduce maintenance and potential for clogging.

Utility Removal

This entails decommissioning the utility line and removal of the section that crosses Moodna Creek. The sanitary sewer line is a 16-inch ductile iron pipe; an approximately 100-foot-long section spans the channel and is contained in a concrete encasement approximately five feet wide and five feet deep. Full removal of the utility line at the channel crossing is proposed as the alternative that most effectively restores fish passage through the site, and also eliminates the structure that is currently exposed, undermined by subsurface flow, and at risk for damage or rupture.

The recommended plan for decommissioning the line includes accessing the existing manhole on the floodplain to the north (i.e. river left side), and sealing-off the incoming sanitary line with concrete or similar means. On the river right bank, where the utility descends steeply from the inactive railroad bed at the top of the slope, the draft plan for decommissioning this sewer line was to break the existing line at the base of the slope and install a manhole. The recommended plan proposes decommissioning the sewer line on the river right bank by mechanically plugging and capping the line with a concrete thrust block. In additional, the sewer line at the upslope manhole is also recommended to be mechanically plugged.

Rock Ramp

At the Utility Crossing on Moodna Creek, this element, proposed as Alternative 2, includes constructing a stabilized boulder rock ramp, as a nature-like fishway, on the downstream side that is fish passable. The rock ramp would be approximately 20:1 slope as per fish passage guidelines for nature-like fishways, and would be comprised of several boulder

rock weirs and intervening pools that provide deeper, slower water to facilitate upstream fish passage. The appropriate boulder size and the configuration of the rock ramp would be determined following a detailed topographic survey, hydrologic and hydraulic analysis, and consideration of fish passage guidelines. Boulders are an abundant, natural component of Moodna Creek and thus additional use would provide a natural aesthetic that blends with adjacent reaches. In addition, the existing utility crossing would likely require sheet-piling, or similar subsurface barrier, installed upstream of the concrete encasement to eliminate the existing subsurface flow that is undermining the utility crossing as that could undermine the constructed rock ramp. This rock ramp alternative allows for the utility to remain in place but would require routine inspections, maintenance, and repairs over the long-term in order to ensure optimal fish passage conditions. A technical fishway was not proposed at this location because the hydraulic height of the existing utility is only two feet approximately, well within the limitations of nature-like fishways. Furthermore, the nature-like fishway can accommodate the full width of the channel, which greatly increases fish passage efficiency, whereas a technical fishway could only accommodate a fraction of the channel width. A technical fishway would require a concrete structural housing, with higher anticipated design and construction costs, and greater maintenance demands (e.g. routine debris clearing).

Fishway

At Firth Cliff Dam, this element entails the construction of a technical fishway at the dam as Alternative 2. A nature-like fish bypass would not be feasible at this location due to the confining valley walls and the 10-plus vertical feet that would need to be accommodated from downstream channel invert to dam spillway crest, which would require extensive length and large material costs that would likely cost more than a technical fishway to construct. Creation of the technical fishway would likely require excavation into adjacent banks, concrete, and soils of the former facility. The entrance (i.e. downstream end) would likely be placed as close to the spillway as possible to ensure that fish that arrive at the dam could still locate the fishway entrance.

At Eddyville Dam on Rondout Creek, a technical fishway is proposed as Alternative 1 that could accommodate some fish passage. This structure is proposed on the river left side, which would facilitate construction, and long-term monitoring and maintenance. A nature-like fishway would not be feasible at this location due to the extreme river depths downstream of the dam, leaving little or no existing subgrade on which a rock ramp or nature-like fishway could be reasonably founded and built.

The specific type of technical fishways (e.g. Denil Step-pool or Alaskan Steep-pass) and its design would be determined following detailed topographic survey, hydrologic and hydraulic analysis, identification of target species, and consideration of fish passage guidelines. Fishways typically are not capable of restoring fish passage to the full range

of diadromous or resident fish, or all size classes (e.g. age classes), and are therefore considered to be a partial restoration of passage at a dam. These structures would require routine inspections, maintenance, and repairs over the long-term in order to ensure optimal fish passage conditions.

Dam Breach

At the Orr's Mill Dam (AOP 3 barrier), this element is proposed as Alternative 2 and entails breaking through the spillway concrete crest and underlying cobble/boulder-filled timber crib structure, removing the vertical extent of a central portion of the spillway, and leaving the side portions in place. The ends of the spillway could be stabilized at their base with placed boulders, while the upper portions could be left open for visibility of the spillway's interior construction. This alternative effectively removes the dam, but retains a portion of the spillway in place as a physical marker and historical monument of the former dam if desired by the dam owner; however, similar to current conditions, the remaining spillway would be subject to slow deterioration due to weathering and river conditions (freeze/thaw, ice floes, scour, abrasion, debris impact, etc.). Full dam removal would not leave a portion of the spillway to serve as a long-lasting historical monument onsite.

With the full vertical extent of the central portion of the spillway removed, a similar channel response is likely to be triggered as with full removal but with more retention of sediment on the channel margins proximal to the dam. The pronounced accumulation of boulders behind the dam, which may shift in position during construction and after dam breach, has the potential to form a steep (5% slope) boulder cascade or reveal natural bedrock falls (although no historic record of a natural waterfall has been identified). This potential steep transition was an assumption of the draft plan. However, the recommended plan is based on the more likely, and conservative estimate for a potential post-dam breach equilibrium slope that extends approximately 325 feet upstream of the spillway crest resulting in a cobble-boulder riffle at 1.6 percent. Approximately 900 feet upstream of the dam, a large boulder riffle exists that would likely serve as grade control if channel adjustment extends to that point.

The re-formation of a cobble-boulder riffle would likely restore passage to a range of fish and other aquatic organisms in Moodna Creek. However, the emergence of a bedrock falls or formation of a steep boulder cascade may not provide full passage for fish; and in this case, some active re-grading and re-positioning of boulders may be recommended to facilitate fish passage while maintaining grade control. If in situ boulders are insufficient to maintain a stable grade change and/or fish passage conditions, the recommended plan also includes supplementing this reach with large boulders. The small cobble dominated tributary which flows under a residence and joins Moodna Creek approximately 250 feet upstream of the dam, may require grade control to prevent undermining of the over-lying house.

Dam breach is the recommended plan for Orr's Mill. The refinement of water and sediment control for this alternative removed the use of sheet pile coffer dam and replaced it with two (2) rock check dams. One of the check dams shall be installed immediately upstream of the dam and will be constructed wide enough to use for construction access. It is assumed that to have a 15 feet top width, be 5 feet high, and have a 1 foot horizontal to one-foot vertical slope on the upstream and downstream sides. It is assumed that a D50 of 12 inches with variation from 6 to 18-inch diameter rock would be used for construction. An impermeable liner is proposed to be installed on the upstream face of the check dam for stability and to eliminate the potential for flow through the rock. This rock filter is proposed to be approximately 220 feet long. The downstream check dam shall be installed such that mobilized sediment will within the existing scour hole. The check dam is proposed to be installed at the head of the riffle immediately downstream of the dam and scour hole and upstream of the Route 32 bridge. This feature shall be constructed on the same size rock with the dimensions of 3 feet high, a 3 feet top width, and 3 horizonal to 1 vertical side slopes on both sides. The upstream face will have a geotextile filter fabric and a one-foot thick rock layer ranging from ¾-inch to 6 inches in diameter install. The rock filter is proposed to be approximately 140 feet long to span the Moodna Creek.

Dam Notching

At the Eddyville Dam on Rondout Creek, this element, proposed as Alternative 3, involves removing a portion of the spillway, likely in the center, to provide for fish passage and leaving the remainder of the spillway intact at its existing elevation. This design was advanced as the recommended plan. The extent of the notch (width and depth) of the spillway would be determined through detailed site survey and hydrologic and hydraulic analysis to create optimal hydraulic conditions for upstream fish passage for as many target species as possible.

Notching, as opposed to full removal, allows a portion of the spillway to remain as an enduring feature on the site and physical marker of the historic dam. Similar to current conditions, the remaining spillway would be subject to slow deterioration due to weathering and river conditions (freeze/thaw, ice flows, scour, abrasion, debris impact, etc.).

The notching of the dam would also result in a reduction in normal water surface elevation albeit less than the full removal, in addition to an upstream tidal influence likely less than the full removal would create.

It is assumed that adequate shallow bedrock or consolidated river bottom exists immediately upstream and/or downstream of the dam to allow for a rock-lined construction accessway to convey an excavator to the portion of the spillway to be notched. The dam and shallow bedrock at the notch would remain as a barrier to boat

navigation from downstream of the dam to the upstream reaches. A detailed hydrologic and hydraulic analysis would be required to affirm the extent and magnitude of this effect.

8. Designs and Quantities

A series of 23 alternative concept designs and details for the project sites were developed using the above information and techniques (Attachment E) for the draft plan. Development of the excavation quantities as well as assumptions that informed the concept development are described below. The Cost Engineering Appendix (Appendix E) details the development of quantities and cost assumptions and describes in further detail the item descriptions associated with the restoration measures outlined above.

8.1 Excavation Volumes

Wetland Restoration

The excavation required to restore the wetlands is based on the proposed area of wetland multiplied by the elevation difference between existing grade and the 2027 mean tide elevation plus an additional six inches to account for the select amended soil. In some instances, fill was required to maintain a wetland community through 2075. In these cases, the difference between existing grade and the 2075 mean tide elevation less six inches was used to calculate the fill volume necessary to meet subgrade elevations.

The excavation volumes for the optimized recommend plans used LiDAR supplemented with ground elevations obtained from the site investigations to model the existing surface. The proposed surface was developed from the proposed grading including the transitional slope to meet existing grade. These two surfaces were compared to determine the volume of material to be excavated.

Shoreline – Cribbing

For the installation of cribbing, a number of assumptions were made in order to obtain a safe and functional installation of the materials. It was assumed that the work area will be dewatered and controlled for the duration of the active construction. It is anticipated that temporary shoring will need to be installed as well the installation of an 18-inch diameter stand pipe with 4-inch diameter diaphragm pump with hosing. All of the excavation associated with this element was considered wet excavation. It was assumed that the area bank ward of the cribbing would be excavated approximately ten feet back and to a depth of three feet into existing substrate waterward of the existing cribbing.

Shoreline – Stabilization

For grading along the banks, the difference between an averaged or a typical surveyed cross section was overlaid on a scale conceptual detail and multiplied by the length of the

restoration element. A variety of cross-sections were used to calculate the volume and all values were the same within reason.

Additionally, when rock is proposed to provide stabilization, the cross-sectional bank length was multiplied by the length of the element and divided by the diameter of the rock to determine the quantity of rock required. If a linear element of rock was proposed such as a boulder toe, the length was divided by the diameter of the rock.

All excavation below mean high tide was considered wet excavations and anything above mean high tide was considered dry excavation.

The excavation volumes for the optimized recommend plans used LiDAR supplemented with ground elevations obtained from the site investigations to model the existing surface. The proposed surface was developed from the proposed grading including the transitional slope to meet existing grade. These two surfaces were compared to determine the volume of material to be excavated.

Side Channel

Excavation volumes were calculated based on existing grade elevations and the proposed channel invert. Specifically, three-dimensional surfaces were created for the existing ground surface based on LiDAR derived elevation data and a typical cross-section and channel profile of the proposed condition. The difference between the two surfaces was the calculated insitu volume. The 2027 MHHW elevation was used to determine the volume of wet verses dry excavation.

The excavation volumes for the optimized recommend plans used LiDAR supplemented with ground elevations obtained from the site investigations to model the existing surface. The proposed surface was developed from the proposed grading including the transitional slope to meet existing grade. These two surfaces were compared to determine the volume of material to be excavated.

Culverts

The excavation volume for both box and floodplain culverts, were assumed to be trapezoidal with a bottom width equal to the outside culvert width plus a three-foot buffer width, and three feet horizontal by one-foot vertical side slopes to the existing grade. It was assumed that all culverts had a foot of base course below the outer invert. The up and downstream slopes from the existing surface are proposed to be set to three feet horizontal by one-foot vertical side slopes. In the immediate location of the culvert, the slope was determined from the top of the end treatment.

The excavation volume for both box and floodplain culverts were calculated based on a cut/fill analysis of the existing grade vs. the average proposed subgrade for the culverts.

The analysis was done using surfaces created in GIS for both the existing grade and the subgrade. It was assumed that all culverts had a one-foot base course below the outer invert. The up and downstream slopes from the existing surface are proposed to be set to three feet horizontal by one-foot vertical side slopes. In the immediate location of the culvert, the slope was determined from the top of the end treatment.

8.2 Disposal/Placement

For all alternatives, it was assumed that excavated earth material would remain onsite. Concrete that cannot be reused for stabilization measures, asphalt, trash and/or other unnatural material is proposed to be lawfully disposed of offsite. If additional volumes of material are required to be removed from the site and disposed of according to local regulations, the costs shall be modified to account for hauling and disposal fees.

The disposal and placement of excavated material for the optimized recommend plans varied by materials and site. For each recommended plan, it was assumed that concrete that cannot be reused for stabilization measures, asphalt, trash and/or other unnatural material is proposed to be lawfully disposed of offsite.

It was assumed that for Henry Hudson, excavated material would be loaded and hauled to a nearby disposal facility using triaxle trucks. This includes a tipping/disposal fee for the 36,000 CY of excavated material.

For the Schodack Island restoration site, it was assumed that the 85,000 CY of excess material excavated as part of the restoration would be hauled to the Houghtaling Disposal Facility on the island. Hauling of the material onsite to a loading location, loading the material onto trucks, and hauling the material down the island to the disposal facility was incorporated into the cost estimate. In addition, it was assumed the material would be disposed of in Cell A.1 of the facility – this assumption was used to develop costs for the handling of material once onsite at the disposal facility. The soil disposal costs include soil erosion controls, dewatering if necessary, grading of the disposed soil material, and vegetated stabilization at the disposal location.

9. Cross Section Designs

For each site, conceptual design alternatives and cross-sectional details were prepared and are included in Attachment E.

10. Recommended Plans

The twenty-three (23) conceptual design alternatives were narrowed to five (5) recommended plans. The recommended plans are:

- Schodack North Alternative 2
- Henry Hudson Alternative 1

- Moodna Creek- AOP 1 (Utility Crossing) Alternative 1
- Moodna Creek- AOP 2 (Firth Cliff) Alternative 1
- Moodna Creek- AOP 3 (Orr's Mill) Alternative 2

The concept designs for the Schodack Island and Henry Hudson Park alternatives were optimized with regards to grading and plant palette. The optimal alternatives for Moodna Creek were selected based on engineering feasibility, cost, and ecological uplift. Refer to Attachment F for recommended plans and quantities.

11. Further Analysis and Design Development Needs

Geotechnical borings and investigations are required to investigate the depth to bedrock, type of soils, and depth to groundwater in order to determine the depth of excavation required to achieve wetland hydrology and suitable substrate. A chemical analysis should also be performed to identify potential pollutants and inform disposal of excavated materials. Additionally, reference wetlands will be identified in the vicinity of the wetland restoration sites to establish biological benchmarks and survey the native flora. The biological benchmarks will inform the wetland community design elevations, while local flora will inform the plant pallet.

A preliminary hydrologic and hydraulic analysis was completed for the Moodna Creek sites and is discussed in Attachment B. However, implementation of the recommended plans at the three AOP areas of interest will likely require additional data collection and analysis in the PED phase to complete planning, engineering design, and permitting, including (i) additional topographic survey to update and re-analyze the hydraulic model, and (ii) sediment sampling and analysis for potential pollutants. H&H modeling at Moodna Creek should thoroughly investigate the risk of exacerbating known instances of bank failure as a result of the proposed improvements. It is further noted that even the perceived risk of exacerbating bank failure must be anticipated and fully considered during all phases of this project. PED phase H&H modeling at Moodna Creek should also consider the preliminary Climate Hydrology Assessment findings which indicate potential increases in streamflow relative to current conditions so as to better gauge the risks increased streamflow will have on the future with project condition.

Detailed river hydrologic and hydraulic analyses shall be completed for the additional sites in the PED phase. Project elements with direct exposure to the Hudson River (Schodack Island and Henry Hudson Park) shall have wave/wake calculations performed to confirm the stability and resistance to energy created by these forces. Tidal datum definitions shall be updated to incorporate additional data from the HRECOS Schodack gauge should it remain operational until PED. However, since a NOAA long-term gauge is not within the project vicinity, the HRECOS Schodack gauge will continue to represent the best available data and could serve as a long-term gauge after 19 years of data collection, on

or around 2027. In order to mitigate potential tidal datum uncertainty affecting the design elevation of habitats, bio-benchmark surveys shall be performed in order to correlate specific elevations with tidal habitat ranges

12. Operations, Maintenance, Repair, Replacement, and Rehabilitation

Activities associated with operation, maintenance, repair, replacement, and rehabilitation (OMRR&R) efforts were developed for Schodack Island and Henry Hudson Park. Operation and maintenance activities were identified for the first 10 years following the Monitoring and Adaptive Management period. Repair, replacement, and rehabilitation activities for structural features were identified for 50 years following the Monitoring and Adaptive Management period. The following activities are assumed for Schodack Island:

- **Site Survey and Assessments** – Two senior scientists would be required to spend one 10-hour day per year for 10-years.
- **Invasive Species Treatment** – Each year for the 10-year period, 2% of the initial planted area would be treated for invasive species.
- **Channel Stabilization Measures** – Channel stabilization measures to protect the integrity of the installed structures, which were anticipated during the adaptive management phase of the project, would again be required during the O&M phase of the project. Measures include minor grading, seeding, and matting.
- **Minor Debris Removal** – One laborer to hand remove any debris blockage during a four-hour window, one day per year for the 50-year structural OMRR&R period.
- **Major Debris Removal** – One operator and one laborer to remove any debris blockage with a hydraulic excavator for one 8-hour day per year for the 50-year structural OMRR&R period. It was assumed that this equipment would be on-site and no mobilization, demobilization, or equipment costs would be necessary; only labor costs were assumed for this OMRR&R cost.

The following activities are assumed for Henry Hudson:

- **Site Survey/Assessment and Minor Debris Clearing** – Two senior scientists would be required to spend one 10-hour day per year for the 10-year OMRR&R period completing a site assessment. Also, they would clear by hand any minor debris blockages of channels, if necessary.
- **Invasive Species Treatment** – Two laborers would treat by hand minor areas of invasive species during an 8-hour day once per year for 10-years.
- **Shoreline Bank Stabilization** – Vegetative riprap stabilization would require repair or re-stabilization once during the 50-year OMRR&R period. It was

assumed 15% of original values for amended soil, riprap, and plantings will need to be restored during this effort.

No OMRR&R activities are anticipated for the Moodna Creek AOP barriers after the 5-year Monitoring and Adaptive Management period.

13. References

City of Albany, N. (2013). *Albany Climate Change.* Albany, NY: NY State Department of State.

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ATTACHMENT A

EXISTING CONDITIONS CROSS SECTIONS AND PROFILES

LEGEND

BK-1 — SHORELINE PROFILE / STREAM CROSS SECTION

GRAPHIC SCALE

0 20 40 60 80 100 200 300 400 FEET

SCALE: 1" = 100'

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DESIGNED BY:
DRAWN BY: VM
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ISSUE DATE: MAY 2018
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ALBANY COUNTY, NY

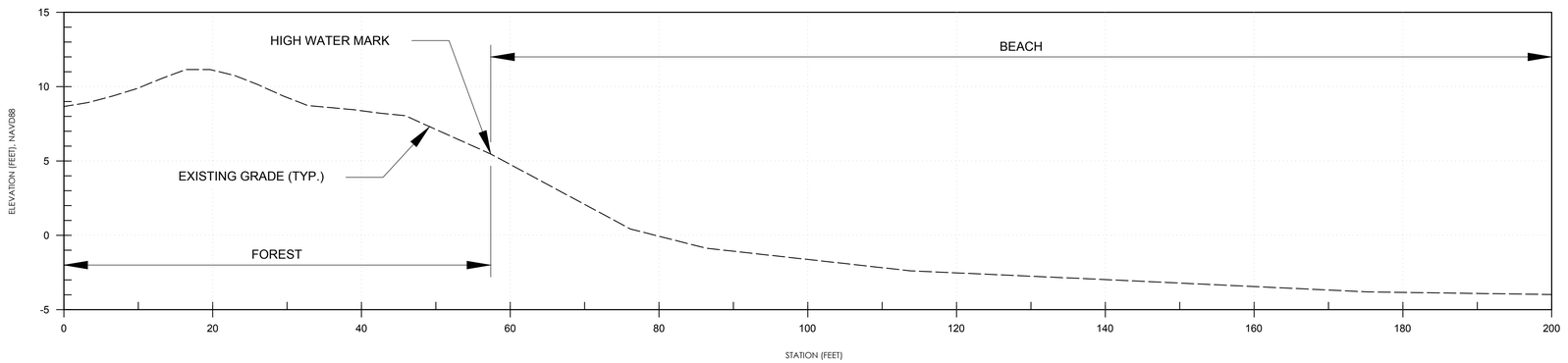
BINNEN KILL SHORELINE PROFILE AND STREAM CROSS SECTION PLAN

SHEET ID

V-101

JUL.2018

PROFILE BK-1



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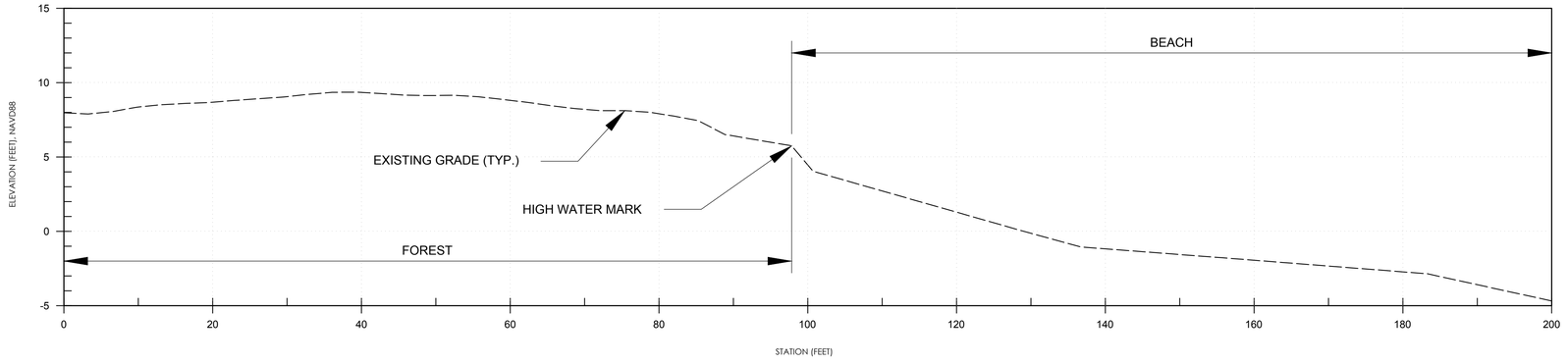

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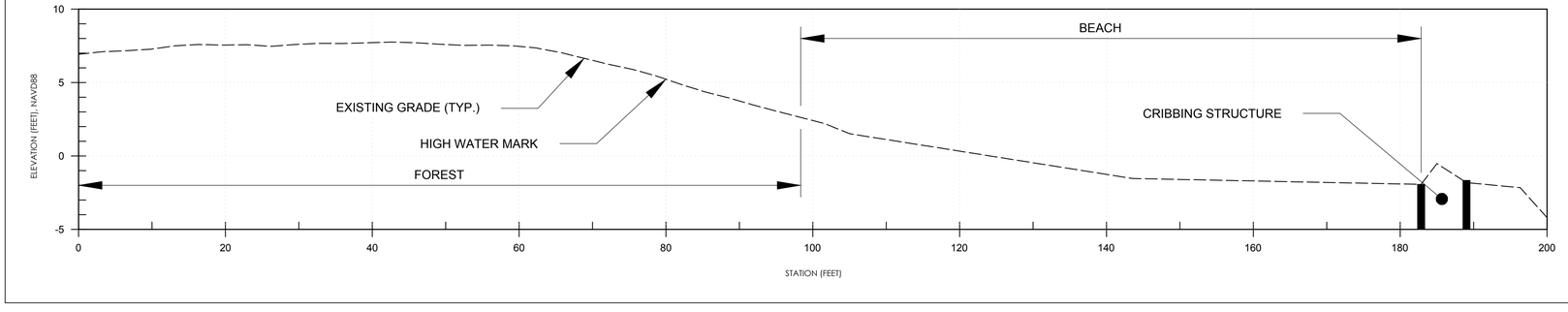

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HORIZ. SCALE: 1" = 10'

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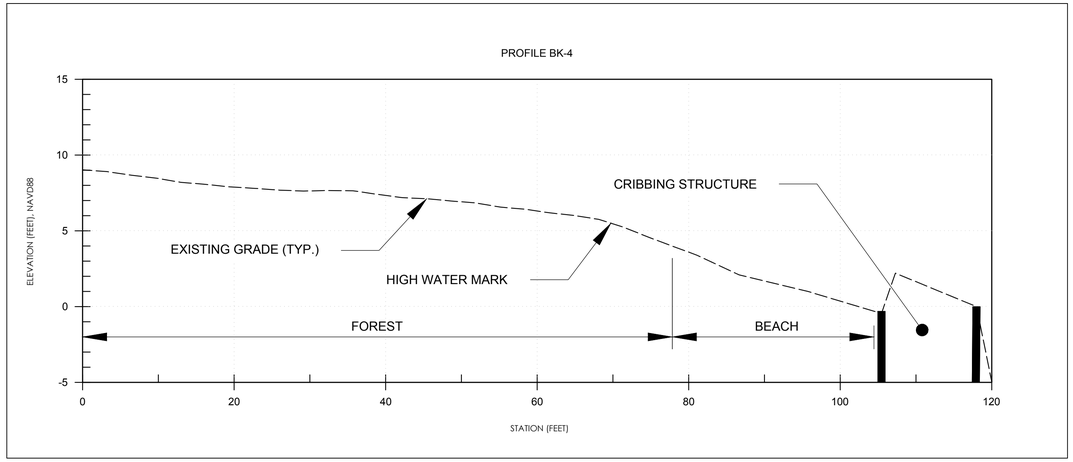
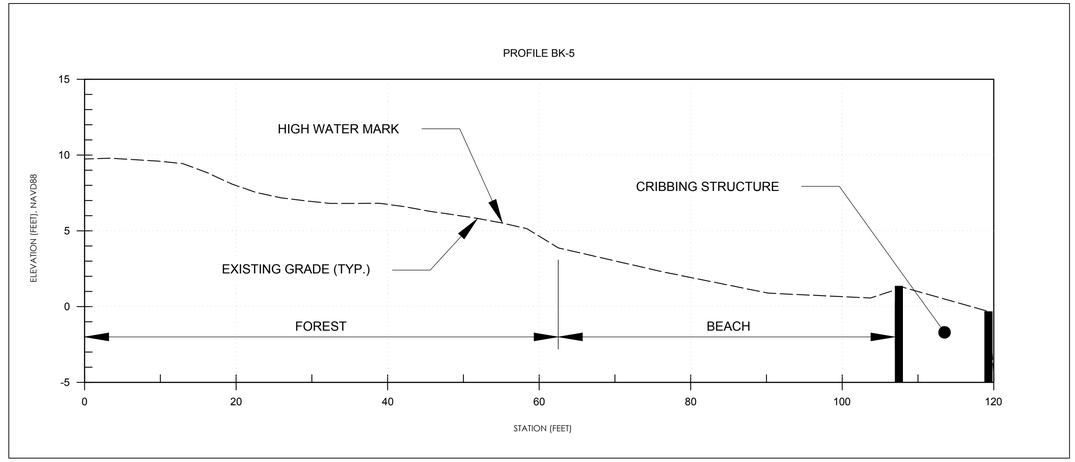
ALBANY COUNTY, NY

BINNEN KILL
SHORELINE PROFILE SHEET 1

SHEET ID
V-301

JUL.2018





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HORIZ. SCALE: 1" = 10'

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ALBANY COUNTY, NY

BINNEN KILL
SHORELINE PROFILE SHEET 2

SHEET ID

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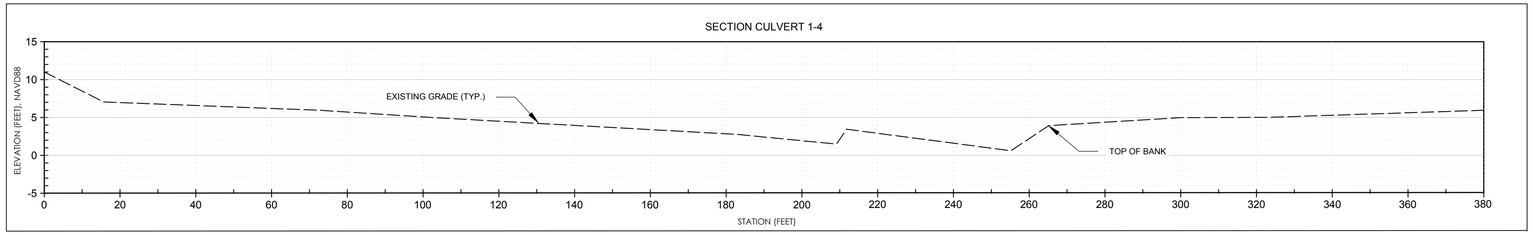

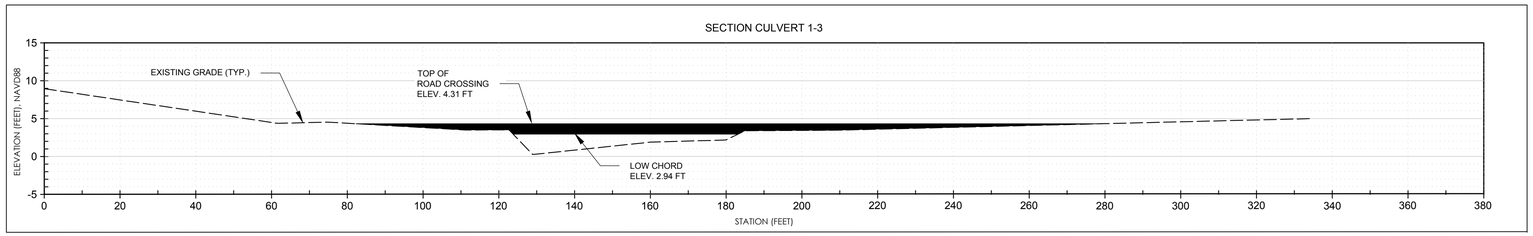

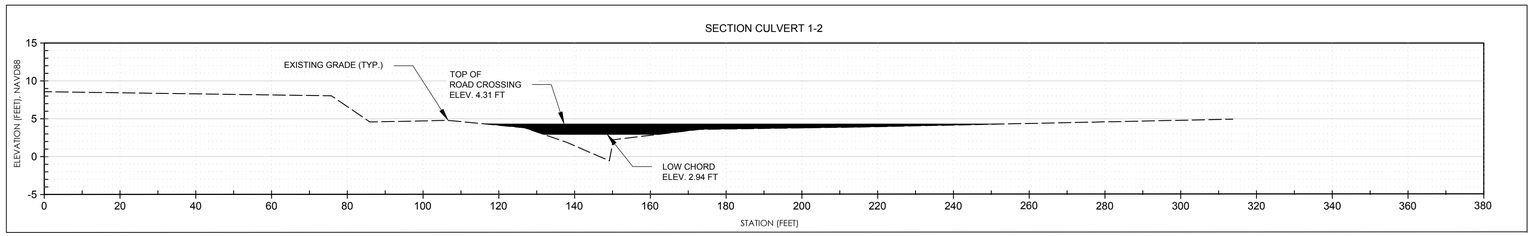

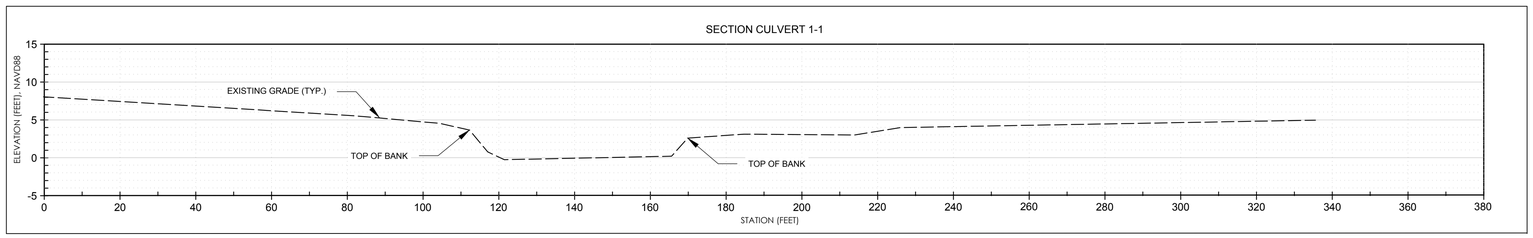

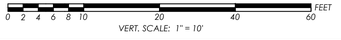

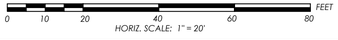

LEGEND

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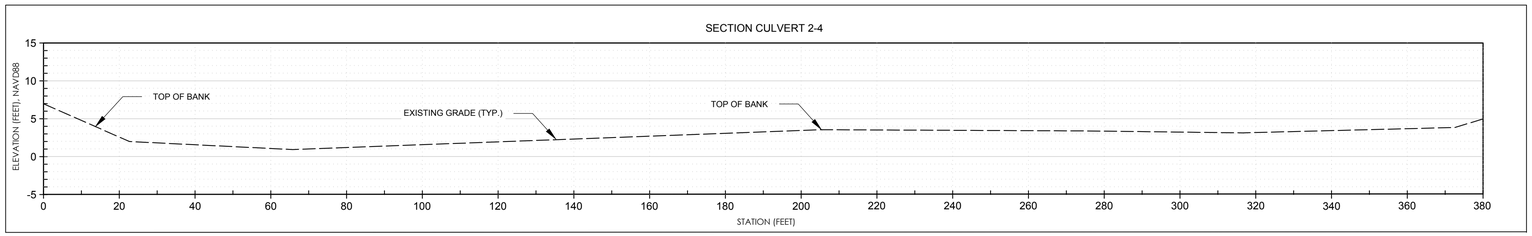
ALBANY COUNTY, NY

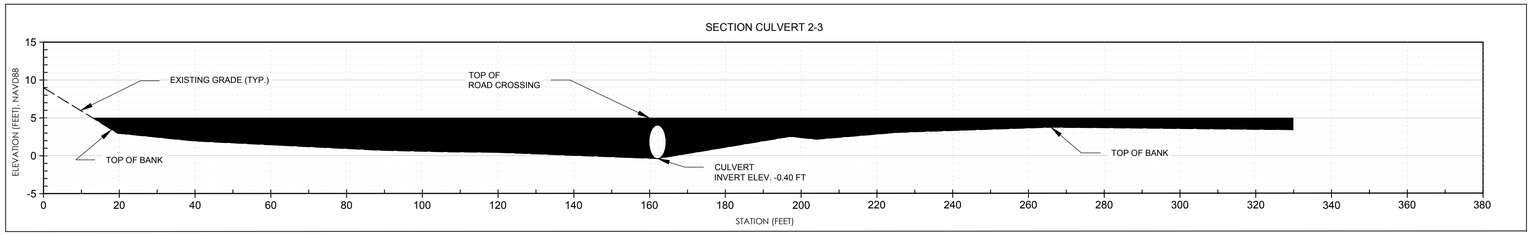
BINNEN KILL
CROSSING 1
STREAM CROSS SECTION SHEET 1

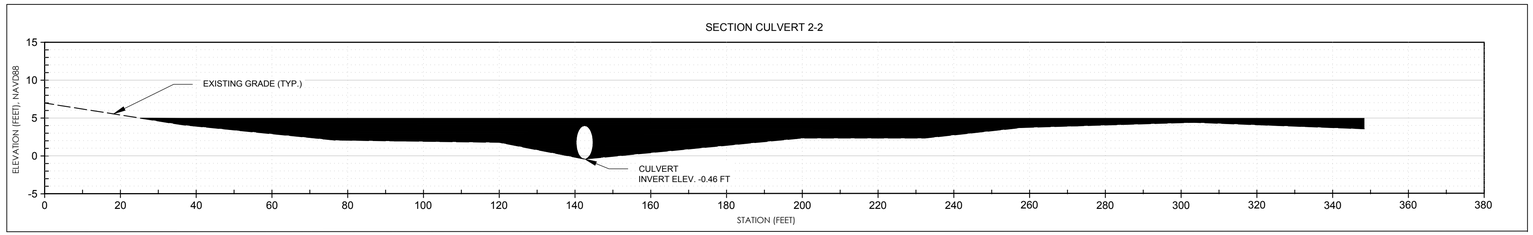
SHEET ID

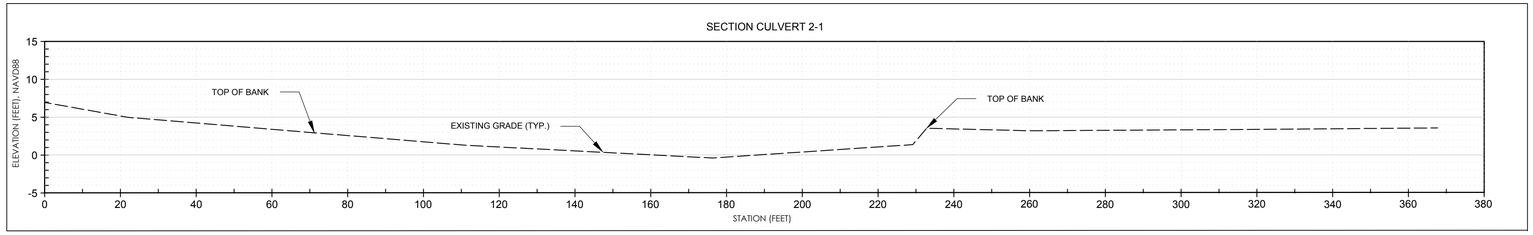
V-303

JUL.2018









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BINNEN KILL
CROSSING 2
STREAM CROSS SECTION SHEET 2

SHEET ID

V-304

JUL.2018

LEGEND

SI-1 SHORELINE PROFILE

GRAPHIC SCALE

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SCALE: 1" = 100'

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SCHODACK ISLAND
SHORELINE PROFILE PLAN SHEET 1

SHEET ID

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SI-1 SHORELINE PROFILE

GRAPHIC SCALE

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SCALE: 1" = 100'

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SCHODACK ISLAND
SHORELINE PROFILE PLAN SHEET 2

SHEET ID

V-102

JUL.2018

LEGEND

SI-1 SHORELINE PROFILE

GRAPHIC SCALE

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SCALE: 1" = 100'

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SCHODACK ISLAND
SHORELINE PROFILE PLAN SHEET 3

SHEET ID

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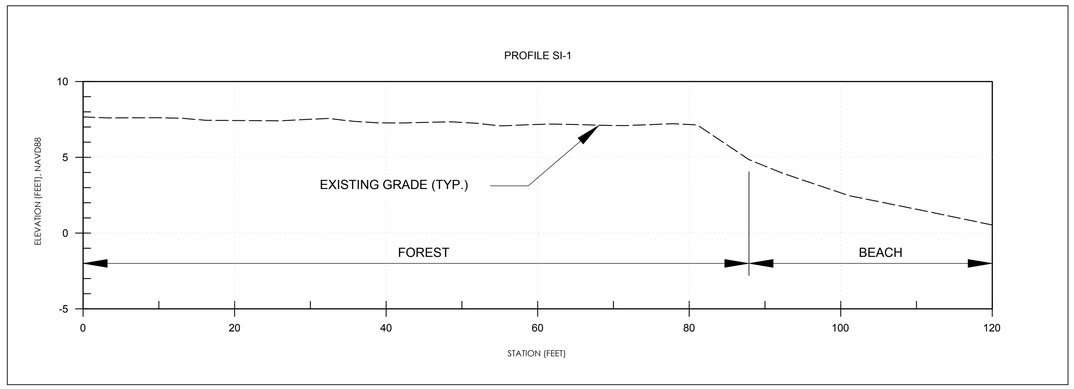

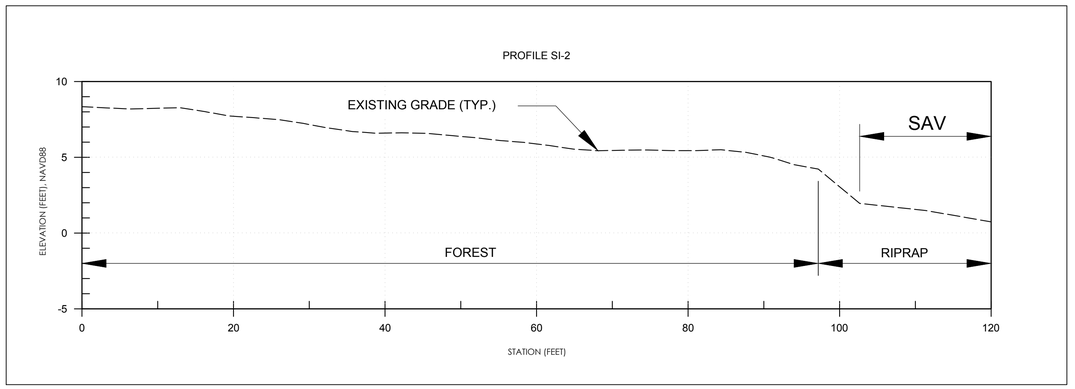

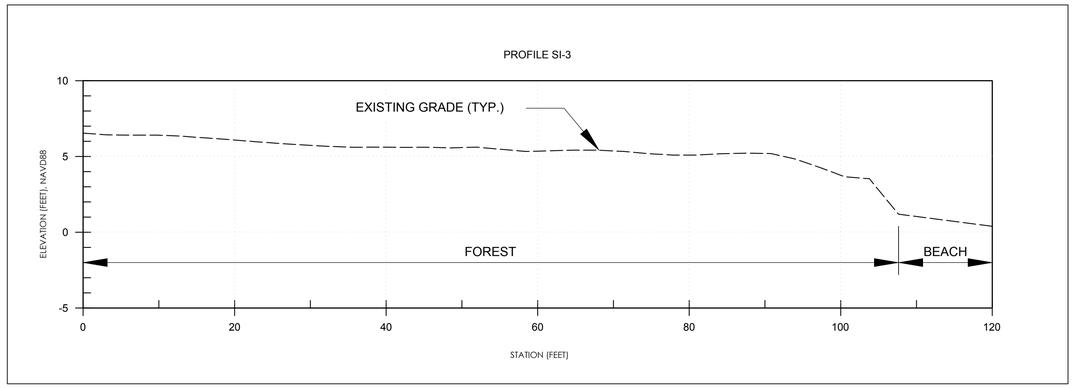

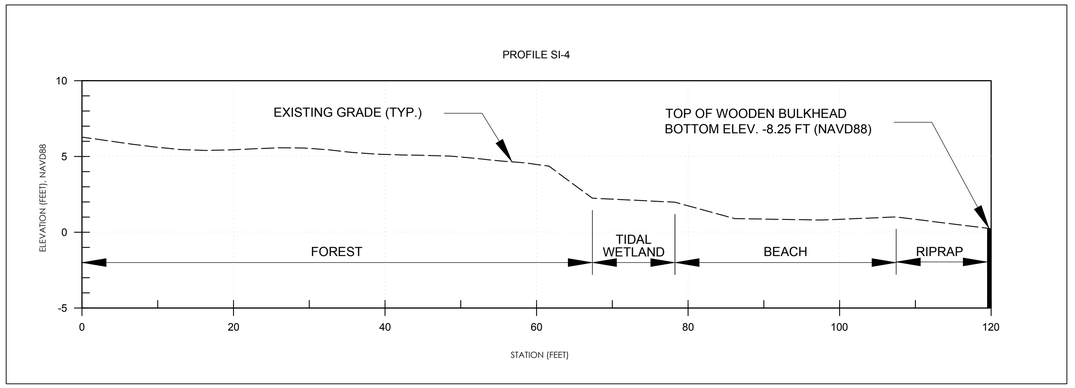

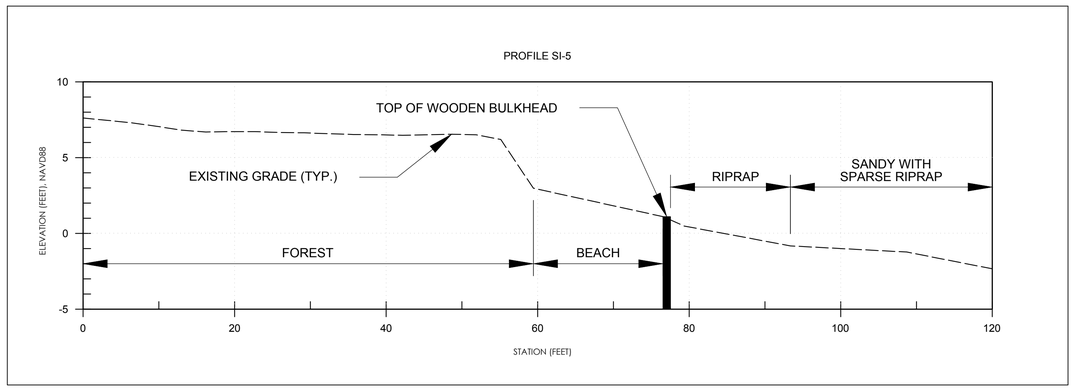

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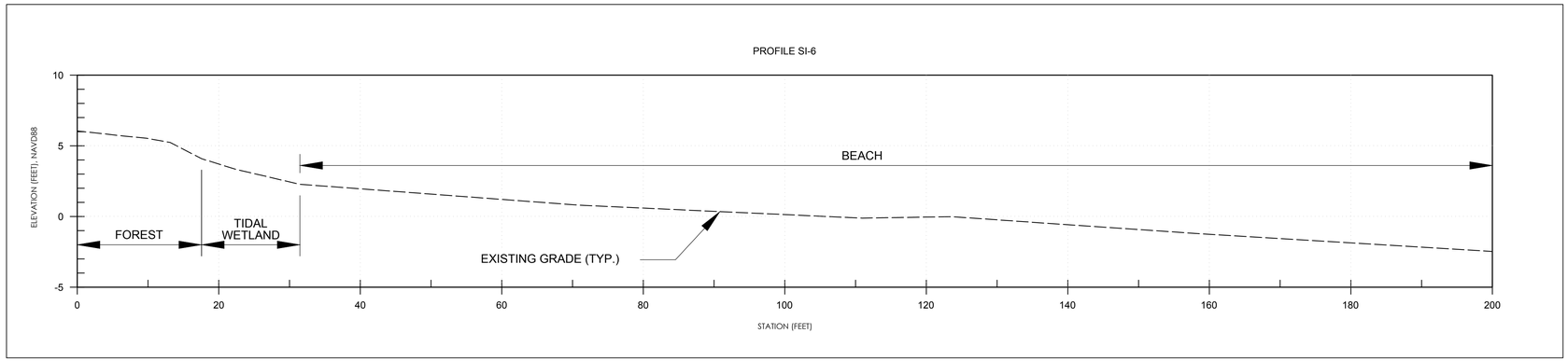
COLUMBIA, GREENE, AND RENSSELAER COUNTIES, NY

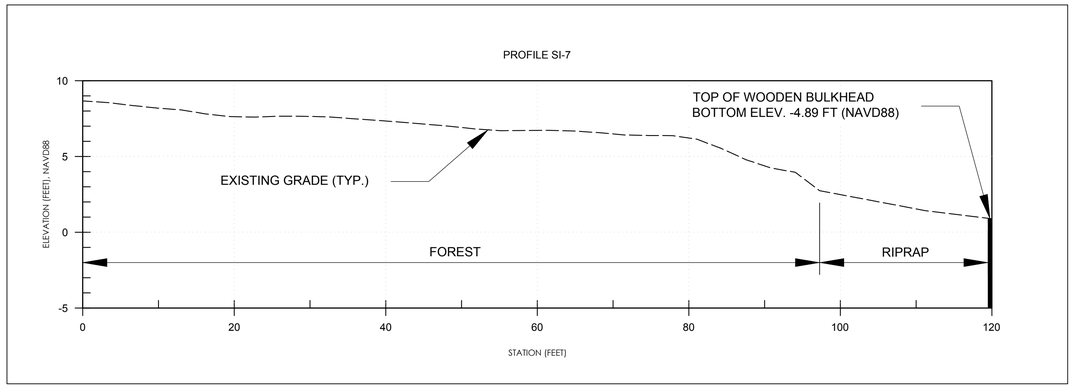
SCHODACK ISLAND SHORELINE PROFILE SHEET 1

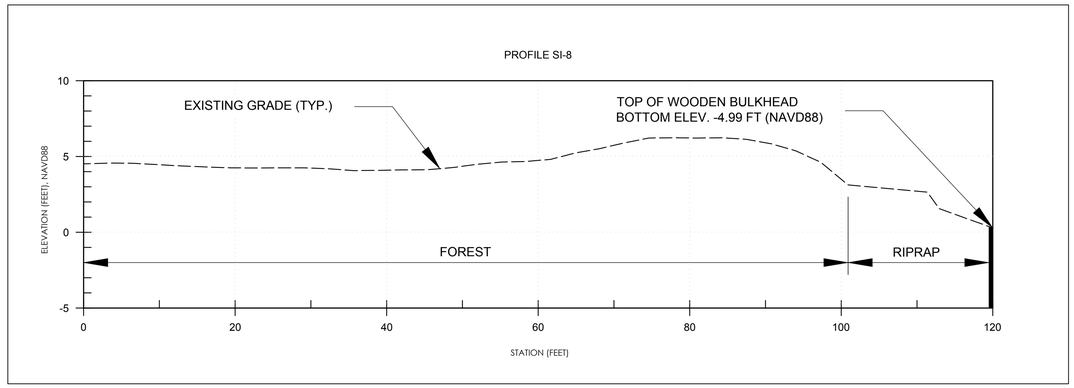
SHEET ID

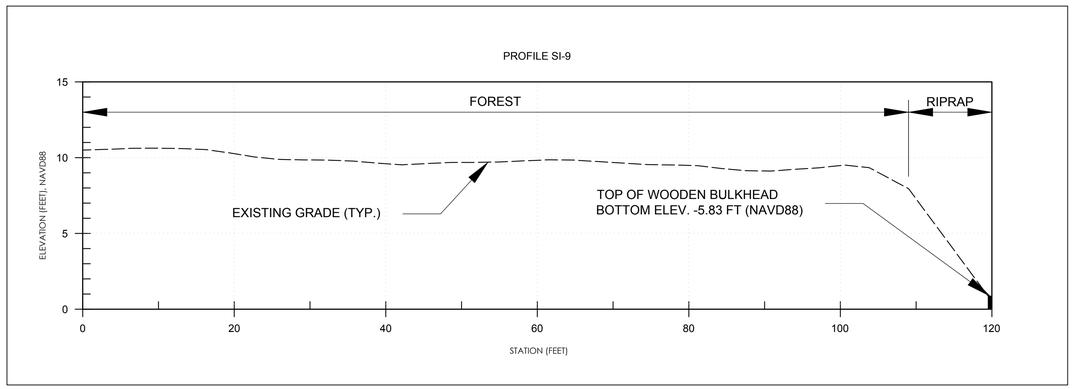
V-301

JUL.2018









LEGEND

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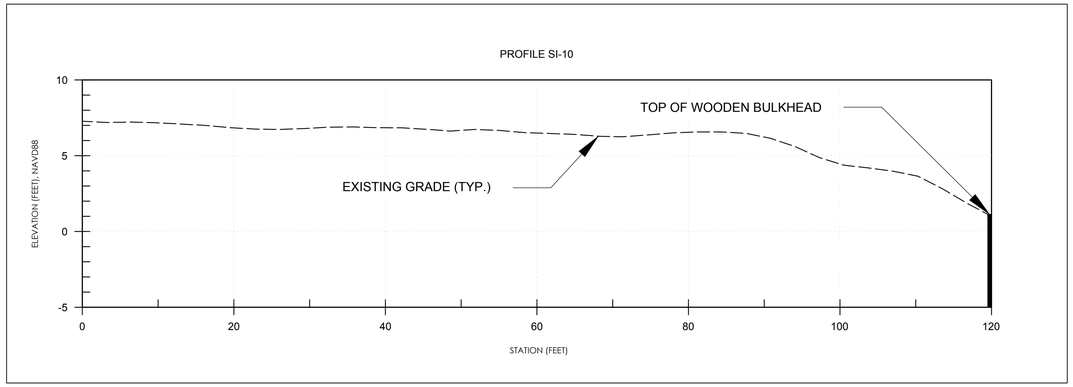
HUDSON RIVER HABITAT RESTORATION
SCHODACK ISLAND STATE PARK
COLUMBIA, GREENE, AND RENSSELAER COUNTIES, NY

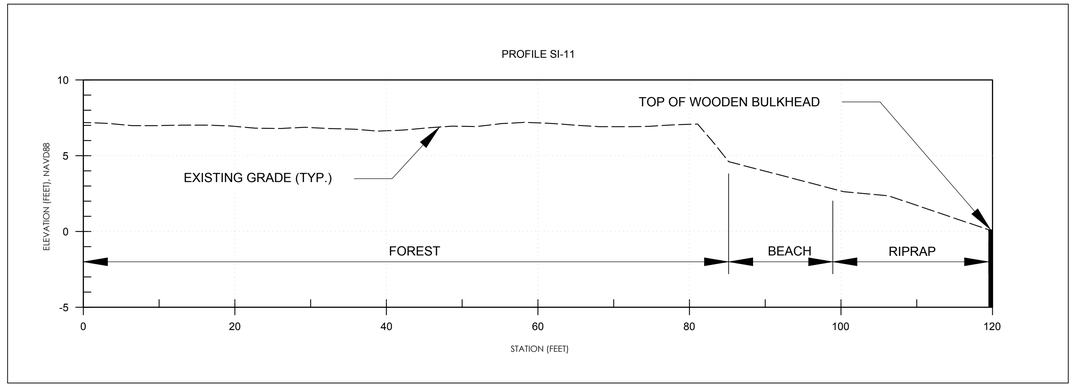
SCHODACK ISLAND SHORELINE PROFILE SHEET 2

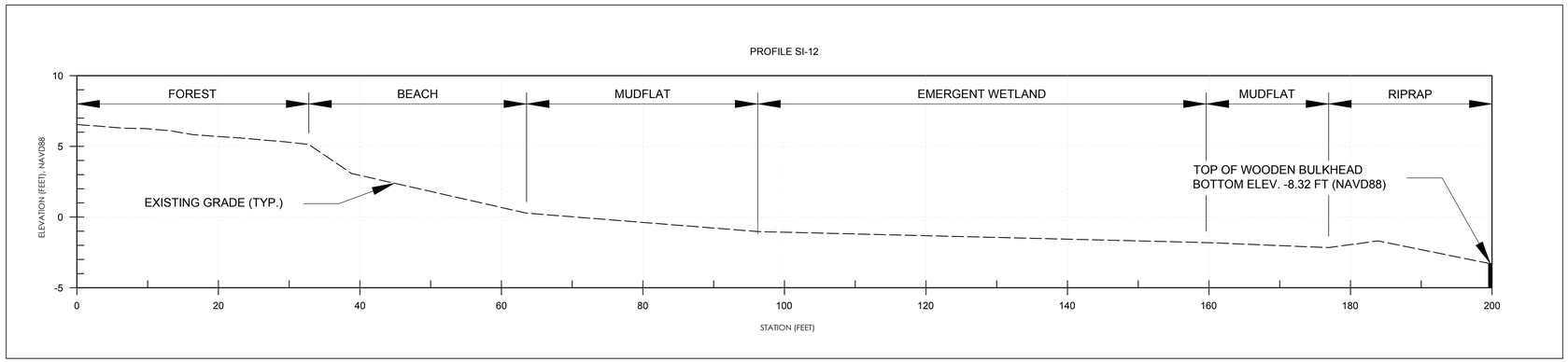
SHEET ID

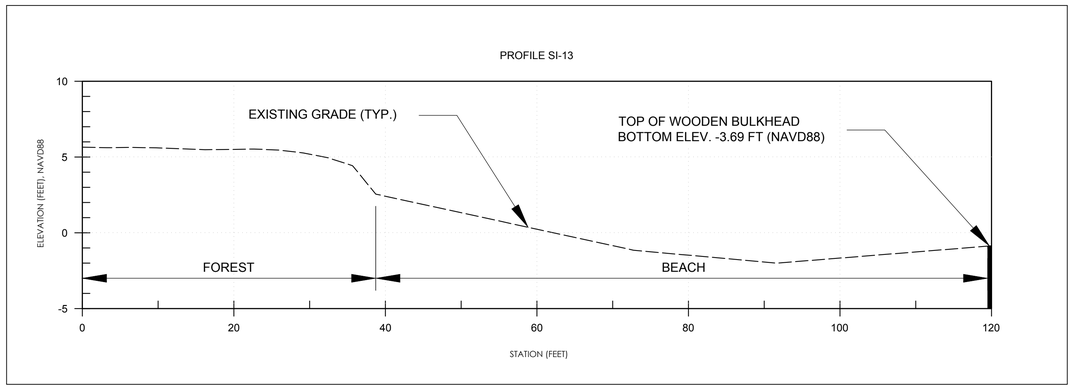
V-302

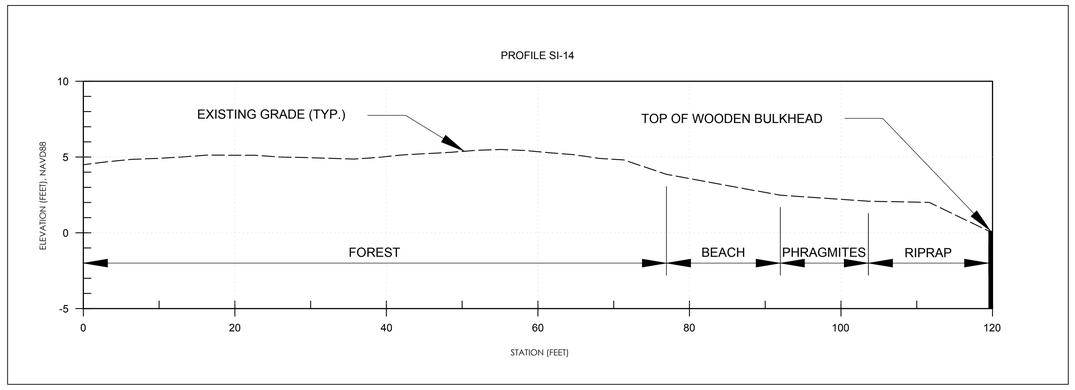
JUL.2018











NOTE:
PROFILE SI-10 WAS UNABLE TO BE SURVEYED DUE TO HAZARDOUS ACCESS CONDITIONS. THE DISPLAYED PROFILE ELEVATIONS WERE OBTAINED FROM LIDAR DATA.

LEGEND

EXISTING GRADE

FEET 0 1 2 3 4 5 10 20 30
VERT. SCALE: 1" = 5'

FEET 0 5 10 20 30 40
HORIZ. SCALE: 1" = 10'

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

DESIGNED BY:
DRAWN BY: TH
CHECKED BY:
ISSUE DATE: MAY 2018
SOLICITATION NO.:
CONTRACT NO.: W912DS-14-D-0001
SUBMITTED BY: PRINCETON HYDRO
SCALE:
SIZE: ANSI D

U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT
26 FEDERAL PLAZA
NEW YORK, NEW YORK, 10278

PRINCETON HYDRO, LLC
1108 OLD YORK ROAD
RINGOES, NEW JERSEY, 08551

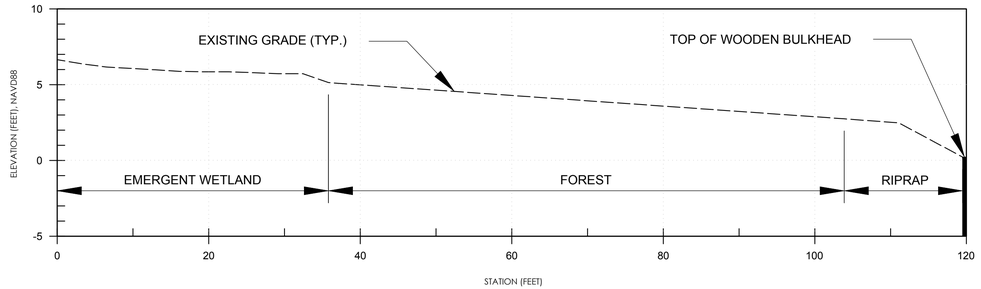
HUDSON RIVER HABITAT RESTORATION
SCHODACK ISLAND STATE PARK
COLUMBIA, GREENE, AND RENSSELAER COUNTIES, NY

SCHODACK ISLAND
SHORELINE PROFILE SHEET 3

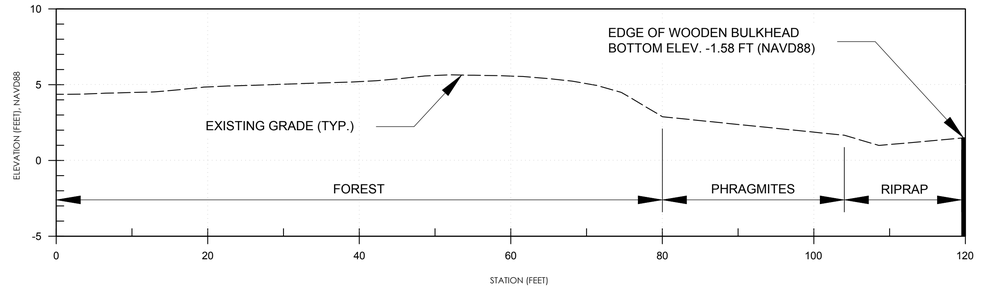
SHEET ID
V-303

JUL.2018

PROFILE SI-15



PROFILE SI-16



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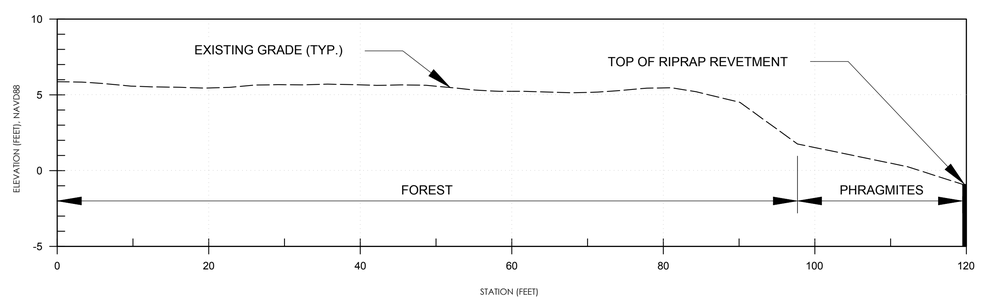

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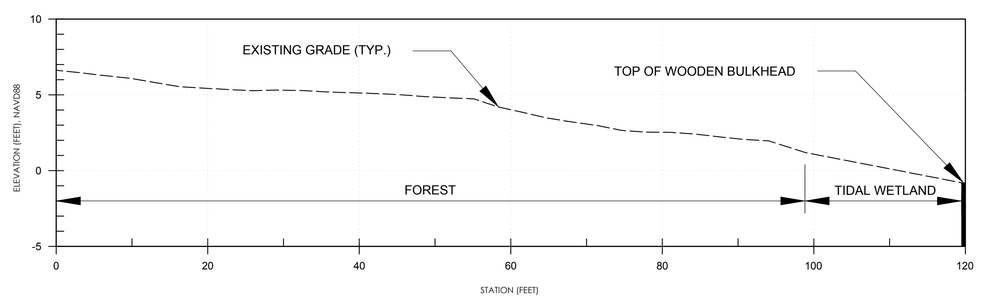
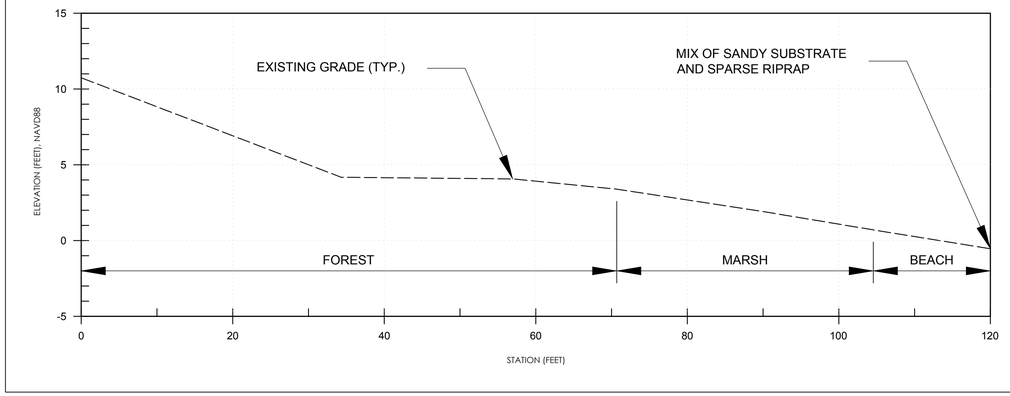


PROFILE SI-19



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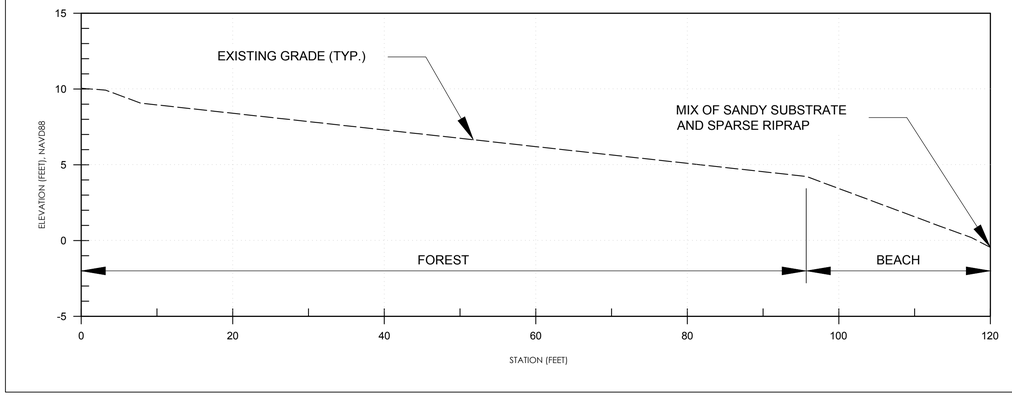


LEGEND

EXISTING GRADE

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

DESIGNED BY:
DRAWN BY: TH
CHECKED BY:
ISSUE DATE: MAY 2018
SOLICITATION NO.:
CONTRACT NO.: W912DS-14-D-0001
SUBMITTED BY: PRINCETON HYDRO
SIZE: ANSI D

U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT
26 FEDERAL PLAZA
NEW YORK, NEW YORK, 10278

PRINCETON HYDRO, LLC
1108 OLD YORK ROAD
RINGOES, NEW JERSEY, 08551

HUDSON RIVER HABITAT RESTORATION
SCHODACK ISLAND STATE PARK
COLUMBIA, GREENE, AND RENSSELAER COUNTIES, NY

SCHODACK ISLAND
SHORELINE PROFILE SHEET 4

SHEET ID

V-304

JUL.2018

LEGEND

CR-1 SHORELINE PROFILE

GRAPHIC SCALE

0 20 40 60 80 100 200 300 400 FEET

SCALE: 1" = 100'

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

DESIGNED BY:	ISSUE DATE: MAY 2018
DRAWN BY: VM	SOLICITATION NO.:
CHECKED BY:	CONTRACT NO.: W912DS-14-D-0001
SUBMITTED BY: PRINCETON HYDRO	
SIZE: ANSI D	

U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT
26 FEDERAL PLAZA
NEW YORK, NEW YORK, 10278

PRINCETON HYDRO, LLC
1108 OLD YORK ROAD
RINGOES, NEW JERSEY, 08551

HUDSON RIVER HABITAT RESTORATION
CHARLES RIDER PARK
ULSTER COUNTY, NY

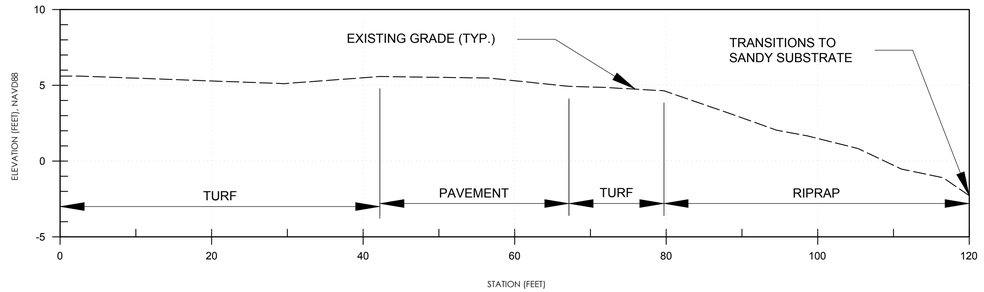
CHARLES RIDER PARK SHORELINE PROFILE PLAN

SHEET ID

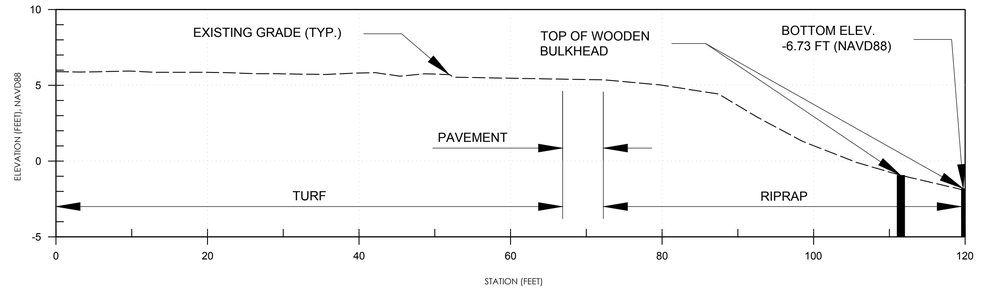
V-101

JUL.2018

PROFILE CR-1



PROFILE CR-2



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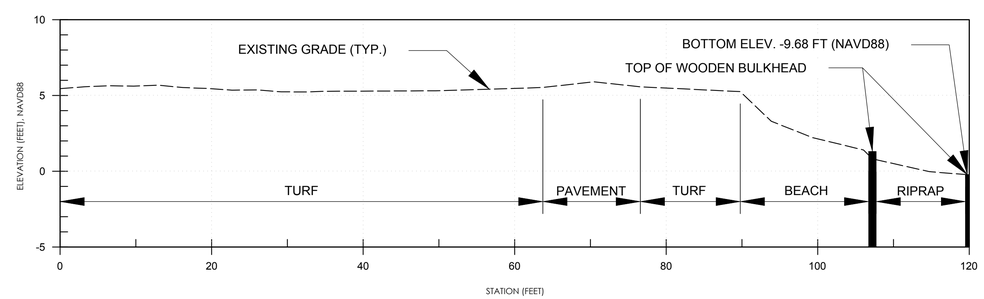
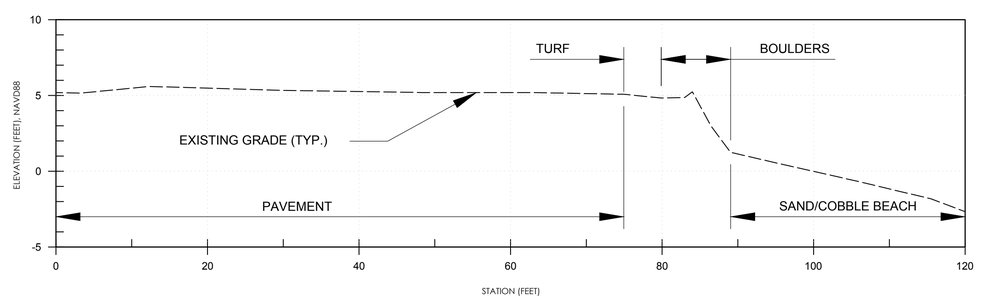
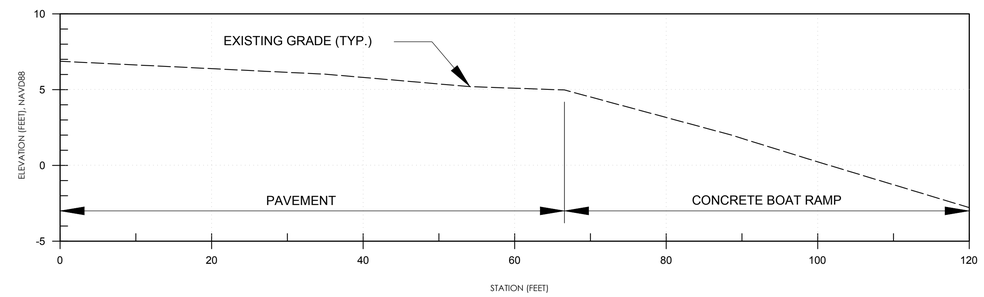


PROFILE CR-4



PROFILE CR-5



LEGEND

EXISTING GRADE

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

DESIGNED BY:	ISSUE DATE: MAY 2018
DRAWN BY: TH	SOLICITATION NO.:
CHECKED BY:	CONTRACT NO.: W912DS-14-D-0001
SUBMITTED BY: PRINCETON HYDRO	
SIZE: ANSI D	

U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT
26 FEDERAL PLAZA
NEW YORK, NEW YORK, 10278

PRINCETON HYDRO, LLC
1108 OLD YORK ROAD
RINGOES, NEW JERSEY, 08551

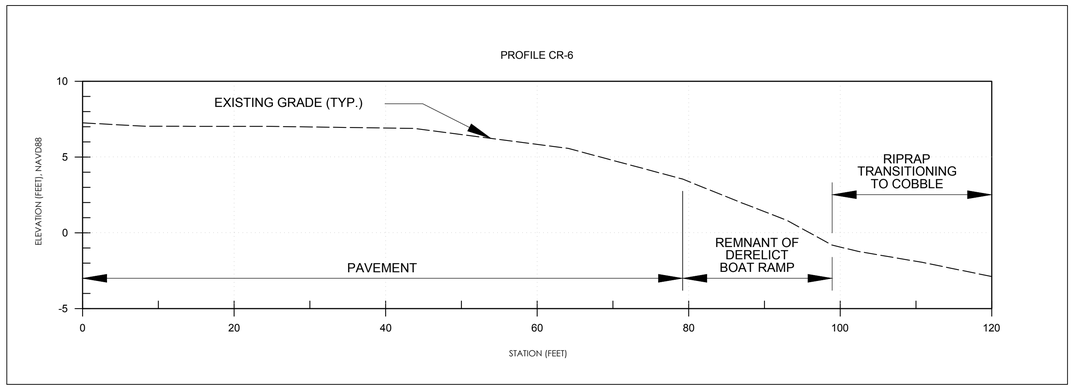
HUDSON RIVER HABITAT RESTORATION
CHARLES RIDER PARK
ULSTER COUNTY, NY

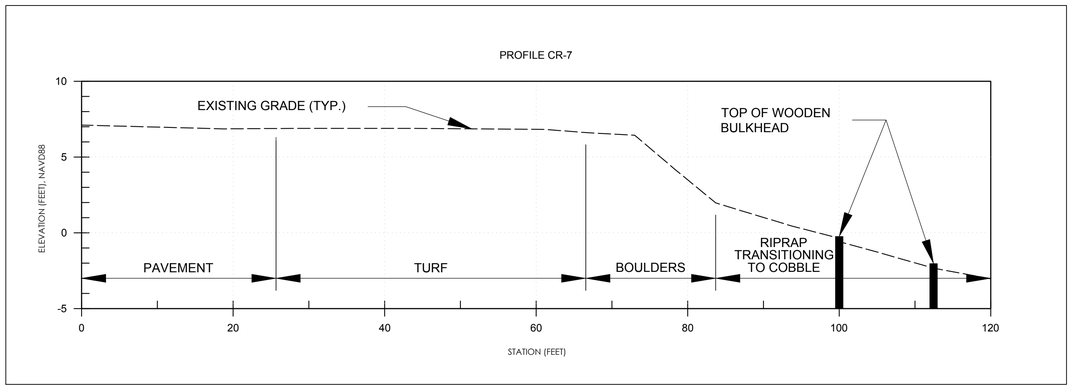
CHARLES RIDER PARK
SHORELINE PROFILE SHEET 1

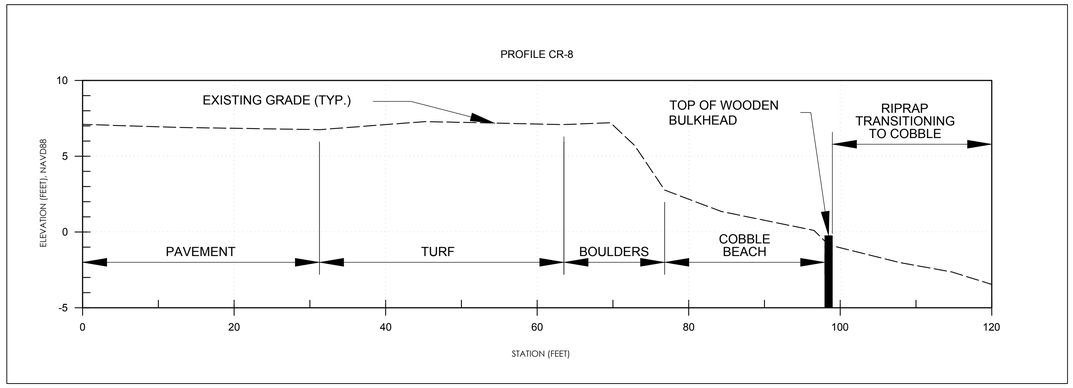
SHEET ID

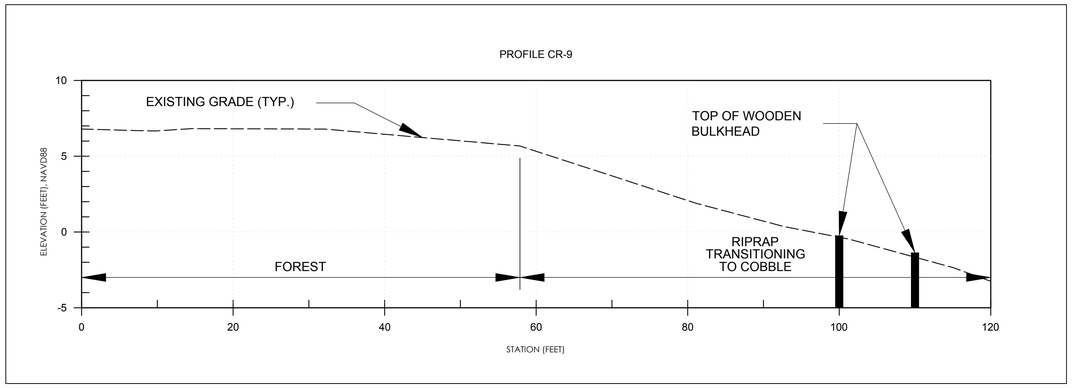
V-301

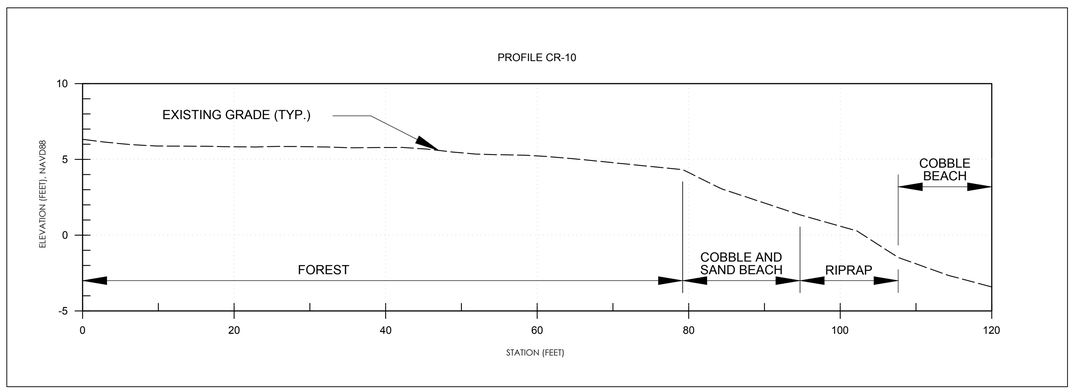
JUL.2018











LEGEND

EXISTING GRADE

FEET 0 1 2 3 4 5 10 20 30
VERT. SCALE: 1" = 5'

FEET 0 5 10 20 30 40
HORIZ. SCALE: 1" = 10'

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

DESIGNED BY:
DRAWN BY: TH
CHECKED BY:
ISSUE DATE: MAY 2018
SOLICITATION NO.:
CONTRACT NO.: W912DS-14-D-0001
SUBMITTED BY: PRINCETON HYDRO
SIZE: ANSI D

U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT
26 FEDERAL PLAZA
NEW YORK, NEW YORK, 10278

PRINCETON HYDRO, LLC
1108 OLD YORK ROAD
RINGOES, NEW JERSEY, 08551

HUDSON RIVER HABITAT RESTORATION
CHARLES RIDER PARK
ULSTER COUNTY, NY

CHARLES RIDER PARK
SHORELINE PROFILE SHEET 2

SHEET ID

V-302

JUL.2018

LEGEND

HH-1 SHORELINE PROFILE

GRAPHIC SCALE

0 20 40 60 80 100 200 300 400 FEET

SCALE: 1" = 100'

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

DESIGNED BY:	ISSUE DATE: MAY 2018
DRAWN BY: VM	SOLICITATION NO.:
CHECKED BY:	CONTRACT NO.: W912DS-14-D-0001
SUBMITTED BY: PRINCETON HYDRO	
SIZE: ANSI D	

U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT
26 FEDERAL PLAZA
NEW YORK, NEW YORK, 10278

PRINCETON HYDRO, LLC
1108 OLD YORK ROAD
RINGOES, NEW JERSEY, 08551

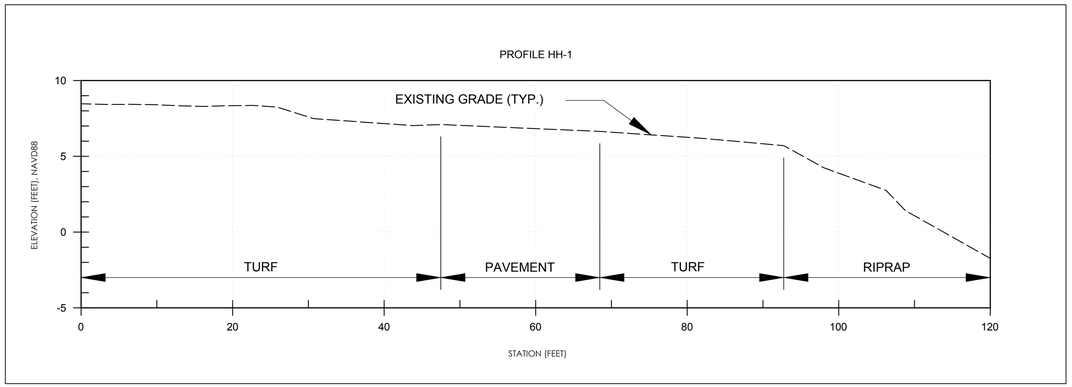
HUDSON RIVER HABITAT RESTORATION
HENRY HUDSON PARK
ALBANY COUNTY, NY

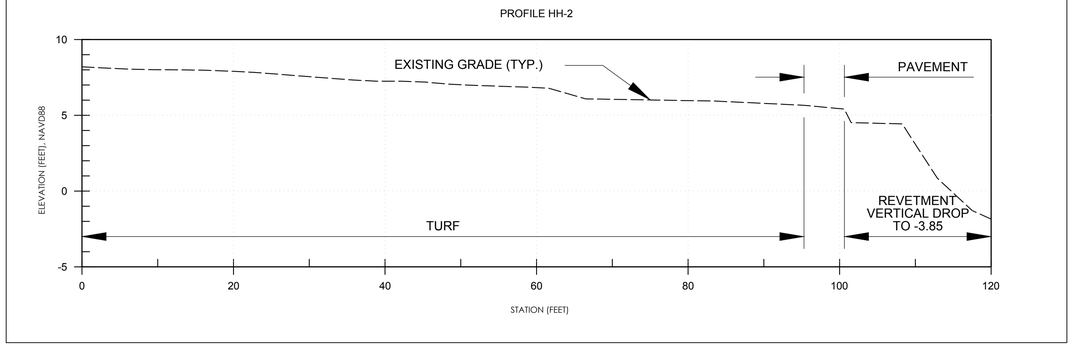
HENRY HUDSON PARK
SHORELINE PROFILE PLAN

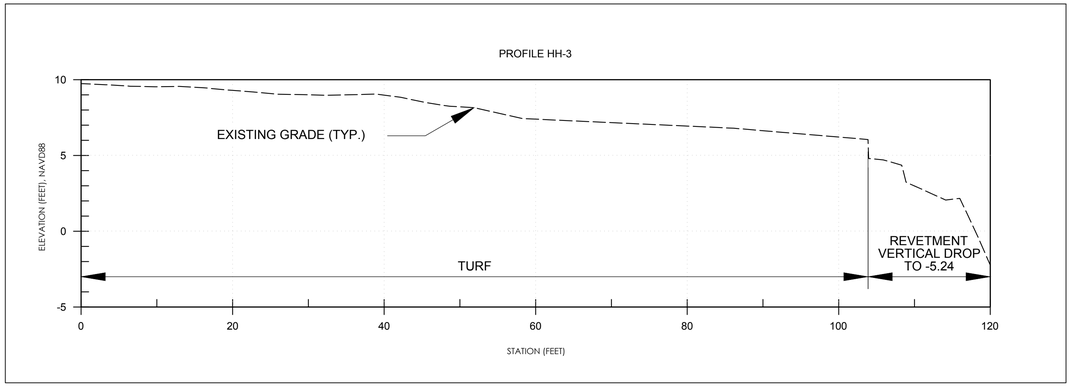
SHEET ID

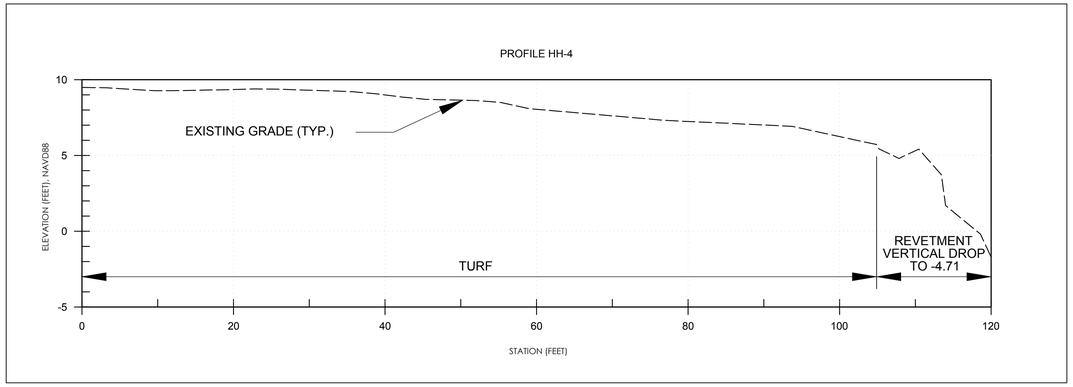
V-101

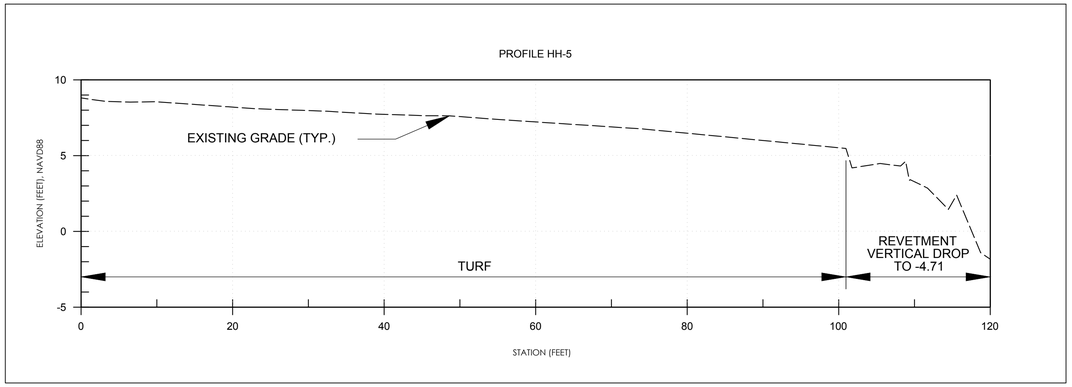
JUL.2018











LEGEND

EXISTING GRADE

VERT. SCALE: 1" = 5'

HORIZ. SCALE: 1" = 10'

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

DESIGNED BY:
DRAWN BY: TH
CHECKED BY:
ISSUE DATE: MAY 2018
SOLICITATION NO.:
CONTRACT NO.: W912DS-14-D-0001
SUBMITTED BY: PRINCETON HYDRO
SIZE: ANSI D

U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT
26 FEDERAL PLAZA
NEW YORK, NEW YORK, 10278

PRINCETON HYDRO, LLC
1108 OLD YORK ROAD
RINGOES, NEW JERSEY, 08551

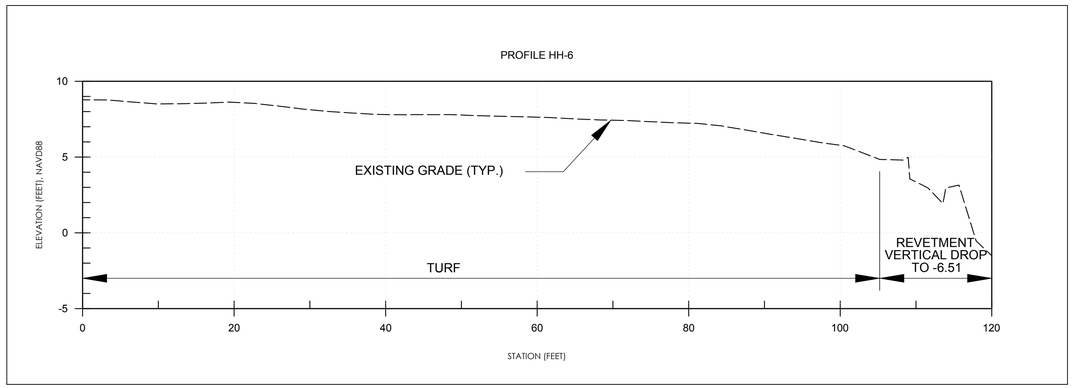
HUDSON RIVER HABITAT RESTORATION
HENRY HUDSON PARK
ALBANY COUNTY, NY

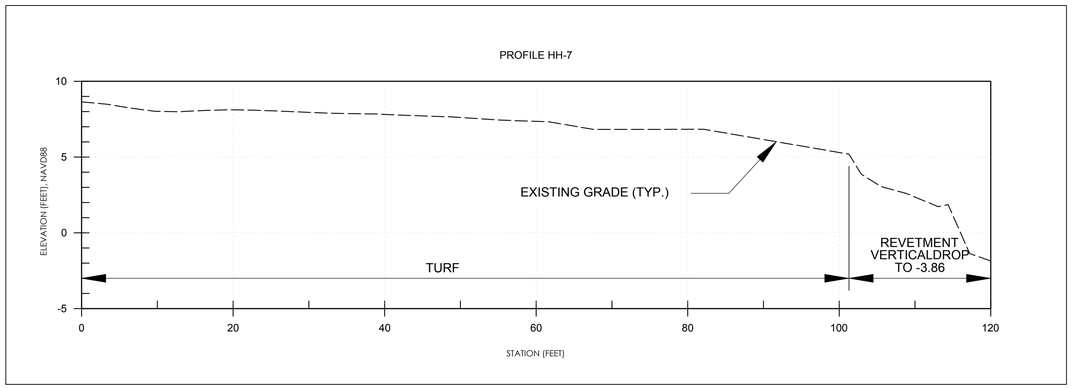
HENRY HUDSON PARK
SHORELINE PROFILE SHEET 1

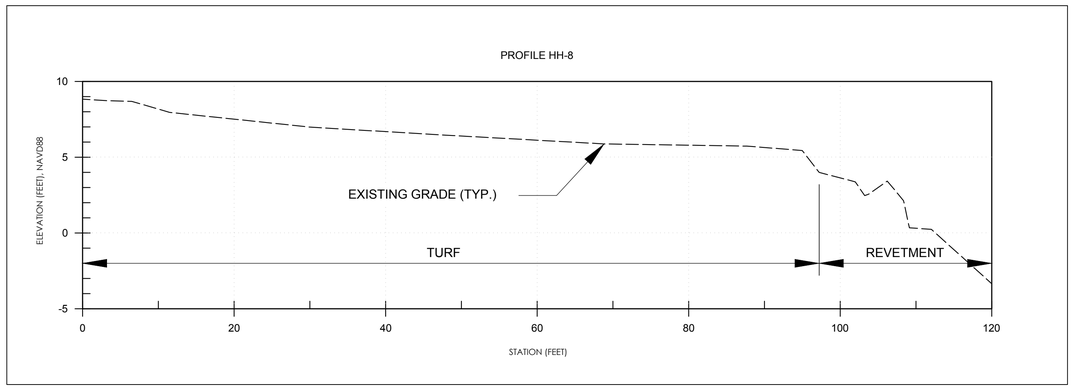
SHEET ID

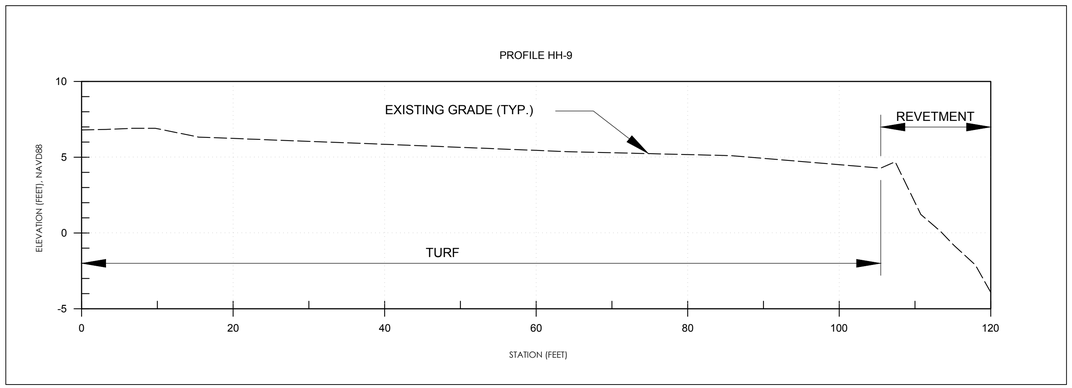
V-301

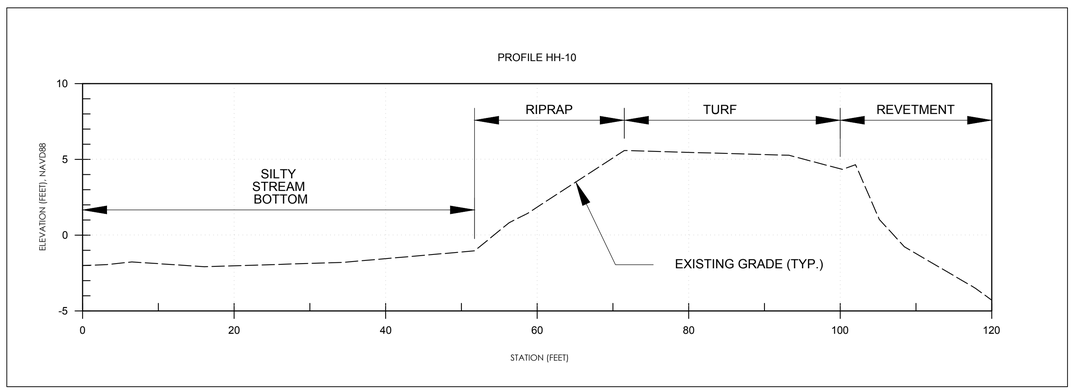
JUL.2018











LEGEND

EXISTING GRADE

VERT. SCALE: 1" = 5'

HORIZ. SCALE: 1" = 10'

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

DESIGNED BY:
DRAWN BY: TH
CHECKED BY:
ISSUE DATE: MAY 2018
SOLICITATION NO.:
CONTRACT NO.: W912DS-14-D-0001
SUBMITTED BY: PRINCETON HYDRO
SCALE:
SIZE: ANSI D

U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT
26 FEDERAL PLAZA
NEW YORK, NEW YORK, 10278

PRINCETON HYDRO, LLC
1108 OLD YORK ROAD
RINGOES, NEW JERSEY, 08551

HUDSON RIVER HABITAT RESTORATION
HENRY HUDSON PARK
ALBANY COUNTY, NY

HENRY HUDSON PARK SHORELINE PROFILE SHEET 2

SHEET ID

V-302

JUL.2018

LEGEND

MC-AOP1-1 — RIVER PROFILE / CROSS-SECTION

GRAPHIC SCALE

0 20 40 60 80 100 200 300 400 FEET

SCALE: 1" = 100'

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

DESIGNED BY:	ISSUE DATE: MAY 2018
DRAWN BY: VM	SOLICITATION NO.:
CHECKED BY:	CONTRACT NO.: W912DS-14-D-0001
SUBMITTED BY: PRINCETON HYDRO	
SIZE: ANSI D	

U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT
26 FEDERAL PLAZA
NEW YORK, NEW YORK, 10278

PRINCETON HYDRO, LLC
1108 OLD YORK ROAD
RINGOES, NEW JERSEY, 08551

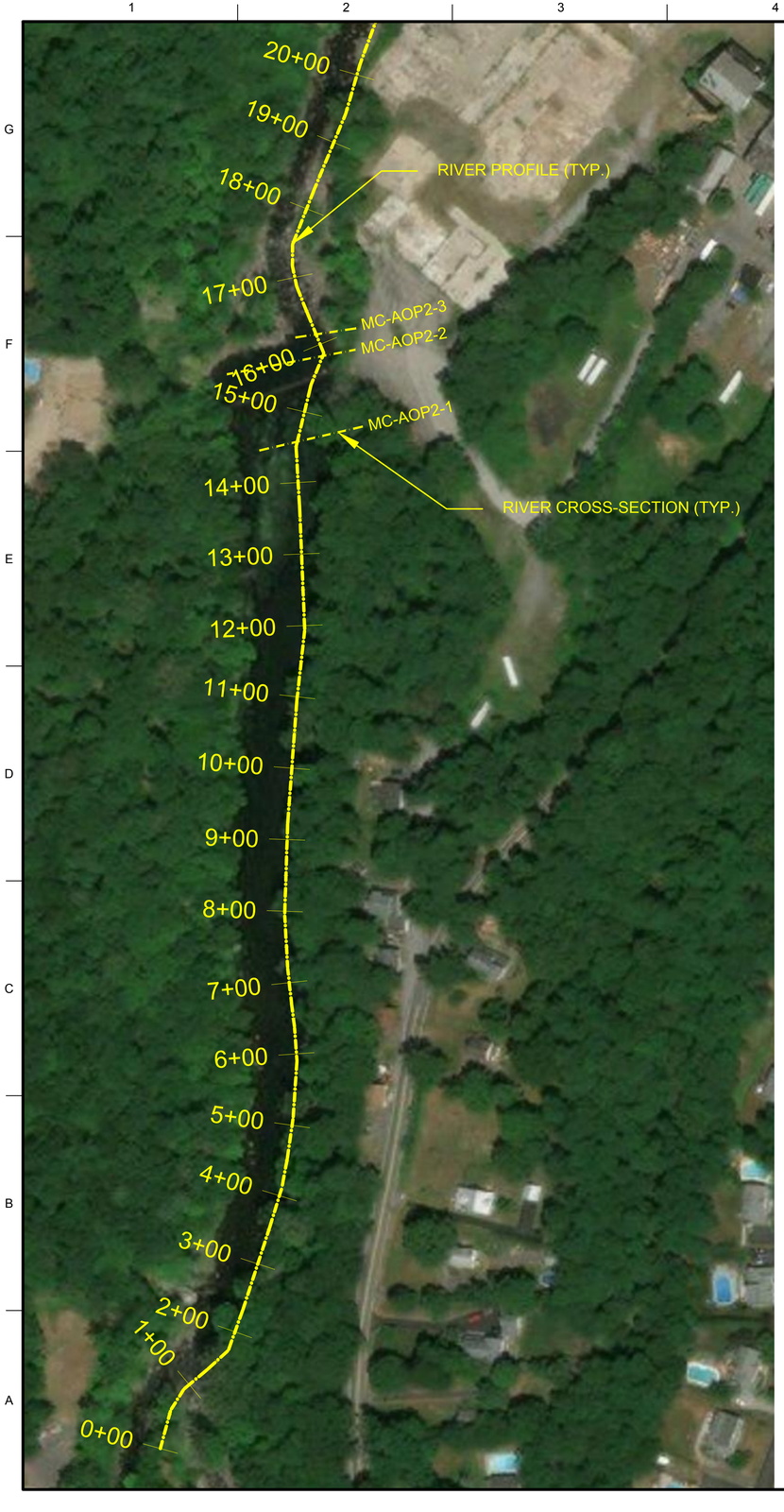
HUDSON RIVER HABITAT RESTORATION
MOODNA CREEK
ORANGE COUNTY, NY

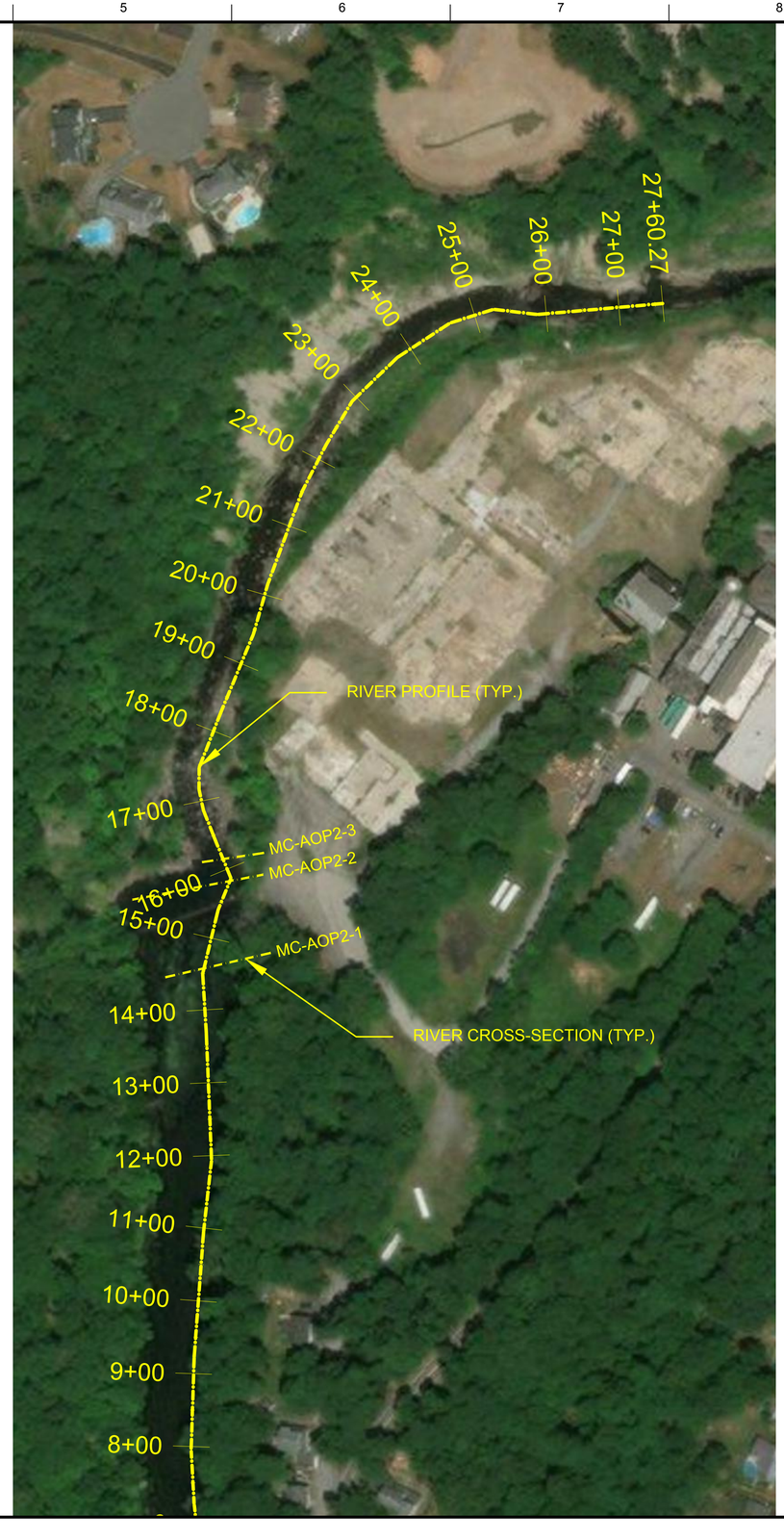
MOODNA CREEK
AOP 1 - UTILITY CROSSING
PROFILE PLAN 1

SHEET ID

V-101

JUL.2018





LEGEND

MC-AOP1-1 — RIVER PROFILE / CROSS-SECTION

GRAPHIC SCALE

0 20 40 60 80 100 200 300 400 FEET

SCALE: 1" = 100'

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

DESIGNED BY:	ISSUE DATE: MAY 2018
DRAWN BY: VM	SOLICITATION NO.:
CHECKED BY:	CONTRACT NO.: W912DS-14-D-0001
SUBMITTED BY: PRINCETON HYDRO	SIZE: ANSI D

U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT
26 FEDERAL PLAZA
NEW YORK, NEW YORK, 10278

PRINCETON HYDRO, LLC
1108 OLD YORK ROAD
RINGOES, NEW JERSEY, 08551

HUDSON RIVER HABITAT RESTORATION
MOODNA CREEK
ORANGE COUNTY, NY

MOODNA CREEK
AOP 2 - FIRTH CLIFF DAM
PROFILE PLAN 1

SHEET ID

V-102

JUL.2018

LEGEND

MC-AOP1-1 — RIVER PROFILE / CROSS-SECTION

GRAPHIC SCALE

0 20 40 60 80 100 200 300 400 FEET

SCALE: 1" = 100'

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

DESIGNED BY:	ISSUE DATE: MAY 2018
DRAWN BY: TH	SOLICITATION NO.:
CHECKED BY:	CONTRACT NO.: W912DS-14-D-0001
SUBMITTED BY: PRINCETON HYDRO	
SIZE: ANSI D	

U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT
26 FEDERAL PLAZA
NEW YORK, NEW YORK, 10278

PRINCETON HYDRO, LLC
1108 OLD YORK ROAD
RINGOES, NEW JERSEY, 08551

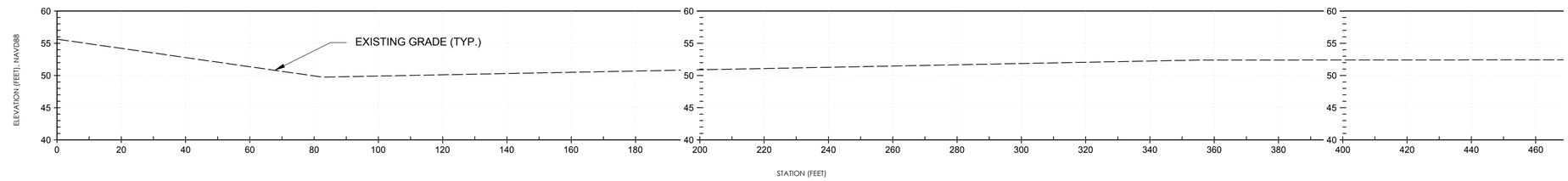
HUDSON RIVER HABITAT RESTORATION
MOODNA CREEK
ORANGE COUNTY, NY

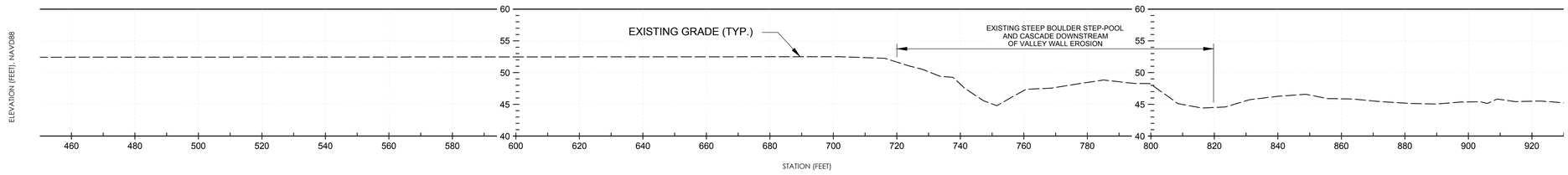
MOODNA CREEK
AOP 3 - ORRS MILL DAM
PROFILE PLAN 1

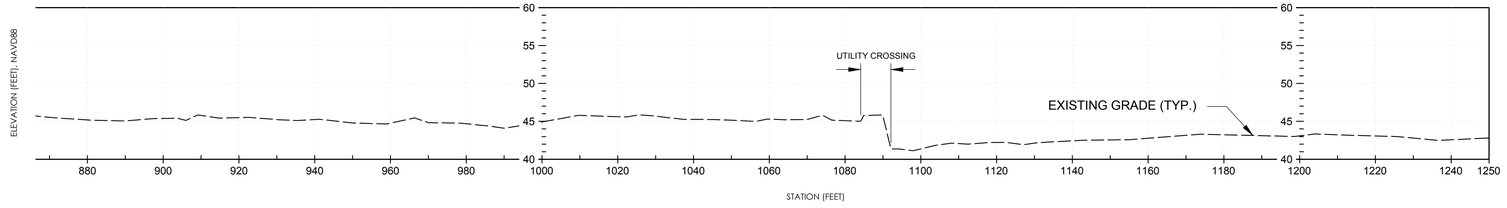
SHEET ID

V-103

JUL.2018







LEGEND

——————— EXISTING GRADE

FEET 0 5 10 20 30 40
VERT. SCALE: 1" = 10'

FEET 0 10 20 40 60 80
HORIZ. SCALE: 1" = 20'

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

DESIGNED BY:
ISSUE DATE: MAY 2018
DRAWN BY: TH
SOLICITATION NO.:
CHECKED BY:
CONTRACT NO.: W912DS-14-D-0001
SUBMITTED BY: PRINCETON HYDRO
SIZE: ANSI D

U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT
26 FEDERAL PLAZA
NEW YORK, NEW YORK, 10278

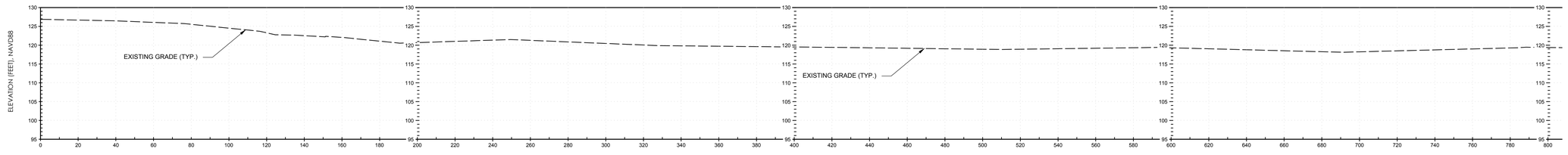
PRINCETON HYDRO, LLC
1108 OLD YORK ROAD
RINGOES, NEW JERSEY, 08551

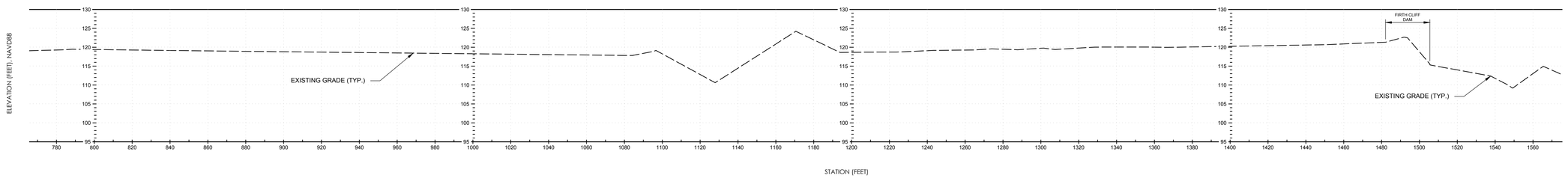
HUDSON RIVER HABITAT RESTORATION
MOODNA CREEK
ORANGE COUNTY, NY

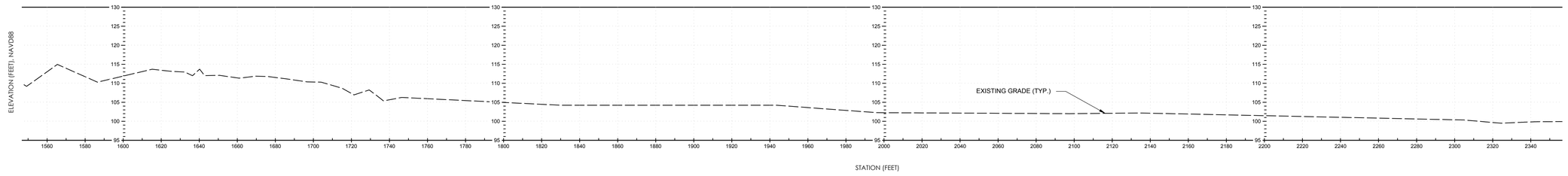
MOODNA CREEK
AOP 1 - UTILITY CROSSING
PROFILE SHEET 1

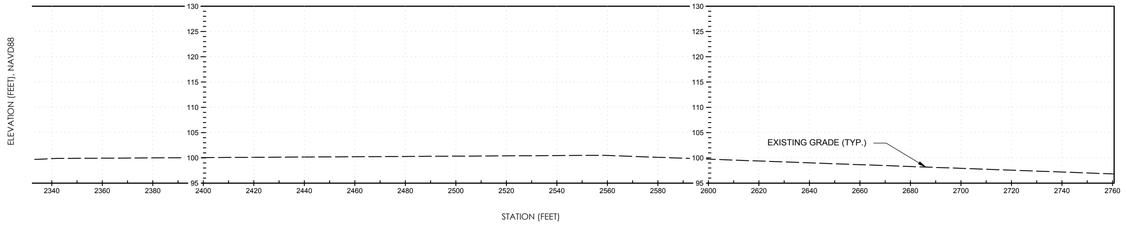
SHEET ID
V-201

JUL.2018









LEGEND

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FEET 0 15 30 60 90 120
HORIZ. SCALE: 1" = 30'

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MARK	DESCRIPTION	DATE

DESIGNED BY:
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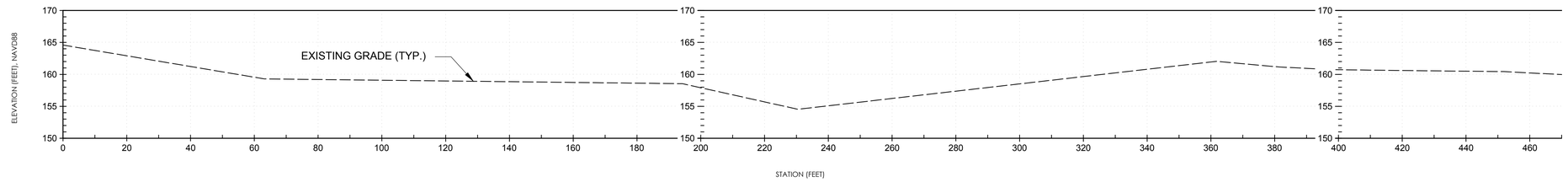
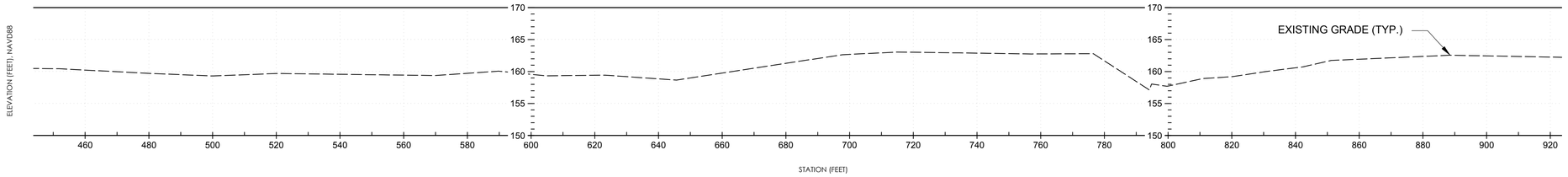
HUDSON RIVER HABITAT RESTORATION
MOODNA CREEK
ORANGE COUNTY, NY

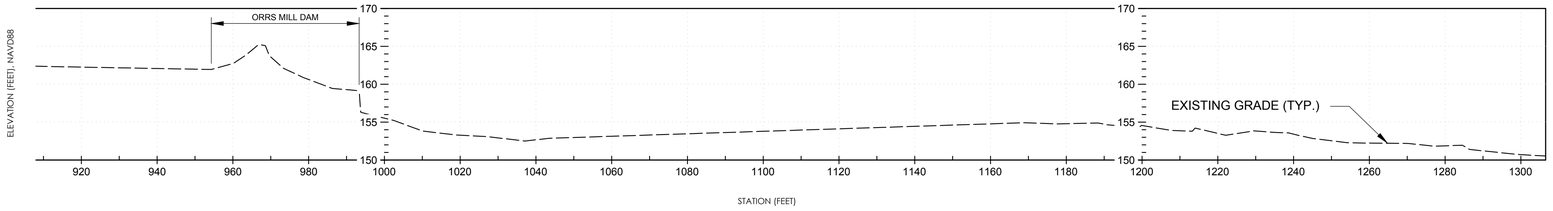
MOODNA CREEK
AOP 2 - FIRTH CLIFF DAM
PROFILE SHEET 2

SHEET ID
V-202

JUL.2018







LEGEND

EXISTING GRADE

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HORIZ. SCALE: 1" = 20'

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HUDSON RIVER HABITAT RESTORATION
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ORANGE COUNTY, NY

MOODNA CREEK
AOP 3 - ORRS MILL DAM
PROFILE SHEET 3

SHEET ID

V-203

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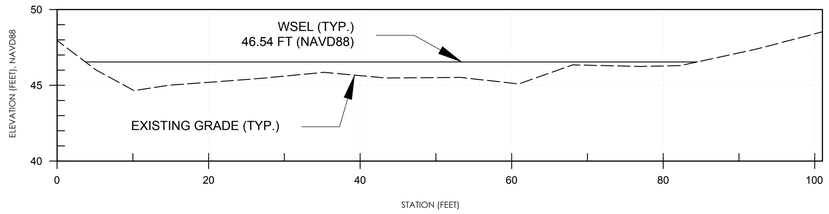

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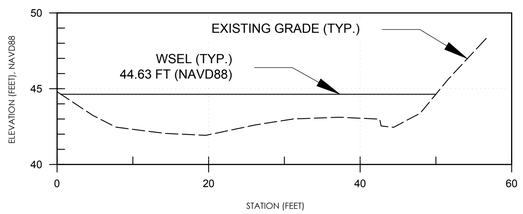

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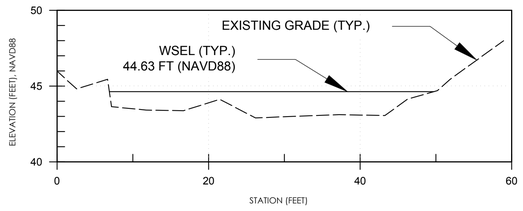

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EXISTING GRADE

WATER SURFACE ELEVATION (WSEL)

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VERT. SCALE: 1" = 5'

FEET 0 5 10 20 30 40
HORIZ. SCALE: 1" = 10'

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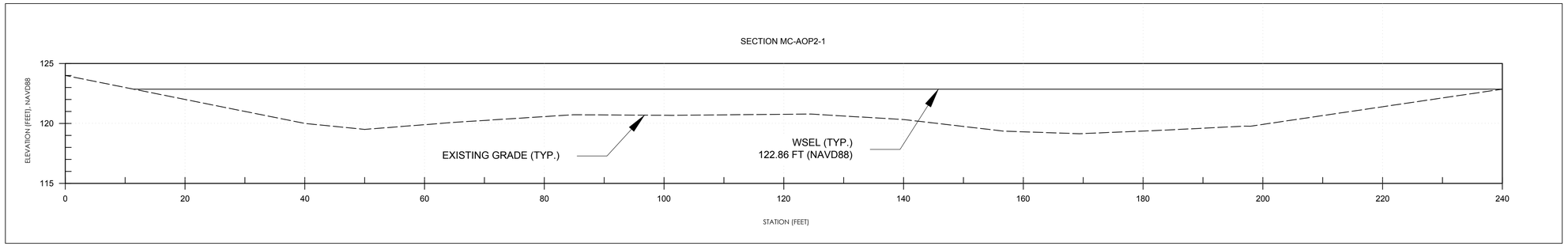
HUDSON RIVER HABITAT RESTORATION
MOODNA CREEK
ORANGE COUNTY, NY

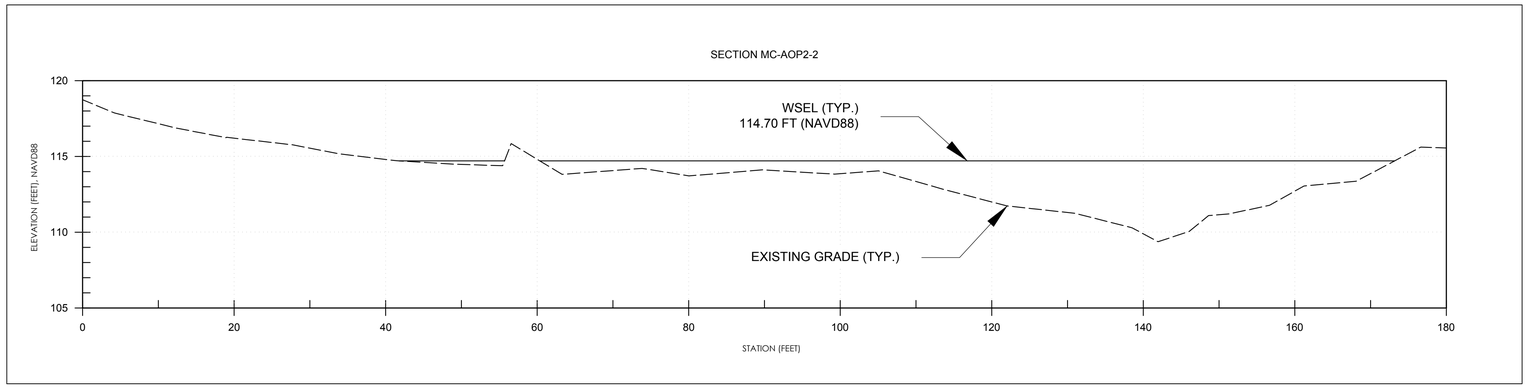
MOODNA CREEK
AOP 1 - UTILITY CROSSING
CROSS SECTION SHEET 1

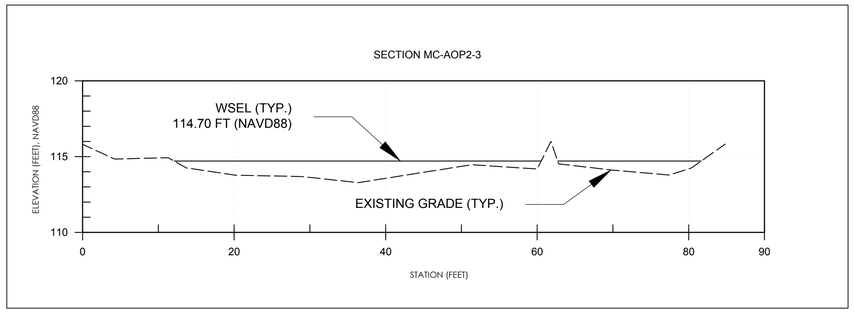
SHEET ID

V-301

JUL.2018







LEGEND

- EXISTING GRADE
- WATER SURFACE ELEVATION (WSEL)

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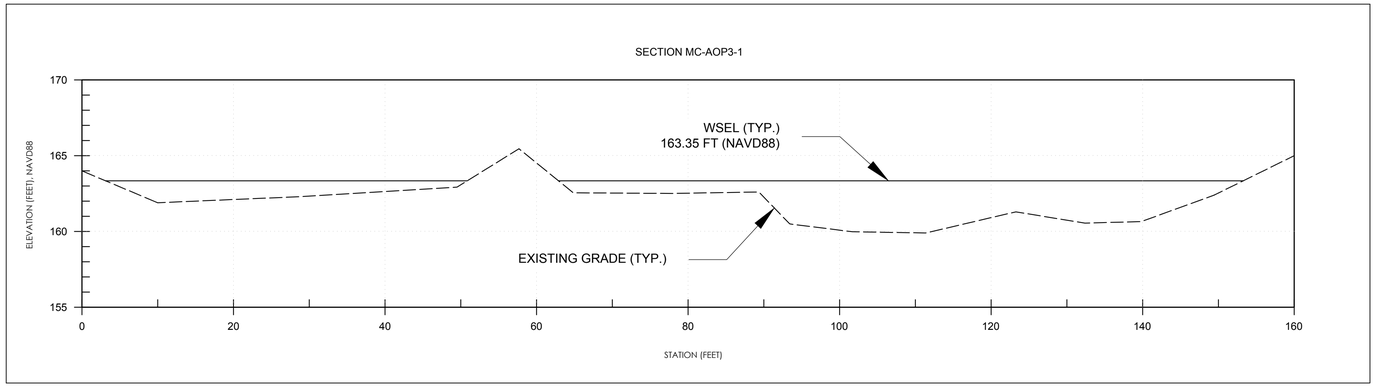
HUDSON RIVER HABITAT RESTORATION
MOODNA CREEK
ORANGE COUNTY, NY

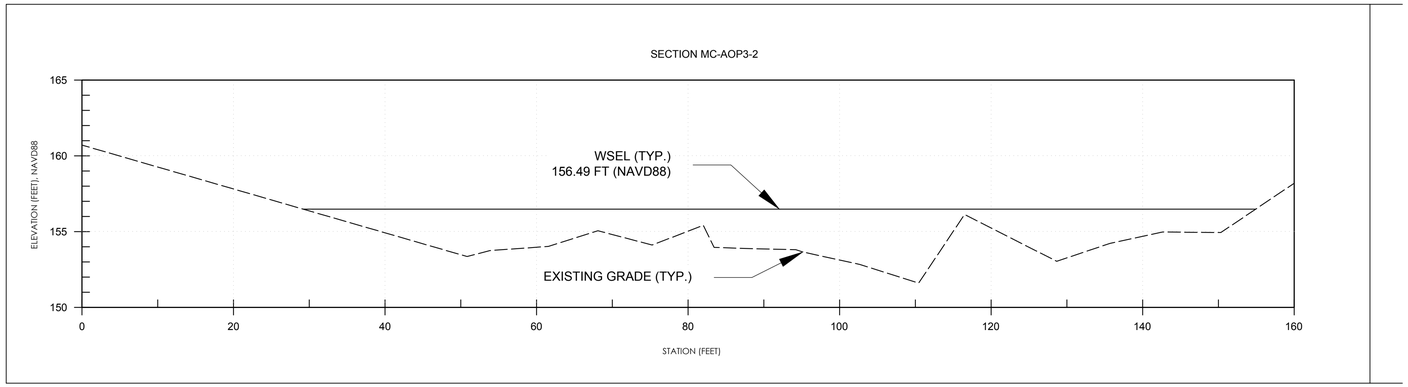
MOODNA CREEK
AOP 2 - FIRTH CLIFF DAM
CROSS SECTION SHEET 2

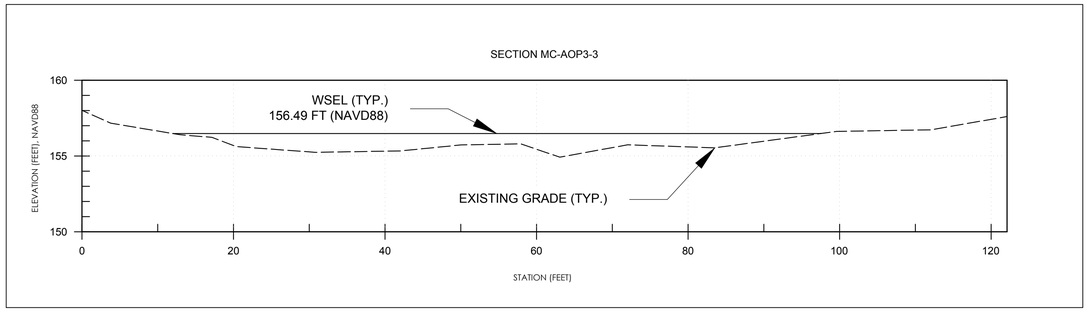
SHEET ID

V-302

JUL.2018







LEGEND

EXISTING GRADE

WATER SURFACE ELEVATION (WSEL)

FEET 0 1 2 3 4 5 10 20 30
VERT. SCALE: 1" = 5'

FEET 0 5 10 20 30 40
HORIZ. SCALE: 1" = 10'

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HUDSON RIVER HABITAT RESTORATION
MOODNA CREEK
ORANGE COUNTY, NY

MOODNA CREEK
AOP 3 - ORRS MILL DAM
CROSS SECTION SHEET 3

SHEET ID
V-303

JUL.2018

ATTACHMENT B

QUALITATIVE ASSESSMENT OF HYDRAULIC AND SEDIMENT CONDITIONS

HUDSON RIVER HABITAT RESTORATION

ECOSYSTEM RESTORATION
FINAL INTEGRATED FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT

QUALITATIVE ASSESSMENT OF SEDIMENT/HYDRAULIC CONDITIONS

Moodna Creek

U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT

August 2020

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Attachment A: Annual Sediment Yield Calculation

Attachment B: Hydraulic Report Callout

INTRODUCTION

The Moodna Creek Site is comprised of the removal or modification of three barriers to aquatic organism passage (AOP #1, #2, and #3) along the Moodna Creek. AOP #1 is the Utility Crossing approximately 1,100 ft upstream of the Forge Hill Road / Route 74 Bridge in the Town of New Windsor. AOP #2 is the Firth Cliff Dam, accessed by Old Mill Street (off Route 32) in the Town of Cornwall. AOP #3 is the Orr's Mill Dam located 80 feet upstream of the Route 32 Bridge in the Town of Cornwall. Tentatively Selected Plans (TSP) to improve organism passage were described for each AOP barrier in T*he Hudson River Habitat Restoration Ecosystem Restoration Feasibility Study Integrated Feasibility Report and Environmental Assessment*. The following report assesses the anticipated changes in hydraulic condition and the anticipated transport of impounded sediment upon the implementation of the recommended plans (or optimized alternatives). The recommended plans for each AOP barrier are as follows:

- AOP #1, full removal of the Utility Crossing;
- AOP #2, full removal of the Firth Cliff Dam spillway; and
- AOP#3, the breach of the Orr's Mill Spillway, including removal of the central portion of the spillway while retaining and stabilizing the sides of the spillway.

This report was built on two distinct efforts completed in 2018 to study the Moodna Creek, including 1) a flood risk assessment of the Moodna Creek (Princeton Hydro, 2018), and 2) field assessments of the three AOP barriers.

A flood risk assessment was completed in 2018 of the Lower Moodna Creek Watershed for Orange County (Princeton Hydro, 2018) in which a hydraulic model was developed to delineate floodplains along Moodna Creek. For Moodna Creek and its tributaries, new cross section topography was extracted from 2014 1-meter resolution LiDAR data and flood discharges were utilized from either the effective 2009 FEMA Flood Insurance Study (FIS) or StreamStats. In particular, FIS flood discharges were computed using rural regression equations from USGS WRI 90-4197 (Lumia 1991). Most of the bridge and culvert structures were coded based on information obtained from the Effective 2009 FEMA HEC-2 model, including opening width, bridge deck thickness, and invert elevation. Manning's roughness coefficients were developed based on the 2011 National Land Cover Database developed by the USGS. Each land cover type was assigned a Manning's n value and was overlaid with the cross sections. This pre-existing model, referenced herein as the '2018 Hydraulic Model', served as the base model for the following assessment.

As part of this Hudson River Habitat Restoration Study, field assessments were completed in 2018 of the three AOP barriers. The field assessments included limited topographic survey with survey-grade RTK-GPS, and observations and photo-documentation of the structural condition of each AOP barrier, the impoundment, impounded sediment, and river reaches upstream and downstream of the structures. The field assessment and topographic survey was used to assess the potential for sediment mobilization and channel adjustment following AOP barrier removal or breach, and to estimate the impounded sediment volume. Topographic survey captured the crest of the structures and limited geometry of the river channel, including a longitudinal profile and cross sections in the vicinity of the AOP barrier. The topographic survey was used to update the 2018 existing conditions hydraulic model.

The qualitative observations from the field assessments, the anticipated changes in transport of impounded sediment, along with results of the hydraulic modelling that compare existing and anticipated conditions have been utilized in this report to present the anticipated changes upon implementation of each recommended plan at the three AOP areas of interest.

METHODS

DETERMINING EQUILIBRIUM PROFILE

After the removal or breach of the dam/barrier, Moodna Creek will adjust by eroding down vertically into impounded sediment and re-equilibrating at or close to the pre-dam channel profile. This anticipated equilibrium profile represents an average elevation, which the river can be expected to fluctuate above and below gradually through time, with the formation and migration of geomorphic features like riffles, point bars, and pools.

Predicting the equilibrium profile is important to quantifying the volume of impounded sediment, assessing the magnitude and extent of channel adjustments, and predicting channel dimension, pattern, and profile for modeling hydraulic conditions post-dam removal. Further, determining equilibrium profile can identify potential conflicts with property or infrastructure (e.g. below-ground utilities or bridges). Information gathered in the site investigation and subsequent analysis of the surveyed longitudinal profile were used to predict the equilibrium profile at each AOP site.

The site investigation identified (i) the extent of the impoundment, (ii) the character and depth of uncompacted impounded sediment, (iii) the presence of glacial erratic boulders or potential for boulder cascade or waterfall, and (iv) presence of geomorphic features like dominant substrate size, meanders, tributary confluences, or valley wall failures that influence river profile.

Subsequently, the survey of the longitudinal profile of the river thalweg was analyzed in CAD to delineate and measure the post-dam river profile. The downstream control point – a stable geomorphic control feature that is likely to persist after dam removal – was identified at the invert of the dam or the pool tail crest of the scour pool below the structure. The upstream control point was identified at the upstream extent of unconsolidated impounded sediment and the re-emergence of consolidated native river bottom. The straight-line slope connecting the two control points was adjusted vertically, as necessary, if the bottom of sediment survey points were lower in elevation than the straight-line slope between control points. The slope of the profile was then confirmed to be within typical ranges and compared to adjacent upstream and downstream reaches to determine if it was either similar or differing. Differences in slopes could be explained by geologic/geomorphic features in the reach, but in most cases, the slopes of upstream, impounded, and downstream reaches were similar, which indicated a continuity of stream profile from upstream reaches, through the impoundment, to downstream reaches. In some places, the equilibrium profile identified where impounded sediment was too compacted or coarse-grained to be fully probed, and thus the delineated profile superseded the probe data and justified a lower, more conservative, channel invert elevation.

DETERMINING AVERAGE ANNUAL WATERSHED SEDIMENT YIELD

Detailed watershed sediment yield modeling and calculations can be a complex process that is out of scale with the removal of these small barriers. However, watershed sediment yield was estimated following methods referenced in Dam Removal *Analysis Guidelines for Sediment* (Randle et al., 2017), specifically the broad-level procedure in Erosion and Sedimentation Manual (Randle et al., 2006) (See Attachment A). Randle et al. (2006) describe a sediment yield classification procedure that predicts sediment yield as a function of nine individual drainage basin characteristics including surface geology, soils, climate, runoff, topography, ground cover, land use, upland erosion, and channel erosion. Numerical ratings for each of the basin characteristics were assigned based on a general understanding of watershed conditions and review of aerial imagery. As this method of rating drainage basin characteristics is qualitative/semi-quantitative, both higher and lower ratings were assigned for each characteristic to account for the inherent uncertainty and to establish a likely range of values for the watershed. Ratings were then summed, and the drainage basin was allocated to one of five drainage

basin classes (as per Table 2.10 in Attachment A), which correspond to ranges in volumetric annual sediment yields. The annual sediment yield of the Moodna Creek watershed likely falls within the range of 0.2 to 0.5 acre feet per square mile of watershed. This average annual sediment yield was then applied to the watershed area to each AOP site to calculate an average annual sediment volume. To calculate the percent of the annual watershed sediment yield that is impounded by each structure, the volume of impounded sediment was divided by the average annual watershed sediment volume (in cubic yards).

HYDRAULIC MODELING

The 2018 Hydraulic Model was supplemented with channel profile and cross-sectional data from the 2018 field effort to develop the existing conditions model for this assessment. In addition, the extent of the river in the model domain was reduced to include only the river reaches that encompass the three AOP areas of interest. There is approximately 6,400 feet between AOP #1 and AOP #2 and approximately 3,725 feet between AOP #2 and AOP #3. In total, the model includes 27,500 feet of the Moodna Creek, extending from the Route 74 bridge (5,500 feet downstream of AOP #1) upstream to the Pleasant Hill Drive bridge(11,800 upstream of AOP #3).

The model was supplemented with cross sections (Table 1) using Manning's n values from adjacent cross sections.

Table 1 - Updated Cross Section Geometries.

AOP	Number of Updated Cross sections		River Length of Updated Model at AOP (feet)	
	Upstream	Downstream	Upstream	Downstream
Utility Crossing	4	3	275	115
Firth Cliff	6	3	825	100
Orr's Mill	3	2	260	200

The flows modeled for this assessment include the 1 Percent Annual Chance Flood Hazard discharge from the effective 2009 FEMA FIS, and the annual median discharge and the bankfull discharge, calculated using USGS StreamStats (Lumia et al., 2006; Mulvihill et al., 2009). Flows in the current model and their respective upstream and downstream boundary condition are shown in Table 2.

Table 2 - Moodna Creek Discharges by Flow at AOP.

Flow / % Chance	Discharge at AOP #1 (CFS)	Discharge at AOP #2 & AOP #3 (CFS)
Median*	140	126
Bankfull*	2,730	2,560
1% Flood**	13,220	13,024

* Source: USGS StreamStats

** Source: Effective 2009 FEMA FIS

While multiple cross sections have been updated with recent topographic data, it is important to note that most of the model geometry relies on 2014 1-meter resolution LiDAR data. Despite not having a full topographic survey, the hydraulic model captures changes in hydraulic conditions pre- and post-implementation for these AOP areas of interest.

ASSESSMENT OF ANTICIPATED CONDITIONS

The updated 2018 Hydraulic Model and observations from the site assessment were used to anticipate the conditions at each of the three AOP areas of interest following implementation of the recommended plans, removal or breach.

AOP #1 - UTILITY CROSSING

ASSESSMENT OF TRANSPORT OF IMPOUNDED SEDIMENT

The utility crossing forms a weir that creates a hydraulic head of 2 feet. It is a concrete-encased utility crossing spanning the channel which retains bedload immediately upstream. River bed substrate at this location is predominantly compact gravel and cobble with interstitial sand. This coarse sediment will be prone to mobilization following removal of the utility crossing in the recommended plan.

EQUILIBRIUM PROFILE

In this narrow riverine Impoundment, all impounded sediment will be prone to mobilization and transport downstream, at which point the channel in the impoundment will return to a lower, equilibrium profile, at the approximate original channel bottom. Analysis of the surveyed longitudinal profile indicates an anticipated post-dam equilibrium slope through the site at approximately 0.4 percent. Based on the anticipated channel invert, channel width, and cross-sectional shape, the estimated volume of impounded sediment is 240 cubic yards (CY). All impounded sediment at the utility crossing is anticipated to be mobilized by several high flow events after removal of the utility crossing.

WATERSHED SEDIMENT YIELD

Applying the procedure in *Erosion and Sedimentation Manual (Randle et al., 2006)* to this site of interest on Moodna Creek, the estimated average annual sediment yield ranges from approximately 55,000 to 147,000 CY (Attachment A). Thus, the impounded sediment volume is approximately less than 1 percent of the estimated average annual sediment yield.

Transport of this sediment through downstream reaches will be observable in the boulder riffle immediately downstream of the site but largely imperceptible in downstream reaches. Due to the insignificant volume of impounded sediment, no adverse impacts to downstream aquatic biota, habitats, structures or properties are anticipated.

ASSESSMENT OF CHANGES IN HYDRAULIC CONDITIONS

Following the anticipated transport in impounded sediment and related channel adjustment described above, the river profile and cross sections were modified in the hydraulic model to evaluate the resulting changes in hydraulic conditions in the recommended plan, removal of the utility crossing.

HYDRAULIC MODEL GEOMETRY FOR EXISTING CONDITIONS

Figure 1 shows the 2018 topographic survey shots and the cross sections that were updated for the existing conditions model. The cross sections pictured below were modified with either cross section or profile survey data.

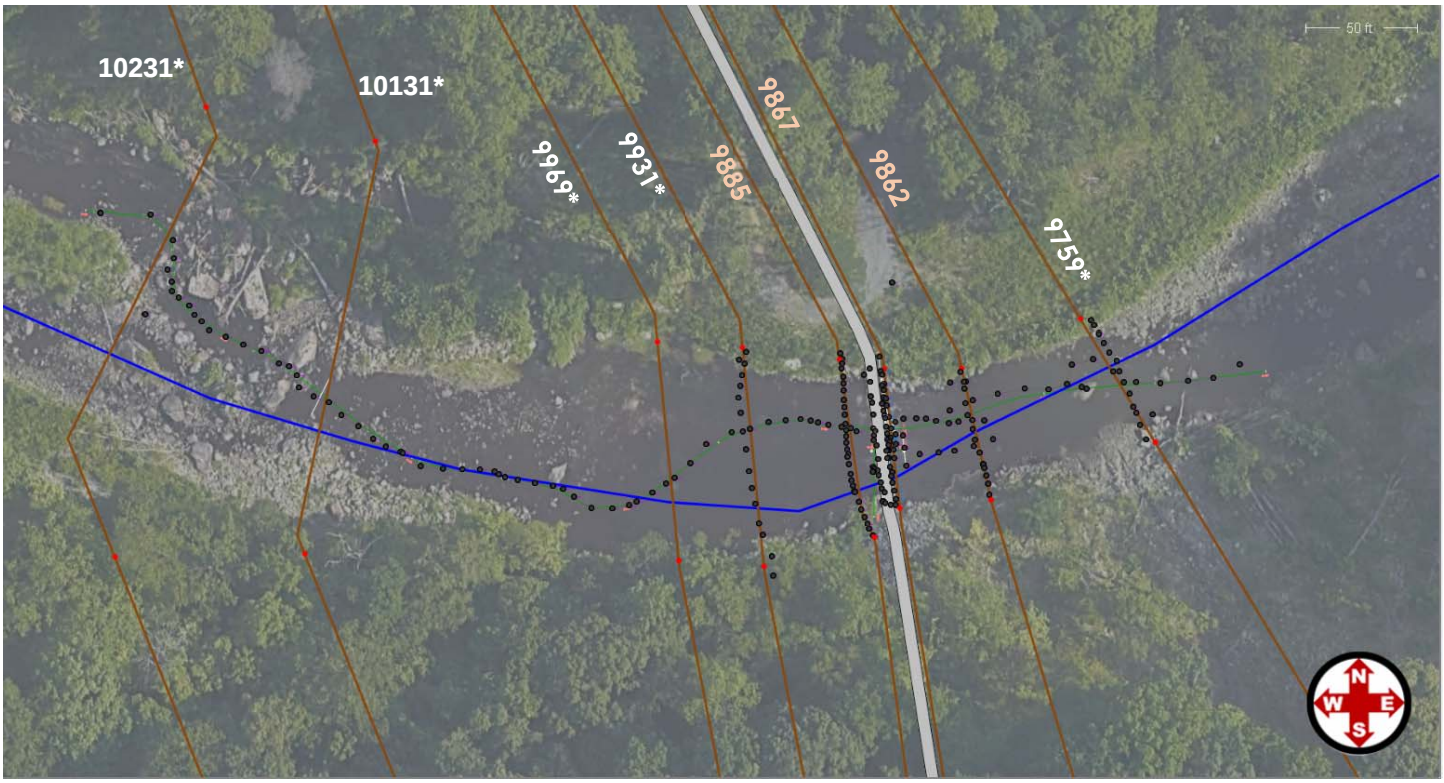

Figure 1 – Planview of hydraulic model geometry for existing conditions at AOP #1. Dark circles indicate survey points collected during the 2018 field investigation. Brown lines indicate cross section locations; the blue line indicates the stream centerline, and the light gray block indicates the AOP barrier structure. For the proposed model, cross sections with asterisks had updated geometries to reflect anticipated conditions, and cross sections labeled in orange were removed to better represent the anticipated channel profile. The existing geometry was modified to reflect the anticipated conditions described above in the recommended plan with the barrier removed and the channel adjusted to a lower vertical elevation. Specifically, cross sections 9885, 9867, and 9826 were removed to better represent the anticipated channel profile.

HYDRAULIC MODEL RESULTS

Model results are compared in Figure 2, which depicts the water surface elevation profiles near the utility crossing for the 1 Percent Annual Chance Flood, bankfull, and median flows in existing conditions (blue) and in the recommended plan, full removal (red).

In existing conditions, the utility crossing functions as the local hydraulic control, as indicated by the nearly level water surface profile (Figure 3) extending 250 feet upstream of the structure in all modeled flows. Model results for the recommended plan with the utility crossing removed indicate that the water surface profile is lower in elevation for all modeled flows. For the 1 Percent Annual Chance Flood flow, model results show that the removal of the utility crossing will lower water surface elevation by 0.8 feet at the structure (see Table 3); upstream of the top of the boulder steps the existing and proposed water surface elevations are coincident. For the bankfull and median flows, model results show the removal of the structure and adjustment of the bed results in lower water surface elevation from 0.8 to 1.6 feet at the structure (see Table 3), which diminishes to zero change approximately 250 feet upstream, or until the base of the boulder steps. At the anticipated equilibrium slope with the structure removed, water levels will be lower and water velocity and shear stress in the channel will increase to free-flowing conditions. Table 3 shows this phenomenon for all discharges at cross section 9931, the first cross section upstream of the structure.

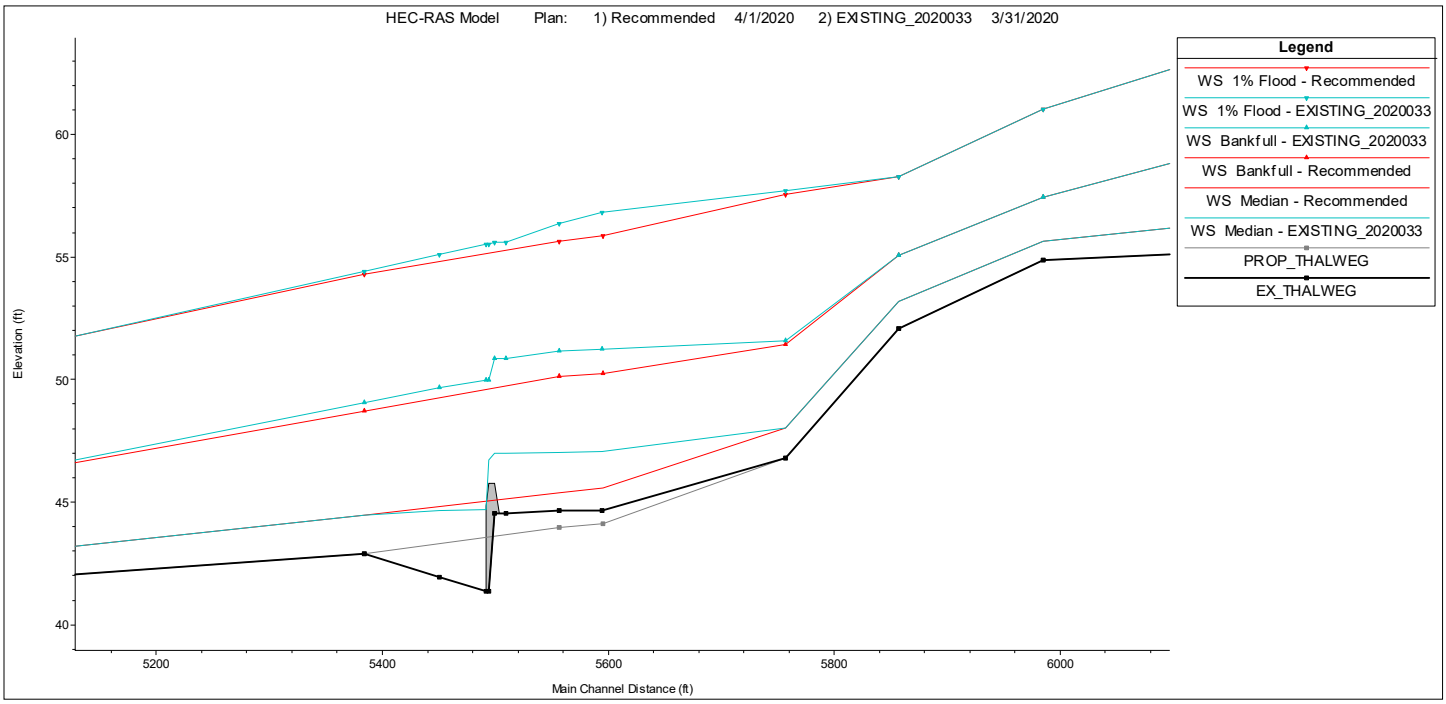

Figure 2 – Hydraulic model results. Water Surface Profile at AOP #1 – Utility Line. Black line is existing thalweg; grey line is thalweg in recommended plan; AOP #1 - Utility Crossing is gray object; blue lines are water surface profiles in existing conditions; red lines are water surface profiles resulting from the recommended plan.

The hydraulic model indicates that the vertical plunging flow at the downstream face of the structure is eliminated by the removal of the structure and the natural adjustment of the channel in the recommended plan. One hundred feet downstream of the structure, existing and anticipated water surface profiles are coincident, showing the downstream extent of influence of the structure removal for the recommended plan. A complete table of results from the hydraulic model, including water surface elevation at each relevant cross section, is shown in Attachment B.

Table 3 - Existing Conditions and Recommended Plan (Proposed) Water Surface Elevation (WSEL) and Velocity (Vel) for Cross Section 9931 (Immediately Upstream of AOP #1 - Utility Crossing).

Discharge	Existing WSEL (FT)	Proposed WSEL (FT)	Existing Velocity (Ft/s)	Proposed Velocity (Ft/s)
1% Flood	56.4	55.6	10.7	12.1
Bankfull	51.1	50.1	4.8	5.4
Median	47.0	45.4	1.2	2.4

IMPACTS TO FLOODING

The utility crossing was not intended to provide any flood control nor was it constructed in a form that would provide any incidental flood attenuation. As such, there is no loss of flood attenuation by the removal of the utility crossing, or any increase in downstream flood discharge, velocity, or depths caused by its removal. In addition, the recommended plan is predicted to lower the water levels at the structure by 1.6 feet in the median flow and 0.8 feet for the 1 Percent Annual Chance Flood.

AOP #2 - FIRTH CLIFF DAM

ASSESSMENT OF TRANSPORT OF IMPOUNDED SEDIMENT

Firth Cliff Dam is nine feet tall. The dam impounds predominantly gravel and cobble sediment, with frequent large boulders (including glacial erratics), and some interstitial sand. Finer size classes (i.e. clay and silt), which can form more cohesive sediment deposits, are not impounded and pass over the dam to downstream reaches. The coarse and non-cohesive sediment would be prone to gradual mobilization post dam removal. Initial mobilization would occur by incision or head-cutting into the non-cohesive sediments. This initial mobilization process can occur in low or normal flows but is accelerated during high flow events. Eventually, impounded sediment mobilization widens to the full span of the channel and is driven largely by higher flow events.

EQUILIBRIUM PROFILE

In this narrow riverine Impoundment, all impounded sediment eventually will be prone to mobilization and transport downstream, at which point the channel in the impoundment will return to a lower, equilibrium profile, and its approximate pre-dam channel bottom. Analysis of the surveyed longitudinal profile indicates an anticipated post-dam equilibrium slope through the site at approximately 0.5 percent. Based on the anticipated channel invert, channel width, and cross-sectional shape, the estimated volume of impounded sediment is 5,500 CY. All impounded sediment is anticipated to be mobilized over the course of approximately 6 months.

WATERSHED SEDIMENT YIELD

Applying the procedure in *Erosion and Sedimentation Manual (Randle et al., 2006)* to this site of interest on Moodna Creek, the estimated average annual sediment yield ranges from approximately 53,000 to 144,000 CY. Thus, the impounded sediment volume is approximately 4 - 10 percent of the estimated average annual sediment yield.

Transport of impounded sediment from Firth Cliff Dam through downstream reaches can be described as a diffuse wave, which diminishes rapidly in depth (i.e. sediment thickness) with distance downstream from the dam. New mid-channel bars may form temporarily. Sediment transported during channel-spanning or bankfull events will be incorporated into existing depositional features such as riffles and point bars. Due to this gradual process and the relatively small volume of sediment small volume of sediment, no adverse impacts to downstream aquatic biota, habitats, structures, or properties are anticipated.

ASSESSMENT OF CHANGES IN HYDRAULIC CONDITIONS

Following the anticipated transport in impounded sediment and related channel adjustment described above, the river profile and cross sections were modified in the hydraulic model to evaluate the resulting changes in hydraulic conditions for the recommended plan, full removal of the spillway.

HYDRAULIC MODEL GEOMETRY FOR EXISTING CONDITIONS

Figure 3 shows the 2018 topographic survey shots and the cross sections that were updated for the existing conditions model. The nine cross sections pictured below were updated with full in-channel cross section survey.

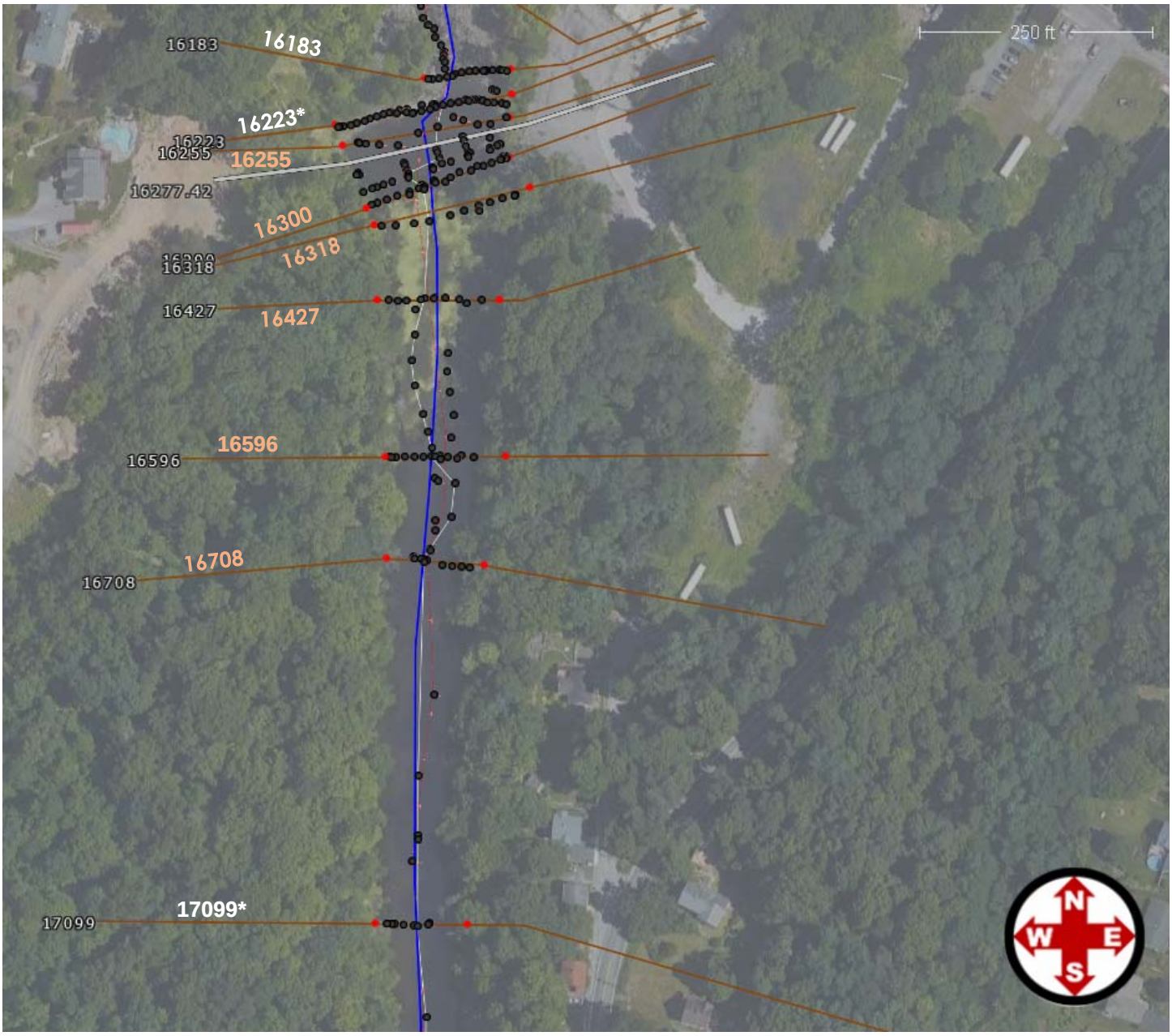

Figure 3 - Planview of hydraulic model geometry for existing conditions at AOP #2. Dark circles indicate survey points collected during the 2018 field investigation. Brown lines indicate cross section locations; the blue line indicates the stream centerline; and the light gray block indicates the AOP barrier structure. For the proposed model, cross sections with asterisks had updated geometries to reflect anticipated conditions and cross sections labeled in orange were removed to better represent the anticipated channel profile. The existing geometry was updated to reflect the anticipated conditions in the recommended plan with the full removal of the dam spillway and the resulting channel adjustment to a lower vertical elevation. Cross sections 16708, 16596, 16427, 16318, 16300, and 16255 were removed to reflect the anticipated channel profile.

Model results are compared in Figure 4, which depicts the water surface elevation profiles near Firth Cliff Dam for the 1 Percent Annual Chance Flood, bankfull, and median flows for existing conditions (blue) and for the recommended plan, full removal (red).

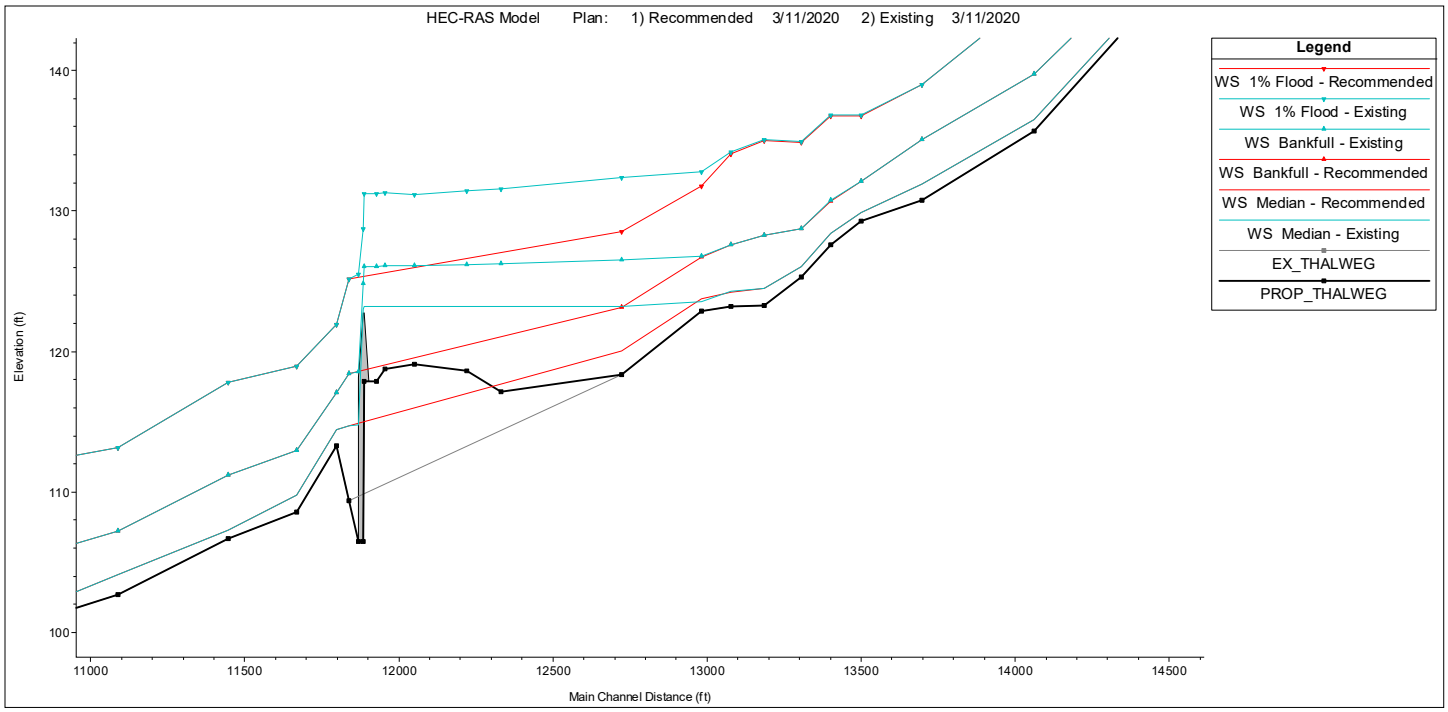

Figure 4 - Water Surface Profile at AOP #2 – Firth Cliff Dam. Black line is existing thalweg; gray line is thalweg in recommended plan; AOP #2 - Firth Cliff Dam is gray object; blue lines are water surface profiles in existing conditions; red lines are water surface profiles in the recommended plan.

In existing conditions, Firth Cliff Dam functions as the hydraulic control as indicated by the level water surface profile extending over 1,000 feet upstream of the dam in all modeled flows. Model results for the recommended plan with the dam spillway removed and after channel adjustment indicate that the water surface is lower in elevation in the former impoundment for all modeled flows. For the 1 Percent Annual Chance Flood, model results indicate that the breach of the dam will lower water surface elevations by 3.8 feet at the dam (see Table 4). For the bankfull and median flows, model results indicate that the removal of the dam will lower water surface elevation 3.4 and 3.3 feet, respectively, at the structure (see Table 5). At the anticipated equilibrium slope with the dam spillway removed, water levels will be lower and water velocity and shear stress in the channel will increase as in free-flowing conditions. Table 4 shows this phenomenon for all discharges at cross section 17099, the first cross section upstream of the structure.

Table 4 - Existing Conditions and Recommended Plan (Proposed) Water Surface Elevation (WSEL) and Velocity (Vel) for Cross Section 17099 (Immediately Upstream of AOP #2 – Firth Cliff).

Discharge	Existing WSEL (FT)	Proposed WSEL (FT)	Existing Velocity (Ft/s)	Proposed Velocity (Ft/s)
1% Flood	132.4	128.6	10.7	15.9
Bankfull	126.5	123.1	4.2	9.6
Median	123.3	120.0	0.5	4.6

The hydraulic model indicates that the vertical plunging flow at the downstream face of the structure is eliminated by the removal of the structure and the natural adjustment of the channel for the recommended plan. The downstream influence of the structure removal is limited to approximately 50 feet downstream of the structure where existing and anticipated water surface profiles become coincident. A complete table of results from the hydraulic model, including water surface elevation at each relevant cross section, is shown in Attachment B.

IMPACTS TO FLOODING

As a run of the river dam, Firth Cliff Dam was constructed to provide hydro-mechanical power to an adjacent mill and not to provide any flood control. The spillway has no ability to control flows and the impoundment has no capacity to store flood flows; the flow that enters the impoundment is equivalent to the flow that goes over the spillway. Therefore, the removal of the dam spillway has no impact on downstream flooding. The hydraulic model shows the removal of the structure likely will reduce water levels by several feet (approximately 4 feet) at the dam during the 1 Percent Annual Chance Flood.

AOP #3 - ORR'S MILL DAM

ASSESSMENT OF TRANSPORT OF IMPOUNDED SEDIMENT

Orr's Mill Dam is 10 feet tall. The dam retains numerous boulders (including large glacial erratics and potential bedrock outcrop) and cobble with interstitial sand and gravel. There were no substantial deposits of unconsolidated fine sediment (i.e. sediment not penetrable by manual probe); finer size classes (i.e. clay and silt) are not impounded and pass over the dam to downstream reaches. The recommended plan for AOP #3 involves removal of the central portion of the spillway and stabilizing the sides of the spillway that remain in place. With the full vertical extent of the central portion of the spillway removed, a similar channel response is likely to be triggered as with full spillway removal but with more retention of sediment on the channel margins proximal to the dam. The sand, gravel, and cobble sediment would be prone to mobilization post dam removal. The pronounced accumulation of boulders behind the dam, which may shift in position during construction and after dam breach, has the potential to form a steep boulder cascade or reveal natural bedrock falls (although no historic record of a natural waterfall has been identified). More likely, a cobble-boulder riffle, at a lower slope much like upstream and downstream reaches, may re-form in the impoundment.

EQUILIBRIUM PROFILE

As mobile sediment is transported from the impoundment following partial removal of the spillway, the channel will shift to a lower slope and equilibrium profile maintained by the cobble/boulder substrate that remains. Due to the difficulty in evaluating the potential for buried boulders to form a steep boulder cascade, estimating the

equilibrium slope at the Orr's Mill Dam is subject to greater uncertainty than at the other sites of interest (AOP #1 and AOP #2). The existing boulder substrate and bedrock formation has the potential to stabilize the channel in a water fall or steep boulder cascade at approximately a 5 percent slope. However, the more likely, and conservative, estimate for a potential post-dam breach equilibrium slope extends approximately 325 feet upstream of the spillway crest at 1.6 percent resulting in a cobble-boulder riffle. Based on the anticipated channel invert, channel width, and cross-sectional shape, the estimated volume of impounded sediment is 5,100 CY. Approximately 900 feet upstream of the dam, a large boulder riffle exists that would likely serve as grade control if channel adjustment extends to that point.

The re-formation of a cobble-boulder riffle would likely restore passage to a range of fish and other aquatic organisms in Moodna Creek. However, the emergence of a bedrock falls or formation of a steep boulder cascade may not provide full passage for fish; and in this case, some active re-grading and re-positioning of boulders may be recommended to facilitate fish passage while maintaining grade control. If in situ boulders are insufficient to maintain a stable grade change and/or fish passage conditions, the recommended plan also includes supplementing this reach with large boulders. The small cobble dominated tributary which flows under a residence and joins Moodna Creek approximately 250 feet upstream of the dam may require grade control to prevent undermining of the over-lying house. It is recommended that this site be subject to adaptive management for up to a 5-year monitoring period.

WATERSHED SEDIMENT YIELD

Applying the procedure in *Erosion and Sedimentation Manual (Randle et al., 2006)* to this site of interest on Moodna Creek, the estimated average annual sediment yield ranges from approximately 52,000 to 140,000 CY. Thus, the impounded sediment volume is approximately 4 - 10 percent of the estimated average annual sediment yield.

Transport of the sediment of finer size classes (sand and gravel) will initiate with dam breach, while transport of cobble and boulder sediment will occur mostly during high flow events. Some sediment transported downstream will fill in the deep pool downstream of the dam and upstream of the bridge. The sediment impounded behind the dam is comparable to the substrates of upstream and downstream reaches and forms the natural habitat features of Moodna Creek. Importantly, the Route 32 bridge immediately downstream of the dam has sufficient hydraulic capacity to allow for the transport of impounded sediment without increasing risk of overtopping. Since the quantity of sediment is small relative to the estimated annual sediment yield, and its release is anticipated to be gradual, no adverse impacts to downstream aquatic biota, habitats, structures, or properties are anticipated.

ASSESSMENT OF CHANGES IN HYDRAULIC CONDITIONS

Following the anticipated transport in impounded sediment and related channel adjustment described above, the river profile and cross sections were modified in the hydraulic model to evaluate the resulting changes in hydraulic conditions in the recommended plan, breach of the spillway and stabilization of the spillway sides.

HYDRAULIC MODEL GEOMETRY FOR EXISTING CONDITIONS

Figure 5 shows the 2018 topographic survey shots and the cross sections that were updated for the existing conditions model. The following cross sections were updated for the existing conditions hydraulic model with full cross section survey: 19819, 19856, 19977, 20053, and 20093.

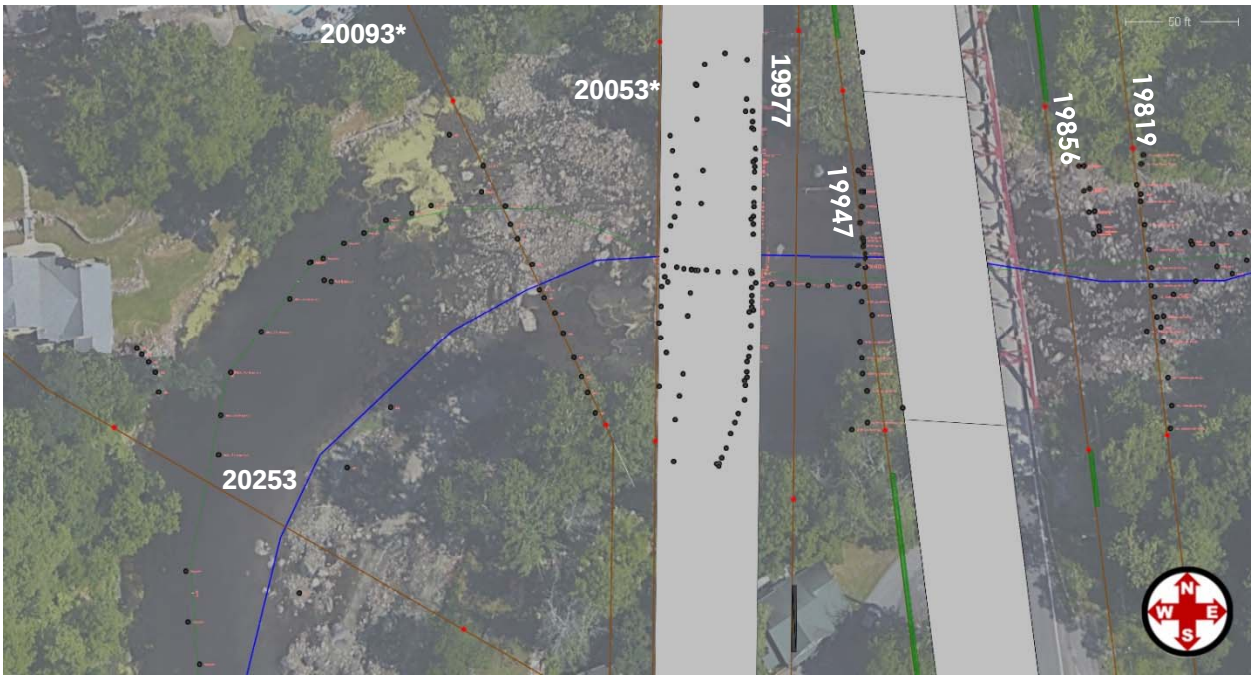

Figure 5 - Planview of hydraulic model geometry for existing conditions at AOP #3. Dark circles indicate survey points collected during the 2018 field investigation. Brown lines indicate cross section locations; the blue line indicates the stream centerline; and the light gray blocks indicate Orr's Mill Dam and the downstream Route 32 bridge. For the proposed model, cross sections with asterisks had updated geometries to reflect anticipated conditions

HYDRAULIC MODEL GEOMETRY FOR THE RECOMMENDED PLAN

The existing geometry was modified to reflect the anticipated conditions described above as the cobble-boulder dominated riffle in the recommended plan. As illustrated in the engineering plans, the recommended spillway breach is 75 feet wide in the center of the spillway. In addition to the breach geometry, the inverts of cross sections 20053 and 20093 upstream of the structure were lowered to reflect the anticipated slope of 1.6 percent of the profile, as shown in the engineering design. No additional cross sections were updated from the existing geometry.

HYDRAULIC MODEL RESULTS

Model results are compared in Figure 6, which depicts the water surface elevation profile near Orr's Mill Dam for the 1 Percent Annual Chance Flood, bankfull, and median flows in existing conditions (blue) and in the recommended plan, spillway breach (red).

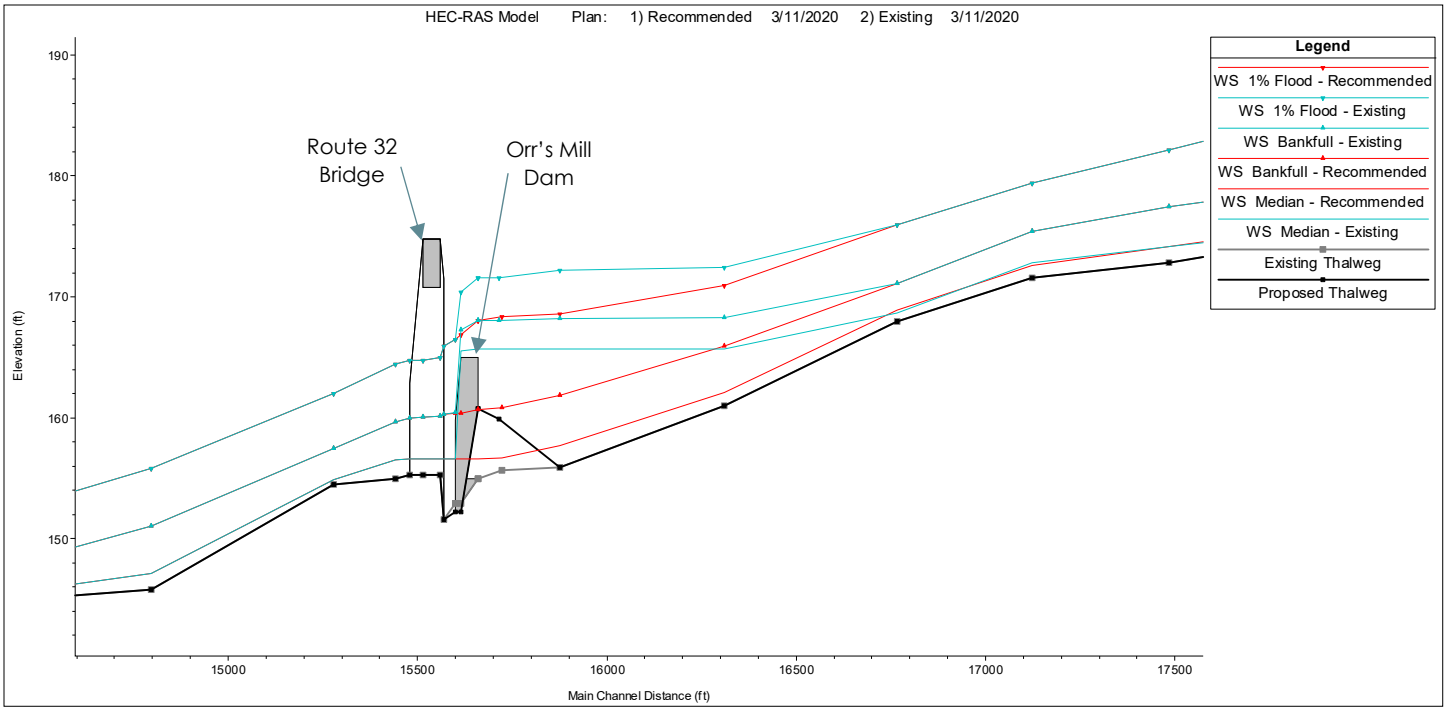

Figure 6 - Water Surface Profile showing thalweg in existing conditions (black) and recommended plan (gray) and existing AOP #3 - Orr's Mill Dam. The existing water surface profiles are shown in blue, and the anticipated water surface profiles are shown in red.

In existing conditions, Orr's Mill Dam functions as the hydraulic control as indicated by the level water surface profile extending several hundred feet upstream of the dam in all modeled flows. In the recommended plan with the central portion of the dam spillway removed and after channel adjustment to the conservative 1.6 percent slope, model results indicate that the water surface is lower in elevation in the former impoundment for all modeled flows. For the 1 Percent Annual Chance Flood, model results indicate that the breach of the dam will lower water surface elevations by 3.5 feet at the dam (see Table 5). For the bankfull and median flows, model results indicate that the removal of the dam will lower water surface elevation 7.3 and 9.1 feet, respectively, at the structure (see Table 5). The vertical drop in the water surface profile at the dam breach in the recommended plan for the 1 Percent Annual Chance Flood indicates that the current dimensions of the breach create a modest flow constriction during larger floods.

After breach of the dam and adjustment of the channel, water levels drop and velocity of water in the channel increases with the transition to free-flowing conditions. The increase in velocity coincides with an increase in shear stress in the channel, which is anticipated to increase sediment transport capacity to mobilize the large gravel, cobble, and small boulders during high flow events. Hydraulic conditions are shown in Table 5.

Table 5 – Existing Conditions and Recommended Plan (Proposed) Water Surface Elevation (WSEL) and Velocity (Vel) for Cross Section 20053 (Immediately Upstream of AOP #3 - Orr's Mill Dam)

Discharge	Existing WSEL (FT)	Proposed WSEL (FT)	Existing Velocity (Ft/s)	Proposed Velocity (Ft/s)
1% Flood	171.6	168.1	7.7	8.9
Bankfull	168.0	160.7	2.8	5.5
Median	165.7	156.6	0.3	1.4

IMPACTS TO FLOODING

Orr's Mill Dam does not have any ability to attenuate flood flows. The spillway has no ability to control flows and the impoundment has no capacity to store flood flows. As stated above, the hydraulic model indicates that the current dimensions of the breach create a modest flow constriction in the 1 Percent Annual Chance Flood, which in theory, could reduce the discharge through the breach; however, modeling the attenuation effects are beyond the scope of this assessment. The cross section from the hydraulic model (Figure 7) shows the proposed 1 Percent Flood water surface elevation is above the crest elevation of the breached dam. Detailed modeling during the PED phase is recommended to further investigate potential impacts such as impoundment.

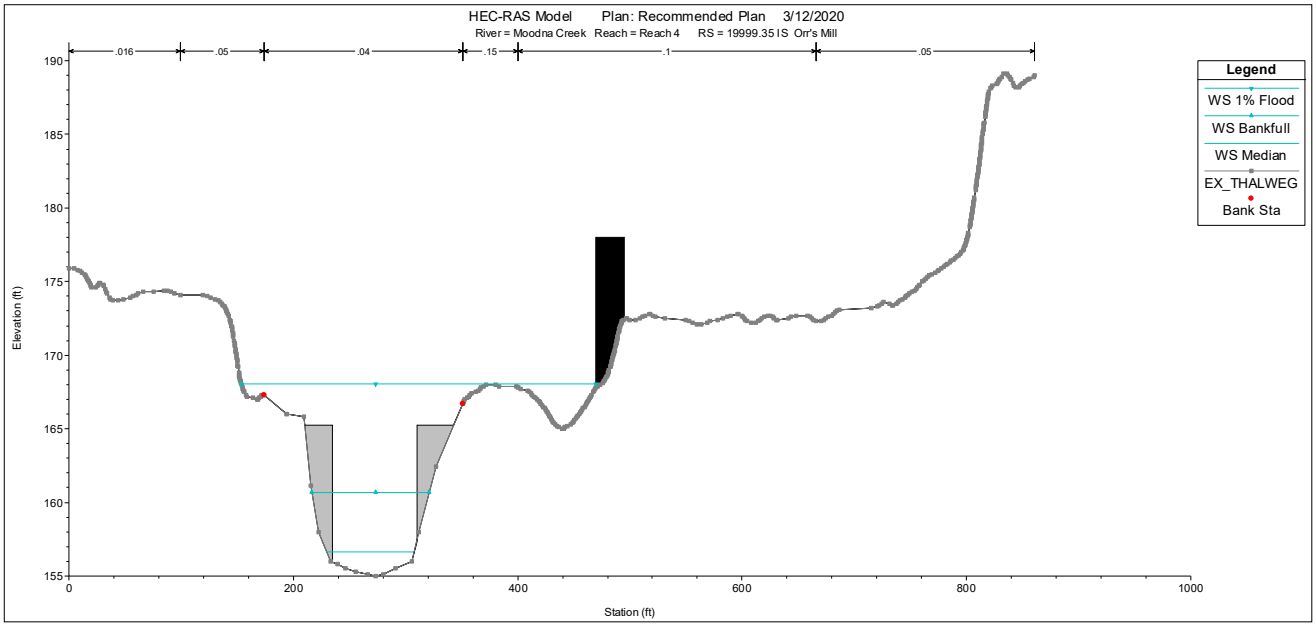

Figure 7 - Cross section geometry of the proposed breach in the dam. Water surface elevations are shown for all three flows in blue

SUMMARY

The results of the above assessment may be summarized generally as follows:

	Sediment Type	River Profile Adjustment	Relative Sediment Volume	Flood Impacts
AOP #1 Utility Line	Gravel, some cobble, and interstitial sand	Minor	<1%, Negligible	Minor Reduction
AOP #2 Firth Cliff Dam	Gravel and cobble, numerous large boulders, interstitial sand	Moderate	10%-4%, Negligible	Moderate Reduction
AOP #3 Orr's Mill Dam	Cobble, numerous large boulders, interstitial sand and gravel	Moderate/Major	10%-4%, Negligible	Moderate Reduction

NEXT STEPS

Implementation of the recommended plans at the three AOP areas of interest will likely require additional data collection and analysis in the Preconstruction Engineering and Design (PED) phase to complete planning, engineering design, and permitting.

SURVEY

Additional topographic survey of the areas of impact is necessary to refine the hydraulic model and develop engineering plans that are sufficient for permitting and construction. Additional in-channel cross sections should be surveyed farther upstream and downstream of the AOP barriers to replace existing cross sections derived from LiDAR and improve model accuracy of all modeled flows and flooding effects in existing conditions and in the recommended plan.

SEDIMENT QUALITY TESTING

Sediment sampling and analysis at the dams is strongly recommended as a next step for progressing with the removal of Firth Cliff Dam and the breach of Orr's Mill Dam. Sediment sampling is a standard measure of due diligence for dam removals, and a requirement of New York State Department of Environmental Conservation (NYSDEC) and USACE. Impounded sediment would need to be sampled and analyzed in a NY-certified laboratory for a broad range of potential pollutants (metals, PAHs, PCBs, dioxins, pesticides/herbicides) and, analytical results would have to show few or no exceedances for human health and ecological criteria, and be no more contaminated than upstream or downstream reaches. Due to the coarse-grained nature of sediments, sampling and analysis is not anticipated to reveal high concentrations of contaminants. Regardless, analytical analysis is necessary (i) to demonstrate the chemical quality of the sediments, (ii) to plan and mitigate for any unanticipated contamination, and (iii) to justify in-stream management or passive release of any sediment to downstream. Moreover, contamination – HTRW sampling is needed to determine if removal and off-site disposal of impounded sediment is needed to occur prior to restoration paid for 100 percent by the non-federal sponsor.

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Randle, T.R. and Bountry, J. 2017. Dam Removal Analysis Guidelines for Sediment. U.S. Department of the Interior, Bureau of Reclamation, Denver, Colorado.

ATTACHMENT B1

ANNUAL SEDIMENT YIELD CALCULATION

List of drainage basin characteristics and possible range of numerical ratings (modified from Pacific Southwest Interagency Committee, Water Management Subcommittee, 1968; Table 2.9 Published in Randle, T.J., Yang, C. T., Daraio, J., 2006. "Chapter 2, Erosion and Reservoir Sedimentation" in Erosion and Sedimentation Manual. U.S. Department of the Interior, Bureau of Reclamation, Denver, CO, 94 pp.)				Site Assessment		
Drainage basin characteristic	Sediment yield levels					
	High rating	Moderate rating	Low rating	Site Conditions	Lower Rating	Upper Rating
Surface geology	10: marine shales and related mudstones and siltstones	5: rocks of medium hardess moderately weathered and fractured	0: massive hard formations	Moderate hardness, mostly metamorphic, moderately weathered and fractured	5	7
Soils	10: fine textured and easily dispersed or single grain salts and fine sands	5: medium textured, occasional rock fragments, or caliche crusted layers	0: frequent rock fragments, aggregated clays, or high organic content	Medium textured, moderate organic content	4	6
Climate	10: frequent intense convective storms	5: infrequent convective storms, moderate intensity	0: humid climate with low intensity rainfall, arid climate with low intensity rainfall, or arid climate with rare convective storms	Humid climate but occasional moderate intensity storms	4	6
Runoff	10: high flows or volume per unit area	5: moderate flows or runoff volume per unit area	0: low flows or volume per unit area or rare runoff events	Moderate flows or runoff volumes per unit area	5	6
Topography	20: steep slopes (in excess of 30%), high relief, little or no flood plain development	10: moderate slopes (20%), moderate flood plain development	0: gentle slopes (less than 5%), extensive flood plain development	Gentle to moderate slopes (5-20%), moderate to extensive floodplain development	8	12
Ground cover	10: ground cover less than 20%, no rock or organic litter in surface soil	0: ground cover less than 40%, noticable organic litter in surface soil	-10: area completely covered by vegetation, rock fragments, organic litter with little opportunity for rainfall to erode soil	Mostly covered by vegetation; MUCH FORESTED/MOUNTAINS WITH STATE PARKS	-8	-5
Land use	10: more than 50% cultivated, sparse vegetation, and no rock in surface soil	0: less than 25% cultivated, less than 50% intensively grazed	-10: no cultivation, no recent logging, and only low intensity grazing, if any	Little agricultural; residential/commercial development; undeveloped areas are forested, not logged	-8	-6
Upland erosion	25: rill, gully, or landslide erosion over than 50% of the area	10: rill, gully, or landslide erosion over about 25% of area	0: no apparent signs of erosion	Limited upland erosion	1	5
Channel erosion	25: continuous or frequent bank erosion, or active headcuts and degradation in tributary channels	10: occasional channel erosion of bed or banks	0: wide shallow channels with mild gradients, channels in massive rock, large boulders, or dense vegetation or artificially protected channels	Bank erosion and channel incision are common	12	22
				Total	23	53
				Sediment yield classification (ac-ft/mi2) (Randle, 1996)	0.2	0.54

Table 2.10. Drainage basin sediment yield classification (Randle, 1996)

Drainage basin classification number	Total rating	Annual sediment yield (ac-ft/mi^2)
1	> 100	> 3
2	75 to 100	1.0 to 3.0
3	50 to 75	0.5 to 1.0
4	25 to 50	0.2 to 0.5
5	0 to 25	<0.2

AOP #1 - Utility Line

	Lower Sediment Yield Estimate	Upper Sediment Yield Estimate	
Sediment Yield Rate	0.2	0.54	ac-ft/mi2
Watershed Area	169		mi2
	33.8	91.26	ac-ft
Annual Watershed Sediment Yield	1,472,328	3,975,286	ft3
	54,531	147,233	CY
Impounded sediment volume	240		CY
Percent of Annual Sediment Yield	0.44%	0.16%	
Negligible is <10% of Annual Sediment Yield			

APO #2 - Firth Cliff

	Lower Sediment Yield Estimate	Upper Sediment Yield Estimate	
Sediment Yield Rate	0.2	0.54	ac-ft/mi2
Watershed Area	165		mi2
	33	89.1	ac-ft
Annual Watershed Sediment Yield	1,437,480	3,881,196	ft3
	53,240	143,748	CY
Impounded sediment volume	5,500		CY
Percent of Annual Sediment Yield	10.33%	3.83%	
Negligible is <10% of Annual Sediment Yield			

AOP #3 - Orr's Mill

	Lower Sediment Yield Estimate	Upper Sediment Yield Estimate	
Sediment Yield Rate	0.2	0.54	ac-ft/mi2
Watershed Area	161		mi2
	32.2	86.94	ac-ft
Annual Watershed Sediment Yield	1,402,632	3,787,106	ft3
	51,949	140,263	CY
Impounded sediment volume	5,100		CY
Percent of Annual Sediment Yield	9.82%	3.64%	
Negligible is <10% of Annual Sediment Yield			

ATTACHMENT B2

HYDRAULIC REPORT

CALLOUT

River Sta	Profile	Plan	Q Total	W.S. Elev	Max Chl Dpth	Vel Chnl	Shear Chan	Froude # Chl
			(cfs)	(ft)	(ft)	(ft/s)	(lb/sq ft)	
4374	Median	Recommended	140	3.29	1.49	2.23	0.22	0.39
4374	Median	Existing	140	3.29	1.49	2.23	0.22	0.39
4374	Bankfull	Recommended	2730	7.92	6.12	6.61	1.14	0.51
4374	Bankfull	Existing	2730	7.92	6.12	6.61	1.14	0.51
4374	1% Flood	Recommended	13220	14.88	13.08	11.61	2.66	0.59
4374	1% Flood	Existing	13220	14.88	13.08	11.61	2.66	0.59
4727	Median	Recommended	140	4.45	1.35	1.29	0.09	0.31
4727	Median	Existing	140	4.45	1.35	1.29	0.09	0.31
4727	Bankfull	Recommended	2730	9.01	5.91	2.84	0.21	0.23
4727	Bankfull	Existing	2730	9.01	5.91	2.84	0.21	0.23
4727	1% Flood	Recommended	13220	16.88	13.78	5.22	0.53	0.26
4727	1% Flood	Existing	13220	16.88	13.78	5.22	0.53	0.26
4806	Median	Recommended	140	4.72	1.42	1.49	0.13	0.38
4806	Median	Existing	140	4.72	1.42	1.49	0.13	0.38
4806	Bankfull	Recommended	2730	9.07	5.77	3.03	0.25	0.25
4806	Bankfull	Existing	2730	9.07	5.77	3.03	0.25	0.25
4806	1% Flood	Recommended	13220	17.1	13.8	4.53	0.4	0.23
4806	1% Flood	Existing	13220	17.1	13.8	4.53	0.4	0.23
5012	Median	Recommended	140	5.4	0.9	1.64	0.13	0.33
5012	Median	Existing	140	5.4	0.9	1.64	0.13	0.33
5012	Bankfull	Recommended	2730	9.17	4.67	5.05	0.71	0.43
5012	Bankfull	Existing	2730	9.17	4.67	5.05	0.71	0.43
5012	1% Flood	Recommended	13220	16.94	12.44	7.2	1.03	0.37
5012	1% Flood	Existing	13220	16.94	12.44	7.2	1.03	0.37
5566	Median	Recommended	140	7.27	1.27	1.31	0.3	0.22
5566	Median	Existing	140	7.27	1.27	1.31	0.3	0.22
5566	Bankfull	Recommended	2730	11.52	5.52	4.82	2.23	0.38
5566	Bankfull	Existing	2730	11.52	5.52	4.82	2.23	0.38
5566	1% Flood	Recommended	13220	18.33	12.33	7.32	3.8	0.38
5566	1% Flood	Existing	13220	18.33	12.33	7.32	3.8	0.38
5851	Median	Recommended	140	9.48	0.58	3.27	0.61	0.82
5851	Median	Existing	140	9.48	0.58	3.27	0.61	0.82
5851	Bankfull	Recommended	2730	12.96	4.06	5.38	0.85	0.5
5851	Bankfull	Existing	2730	12.96	4.06	5.38	0.85	0.5
5851	1% Flood	Recommended	13220	19.2	10.3	8.24	1.43	0.46
5851	1% Flood	Existing	13220	19.2	10.3	8.24	1.43	0.46
6458	Median	Recommended	140	16.96	1.56	1.16	0.61	0.18
6458	Median	Existing	140	16.96	1.56	1.16	0.61	0.18
6458	Bankfull	Recommended	2730	18.89	3.49	7.14	16.24	0.74
6458	Bankfull	Existing	2730	18.89	3.49	7.14	16.24	0.74
6458	1% Flood	Recommended	13220	22.76	7.36	9.18	19.32	0.64

River Sta	Profile	Plan	Q Total	W.S. Elev	Max Chl Dpth	Vel Chnl	Shear Chan	Froude # Chl
			(cfs)	(ft)	(ft)	(ft/s)	(lb/sq ft)	
6458	1% Flood	Existing	13220	22.76	7.36	9.18	19.32	0.64
6967	Median	Recommended	140	20.13	0.93	2.21	0.24	0.45
6967	Median	Existing	140	20.13	0.93	2.21	0.24	0.45
6967	Bankfull	Recommended	2730	24.07	4.87	5.83	0.95	0.5
6967	Bankfull	Existing	2730	24.07	4.87	5.83	0.95	0.5
6967	1% Flood	Recommended	13220	28.38	9.18	11.3	2.85	0.68
6967	1% Flood	Existing	13220	28.38	9.18	11.3	2.85	0.68
7421	Median	Recommended	140	23.09	0.79	2.12	0.26	0.54
7421	Median	Existing	140	23.09	0.79	2.12	0.26	0.54
7421	Bankfull	Recommended	2730	25.98	3.68	5.73	1.01	0.56
7421	Bankfull	Existing	2730	25.98	3.68	5.73	1.01	0.56
7421	1% Flood	Recommended	13220	30.78	8.48	10.33	2.47	0.66
7421	1% Flood	Existing	13220	30.78	8.48	10.33	2.47	0.66
7810	Median	Recommended	140	29.84	1.84			0
7810	Median	Existing	140	29.84	1.84			0
7810	Bankfull	Recommended	2730	31.88	3.88	9.62	3.56	1.33
7810	Bankfull	Existing	2730	31.88	3.88	9.62	3.56	1.33
7810	1% Flood	Recommended	13220	35.77	7.77	15.41	6.08	1.16
7810	1% Flood	Existing	13220	35.77	7.77	15.41	6.08	1.16
8085	Median	Recommended	140	33.62	1.82	1.38	0.35	0.28
8085	Median	Existing	140	33.62	1.82	1.38	0.35	0.28
8085	Bankfull	Recommended	2730	36.92	5.12	4.66	2.12	0.42
8085	Bankfull	Existing	2730	36.92	5.12	4.66	2.12	0.42
8085	1% Flood	Recommended	13220	41.56	9.76	8.18	5	0.5
8085	1% Flood	Existing	13220	41.56	9.76	8.18	5	0.5
8505	Median	Recommended	140	34.95	0.95	1.53	0.09	0.3
8505	Median	Existing	140	34.95	0.95	1.53	0.09	0.3
8505	Bankfull	Recommended	2730	38.45	4.45	4.77	0.54	0.42
8505	Bankfull	Existing	2730	38.45	4.45	4.77	0.54	0.42
8505	1% Flood	Recommended	13220	43.05	9.05	8.06	1.22	0.48
8505	1% Flood	Existing	13220	43.05	9.05	8.06	1.22	0.48
8718	Median	Recommended	140	35.4	1.3	2.01	0.18	0.34
8718	Median	Existing	140	35.4	1.3	2.01	0.18	0.34
8718	Bankfull	Recommended	2730	38.92	4.82	6.64	1.33	0.63
8718	Bankfull	Existing	2730	38.92	4.82	6.64	1.33	0.63
8718	1% Flood	Recommended	13220	42.96	8.86	13.69	4.48	0.92
8718	1% Flood	Existing	13220	42.96	8.86	13.69	4.48	0.92
8893	Median	Recommended	140	36.93	0.83	4.12	1.28	1.01
8893	Median	Existing	140	36.93	0.83	4.12	1.28	1.01
8893	Bankfull	Recommended	2730	40.24	4.14	7.89	2.38	0.8

River Sta	Profile	Plan	Q Total	W.S. Elev	Max Chl Dpth	Vel Chnl	Shear Chan	Froude # Chl
			(cfs)	(ft)	(ft)	(ft/s)	(lb/sq ft)	
8893	Bankfull	Existing	2730	40.24	4.14	7.89	2.38	0.8
8893	1% Flood	Recommended	13220	45.51	9.41	12.22	4.1	0.75
8893	1% Flood	Existing	13220	45.51	9.41	12.22	4.1	0.75
9331	Median	Recommended	140	42.35	0.85	2.13	0.25	0.44
9331	Median	Existing	140	42.35	0.85	2.13	0.25	0.44
9331	Bankfull	Recommended	2730	45.18	3.68	7.93	2.09	0.77
9331	Bankfull	Existing	2730	45.18	3.68	7.93	2.09	0.77
9331	1% Flood	Recommended	13220	50.09	8.59	14.45	5.11	0.9
9331	1% Flood	Existing	13220	50.02	8.52	14.59	5.22	0.91
9759	Median	Recommended	140	44.46	1.57	2.74	0.32	0.45
9759	Median	Existing	140	44.46	1.57	2.74	0.32	0.45
9759	Bankfull	Recommended	2730	48.71	5.82	8.72	2.06	0.71
9759	Bankfull	Existing	2730	49.05	6.16	7.27	1.58	0.69
9759	1% Flood	Recommended	13220	54.28	11.39	14.55	4.43	0.8
9759	1% Flood	Existing	13220	54.41	11.52	12.91	3.66	0.76
9826	Median	Existing	140	44.65	2.73	1.52	0.09	0.2
9826	Bankfull	Existing	2730	49.68	7.76	6.01	1.01	0.51
9826	1% Flood	Existing	13220	55.12	13.2	11.82	3.05	0.69
9867	Median	Existing	140	44.69	3.33	1.33	0.06	0.17
9867	Bankfull	Existing	2730	49.98	8.62	4.99	0.64	0.38
9867	1% Flood	Existing	13220	55.54	14.18	11.36	2.67	0.61
9873 Util	Median	Existing	140	47				
9873 Util	Bankfull	Existing	2730	50.86				
9873 Util	1% Flood	Existing	13220	55.6				
9885	Median	Existing	140	47	2.46	1.28	0.07	0.19
9885	Bankfull	Existing	2730	50.86	6.32	5.64	0.91	0.49
9885	1% Flood	Existing	13220	55.6	11.06	12.1	3.26	0.73
9931	Median	Recommended	140	45.36	1.41	2.44	0.29	0.48
9931	Median	Existing	140	47.04	2.4	1.2	0.06	0.18
9931	Bankfull	Recommended	2730	50.14	6.19	5.38	0.76	0.42
9931	Bankfull	Existing	2730	51.14	6.5	4.78	0.62	0.39
9931	1% Flood	Recommended	13220	55.64	11.69	12.13	3.04	0.66
9931	1% Flood	Existing	13220	56.38	11.74	10.68	2.42	0.6
9969	Median	Existing	140	47.07	2.43	1.17	0.06	0.18
9969	Bankfull	Existing	2730	51.24	6.6	4.68	0.59	0.38
9969	1% Flood	Existing	13220	56.83	12.19	9.75	2.03	0.55
9970	Median	Recommended	140	45.58	1.47	2.28	0.25	0.44

River Sta	Profile	Plan	Q Total	W.S. Elev	Max Chl Dpth	Vel Chnl	Shear Chan	Froude # Chl
			(cfs)	(ft)	(ft)	(ft/s)	(lb/sq ft)	
9970	Bankfull	Recommended	2730	50.23	6.12	5.44	0.78	0.43
9970	1% Flood	Recommended	13220	55.87	11.76	11.99	2.96	0.65
10131	Median	Recommended	140	48.04	1.24	4.81	1.18	1.01
10131	Median	Existing	140	48.04	1.24	4.81	1.18	1.01
10131	Bankfull	Recommended	2730	51.44	4.64	8.08	2.34	1
10131	Bankfull	Existing	2730	51.57	4.77	7.58	2.03	0.92
10131	1% Flood	Recommended	13220	57.54	10.74	8.87	1.8	0.56
10131	1% Flood	Existing	13220	57.7	10.9	8.69	1.71	0.54
10231	Median	Recommended	140	53.19	1.12	3.7	0.84	1.03
10231	Median	Existing	140	53.19	1.12	3.7	0.84	1.03
10231	Bankfull	Recommended	2730	55.06	2.99	7.55	2.13	1
10231	Bankfull	Existing	2730	55.06	2.99	7.55	2.13	1
10231	1% Flood	Recommended	13220	58.29	6.22	12.33	4.08	0.99
10231	1% Flood	Existing	13220	58.29	6.22	12.33	4.08	0.99
10232	Median	Recommended	140	55.64	0.76	2.3	0.31	0.61
10232	Median	Existing	140	55.64	0.76	2.3	0.31	0.61
10232	Bankfull	Recommended	2730	57.44	2.56	7.85	2.24	1
10232	Bankfull	Existing	2730	57.44	2.56	7.85	2.24	1
10232	1% Flood	Recommended	13220	61.03	6.15	12.34	3.99	0.96
10232	1% Flood	Existing	13220	61.03	6.15	12.34	3.99	0.96
10233	Median	Recommended	140	56.58	1.27	1.79	0.15	0.31
10233	Median	Existing	140	56.58	1.27	1.79	0.15	0.31
10233	Bankfull	Recommended	2730	59.94	4.63	6.77	1.4	0.66
10233	Bankfull	Existing	2730	59.94	4.63	6.77	1.4	0.66
10233	1% Flood	Recommended	13220	63.97	8.66	12.71	4.01	0.9
10233	1% Flood	Existing	13220	63.97	8.66	12.71	4.01	0.9
10234	Median	Recommended	140	56.9	1.49	1.77	0.13	0.29
10234	Median	Existing	140	56.9	1.49	1.77	0.13	0.29
10234	Bankfull	Recommended	2730	60.92	5.51	5.82	0.97	0.51
10234	Bankfull	Existing	2730	60.92	5.51	5.82	0.97	0.51
10234	1% Flood	Recommended	13220	65.51	10.1	12.03	3.31	0.75
10234	1% Flood	Existing	13220	65.51	10.1	12.03	3.31	0.75
10885	Median	Recommended	140	57.43	1.43	2.48	0.33	0.57
10885	Median	Existing	140	57.43	1.43	2.48	0.33	0.57
10885	Bankfull	Recommended	2730	61.6	5.6	4.58	0.59	0.39
10885	Bankfull	Existing	2730	61.6	5.6	4.58	0.59	0.39
10885	1% Flood	Recommended	13220	67.07	11.07	9.58	1.96	0.54
10885	1% Flood	Existing	13220	67.07	11.07	9.58	1.96	0.54
10886	Median	Recommended	140	59.35	0.96	3.89	0.87	0.99
10886	Median	Existing	140	59.35	0.96	3.89	0.87	0.99

River Sta	Profile	Plan	Q Total	W.S. Elev	Max Chl Dpth	Vel Chnl	Shear Chan	Froude # Chl
			(cfs)	(ft)	(ft)	(ft/s)	(lb/sq ft)	
10886	Bankfull	Recommended	2730	61.97	3.58	8.87	2.67	1.01
10886	Bankfull	Existing	2730	61.97	3.58	8.87	2.67	1.01
10886	1% Flood	Recommended	13220	67.74	9.35	9.23	2.14	0.67
10886	1% Flood	Existing	13220	67.74	9.35	9.23	2.14	0.67
10887	Median	Recommended	140	61.31	0.97	2.41	0.29	0.49
10887	Median	Existing	140	61.31	0.97	2.41	0.29	0.49
10887	Bankfull	Recommended	2730	64.44	4.1	8.06	2.06	0.83
10887	Bankfull	Existing	2730	64.44	4.1	8.06	2.06	0.83
10887	1% Flood	Recommended	13220	68.78	8.44	11.84	3.9	1
10887	1% Flood	Existing	13220	68.78	8.44	11.84	3.9	1
10888	Median	Recommended	140	64.96	0.79	4.36	1.03	1
10888	Median	Existing	140	64.96	0.79	4.36	1.03	1
10888	Bankfull	Recommended	2730	67.45	3.28	8.75	2.62	1.01
10888	Bankfull	Existing	2730	67.45	3.28	8.75	2.62	1.01
10888	1% Flood	Recommended	13220	71.83	7.66	13.1	4.21	0.91
10888	1% Flood	Existing	13220	71.83	7.66	13.1	4.21	0.91
11532	Median	Recommended	126	68.08	1.38	2.68	0.38	0.6
11532	Median	Existing	126	68.08	1.38	2.68	0.38	0.6
11532	Bankfull	Recommended	2560	70.75	4.05	8.5	2.43	0.96
11532	Bankfull	Existing	2560	70.75	4.05	8.5	2.43	0.96
11532	1% Flood	Recommended	13024	75.09	8.39	15.47	5.77	1.06
11532	1% Flood	Existing	13024	75.09	8.39	15.47	5.77	1.06
11969	Median	Recommended	126	72.7	0.6	2.38	0.33	0.61
11969	Median	Existing	126	72.7	0.6	2.38	0.33	0.61
11969	Bankfull	Recommended	2560	75.51	3.41	6.24	1.23	0.64
11969	Bankfull	Existing	2560	75.51	3.41	6.24	1.23	0.64
11969	1% Flood	Recommended	13024	80.37	8.27	11.8	3.19	0.75
11969	1% Flood	Existing	13024	80.37	8.27	11.8	3.19	0.75
12498	Median	Recommended	126	76.1	1	2.24	0.24	0.42
12498	Median	Existing	126	76.1	1	2.24	0.24	0.42
12498	Bankfull	Recommended	2560	79.38	4.28	9.03	2.37	0.81
12498	Bankfull	Existing	2560	79.38	4.28	9.03	2.37	0.81
12498	1% Flood	Recommended	13024	85.46	10.36	17.65	6.61	0.99
12498	1% Flood	Existing	13024	85.46	10.36	17.65	6.61	0.99
13025	Median	Recommended	126	78.43	1.13	2.39	0.27	0.44
13025	Median	Existing	126	78.43	1.13	2.39	0.27	0.44
13025	Bankfull	Recommended	2560	83.12	5.82	7	1.28	0.54
13025	Bankfull	Existing	2560	83.12	5.82	7	1.28	0.54
13025	1% Flood	Recommended	13024	91.15	13.85	13.57	3.54	0.66
13025	1% Flood	Existing	13024	91.15	13.85	13.57	3.54	0.66

River Sta	Profile	Plan	Q Total	W.S. Elev	Max Chl Dpth	Vel Chnl	Shear Chan	Froude # Chl
			(cfs)	(ft)	(ft)	(ft/s)	(lb/sq ft)	
13756	Median	Recommended	126	87.01	0.61	3.81	0.86	1
13756	Median	Existing	126	87.01	0.61	3.81	0.86	1
13756	Bankfull	Recommended	2560	89.78	3.38	9.44	2.8	0.96
13756	Bankfull	Existing	2560	89.78	3.38	9.44	2.8	0.96
13756	1% Flood	Recommended	13024	95.35	8.95	15.49	5.32	0.93
13756	1% Flood	Existing	13024	95.35	8.95	15.49	5.32	0.93
14327	Median	Recommended	126	94.11	1.21	2.75	0.36	0.52
14327	Median	Existing	126	94.11	1.21	2.75	0.36	0.52
14327	Bankfull	Recommended	2560	96.78	3.88	6.25	1.3	0.69
14327	Bankfull	Existing	2560	96.78	3.88	6.25	1.3	0.69
14327	1% Flood	Recommended	13024	101.49	8.59	11.04	2.85	0.72
14327	1% Flood	Existing	13024	101.49	8.59	11.04	2.85	0.72
14759	Median	Recommended	126	97.09	1.19	3.01	0.42	0.55
14759	Median	Existing	126	97.09	1.19	3.01	0.42	0.55
14759	Bankfull	Recommended	2560	100.53	4.63	11.26	3.65	1
14759	Bankfull	Existing	2560	100.53	4.63	11.26	3.65	1
14759	1% Flood	Recommended	13024	109.27	13.37	12.54	3.07	0.62
14759	1% Flood	Existing	13024	109.27	13.37	12.54	3.07	0.62
15065	Median	Recommended	126	100.53	0.73	3.41	0.65	0.82
15065	Median	Existing	126	100.53	0.73	3.41	0.65	0.82
15065	Bankfull	Recommended	2560	104.44	4.64	7.04	1.4	0.61
15065	Bankfull	Existing	2560	104.44	4.64	7.04	1.4	0.61
15065	1% Flood	Recommended	13024	111.46	11.66	11.16	2.53	0.59
15065	1% Flood	Existing	13024	111.46	11.66	11.16	2.53	0.59
15474	Median	Recommended	126	104.12	1.42	2.57	0.3	0.45
15474	Median	Existing	126	104.12	1.42	2.57	0.3	0.45
15474	Bankfull	Recommended	2560	107.24	4.54	10.05	3	0.94
15474	Bankfull	Existing	2560	107.24	4.54	10.05	3	0.94
15474	1% Flood	Recommended	13024	113.16	10.46	17.7	6.72	1.01
15474	1% Flood	Existing	13024	113.16	10.46	17.7	6.72	1.01
15832	Median	Recommended	126	107.3	0.6	3.61	0.74	0.89
15832	Median	Existing	126	107.3	0.6	3.61	0.74	0.89
15832	Bankfull	Recommended	2560	111.18	4.48	7.67	1.66	0.66
15832	Bankfull	Existing	2560	111.18	4.48	7.67	1.66	0.66
15832	1% Flood	Recommended	13024	117.8	11.1	13.85	3.95	0.74
15832	1% Flood	Existing	13024	117.8	11.1	13.85	3.95	0.74
16053	Median	Recommended	126	109.78	1.18	2.8	0.36	0.51
16053	Median	Existing	126	109.78	1.18	2.8	0.36	0.51
16053	Bankfull	Recommended	2560	112.98	4.38	10.42	3.26	0.99
16053	Bankfull	Existing	2560	112.98	4.38	10.42	3.26	0.99
16053	1% Flood	Recommended	13024	118.96	10.36	16.86	6.11	0.97

River Sta	Profile	Plan	Q Total	W.S. Elev	Max Chl Dpth	Vel Chnl	Shear Chan	Froude # Chl
			(cfs)	(ft)	(ft)	(ft/s)	(lb/sq ft)	
16053	1% Flood	Existing	13024	118.96	10.36	16.86	6.11	0.97
16183	Median	Recommended	126	114.46	1.18	4.04	0.94	1.02
16183	Median	Existing	126	114.46	1.18	4.04	0.94	1.02
16183	Bankfull	Recommended	2560	117.1	3.82	9.35	2.84	1
16183	Bankfull	Existing	2560	117.1	3.82	9.35	2.84	1
16183	1% Flood	Recommended	13024	121.91	8.63	16.02	5.95	1.03
16183	1% Flood	Existing	13024	121.91	8.63	16.02	5.95	1.03
16223	Median	Recommended	126	114.74	5.37	0.52	0.01	0.06
16223	Median	Existing	126	114.74	5.37	0.52	0.01	0.06
16223	Bankfull	Recommended	2560	118.41	9.04	3.11	0.27	0.26
16223	Bankfull	Existing	2560	118.41	9.04	3.11	0.27	0.26
16223	1% Flood	Recommended	13024	125.19	15.82	6.13	0.78	0.33
16223	1% Flood	Existing	13024	125.19	15.82	6.13	0.78	0.33
16255	Median	Existing	126	114.75	8.26	0.13	0	0.01
16255	Bankfull	Existing	2560	118.54	12.05	1.55	0.05	0.09
16255	1% Flood	Existing	13024	125.51	19.02	4.45	0.36	0.2
16277.42 Fi	Median	Existing	126	123.24				
16277.42 Fi	Bankfull	Existing	2560	126.07				
16277.42 Fi	1% Flood	Existing	13024	131.24				
16290	Median	Existing	126	123.24	5.35	0.22	0	0.02
16290	Bankfull	Existing	2560	126.07	8.18	2.55	0.16	0.18
16290	1% Flood	Existing	13024	131.24	13.35	7.02	1	0.37
16318	Median	Existing	126	123.24	4.45	0.25	0	0.03
16318	Bankfull	Existing	2560	126.08	7.29	2.58	0.17	0.19
16318	1% Flood	Existing	13024	131.32	12.53	6.83	0.95	0.36
16427	Median	Existing	126	123.24	4.14	0.33	0	0.03
16427	Bankfull	Existing	2560	126.09	6.99	3.38	0.29	0.25
16427	1% Flood	Existing	13024	131.16	12.06	8.91	1.63	0.48
16596	Median	Existing	126	123.24	4.61	0.33	0	0.03
16596	Bankfull	Existing	2560	126.19	7.56	3.49	0.2	0.25
16596	1% Flood	Existing	13024	131.47	12.84	8.98	1.06	0.48
16708	Median	Existing	126	123.24	6.1	0.3	0	0.03
16708	Bankfull	Existing	2560	126.27	9.13	3.42	0.28	0.23
16708	1% Flood	Existing	13024	131.57	14.43	9.63	1.83	0.48
17099	Median	Recommended	126	120.01	1.64	4.6	1.12	1.02
17099	Median	Existing	126	123.25	4.88	0.45	0.01	0.05

River Sta	Profile	Plan	Q Total	W.S. Elev	Max Chl Dpth	Vel Chnl	Shear Chan	Froude # Chl
			(cfs)	(ft)	(ft)	(ft/s)	(lb/sq ft)	
17099	Bankfull	Recommended	2560	123.13	4.76	9.56	2.93	1
17099	Bankfull	Existing	2560	126.53	8.16	4.21	0.44	0.3
17099	1% Flood	Recommended	13024	128.57	10.2	15.93	5.73	0.98
17099	1% Flood	Existing	13024	132.39	14.02	10.67	2.26	0.54
17359	Median	Recommended	126	123.74	0.84	2.35	0.29	0.53
17359	Median	Existing	126	123.52	0.62	3.64	0.81	1.01
17359	Bankfull	Recommended	2560	126.72	3.82	7.55	1.74	0.73
17359	Bankfull	Existing	2560	126.76	3.86	7.47	1.69	0.72
17359	1% Flood	Recommended	13024	131.75	8.85	15.11	5.12	0.92
17359	1% Flood	Existing	13024	132.82	9.92	13.32	3.82	0.77
17359.5	Median	Recommended	126	124.21	0.98	1.79	0.15	0.35
17359.5	Median	Existing	126	124.26	1.03	1.67	0.13	0.31
17359.5	Bankfull	Recommended	2560	127.62	4.39	6.37	1.19	0.58
17359.5	Bankfull	Existing	2560	127.63	4.4	6.36	1.18	0.58
17359.5	1% Flood	Recommended	13024	134.08	10.85	11.23	2.68	0.63
17359.5	1% Flood	Existing	13024	134.22	10.99	11.07	2.6	0.62
17360	Median	Recommended	126	124.5	1.23	1.66	0.13	0.31
17360	Median	Existing	126	124.51	1.24	1.63	0.12	0.3
17360	Bankfull	Recommended	2560	128.24	4.97	5.53	0.87	0.48
17360	Bankfull	Existing	2560	128.25	4.98	5.53	0.87	0.48
17360	1% Flood	Recommended	13024	135	11.73	9.88	2.08	0.56
17360	1% Flood	Existing	13024	135.09	11.82	9.78	2.04	0.55
17683	Median	Recommended	126	126.08	0.78	4.06	0.94	1.01
17683	Median	Existing	126	126.08	0.78	4.06	0.94	1.01
17683	Bankfull	Recommended	2560	128.78	3.48	8.99	2.69	1
17683	Bankfull	Existing	2560	128.77	3.47	9.03	2.72	1.01
17683	1% Flood	Recommended	13024	134.87	9.57	12.86	3.67	0.78
17683	1% Flood	Existing	13024	134.96	9.66	12.71	3.57	0.76
17683.5	Median	Recommended	126	128.39	0.81	3.44	0.65	0.81
17683.5	Median	Existing	126	128.39	0.81	3.44	0.65	0.81
17683.5	Bankfull	Recommended	2560	130.73	3.15	6.84	1.64	0.82
17683.5	Bankfull	Existing	2560	130.74	3.16	6.82	1.63	0.82
17683.5	1% Flood	Recommended	13024	136.8	9.22	8.71	1.73	0.55
17683.5	1% Flood	Existing	13024	136.83	9.25	8.68	1.72	0.55
17684	Median	Recommended	126	129.9	0.63	2.57	0.37	0.63
17684	Median	Existing	126	129.9	0.63	2.57	0.37	0.63
17684	Bankfull	Recommended	2560	132.11	2.84	8.7	2.59	1
17684	Bankfull	Existing	2560	132.11	2.84	8.7	2.59	1
17684	1% Flood	Recommended	13024	136.79	7.52	11.17	3.15	0.81
17684	1% Flood	Existing	13024	136.82	7.55	11.11	3.12	0.81

River Sta	Profile	Plan	Q Total	W.S. Elev	Max Chl Dpth	Vel Chnl	Shear Chan	Froude # Chl
			(cfs)	(ft)	(ft)	(ft/s)	(lb/sq ft)	
18073	Median	Recommended	126	131.93	1.13	2.88	0.42	0.6
18073	Median	Existing	126	131.93	1.13	2.88	0.42	0.6
18073	Bankfull	Recommended	2560	135.09	4.29	5.26	0.98	0.64
18073	Bankfull	Existing	2560	135.1	4.3	5.26	0.98	0.64
18073	1% Flood	Recommended	13024	139.01	8.21	8.66	1.92	0.65
18073	1% Flood	Existing	13024	139.01	8.21	8.66	1.92	0.65
18439	Median	Recommended	126	136.52	0.82	3.87	0.78	0.83
18439	Median	Existing	126	136.52	0.82	3.87	0.77	0.83
18439	Bankfull	Recommended	2560	139.76	4.06	10.1	3.11	0.98
18439	Bankfull	Existing	2560	139.76	4.06	10.1	3.11	0.98
18439	1% Flood	Recommended	13024	145.42	9.72	16.39	5.87	0.97
18439	1% Flood	Existing	13024	145.42	9.72	16.39	5.87	0.97
18820	Median	Recommended	126	145.57	0.57	3.53	0.77	0.99
18820	Median	Existing	126	145.57	0.57	3.53	0.77	0.99
18820	Bankfull	Recommended	2560	147.95	2.95	8.74	2.61	1.01
18820	Bankfull	Existing	2560	147.95	2.95	8.74	2.61	1.01
18820	1% Flood	Recommended	13024	152.53	7.53	14.43	4.96	0.97
18820	1% Flood	Existing	13024	152.53	7.53	14.43	4.96	0.97
19173	Median	Recommended	126	147.16	1.36	1.54	0.1	0.26
19173	Median	Existing	126	147.16	1.36	1.54	0.1	0.26
19173	Bankfull	Recommended	2560	151.03	5.23	6.15	1.03	0.5
19173	Bankfull	Existing	2560	151.03	5.23	6.15	1.03	0.5
19173	1% Flood	Recommended	13024	155.8	10	14.82	4.72	0.85
19173	1% Flood	Existing	13024	155.8	10	14.82	4.72	0.85
19655	Median	Recommended	126	154.89	1.09	4.48	1.37	1.46
19655	Median	Existing	126	154.89	1.09	4.48	1.37	1.46
19655	Bankfull	Recommended	2560	157.48	3.67	9.77	3.17	1.08
19655	Bankfull	Existing	2560	157.48	3.67	9.77	3.17	1.08
19655	1% Flood	Recommended	13024	162.04	8.24	15.16	5.43	1
19655	1% Flood	Existing	13024	162.04	8.24	15.16	5.43	1
19819	Median	Recommended	126	156.54	1.61	1.8	0.16	0.35
19819	Median	Existing	126	156.54	1.61	1.8	0.16	0.35
19819	Bankfull	Recommended	2560	159.69	4.76	5.6	0.93	0.53
19819	Bankfull	Existing	2560	159.69	4.76	5.6	0.93	0.53
19819	1% Flood	Recommended	13024	164.42	9.49	10.95	2.69	0.67
19819	1% Flood	Existing	13024	164.42	9.49	10.95	2.69	0.67
19856	Median	Recommended	126	156.6	1.3	0.9	0.01	0.14
19856	Median	Existing	126	156.6	1.3	0.9	0.01	0.14
19856	Bankfull	Recommended	2560	160.01	4.71	4.24	0.2	0.37
19856	Bankfull	Existing	2560	160.01	4.71	4.24	0.2	0.37
19856	1% Flood	Recommended	13024	164.75	9.45	9.78	0.83	0.58

River Sta	Profile	Plan	Q Total	W.S. Elev	Max Chl Dpth	Vel Chnl	Shear Chan	Froude # Chl
			(cfs)	(ft)	(ft)	(ft/s)	(lb/sq ft)	
19856	1% Flood	Existing	13024	164.75	9.45	9.78	0.83	0.58
19903	Median	Recommended	126	156.63				
19903	Median	Existing	126	156.63				
19903	Bankfull	Recommended	2560	160.29				
19903	Bankfull	Existing	2560	160.29				
19903	1% Flood	Recommended	13024	165.97				
19903	1% Flood	Existing	13024	165.97				
19947	Median	Recommended	126	156.63	5.02	0.38	0	0.04
19947	Median	Existing	126	156.63	5.02	0.38	0	0.04
19947	Bankfull	Recommended	2560	160.29	8.68	2.96	0.22	0.22
19947	Bankfull	Existing	2560	160.29	8.68	2.96	0.22	0.22
19947	1% Flood	Recommended	13024	165.97	14.36	7.07	1.01	0.37
19947	1% Flood	Existing	13024	165.97	14.36	7.07	1.01	0.37
19977	Median	Recommended	126	156.63	3.73	0.21	0	0.02
19977	Median	Existing	126	156.63	4.43	0.15	0	0.01
19977	Bankfull	Recommended	2560	160.4	7.5	1.92	0.09	0.13
19977	Bankfull	Existing	2560	160.41	8.21	1.65	0.03	0.1
19977	1% Flood	Recommended	13024	166.46	13.56	5	0.49	0.25
19977	1% Flood	Existing	13024	166.52	14.32	4.61	0.23	0.22
19999.35 O	Median	Recommended	126	156.62				
19999.35 O	Median	Existing	126	165.71				
19999.35 O	Bankfull	Recommended	2560	160.69				
19999.35 O	Bankfull	Existing	2560	168.03				
19999.35 O	1% Flood	Recommended	13024	168.06				
19999.35 O	1% Flood	Existing	13024	171.55				
20053	Median	Recommended	126	156.62	1.62	1.43	0.09	0.24
20053	Median	Existing	126	165.71	4.94	0.25	0	0.02
20053	Bankfull	Recommended	2560	160.69	5.69	5.52	0.84	0.46
20053	Bankfull	Existing	2560	168.03	7.26	2.8	0.21	0.22
20053	1% Flood	Recommended	13024	168.06	13.06	8.85	1.77	0.54
20053	1% Flood	Existing	13024	171.55	10.78	7.72	1.33	0.47
20093	Median	Recommended	126	156.71	1.01	3.04	0.46	0.61
20093	Median	Existing	126	165.71	5.81	0.21	0	0.02
20093	Bankfull	Recommended	2560	160.81	5.11	6.67	1.37	0.66
20093	Bankfull	Existing	2560	168.07	8.17	2.62	0.17	0.19
20093	1% Flood	Recommended	13024	168.33	12.63	8.54	1.56	0.49
20093	1% Flood	Existing	13024	171.61	11.71	8.02	1.37	0.46
20253	Median	Recommended	126	157.69	1.81	2.72	0.32	0.44

River Sta	Profile	Plan	Q Total	W.S. Elev	Max Chl Dpth	Vel Chnl	Shear Chan	Froude # Chl
			(cfs)	(ft)	(ft)	(ft/s)	(lb/sq ft)	
20253	Median	Existing	126	165.71	9.84	0.17	0	0.01
20253	Bankfull	Recommended	2560	161.87	6	8.05	1.95	0.76
20253	Bankfull	Existing	2560	168.17	12.3	2.18	0.11	0.15
20253	1% Flood	Recommended	13024	168.64	12.77	10.36	2.53	0.68
20253	1% Flood	Existing	13024	172.2	16.33	6.79	0.96	0.37
20687	Median	Recommended	126	162.06	1.06	4.43	1.05	1.01
20687	Median	Existing	126	165.71	4.71	0.38	0	0.04
20687	Bankfull	Recommended	2560	165.91	4.91	7.27	1.64	0.73
20687	Bankfull	Existing	2560	168.28	7.28	3.99	0.42	0.32
20687	1% Flood	Recommended	13024	170.97	9.97	13.04	3.95	0.84
20687	1% Flood	Existing	13024	172.47	11.47	10.84	2.57	0.64
21144	Median	Recommended	126	168.88	0.88	2.51	0.33	0.56
21144	Median	Existing	126	168.66	0.66	3.82	0.86	1.01
21144	Bankfull	Recommended	2560	171.13	3.13	8.93	2.66	0.99
21144	Bankfull	Existing	2560	171.13	3.13	8.94	2.66	0.99
21144	1% Flood	Recommended	13024	175.96	7.96	13.52	4.27	0.88
21144	1% Flood	Existing	13024	175.96	7.96	13.52	4.27	0.88
21502	Median	Recommended	126	172.58	0.98	3.07	0.5	0.68
21502	Median	Existing	126	172.86	1.26	1.86	0.19	0.45
21502	Bankfull	Recommended	2560	175.43	3.83	5.9	1.12	0.62
21502	Bankfull	Existing	2560	175.43	3.83	5.91	1.12	0.62
21502	1% Flood	Recommended	13024	179.41	7.81	12.25	3.59	0.83
21502	1% Flood	Existing	13024	179.41	7.81	12.25	3.59	0.83
21863	Median	Recommended	126	174.19	1.39	1.72	0.13	0.3
21863	Median	Existing	126	174.15	1.35	1.8	0.15	0.32
21863	Bankfull	Recommended	2560	177.42	4.62	6.57	1.23	0.58
21863	Bankfull	Existing	2560	177.42	4.62	6.57	1.23	0.58
21863	1% Flood	Recommended	13024	182.19	9.39	14.33	4.51	0.85
21863	1% Flood	Existing	13024	182.19	9.39	14.33	4.51	0.85
22311	Median	Recommended	126	175.93	0.63	2.68	0.39	0.62
22311	Median	Existing	126	175.96	0.66	2.54	0.34	0.57
22311	Bankfull	Recommended	2560	179.63	4.33	6.6	1.25	0.59
22311	Bankfull	Existing	2560	179.63	4.33	6.6	1.25	0.59
22311	1% Flood	Recommended	13024	185.62	10.32	12.14	3.12	0.68
22311	1% Flood	Existing	13024	185.62	10.32	12.14	3.12	0.68
22670	Median	Recommended	126	178.16	0.86	1.66	0.15	0.37
22670	Median	Existing	126	178.14	0.84	1.71	0.16	0.39
22670	Bankfull	Recommended	2560	181.39	4.09	4.99	0.73	0.46
22670	Bankfull	Existing	2560	181.39	4.09	4.99	0.73	0.46
22670	1% Flood	Recommended	13024	188.01	10.71	8.41	1.47	0.46
22670	1% Flood	Existing	13024	188.01	10.71	8.41	1.47	0.46

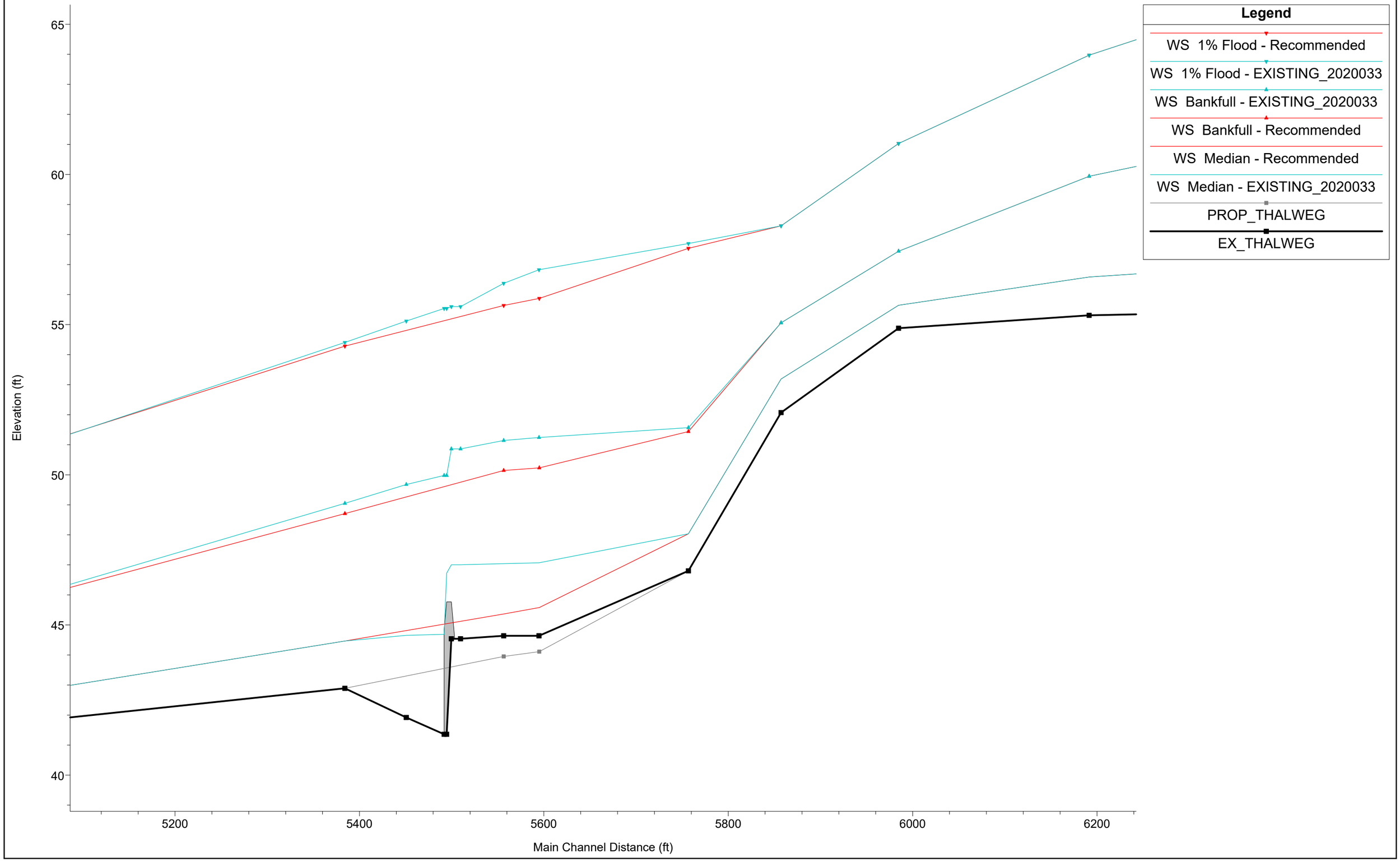
River Sta	Profile	Plan	Q Total	W.S. Elev	Max Chl Dpth	Vel Chnl	Shear Chan	Froude # Chl
			(cfs)	(ft)	(ft)	(ft/s)	(lb/sq ft)	
23020	Median	Recommended	126	180.89	0.49	2.87	0.54	0.88
23020	Median	Existing	126	180.91	0.51	2.72	0.48	0.81
23020	Bankfull	Recommended	2560	183.05	2.65	7.38	1.86	0.85
23020	Bankfull	Existing	2560	183.05	2.65	7.38	1.86	0.85
23020	1% Flood	Recommended	13024	188.78	8.38	10.1	2.31	0.63
23020	1% Flood	Existing	13024	188.78	8.38	10.1	2.31	0.63
23778	Median	Recommended	126	186.35	1.05	1.69	0.14	0.35
23778	Median	Existing	126	186.33	1.03	1.73	0.15	0.36
23778	Bankfull	Recommended	2560	189.25	3.95	5.76	1.02	0.57
23778	Bankfull	Existing	2560	189.25	3.95	5.76	1.02	0.57
23778	1% Flood	Recommended	13024	192.93	7.63	12.64	3.81	0.85
23778	1% Flood	Existing	13024	192.93	7.63	12.64	3.81	0.85
24460	Median	Recommended	126	187.25	1.44	1.14	0.05	0.18
24460	Median	Existing	126	187.25	1.45	1.13	0.05	0.18
24460	Bankfull	Recommended	2560	191.46	5.66	5	0.65	0.38
24460	Bankfull	Existing	2560	191.46	5.66	5	0.65	0.38
24460	1% Flood	Recommended	13024	197.23	11.43	11.44	2.67	0.61
24460	1% Flood	Existing	13024	197.23	11.43	11.44	2.67	0.61
24979	Median	Recommended	126	190.23	0.63	3.8	0.86	1
24979	Median	Existing	126	190.23	0.63	3.8	0.86	1
24979	Bankfull	Recommended	2560	193.06	3.46	8.79	2.46	0.91
24979	Bankfull	Existing	2560	193.06	3.46	8.79	2.46	0.91
24979	1% Flood	Recommended	13024	199.28	9.68	13.81	4.14	0.81
24979	1% Flood	Existing	13024	199.28	9.68	13.81	4.14	0.81
25317	Median	Recommended	126	193.42	0.82	1.67	0.15	0.38
25317	Median	Existing	126	193.42	0.82	1.67	0.15	0.38
25317	Bankfull	Recommended	2560	196.3	3.7	5.15	0.82	0.52
25317	Bankfull	Existing	2560	196.3	3.7	5.15	0.82	0.52
25317	1% Flood	Recommended	13024	202.65	10.05	8.37	1.5	0.48
25317	1% Flood	Existing	13024	202.65	10.05	8.37	1.5	0.48
26097	Median	Recommended	126	197.26	0.96	2.14	0.24	0.47
26097	Median	Existing	126	197.26	0.96	2.14	0.24	0.47
26097	Bankfull	Recommended	2560	200.22	3.92	6.39	1.27	0.64
26097	Bankfull	Existing	2560	200.22	3.92	6.39	1.27	0.64
26097	1% Flood	Recommended	13024	205.02	8.72	11.95	3.24	0.75
26097	1% Flood	Existing	13024	205.02	8.72	11.95	3.24	0.75
26573	Median	Recommended	126	199.12	1.02	1.64	0.13	0.32
26573	Median	Existing	126	199.12	1.02	1.64	0.13	0.32
26573	Bankfull	Recommended	2560	202.55	4.45	5.35	0.82	0.47
26573	Bankfull	Existing	2560	202.55	4.45	5.35	0.82	0.47

River Sta	Profile	Plan	Q Total	W.S. Elev	Max Chl Dpth	Vel Chnl	Shear Chan	Froude # Chl
			(cfs)	(ft)	(ft)	(ft/s)	(lb/sq ft)	
26573	1% Flood	Recommended	13024	207.97	9.87	10.49	2.36	0.6
26573	1% Flood	Existing	13024	207.97	9.87	10.49	2.36	0.6
27030	Median	Recommended	126	201.5	1.4	2.29	0.34	0.68
27030	Median	Existing	126	201.5	1.4	2.29	0.34	0.68
27030	Bankfull	Recommended	2560	204.73	4.63	7.81	1.88	0.77
27030	Bankfull	Existing	2560	204.73	4.63	7.81	1.88	0.77
27030	1% Flood	Recommended	13024	210.17	10.07	13.13	3.81	0.79
27030	1% Flood	Existing	13024	210.17	10.07	13.13	3.81	0.79
27314	Median	Recommended	126	203.49	1.59	1.42	0.14	0.37
27314	Median	Existing	126	203.49	1.59	1.42	0.14	0.37
27314	Bankfull	Recommended	2560	206.7	4.8	4.57	0.72	0.44
27314	Bankfull	Existing	2560	206.7	4.8	4.57	0.72	0.44
27314	1% Flood	Recommended	13024	212.49	10.59	7.6	1.42	0.44
27314	1% Flood	Existing	13024	212.49	10.59	7.6	1.42	0.44
27722	Median	Recommended	126	206.52	0.72	1.68	0.32	0.49
27722	Median	Existing	126	206.52	0.72	1.68	0.32	0.49
27722	Bankfull	Recommended	2560	208.71	2.91	4.48	1.25	0.51
27722	Bankfull	Existing	2560	208.71	2.91	4.48	1.25	0.51
27722	1% Flood	Recommended	13024	213.7	7.9	7.01	2.04	0.45
27722	1% Flood	Existing	13024	213.7	7.9	7.01	2.04	0.45
28272	Median	Recommended	126	209.81	1.31	1.02	0.18	0.19
28272	Median	Existing	126	209.81	1.31	1.02	0.18	0.19
28272	Bankfull	Recommended	2560	213.03	4.53	4.28	1.8	0.38
28272	Bankfull	Existing	2560	213.03	4.53	4.28	1.8	0.38
28272	1% Flood	Recommended	13024	217.27	8.77	9.31	6.68	0.57
28272	1% Flood	Existing	13024	217.27	8.77	9.31	6.68	0.57
28774	Median	Recommended	126	210.64	1.94	0.78	0.09	0.11
28774	Median	Existing	126	210.64	1.94	0.78	0.09	0.11
28774	Bankfull	Recommended	2560	215.39	6.69	3.5	1.14	0.25
28774	Bankfull	Existing	2560	215.39	6.69	3.5	1.14	0.25
28774	1% Flood	Recommended	13024	221.55	12.85	6.78	3.38	0.34
28774	1% Flood	Existing	13024	221.55	12.85	6.78	3.38	0.34
29425	Median	Recommended	126	210.92	2.32	0.87	0.03	0.11
29425	Median	Existing	126	210.92	2.32	0.87	0.03	0.11
29425	Bankfull	Recommended	2560	216.29	7.69	3.82	0.35	0.26
29425	Bankfull	Existing	2560	216.29	7.69	3.82	0.35	0.26
29425	1% Flood	Recommended	13024	222.93	14.33	9.02	1.55	0.43
29425	1% Flood	Existing	13024	222.93	14.33	9.02	1.55	0.43
29676	Median	Recommended	126	211.1	0.7	3.33	0.72	1.01
29676	Median	Existing	126	211.1	0.7	3.33	0.72	1.01

River Sta	Profile	Plan	Q Total	W.S. Elev	Max Chl Dpth	Vel Chnl	Shear Chan	Froude # Chl
			(cfs)	(ft)	(ft)	(ft/s)	(lb/sq ft)	
29676	Bankfull	Recommended	2560	216.58	6.18	2.89	0.22	0.22
29676	Bankfull	Existing	2560	216.58	6.18	2.89	0.22	0.22
29676	1% Flood	Recommended	13024	223.94	13.54	5.73	0.64	0.28
29676	1% Flood	Existing	13024	223.94	13.54	5.73	0.64	0.28
30476	Median	Recommended	126	215.48	1.38	1.53	0.11	0.29
30476	Median	Existing	126	215.48	1.38	1.53	0.11	0.29
30476	Bankfull	Recommended	2560	217.41	3.31	9.28	2.83	1.01
30476	Bankfull	Existing	2560	217.41	3.31	9.28	2.83	1.01
30476	1% Flood	Recommended	11620	224.43	10.33	10.04	2.15	0.57
30476	1% Flood	Existing	11620	224.43	10.33	10.04	2.15	0.57
30849	Median	Recommended	126	217.72	0.72	3.52	0.78	1.02
30849	Median	Existing	126	217.72	0.72	3.52	0.78	1.02
30849	Bankfull	Recommended	2560	221.24	4.24	5.93	1.03	0.55
30849	Bankfull	Existing	2560	221.24	4.24	5.93	1.03	0.55
30849	1% Flood	Recommended	11620	225.76	8.76	11.42	2.93	0.7
30849	1% Flood	Existing	11620	225.76	8.76	11.42	2.93	0.7
31190	Median	Recommended	126	220.01	1.01	1.74	0.14	0.32
31190	Median	Existing	126	220.01	1.01	1.74	0.14	0.32
31190	Bankfull	Recommended	2560	222.97	3.97	7.36	1.61	0.69
31190	Bankfull	Existing	2560	222.97	3.97	7.36	1.61	0.69
31190	1% Flood	Recommended	11620	227.67	8.67	12.84	3.7	0.79
31190	1% Flood	Existing	11620	227.67	8.67	12.84	3.7	0.79
31355	Median	Recommended	126	220.33	1.23	1.19	0.08	0.21
31355	Median	Existing	126	220.33	1.23	1.19	0.08	0.21
31355	Bankfull	Recommended	2560	224.21	5.11	4.62	0.75	0.38
31355	Bankfull	Existing	2560	224.21	5.11	4.62	0.75	0.38
31355	1% Flood	Recommended	11620	229.96	10.86	7.87	1.65	0.43
31355	1% Flood	Existing	11620	229.96	10.86	7.87	1.65	0.43
31677	Median	Recommended	126	220.38	4.38	0.42	0.01	0.04
31677	Median	Existing	126	220.38	4.38	0.42	0.01	0.04
31677	Bankfull	Recommended	2560	224.76	8.76	3.79	0.33	0.24
31677	Bankfull	Existing	2560	224.76	8.76	3.79	0.33	0.24
31677	1% Flood	Recommended	11620	230.56	14.56	8.43	1.37	0.41
31677	1% Flood	Existing	11620	230.56	14.56	8.43	1.37	0.41
31755 Brid	Median	Recommended	126	221.37				
31755 Brid	Median	Existing	126	221.37				
31755 Brid	Bankfull	Recommended	2559.99	225.7				
31755 Brid	Bankfull	Existing	2559.99	225.7				
31755 Brid	1% Flood	Recommended	11284.69	232.37				
31755 Brid	1% Flood	Existing	11284.69	232.37				

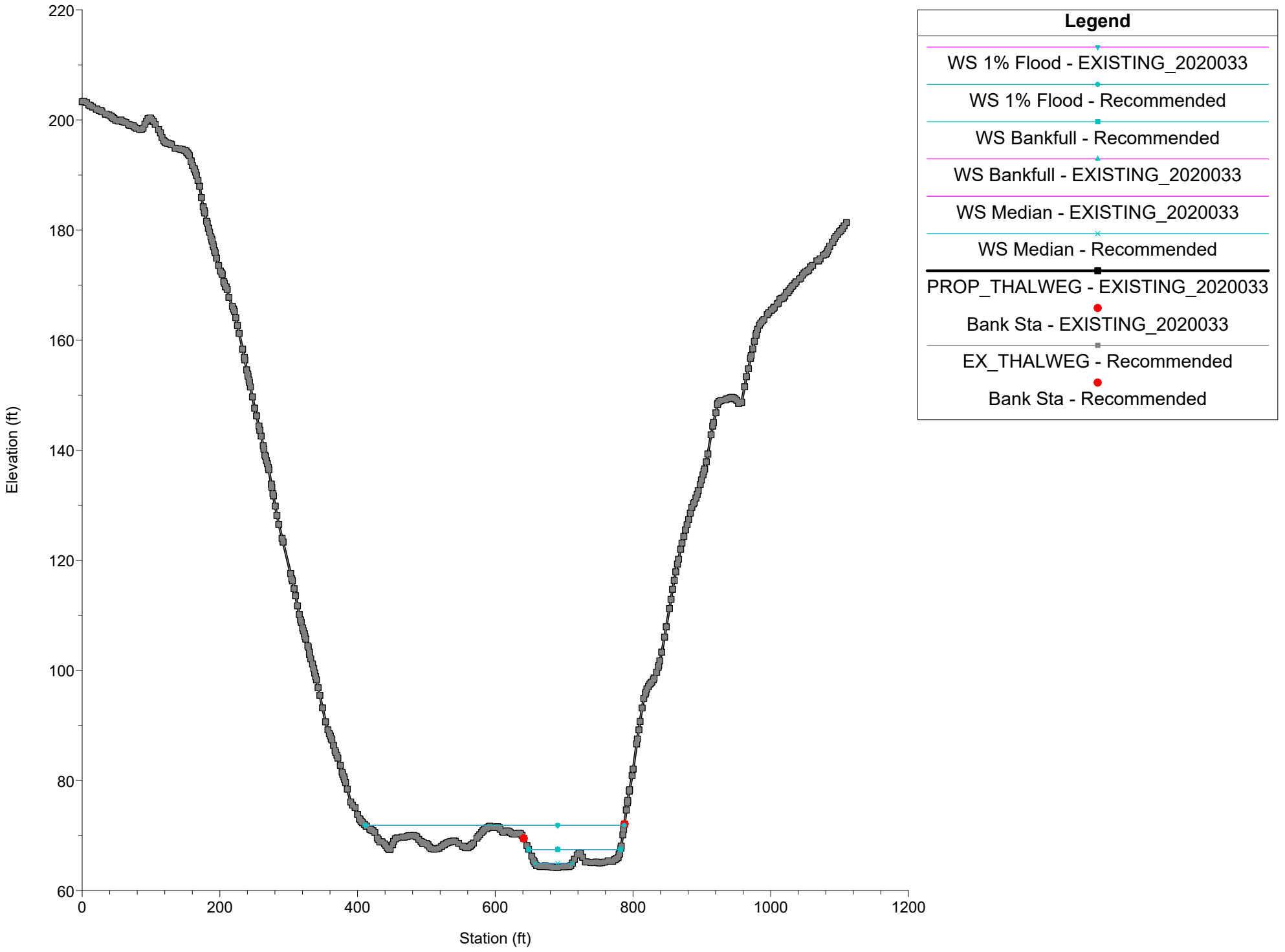
River Sta	Profile	Plan	Q Total	W.S. Elev	Max Chl Dpth	Vel Chnl	Shear Chan	Froude # Chl
			(cfs)	(ft)	(ft)	(ft/s)	(lb/sq ft)	
31822	Median	Recommended	126	221.37	4.27	0.4	0	0.04
31822	Median	Existing	126	221.37	4.27	0.4	0	0.04
31822	Bankfull	Recommended	2560	225.7	8.6	3.43	0.27	0.22
31822	Bankfull	Existing	2560	225.7	8.6	3.43	0.27	0.22
31822	1% Flood	Recommended	11620	232.63	15.53	5.64	0.6	0.26
31822	1% Flood	Existing	11620	232.63	15.53	5.64	0.6	0.26
31874	Median	Recommended	126	221.37	1.57	0.93	0.04	0.14
31874	Median	Existing	126	221.37	1.57	0.93	0.04	0.14
31874	Bankfull	Recommended	2560	225.72	5.92	3.96	0.4	0.3
31874	Bankfull	Existing	2560	225.72	5.92	3.96	0.4	0.3
31874	1% Flood	Recommended	11620	232.6	12.8	6.45	0.82	0.32
31874	1% Flood	Existing	11620	232.6	12.8	6.45	0.82	0.32

HEC-RAS Model Plan: 1) Recommended 4/1/2020 2) EXISTING_2020033 3/31/2020



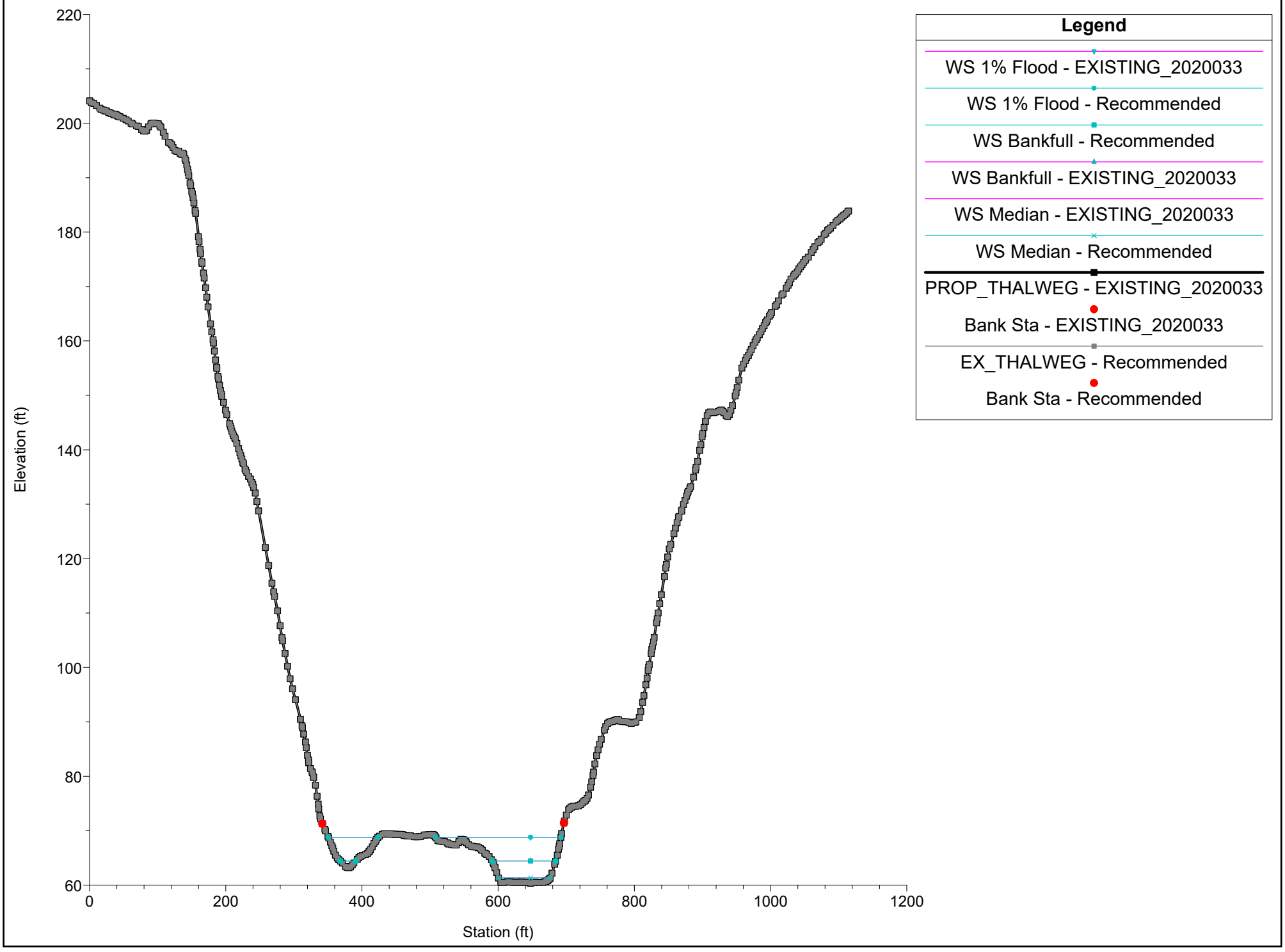
HEC-RAS Model Plan: 1) Recommended 2) EXISTING_2020033

River = Moodna Creek Reach = Reach 3 RS = 10888



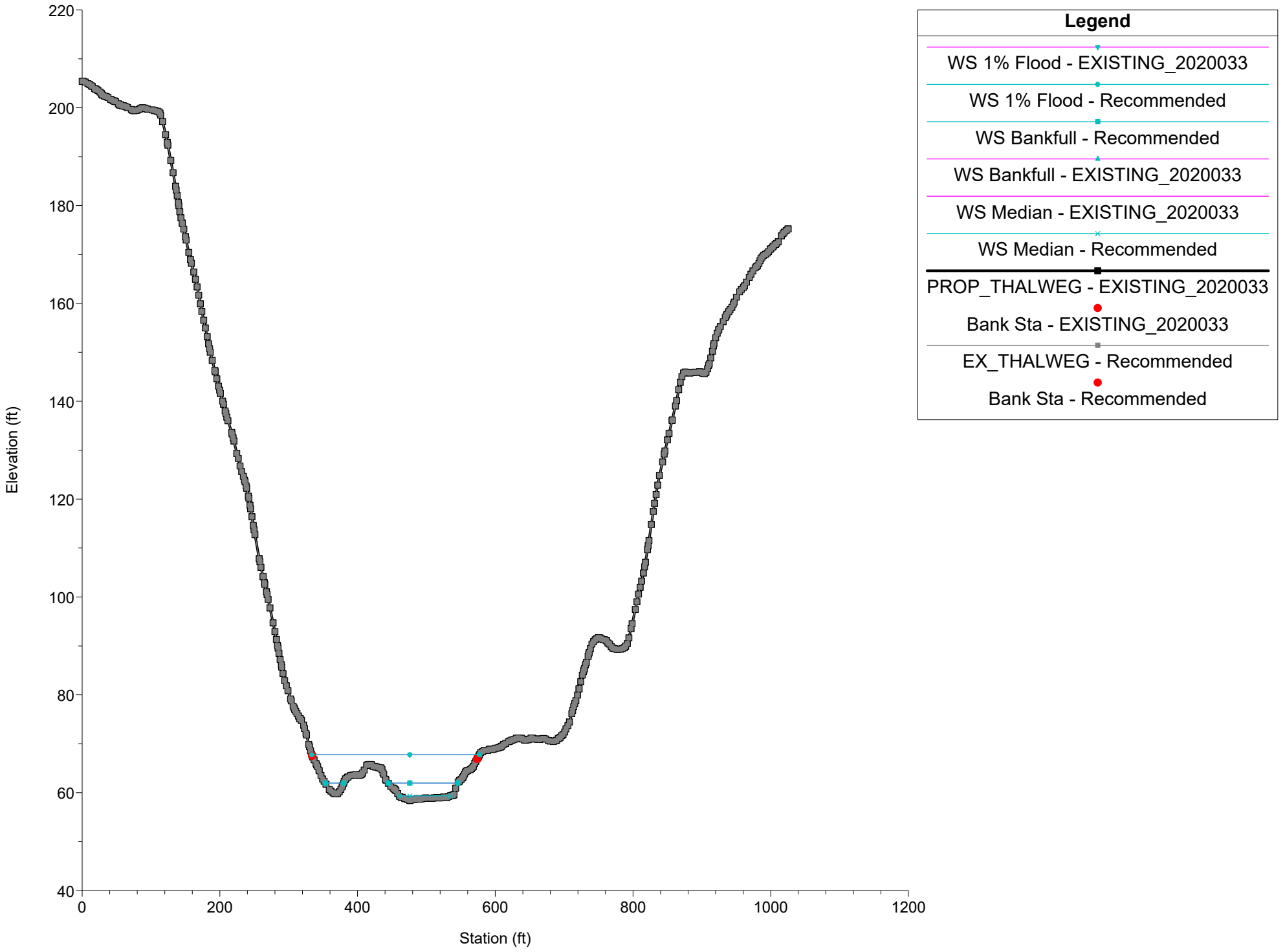
HEC-RAS Model Plan: 1) Recommended 2) EXISTING_2020033

River = Moodna Creek Reach = Reach 3 RS = 10887



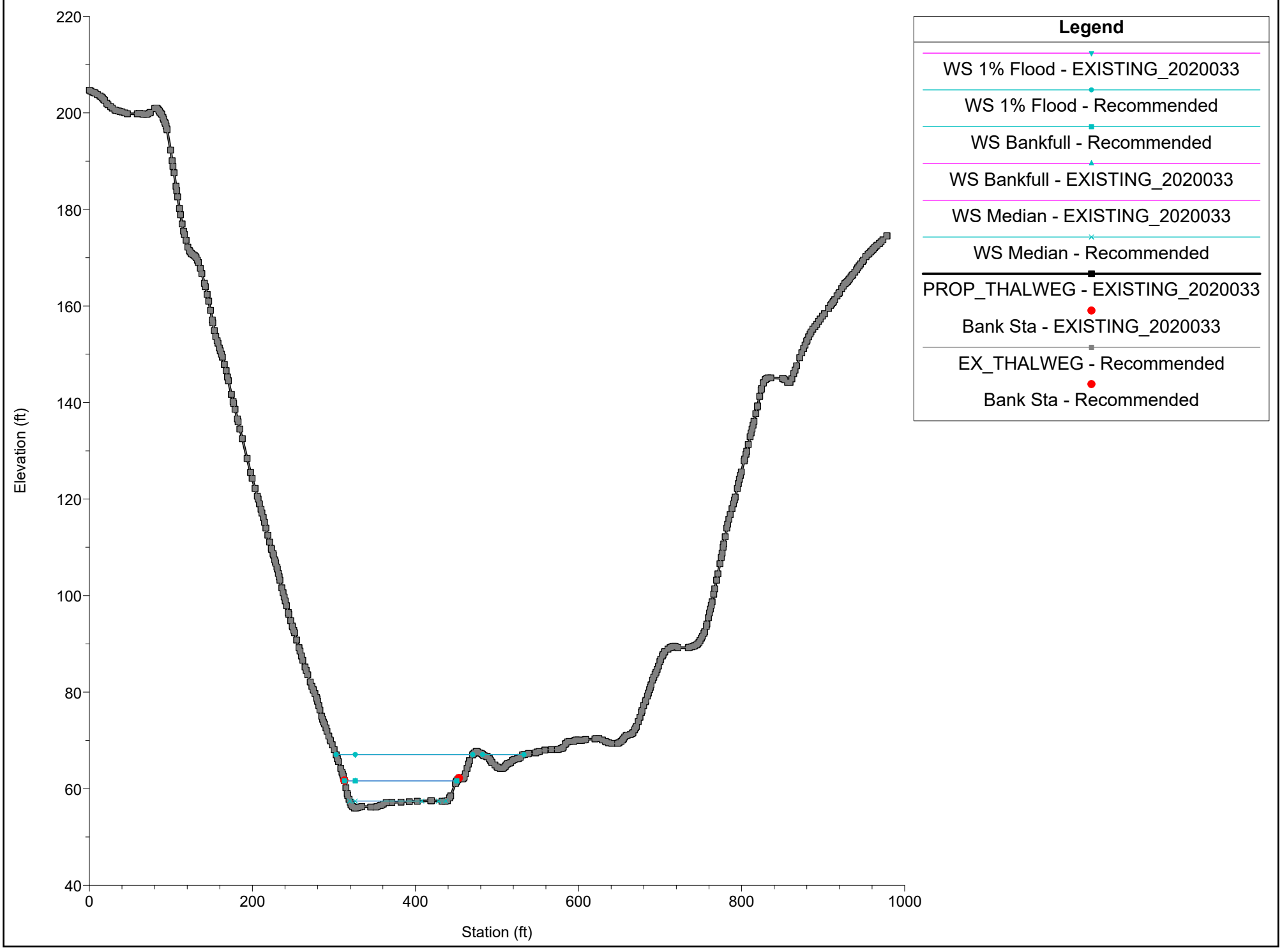
HEC-RAS Model Plan: 1) Recommended 2) EXISTING_2020033

River = Moodna Creek Reach = Reach 3 RS = 10886



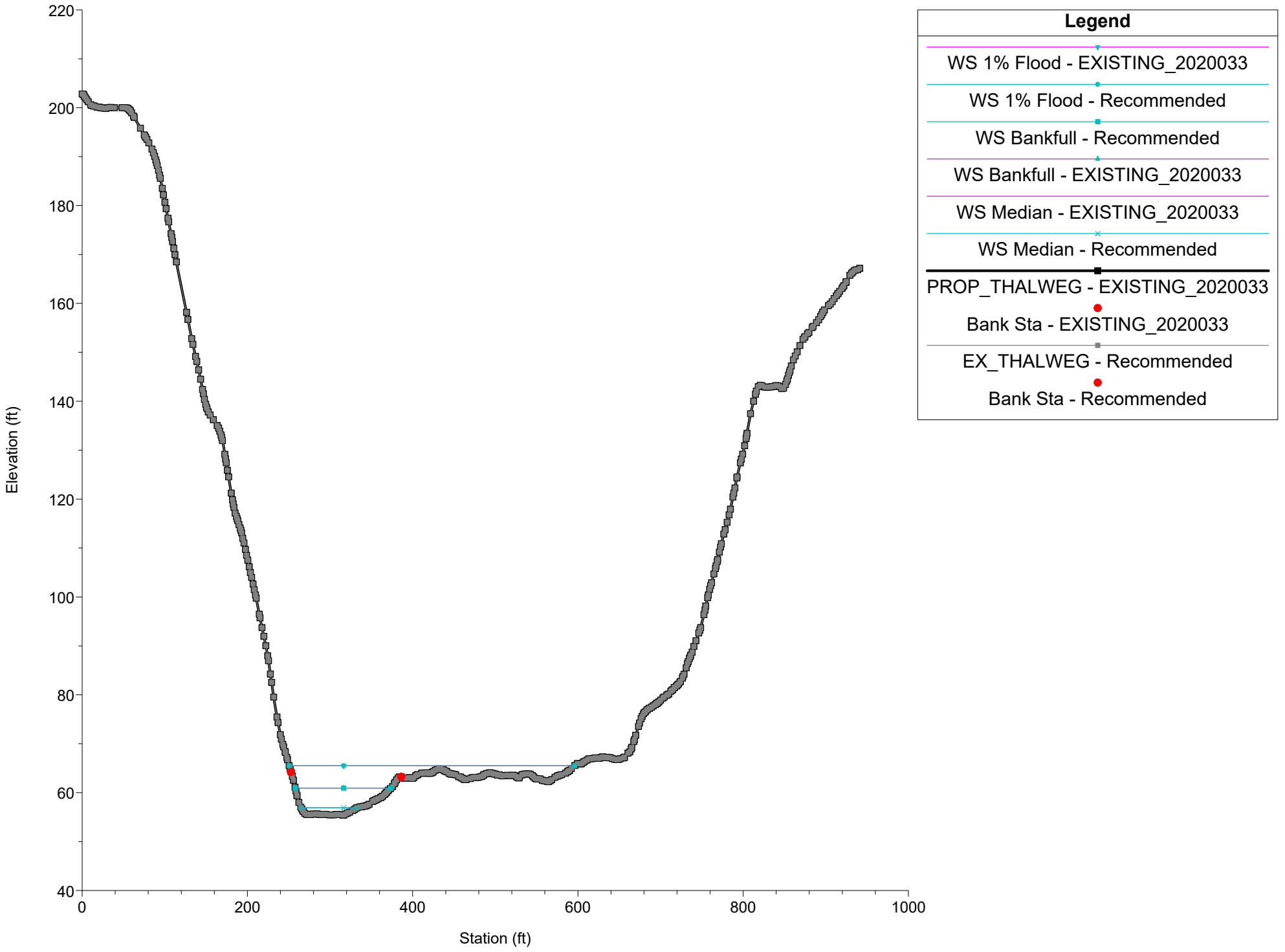
HEC-RAS Model Plan: 1) Recommended 2) EXISTING_2020033

River = Moodna Creek Reach = Reach 3 RS = 10885



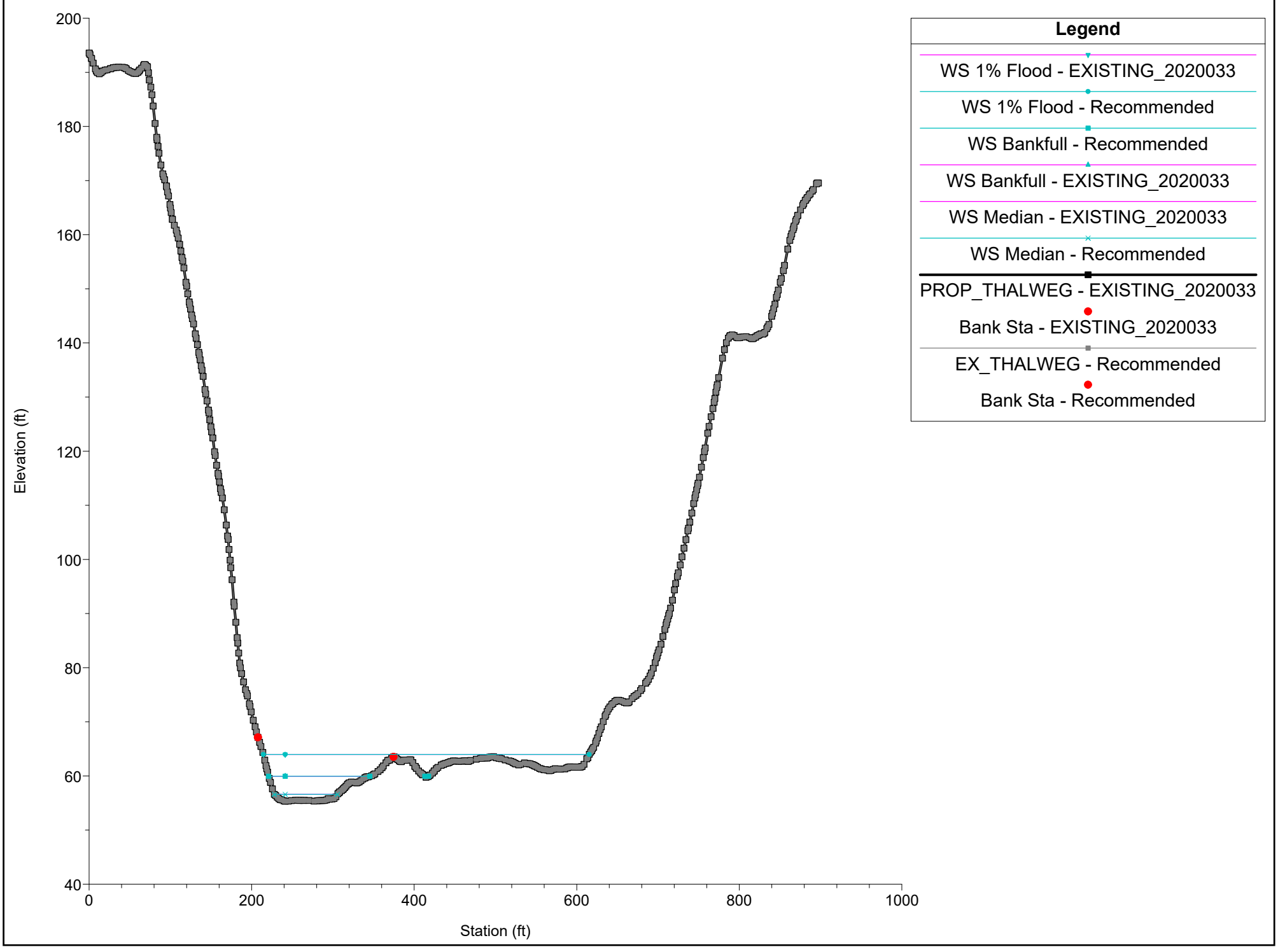
HEC-RAS Model Plan: 1) Recommended 2) EXISTING_2020033

River = Moodna Creek Reach = Reach 3 RS = 10234



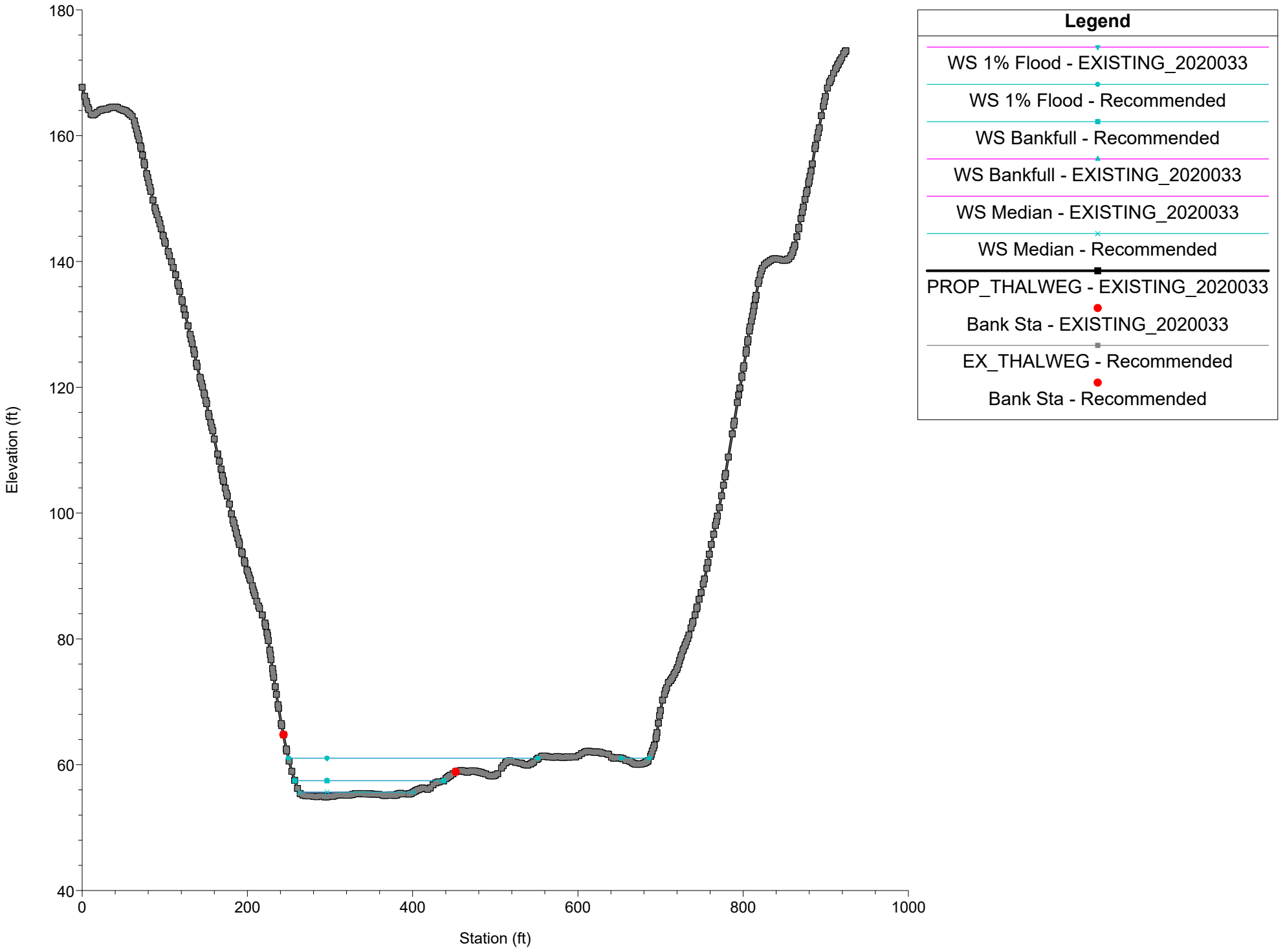
HEC-RAS Model Plan: 1) Recommended 2) EXISTING_2020033

River = Moodna Creek Reach = Reach 3 RS = 10233



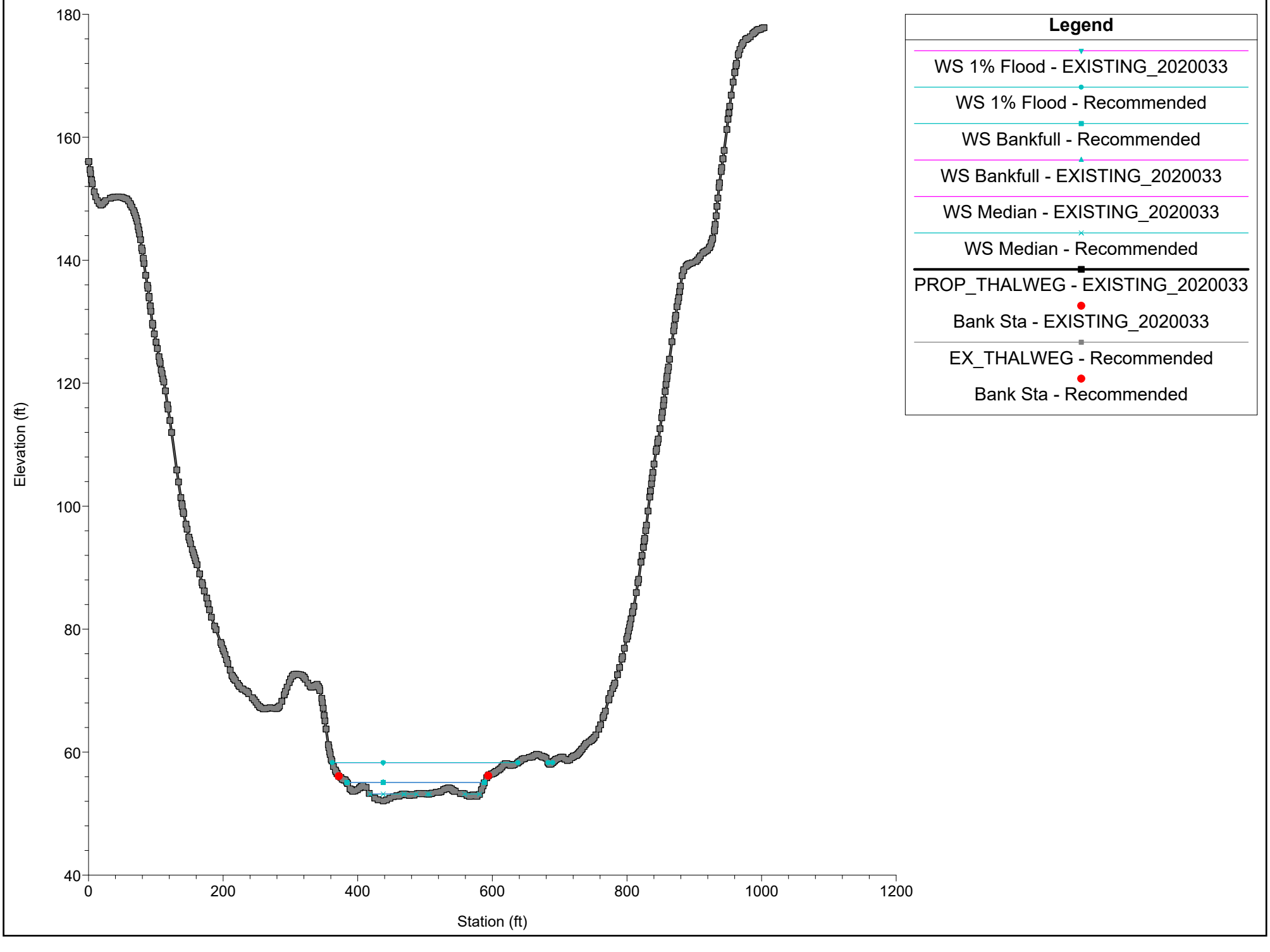
HEC-RAS Model Plan: 1) Recommended 2) EXISTING_2020033

River = Moodna Creek Reach = Reach 3 RS = 10232



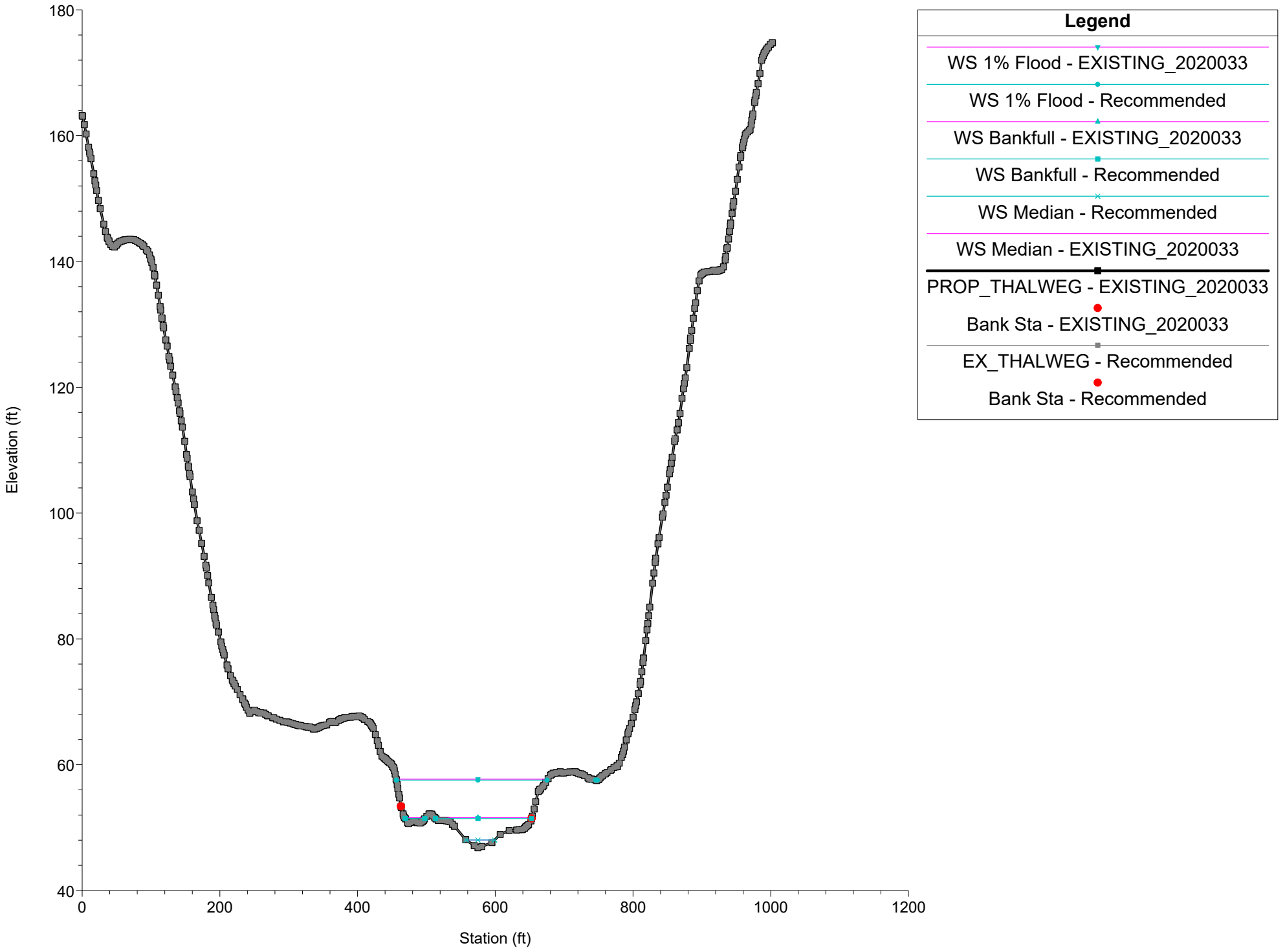
HEC-RAS Model Plan: 1) Recommended 2) EXISTING_2020033

River = Moodna Creek Reach = Reach 3 RS = 10231



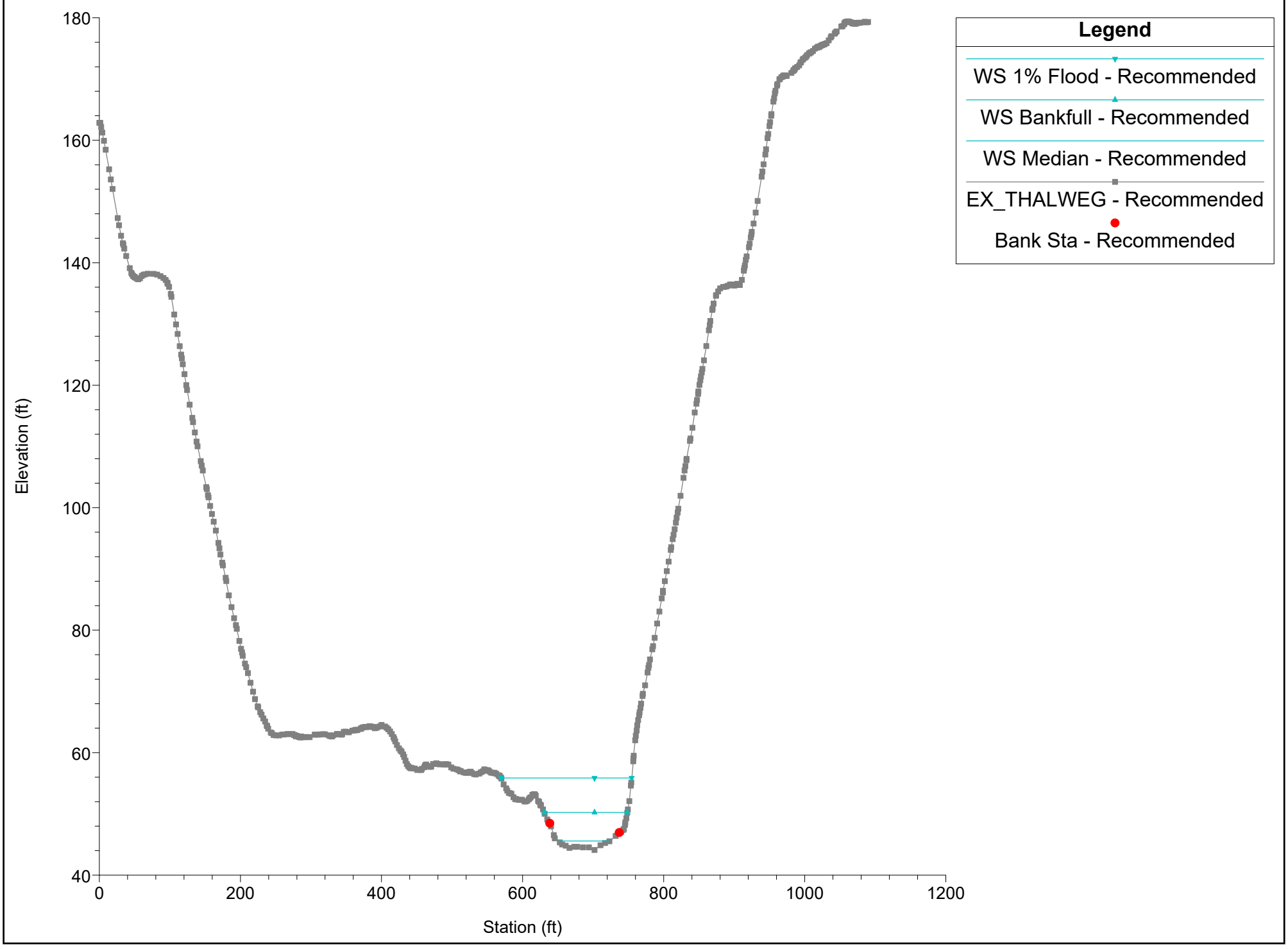
HEC-RAS Model Plan: 1) Recommended 2) EXISTING_2020033

River = Moodna Creek Reach = Reach 3 RS = 10131



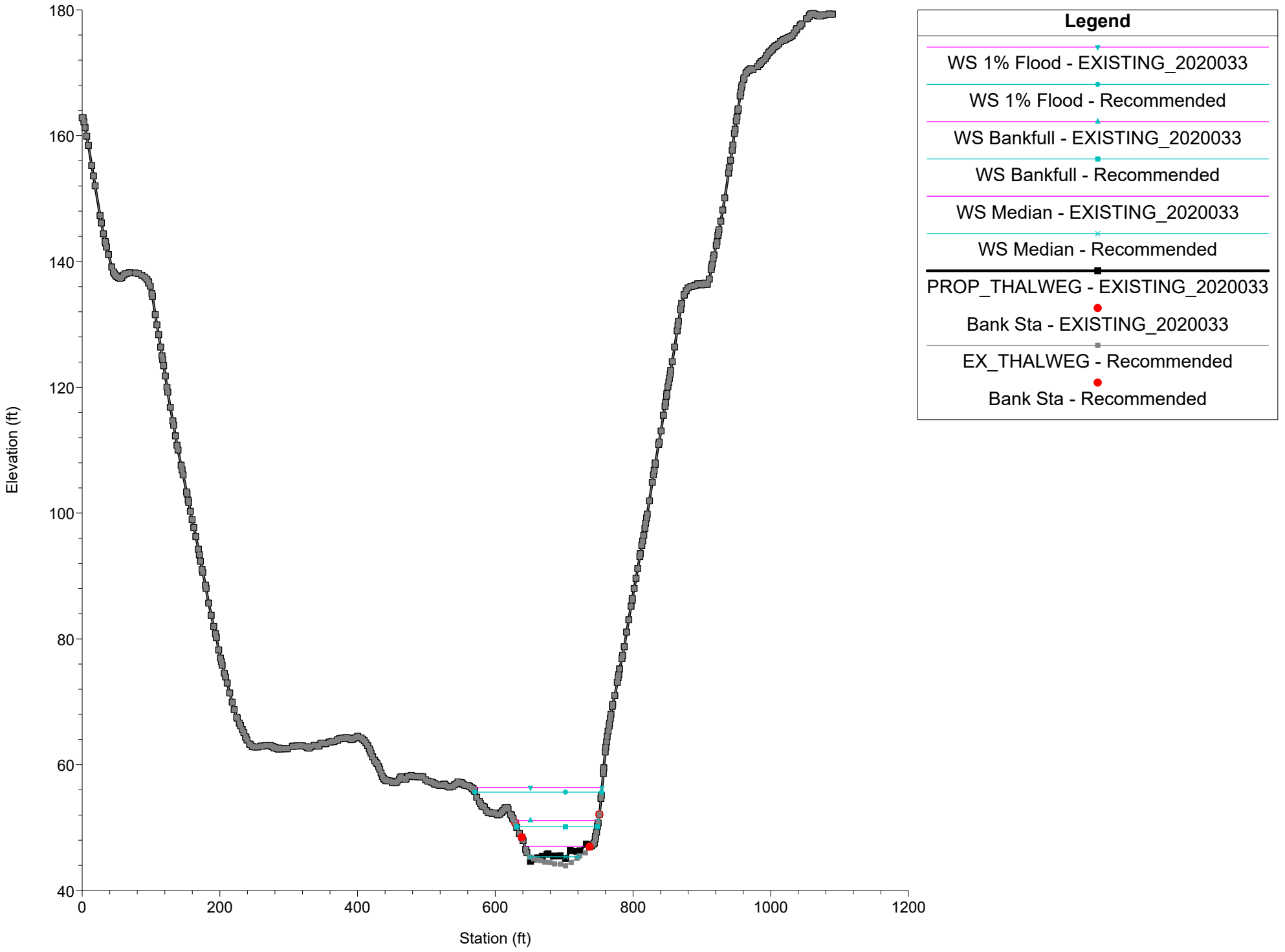
HEC-RAS Model Plan: 1) Recommended 2) EXISTING_2020033

River = Moodna Creek Reach = Reach 3 RS = 9970



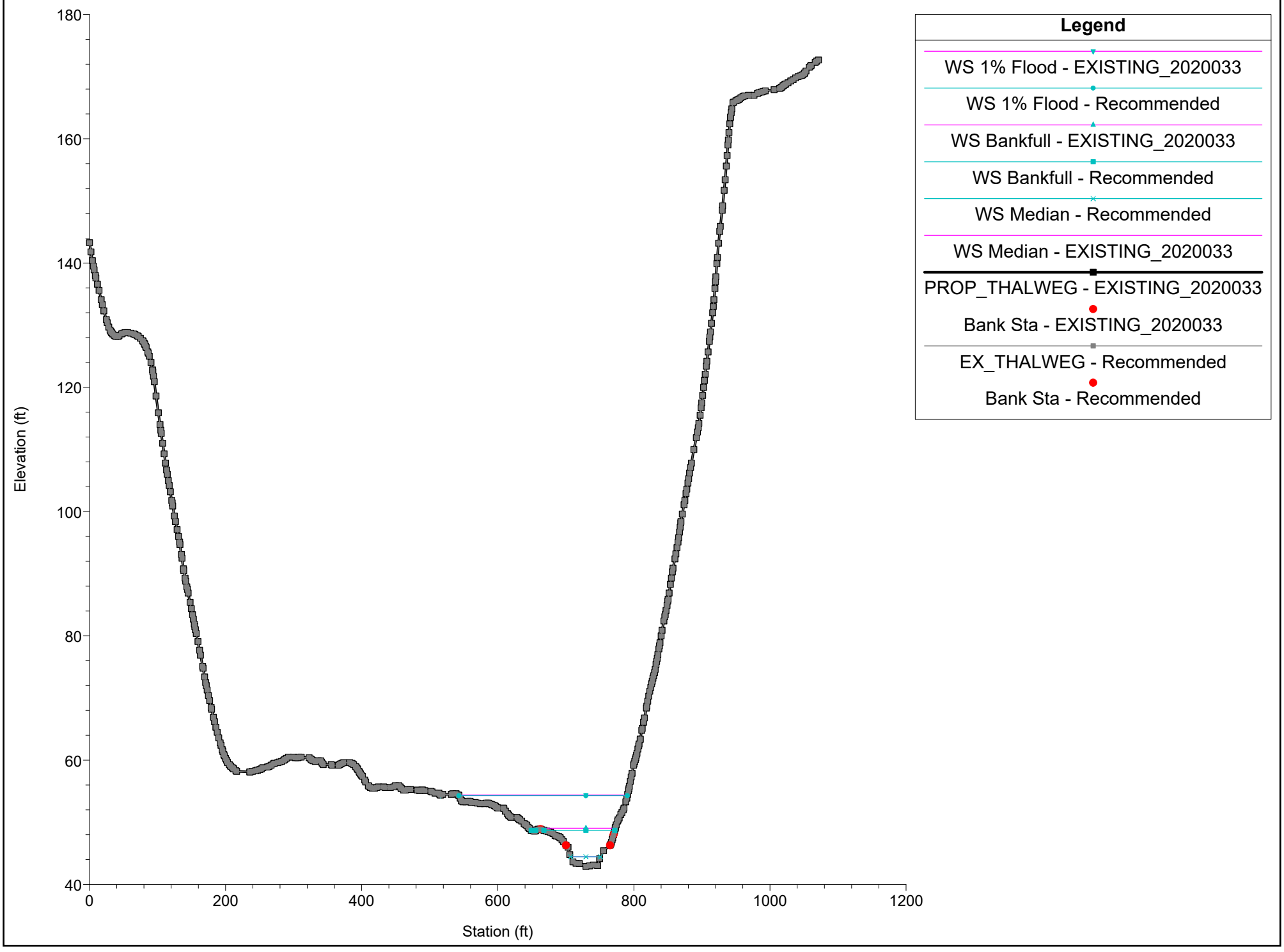
HEC-RAS Model Plan: 1) Recommended 2) EXISTING_2020033

River = Moodna Creek Reach = Reach 3 RS = 9931



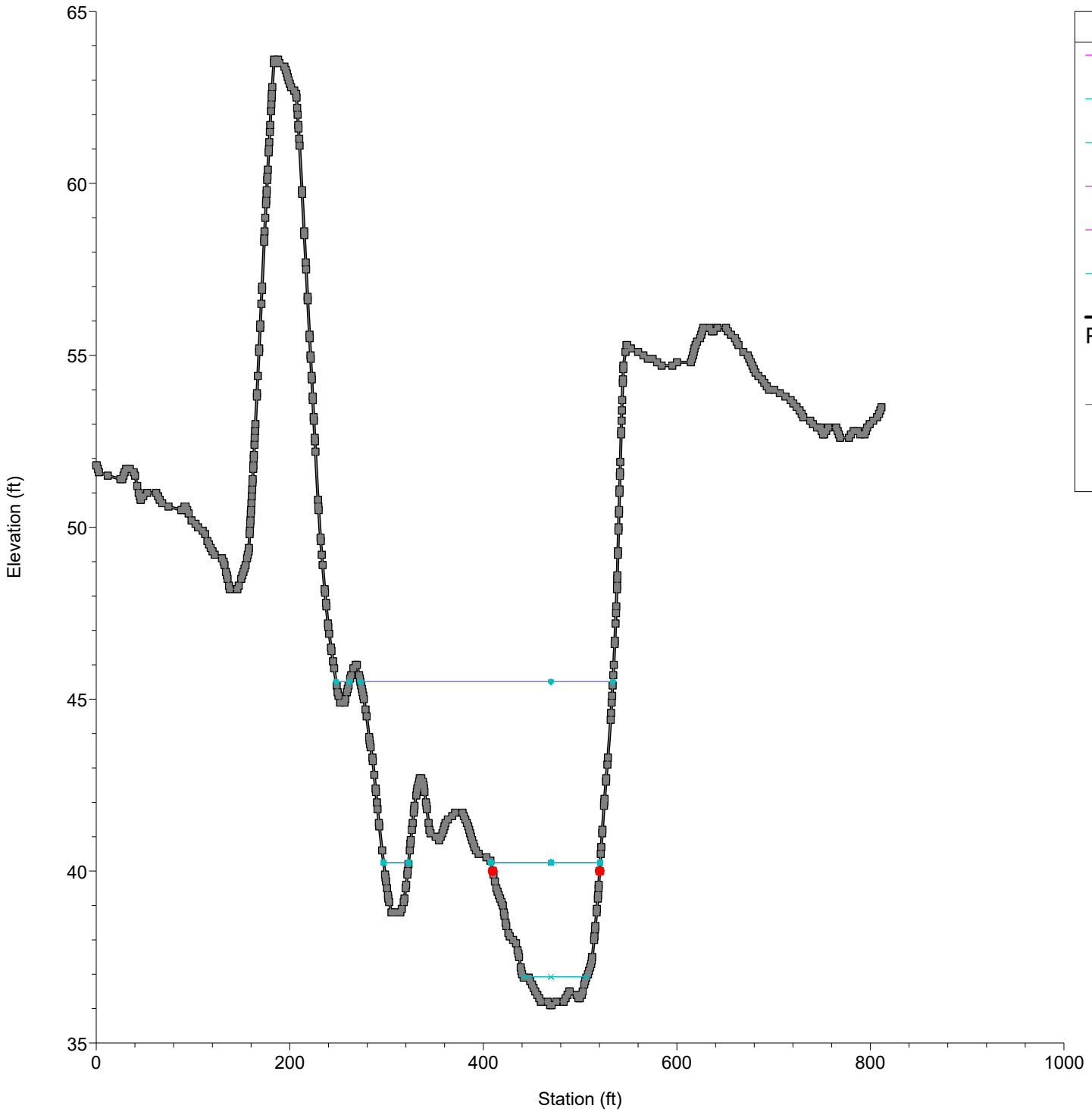
HEC-RAS Model Plan: 1) Recommended 2) EXISTING_2020033

River = Moodna Creek Reach = Reach 3 RS = 9759



HEC-RAS Model Plan: 1) Recommended 2) EXISTING_2020033

River = Moodna Creek Reach = Reach 3 RS = 8893

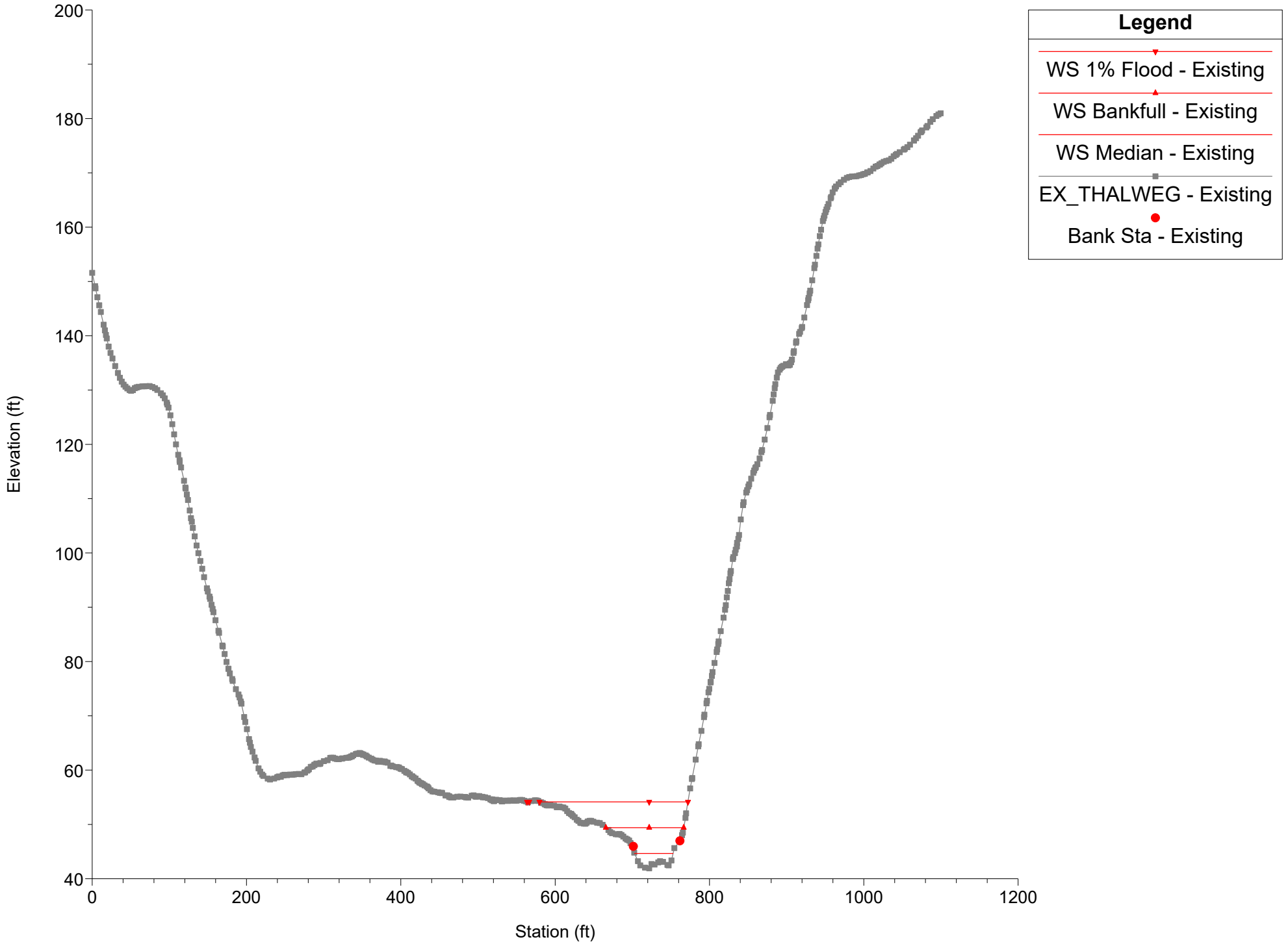


Legend

- WS 1% Flood - EXISTING_2020033
- WS 1% Flood - Recommended
- WS Bankfull - Recommended
- WS Bankfull - EXISTING_2020033
- WS Median - EXISTING_2020033
- WS Median - Recommended
- PROP_THALWEG - EXISTING_2020033
- Bank Sta - EXISTING_2020033
- EX_THALWEG - Recommended
- Bank Sta - Recommended

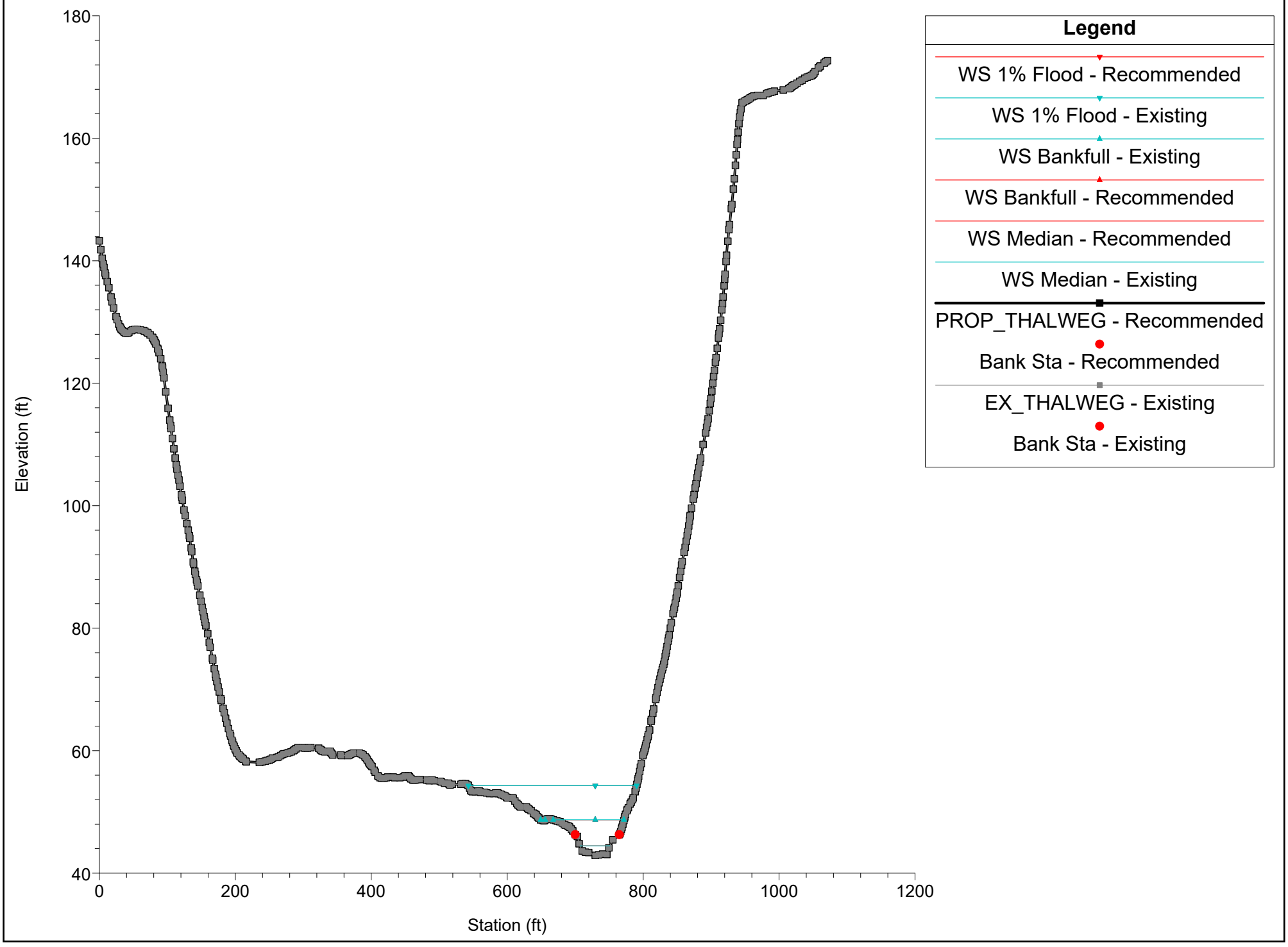
HEC-RAS Model Plan: 1) Existing 2) Recommended

River = Moodna Creek Reach = Reach 3 RS = 9826



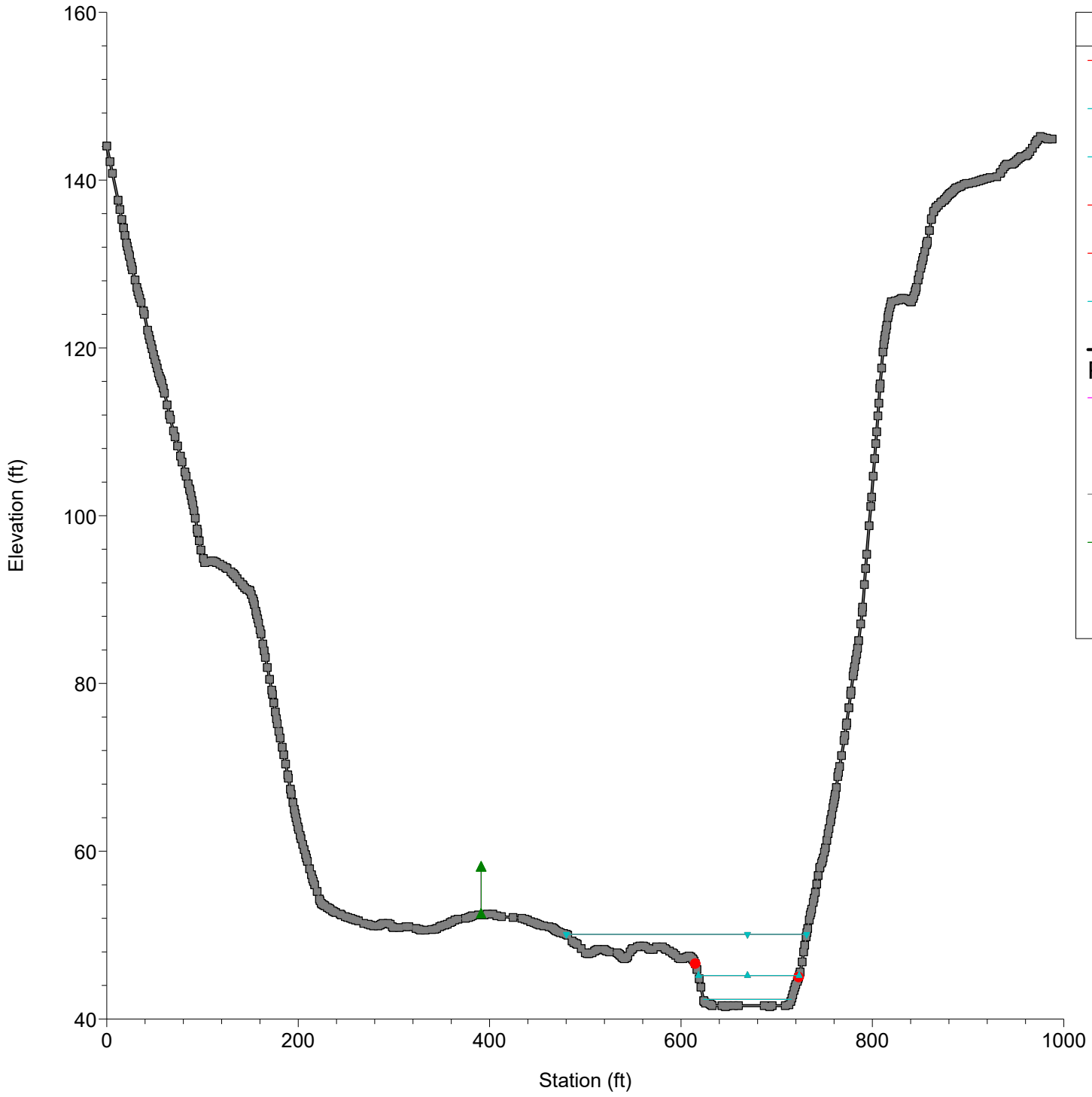
HEC-RAS Model Plan: 1) Existing 2) Recommended

River = Moodna Creek Reach = Reach 3 RS = 9759

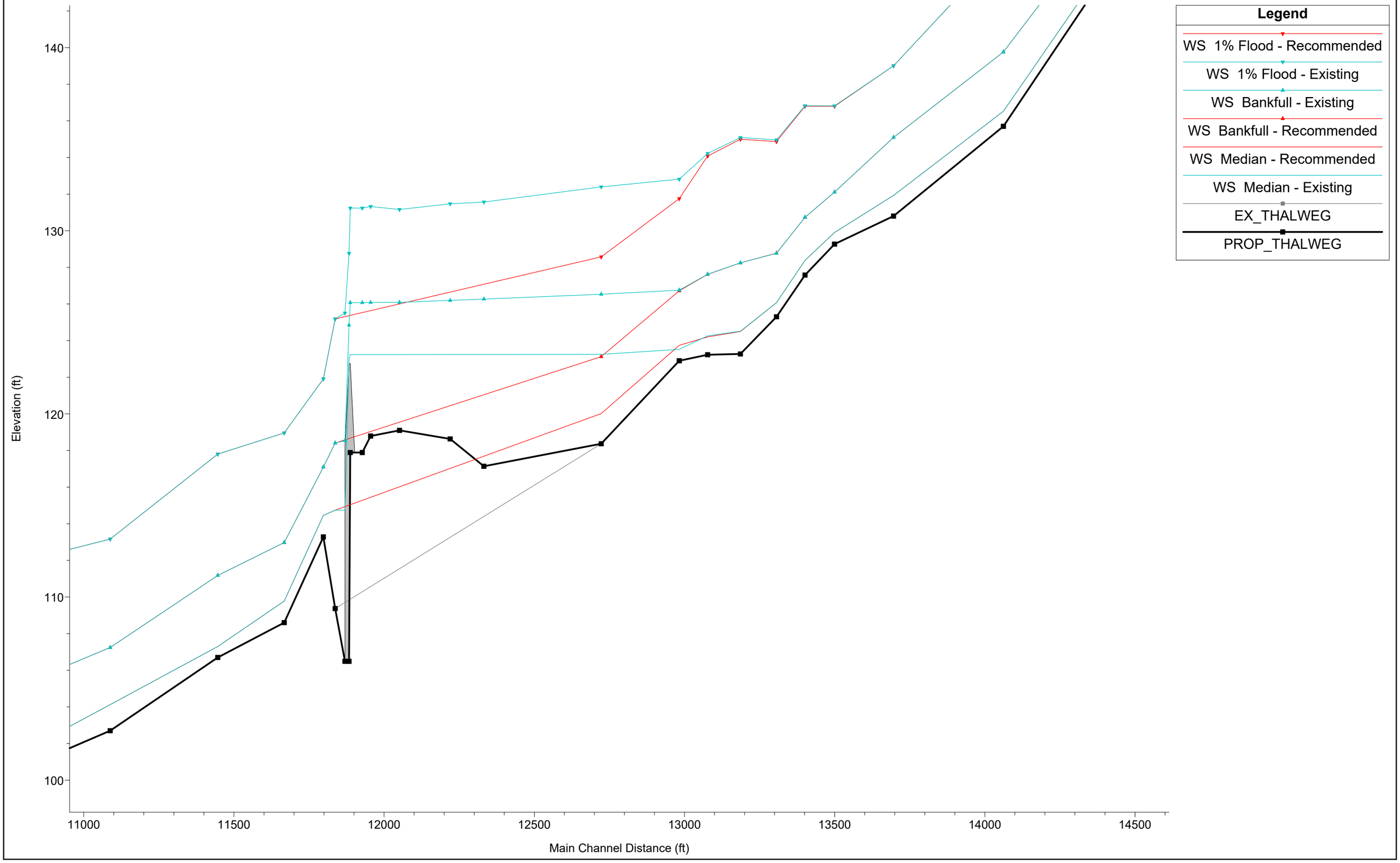


HEC-RAS Model Plan: 1) Existing 2) Recommended

River = Moodna Creek Reach = Reach 3 RS = 9331

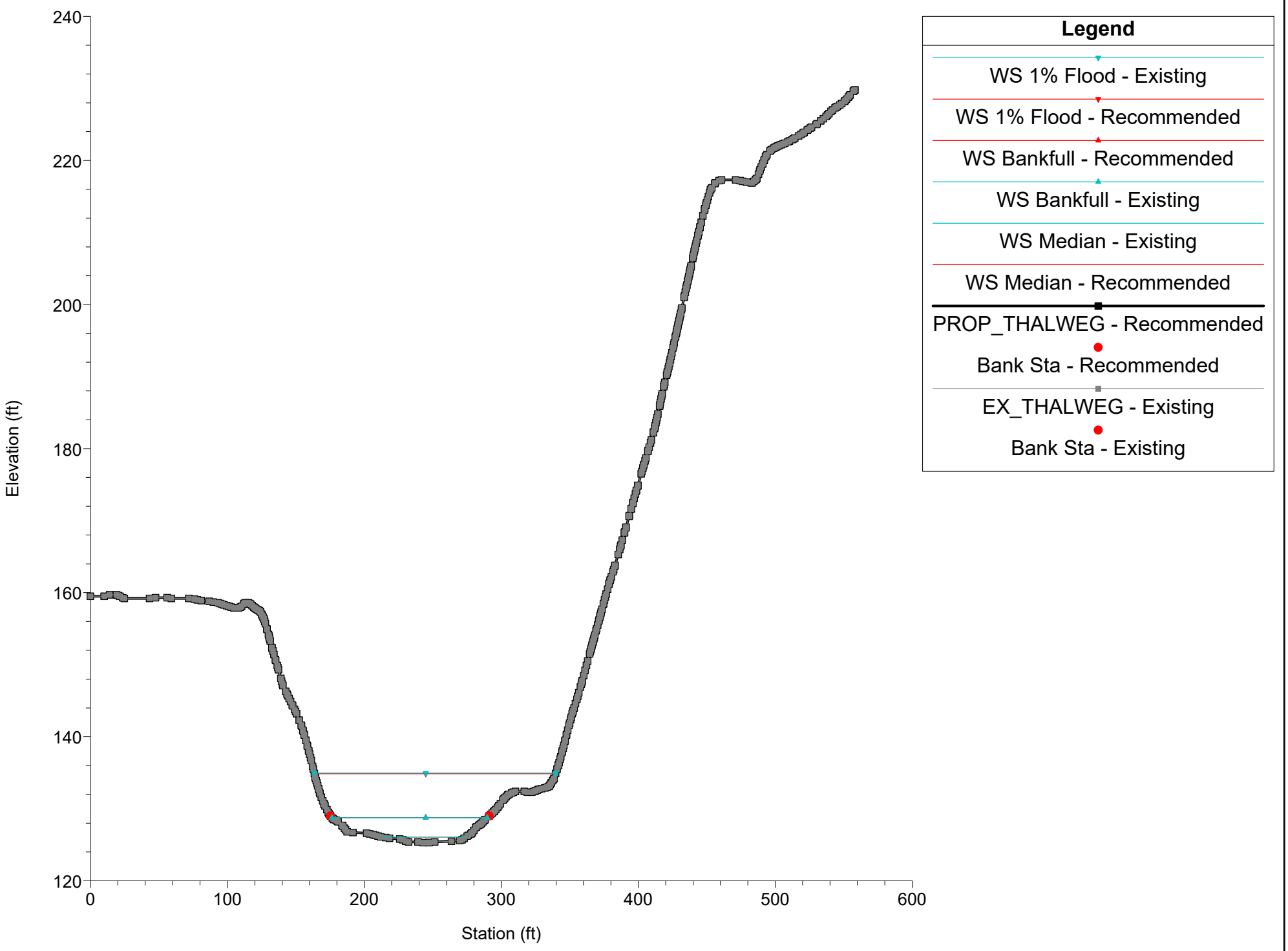


HEC-RAS Model Plan: 1) Recommended 3/11/2020 2) Existing 3/11/2020



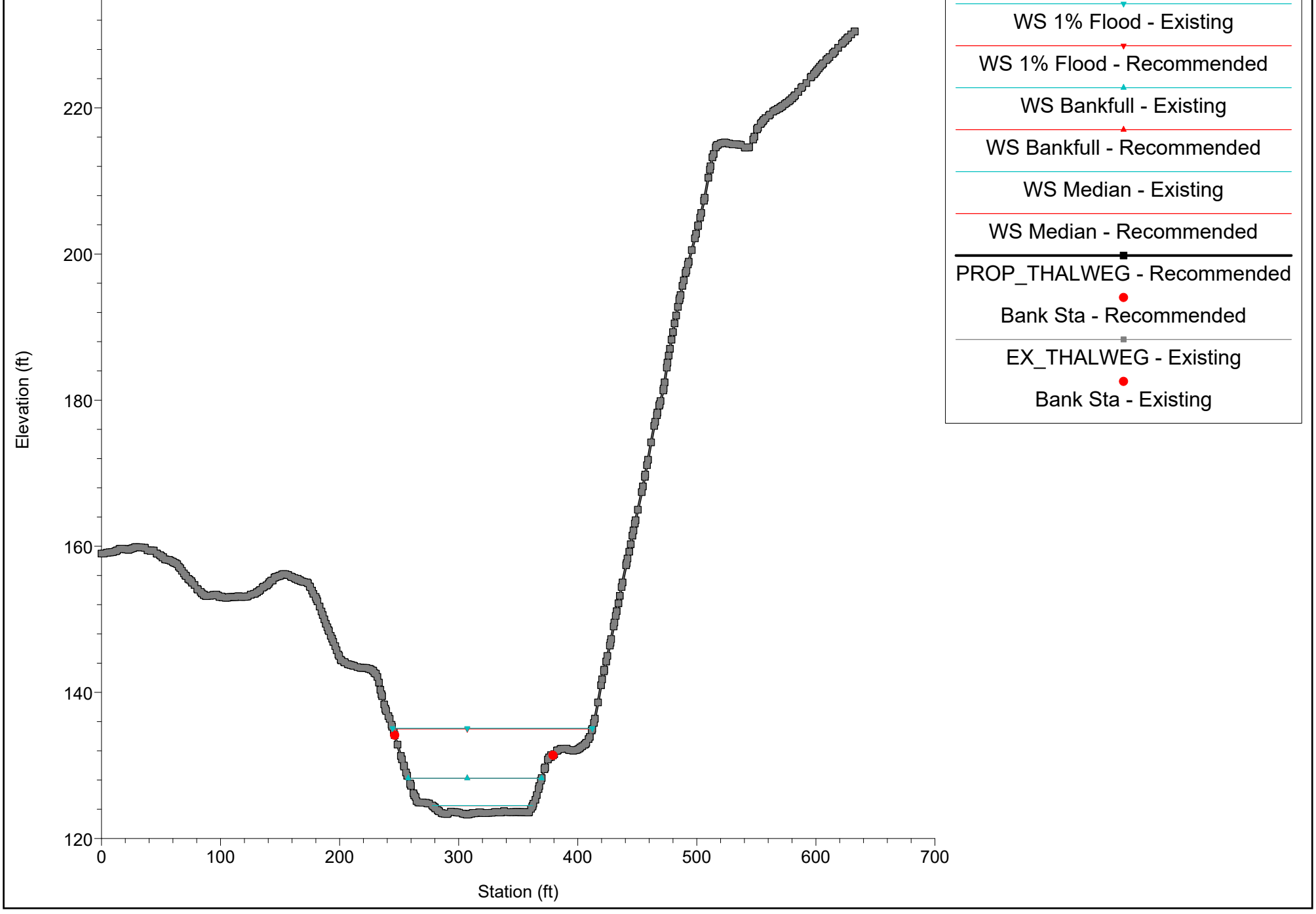
HEC-RAS Model Plan: 1) Existing 2) Recommended

River = Moodna Creek Reach = Reach 4 RS = 17683



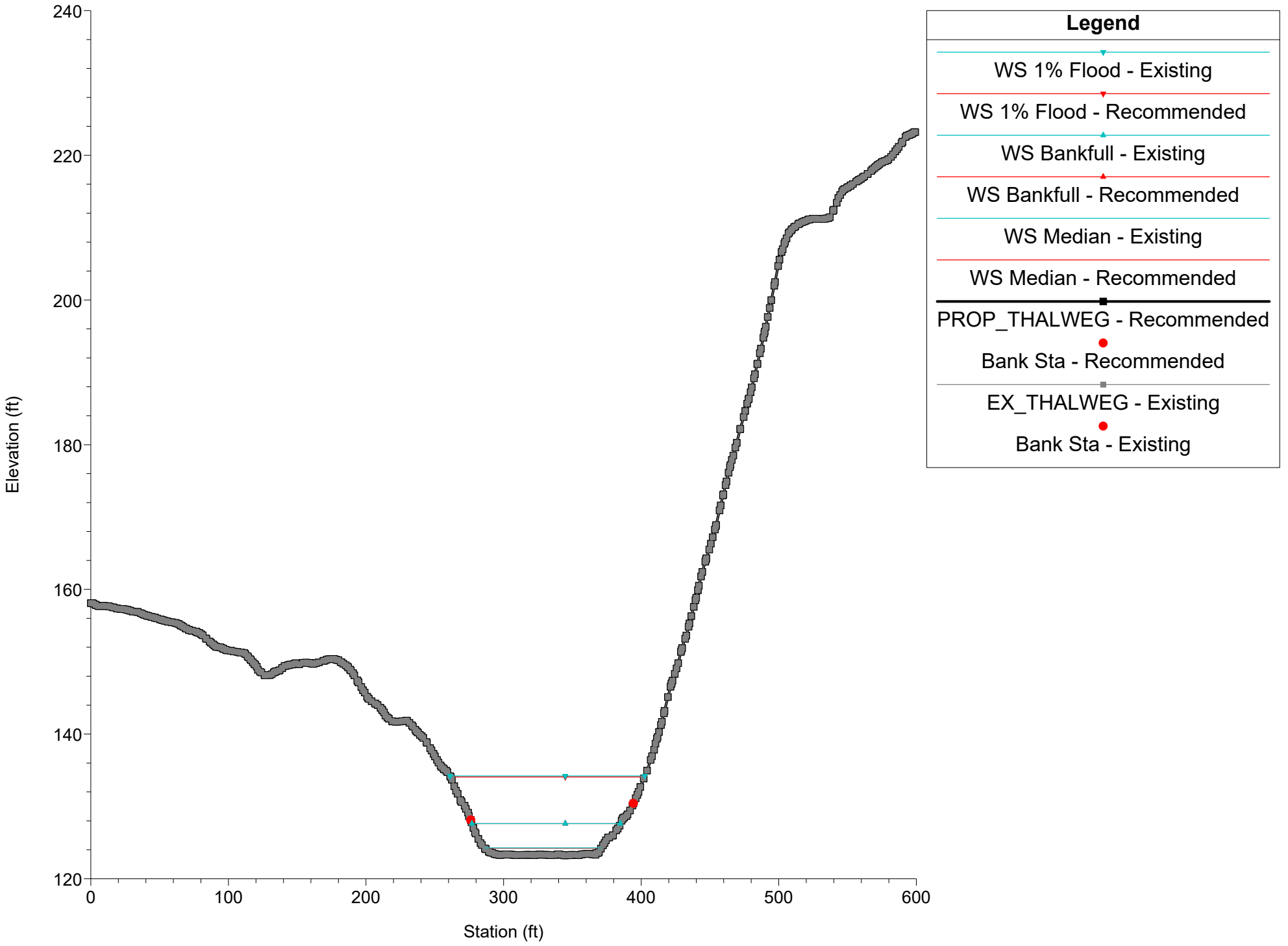
HEC-RAS Model Plan: 1) Existing 2) Recommended

River = Moodna Creek Reach = Reach 4 RS = 17360



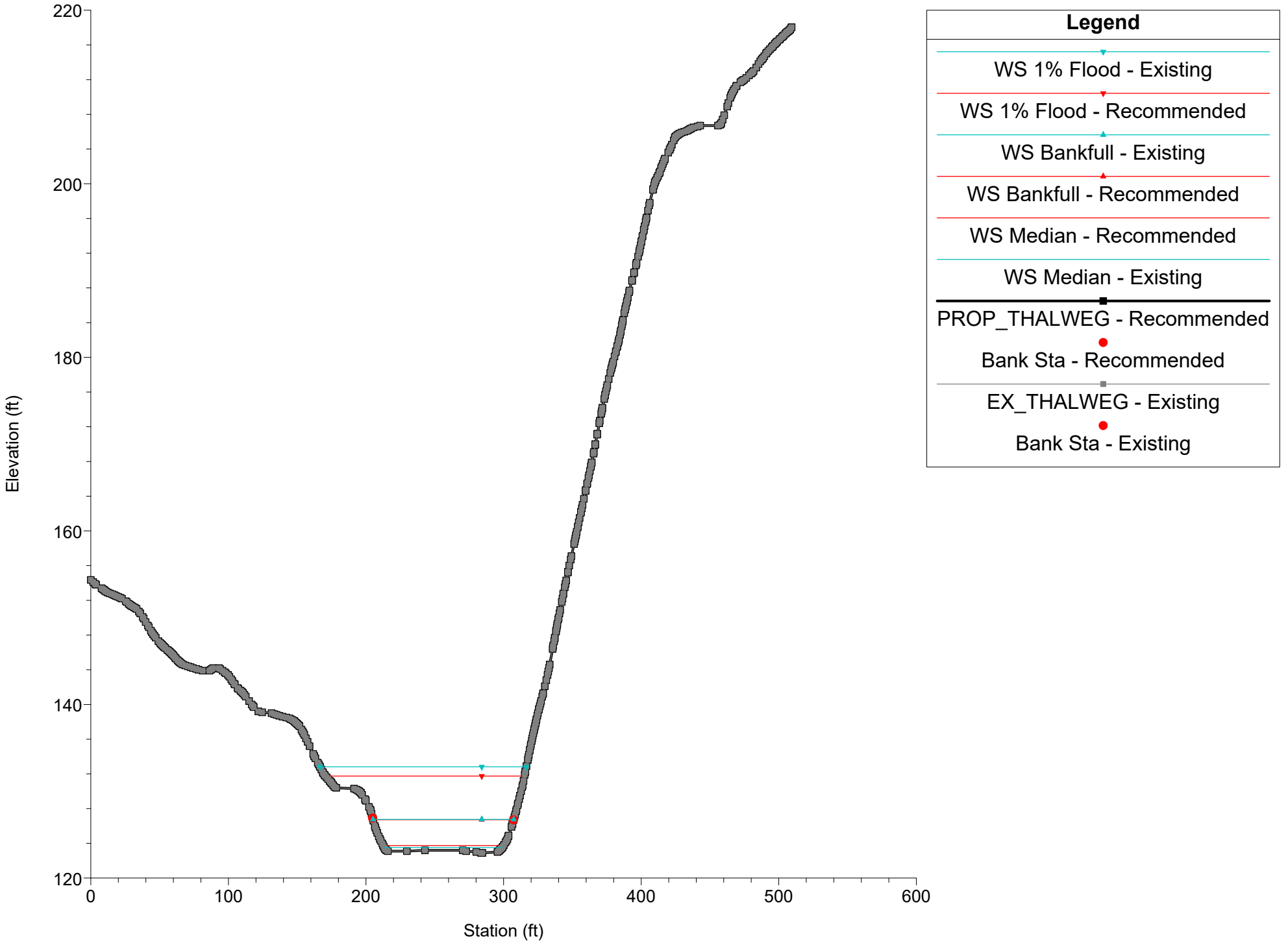
HEC-RAS Model Plan: 1) Existing 2) Recommended

River = Moodna Creek Reach = Reach 4 RS = 17359.5



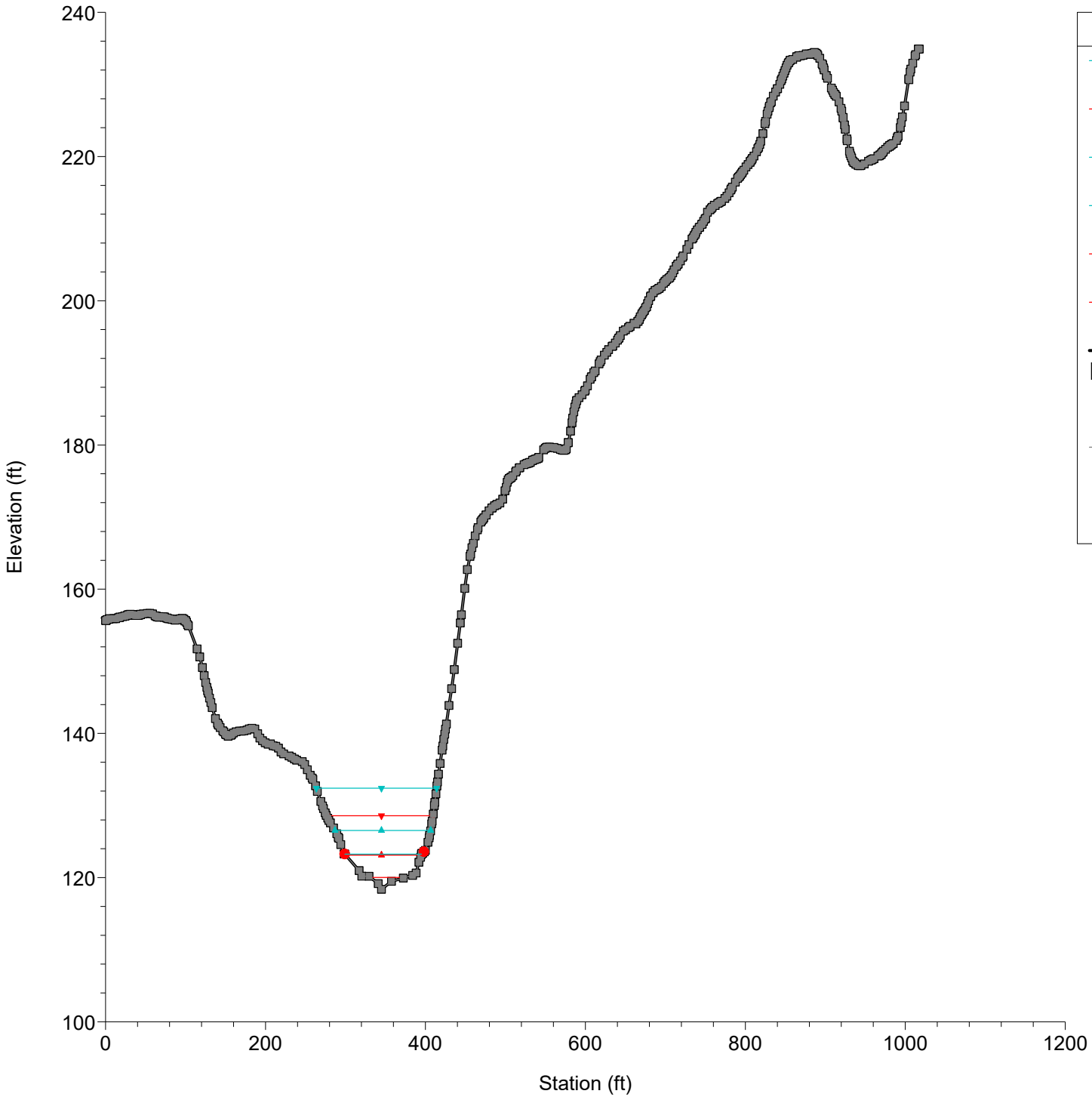
HEC-RAS Model Plan: 1) Existing 2) Recommended

River = Moodna Creek Reach = Reach 4 RS = 17359



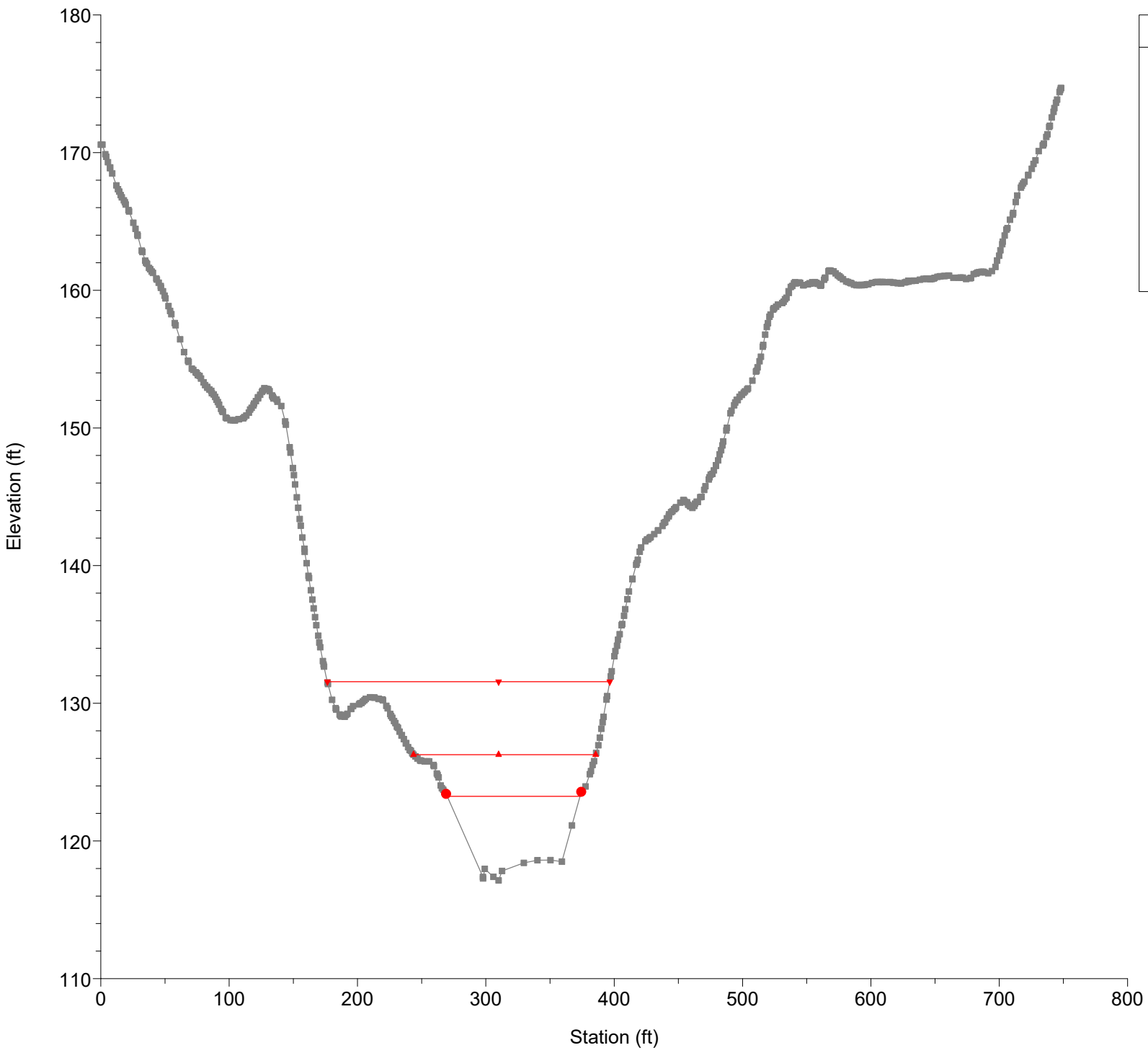
HEC-RAS Model Plan: 1) Existing 2) Recommended

River = Moodna Creek Reach = Reach 4 RS = 17099



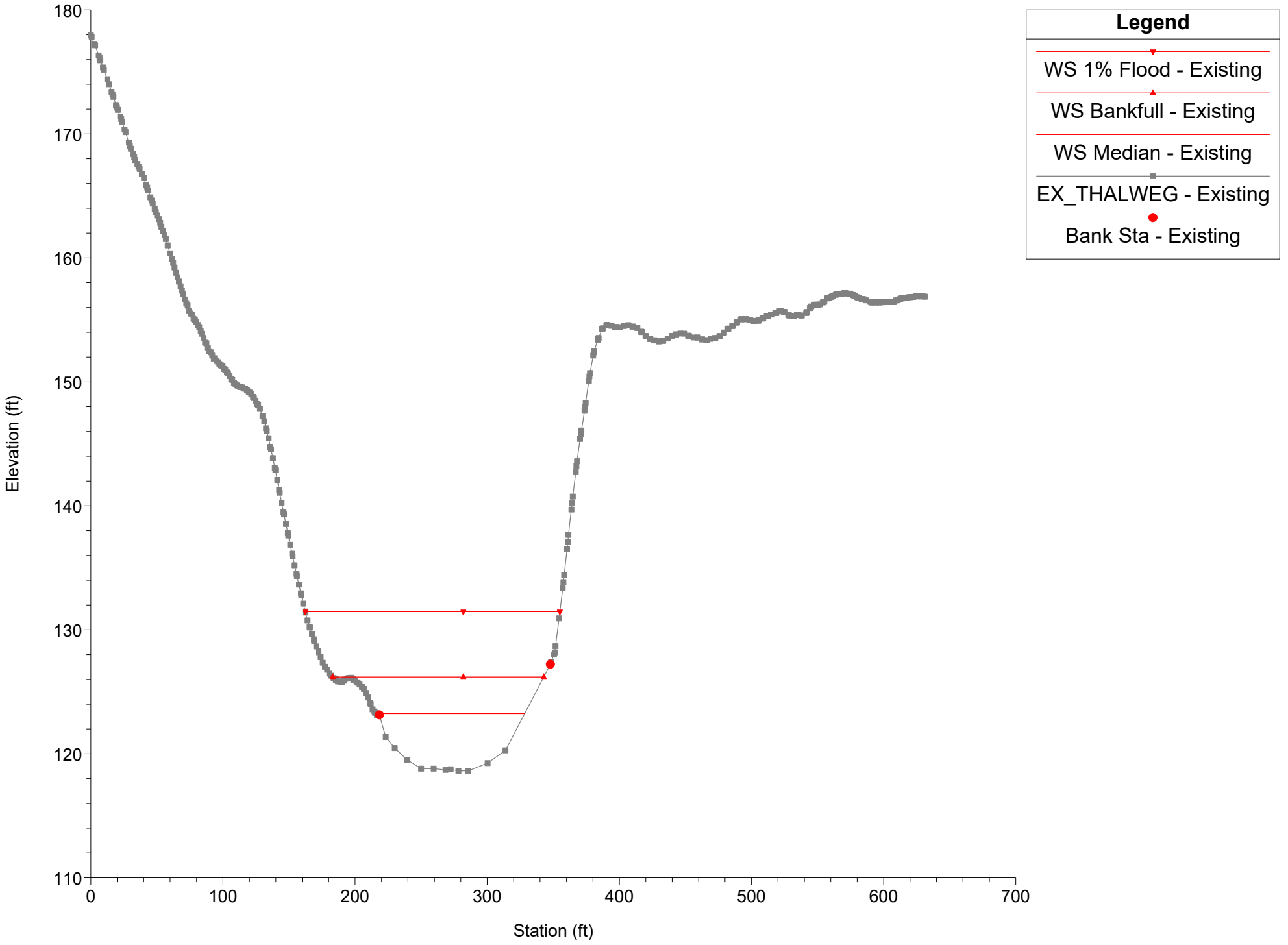
HEC-RAS Model Plan: 1) Existing 2) Recommended

River = Moodna Creek Reach = Reach 4 RS = 16708



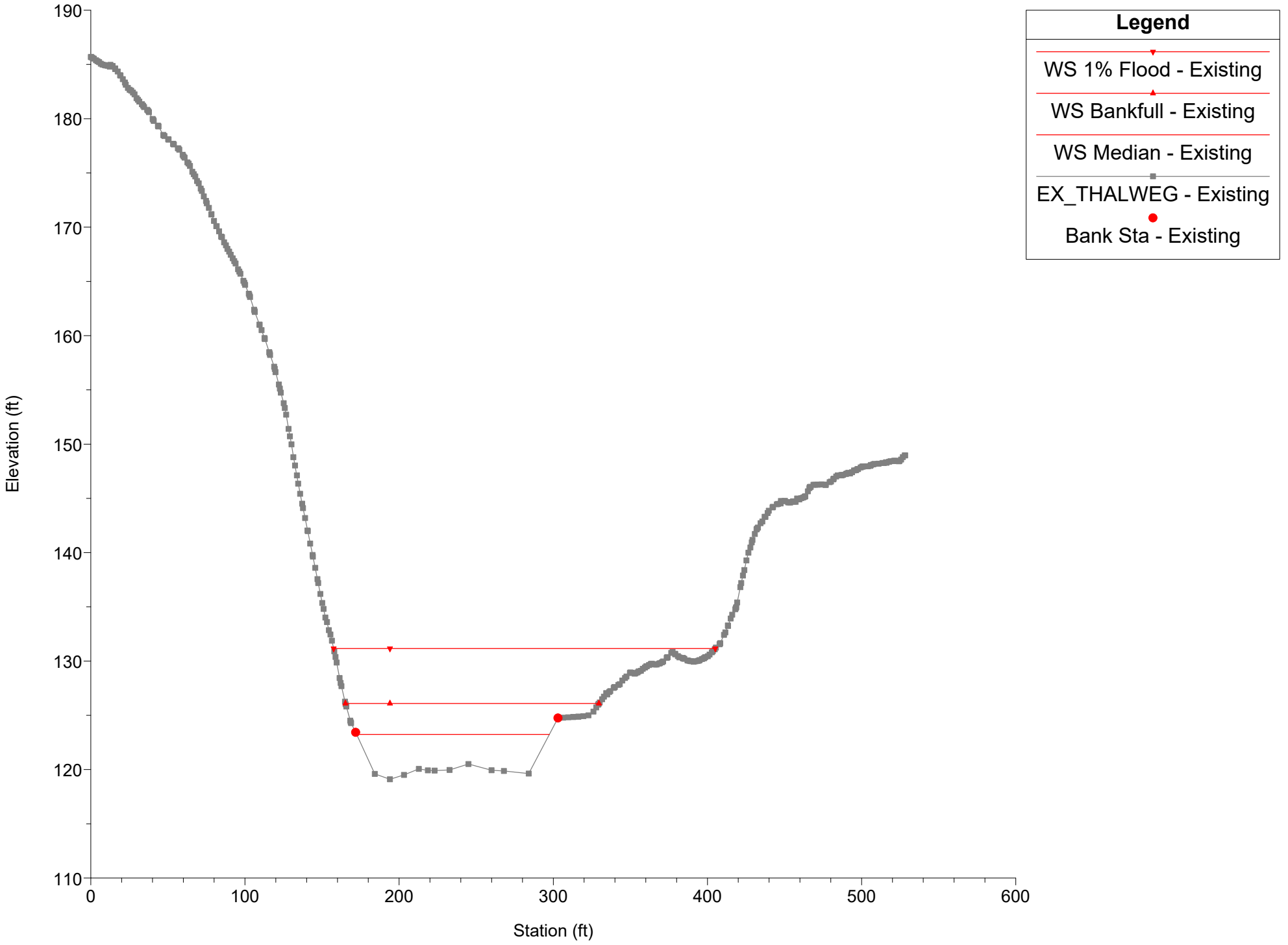
HEC-RAS Model Plan: 1) Existing 2) Recommended

River = Moodna Creek Reach = Reach 4 RS = 16596



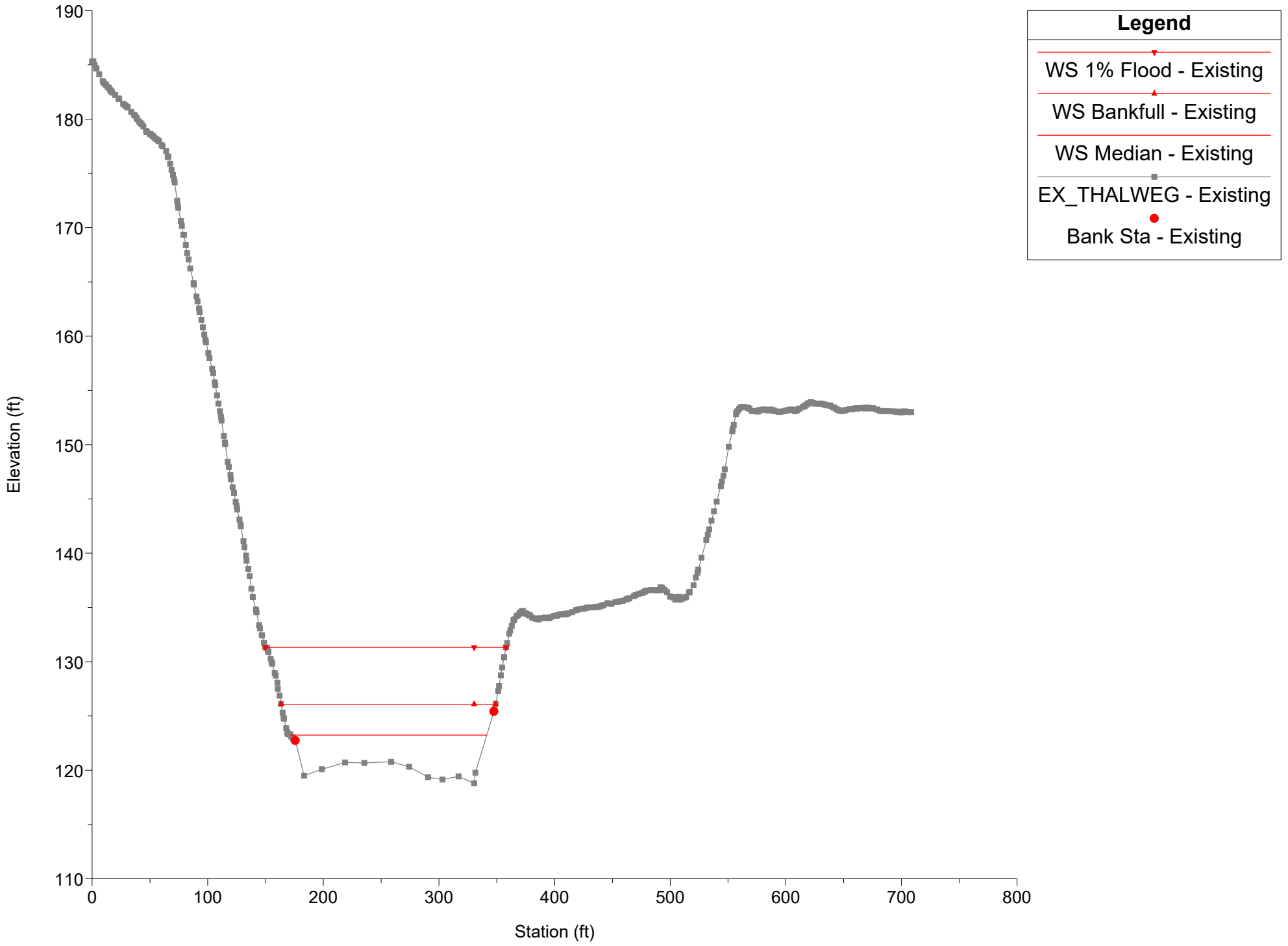
HEC-RAS Model Plan: 1) Existing 2) Recommended

River = Moodna Creek Reach = Reach 4 RS = 16427



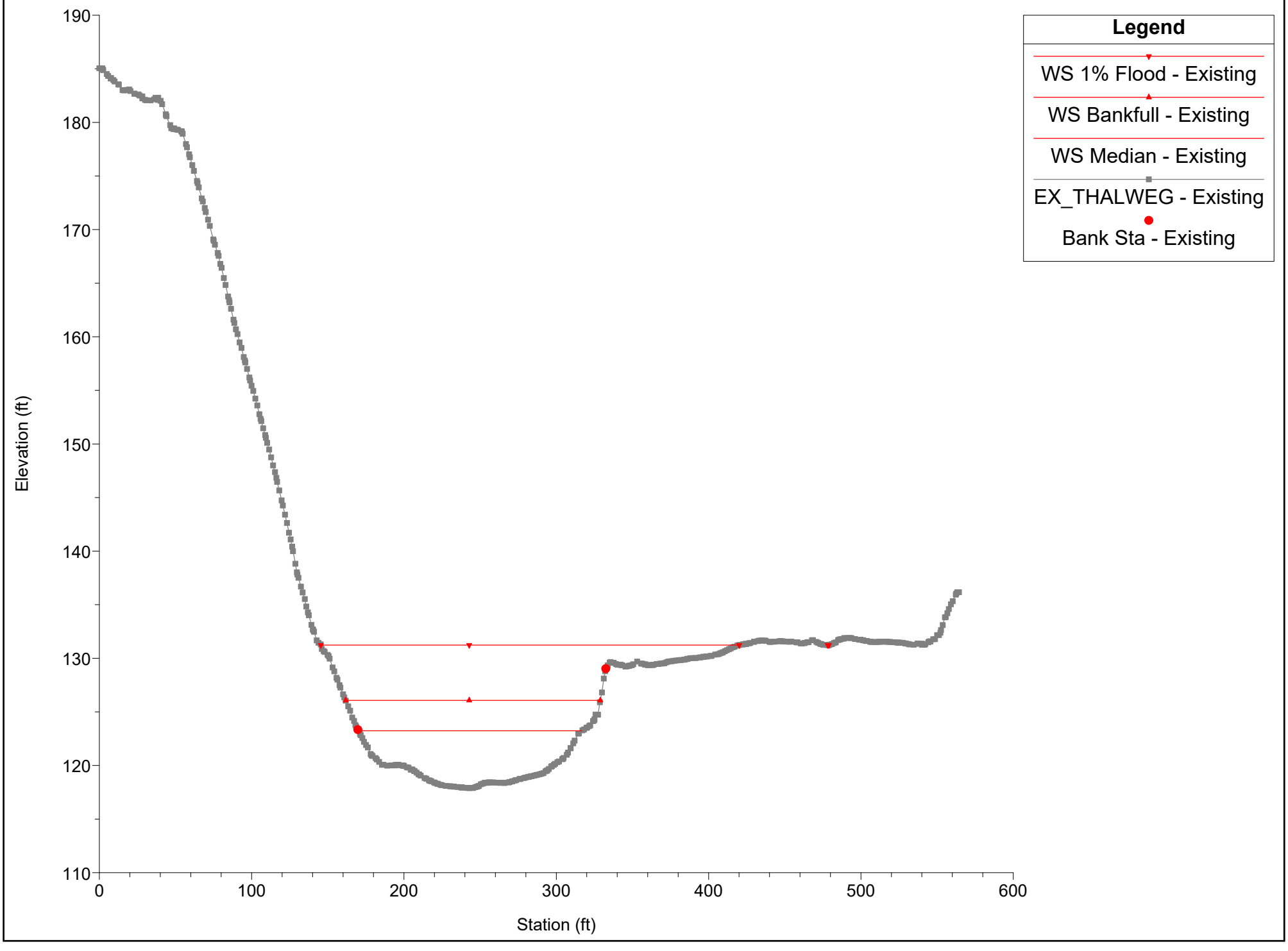
HEC-RAS Model Plan: 1) Existing 2) Recommended

River = Moodna Creek Reach = Reach 4 RS = 16318



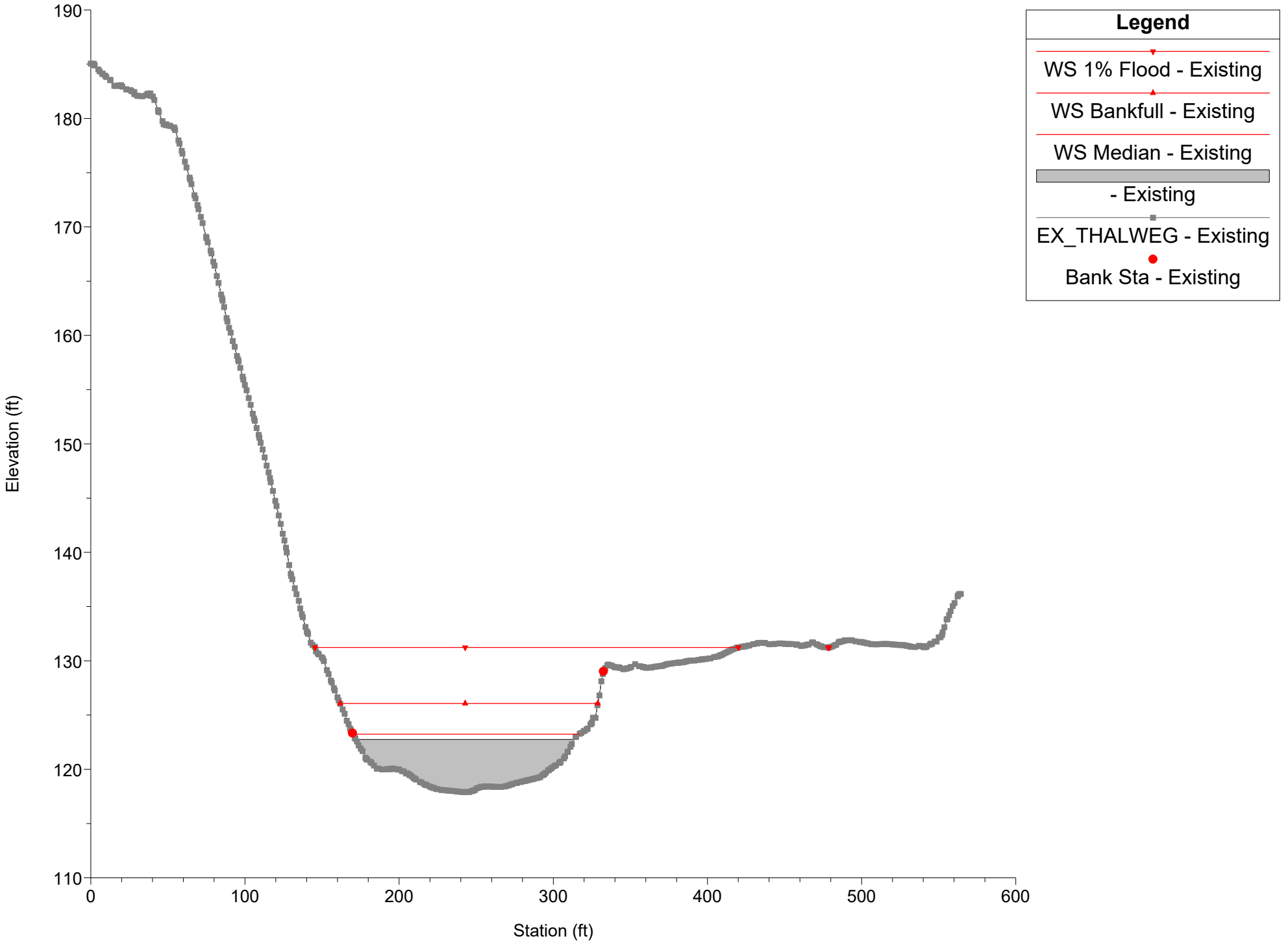
HEC-RAS Model Plan: 1) Existing 2) Recommended

River = Moodna Creek Reach = Reach 4 RS = 16290



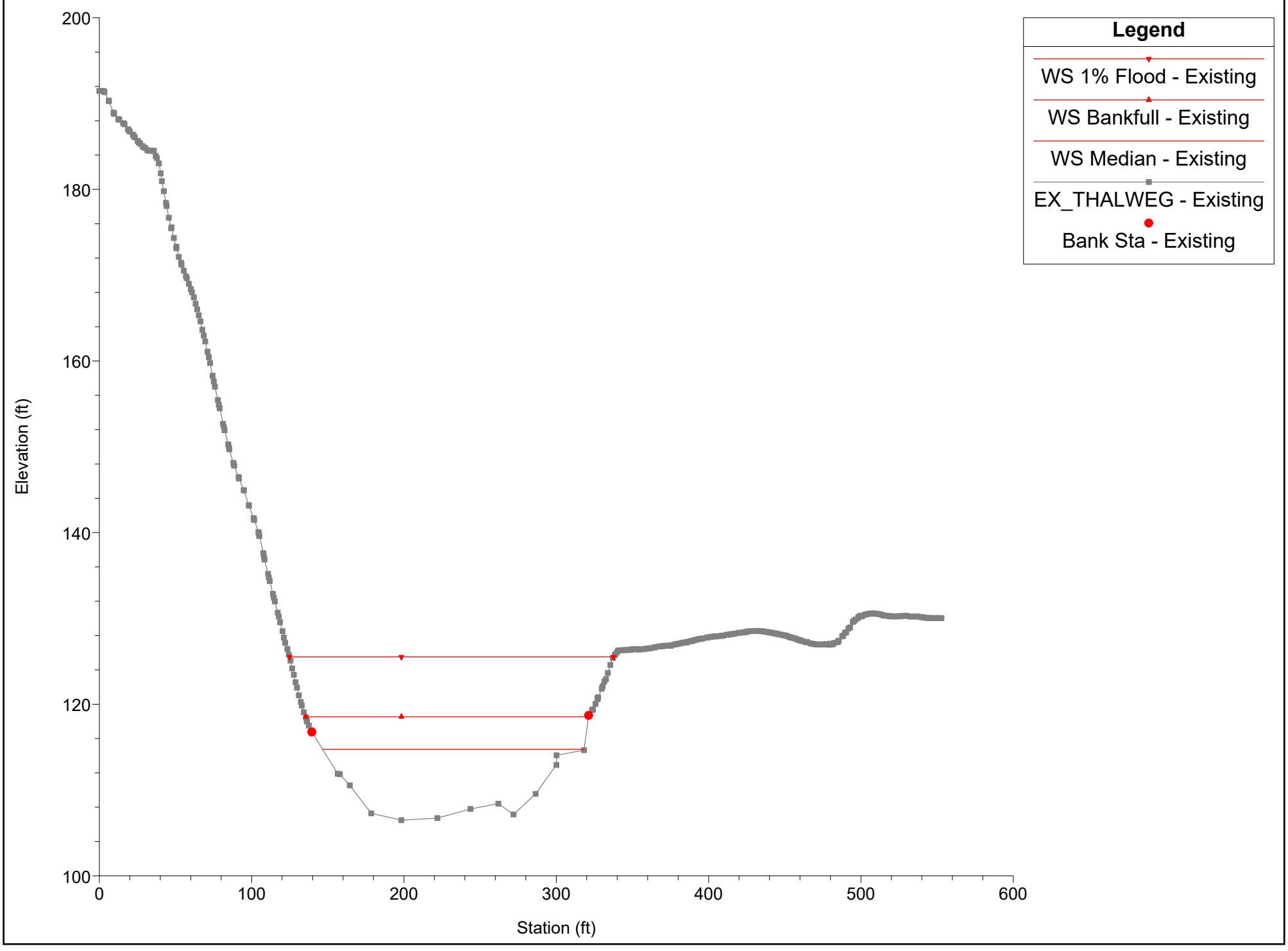
HEC-RAS Model Plan: 1) Existing 2) Recommended

River = Moodna Creek Reach = Reach 4 RS = 16277.42 IS Firth Cliff Firthcliffe Dam. Dam information from effective profile and New



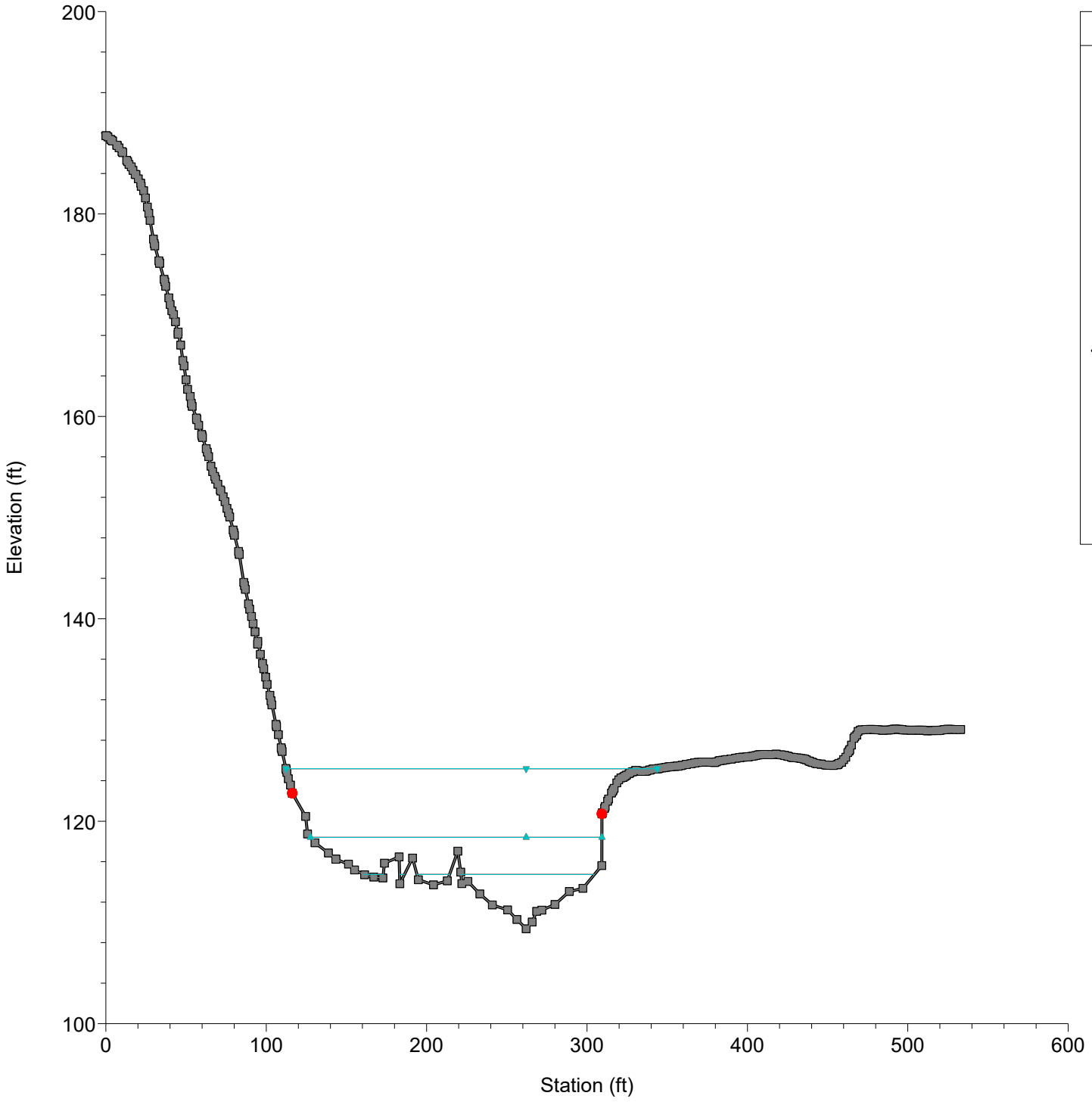
HEC-RAS Model Plan: 1) Existing 2) Recommended

River = Moodna Creek Reach = Reach 4 RS = 16255



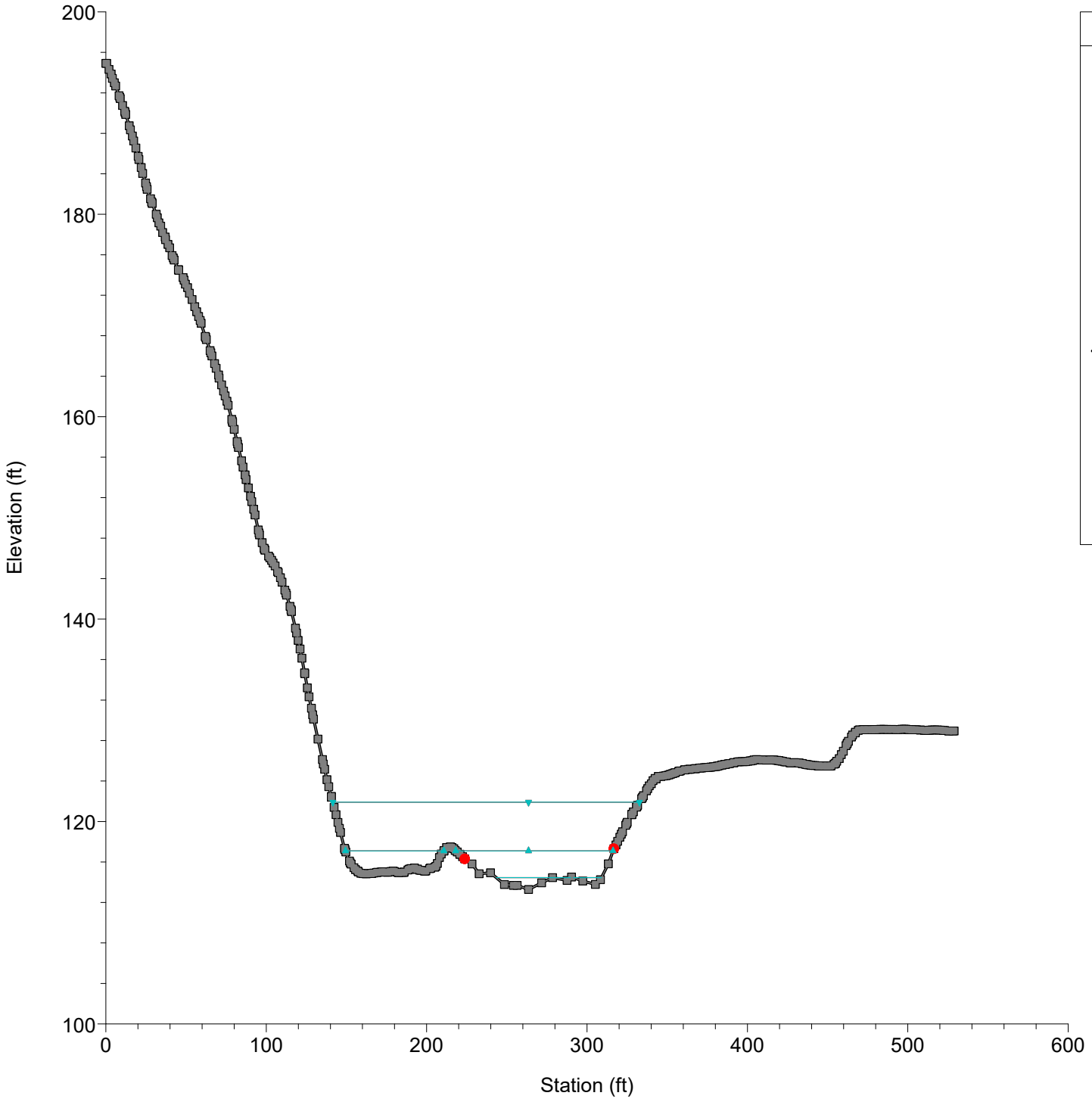
HEC-RAS Model Plan: 1) Existing 2) Recommended

River = Moodna Creek Reach = Reach 4 RS = 16223



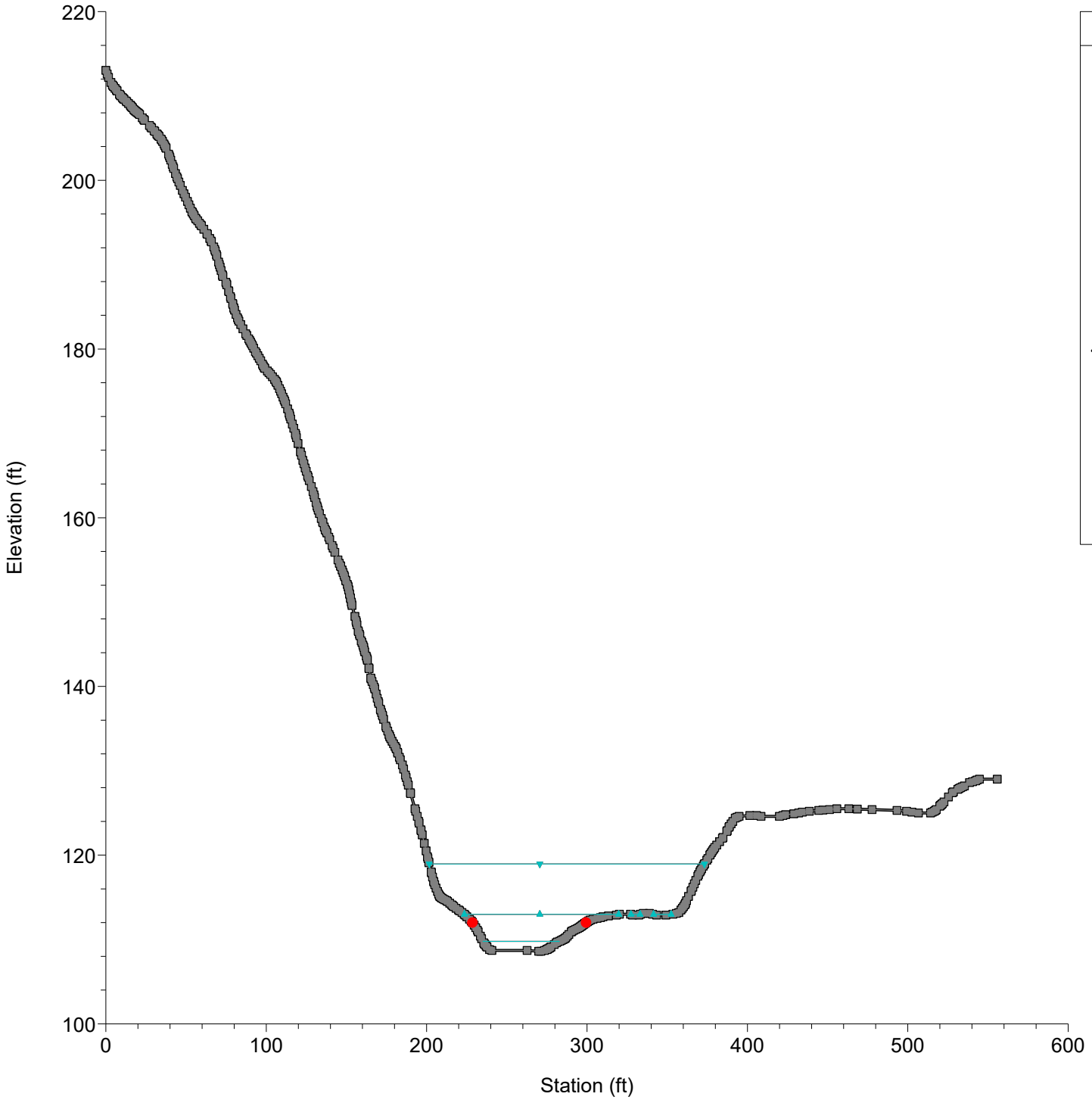
HEC-RAS Model Plan: 1) Existing 2) Recommended

River = Moodna Creek Reach = Reach 4 RS = 16183



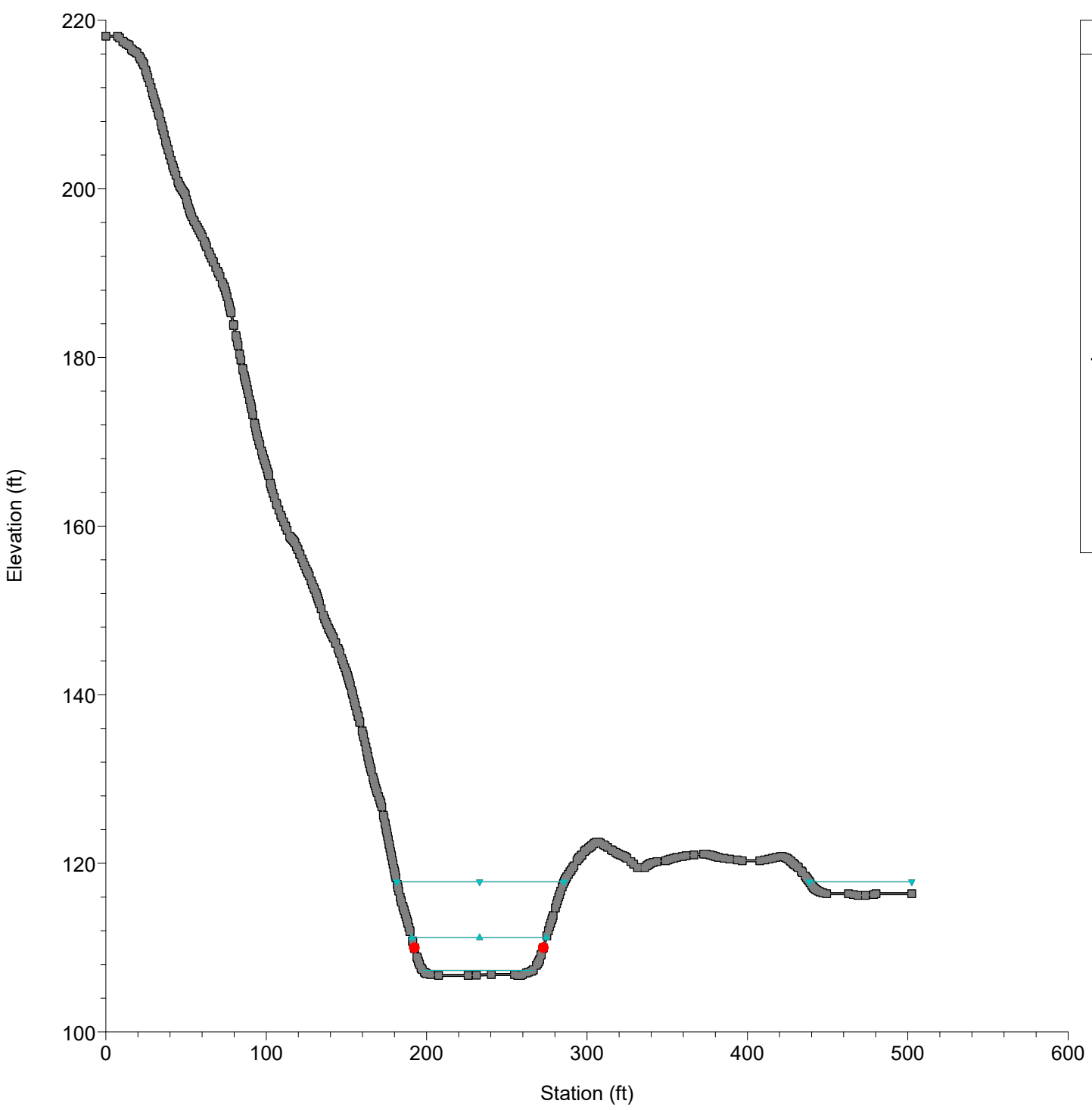
HEC-RAS Model Plan: 1) Existing 2) Recommended

River = Moodna Creek Reach = Reach 4 RS = 16053



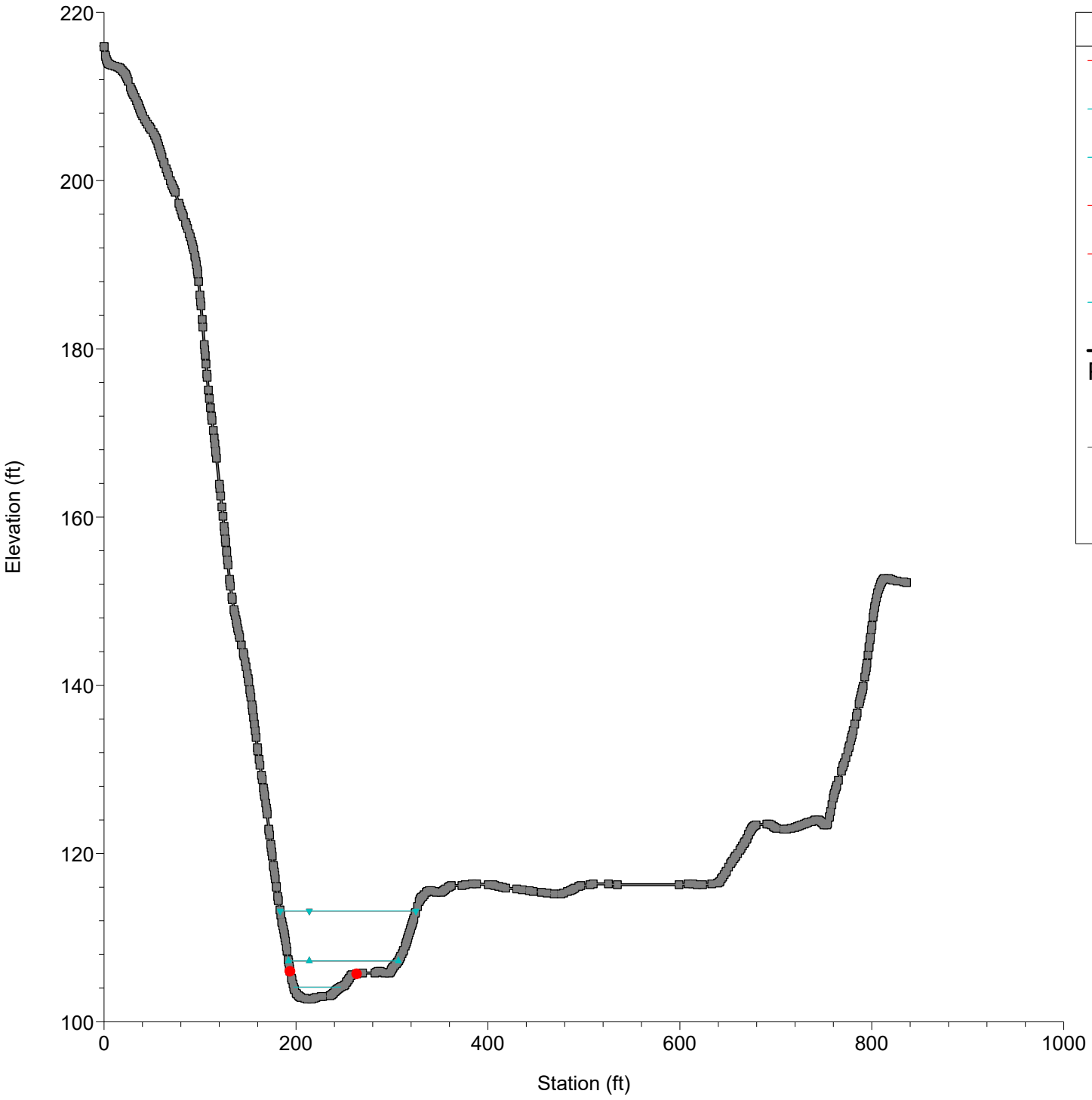
HEC-RAS Model Plan: 1) Existing 2) Recommended

River = Moodna Creek Reach = Reach 4 RS = 15832

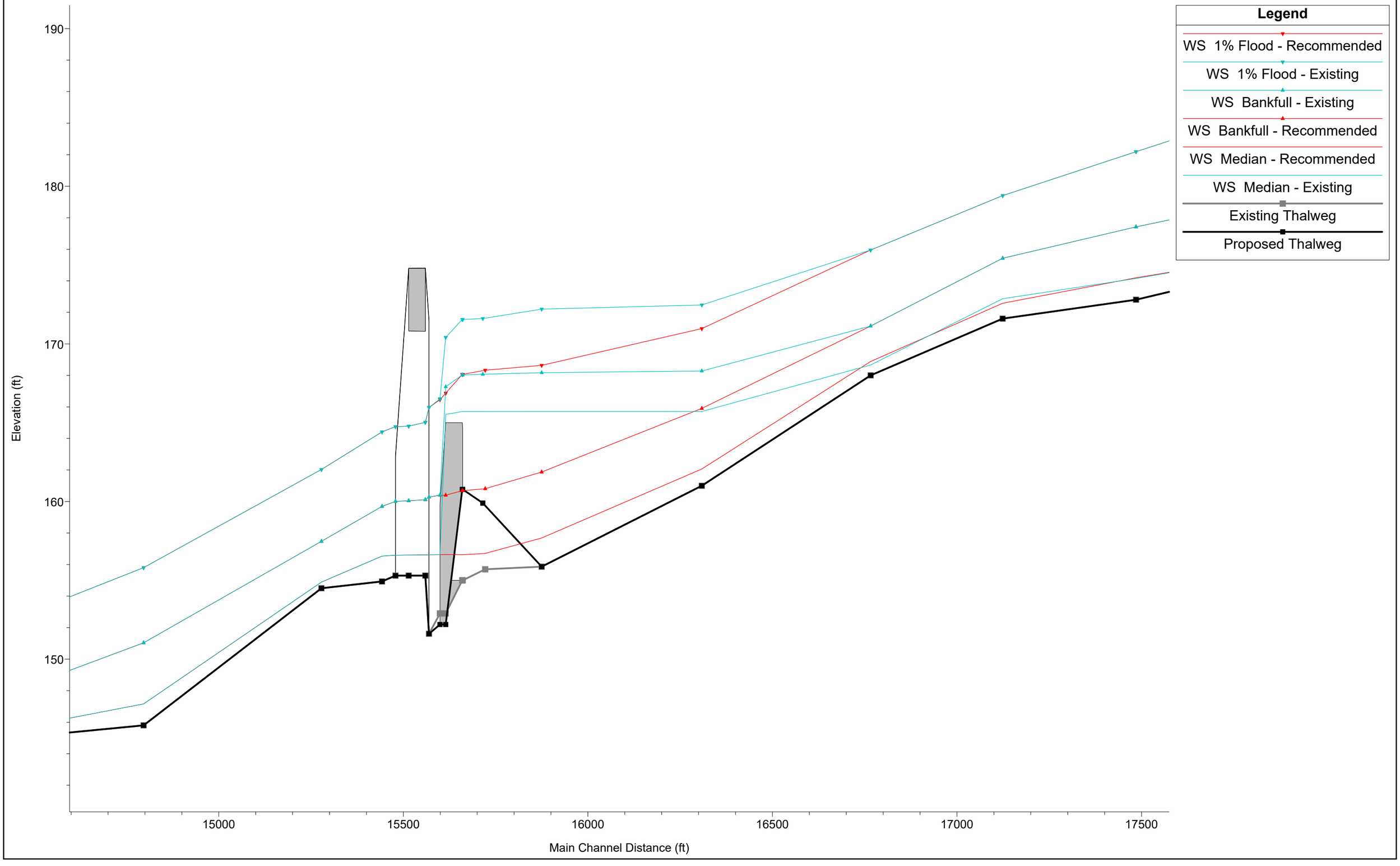


HEC-RAS Model Plan: 1) Existing 2) Recommended

River = Moodna Creek Reach = Reach 4 RS = 15474

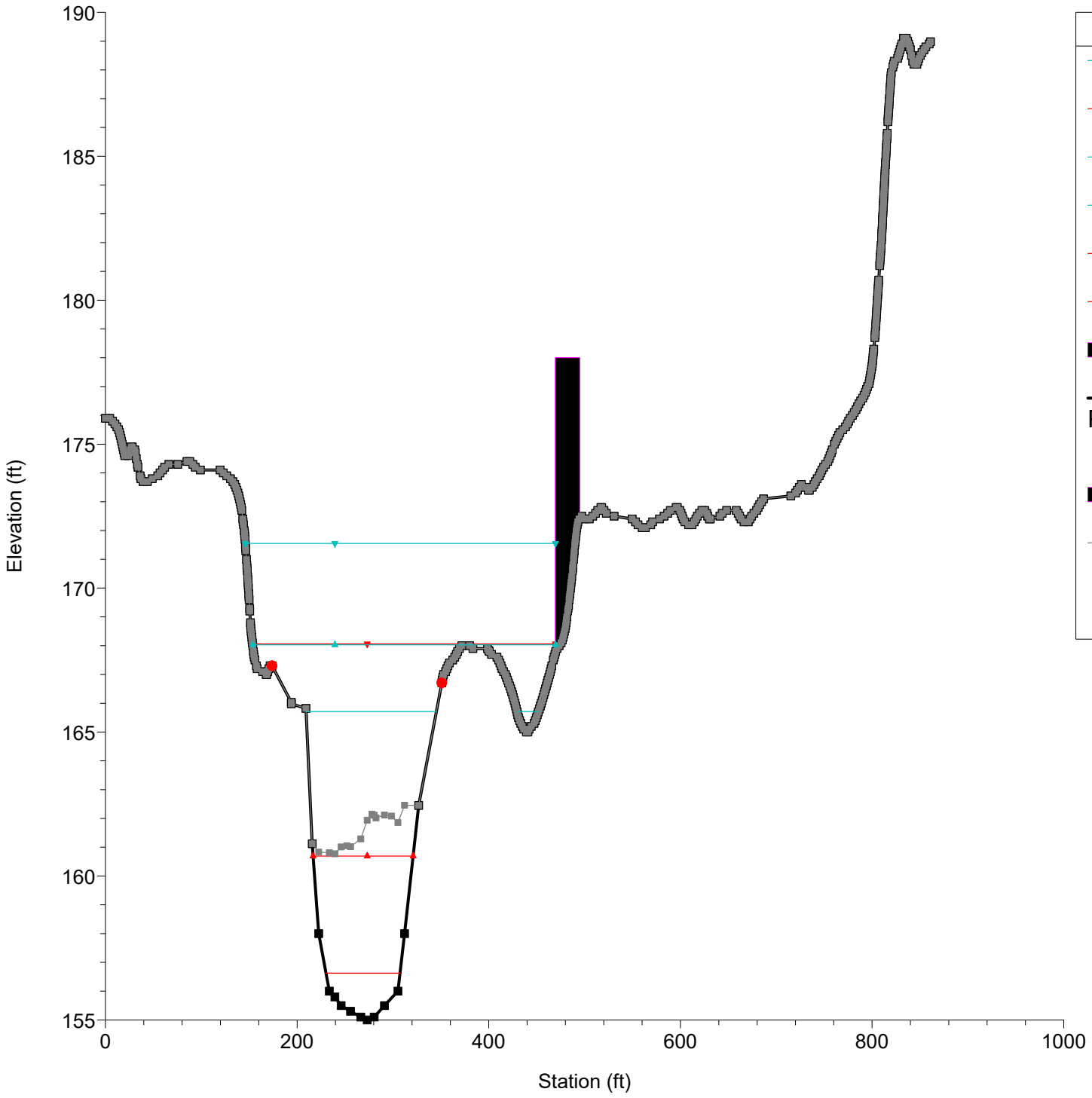


HEC-RAS Model Plan: 1) Recommended 3/11/2020 2) Existing 3/11/2020



HEC-RAS Model Plan: 1) Existing 2) Recommended

River = Moodna Creek Reach = Reach 4 RS = 20053



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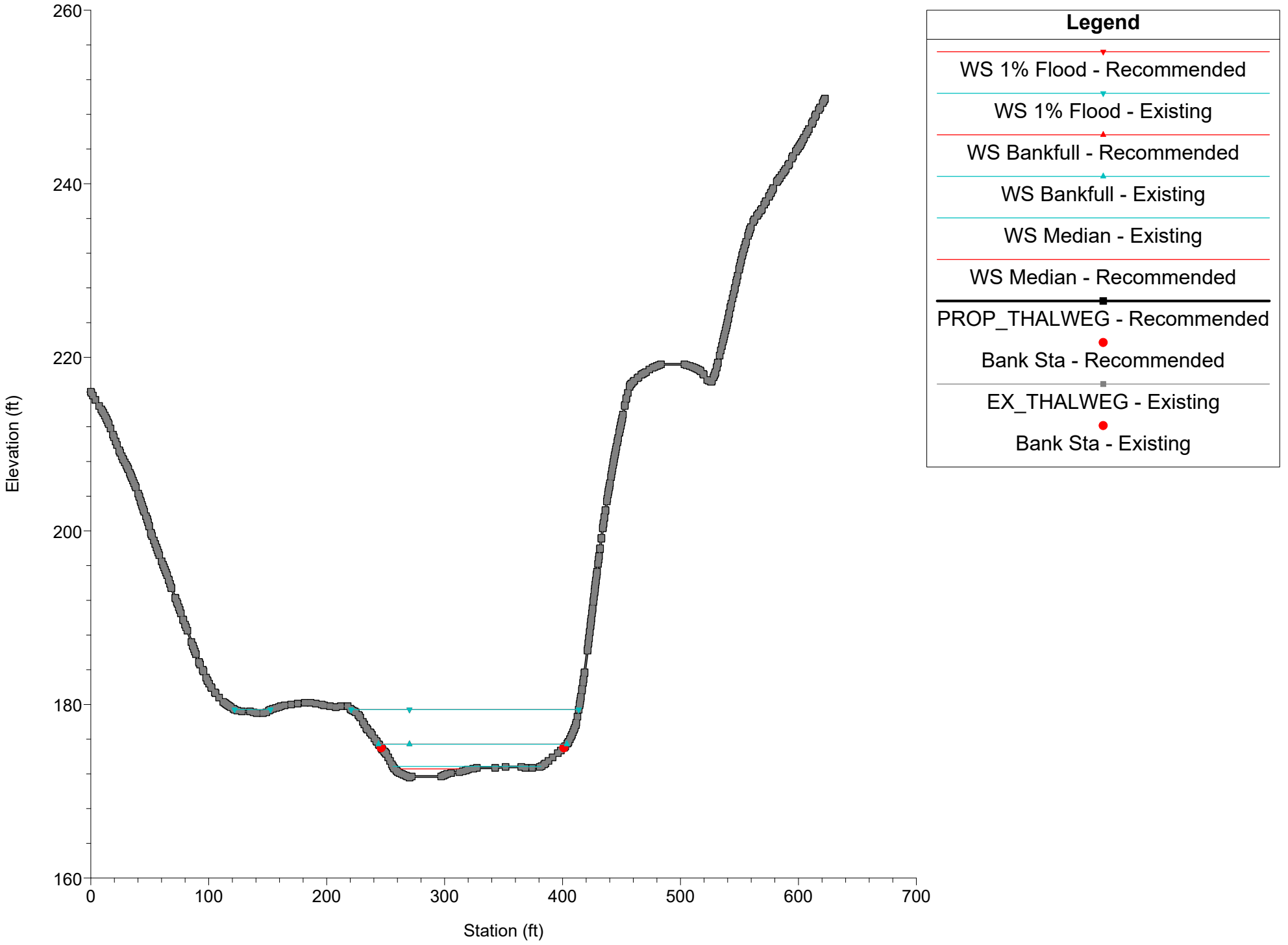

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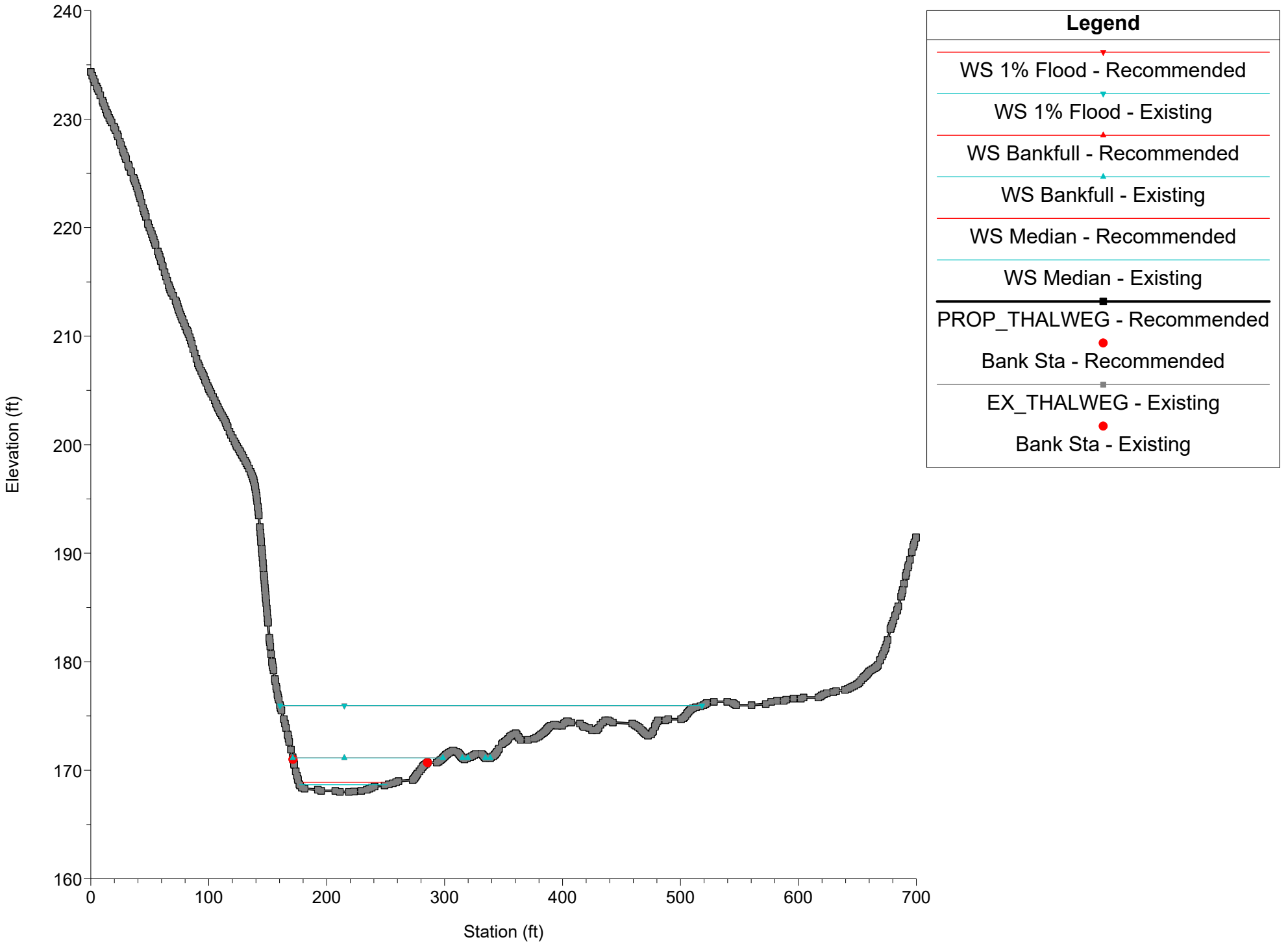

HEC-RAS Model Plan: 1) Existing 2) Recommended

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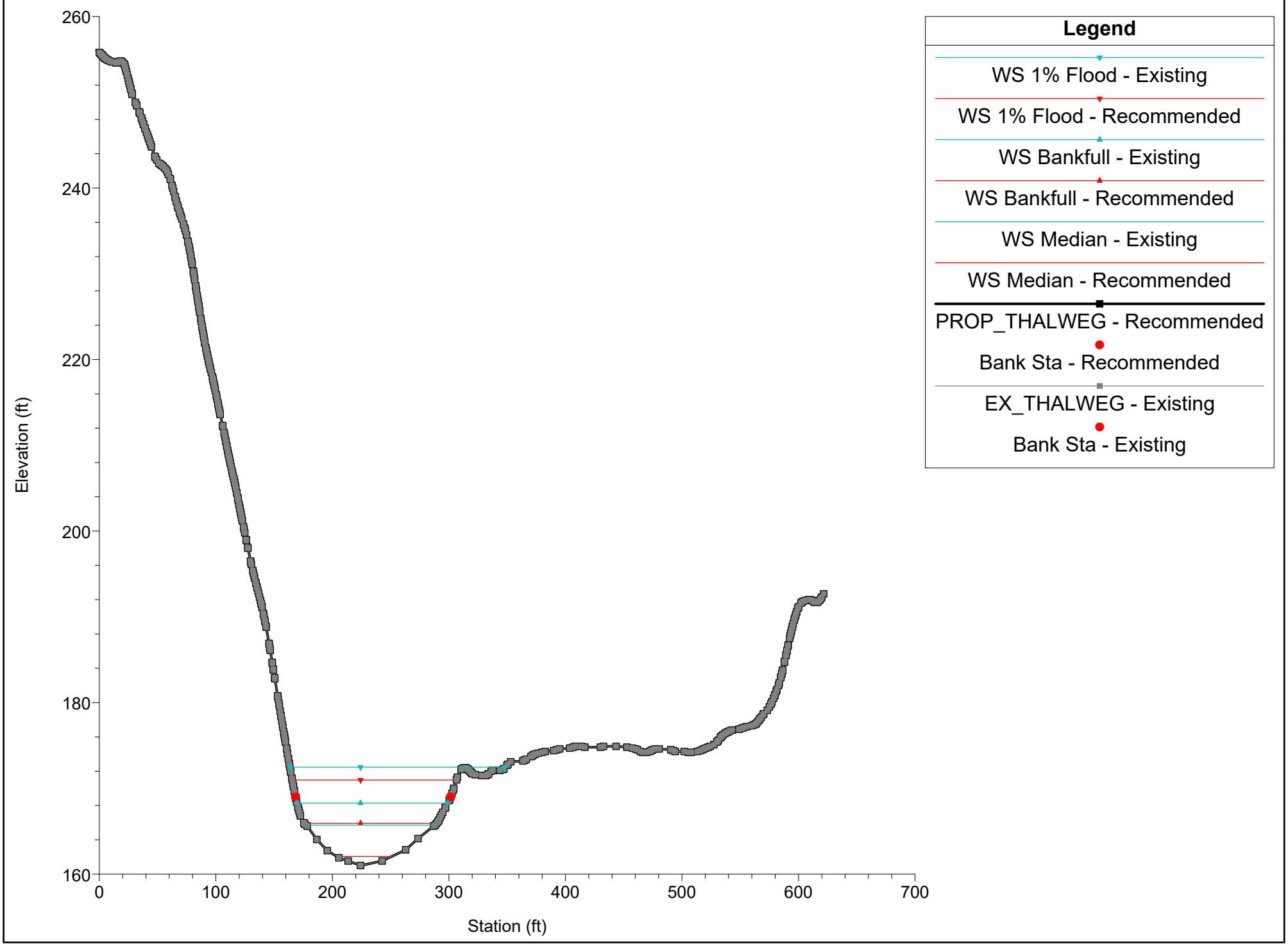

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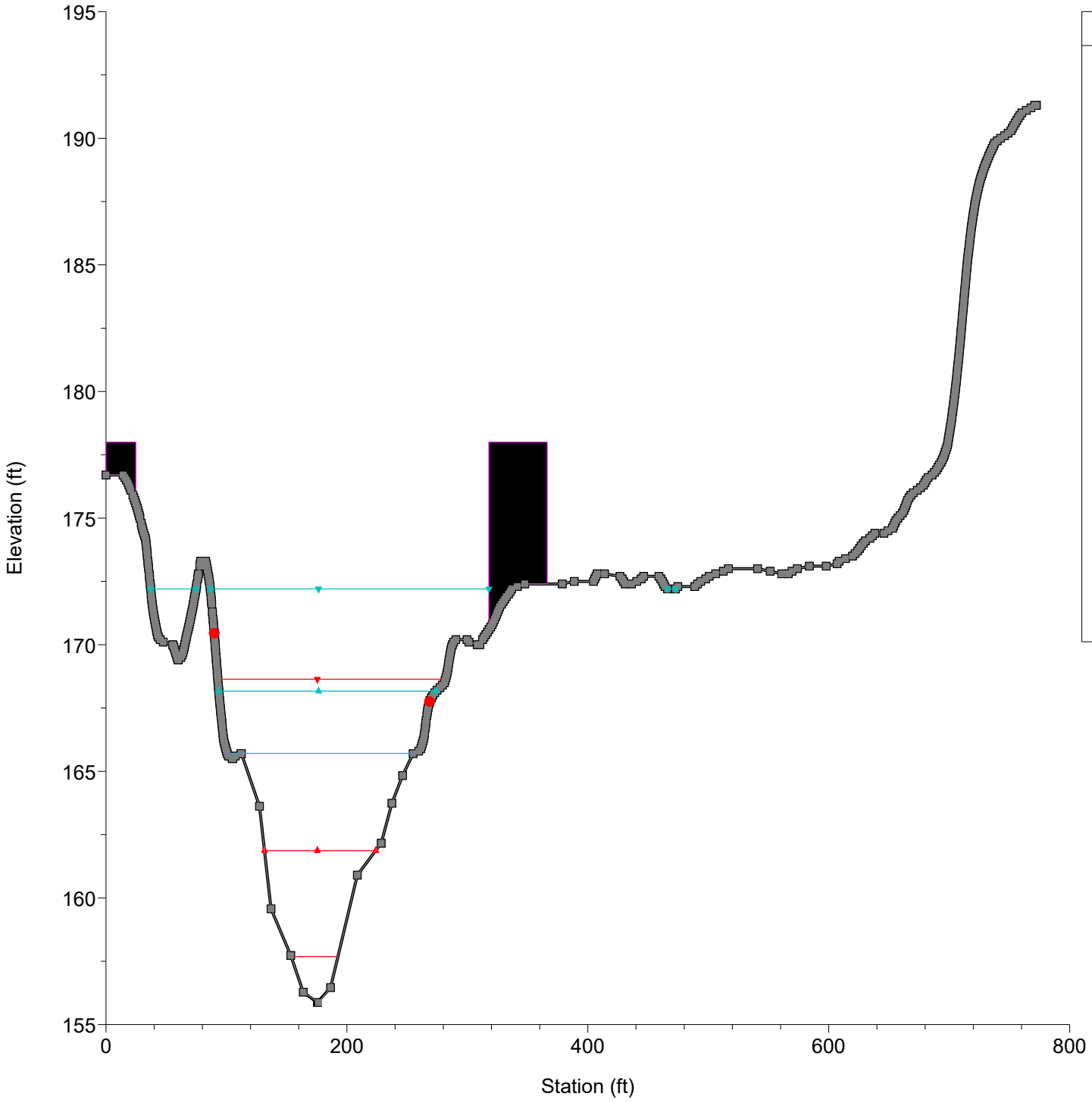

HEC-RAS Model Plan: 1) Existing 2) Recommended

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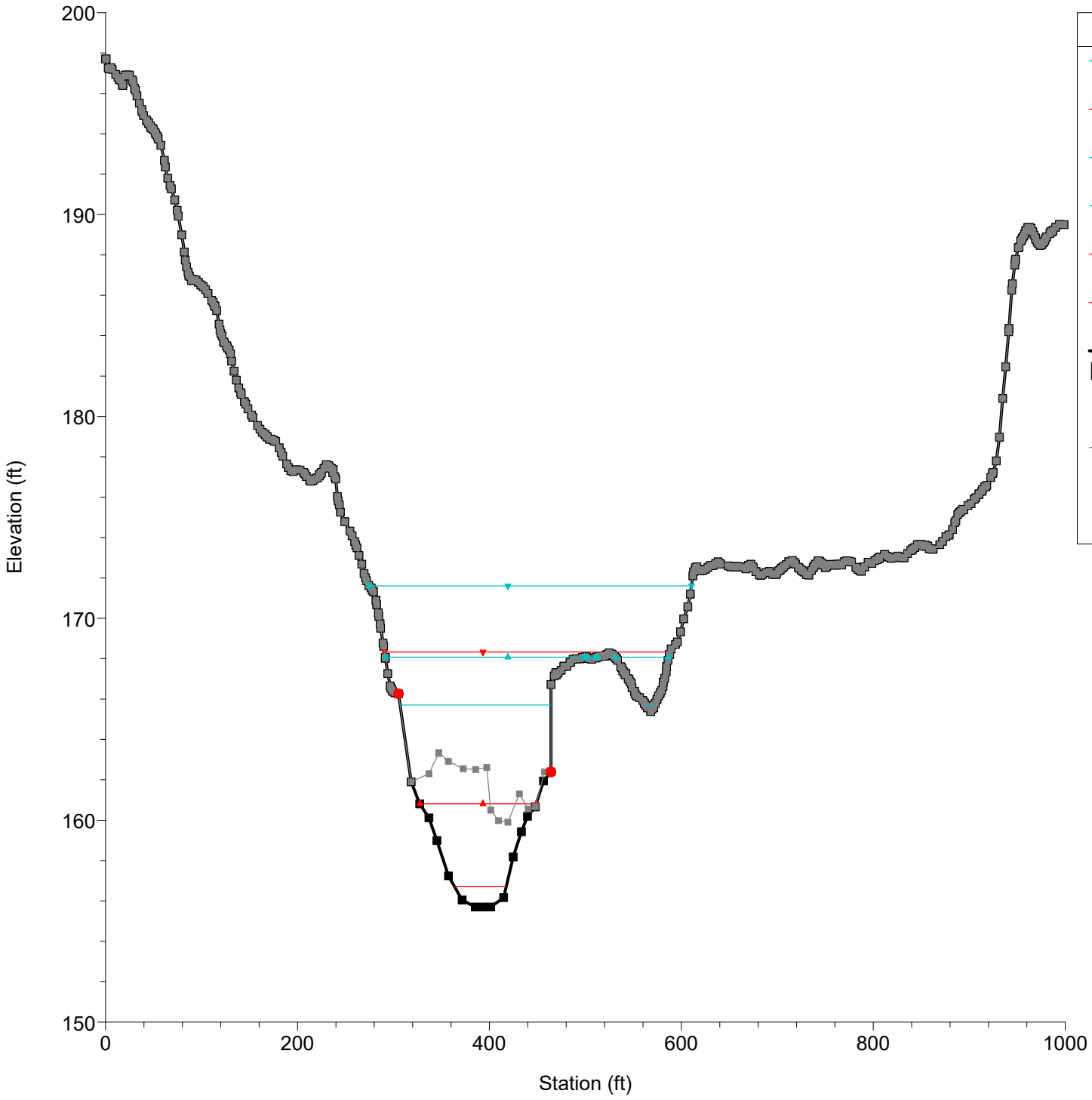
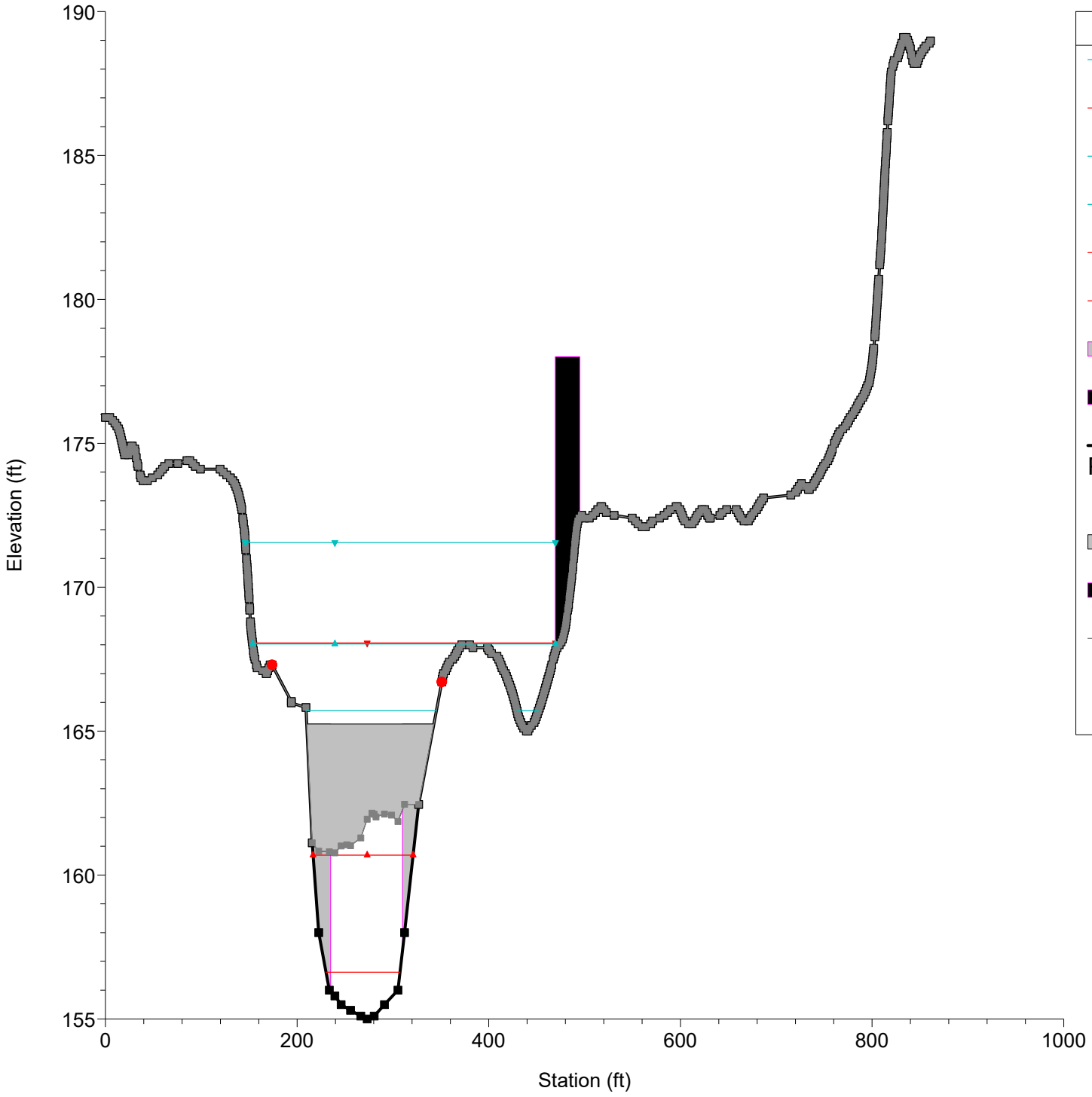


HEC-RAS Model Plan: 1) Existing 2) Recommended

River = Moodna Creek Reach = Reach 4 RS = 19999.35 IS Orr's Mill

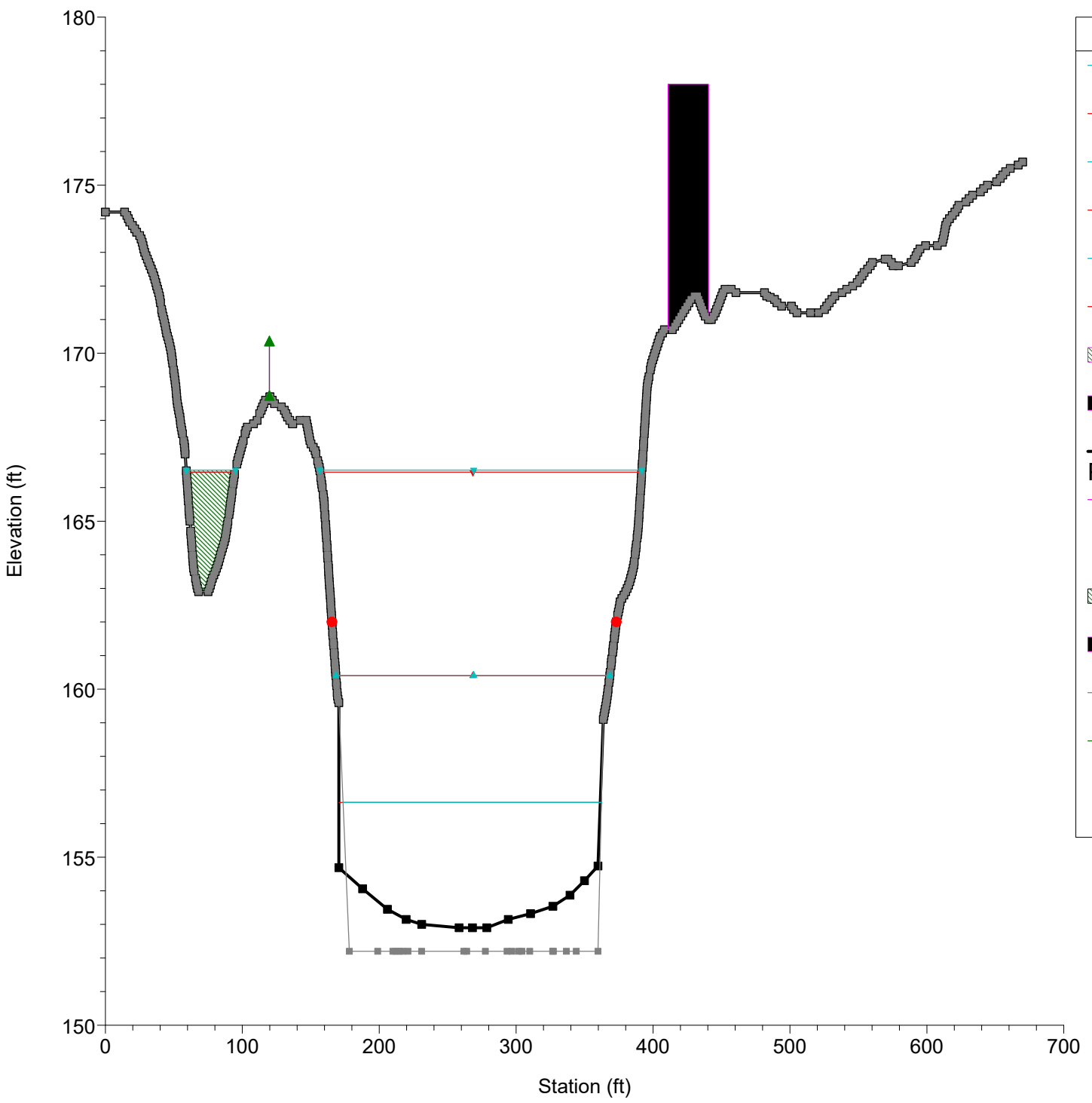


Legend

- WS 1% Flood - Existing
- WS 1% Flood - Recommended
- WS Bankfull - Existing
- WS Median - Existing
- WS Bankfull - Recommended
- WS Median - Recommended
- \- Recommended
- \- Recommended
- PROP_THALWEG - Recommended
- Bank Sta - Recommended
- \- Existing
- \- Existing
- EX_THALWEG - Existing
- Bank Sta - Existing

HEC-RAS Model Plan: 1) Existing 2) Recommended

River = Moodna Creek Reach = Reach 4 RS = 19977



Legend

- WS 1% Flood - Existing
- WS 1% Flood - Recommended
- WS Bankfull - Existing
- WS Bankfull - Recommended
- WS Median - Existing
- WS Median - Recommended
- \- Recommended
- \- Recommended
- PROP_THALWEG - Recommended
- Ineff - Recommended
- Bank Sta - Recommended
- \- Existing
- \- Existing
- EX_THALWEG - Existing
- Ineff - Existing
- Bank Sta - Existing

HEC-RAS Model Plan: 1) Existing 2) Recommended

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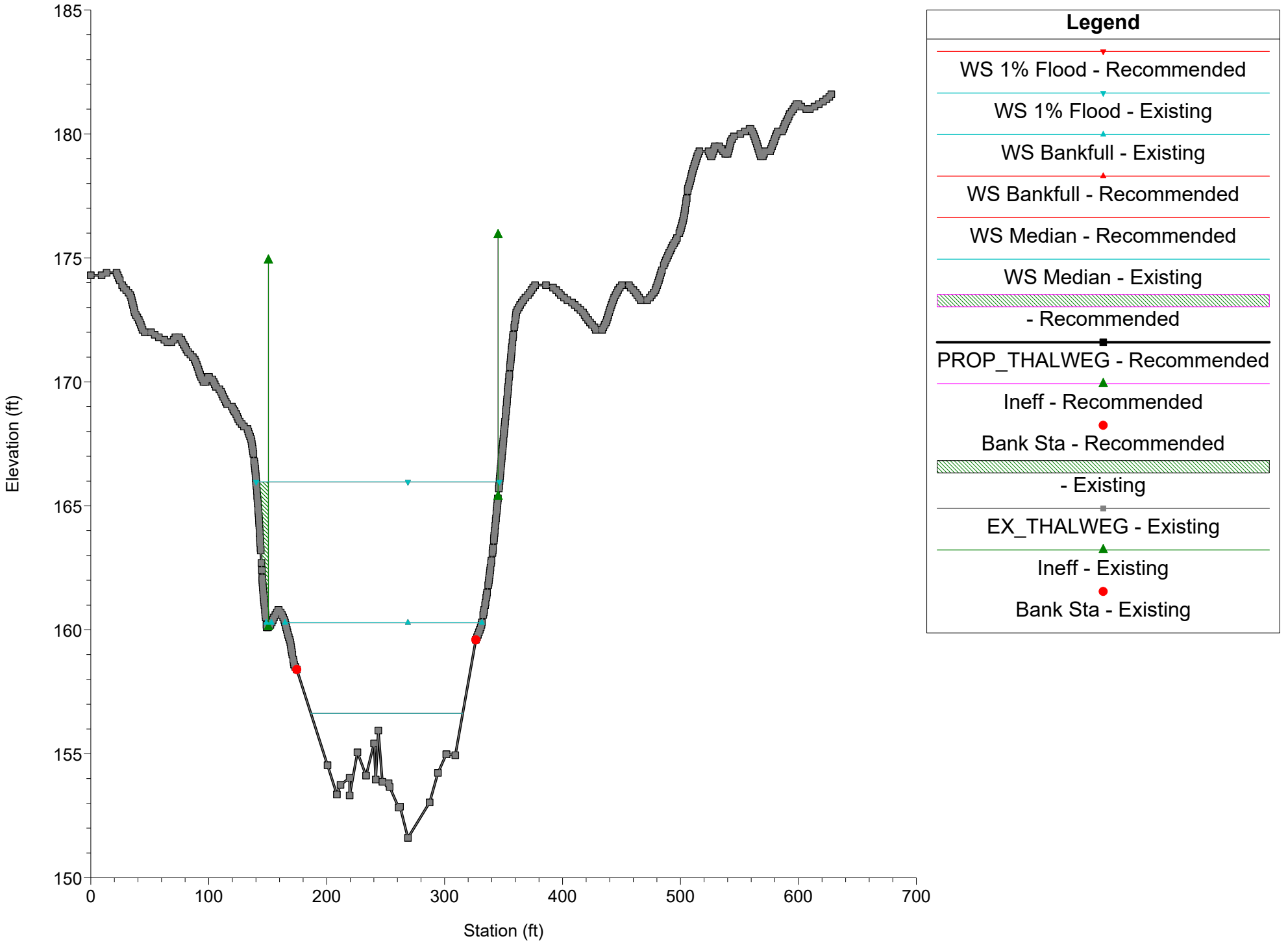
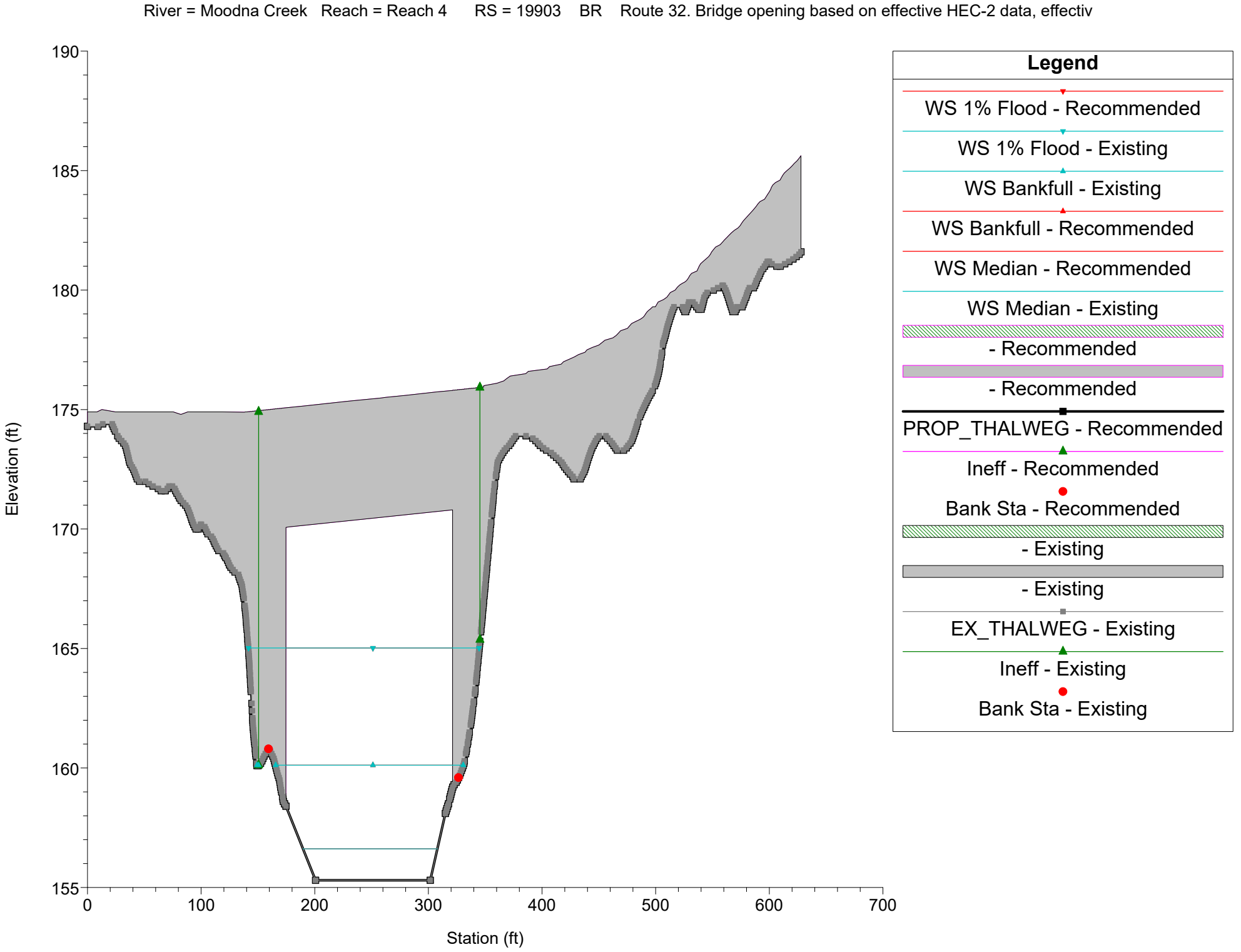


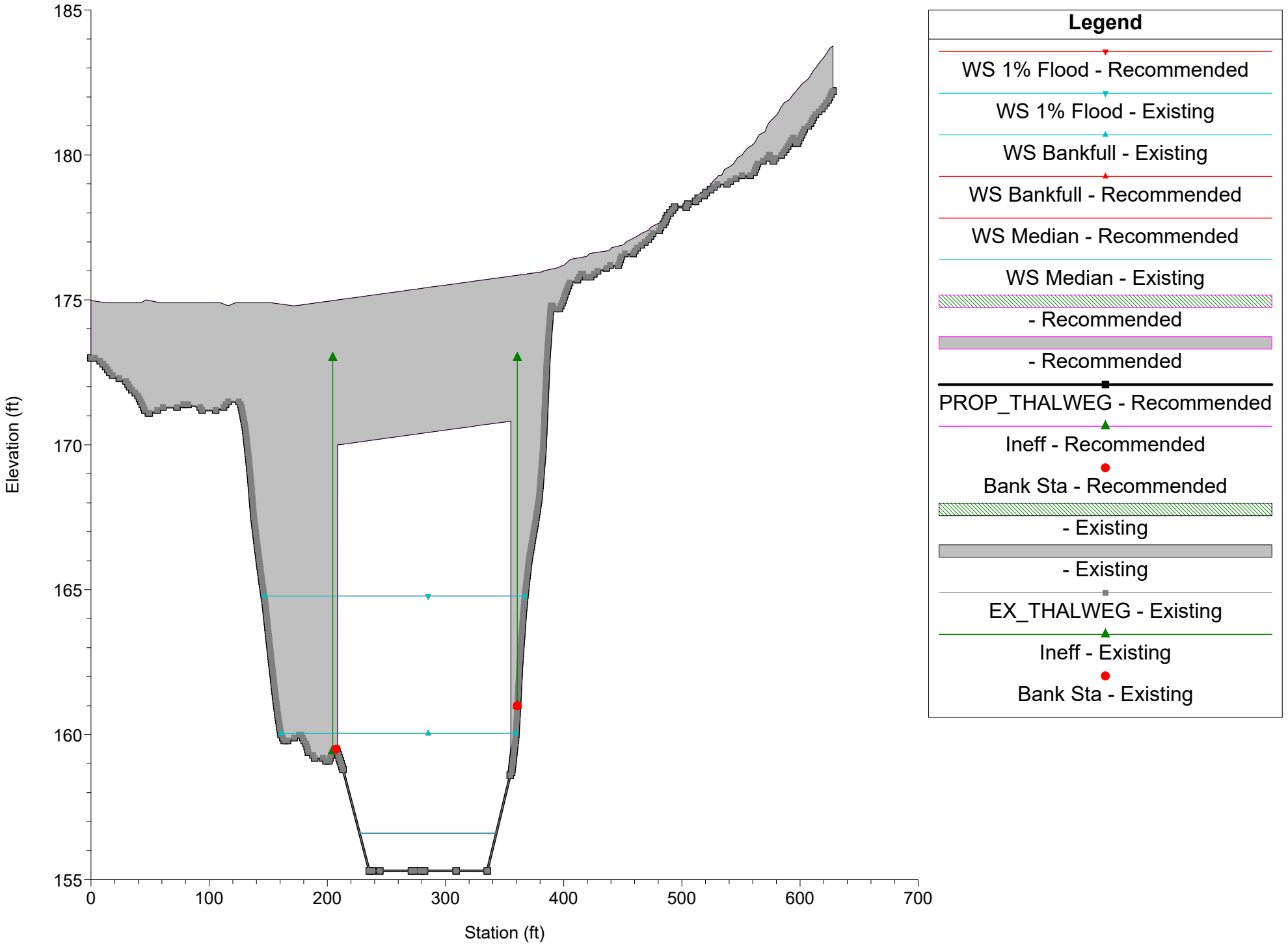
HEC-RAS Model Plan: 1) Existing 2) Recommended

River = Moodna Creek Reach = Reach 4 RS = 19903 BR Route 32. Bridge opening based on effective HEC-2 data, effectiv



HEC-RAS Model Plan: 1) Existing 2) Recommended

River = Moodna Creek Reach = Reach 4 RS = 19903 BR Route 32. Bridge opening based on effective HEC-2 data, effectiv



HEC-RAS Model Plan: 1) Existing 2) Recommended

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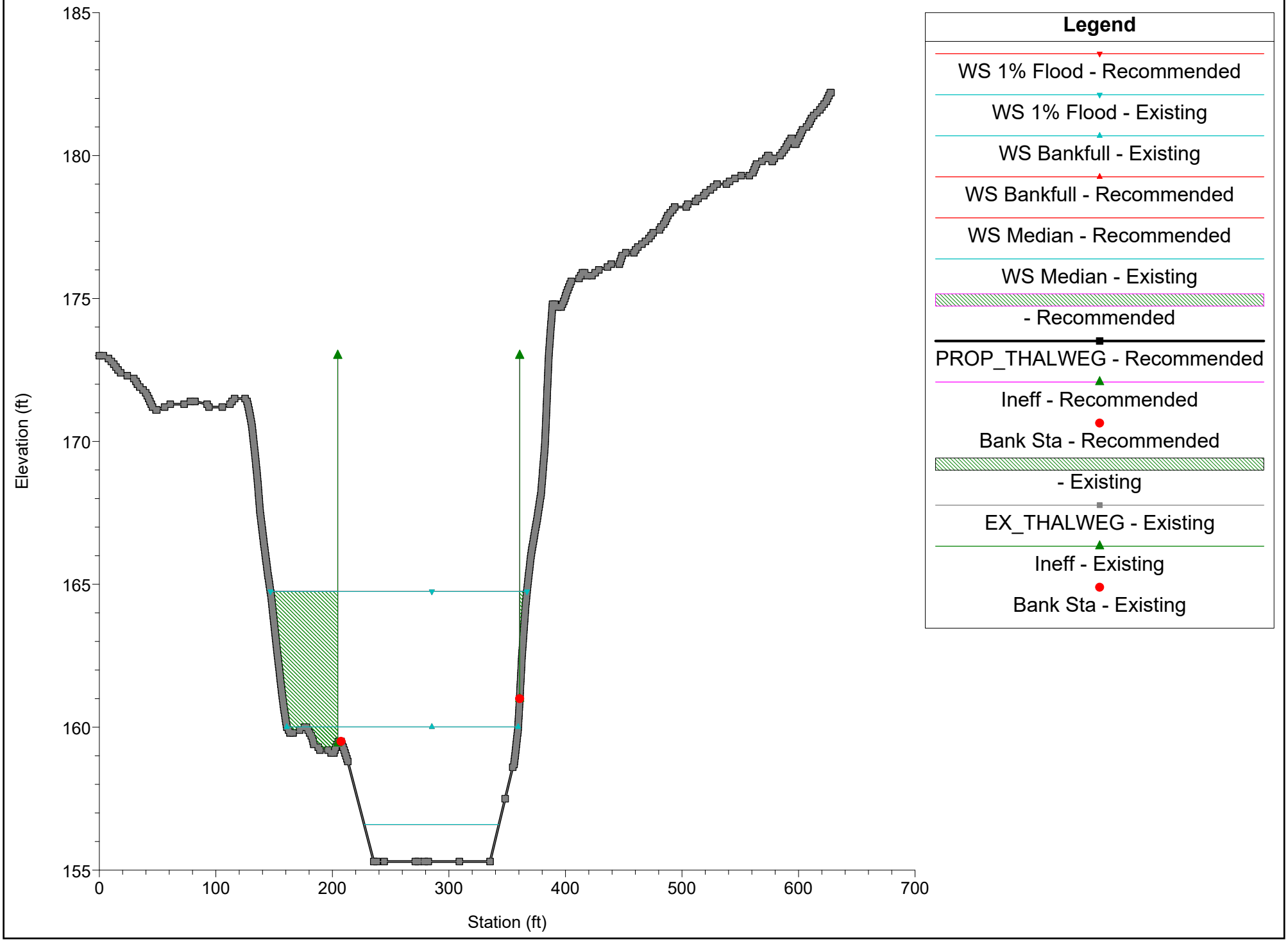

HEC-RAS Model Plan: 1) Existing 2) Recommended

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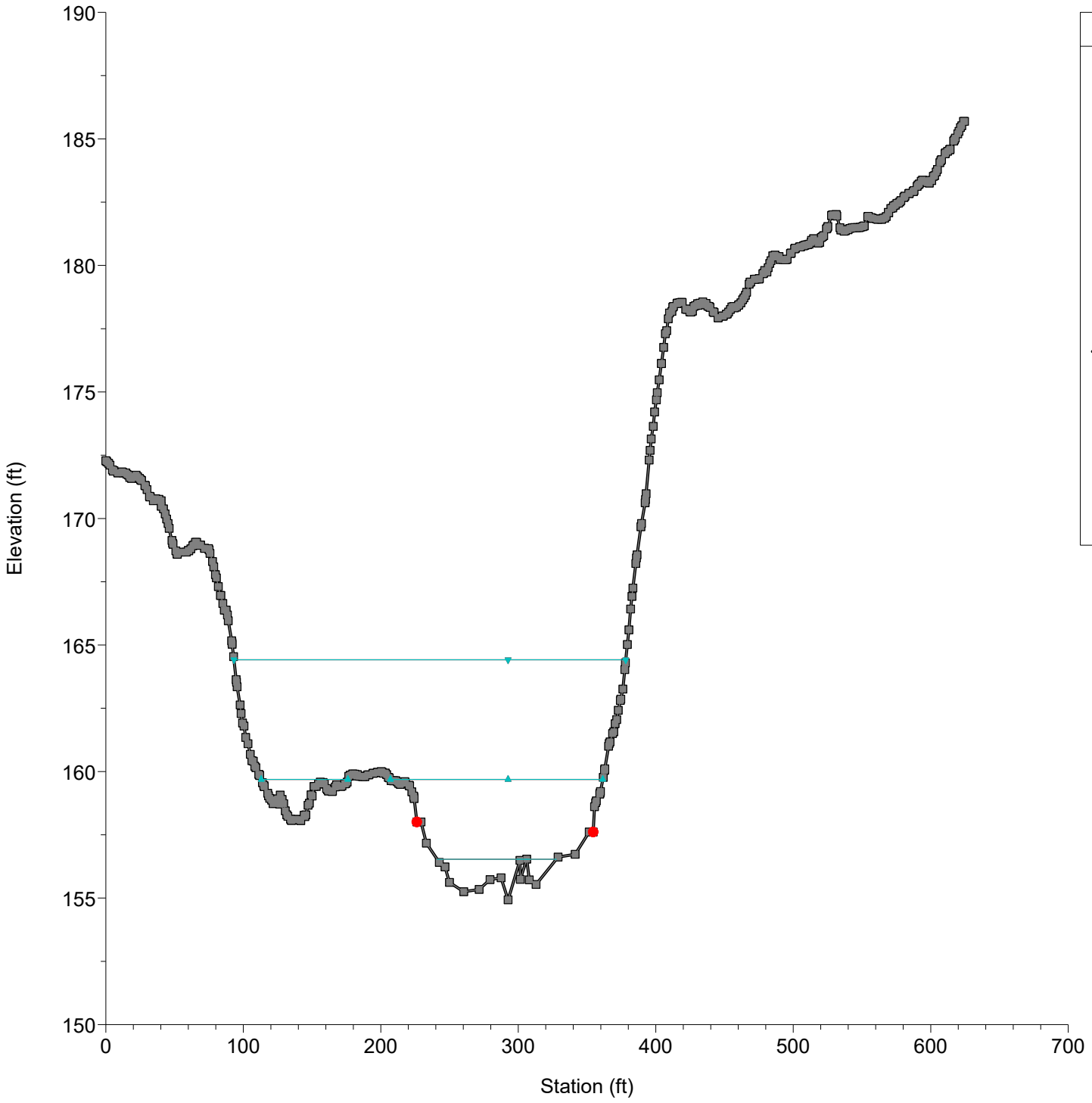
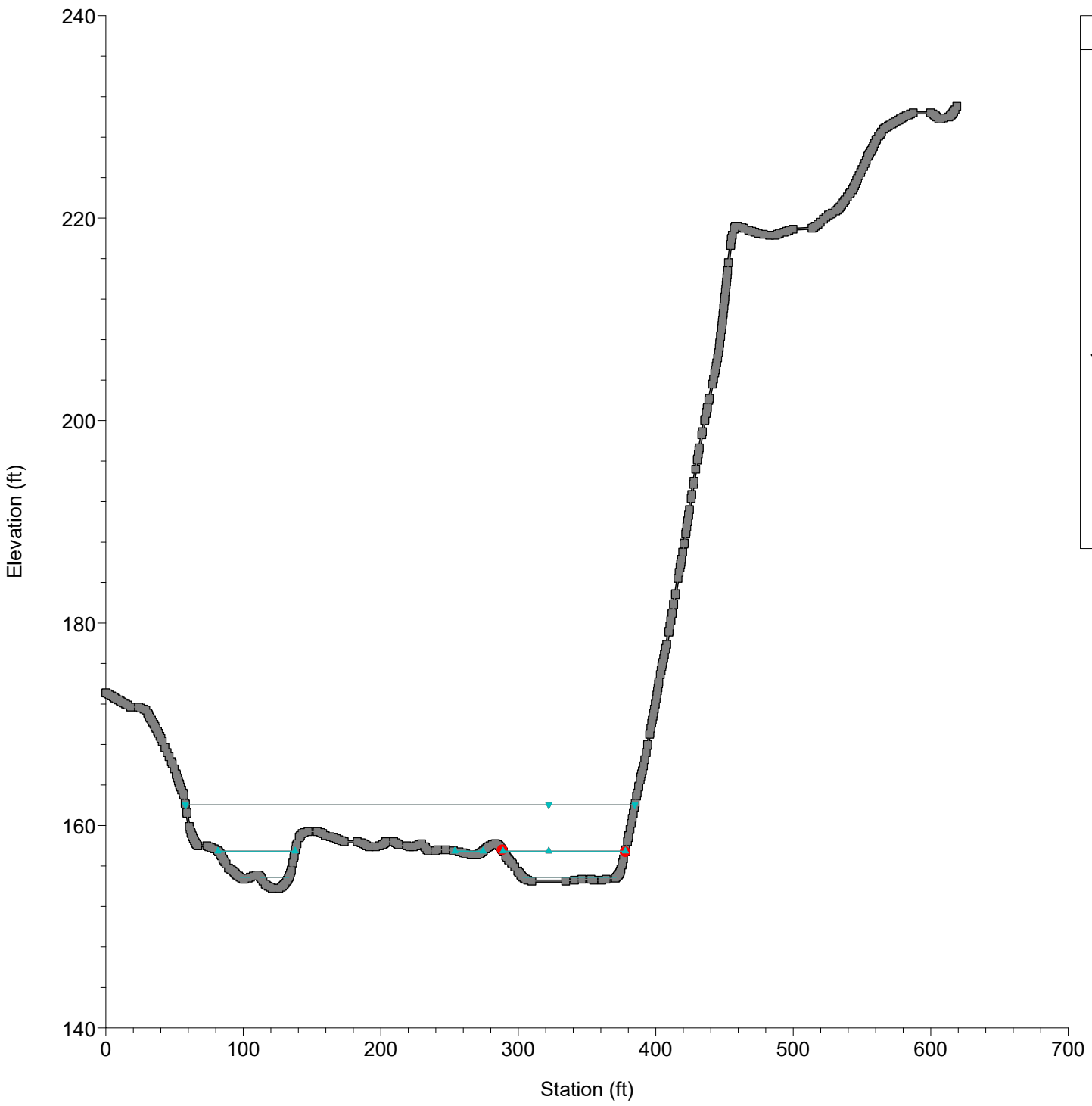


HEC-RAS Model Plan: 1) Existing 2) Recommended

River = Moodna Creek Reach = Reach 4 RS = 19655



ATTACHMENT C

RELATIVE SEA LEVEL CHANGE ANALYSIS

HUDSON RIVER HABITAT RESTORATION

ECOSYSTEM RESTORATION
FINAL INTEGRATED FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT

Relative Sea Level Change Analysis

Henry Hudson Park & Schodack Island Park

U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT

August 2020

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Introduction

The Department of the Army's Engineering Circular EC-1100-2-8162 requires that future sea level change projections must be incorporated into the planning, engineering design, construction, and operation of all civil works projects. The project team should evaluate structural and non-structural components of the proposed alternative in consideration of the "low," "intermediate", and "high" potential rates of future sea level change.

To fulfill this requirement, a Relative Sea Level Change (SLC) analysis was conducted for the selected alternatives at Henry Hudson Park and Schodack Island Park. Specifically, this analysis evaluated the migration of proposed habitat zones under potential future tidal range scenarios. Habitat zone migration was modeled using spatial analysis methods to compare proposed design topography, tidal datum elevations, projected SLC rates, and assumed accretion rates.

Existing Tidal Datums

Existing tidal datums, as of 2018, were calculated using water surface elevation records from the Hudson River Environmental Conditions Observing System (HRECOS) Schodack Island gauge, which is located in the Hudson River adjacent to Schodack Island Park and approximately 3 miles downstream from Henry Hudson Park. Observations at the HRECOS gauges are not subject to external review. For the purpose of this study, datums for the HRECOS Schodack Island gauge were calculated using records from January 2013 through October 2018.

Tidal datums were calculated using the USACE software HEC-DSSVue, version 2.0.1. The existing tide range at the site ranges from 3.80 feet NAVD88 at Mean Higher High Water (MHHW) to -1.63 feet NAVD88 and Mean Lower Low Water (MLLW) (Figure 1).

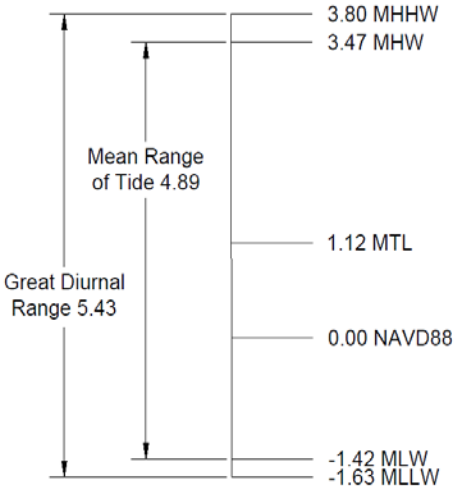

Figure 1: 2018 Tidal Datums at Henry Hudson Park and Schodack Island Park, relative to NAVD88, feet.

Sea Level Change Projections

Relative SLC on-site, and along the Hudson River overall, have historically trended positive, resulting in a net Sea Level Rise (SLR). This trend is expected to continue and accelerate in the foreseeable future. Relative Sea Level Change (SLC) projections were estimated using the USACE Sea-Level Change Curve Calculator v. 2017.55. SLC projections were estimated from 2018 to 2100, in 5-year increments, for the NOAA Gauge at The Battery, NY (8518750), and applied to local tidal datums as calculated from the HRECOS Schodack Island gauge. The calculator provided three SLC projection scenarios based on USACE 2013 low, intermediate, and high curves:

1. Low Curve – Computed using the historic rate of sea-level change, representing the minimum expected SLC.
2. Intermediate Curve - Computed from the modified NRC Curve I, considering both the most recent IPCC projections and modified NRC projections with the local rate of vertical land movement added.

3. High Curve - computed from the modified NRC Curve III, considering both the most recent IPCC projections and modified NRC projections with the local rate of vertical land movement added.

This analysis assumed that the proposed design construction would begin in 2025 with a 1.5-year and 2-year construction duration for Henry Hudson Park and Schodack Island Park, respectively. Therefore, tidal datum projections for 2027, intermediate rate curve, were used as a baseline for design elevations and planting ranges. Relative SLC for 2027 was calculated using linear interpolation of the SLC values for the two closest time step intervals (i.e. 2025 and 2030). Projected tidal datums for the 20-year (2047), 25-year (2052), 50-year (2077), and 55-year (2082) time horizons were also calculated in an identical fashion. Henry Hudson Park was evaluated using 20-year and 50-year projected tidal datums (Table 1) while Schodack Island Park was evaluated using 25-year and 55-year projected tidal datums (Table 2).

Table 1: Henry Hudson Park tidal datum predictions for the low, intermediate, and high rates of sea level change.

Datum	2018	2027 (ft, NAVD88)			2047 (ft, NAVD88)			2077 (ft, NAVD88)		
		LOW	INT	HIGH	LOW	INT	HIGH	LOW	INT	HIGH
MHHW	3.80	3.88	3.93	4.09	4.07	4.28	4.94	4.34	4.92	6.76
MHW	3.47	3.55	3.60	3.76	3.74	3.95	4.61	4.01	4.59	6.43
MTL	1.12	1.20	1.25	1.41	1.39	1.60	2.26	1.66	2.24	4.08
MLW	-1.42	-1.34	-1.29	-1.13	-1.15	-0.94	-0.28	-0.88	-0.30	1.54
MLLW	-1.63	-1.54	-1.49	-1.33	-1.35	-1.14	-0.48	-1.08	-0.50	1.34

Table 2: Schodack Island Park tidal datum predictions for the low, intermediate, and high rates of sea level change.

Datum	2018	2027 (ft, NAVD88)			2052 (ft, NAVD88)			2082 (ft, NAVD88)		
		LOW	INT	HIGH	LOW	INT	HIGH	LOW	INT	HIGH
MHHW	3.80	3.88	3.93	4.09	4.11	4.37	5.20	4.38	5.04	7.14
MHW	3.47	3.55	3.60	3.76	3.78	4.04	4.87	4.05	4.71	6.81
MTL	1.12	1.20	1.25	1.41	1.43	1.69	2.52	1.70	2.36	4.46
MLW	-1.42	-1.34	-1.29	-1.13	-1.11	-0.85	-0.02	-0.84	-0.18	1.92
MLLW	-1.63	-1.54	-1.49	-1.33	-1.31	-1.05	-0.22	-1.04	-0.38	1.72

Habitat Zone Elevation Ranges

As previously stated, the proposed design grading and habitat zone ranges were based on the intermediate rate curve projected tidal ranges for 2027, the assumed construction completion year. Proposed habitat zones and design elevations were as follows:

Table 3: Design habitat zone elevation ranges at Henry Hudson Park. Design assumes project completion year of 2027 with intermediate rate SLR.

Habitat Zone	Tidal Range	Design Elevation NAVD88 - Feet (2027)
Upland Herbaceous, Upland Shrub	Above MHHW	> 3.93
Upper Tidal Wetland	MTL – MHHW	1.25 – 3.93
Lower Tidal Wetland	MLW - MTL	-1.29 – 1.25
Open Water	Below MLW	< -1.29

Table 4: Design habitat zone elevation ranges at Schodack Island Park. Design assumes project completion year of 2027 with intermediate rate SLR.

Habitat Zone	Tidal Range	Design Elevation NAVD88 - Feet (2027)
Upland Herbaceous, Upland Shrub*	Above MHHW	> 3.93
Scrub Shrub Wetland*	MHHW – Elev 5.0 (NAVD88)	3.93 – 5.0
Upper Tidal Wetland	MTL – MHHW	1.25 – 3.93
Lower Tidal Wetland	MLW - MTL	-1.29 – 1.25
Open Water	Below MLW	< -1.29

*Upland Herbaceous and Upland Shrub zones are proposed along steep slopes while the Scrub Shrub Wetland zone is proposed along flatter areas.

It was assumed that as tidal ranges shift with SLR, habitat zone ranges would remain consistent relative to tidal datums. For example, upper tidal wetland would occur between MTL and MHHW regardless of the projected elevation of those tidal datums. Table 5 and Table 6 illustrate the shift in habitat zones relative to SLR.

Table 5: Projected habitat zone elevation ranges at Henry Hudson Park.

Habitat Zone	Tidal Range	Low Rate Curve Elevation (NAVD88 – Feet)		Intermediate Rate Curve Elevation (NAVD88 – Feet)		High Rate Curve Elevation (NAVD88 – Feet)	
		2047	2077	2047	2077	2047	2077
Upland Herbaceous, Upland Shrub	Above MHHW	> 4.07	> 4.34	> 4.28	> 4.92	> 4.94	> 6.76
Upper Tidal Wetland	MTL – MHHW	1.39 – 4.07	1.66 – 4.34	1.60 – 4.28	2.24 – 4.92	2.26 – 4.94	4.08 – 6.76
Lower Tidal Wetland	MLW - MTL	-1.15 – 1.39	-0.88 – 1.66	-0.94 – 1.60	-0.30 – 2.24	-0.28 – 2.26	1.54 – 4.08
Open Water	Below MLW	< -1.15	< -0.88	< -0.94	< -0.30	< -0.28	< 1.54

Table 6: Projected habitat zone elevation ranges at Schodack Island Park.

Habitat Zone	Tidal Range	Low Rate Curve Elevation (NAVD88 – Feet)		Intermediate Rate Curve Elevation (NAVD88 – Feet)		High Rate Curve Elevation (NAVD88 – Feet)	
		2052	2082	2052	2082	2052	2082
Upland Herbaceous, Upland Shrub	Above MHHW	> 4.11	> 4.38	> 4.37	> 5.04	> 5.20	> 7.14
Scrub Shrub Wetland	MHHW – Elev 5.0 (NAVD88)	4.11 – 5.31	4.38 – 5.58	4.37 – 5.57	5.04 – 6.24	5.20 – 6.40	7.14 – 8.34
Upper Tidal Wetland	MTL – MHHW	1.43 – 4.11	1.70 – 4.38	1.69 – 4.37	2.36 – 5.04	2.52 – 5.20	4.56 – 7.14
Lower Tidal Wetland	MLW - MTL	-1.11 – 1.43	-0.84 – 1.70	-0.85 – 1.69	-0.18 – 2.36	-0.02 – 2.52	1.92 – 4.56
Open Water	Below MLW	< -1.11	< -0.84	< -0.85	< -0.18	< -0.02	< 1.92

Assumed Accretion Rates

Accretion is defined as the vertical growth of tidal wetland habitats as a result of sediment deposition and the accumulation of plant material. Accounting for accretion is a critical factor in evaluating the impacts of sea level change; tidal wetlands with accretion rates higher than SLR rates are able to outpace SLR while tidal wetlands with accretion rates lower than SLR rates become unsuitable for wetland vegetation and convert to tidal mudflat or open water.

The specific accretion rates of on-site tidal wetlands, at the time of this study, are unknown. Studies focused on Hudson River tidal wetlands have found that, overall, the tidal wetlands of the Hudson River are accreting at a rate equal to or outpacing current SLR rates (Raltson, Yellen, & Woodruff, 2020 [Submitted]). Sediment deposition rates in Hudson River tidal wetlands range from 0.5 – 29.0 mm/yr (Kiviat, Findlay, & Nieder, 2006). Anthropogenic modifications to the Hudson River over the past few centuries resulted in the direct loss of wetlands and side channels due to filling activities. However, despite these historic losses, there has been a net expansion of tidal wetlands compared to pre-industrial conditions. This expansion of tidal wetlands has occurred in areas such as coves impounded by railroad lines, and historically sub-tidal channels that were brought up to inter-tidal elevations due to filling activities. There is evidence to suggest that these anthropogenic tidal wetlands have higher accretion rates (8.0 - 11.0 mm/yr) compared to rates of historically undisturbed tidal wetlands (3.0 mm/yr) (Yellen et. al., 2020 [Preprint]).

An annual accretion rate of 4.0 mm/yr was used in this analysis for the intermediate and high SLC curve scenarios. A lower rate, 3.5 mm/yr, was used for the low SLC curve scenario. These rates were thought to be reasonably conservative accounting for the Hudson River accretion rate trends described above. It was assumed that accretion rates were consistent across the project area. Given the chosen accretion rates, projected cumulative accretion for the 20-year (2047), 25-year (2052), 50-year (2077), and 55-year (2082) time horizons are as follows:

Table 7: Projected cumulative accretion for tidal wetlands at Henry Hudson Park.

Year	Low Rate Cumulative Accretion (ft)	Intermediate and High Rate Cumulative Accretion (ft)
2047	0.23 ft	0.26 ft
2077	0.57 ft	0.66 ft

Table 8: Projected cumulative accretion for tidal wetlands at Schodack Island Park.

Year	Low Rate Cumulative Accretion (ft)	Intermediate and High Rate Cumulative Accretion (ft)
2052	0.29 ft	0.33 ft
2082	0.63 ft	0.72 ft

GIS Analysis Methodology

Habitat zone areas were calculated using geospatial analysis methods in ArcGIS 10.2.2. Proposed design grading contours were converted to Digital Elevation Model (DEM) raster surfaces using interpolation via the Delaunay triangulation method. Year 20, 25, 50, and 55 elevation DEMs were created by adding projected cumulative accretion values (Table 7, Table 8) to the proposed design DEM. It was assumed that no major topographic changes would occur beyond accretion; the analysis did not account for other potential erosional or depositional forces such as major flooding, ice scour, or wave driven erosion.

For each scenario, the DEM was classified into discrete habitat zones using the projected habitat zone elevation ranges presented in Table 5 and Table 6. It was also assumed that tidal wetlands would not accrete beyond the intertidal range (i.e. wetland habitat could not convert to upland habitat due to accretion). This assumption only affected the low rate scenarios, where accretion was assumed to outpace SLR. Finally, the classified DEMs were converted from raster to vector format in order to calculate the relative habitat zone acreages for each scenario.

Results

Habitat zones were mapped for each SLC scenario (Appendix I) and the habitat zone acreages were compared to Year 0 baseline conditions. The resulting acreages and net change from baseline conditions are presented in Table 9 for Henry Hudson Park and Table 10 for Schodack Island Park.

Table 9: Projected habitat zone area and net change for Henry Hudson Park.

LOW CURVE							
TOTAL AREA (ACRES)				NET CHANGE (ACRES)			
Vegetation Zone	Design (Year 0)	Year 20	Year 50	Vegetation Zone	Design (Year 0)	Year 20	Year 50
Upland Shrub	0.47	0.47	0.47	Upland Shrub	0.00	0.00	0.00
Upland Herbaceous	0.47	0.47	0.47	Upland Herbaceous	0.00	0.00	0.00
Upper Tidal Wetland	3.94	3.96	3.97	Upper Tidal Wetland	0.00	+0.02	+0.03
Lower Tidal Wetland	0.39	0.38	0.37	Lower Tidal Wetland	0.00	-0.01	-0.02
Open Water	0.00	0.00	0.00	Open Water	0.00	0.00	0.00
INTERMEDIATE CURVE							
TOTAL AREA (ACRES)				NET CHANGE (ACRES)			
Vegetation Zone	Design (Year 0)	Year 20	Year 50	Vegetation Zone	Design (Year 0)	Year 20	Year 50
Upland Shrub	0.47	0.46	0.44	Upland Shrub	0.00	-0.01	-0.03
Upland Herbaceous	0.47	0.47	0.47	Upland Herbaceous	0.00	0.00	0.00
Upper Tidal Wetland	3.94	3.95	3.93	Upper Tidal Wetland	0.00	+0.01	-0.01
Lower Tidal Wetland	0.39	0.40	0.43	Lower Tidal Wetland	0.00	+0.01	+0.04
Open Water	0.00	0.00	0.00	Open Water	0.00	0.00	0.00
HIGH CURVE							
TOTAL AREA (ACRES)				NET CHANGE (ACRES)			
Vegetation Zone	Design (Year 0)	Year 20	Year 50	Vegetation Zone	Design (Year 0)	Year 20	Year 50
Upland Shrub	0.47	0.42	0.33	Upland Shrub	0.00	-0.05	-0.14
Upland Herbaceous	0.47	0.46	0.14	Upland Herbaceous	0.00	-0.01	-0.33
Upper Tidal Wetland	3.94	3.90	4.13	Upper Tidal Wetland	0.00	-0.04	+0.19
Lower Tidal Wetland	0.39	0.44	0.36	Lower Tidal Wetland	0.00	+0.05	-0.03
Open Water	0.00	0.06	0.33	Open Water	0.00	+0.06	+0.33

Table 10: Projected habitat zone area and net change for Schodack Island Park.

LOW CURVE							
TOTAL AREA (ACRES)				NET CHANGE (ACRES)			
Vegetation Zone	Design (Year 0)	Year 20	Year 50	Vegetation Zone	Design (Year 0)	Year 20	Year 50
Upland Shrub	2.17	2.17	2.17	Upland Shrub	0.00	0.00	0.00
Upland Herbaceous	0.49	0.49	0.49	Upland Herbaceous	0.00	0.00	0.00
Scrub Shrub Wetland	15.92	16.47	16.82	Scrub Shrub Wetland	0.00	+0.55	+0.90
Upper Tidal Wetland	9.21	8.75	8.45	Upper Tidal Wetland	0.00	-0.47	-0.76
Lower Tidal Wetland	2.48	2.42	2.39	Lower Tidal Wetland	0.00	-0.06	-0.09
Open Water	0.61	0.59	0.57	Open Water	0.00	-0.03	-0.04
INTERMEDIATE CURVE							
TOTAL AREA (ACRES)				NET CHANGE (ACRES)			
Vegetation Zone	Design (Year 0)	Year 20	Year 50	Vegetation Zone	Design (Year 0)	Year 20	Year 50
Upland Shrub	2.17	2.00	1.83	Upland Shrub	0.00	-0.17	-0.34
Upland Herbaceous	0.49	0.47	0.46	Upland Herbaceous	0.00	-0.02	-0.03
Scrub Shrub Wetland	15.92	10.48	8.32	Scrub Shrub Wetland	0.00	-5.44	-7.60
Upper Tidal Wetland	9.21	14.75	16.85	Upper Tidal Wetland	0.00	+5.53	+7.63
Lower Tidal Wetland	2.48	2.54	2.72	Lower Tidal Wetland	0.00	+0.07	+0.25
Open Water	0.61	0.64	0.70	Open Water	0.00	+0.03	+0.09
TOTAL AREA (ACRES)				NET CHANGE (ACRES)			
Vegetation Zone	Design (Year 0)	Year 20	Year 50	Vegetation Zone	Design (Year 0)	Year 20	Year 50
Upland Shrub	2.17	0.87	0.63	Upland Shrub	0.00	-1.30	-1.54
Upland Herbaceous	0.49	0.47	0.39	Upland Herbaceous	0.00	-0.02	-0.11
Scrub Shrub Wetland	15.92	4.80	0.15	Scrub Shrub Wetland	0.00	-11.12	-15.77
Upper Tidal Wetland	9.21	19.80	17.91	Upper Tidal Wetland	0.00	+10.59	+8.70
Lower Tidal Wetland	2.48	4.11	8.76	Lower Tidal Wetland	0.00	+1.64	+6.28
Open Water	0.61	0.83	3.05	Open Water	0.00	+0.22	+2.44

Table 11: Projected habitat zone area as percentage of design (Year 0) for Henry Hudson Park.

Vegetation Zone	Design (Year 0)	Low Curve		Intermediate Curve		High Curve	
		2052	2082	2052	2082	2052	2082
Upland Shrub	*100%*	*100%*	*100%*	*98%*	*95%*	*90%*	*71%*
Upland Herbaceous	*100%*	*100%*	*100%*	*98%*	*98%*	*98%*	*29%*
Upper Tidal Wetland	*100%*	*100%*	*101%*	*100%*	*100%*	*99%*	*105%*
Lower Tidal Wetland	*100%*	*97%*	*94%*	*103%*	*110%*	*112%*	*91%*
Open Water*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*

*** No open water areas (areas below MLW) are present under design conditions, therefore a percent change could not be calculated.**

Table 12: Projected habitat zone area as percentage of design (Year 0) for Schodack Island Park.

Vegetation Zone	Design (Year 0)	Low Curve		Intermediate Curve		High Curve	
		2052	2082	2052	2082	2052	2082
Upland Shrub	*100%*	*100%*	*100%*	*92%*	*84%*	*40%*	*29%*
Upland Herbaceous	*100%*	*100%*	*100%*	*96%*	*94%*	*95%*	*78%*
Scrub Shrub Wetland	*100%*	*103%*	*106%*	*66%*	*52%*	*30%*	*1%*
Upper Tidal Wetland	*100%*	*95%*	*92%*	*160%*	*183%*	*215%*	*194%*
Lower Tidal Wetland	*100%*	*98%*	*96%*	*103%*	*110%*	*166%*	*354%*
Open Water	*100%*	*96%*	*93%*	*104%*	*115%*	*136%*	*499%*

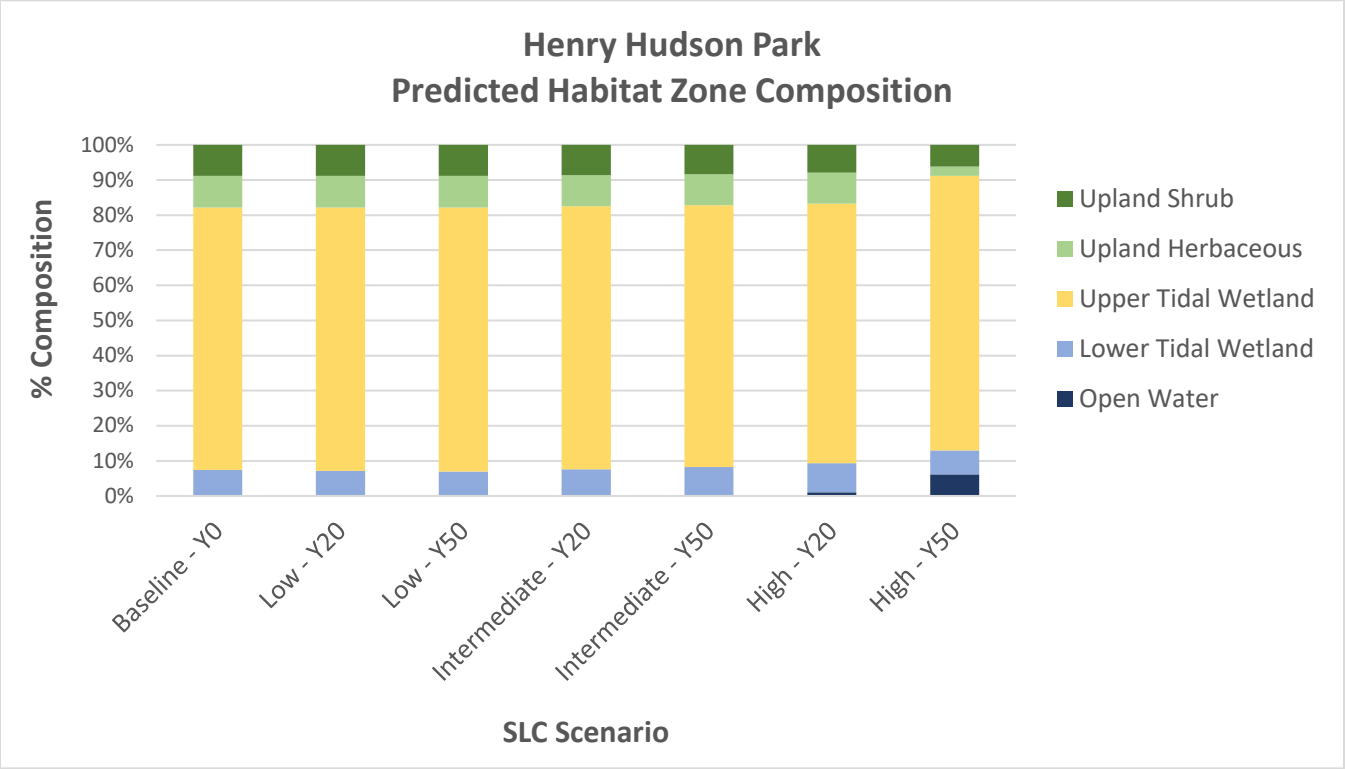

Figure 2: Predicted habitat zone composition as percentage of total site area for Henry Hudson Park.

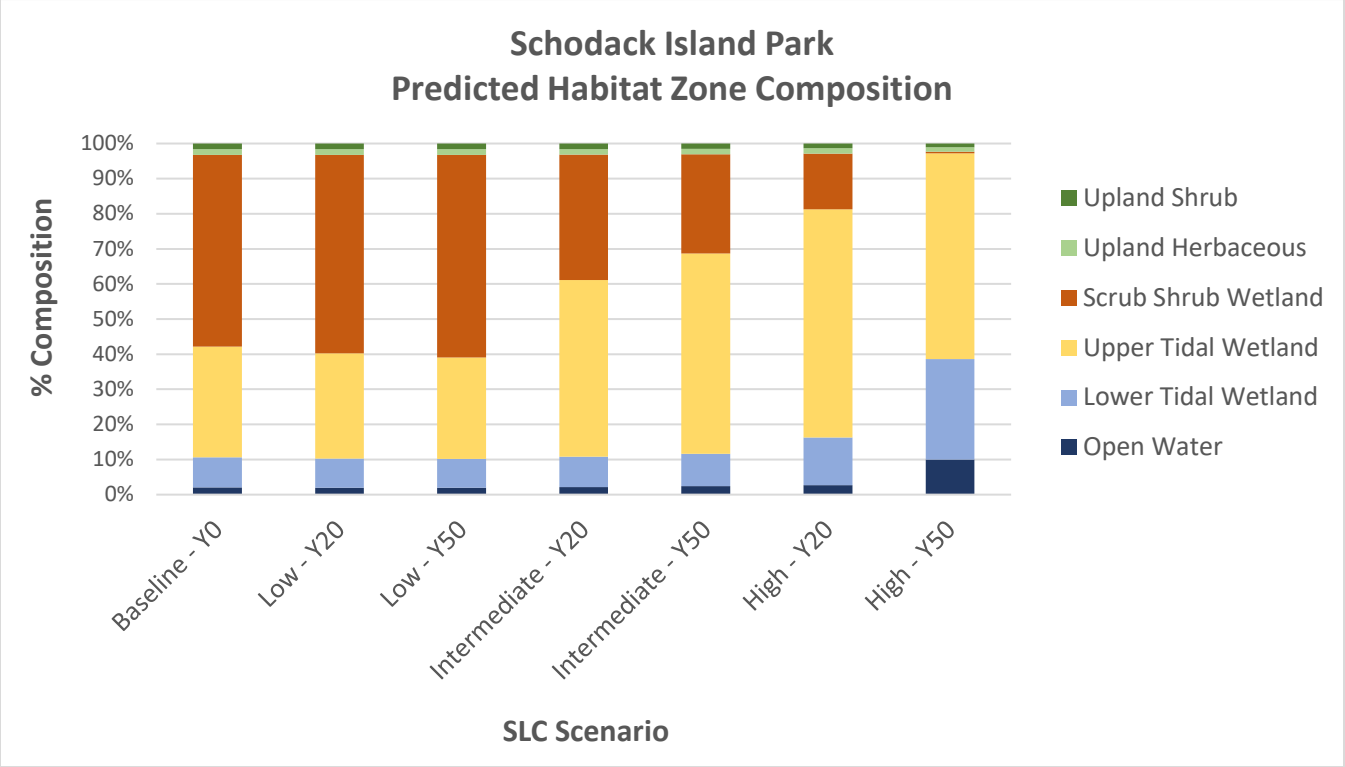

Figure 3: Predicted habitat zone composition as percentage of total site area for Schodack Island Park.

Discussion

Henry Hudson Park

Under low curve SLC projections, the lower tidal wetland area is predicted to decrease slightly by Years 20 and 50, while the upper tidal wetland area is predicted to increase slightly by Years 20 and 50 (Table 9).

Under intermediate curve SLC projections, the lower tidal wetland area is predicted to decrease slightly by Years 20 and 50, while the upland shrub area is predicted to increase slightly by Years 20 and 50. The upper tidal wetland area is predicted to initially increase slightly by Year 20 but decrease slightly by Year 50.

Under high curve SLC projections, the open water area is predicted to increase slightly by Years 20 and 50, while the upland shrub and upland herbaceous area is predicted to decrease slightly by Years 20 and 50. The Lower tidal wetland area is predicted to initially increase by Year 20 but decrease by Year 50, while the upper tidal wetland area is predicted to initially decrease by Year 20 but increase by Year 50.

Overall, predicted habitat zone area changes are expected to be minor (Figure 2). Habitat zone area changes are predicted to not exceed 0.06 acres under all scenarios apart from the high curve - Year 50 scenario. Under the high curve – Year 50 scenario, the greatest predicted change in area occurs in the open water and upland herbaceous areas. These areas are predicted to increase and decrease, respectively, by 0.33 acres. The greatest percent change compared to design area is predicted to occur in the upland herbaceous area under the high curve scenario, which is predicted to decrease to 29% of its design area by Year 50 (Table 11). Under all scenarios, the upper and lower tidal wetland areas are predicted to remain within 12% of their design areas (Table 11). While the balance between upper and lower tidal wetlands varies between each scenario, the total area of tidal wetlands (upper + lower) is expected to remain constant or expand under all SLC projections for both Year 20 and Year 50. Open water areas (areas below the intertidal range) are expected to encroach upon the site only under high curve SLC projections.

The vegetated riprap project component consists of a 3H:1V slope set within the baseline tidal range. Therefore, habitat zone boundaries are expected to shift more significantly along this component compared to the rest of the site. The proposed western tidal wetland project component consists of a relatively flat marsh plain set approximately at MHHW under design conditions (Year 0; elev. 3.93 ft. NAVD88). Flat marsh plains such as this are generally more vulnerable to SLR impacts since they can be rapidly lost if SLR exceeds a critical elevation (i.e. MLLW rises above the marsh plain). However, SLR is not expected to exceed this critical elevation under any scenario. Habitat zone boundaries in the western tidal wetland therefore remain nearly consistent under even the highest SLC projections. The cove tidal wetland project component also consists of a marsh plain; however, it is set at elevation 0.00 (ft. NAVD88). Therefore, the cove tidal wetland contains the most extreme conversion of intertidal habitat to subtidal habitat under the Year 50 high curve SLC projections.

Schodack Island Park

Under low curve SLC projections, the scrub shrub wetland area is predicted to increase by Years 20 and 50, while the upper tidal wetland, lower tidal wetland, and open water areas are predicted to decrease slightly by Years 20 and 50 (Table 10).

Under intermediate and high curve SLC projections, the upland shrub, upland herbaceous, and scrub shrub wetland areas are predicted to decrease by Years 20 and 50, while the upper tidal wetland, lower tidal wetland, and open water areas are predicted to increase slightly by Years 20 and 50.

Overall, predicted habitat zone area changes are expected to vary greatly depending on the habitat zone and SLC scenario (Figure 3). The upland herbaceous and open water areas are the most stable, remaining relatively close to their design areas except for the high curve - Year 50 scenario. Under the high curve – Year 50 scenario however, open water increases significantly, approximately 5-fold, at the expense of scrub shrub wetland, which is reduced to 1% of its original area (Table 12). The lower tidal wetland area is predicted to increase over time under the intermediate and high curve SLC scenarios. The upper tidal wetland area is also predicted to increase over time under the intermediate and high curve SLC scenarios; however, by Year 50 under the high curve scenario upper tidal wetlands begin to decrease in favor of lower tidal wetlands. The total area of wetlands (scrub shrub + upper + lower) is expected to expand under all SLC projections for both Year 20 and Year 50 with the exception of the high curve – Year 50 scenario, where it decreases slightly.

The proposed floodplain consists of a relatively flat shrub scrub marsh plain set just slightly above MHHW under design conditions (Year 0; elev. 4.00 – 5.00 NAVD88), bisected by an intertidal side channel. Under any amount of net SLR, the intertidal range will begin to overtop the side channel banks, expanding upper tidal wetland and contracting shrub scrub wetland. This does not occur under the low curve SLC scenario, where accretion exceeds SLR. While the intertidal range is predicted to overtop the side channel over time, the side channel is predicted to completely contain the subtidal range, under all scenarios, preventing open water areas from encroaching upon the proposed floodplain. Therefore, while the type of wetland in the floodplain is expected to change over time, the overall wetland area in the floodplain is expected to remain relatively constant.

The proposed Schodack Creek Tributary expansion consists of a channel set within the intertidal range under design conditions (Year 0; elev. 0.00 ft. NAVD88), containing free-flowing water under daily mean and high tides. This channel remains within the intertidal range under all scenarios except the high curve – Year 50 scenario, where the subtidal range rises above the channel. Once this occurs, the channel is expected to contain free-flowing open water throughout a typical day regardless of tide stage. This accounts for the majority of the increase in open water area under the high curve – Year 50 scenario.

The Hudson River and Schodack Creek Tributary wetlands consist of tidal wetlands which are present under pre-restoration conditions and will remain post-restoration. These wetlands will be treated for invasive species and re-planted, but not re-graded. These wetlands are predicted to transition from scrub shrub/upper tidal wetland dominated to upper/lower tidal wetland dominated steadily over time with SLR. The Hudson Tidal wetland also contains several isolated upland areas, which are predicted to transition to tidal wetland areas under the high curve – Year 50 scenario.

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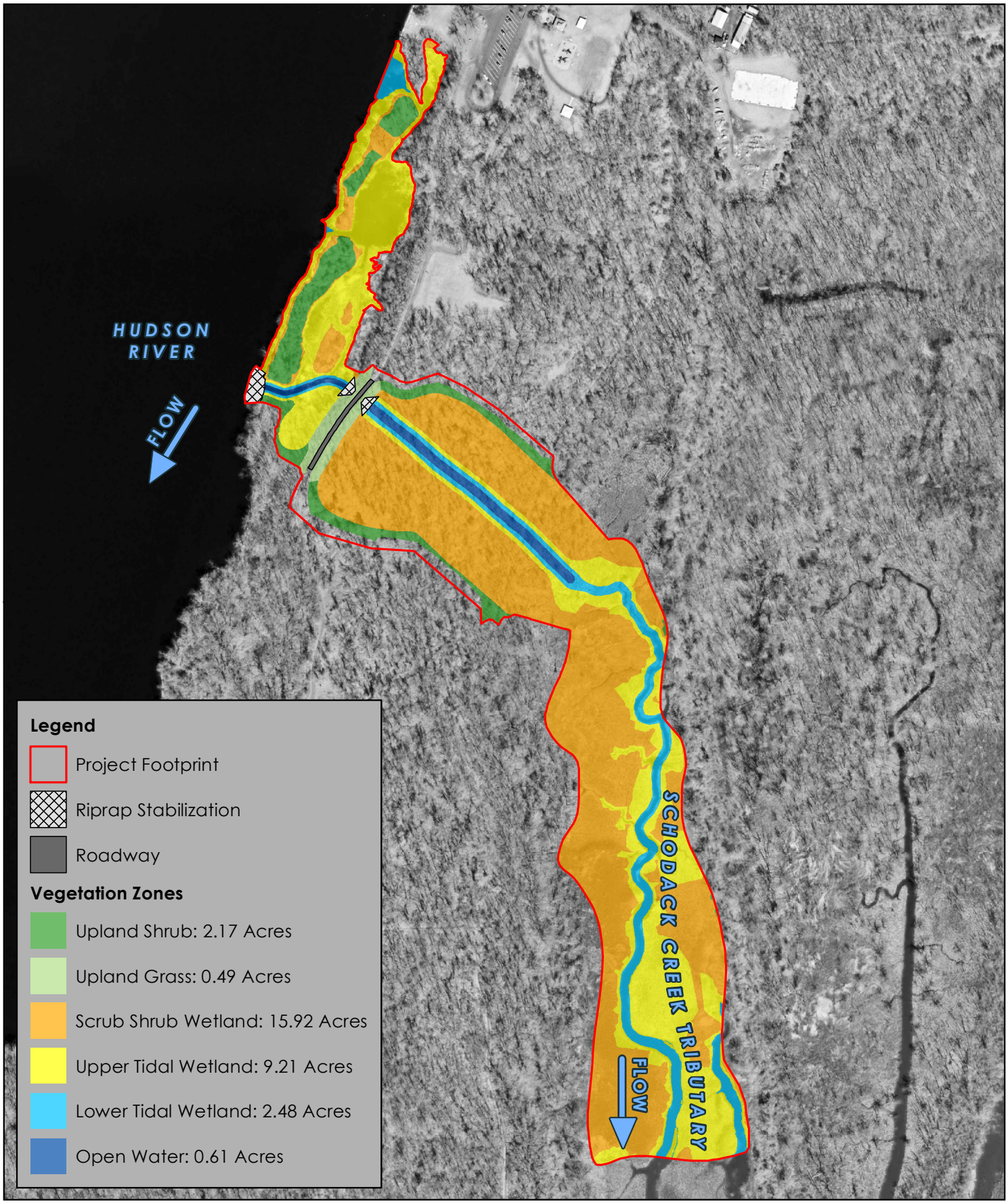
Kiviat, E., S. E. G. Findlay, and W. C. Nieder. "Tidal wetlands of the Hudson River estuary." *The Hudson River Estuary*. (2006): 279-295.

Ralston, David, Brian Yellen, and Jonathon Woodruff. "Watershed sediment supply and potential impacts of dam removals for an estuary." *Estuaries and Coasts [Submitted]*. (2020).

Yellen, B., Woodruff, J., Ladlow, C., Ralston, D., Fernald, S., Lau, W. “Rapid Tidal Marsh Development in Anthropogenic Backwaters.” *EarthArXiv [Preprint]*. (2020)



NOTES:
1. 2017 orthoimagery obtained from the New York State GIS Clearinghouse: gis.ny.gov

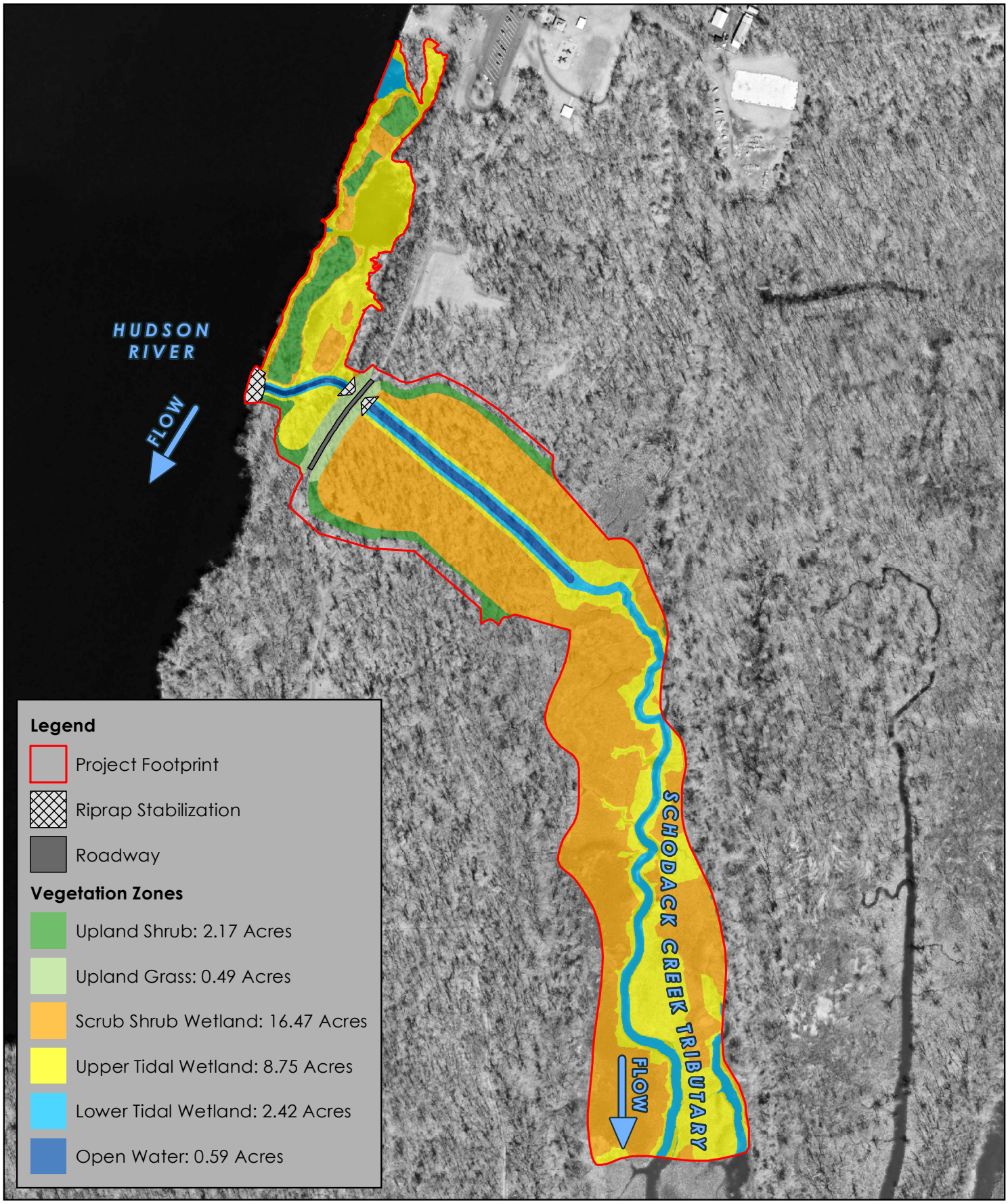
0 200 400 Feet

Map Projection: NAD 1983 StatePlane New York East FIPS 3101 Feet

PROPOSED CONDITIONS
Y0 - 2027

HUDSON RIVER HABITAT RESTORATION
SCHODACK ISLAND STATE PARK
TOWN OF SCHODACK
RENSSELAER COUNTY, NEW YORK

US Army Corps of Engineers®
New York District



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SLC LOW CURVE
Y20 - 2052

HUDSON RIVER HABITAT RESTORATION
SCHODACK ISLAND STATE PARK
TOWN OF SCHODACK
RENSSELAER COUNTY, NEW YORK

US Army Corps of Engineers®
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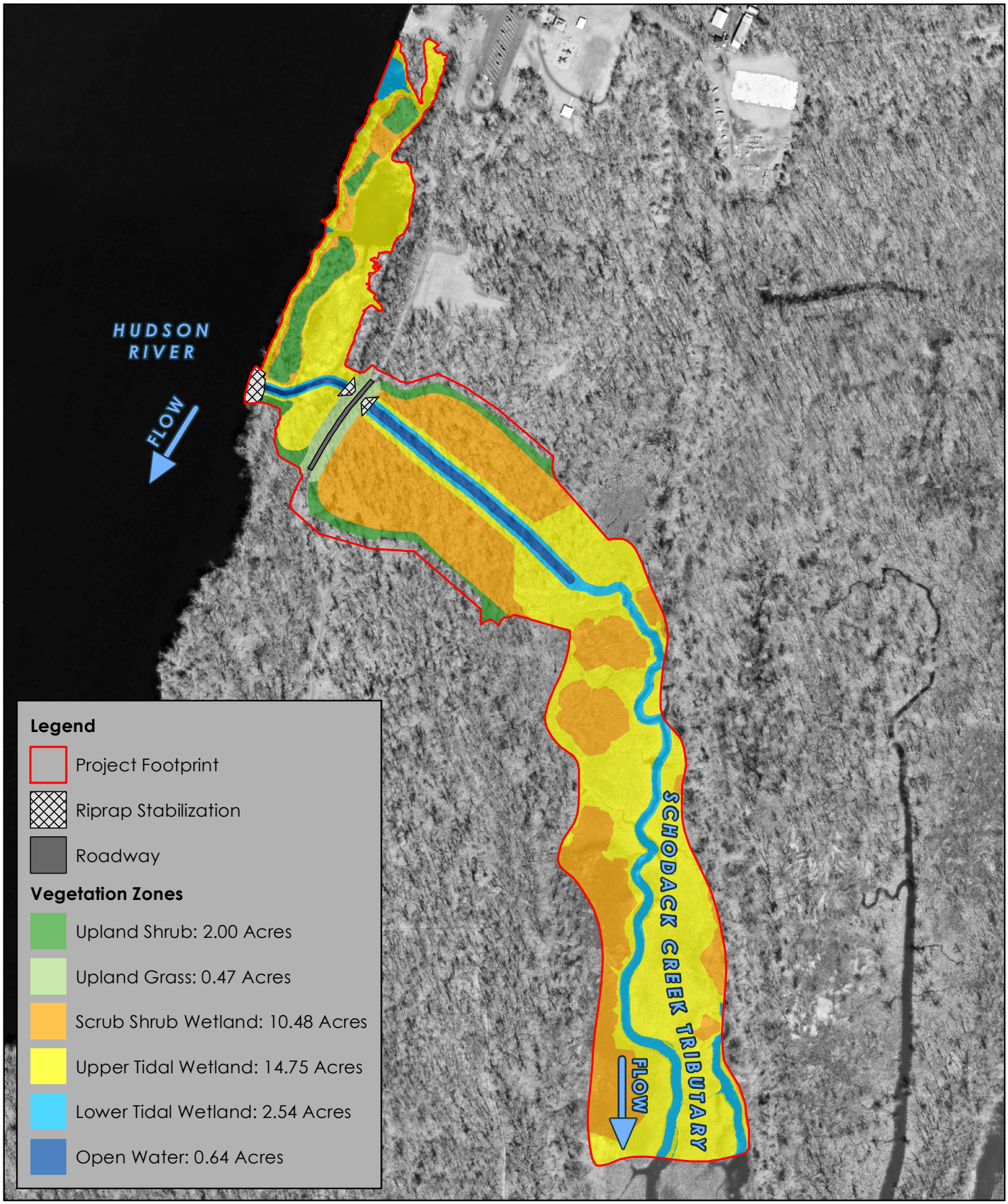

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SLC INTERMEDIATE CURVE
Y20 - 2052

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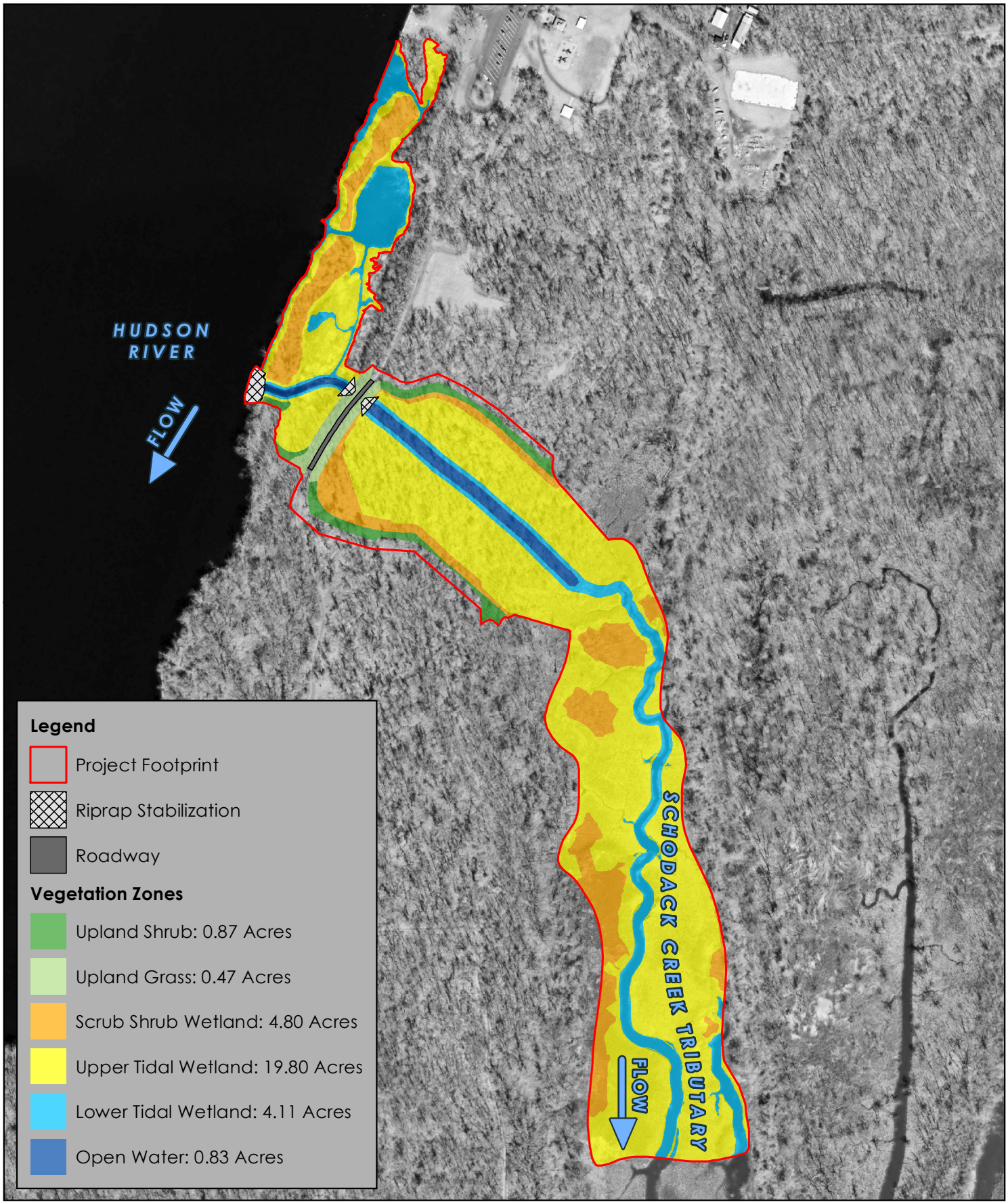

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SLC HIGH CURVE
Y20 - 2052

HUDSON RIVER HABITAT RESTORATION
SCHODACK ISLAND STATE PARK
TOWN OF SCHODACK
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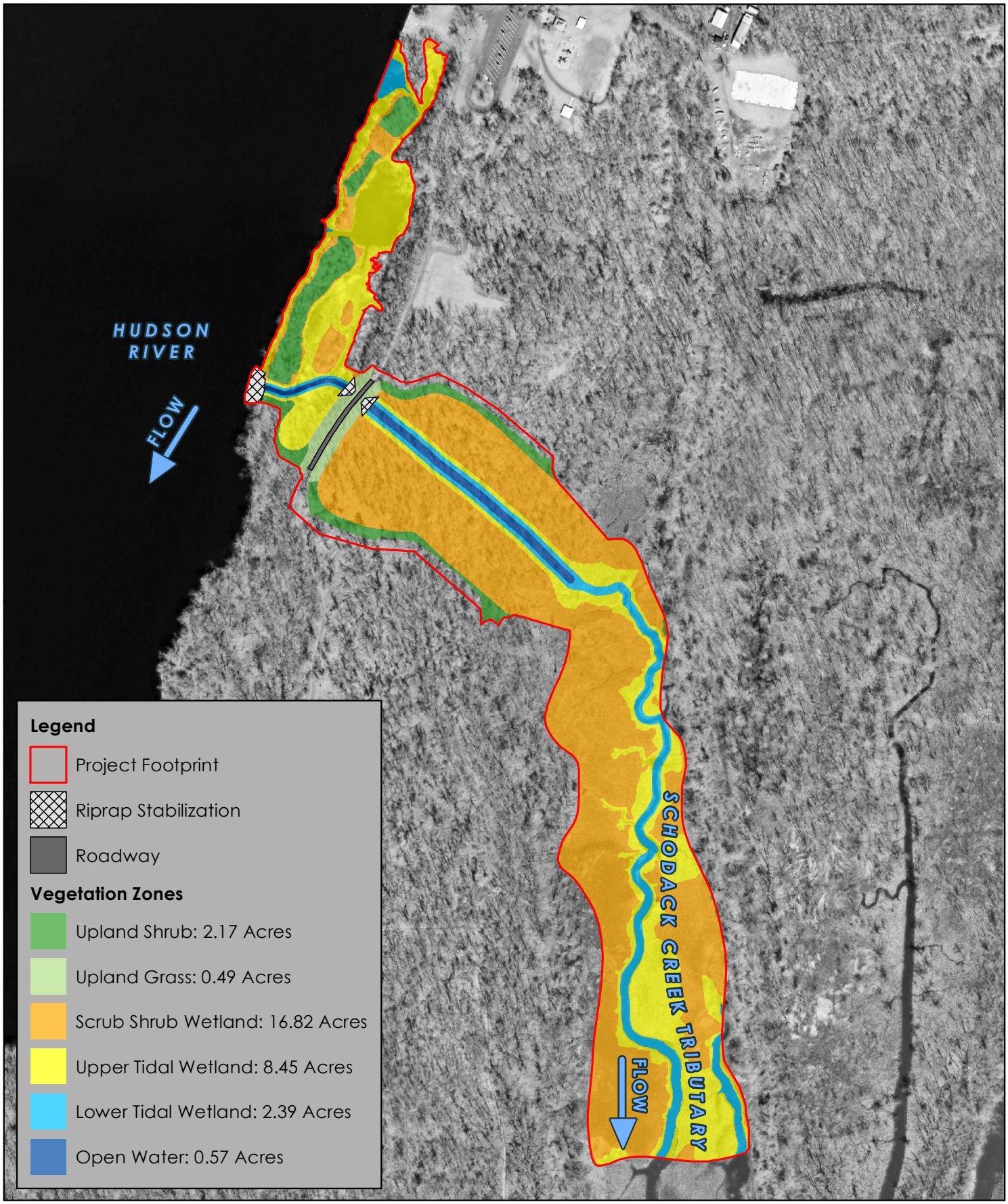

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SLC LOW CURVE
Y50 - 2082

HUDSON RIVER HABITAT RESTORATION
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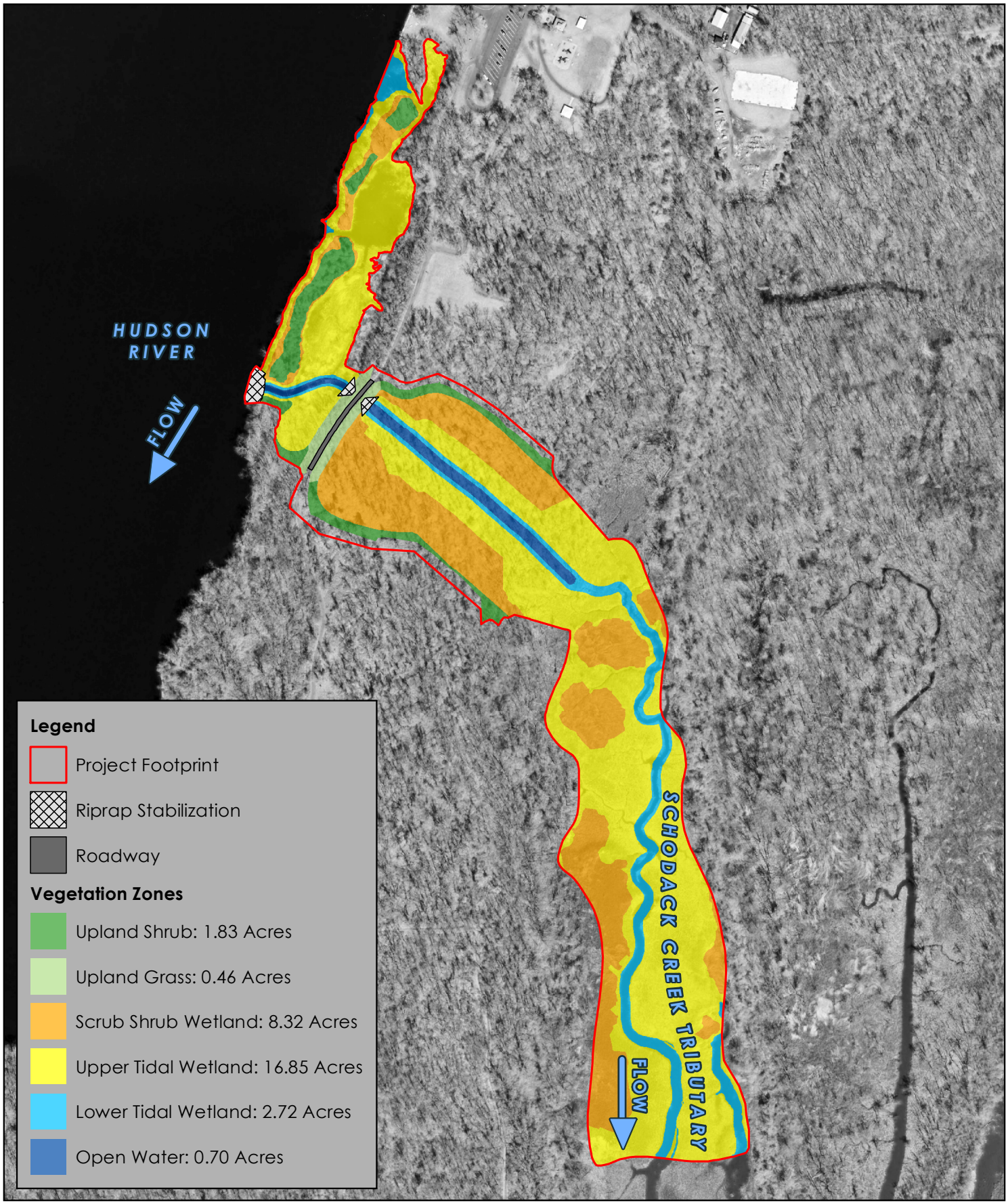

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SLC INTERMEDIATE CURVE
Y50 - 2082

HUDSON RIVER HABITAT RESTORATION
SCHODACK ISLAND STATE PARK
TOWN OF SCHODACK
RENSSELAER COUNTY, NEW YORK

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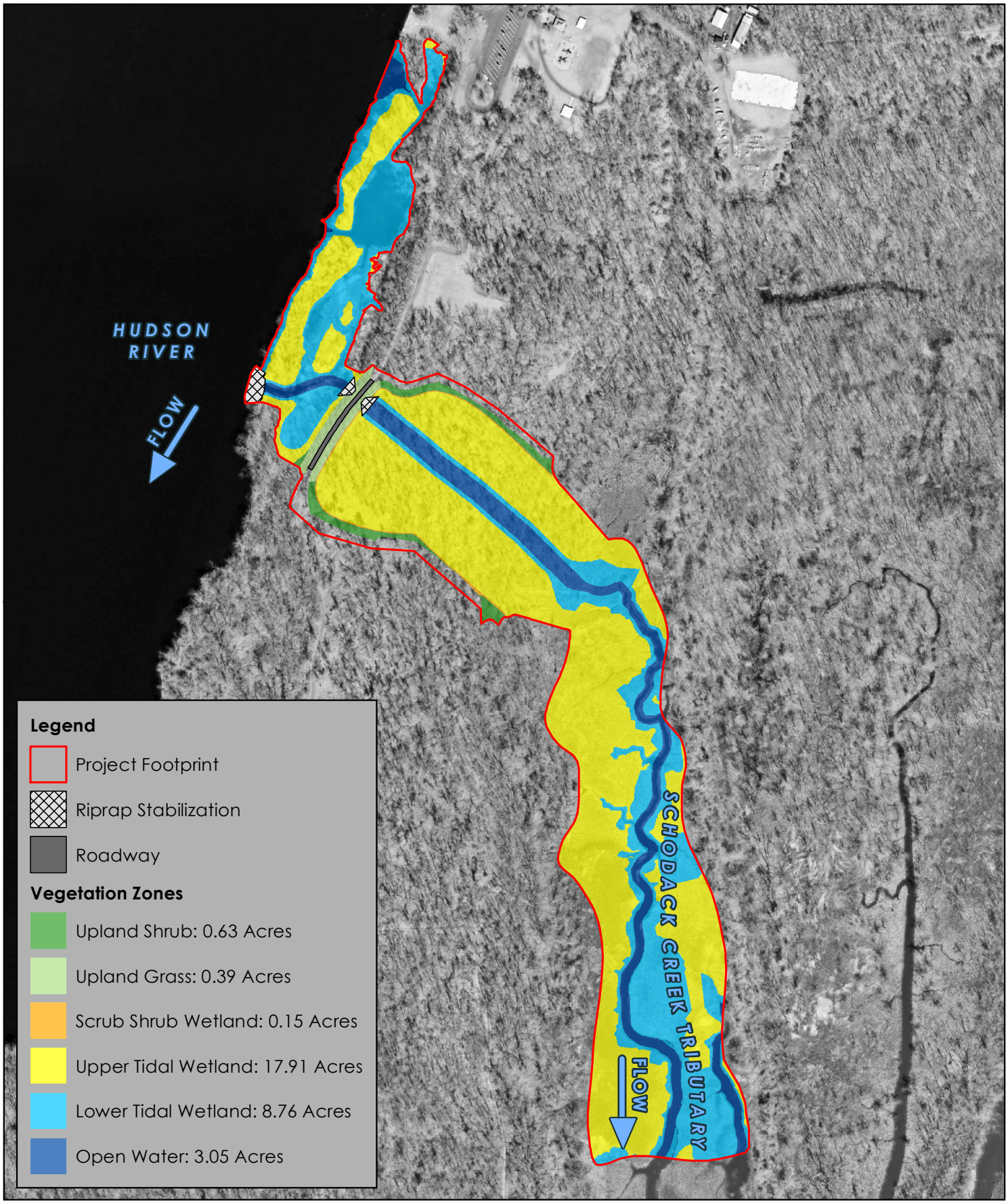

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SLC HIGH CURVE
Y50 - 2082

HUDSON RIVER HABITAT RESTORATION
SCHODACK ISLAND STATE PARK
TOWN OF SCHODACK
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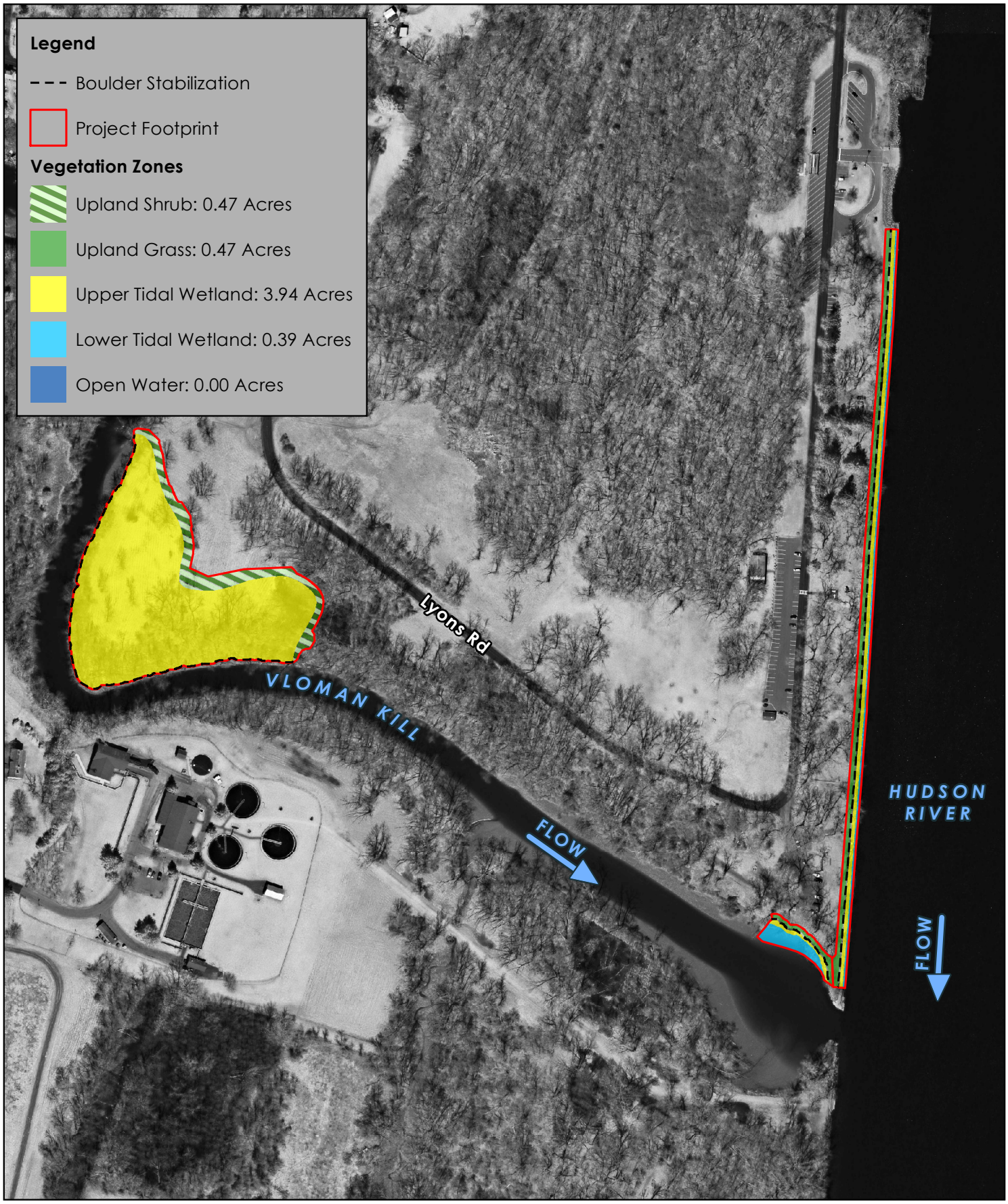

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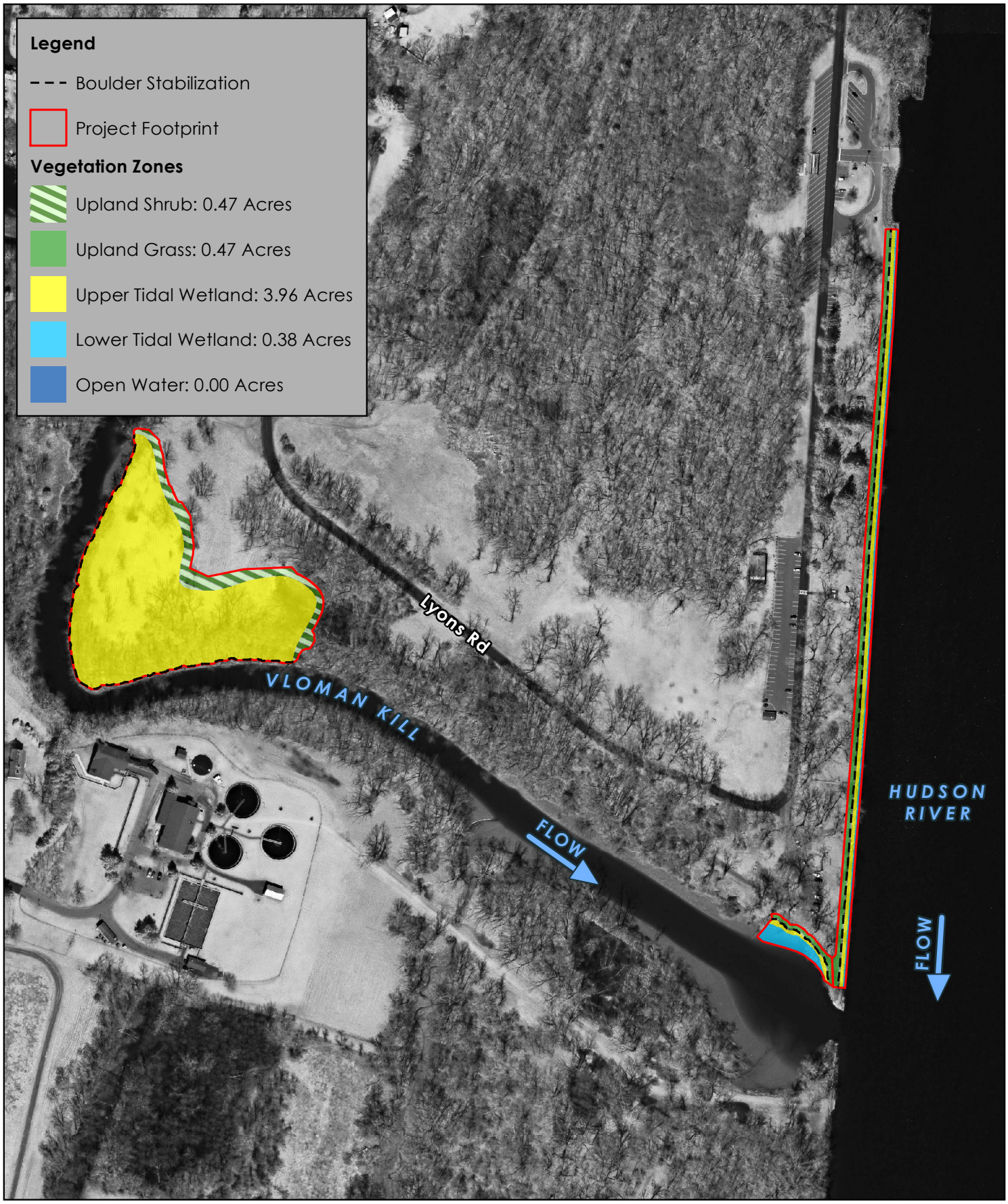
PROPOSED CONDITIONS
Y0 - 2027

HUDSON RIVER HABITAT RESTORATION
HENRY HUDSON PARK
TOWN OF BETHLEHEM
ALBANY COUNTY, NEW YORK

US Army Corps of Engineers®
New York District



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SLC LOW CURVE
Y20 - 2047

HUDSON RIVER HABITAT RESTORATION
HENRY HUDSON PARK
TOWN OF BETHLEHEM
ALBANY COUNTY, NEW YORK

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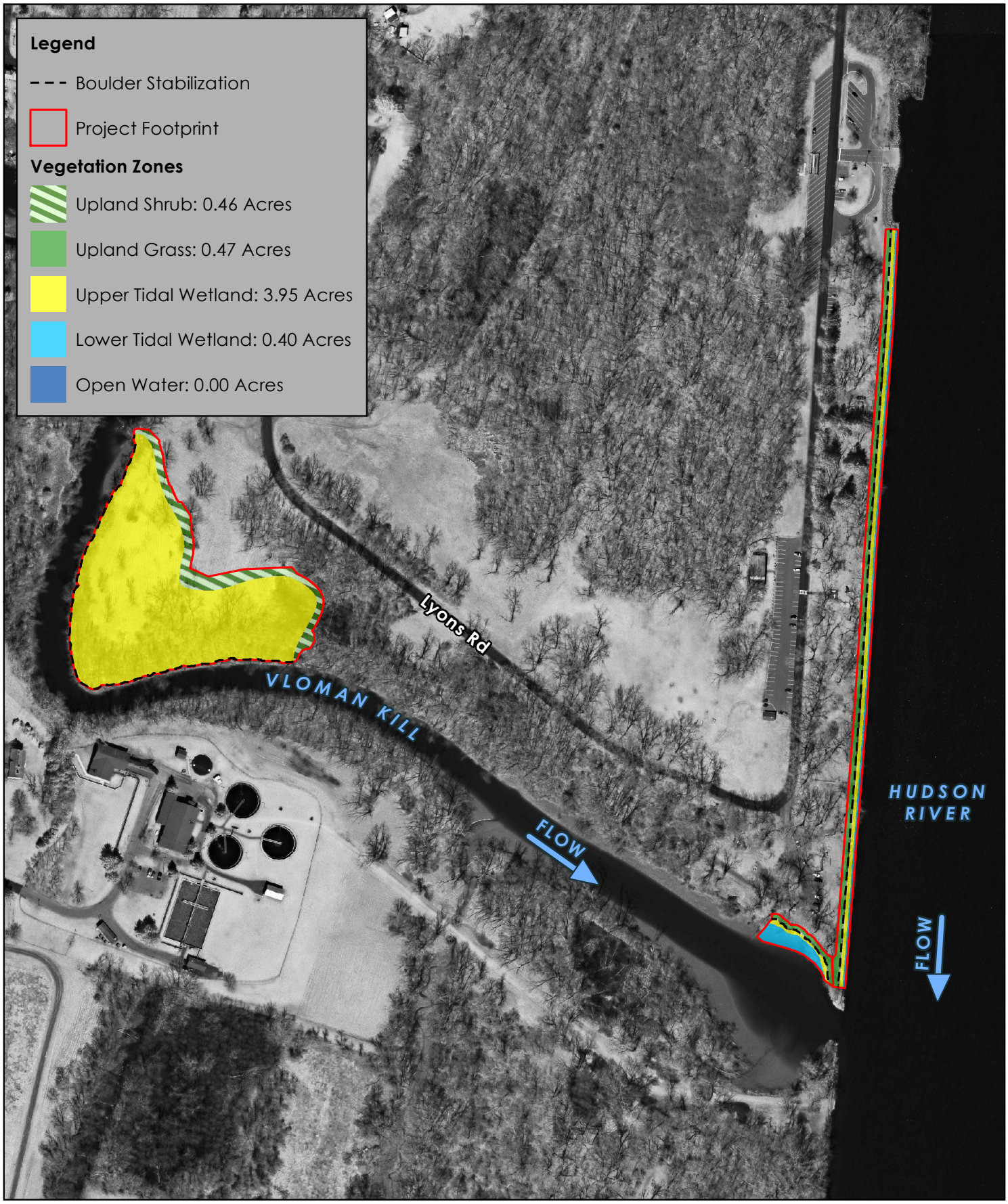

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SLC INTERMEDIATE CURVE
Y20 - 2047

HUDSON RIVER HABITAT RESTORATION
HENRY HUDSON PARK
TOWN OF BETHLEHEM
ALBANY COUNTY, NEW YORK

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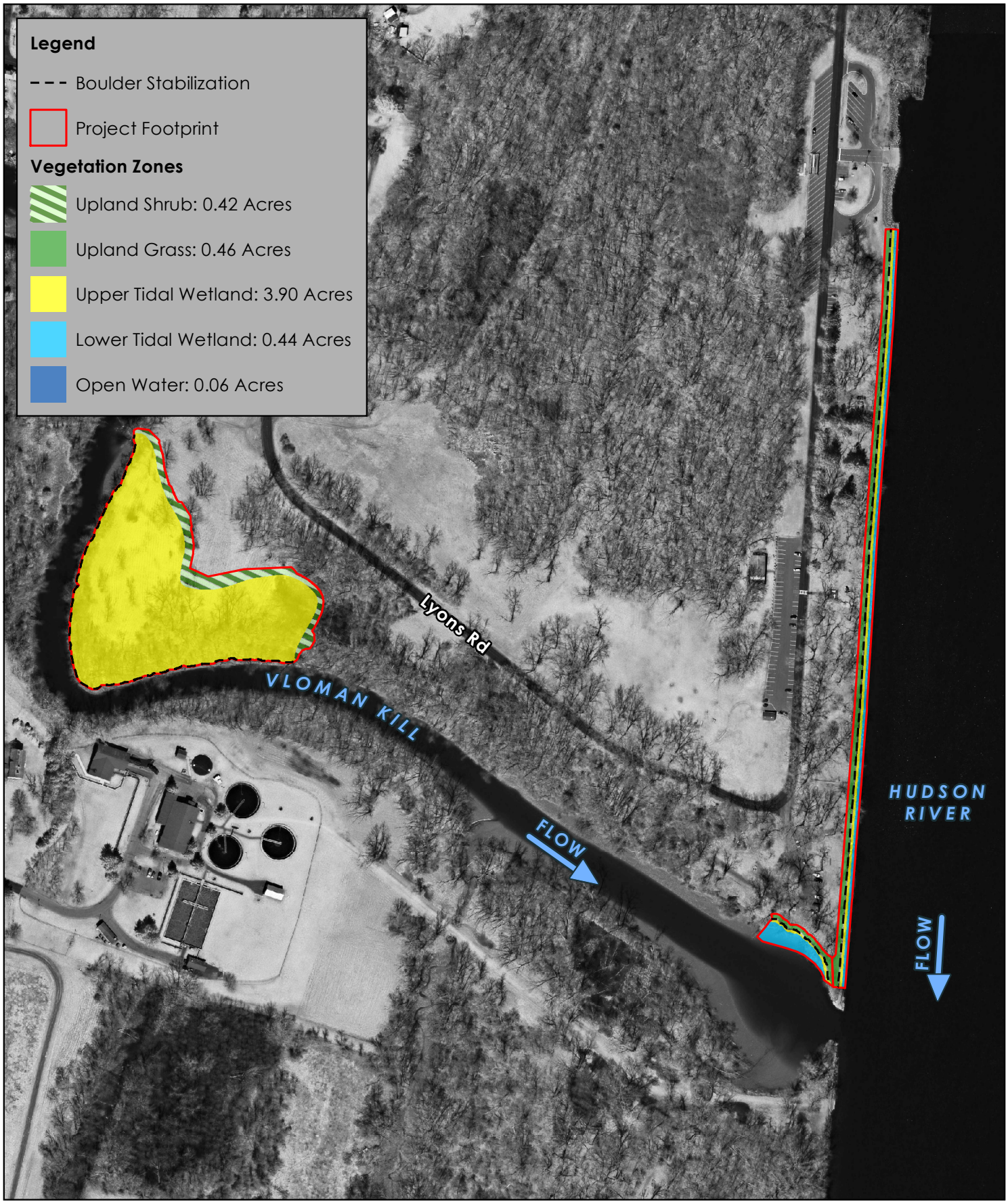

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SLC HIGH CURVE
Y20 - 2047

HUDSON RIVER HABITAT RESTORATION
HENRY HUDSON PARK
TOWN OF BETHLEHEM
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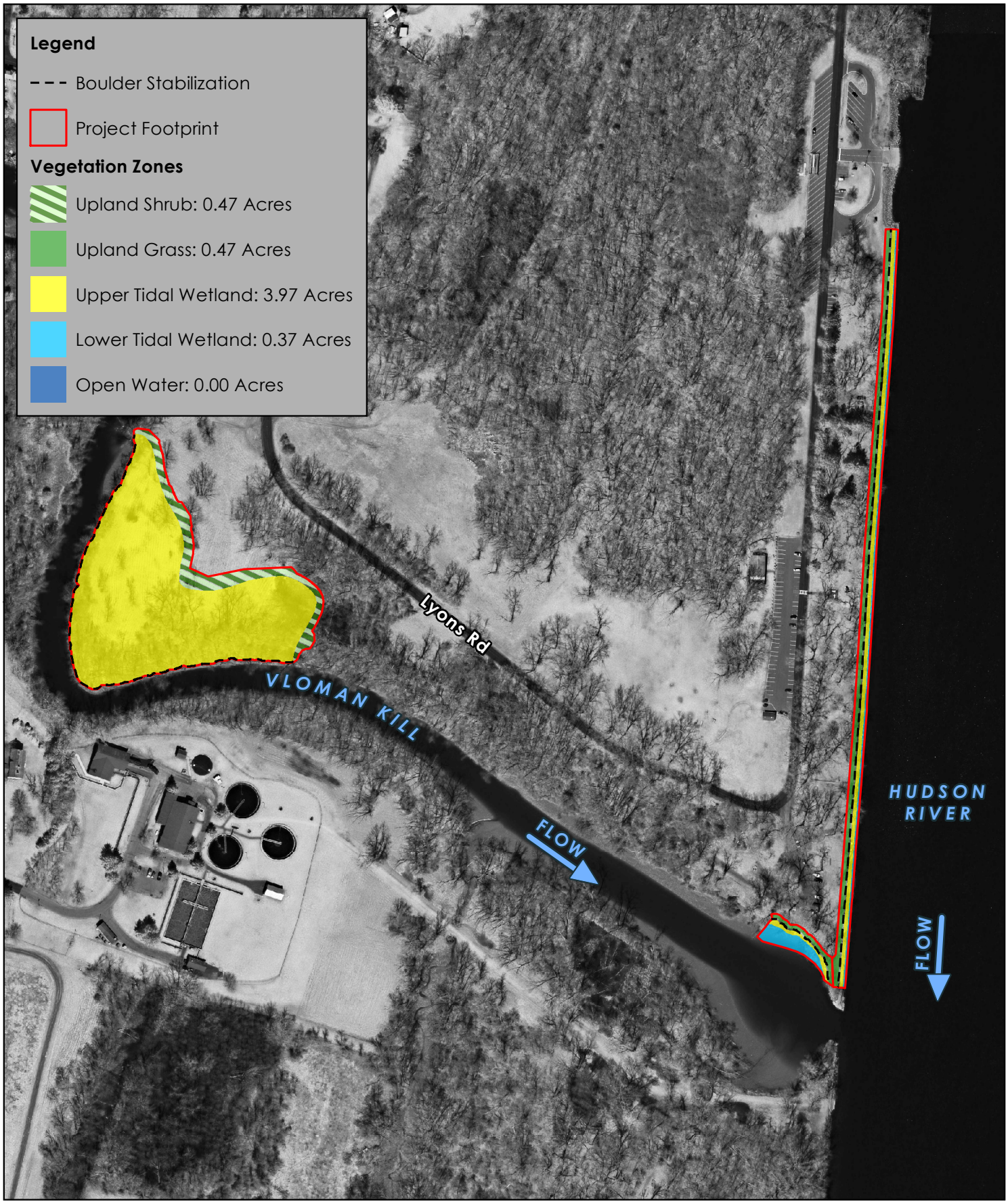

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SLC LOW CURVE
Y50 - 2077

HUDSON RIVER HABITAT RESTORATION
HENRY HUDSON PARK
TOWN OF BETHLEHEM
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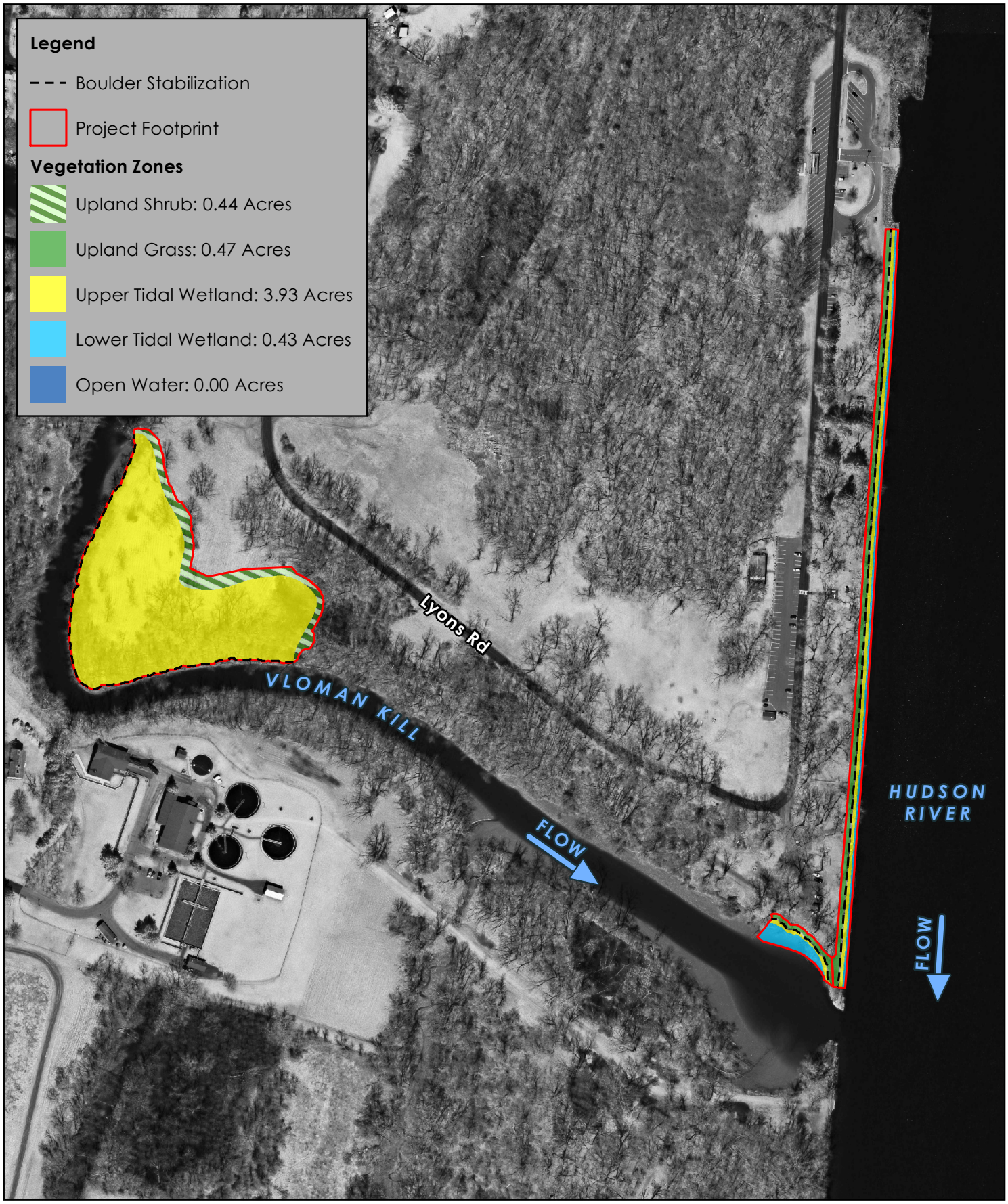

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SLC INTERMEDIATE CURVE
Y50 - 2077

HUDSON RIVER HABITAT RESTORATION
HENRY HUDSON PARK
TOWN OF BETHLEHEM
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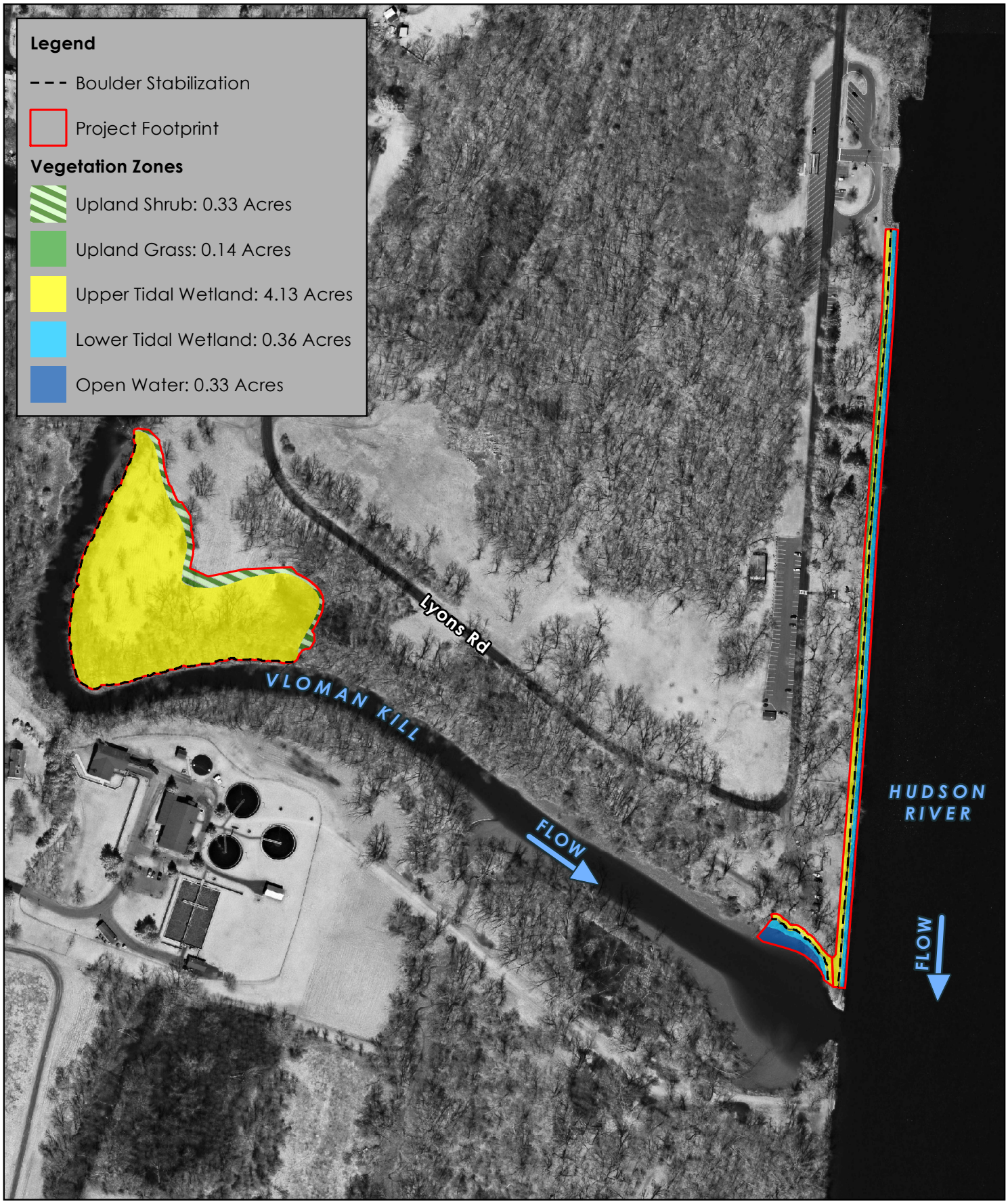

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SLC HIGH CURVE
Y50 - 2077

HUDSON RIVER HABITAT RESTORATION
HENRY HUDSON PARK
TOWN OF BETHLEHEM
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ATTACHMENT D

INLAND HYDROLOGY / NONSTATIONARITY ANALYSIS

HUDSON RIVER HABITAT RESTORATION

ECOSYSTEM RESTORATION
FINAL INTEGRATED FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT

INLAND HYDROLOGY/NONSTATIONARITY ANALYSIS

Henry Hudson Park, Schodack Island Park, and Moodna Creek

U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT

August 2020

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INTRODUCTION

A nonstationarity analysis and hydrologic trend analysis using United States Army Corps of Engineers (USACE) Nonstationarity Detection (NSD) tool and Climate Hydrology Assessment Tool (CHAT) have been completed to inform the designs for the Hudson River Habitat Restoration project sites: Schodack Island Park, Henry Hudson Park, and Moodna Creek (Project Sites).

Stationarity is the assumption that the statistical characteristics of hydrologic time series data are consistent through time. Hydrologic data analysis, and subsequent hydraulic modeling and engineering design for habitat restoration projects rely on the assumption of stationarity in hydrologic data. Recent studies indicate climate change, impacting temperature, precipitation, and streamflow, and anthropogenic modifications of watersheds are undermining the assumption of stationarity. As a result, the USACE requires the assumption of stationarity of observed streamflow records be assessed using the NSD tool for the Project Sites to ensure that the recommended plans will be sustainable with respect to climate change. In addition, CHAT detects trends in observed annual maximum daily flow from selected USGS gage(s). CHAT was also used to project future trends in annual maximum monthly flow within Hydrologic Unit Code (HUC) 0202: Upper Hudson, as the Project Sites are situated within that specific HUC-4 watershed.

USACE NONSTATIONARITY DETECTION TOOL (NSD)

The NSD tool was developed to detect nonstationarities in annual instantaneous peak streamflow data series at any United States Geological Survey (USGS) streamflow gage site with more than 30 years of annual instantaneous peak streamflow records through Water Year 2014.

The NSD applies 12 statistical methods to assess nonstationarities in the time series data driven by changes in mean, variance/standard deviation, and in the distributional properties of the dataset. A "strong" nonstationarity meets the following criteria:

1) **Consensus** – Consensus occurs when two or more methods detect statistically significant changes for the same statistical property (e.g. mean or variance/standard deviation or distribution) at or around the same period of time. If a consensus cannot be found for a given year or short period of time, then it is reasonable to discount the nonstationarity.
2) **Robustness** – Robustness is represented when statistically significant changes are detected for two or more statistical properties (mean, variance/standard deviation, or distribution). This represents a multifaceted change in the data set and should be considered when deciding which portion of the period of record to use in the hydrologic analysis.
3) **Magnitude** – The greater the magnitude of change in a statistical property (mean or variance/standard deviation) before and after the nonstationarity, the more important it is to consider in subsequent hydrologic analysis.

The NSD tool was used to assess the assumption of stationarity in peak annual instantaneous streamflow at the Project Sites. The results of the assessment are described below.

SCHODACK ISLAND PARK, HENRY HUDSON PARK, AND MOODNA CREEK

Each site, Schodack Island Park and Henry Hudson Park, herein referred to as Hudson River Sites, and Moodna Creek are located within HUC 0202: Upper Hudson.

SCHODACK ISLAND PARK AND HENRY HUDSON PARK

GAGE SELECTION

USGS 01358000 Hudson River at Green Island, NY (USGS gage) is the nearest USGS gage to the Hudson River Sites with a sufficient period of record for the NSD analysis. The USGS gage is located approximately 20 miles upstream of the Hudson River Sites (Figure 1) and has continuous streamflow data since February 1946. The drainage area of the USGS gage and Hudson River Sites are similar (8,288 square miles for the USGS gage, 8,440 square miles for the Henry Hudson Park site, 8,570 square miles for Schodack Island Park site). The USGS gage is immediately downstream of the confluence with the Mohawk River – a major tributary of the Hudson River. As the USGS gage captures all major watersheds in the drainage area of the Hudson River Sites, it is assumed to be representative. Therefore, the results from the NSD analysis can be extrapolated from the USGS gage to the Hudson River Sites.

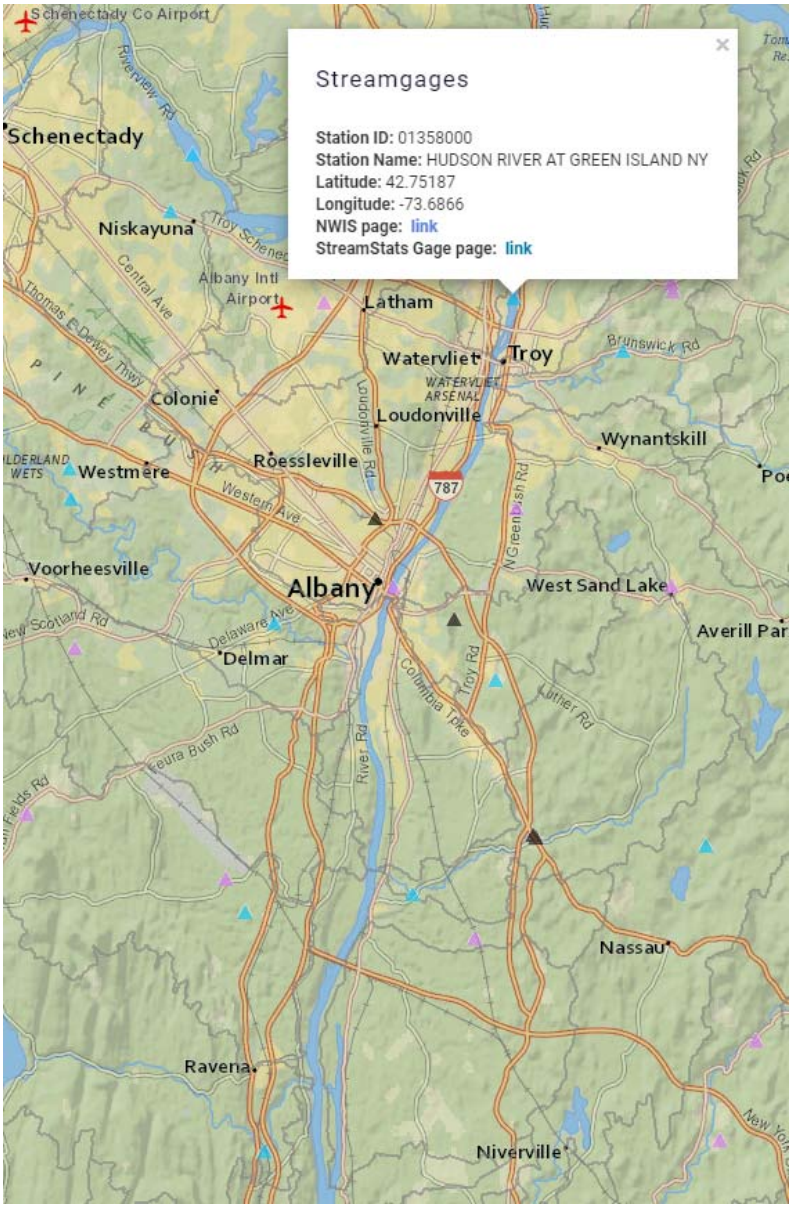


Figure 1. Location of USGS 01358000 Hudson River at Green Island, NY

NONSTATIONARITY DETECTION

Figure 2 shows the output from the NSD tool, which includes the annual peak streamflow from 1946-2020. The vertical blue column shows the detected smooth nonstationarity and the vertical black line shows the detected abrupt nonstationarity.

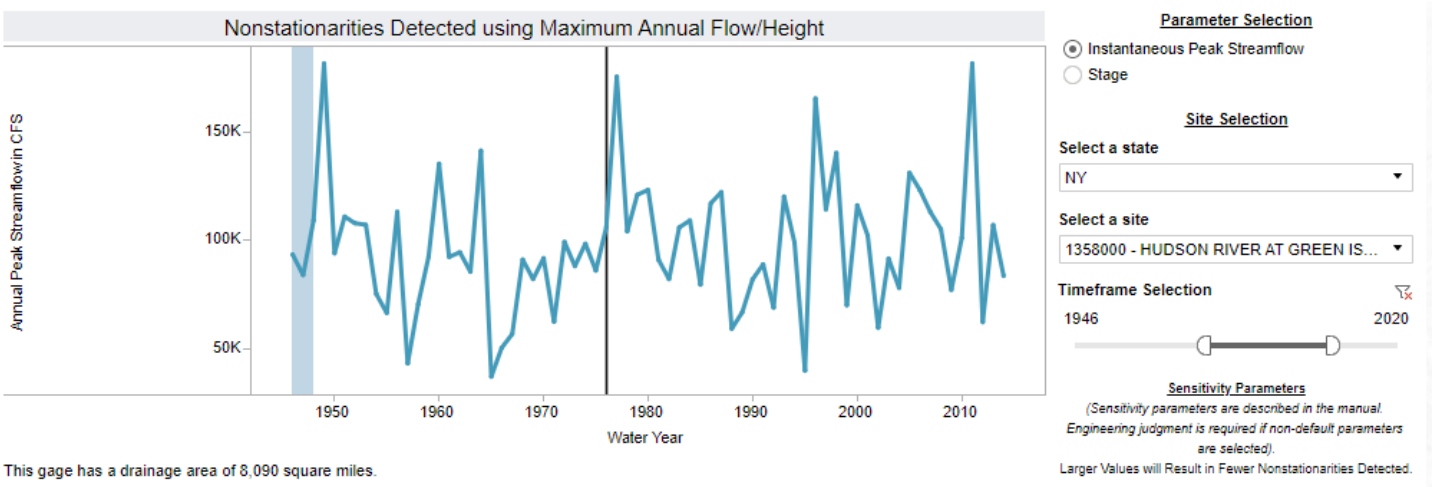


Figure 2. Output from Nonstationarity Detection tool - Hudson River at Green Island, NY – with streamflow data from 1946 to 2020.

Nonstationarity was detected with two methods – the Smooth Lombard Mood method (1948) and the Energy Divisive Method (1976). The heatmap output (Figure 3) shows the graphical representation of the statistical results.

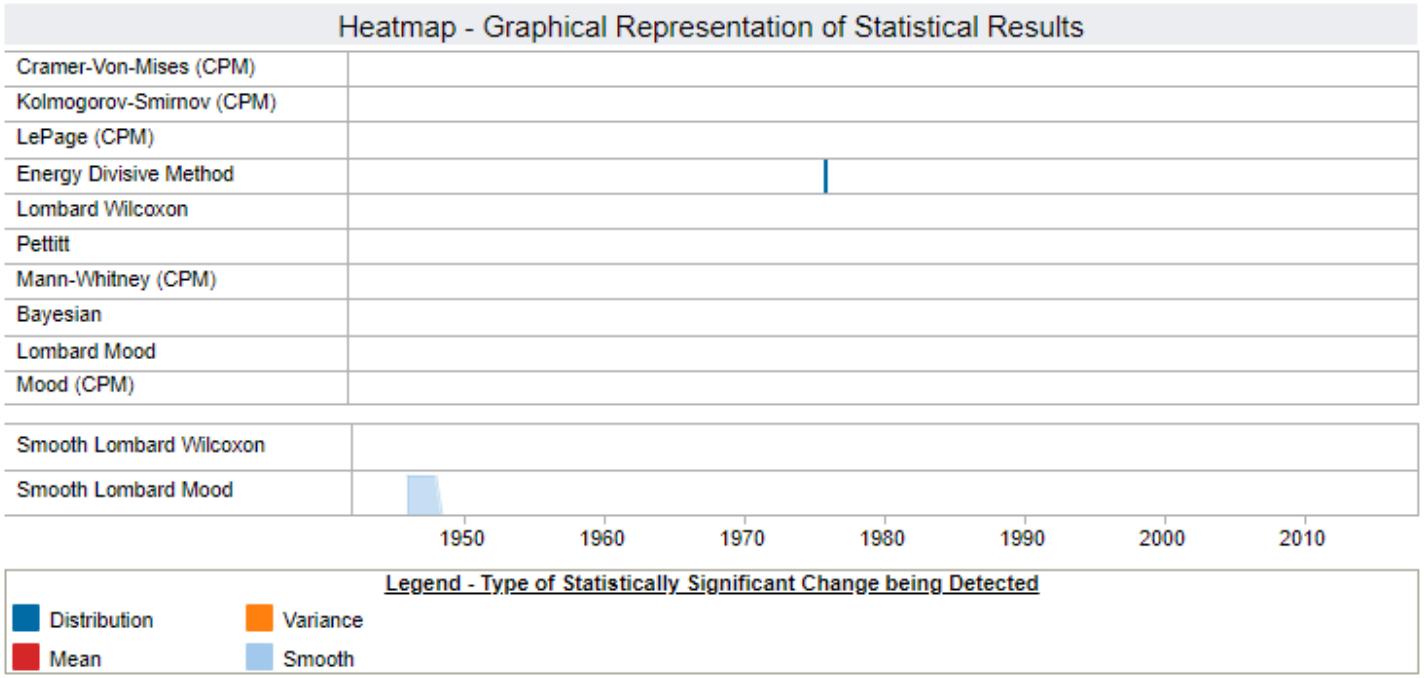


Figure 3. Heatmap shows the Smooth Lombard Mood method (1948) and the Energy Divisive Method (1976) detected nonstationarities.

The nonstationarities detected at the USGS gage lack consensus and robustness (nonstationarity is only detected by one method for both the 1946 and 1976 nonstationarities).

Figure 4 provides the mean, standard deviation, and variance for the subsets of data for each homogenous period of flow data between each of the nonstationarities detected. As shown in Figure 4, the magnitude of the statistical properties of the dataset do not change before and after the identified nonstationarity (1976). #

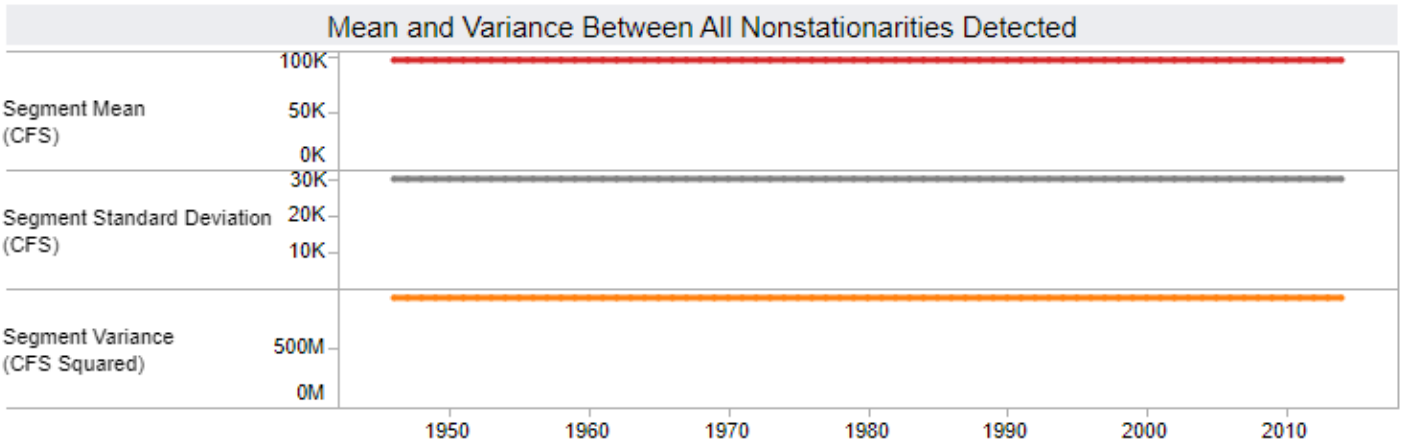


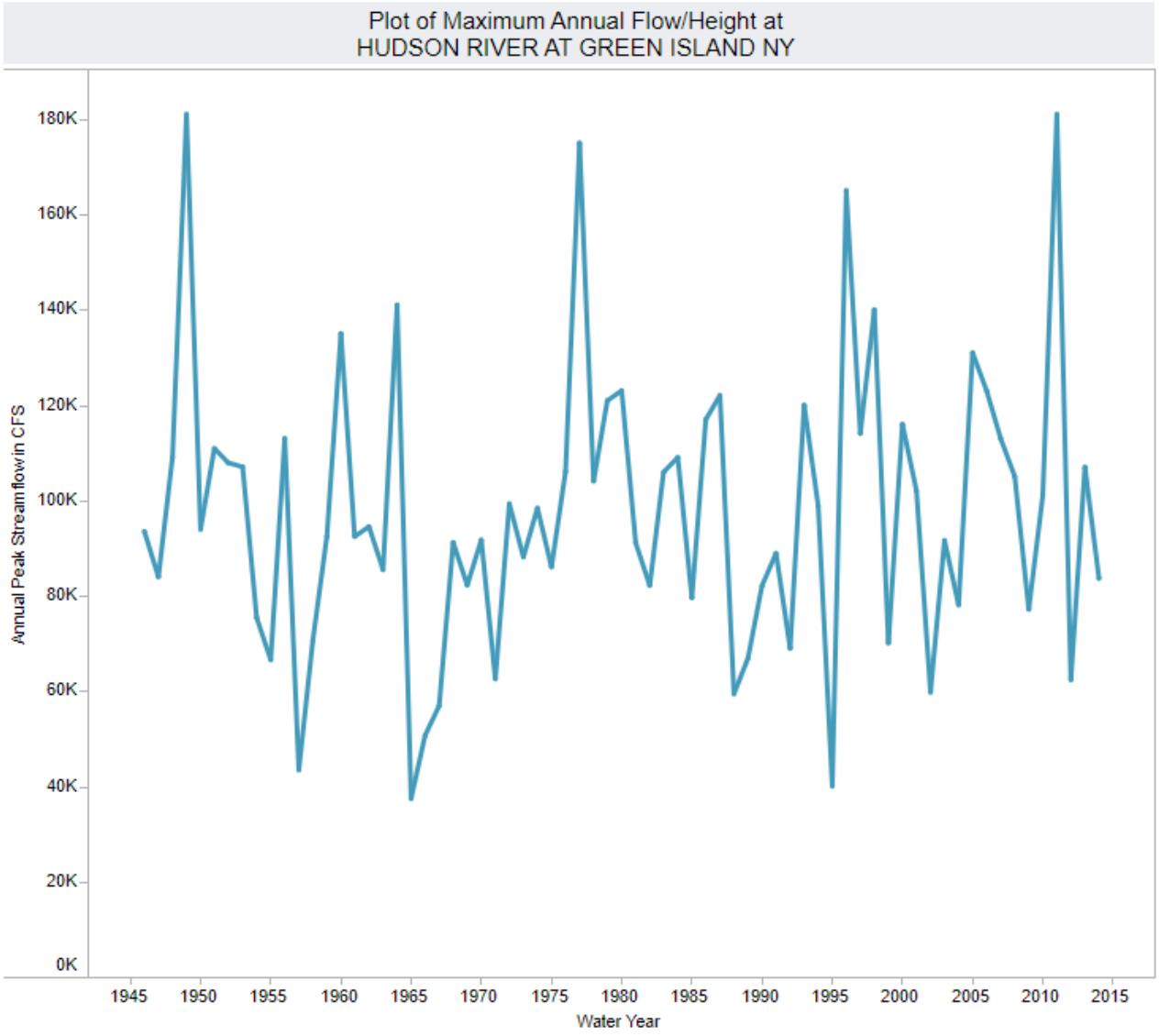
Figure 4. Mean and Variance Between All Nonstationarities Detected

Due to the lack of consensus, robustness, and change in magnitude, the detected nonstationarities are not considered to be strong; and therefore, according to USACE guidelines, stationarity should be assumed for the Schodack Island Park and Henry Hudson Park Sites.

TREND ANALYSIS

The NSD tool can also be used to assess subsets of homogenous data for monotonic trends. In a monotonic trend, the variable consistently increases or decreases through time, but the trend may or may not be linear. Because no strong nonstationarities were identified for the USGS gage, the entire period of record is assumed to be homogenous. Therefore, there is no need to segment the record.

Figure 5 shows the maximum annual flow at the USGS gage. NSD results indicate no statistically significant monotonic trend was detected for this dataset, as the p-values for these tests exceeded the 0.05 threshold.



Monotonic Trend Analysis

Is there a statistically significant trend?
No, using the Mann-Kendall Test at the .05 level of significance. The exact p-value for this test was 0.569.
No, using the Spearman Rank Order Test at the .05 level of significance. The exact p-value for this test was 0.585.

What type of trend was detected?
Using parametric statistical methods, **no trend** was detected.
Using robust parametric statistical methods (Sen's Slope), **no trend** was detected.

Figure 5. Trend Analysis for the Hudson River at Green Island, NY

MOODNA CREEK

GAGE SELECTION

Since there is no USGS gage on Moodna Creek, USGS gages on three proximal streams were analyzed using the NSD tool:

- USGS 01372500 Wappinger Creek Near Wappingers Falls NY;
- USGS 01367500 Rondout Creek at Rosendale NY; and
- USGS 01371500 Wallkill River at Gardiner NY.

These streams were selected due to their proximity to Moodna Creek and similar geographic locations (Figure 6).

Table 1. Drainage Area of Moodna Creek and Proximal Streams

Location	Drainage Area (Sq Mi)
Wappinger Creek	181*
Rondout Creek	383*
Wallkill River	695*
Moodna Creek (at AOP 1)	169**

*Source is USGS Gage Website

**Source is USGS StreamStats Application

Figure 6 shows the locations of the three USGS gages used for the nonstationarity analysis and their corresponding watersheds. The watershed of USGS 01371500 Wallkill River at Gardiner NY is the closest in proximity to the Moodna Creek watershed, as the Wallkill River is immediately North of Moodna Creek. The watershed of USGS 01372500 Wappinger Creek Near Wappingers Falls NY is similar in size and shape to the Moodna Creek watershed.

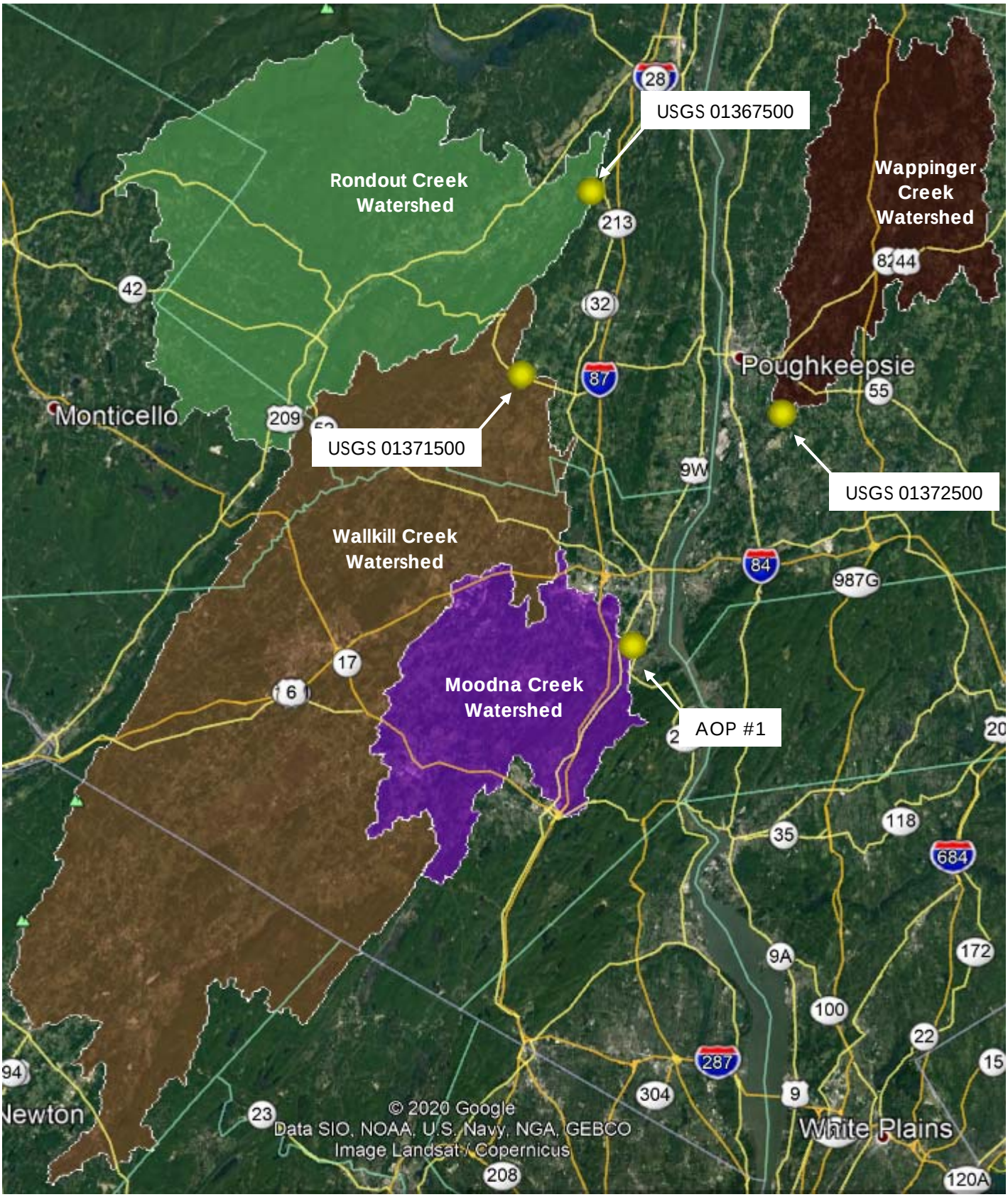


Figure 6. Map of Moodna Creek watershed (at AOP 1) and watersheds of the USGS Gages used for the nonstationarity analysis.

NONSTATIONARITY DETECTION

At two of the three gages, nonstationarities were detected, meeting the three criteria for strong nonstationarity. **Error! Reference source not found.** is a summary showing nonstationarities (by year or period of time) for the three criteria.

Table 2. Summary of Nonstationarity Assessment at Three Gages Proximal to Moodna Creek.

USGS Gage	Consensus	Robust	Magnitude	Strong Nonstationarity	Dates of Detected Nonstationarities
Wappinger Creek	No	No	Yes	No	1956, 2002
Rondout Creek	Yes	Yes	Yes	Yes	1953, Around 1970*
Wallkill River	Yes	Yes	Yes	Yes	1953, mid-1960s*, 2004*

* Detected as strong nonstationarities

NONSTATIONARITY DETECTION – WAPPINGER CREEK

The NSD tool was used to analyze USGS 01372500 Wappinger Creek near Wappingers Falls, New York. Figure 7 shows the annual peak streamflow from 1929-2020 and the detected nonstationarities represented by vertical black lines.

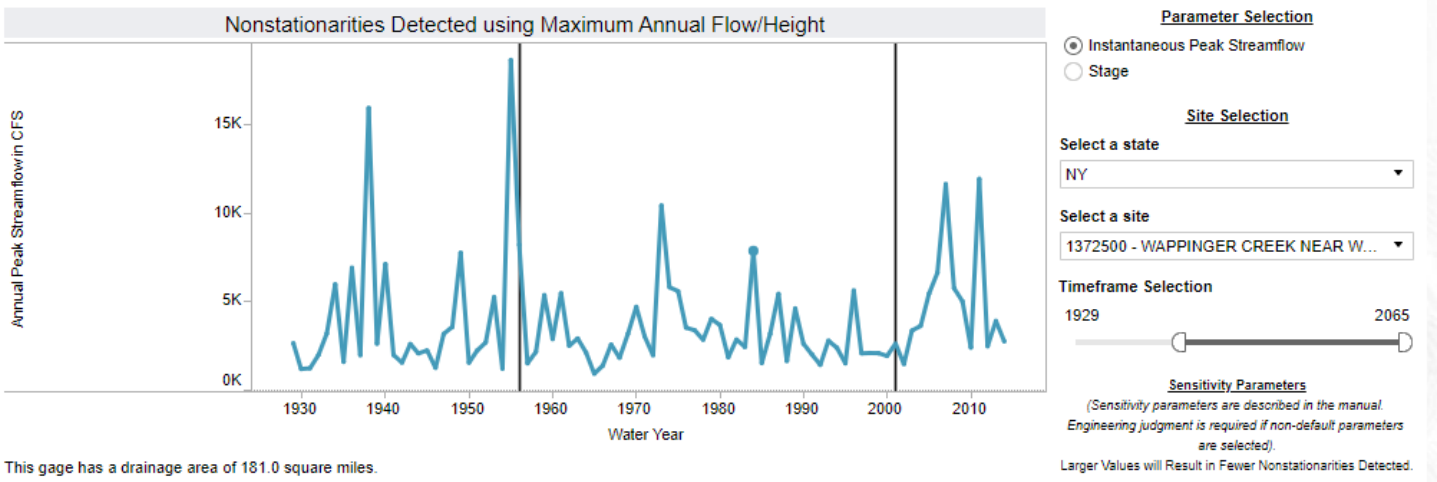


Figure 7. Output from Nonstationarity Detection tool - Wappinger Creek near Wappingers Falls, NY – with streamflow data from 1929 to 2020

The heatmap output shows the Lombard Mood method (1956) and the Energy Divisive Method (2002) both detected nonstationarities (Figure 8).

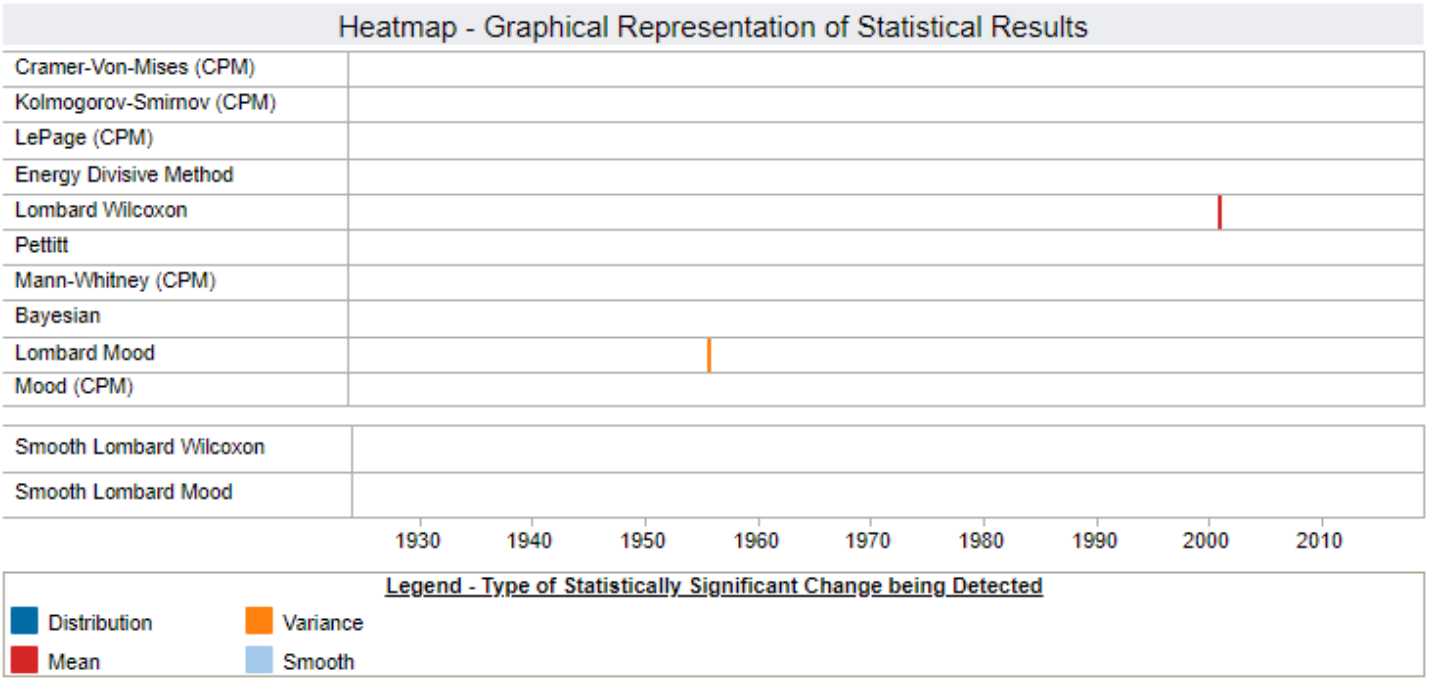


Figure 8. Heatmap shows the Lombard Mood method (1956, variance) and the Lombard Wilcoxon (2002, mean) both detected nonstationarities.

The nonstationarities detected at the Wappinger Creek gage lack consensus and robustness (nonstationarity is only detected by one method for each of the nonstationarities detected in 1956 and 2002).

Figure 9 shows the nonstationarity detected by the Lombard Mood method (1956) produced a change in standard deviation/variance between pre- and post-1956 and the nonstationarity detected by the Lombard Wilcoxon method (2002) produced a smaller change in mean between pre- and post-2002.

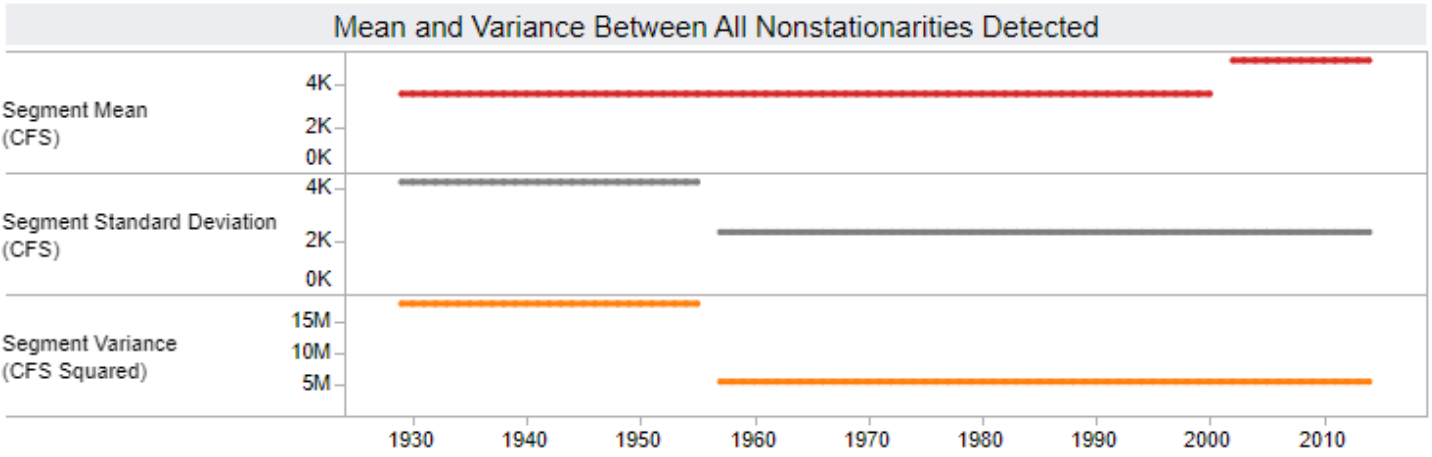


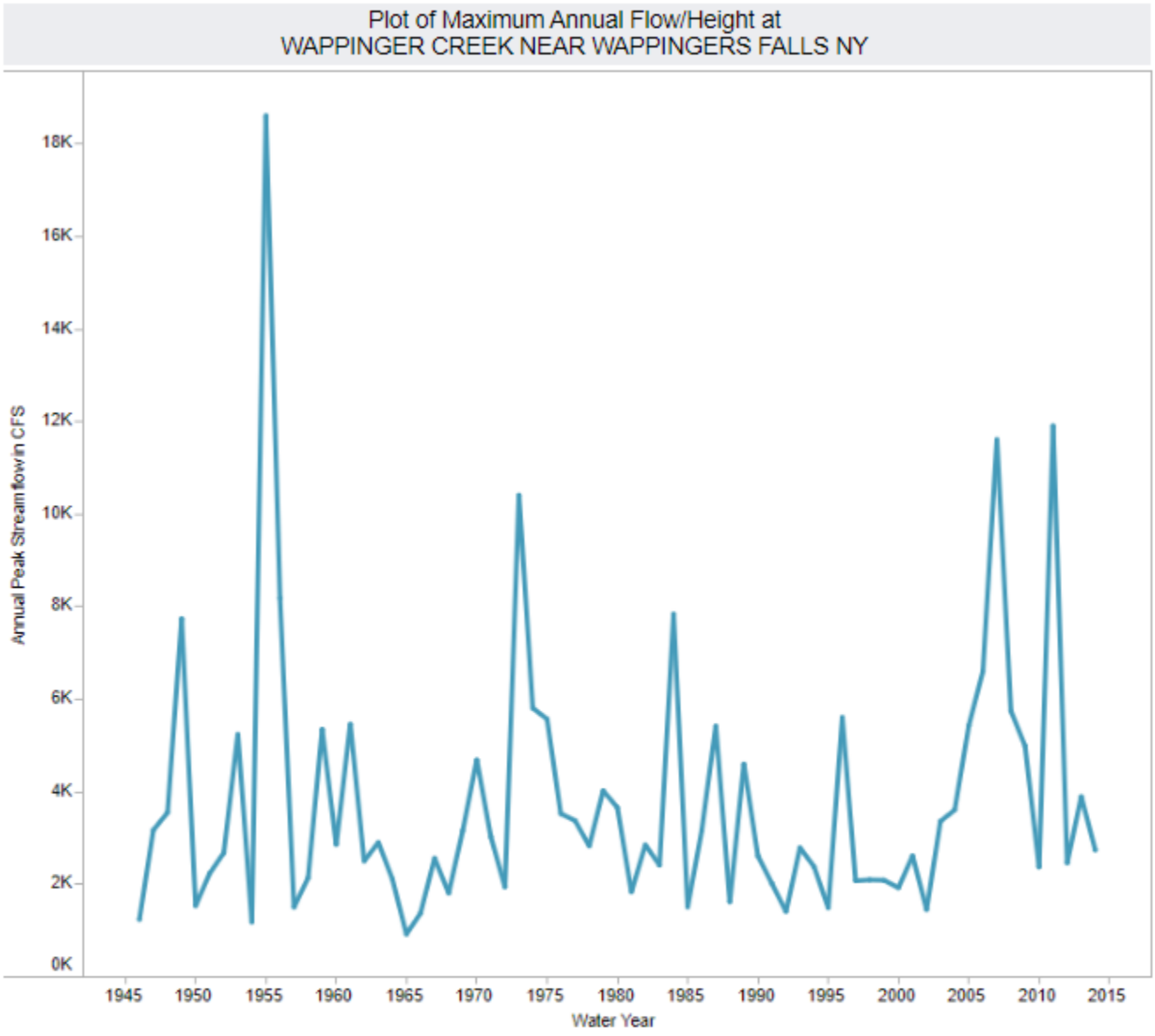
Figure 9. Mean and Variance Between All Nonstationarities Detected

Despite the detection of changes in magnitude of deviation/variance (1956) and mean (2002), these nonstationarities are not considered strong due to the lack of consensus and robustness. Therefore, according to USACE guidelines, stationarity should be assumed for this gage.

TREND ANALYSIS – WAPPINGER CREEK

The NSD tool was also used to assess the subsets of homogenous data for monotonic trends. In this case, because no strong nonstationarities were identified at the Wappinger Creek gage, the entire period of record is assumed to be homogenous and thus there is no need to segment the record.

Figure 10 shows the maximum annual flow for the Wappinger Creek near Wappinger Falls, New York. NSD results indicate no statistically significant monotonic trend for this dataset, as the p-values for these tests exceeded the 0.05 threshold.



Monotonic Trend Analysis

Is there a statistically significant trend?
No, using the Mann-Kendall Test at the .05 level of significance. The exact p-value for this test was 0.468.
No, using the Spearman Rank Order Test at the .05 level of significance. The exact p-value for this test was 0.474.

What type of trend was detected?
Using parametric statistical methods, **no trend** was detected.
Using robust parametric statistical methods (Sen's Slope), **no trend** was detected.

Figure 10. Trend Analysis Tab for the Wappinger Creek Near Wappingers Falls NY

NONSTATIONARITY DETECTION – RONDOUT CREEK

The NSD tool was used to analyze USGS 01367500 Rondout Creek at Rosendale, New York. Figure 11 shows the annual peak streamflow from 1927-2020 and the detected nonstationarities (vertical lines).

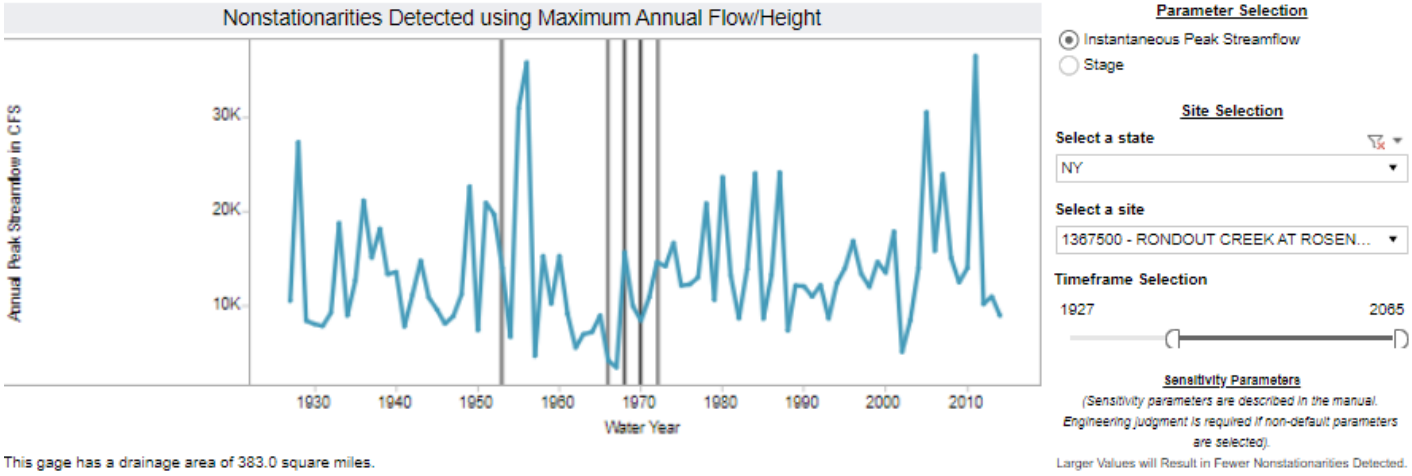


Figure 11. Output from Nonstationarity Detection tool – Rondout Creek at Rosendale NY – with streamflow data from 1927 to 2020

The heatmap output shows the five points of nonstationarity detected and the method by which they were detected, including the Mood (CPM) (1953 and 1968), Lombard Mood (1966), Lombard Wilcoxon (1970), and Energy Divisive Methods (1972) (Figure 12).

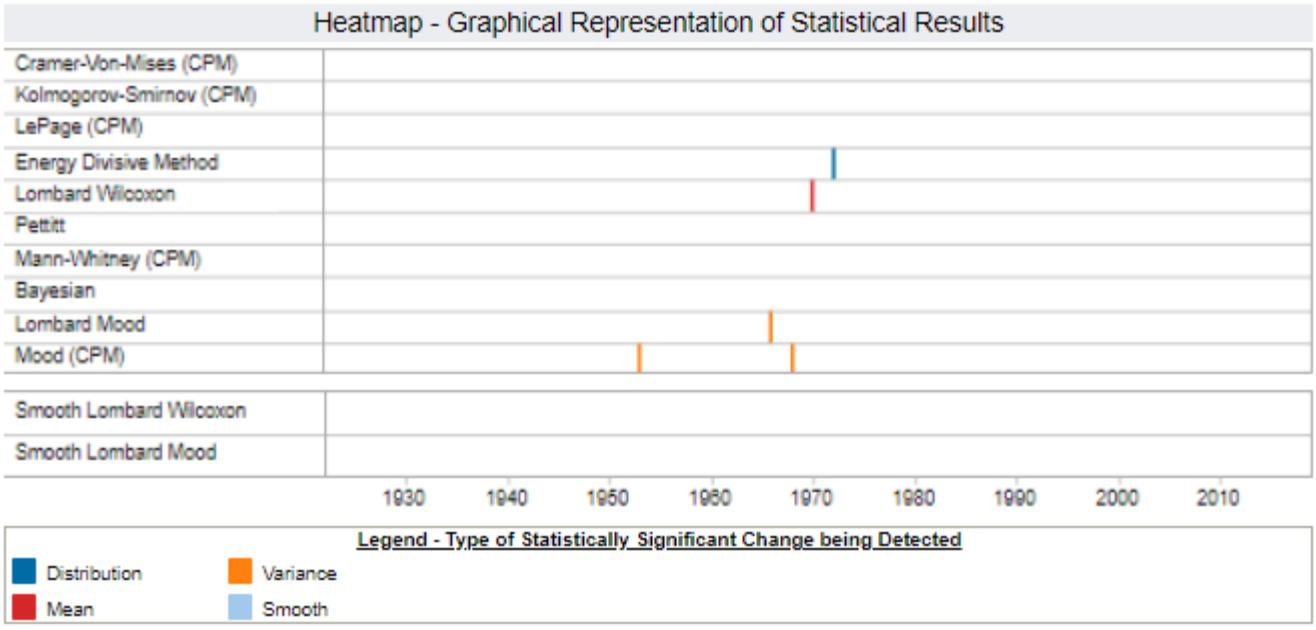


Figure 12. Heatmap shows the year and type of detected nonstationarities.

At this gage, the Lombard Mood and the Mood (CPM) methods are both detecting a nonstationarity for the variance around 1970. These two methods detected statistically significant changes for the same statistical property around the same period of time and represent a consensus.

In addition, at this gage, the Lombard Wilcoxon and Energy Divisive Methods detect nonstationarities in the mean and distribution, respectively, around 1970. Because these two methods detect statistically significant changes for two additional different statistical properties, this nonstationarity can be considered robust.

Figure 13 shows the nonstationarity detected by the Mood (CPM) method targeting standard deviation/variance, signaling a difference in magnitude for standard deviation/variance around the 1956 nonstationarity. In addition, the nonstationarity detected around 1970 signals a difference in both mean and standard deviation/variance.

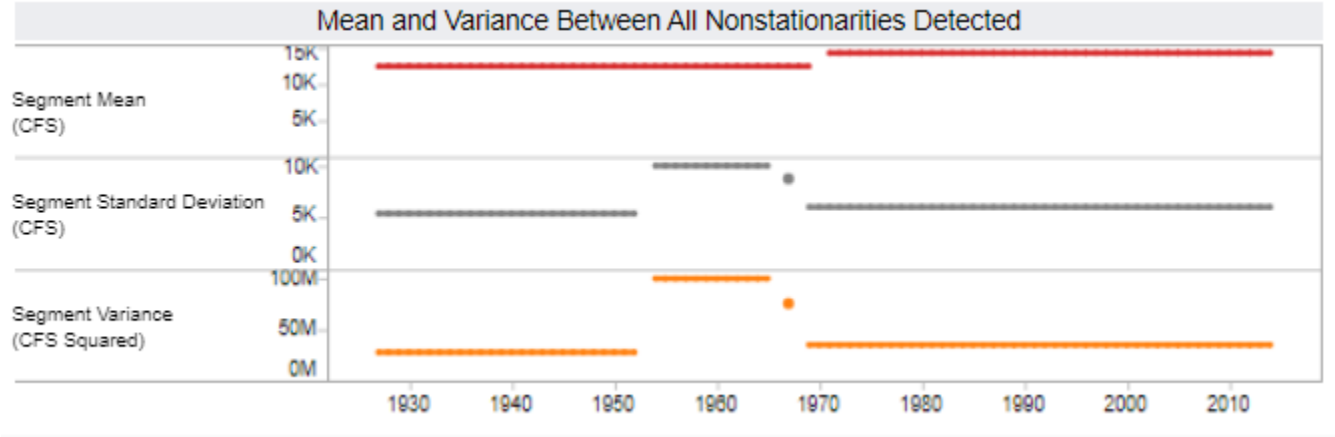
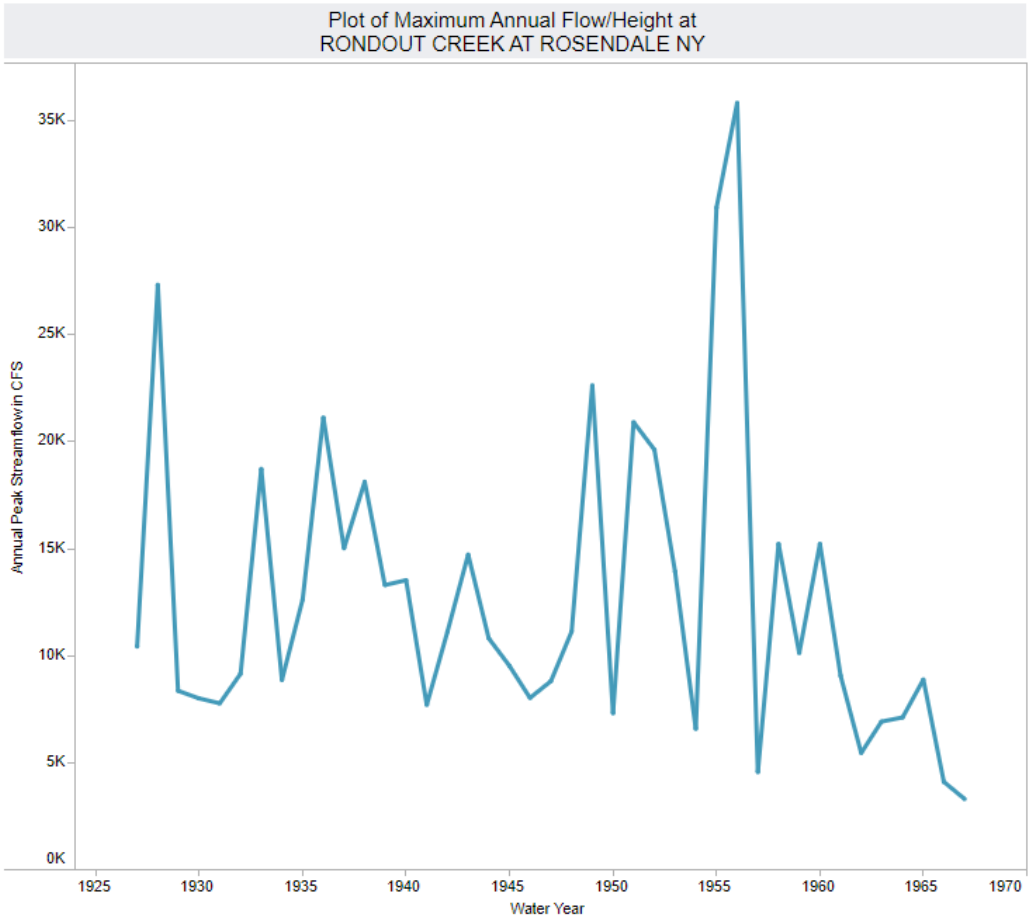


Figure 13. Mean and Variance Between All Nonstationarities Detected

Since the nonstationarity detected around 1970 reaches a consensus, is robust, with statistically significant changes in magnitude, it meets the three criteria to be considered a strong nonstationarity. Therefore, the gage at Rondout Creek in Rosendale, NY shows strong nonstationarity with a change occurring around 1970.

TREND ANALYSIS – RONDOUT CREEK

The NSD tool was used to assess the subsets of homogenous data for monotonic trends. At this gage, a strong nonstationarity was detected around 1970. Therefore, to assess the monotonic trends, the historical gage data was broken into two subsets: pre- and post- 1970. Figure 14 shows that the p-value did not reach the threshold for a statistically significant monotonic trend from 1927-1968. However, the p-values were less than 0.1, implying there may be a negative trend, but one that does not meet the threshold for statistical significance (p-value < 0.05). Figure 15 shows that there is no statistically significant monotonic trend from 1973-2020 on Rondout Creek near Rosendale, NY.

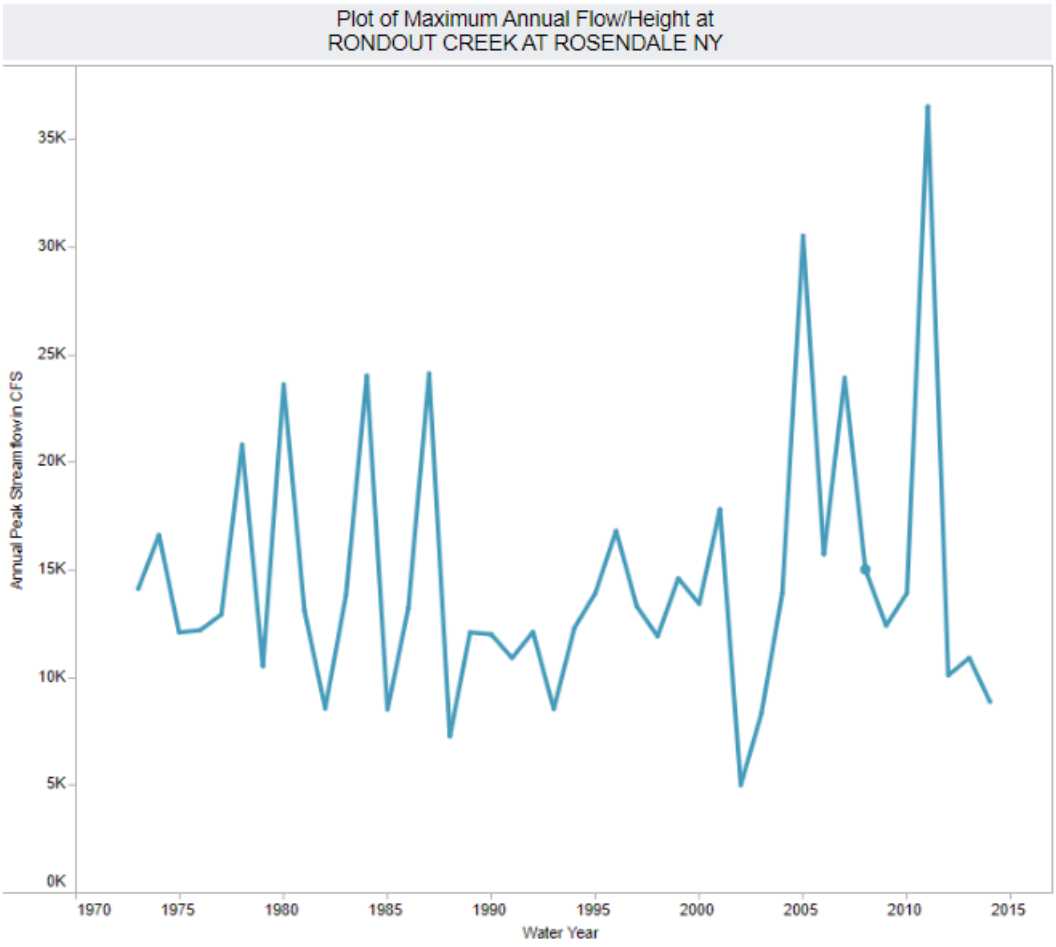


Monotonic Trend Analysis

Is there a statistically significant trend?
No, using the Mann-Kendall Test at the .05 level of significance. The exact p-value for this test was 0.082.
No, using the Spearman Rank Order Test at the .05 level of significance. The exact p-value for this test was 0.084.

What type of trend was detected?
Using parametric statistical methods, **no trend** was detected.
Using robust parametric statistical methods (Sen's Slope), **no trend** was detected.

Figure 14. Monotonic Trend Analysis from 1927 - 1967



Monotonic Trend Analysis

Is there a statistically significant trend?
No, using the Mann-Kendall Test at the .05 level of significance. The exact p-value for this test was 0.837.
No, using the Spearman Rank Order Test at the .05 level of significance. The exact p-value for this test was 0.961.

What type of trend was detected?
Using parametric statistical methods, **no trend** was detected.
Using robust parametric statistical methods (Sen's Slope), **no trend** was detected.

Figure 15. Monotonic Trend Analysis 1973-2020

NONSTATIONARITY DETECTION – WALLKILL RIVER

The NSD tool was used to analyze USGS 01371500 Wallkill River at Gardiner, New York. Figure 16 shows the annual peak streamflow from 1927-2014 and the five detected abrupt nonstationarities (vertical lines).

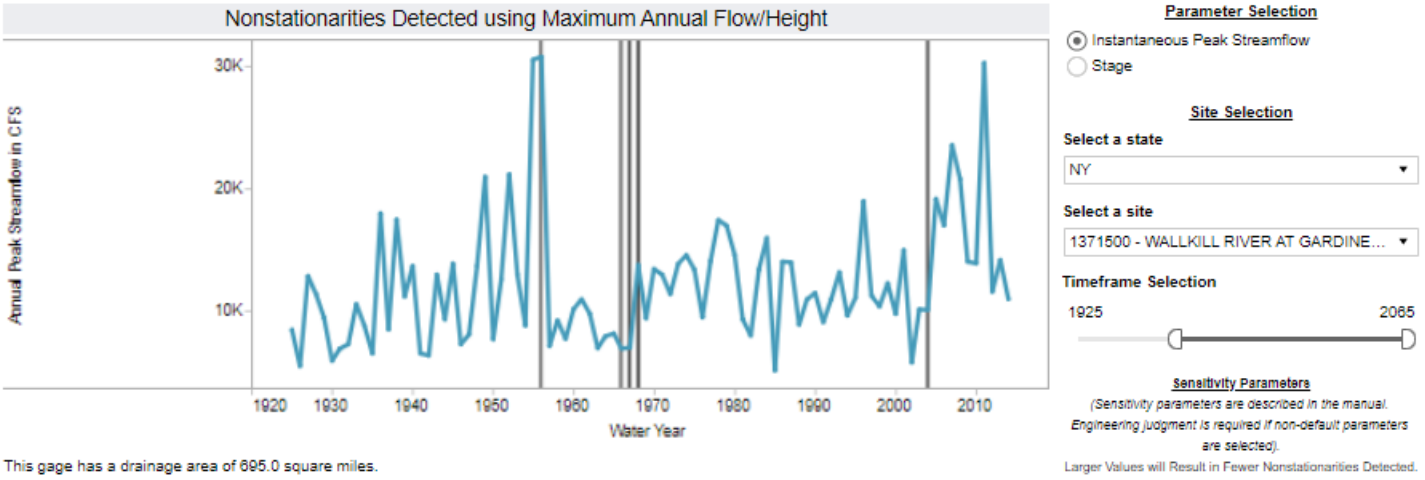


Figure 16. Output from Nonstationarity Detection tool – Wallkill River at Gardiner NY – with streamflow data from 1927 to 2014

The heatmap output shows the five points of nonstationarity detected, and by what method they were detected, including the Lombard Mood (1956), Lombard Wilcoxon (1966), Pettitt (1967), Komogorov-Smirnov (CPM) (1967), Energy Divisive Method (1968), and Mann-Whitney (CPM), LePage (CPM), and Cramer-Von-Misses (all 2004) (Figure 17).

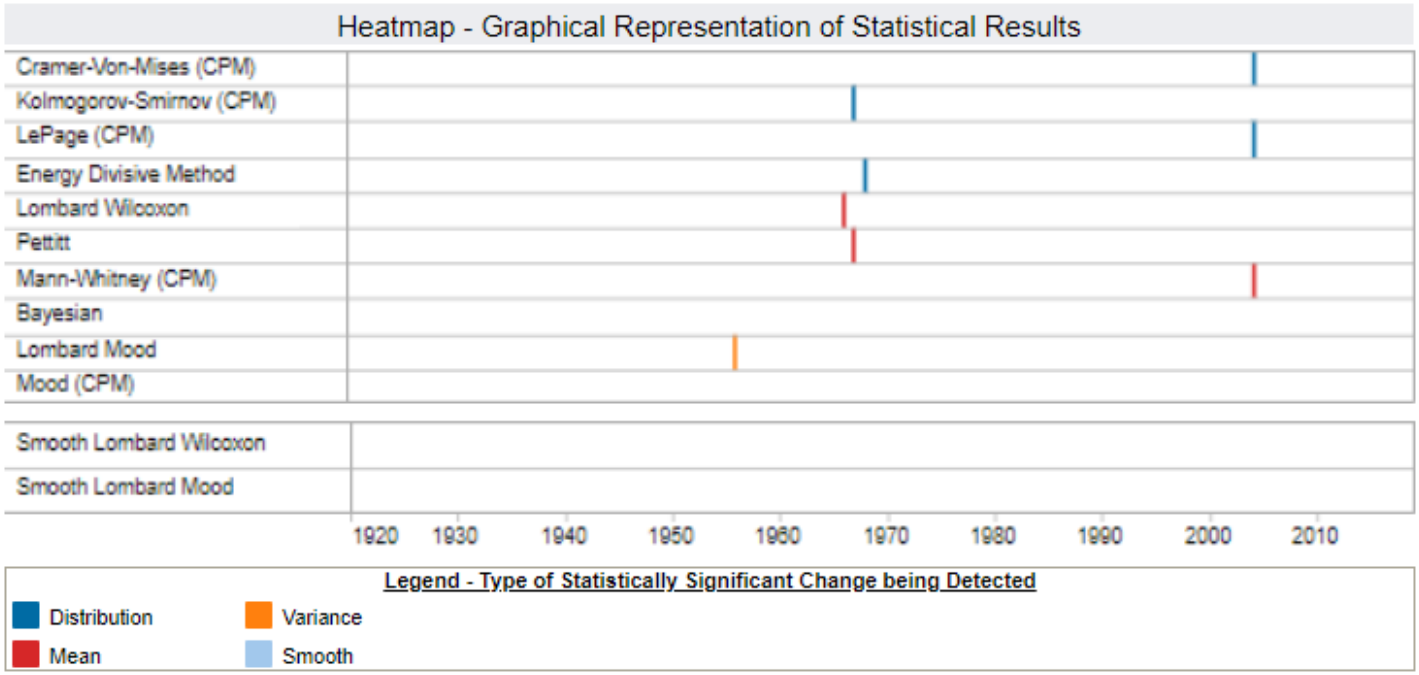


Figure 17. Heatmap shows the year and type of detected nonstationarities

At this gage, there are two detected nonstationarities that show consensus and are considered robust – in the mid-1960s and 2004. The mid-1960s nonstationarity was detected by two methods testing mean (Lombard Wilcoxon and Pettitt) and two methods testing distribution (Komogorov-Smirnov [CPM] and Energy Divisive Method). The nonstationarity detected in 2004 was detected by one method testing mean (Mann-Whitney [CPM]) and two methods testing distribution (LePage [CPM] and Cramer-Von-Misses).

Figure 18 shows a change in mean for the mid-1960s and 2004 nonstationarities, but not standard deviation or variance for the identified nonstationarities. This change in mean in the mid-1960s was relatively small, while the change post-2004 was larger.

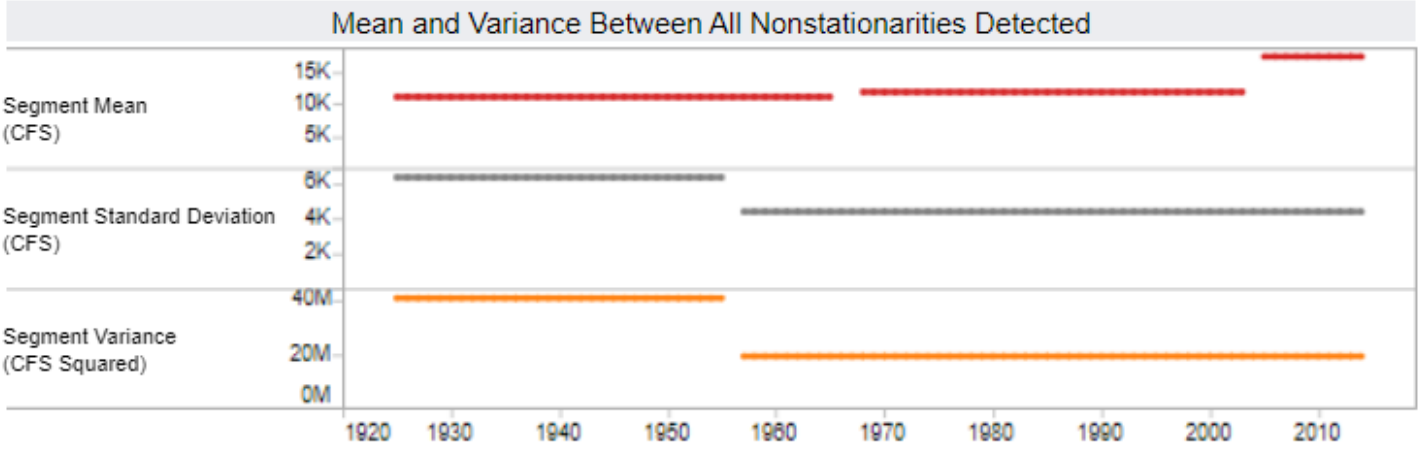


Figure 18. Mean and Variance Between All Nonstationarities Detected

Since the nonstationarities detected during the mid-1960s and 2000 reach a consensus, are robust, with statistically significant changes in magnitude, these meet the three criteria to be considered strong nonstationarities. Therefore, the gage on the Wallkill River at Gardiner, NY show strong nonstationarities with changes occurring in the mid-1960s and in 2004.

TREND ANALYSIS – WALLKILL RIVER

The NSD tool was used to assess the subsets of homogenous data for monotonic trends. At this gage, two strong nonstationarities were detected: mid-1960s and 2004. Therefore, to assess the monotonic trends, the historical gage data was broken into three subsets. Figure 19 shows that there is not a statistically significant monotonic trend from 1927-1965; Figure 20 shows that there is not a statistically significant monotonic trend from 1970-2003; and Figure 21 shows that there is not a statistically significant monotonic trend from 2005-2014 on the Wallkill River at Gardiner, NY.

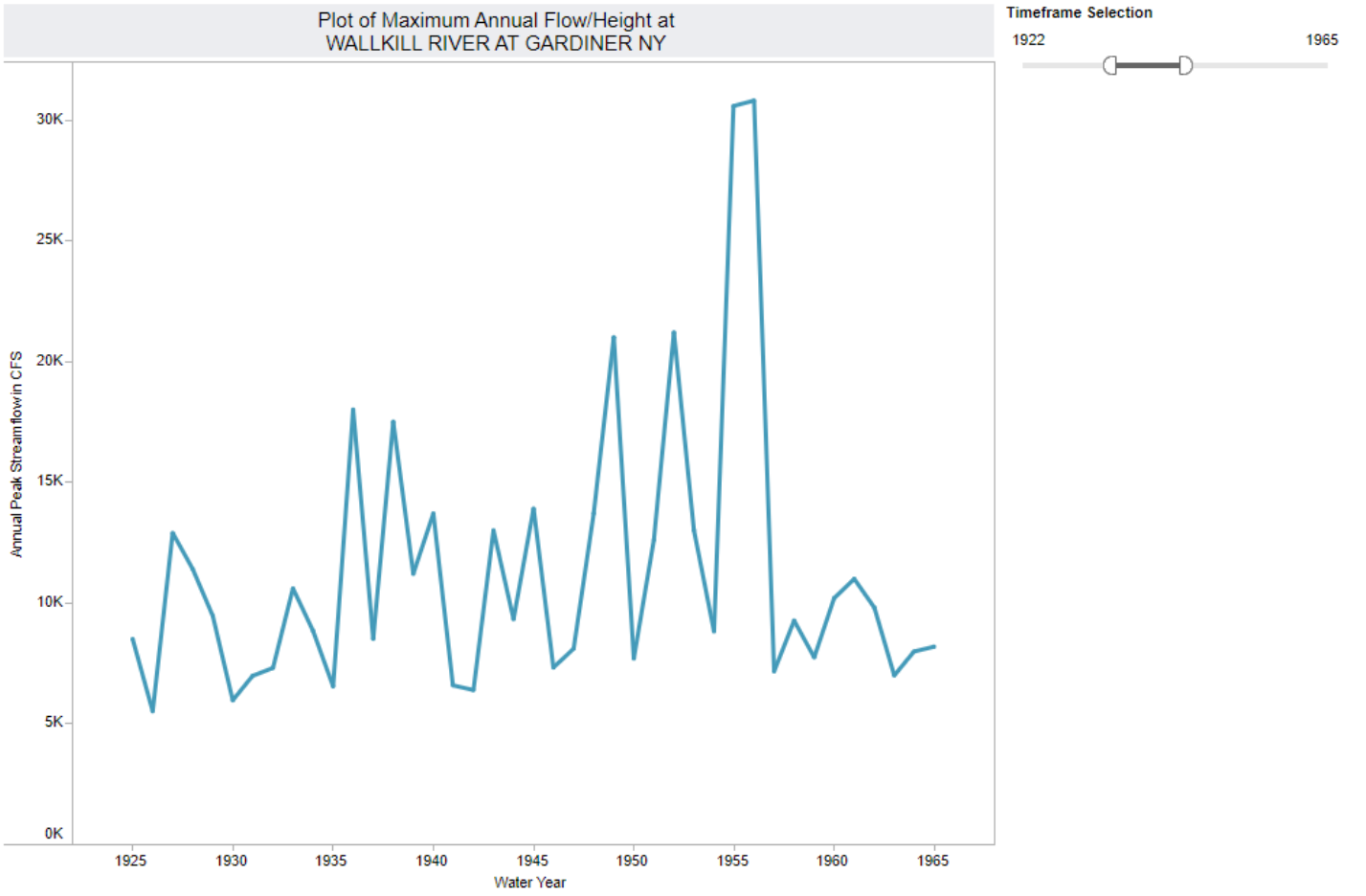
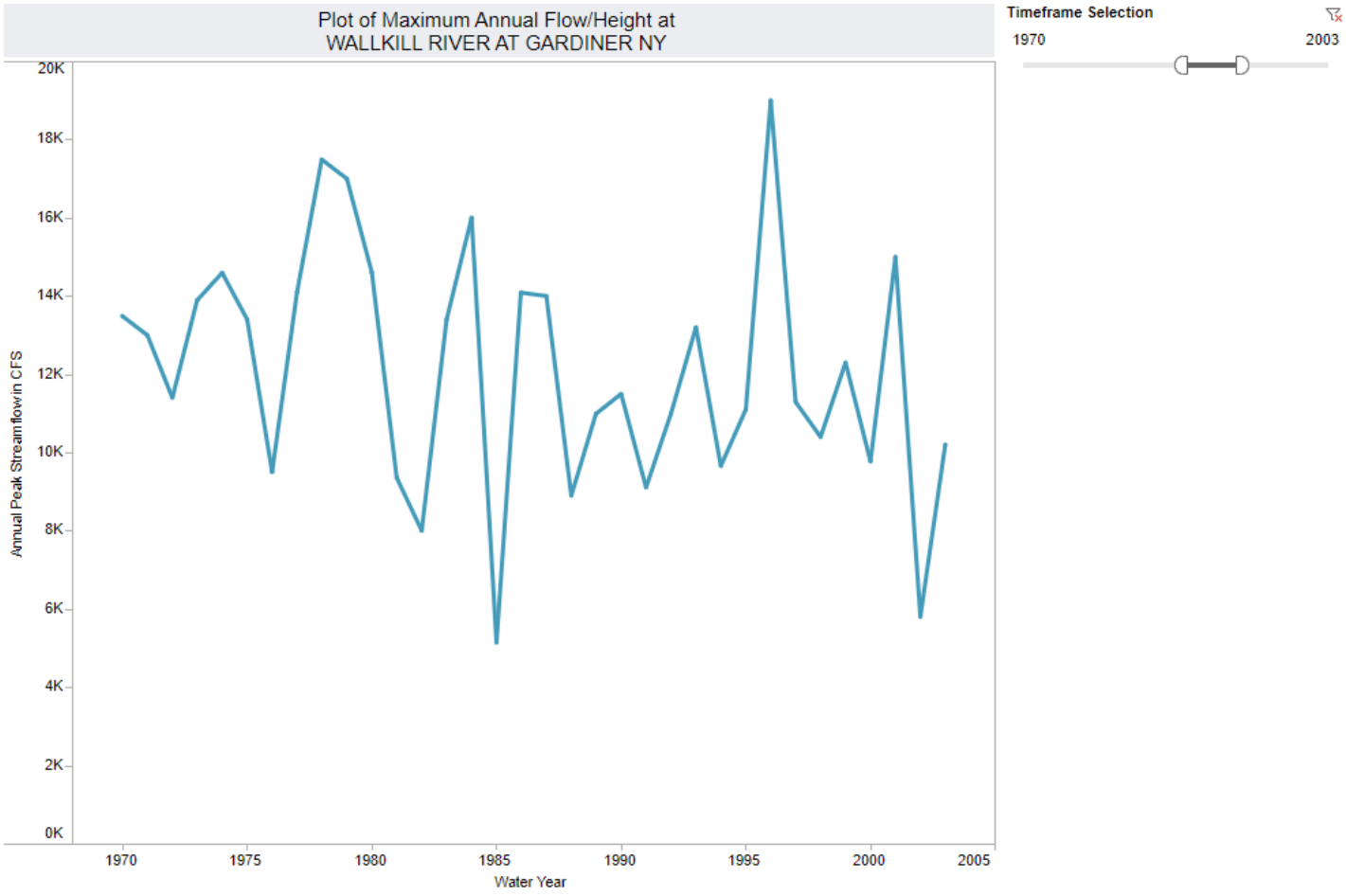


Figure 19. Monotonic Trend Analysis from 1927-1965



Monotonic Trend Analysis

Is there a statistically significant trend?
No, using the Mann-Kendall Test at the .05 level of significance. The exact p-value for this test was 0.116.
No, using the Spearman Rank Order Test at the .05 level of significance. The exact p-value for this test was 0.084.

What type of trend was detected?
Using parametric statistical methods, **no trend** was detected.
Using robust parametric statistical methods (Sen's Slope), **no trend** was detected.

Please acknowledge the US Army Corps of Engineers for producing this nonstationarity detection tool as part of their progress in climate preparedness and resilience and making it freely available.

Figure 20. Monotonic Trend Analysis from 1970-2003

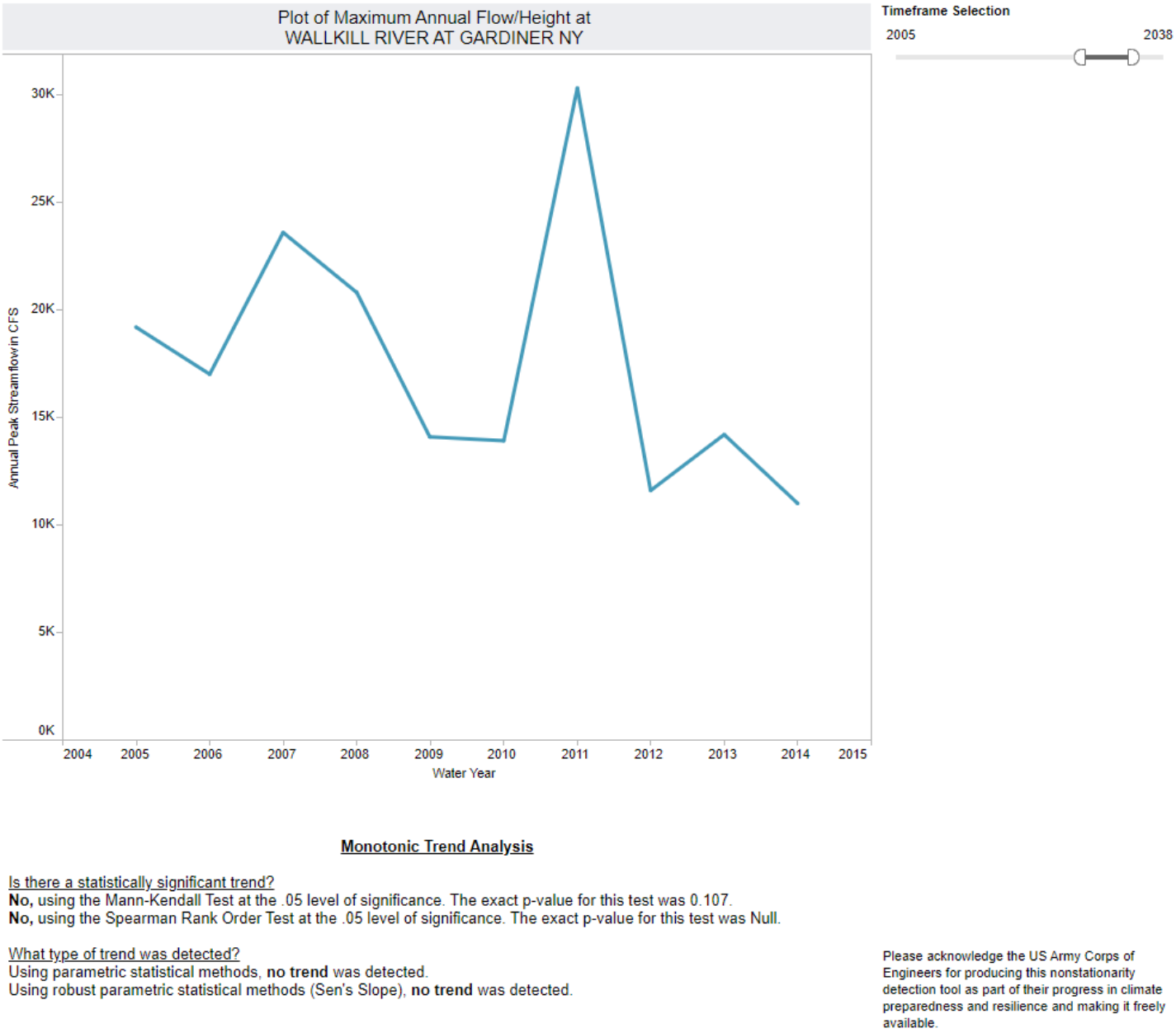


Figure 21. Monotonic Trend Analysis from 2005-2014

CONCLUSION

While results for the Wappinger Creek gage indicated two points in time that did not meet the criteria for strong nonstationarity, several strong nonstationarities were detected for the two other watersheds proximal to Moodna Creek. These results suggest that Moodna Creek hydrology is also subject to nonstationarity.

USACE CLIMATE HYDROLOGY ASSESSMENT TOOL

SCHODACK ISLAND PARK AND HENRY HUDSON PARK

The USACE CHAT was used to assess historical trends in peak instantaneous stream flow at USGS 01358000 Hudson River at Green Island, New York (Figure 22). The trendline p-value is 0.53 which exceeds the accepted threshold for statistical significance of 0.05. Therefore, there may be an increasing trend in the historically observed peak flow data over the period of record 1946-2014, but the trend is not statistically significant.

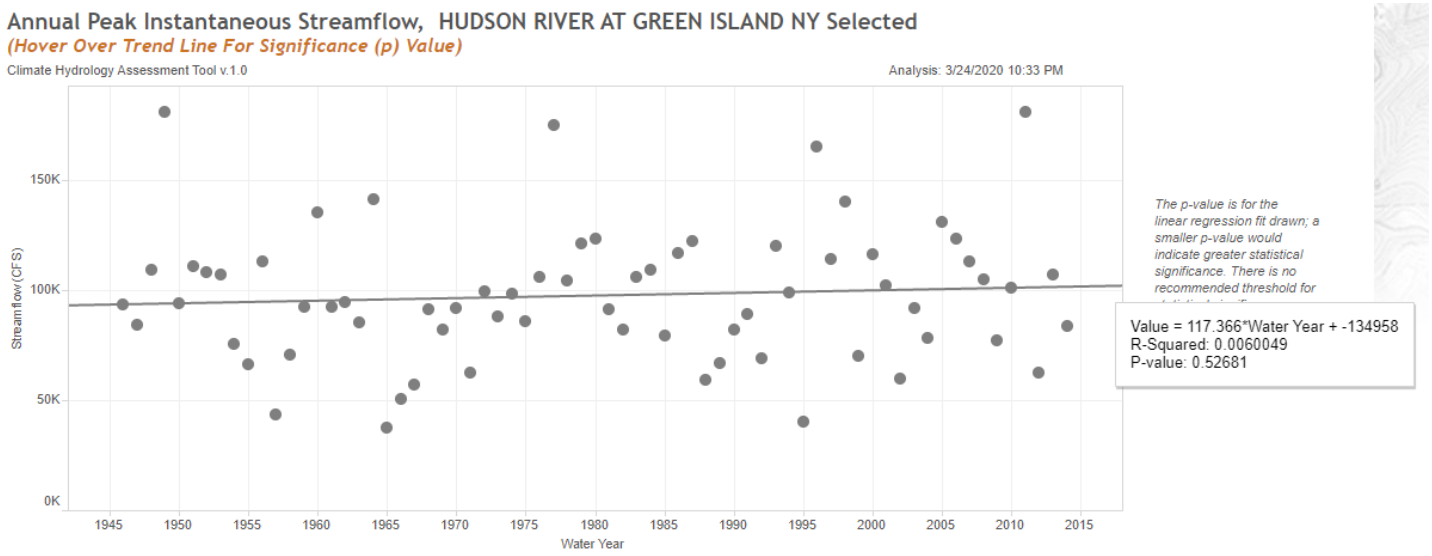


Figure 22. CHAT output using annual instantaneous peak discharge at Hudson River at Green Island, NY Gage 01358000 (HUC 0202)

MOODNA CREEK

Due to the lack of gaging stations on the Moodna Creek, USGS gages on three proximal streams were analyzed (all in HUC 0202) with the USACE CHAT. In summary, the gages on Wappinger Creek and Rondout Creek did not have a statistically significant trend, while the gage on the Wallkill River showed a statistically significant increasing trend in the historically observed peak flow data.

Figure 23 shows the output of the CHAT for USGS 01372500 Wappinger Creek Near Wappingers Falls, New York. The trendline p-value is 0.77 which exceeds the accepted threshold for statistical significance of 0.05. Therefore, there may be an increasing trend in the historically observed peak flow data over the period of record 1929-2014, but the trend is not statistically significant.

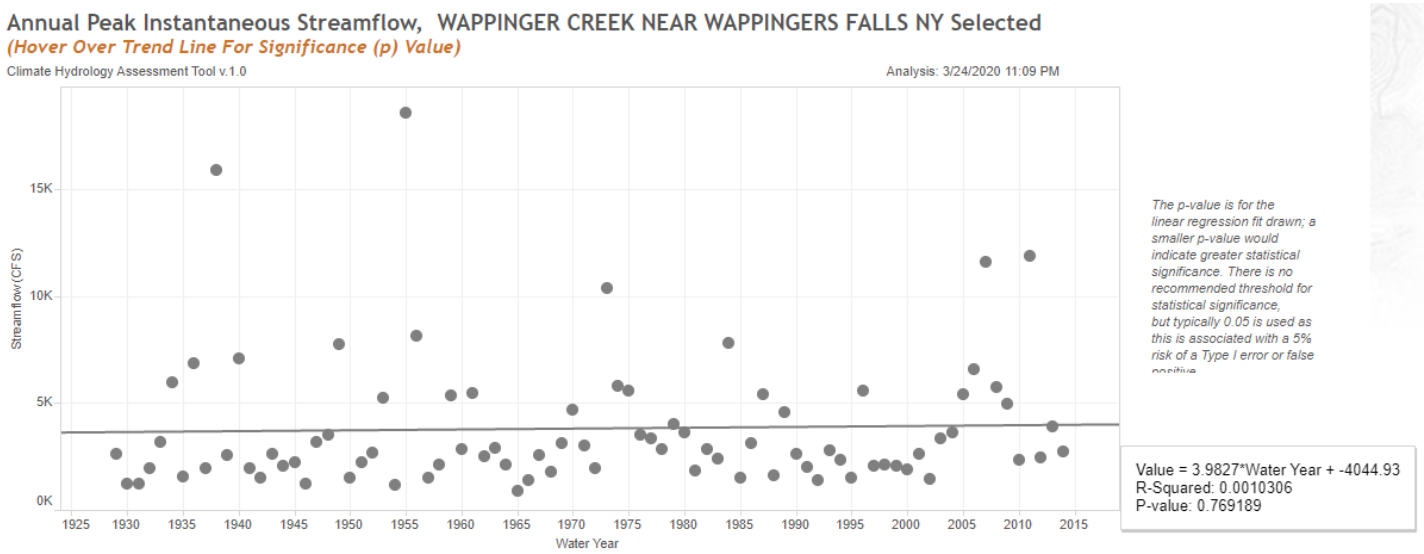


Figure 23. CHAT output using annual instantaneous peak discharge at Wappinger Creek near Wappingers Falls, NY Gage 01372500 (HUC 0202)

Figure 24 shows the output of the CHAT for USGS 01367500 Rondout Creek at Rosendale, New York. The trendline p-value is 0.35 which exceeds the accepted threshold for statistical significance of 0.05. Therefore, there may be an increasing trend in the historically observed peak flow data over the period of record 1927-2014, but the trend is not statistically significant.

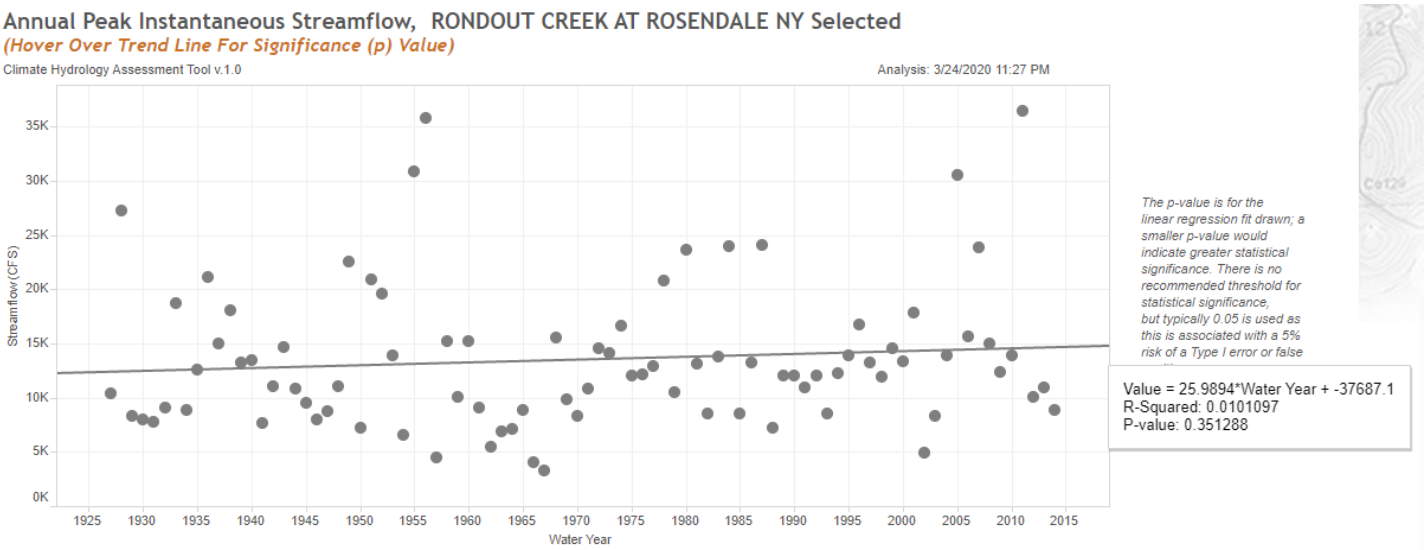


Figure 24. CHAT output using annual instantaneous peak discharge at Rondout Creek at Rosendale, NY Gage 01367500 (HUC 0202)

Figure 25 shows the output of the CHAT for USGS 01371500 Wallkill River at Gardiner, New York. The trendline p-value is 0.03 which satisfies the accepted threshold for statistical significance of 0.05. Therefore, there is a statistically significant increasing trend in the historically observed peak flow data over the period of record 1925-2014.

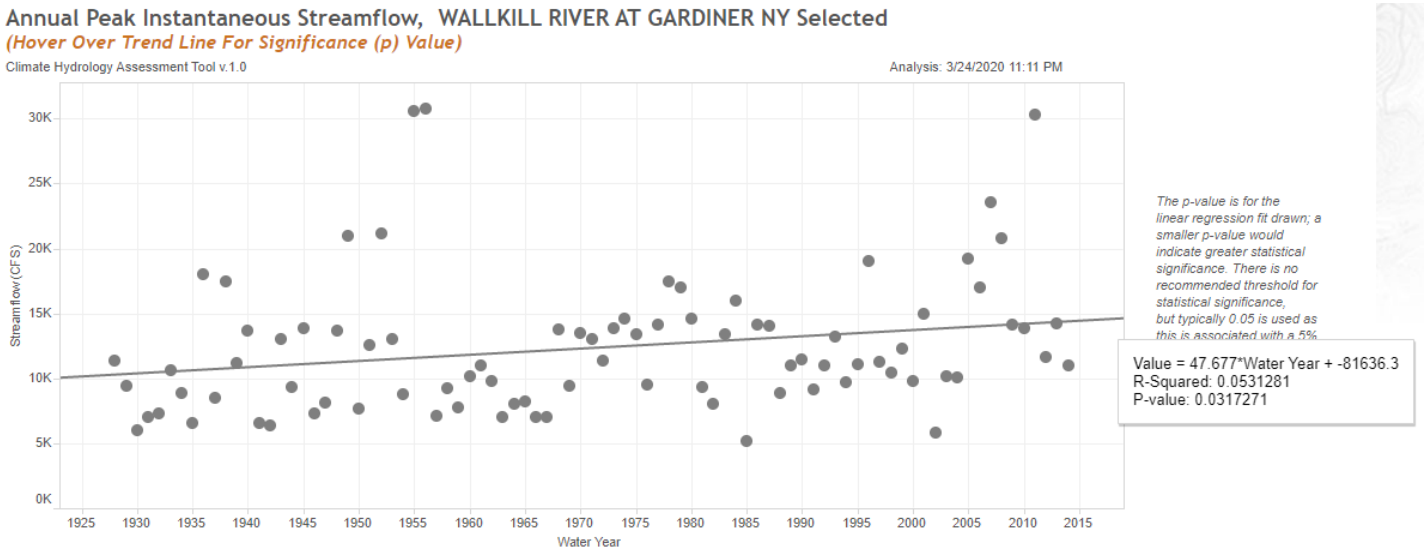


Figure 25. CHAT output using annual instantaneous peak discharge at Wallkill River at Gardiner, NY Gage 01371500 (HUC 0202)

HUC 0202: UPPER HUDSON WATERSHED

The USACE CHAT was used to investigate future changes in mean monthly stream flows in HUC 0202, which encompasses the watersheds of the Project Sites. Figure 26 shows the mean and range of projected, unregulated, annual maximum monthly flows computed by 93 different combinations of General Circulation Model (GCM) outputs generated using different concentration pathways of greenhouse gas emissions. Climate-Changed Hydrology is calculated for the period of 1999-2099 for the HUC Basin 0202 (Upper Hudson).

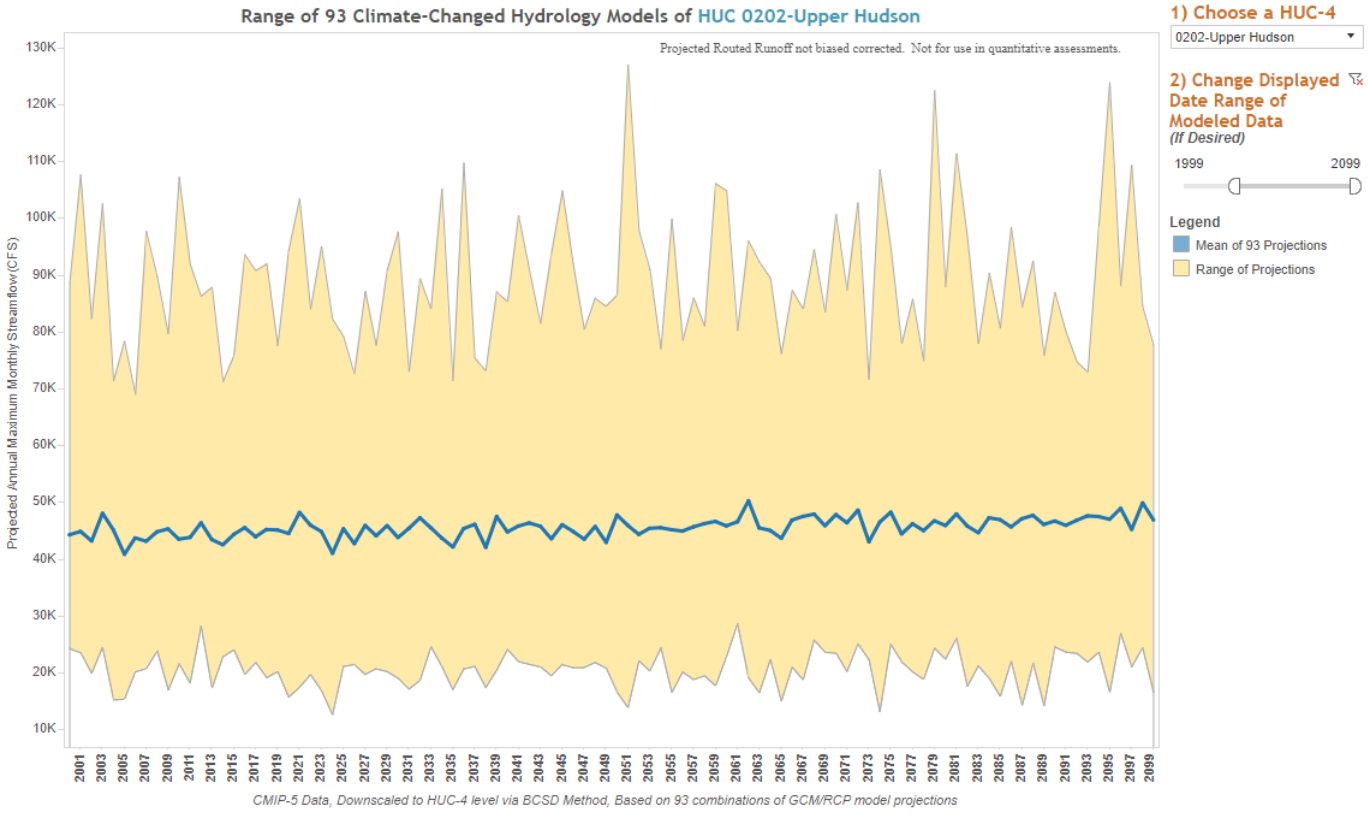


Figure 26. Mean and Range of Projected Annual Maximum Monthly Streamflow in HUC 0202 (Upper Hudson).

A statistical analysis of the projected hydrology for 2000-2099 indicates a statistically significant linear trend of increasing mean annual maximum monthly flows (Figure 27) with a trendline p-value of <0.0001. This increase is statistically significant (p-value < 0.05) and suggests the potential for future increases in streamflow relative to current conditions.

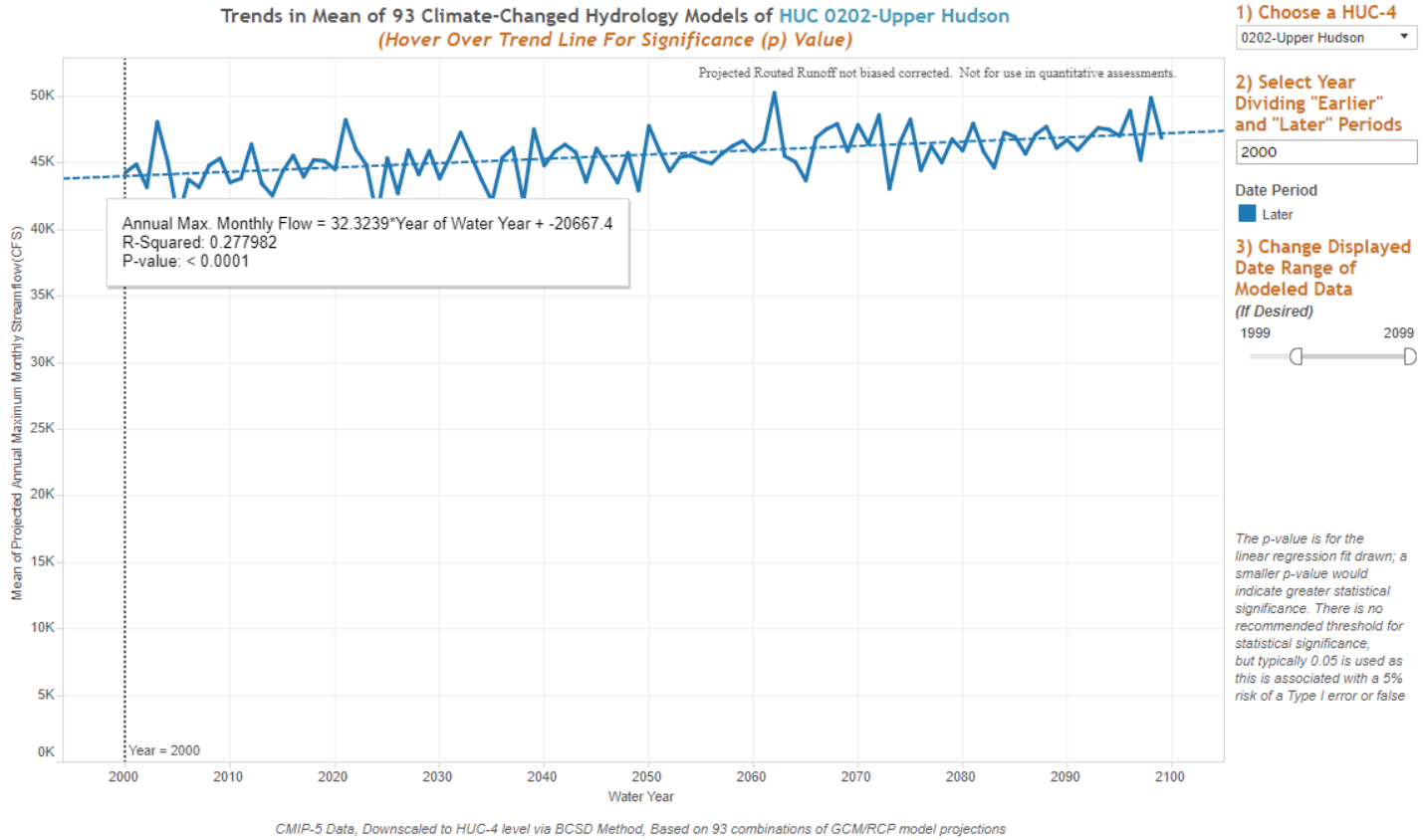


Figure 27. Projected Mean Annual Maximum Monthly Streamflow in HUC 0202 (Upper Hudson)

When comparing the historical records and projected models, the USACE CHAT outputs provided differing results for streams proximate to Moodna Creek. While the CHAT identified a significant increasing trend in peak annual streamflow for the Wallkill gage, the other two gages with smaller watershed sizes that are more reflective of the Moodna Creek watershed (Wappinger and Rondout) did not indicate a similar statistically significant trend. Likewise, for the Schodack Island Park and Henry Hudson Park Sites (Hudson River at Green Island, NY gage), the CHAT result did not identify a statistically significant trend in peak annual streamflow. However, for future projections of HUC 0202: Upper Hudson – which encompasses all Project Sites and subject gages – the CHAT results indicate a statistically significant projected increasing trend of annual maximum monthly flows for 1999-2099. This implies that existing gage data does not capture the hydroclimatic changes that are currently underway, and that could influence the Project Sites over the next century.

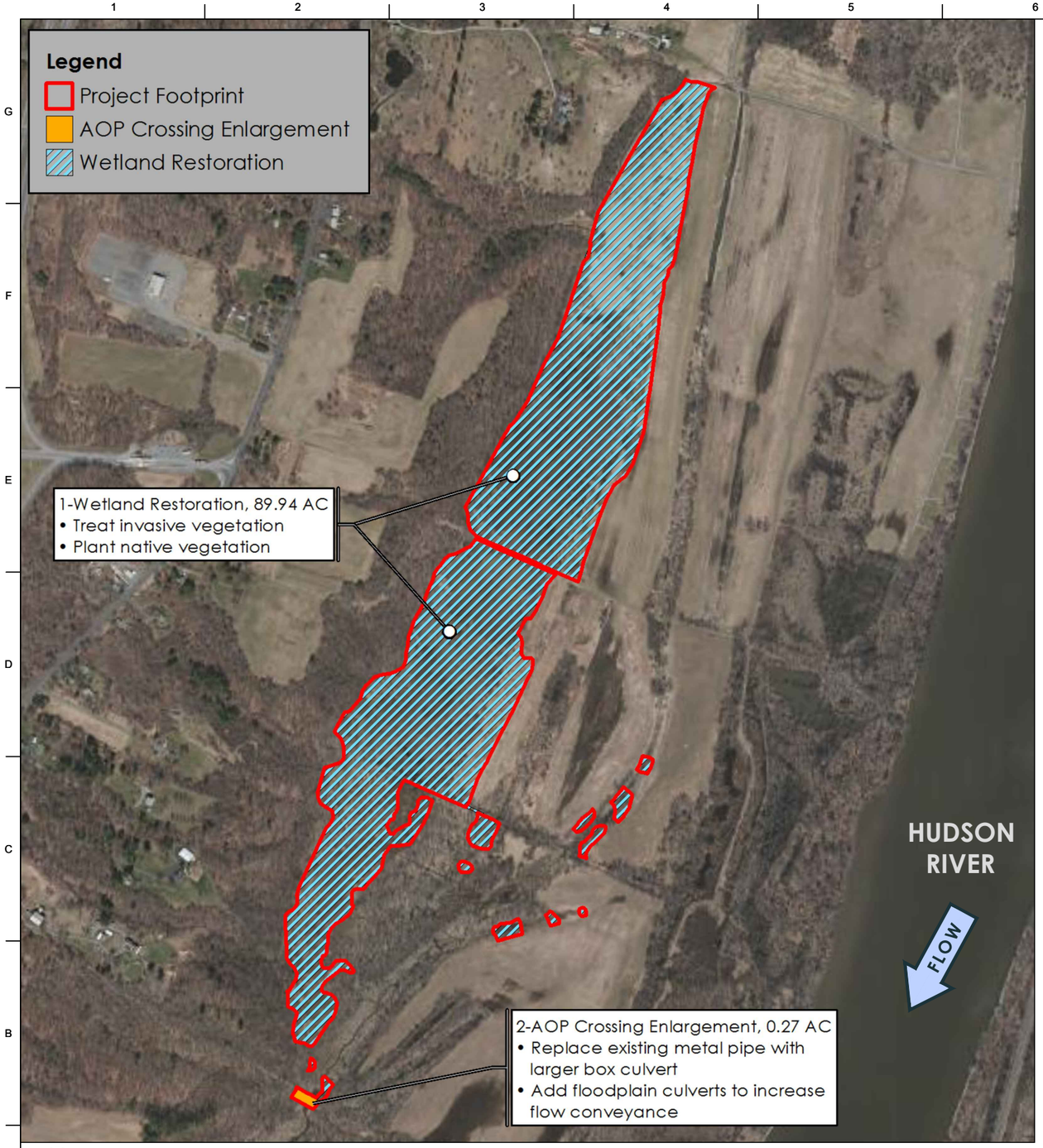
RESOURCES

Hudson-Raritan Estuary Ecosystem Restoration Feasibility Study: Appendix C Engineering. February 2020. Prepared by the New York District, North Atlantic Division, U.S. Army Corps of Engineers.

US Army Corps of Engineers Nonstationarity Detection tool User Guide. Updated September 2018. Climate Preparedness and Resilience Community of Practice, US Army Corps of Engine

ATTACHMENT E

CONCEPT DESIGNS AND QUANTITIES



1 PLAN VIEW
North - Alternative 1
1" = 800'

GRAPHIC SCALE
0 100 200 400 600 800 FEET
SCALE: 1" = 800'

1-Wetland Restoration

Item	*Unit*	*Quantity*
Invasive Species Treatment	AC	89.94
Herbivore Exclusion Fence - Deer	LF	25,300
Plantings (3FT OC)	EA	1,452,000

2-AOP Crossing Enlargement

Item	*Unit*	*Quantity*
Excavation	CY	120
Grading	SF	2,000
Box Culvert	LF	24
Concrete Headwall and Wingwalls	SF	320
Floodplain Culvert	LF	64
Floodplain Culvert End Treatments	EA	4
Stone Base Course	TON	60
Guardrail	LF	140
Boulders - 2' DIA	TON	50
Stream Substrate -Fine	CY	20
Stream Substrate -Boulders	TON	50
Stream Substrate	SF	300
Plantings (3FT OC)	EA	1,400
Herbivore Exclusion Fence - Geese	AC	0.27

General Construction

Item	*Unit*	*Quantity*
Turbidity Barrier	LF	300
Silt Fence	LF	600
Construction Stake Out	AC	0.27
Stabilized Construction Entrance	TON	100
Construction Access Matting	SF	299,400
Construction Access Reinforcement	TON	4,260
Clearing and Grubbing	AC	3.93

A SCHEDULE OF QUANTITIES
North - Alternative 1

Acronym	Definition
AC	Acres
CY	Cubic Yards
EA	Each
FT	Feet
H:V	Horizontal:Vertical
IN	Inches
LF	Linear Feet
NAVD88	North American Vertical Datum of 1988
OC	On Center
SF	Square Feet
SY	Square Yards

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HUDSON RIVER HABITAT RESTORATION
BINNEN KILL
ALBANY COUNTY, NY

BINNEN KILL NORTH ALTERNATIVE 1
SITE LOCATION

SHEET ID
1

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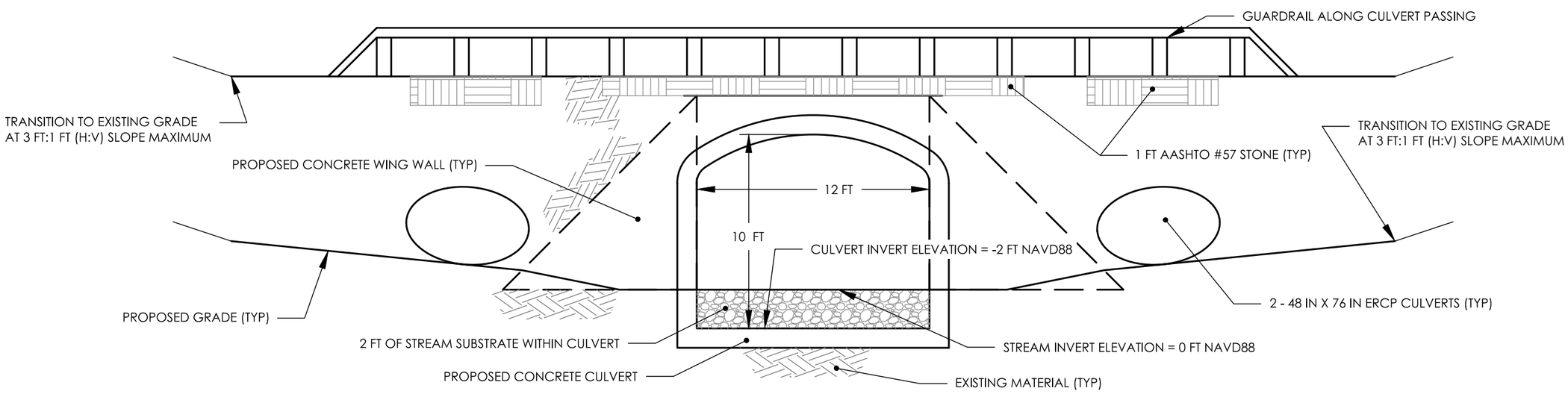
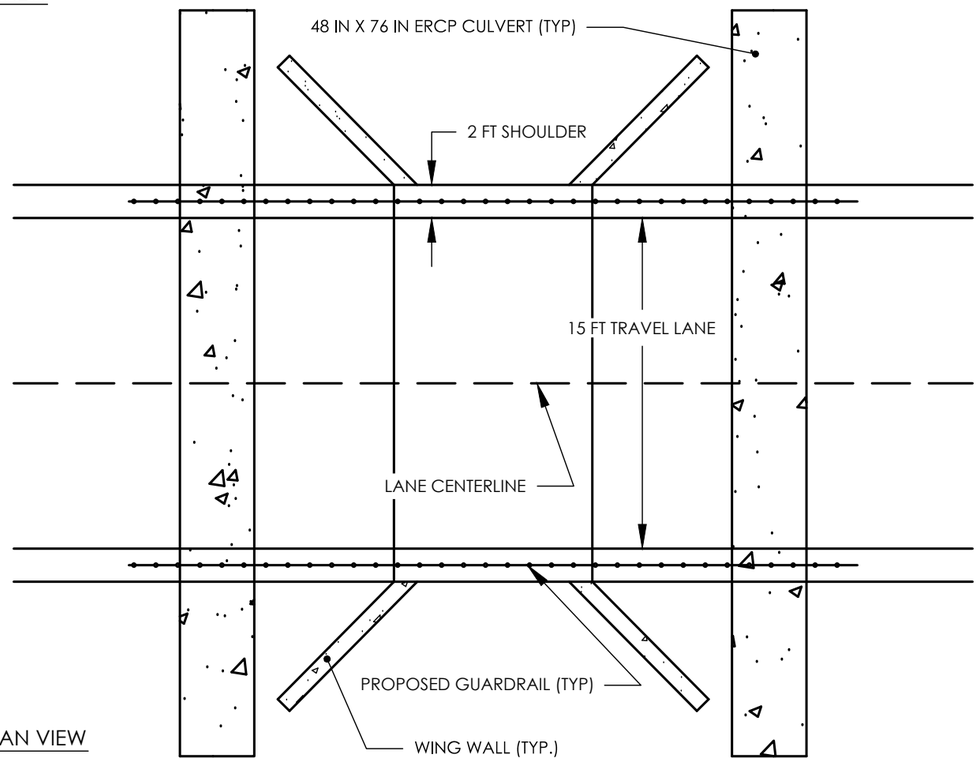


A AOP #2 - ENLARGE CROSSING - CROSS SECTION VIEW
NORTH - ALTERNATIVE 1
BINNEN KILL



B AOP #2 - ENLARGE CROSSING - PLAN VIEW
NORTH - ALTERNATIVE 1
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ALBANY COUNTY, NY

BINNEN KILL NORTH ALTERNATIVE 1
DETAILS

SHEET ID
2

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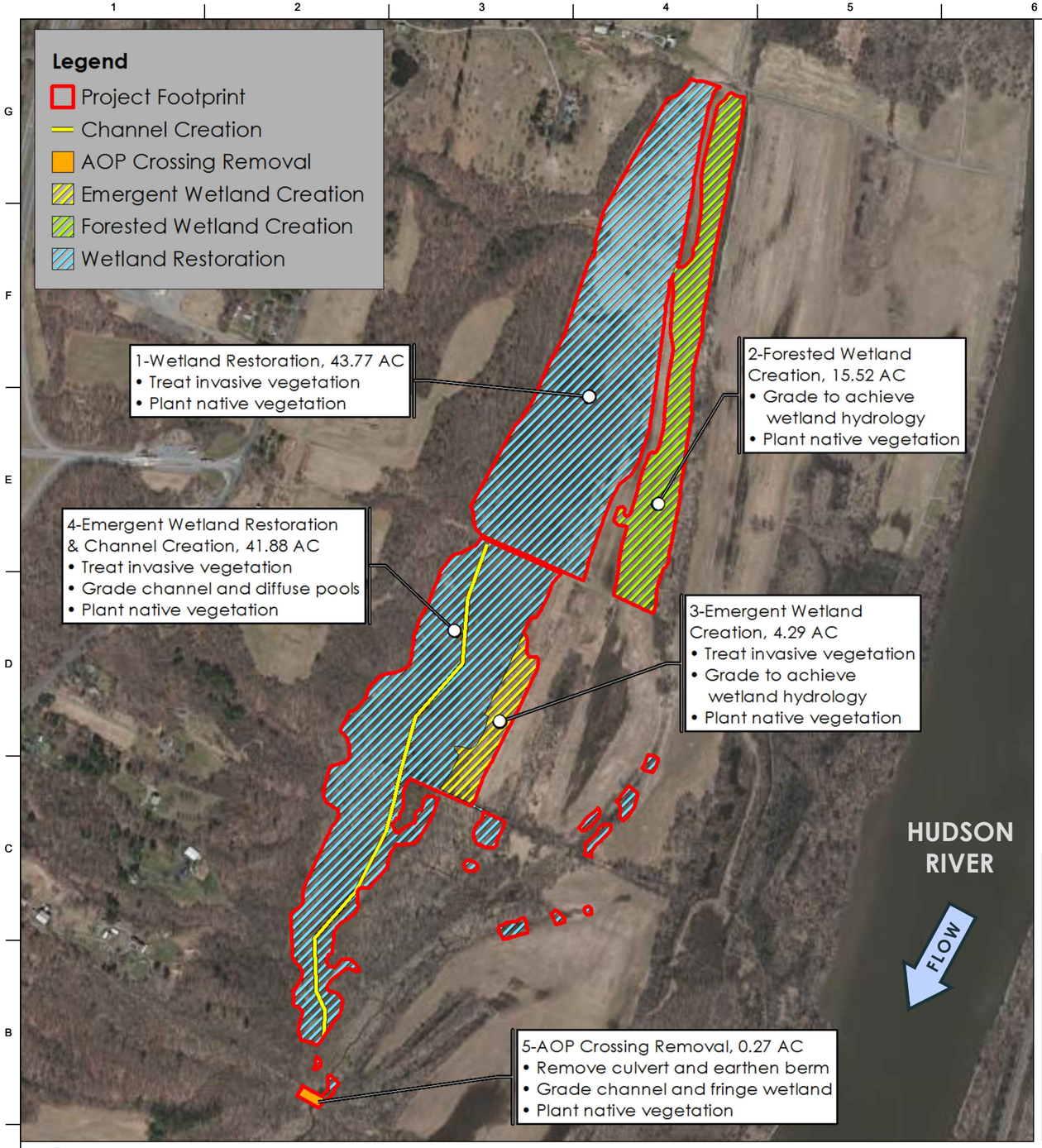

1 PLAN VIEW
North - Alternative 2
1" = 800'

GRAPHIC SCALE
0 100 200 400 600 800 FEET

SCALE: 1" = 800'

Acronym	Definition
AC	Acres
CY	Cubic Yards
EA	Each
FT	Feet
H:V	Horizontal:Vertical
IN	Inches
LF	Linear Feet
NAVD88	North American Vertical Datum of 1988
OC	On Center
SF	Square Feet
SY	Square Yards

1-Wetland Restoration

Item	*Unit*	*Quantity*
Invasive Species Treatment	AC	43.77
Plantings (3FT OC)	EA	211,900
Herbivore Exclusion Fence - Deer	LF	4,500
Herbivore Exclusion Fence - Geese	AC	43.77

2-Forested Wetland Creation

Item	*Unit*	*Quantity*
Grading	AC	15.52
Plantings (3FT OC)	EA	18,800
Herbivore Exclusion Fence - Deer	LF	7,500

3-Emergent Wetland Creation

Item	*Unit*	*Quantity*
Invasive Species Treatment	AC	4.29
Grading	AC	4.29
Plantings (3FT OC)	EA	20,800
Herbivore Exclusion Fence - Deer	LF	2,800
Herbivore Exclusion Fence - Geese	AC	4.29

4-Emergent Wetland Restoration & Channel Creation

Item	*Unit*	*Quantity*
Excavation - Channel	CY	2,500
Grading	SF	283,600
Coir Matting	SF	37,000
Invasive Species Treatment	AC	41.88
Herbivore Exclusion Fence - Deer	LF	10,500
Herbivore Exclusion Fence - Geese	AC	6.51
Plantings (3FT OC)	EA	202,700

5-AOP #2 - Remove Crossing

Item	*Unit*	*Quantity*
Excavation	CY	1,400
Grading	SF	11,800
Plantings (3FT OC)	SF	1,400
Herbivore Exclusion Fence - Geese	AC	0.27

General Construction

Item	*Unit*	*Quantity*
Turbidity Barrier	LF	300
Silt Fence	LF	10,550
Construction Stake Out	AC	42.15
Stabilized Construction Entrance	TON	100
Construction Access Matting	SF	370,000
Construction Access Reinforcement	TON	4,260
Clearing and Grubbing	AC	4.6

A SCHEDULE OF QUANTITIES
North - Alternative 2

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BINNEN KILL
ALBANY COUNTY, NY

BINNEN KILL NORTH ALTERNATIVE 2
SITE LOCATION

SHEET ID
1

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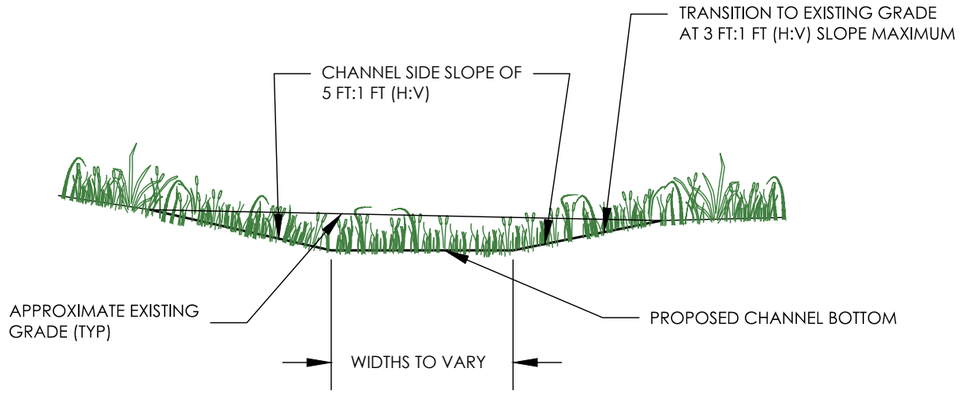
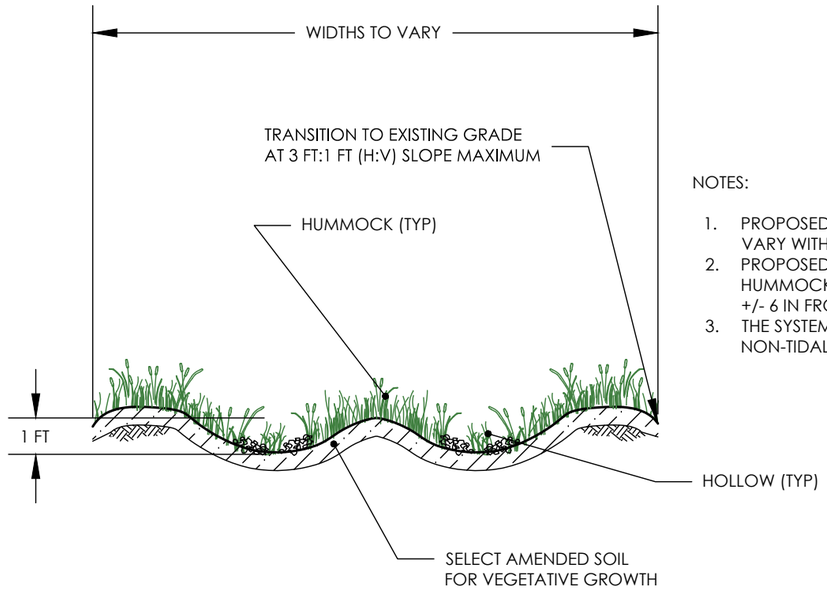


A CHANNEL RESTORATION
NORTH - ALTERNATIVE 2
BINNEN KILL

NOTES:

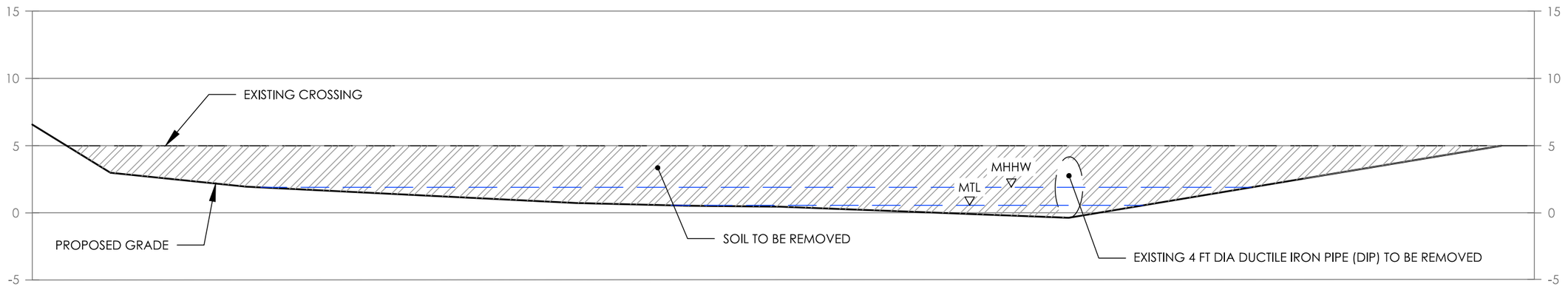
1. CHANNEL TO BE STABILIZED WITH MATTING AND VEGETATION



NOTES:

1. PROPOSED GRADE ELEVATIONS TO VARY WITH EXISTING TOPOGRAPHY.
2. PROPOSED MICROTOPOGRAPHY OF HUMMOCK AND HOLLOW'S TO BE +/- 6 IN FROM PROPOSED GRADE.
3. THE SYSTEM IS ANTICIPATED TO BE NON-TIDAL.

B DIFFUSE POOLS
NORTH - ALTERNATIVE 2
BINNEN KILL



C AOP #2 - ROAD AND CULVERT REMOVAL - CROSS SECTION VIEW
NORTH - ALTERNATIVE 2
BINNEN KILL

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BINNEN KILL
ALBANY COUNTY, NY

BINNEN KILL NORTH ALTERNATIVE 2
DETAILS

SHEET ID
2

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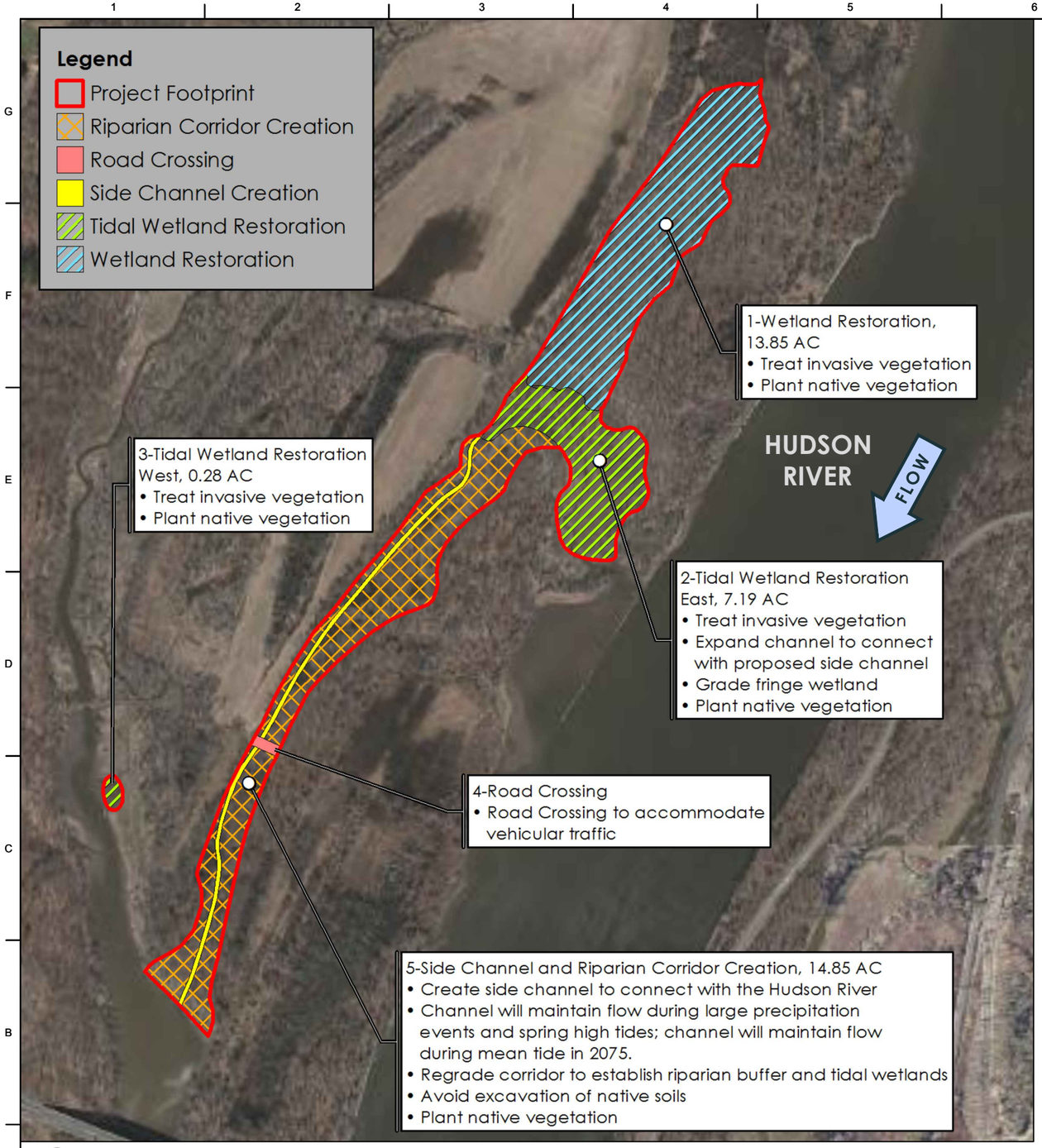

1 PLAN VIEW
South - Alternative 1
1" = 600'

GRAPHIC SCALE
0 200 400 600 1200 1800 2400 FEET
SCALE: 1" = 600'

1-Wetland Restoration

Item	Unit	Quantity
Invasive Species Treatment	AC	13.85
Herbivore Exclusion Fence - Deer	LF	4,400
Plantings (3FT OC)	EA	67,100

2-Tidal Wetland Restoration East

Item	Unit	Quantity
Channel Excavation	CY	2,222
Grading	AC	7.19
Invasive Species Treatment	AC	7.19
Herbivore Exclusion Fence - Deer	LF	3,000
Herbivore Exclusion Fence - Geese	AC	7.19
Plantings (3FT OC)	EA	34,800

3-Tidal Wetland Restoration West

Item	Unit	Quantity
Invasive Species Treatment	AC	0.28
Herbivore Exclusion Fence - Geese	AC	0.28
Plantings (3FT OC)	EA	1,400

4-Road Crossing

Item	Unit	Quantity
Box Culvert	LF	24
Concrete Headwall and Wingwalls	SF	320
Floodplain Culvert	LF	64
Floodplain Culvert End Treatments	EA	4
Stone Base Course	TON	26
Guardrail	LF	100
Stream Substrate	SF	300

5-Side Channel and Riparian Corridor

Item	Unit	Quantity
Excavation	CY	48,700
Grading	AC	14.85
Plantings (3FT OC)s	EA	71,900
Select Amended Soil	CY	12,100
Herbivore Exclusion Fence - Deer	LF	13,850
Herbivore Exclusion Fence - Geese	AC	14.85

General Construction

Item	Unit	Quantity
Turbidity Barrier	LF	930
Silt Fence	LF	6,900
Construction Stake Out	AC	22.04
Stabilized Construction Entrance	TON	50
Construction Access Matting	SF	202,000
Construction Access Reinforcement	TON	2,080
Clearing and Grubbing	AC	3.94

Acronym	Definition
AC	Acres
CY	Cubic Yards
EA	Each
FT	Feet
H:V	Horizontal:Vertical
IN	Inches
LF	Linear Feet
MHHW	Mean Higher High Water
MTL	Mean Tide Line
NAVD88	North American Vertical Datum of 1988
OC	On Center
SF	Square Feet
SY	Square Yards

A SCHEDULE OF QUANTITIES
South - Alternative 1

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HUDSON RIVER HABITAT RESTORATION
BINNEN KILL
ALBANY COUNTY, NY

BINNEN KILL SOUTH ALTERNATIVE 1
SITE LOCATION

SHEET ID
1

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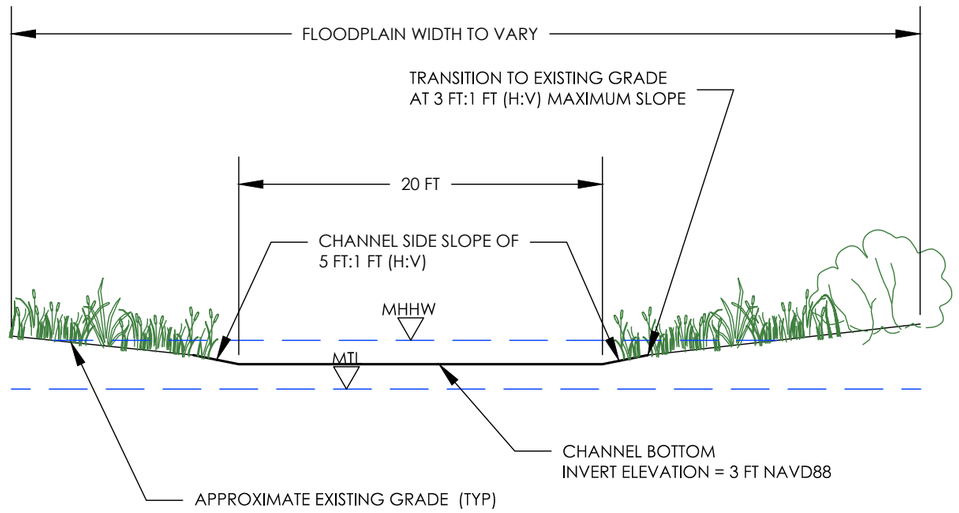
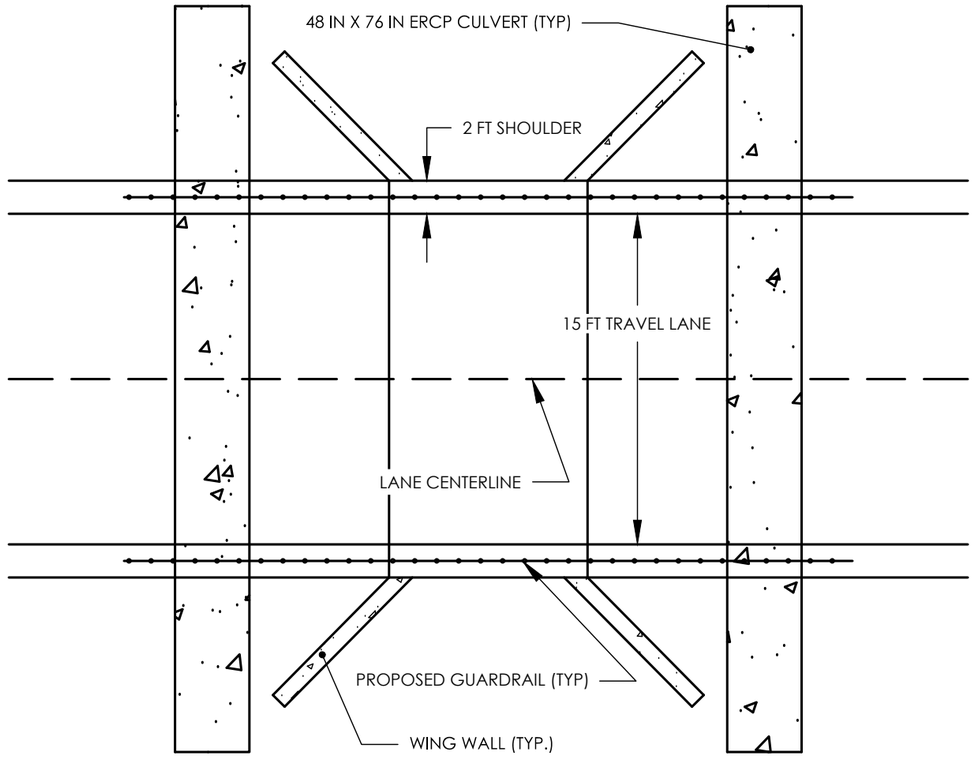
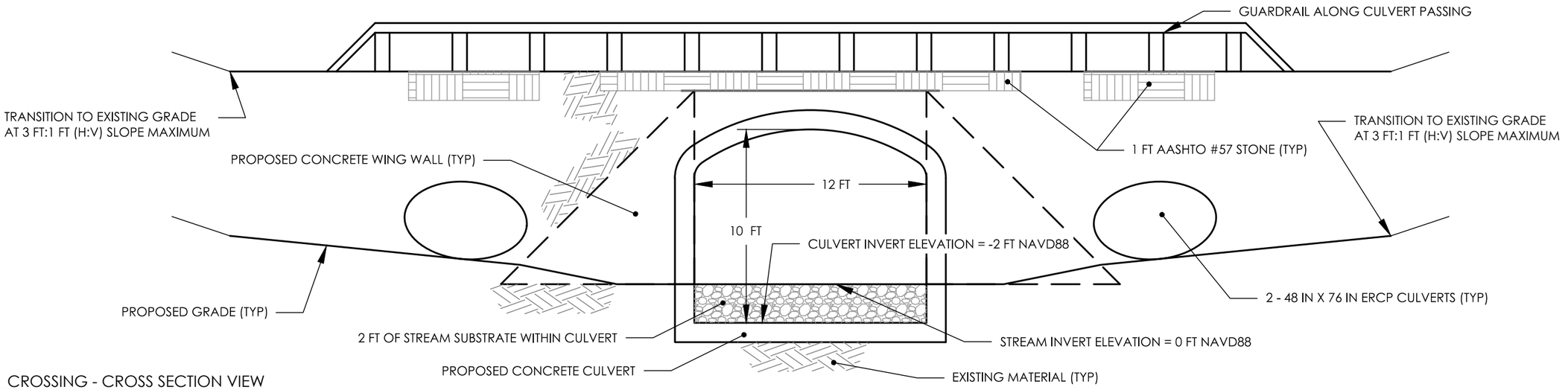


A SIDE CHANNEL
SOUTH - ALTERNATIVE 1
BINNEN KILL



B CROSSING - PLAN VIEW
SOUTH - ALTERNATIVE 1
BINNEN KILL



C CROSSING - CROSS SECTION VIEW
SOUTH - ALTERNATIVE 1
BINNEN KILL

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HUDSON RIVER HABITAT RESTORATION
BINNEN KILL
ALBANY COUNTY, NY

BINNEN KILL SOUTH ALTERNATIVE 1 DETAILS

SHEET ID
2

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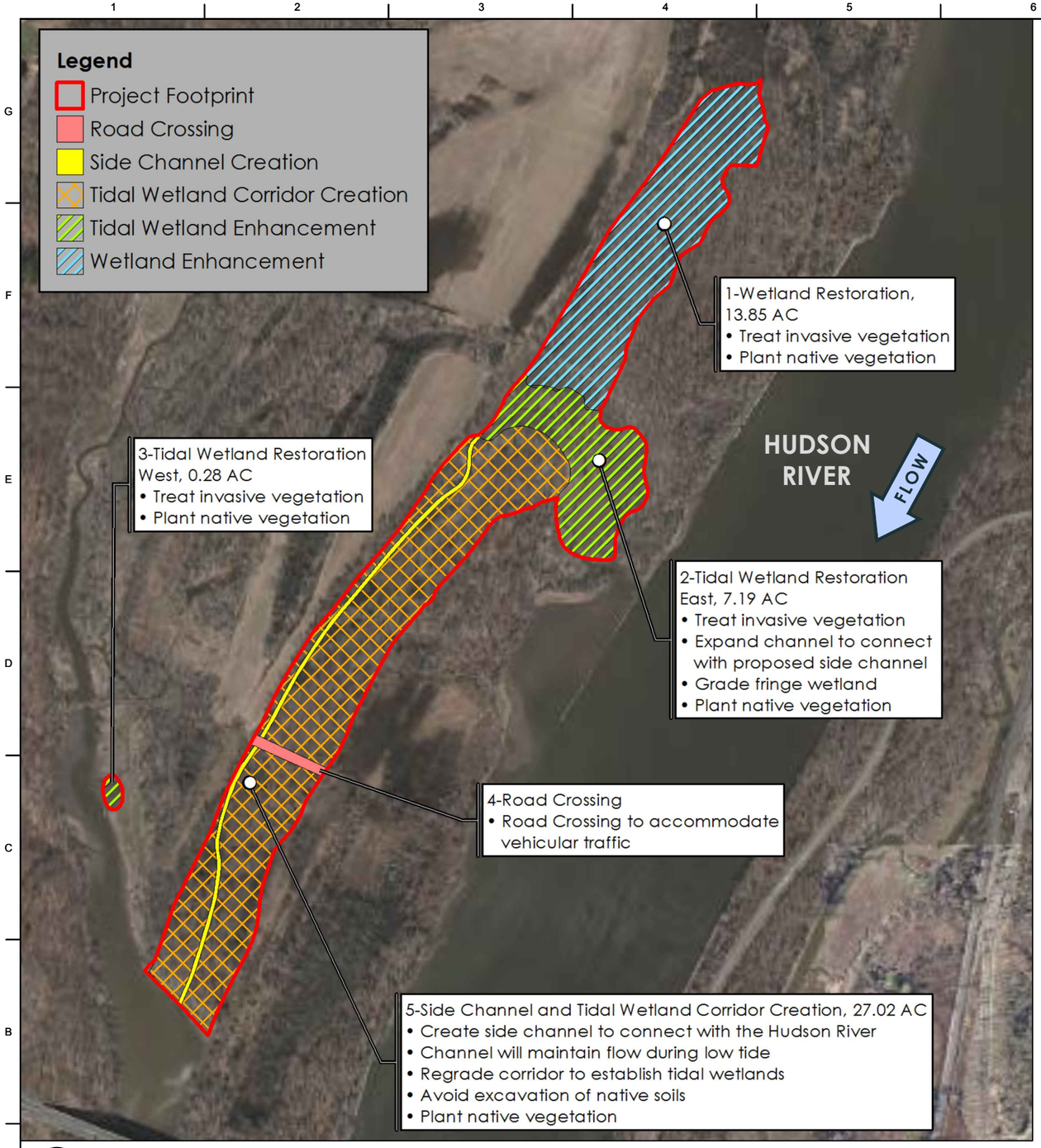

1 PLAN VIEW
South - Alternative 2
1" = 600'

GRAPHIC SCALE
0 200 400 600 1200 1800 2400 FEET
SCALE: 1" = 600'

1-Wetland Restoration

Item	Unit	Quantity
Invasive Species Treatment	AC	13.85
Herbivore Exclusion Fence - Deer	LF	4,400
Plantings (3FT OC)	EA	67,100

2-Tidal Wetland Restoration East

Item	Unit	Quantity
Channel Excavation	CY	2,222
Grading	AC	7.19
Invasive Species Treatment	AC	7.19
Herbivore Exclusion Fence - Deer	LF	3,000
Herbivore Exclusion Fence - Geese	AC	7.19
Plantings (3FT OC)	EA	34,800

3-Tidal Wetland Restoration West

Item	Unit	Quantity
Invasive Species Treatment	AC	0.28
Herbivore Exclusion Fence - Geese	AC	0.28
Plantings (3FT OC)	EA	1,400

4-Road Crossing

Item	Unit	Quantity
Box Culvert	LF	24
Concrete Headwall and Wingwalls	SF	320
Floodplain Culvert	LF	64
Floodplain Culvert End Treatments	EA	4
Stone Base Course	TON	26
Guardrail	LF	100
Stream Substrate	SF	300

5-Side Channel and Tidal Wetland Corridor

Item	Unit	Quantity
Excavation	CY	160,400
Grading	AC	27.02
Plantings (3FT OC)	EA	130,800
Select Amended Soil	CY	22,400
Herbivore Exclusion Fence - Deer	LF	14,200
Herbivore Exclusion Fence - Geese	AC	27.02

General Construction

Item	Unit	Quantity
Turbidity Barrier	LF	930
Silt Fence	LF	6,800
Construction Stake Out	AC	34.21
Stabilized Construction Entrance	TON	50
Construction Access Matting	SF	211,100
Construction Access Reinforcement	TON	2,080
Clearing and Grubbing	AC	4.06

Acronym	Definition
AC	Acres
CY	Cubic Yards
EA	Each
FT	Feet
H:V	Horizontal:Vertical
IN	Inches
LF	Linear Feet
MHHW	Mean Higher High Water
MTL	Mean Tide Line
NAVD88	North American Vertical Datum of 1988
OC	On Center
SF	Square Feet
SY	Square Yards

A SCHEDULE OF QUANTITIES
South - Alternative 2

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BINNEN KILL
ALBANY COUNTY, NY

BINNEN KILL SOUTH ALTERNATIVE 2
SITE LOCATION

SHEET ID
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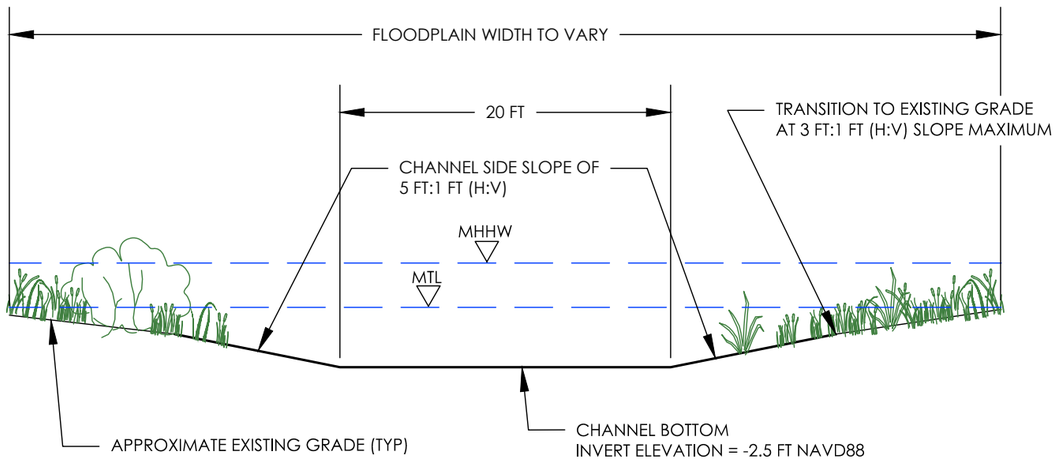
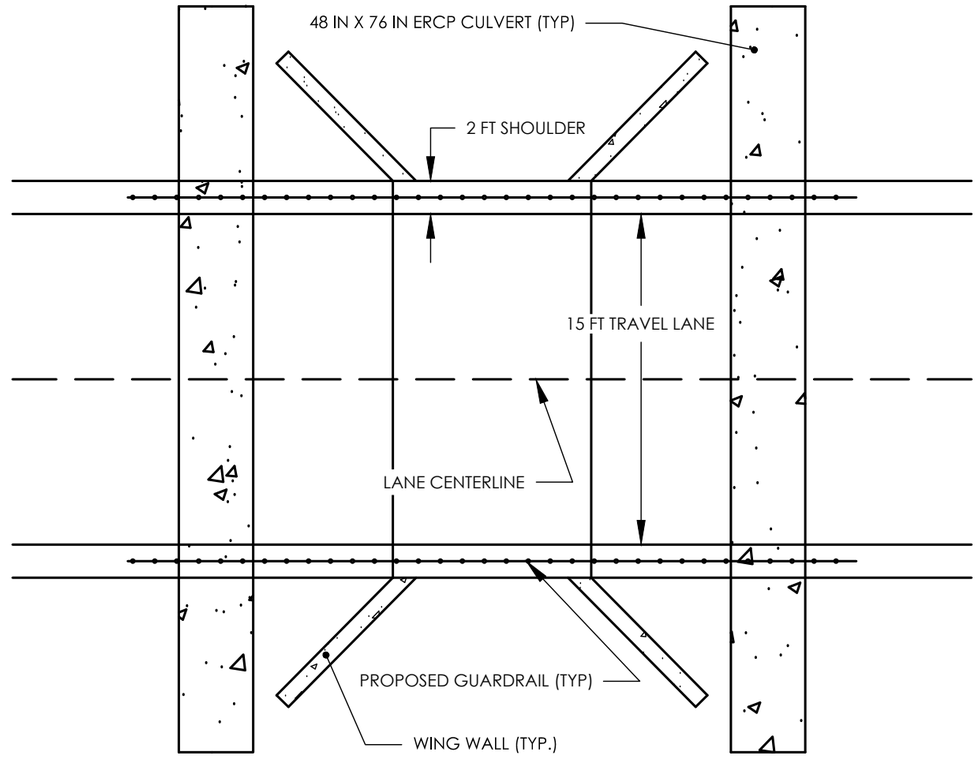
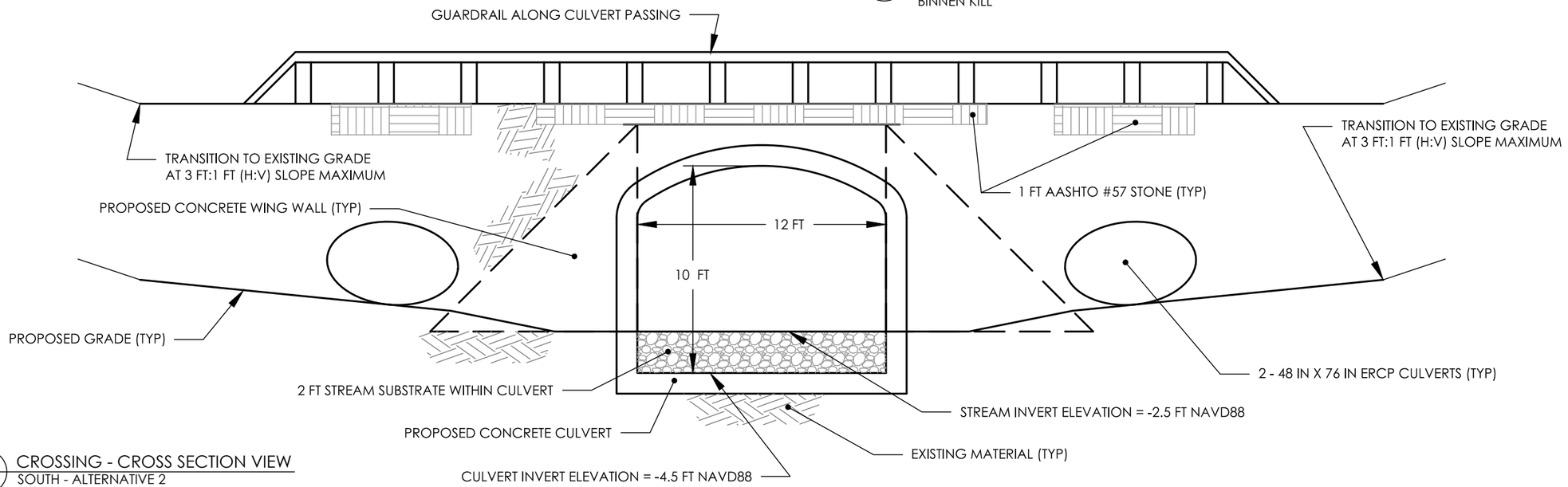


A SIDE CHANNEL
SOUTH - ALTERNATIVE 2
BINNEN KILL



B CROSSING - PLAN VIEW
SOUTH - ALTERNATIVE 2
BINNEN KILL



C CROSSING - CROSS SECTION VIEW
SOUTH - ALTERNATIVE 2
BINNEN KILL

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ALBANY COUNTY, NY

BINNEN KILL SOUTH ALTERNATIVE 2
DETAILS

SHEET ID
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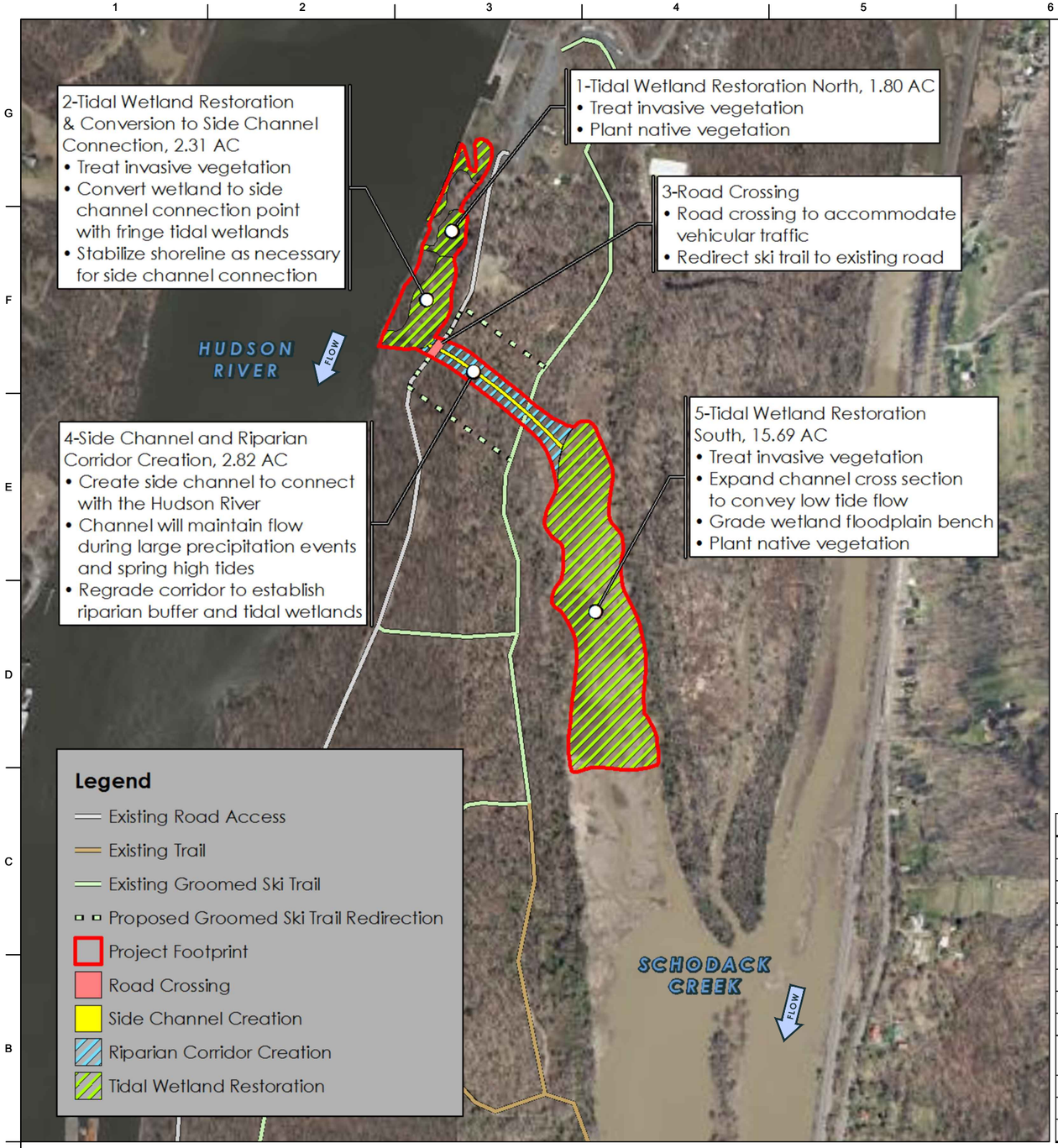


1 PLAN VIEW
North - Alternative 1
1" = 700'

GRAPHIC SCALE
0 350 700 1400 2100 2800 FEET
SCALE: 1" = 700'

1-Tidal Wetland Restoration North

Item	Unit	Quantity
Invasive Species Treatment	AC	1.80
Herbivore Exclusion Fence - Deer	LF	2,200
Herbivore Exclusion Fence - Geese	AC	1.80
Plantings (3FT OC)	EA	8,800

2-Tidal Wetland Restoration & Conversion to Side Channel Connection

Item	Unit	Quantity
Excavation	CY	820
Grading	SF	100,700
Shoreline Stabilization	LF	1,500
Invasive Species Treatment	AC	2.31
Select Amended Soil	CY	1,900
Herbivore Exclusion Fence - Deer	LF	1,600
Herbivore Exclusion Fence - Geese	AC	2.31
Plantings (3FT OC)	EA	11,200

3-Road Crossing

Item	Unit	Quantity
Box Culvert	LF	40
Concrete Headwall and Wingwalls	SF	320
Floodplain Culvert	LF	288
Floodplain Culvert End Treatments	EA	8
Stone Base Course	TON	60
Stream Substrate	SF	300
Guardrail	LF	380

4-Side Channel and Riparian Corridor

Item	Unit	Quantity
Excavation	CY	21,000
Grading	SF	128,600
Plantings (3FT OC)	EA	14,300
Select Amended Soil	CY	2,400
Herbivore Exclusion Fence - Deer	LF	4,400
Herbivore Exclusion Fence - Geese	AC	2.95

5-Tidal Wetland Restoration South

Item	Unit	Quantity
Excavation	CY	2,700
Grading	SF	683,500
Invasive Species Treatment	AC	15.69
Herbivore Exclusion Fence - Geese	AC	15.69
Plantings (3FT OC)	EA	76,000

General Construction

Item	Unit	Quantity
Turbidity Barrier	LF	1,700
Silt Fence	LF	7,700
Construction Stake Out	AC	30
Stabilized Construction Entrance	TON	50
Construction Access Matting	SF	86,300
Construction Access Reinforcement	TON	740
Temporary Bridge	TON	70
Clearing and Grubbing	AC	0.75

Acronym	Definition
AC	Acres
CY	Cubic Yards
EA	Each
FT	Feet
H:V	Horizontal:Vertical
IN	Inches
LF	Linear Feet
MHHW	Mean Higher High Water
MTL	Mean Tide Line
NAVD88	North American Vertical Datum of 1988
OC	On Center
SF	Square Feet
SY	Square Yards

A SCHEDULE OF QUANTITIES
North - Alternative 1

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

DESIGNED BY:
DRAWN BY: TH
CHECKED BY: CP/AEM
SUBMITTED BY: PRINCETON HYDRO
SIZE: 11x17
ISSUE DATE: MAY 2018
SOLICITATION NO.:
CONTRACT NO.: W912DS-14-D-0001

U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT
26 FEDERAL PLAZA
NEW YORK, NEW YORK, 10278

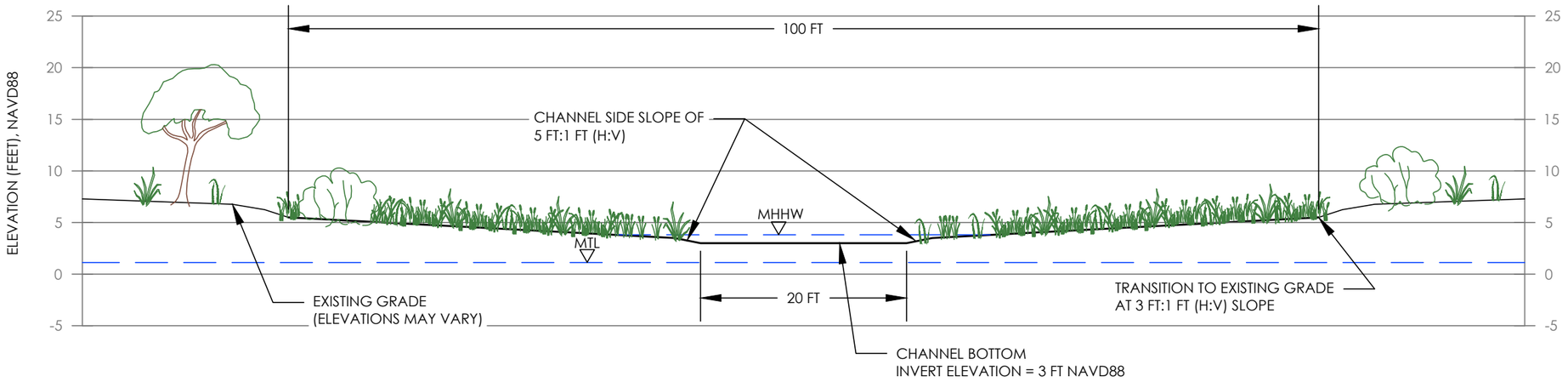
PRINCETON HYDRO, LLC
1108 OLD YORK ROAD
RINGOES, NEW JERSEY, 08551

HUDSON RIVER HABITAT RESTORATION
SCHODACK ISLAND STATE PARK
COLUMBIA, GREENE, AND RENSSELAER COUNTIES, NY

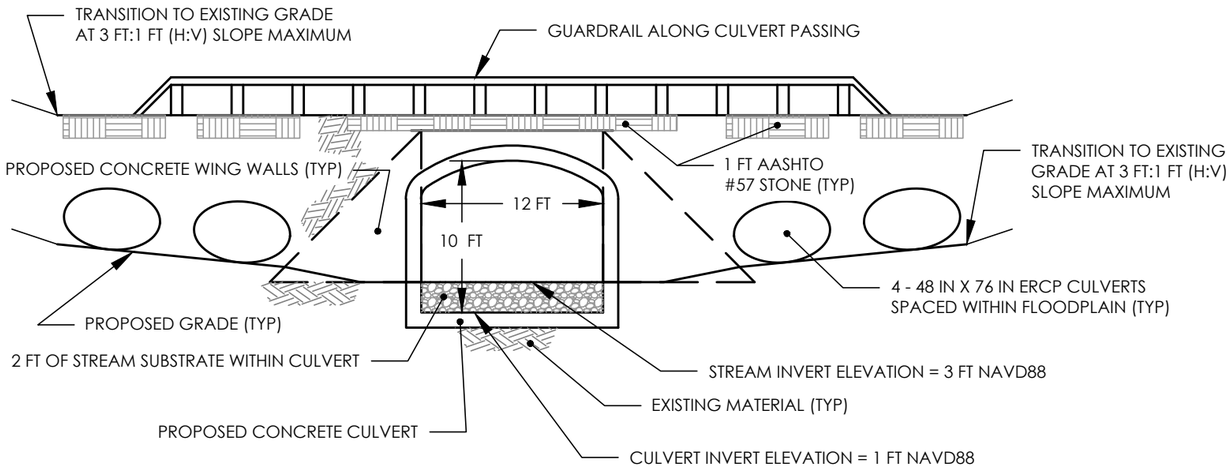
SCHODACK ISLAND NORTH ALTERNATIVE 1
SITE LOCATION

SHEET ID
1

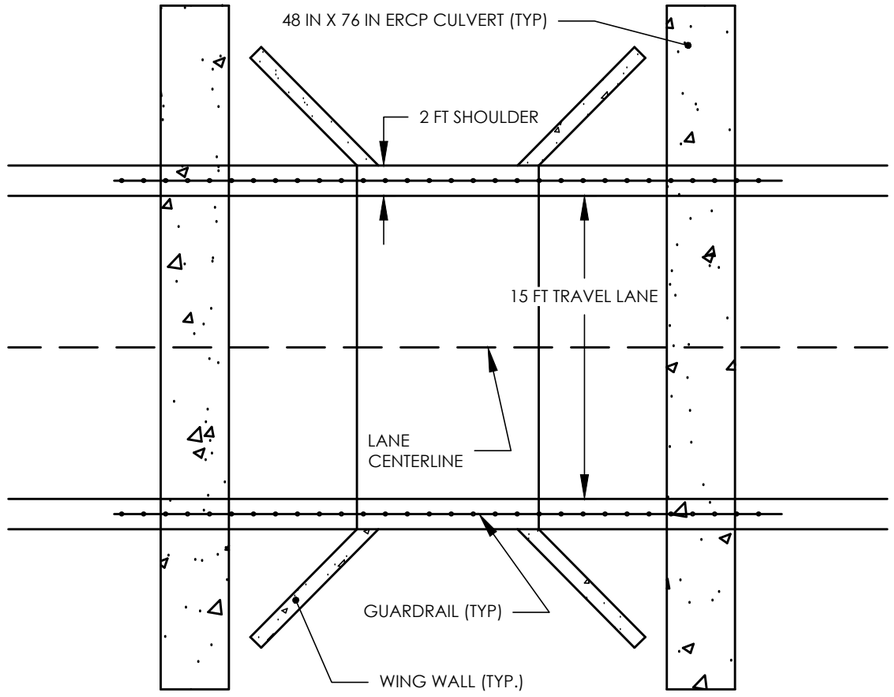
OCT.2018



A SIDE CHANNEL
NORTH - ALTERNATIVE 1
SCHODACK ISLAND



B CROSSING - CROSS SECTION
NORTH - ALTERNATIVE 1
SCHODACK ISLAND



C CROSSING - PLAN VIEW
NORTH - ALTERNATIVE 1
SCHODACK ISLAND

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

ISSUE DATE: MAY 2018
SOLICITATION NO.:
CONTRACT NO.: W912DS-14-D-0001
DESIGNED BY:
DRAWN BY: CS
CHECKED BY: AEM/MJT
SUBMITTED BY: PRINCETON HYDRO
SIZE: 11x17

U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT
26 FEDERAL PLAZA
NEW YORK, NEW YORK, 10278

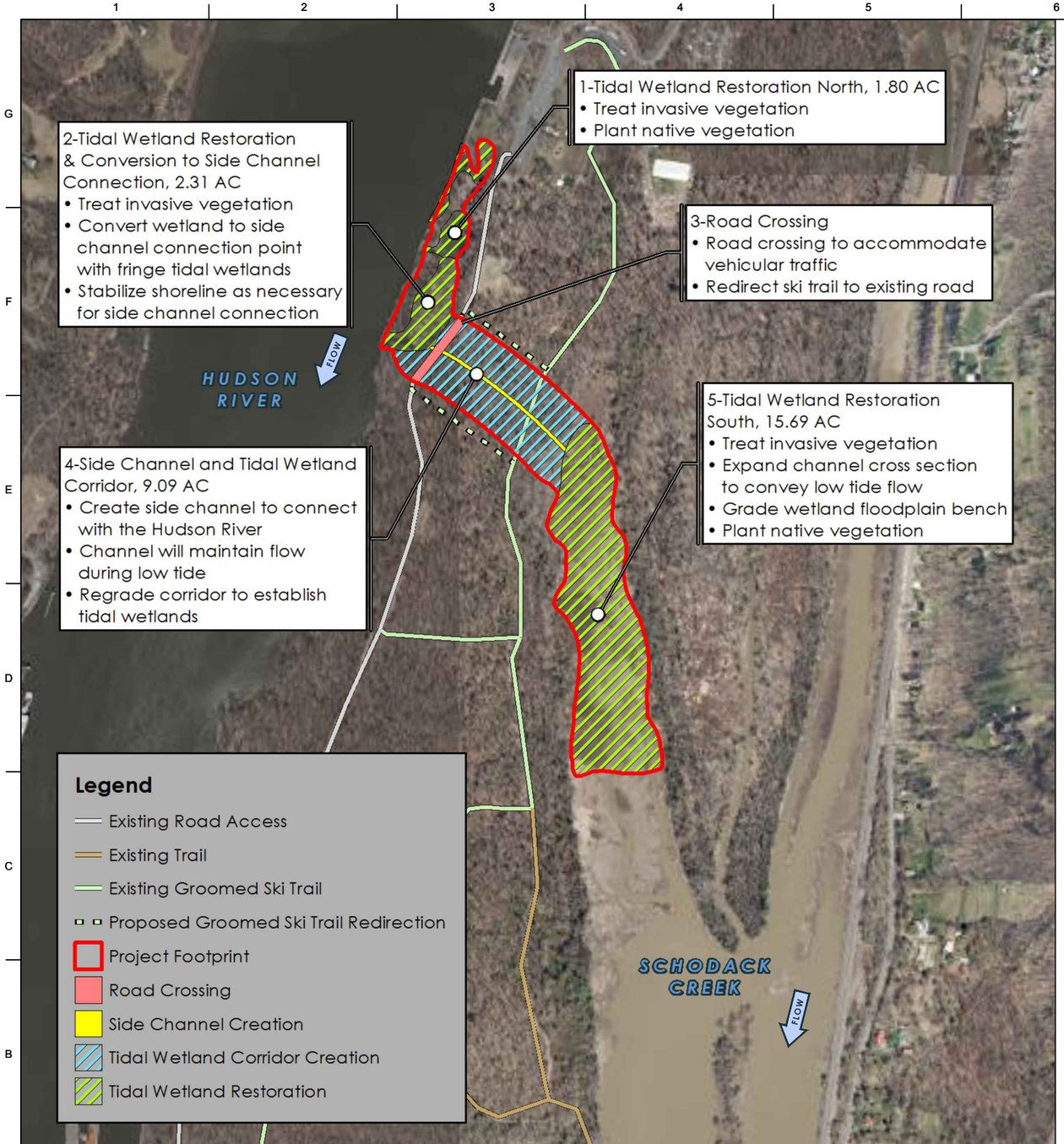
PRINCETON HYDRO, LLC
1108 OLD YORK ROAD
RINGOES, NEW JERSEY, 08551

HUDSON RIVER HABITAT RESTORATION
SCHODACK ISLAND STATE PARK
COLUMBIA, GREENE, AND RENSSELAER COUNTIES, NY

SCHODACK ISLAND NORTH ALTERNATIVE 1
DETAILS

SHEET ID
2

OCT.2018



1 PLAN VIEW
North - Alternative 2
1" = 700'

GRAPHIC SCALE

0 350 700 1400 2100 2800 FEET

SCALE: 1" = 700'

1-Tidal Wetland Restoration North

Item	Unit	Quantity
Invasive Species Treatment	AC	1.79
Herbivore Exclusion Fence - Deer	LF	2,200
Herbivore Exclusion Fence - Geese	AC	1.79
Plantings (3FT OC)	EA	8,700

2-Tidal Wetland Restoration & Conversion to Side Channel Connection

Item	Unit	Quantity
Excavation	CY	815
Grading	SF	100,700
Shoreline Stabilization	LF	1,500
Invasive Species Treatment	AC	2.31
Select Amended Soil	CY	1,900
Herbivore Exclusion Fence - Deer	LF	1,600
Herbivore Exclusion Fence - Geese	AC	2.31
Plantings (3FT OC)	EA	11,200

3-Road Crossing

Item	Unit	Quantity
Box Culvert	LF	72
Concrete Headwall and Wingwalls	SF	320
Floodplain Culvert	LF	832
Floodplain Culvert End Treatments	EA	16
Stone Base Course	TON	60
Stream Substrate	SF	300
Guardrail	LF	1,040

4-Side Channel and Tidal Wetland Corridor

Item	Unit	Quantity
Excavation	CY	126,600
Grading	SF	418,200
Plantings (3FT OC)	EA	46,500
Select Amended Soil	CY	7,800
Herbivore Exclusion Fence - Deer	LF	5,600
Herbivore Exclusion Fence - Geese	AC	9.60

5-Tidal Wetland Restoration South

Item	Unit	Quantity
Excavation	CY	2,700
Grading	SF	683,500
Invasive Species Treatment	AC	15.69
Herbivore Exclusion Fence - Geese	AC	15.69
Plantings (3FT OC)	EA	76,000

General Construction

Item	Unit	Quantity
Turbidity Barrier	LF	1,700
Silt Fence	LF	7,400
Construction Stake Out	AC	30
Stabilized Construction Entrance	TON	50
Construction Access Matting	SF	89,200
Construction Access Reinforcement	TON	640
Temporary Bridge	TON	170
Clearing and Grubbing	AC	0.75

A SCHEDULE OF QUANTITIES
North - Alternative 2

Acronym	Definition
AC	Acres
CY	Cubic Yards
EA	Each
FT	Feet
H:V	Horizontal:Vertical
IN	Inches
LF	Linear Feet
MHHW	Mean Higher High Water
MTL	Mean Tide Line
NAVD88	North American Vertical Datum of 1988
OC	On Center
SF	Square Feet
SY	Square Yards

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

DESIGNED BY:
DRAWN BY: TH
CHECKED BY: CP/AEM
SUBMITTED BY: PRINCETON HYDRO
SIZE: 11x17
ISSUE DATE: MAY 2018
SOLICITATION NO.:
CONTRACT NO.: W912DS-14-D-0001

U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT
26 FEDERAL PLAZA
NEW YORK, NEW YORK, 10278

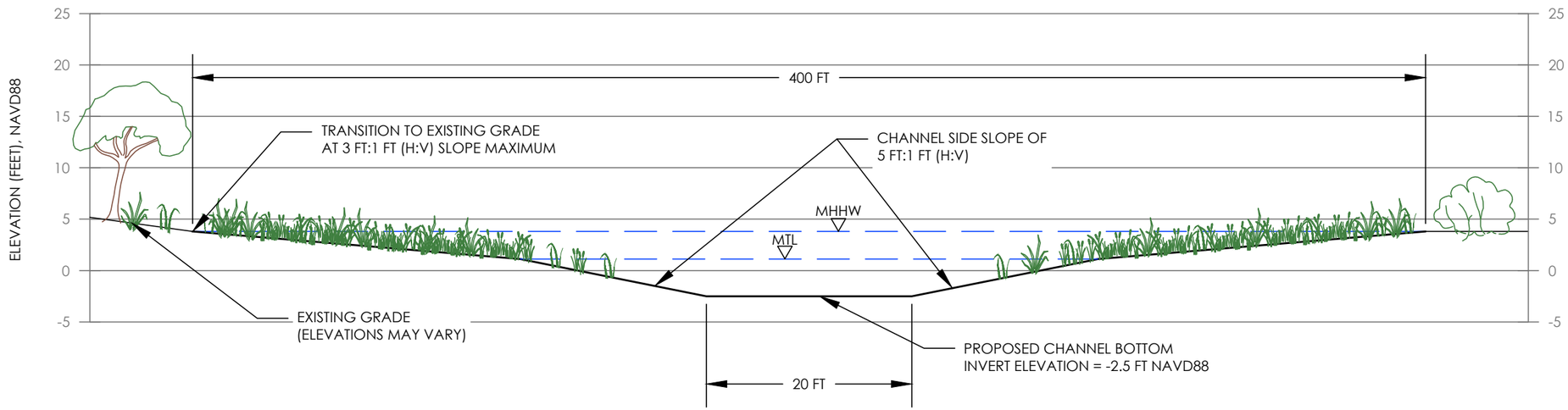
PRINCETON HYDRO, LLC
1108 OLD YORK ROAD
RINGOES, NEW JERSEY, 08551

HUDSON RIVER HABITAT RESTORATION
SCHODACK ISLAND STATE PARK
COLUMBIA, GREENE, AND RENSSELAER COUNTIES, NY

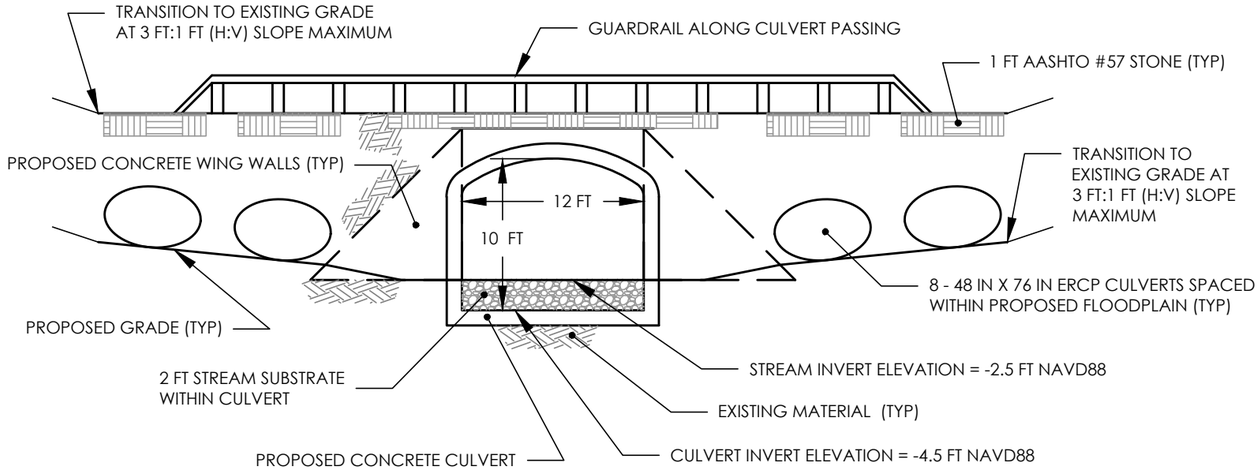
SCHODACK ISLAND NORTH ALTERNATIVE 2
SITE LOCATION

SHEET ID
1

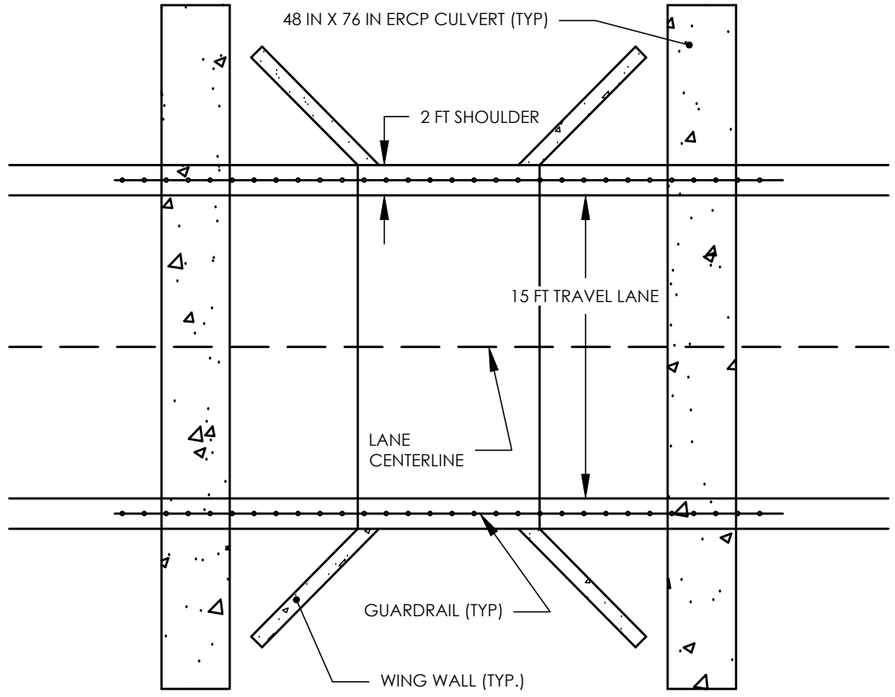
OCT.2018



A SIDE CHANNEL
NORTH - ALTERNATIVE 2
SCHODACK ISLAND



B CROSSING - CROSS SECTION
NORTH - ALTERNATIVE 2
SCHODACK ISLAND



C CROSSING - PLAN VIEW
NORTH - ALTERNATIVE 2
SCHODACK ISLAND

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

ISSUE DATE: MAY 2018
SOLICITATION NO.:
CONTRACT NO.: W912DS-14-D-0001
DESIGNED BY: CS
DRAWN BY: CS
CHECKED BY: AEM/MJT
SUBMITTED BY: PRINCETON HYDRO
SIZE: 11x17

U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT
26 FEDERAL PLAZA
NEW YORK, NEW YORK, 10278

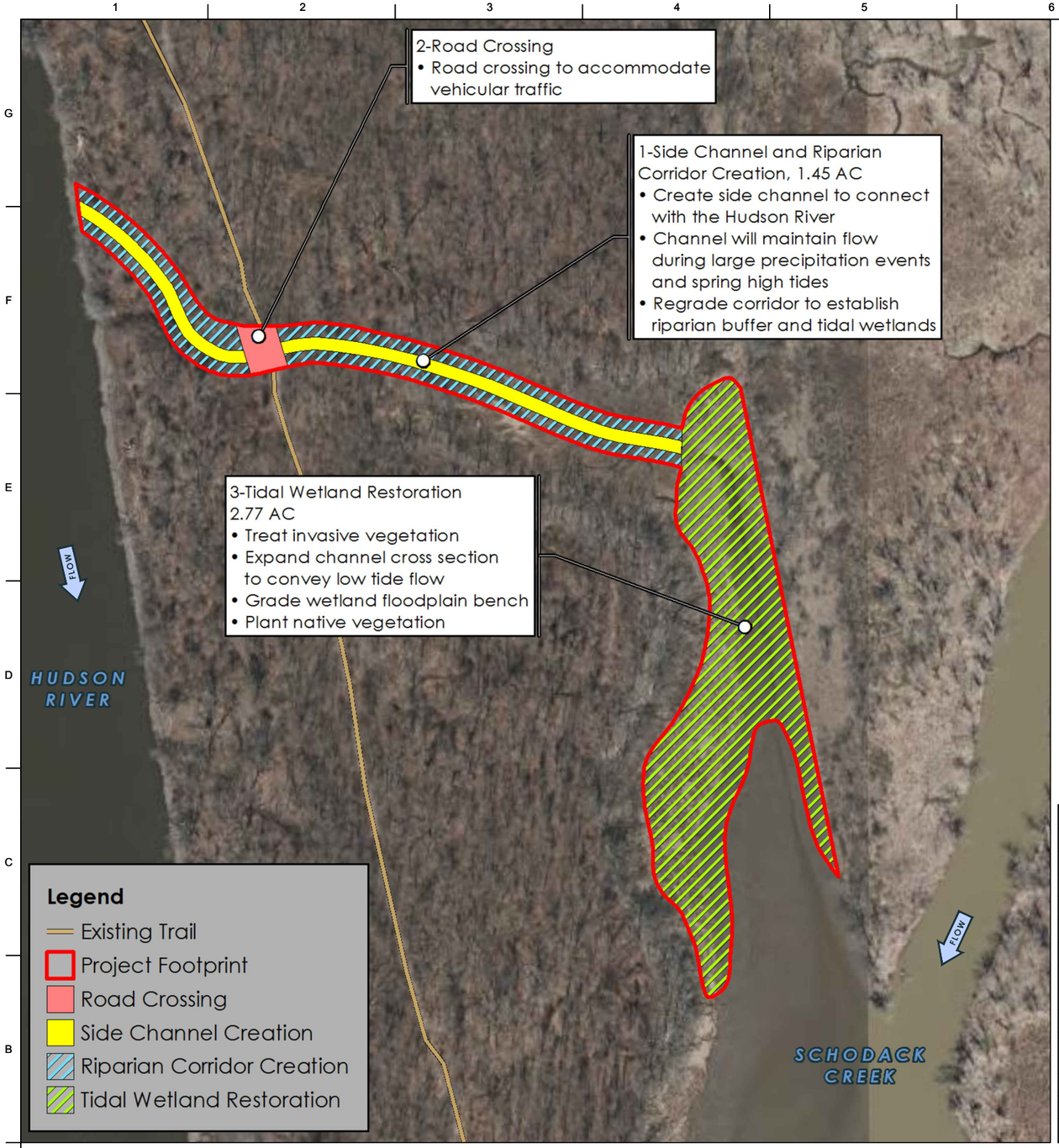
PRINCETON HYDRO, LLC
1108 OLD YORK ROAD
RINGOES, NEW JERSEY, 08551

HUDSON RIVER HABITAT RESTORATION
SCHODACK ISLAND STATE PARK
COLUMBIA, GREENE, AND RENSSELAER COUNTIES, NY

SCHODACK ISLAND NORTH ALTERNATIVE 2 DETAILS

SHEET ID
2

OCT.2018



1 PLAN VIEW
South - Alternative 1
1" = 200'

GRAPHIC SCALE
0 50 100 150 200 400 600 800 FEET
SCALE: 1" = 200'

1-Side Channel and Riparian Corridor

Item	Unit	Quantity
Excavation	CY	8,000
Grading	SF	63,200
Plantings	EA	7,100
Select Amended Soil	CY	1,200
Herbivore Exclusion Fence - Deer	LF	4,300
Herbivore Exclusion Fence - Geese	AC	1.45
Shoreline Stabilization	LF	100

2-Road Crossing

Item	Unit	Quantity
Box Culvert	LF	48
Concrete Headwall and Wingwalls	SF	320
Floodplain Culvert	LF	352
Floodplain Culvert End Treatments	EA	8
Stone Base Course	TON	60
Stream Substrate	SF	300
Guardrail	LF	380

3-Tidal Wetland Restoration

Item	Unit	Quantity
Excavation	CY	4,500
Grading	SF	120,800
Invasive Species Treatment	AC	2.77
Herbivore Exclusion Fence - Geese	AC	2.77
Plantings	EA	13,500

General Construction

Item	Unit	Quantity
Turbidity Barrier	LF	830
Silt Fence	LF	4,000
Construction Stake Out	AC	4.22
Stabilized Construction Entrance	TON	50
Construction Access Matting	SF	51,800
Construction Access Reinforcement	TON	7,830
Temporary Bridge	TON	70
Clearing and Grubbing	AC	1.99

A SCHEDULE OF QUANTITIES
South - Alternative 1

Acronym	Definition
AC	Acres
CY	Cubic Yards
EA	Each
FT	Feet
H:V	Horizontal:Vertical
IN	Inches
LF	Linear Feet
MHHW	Mean Higher High Water
MTL	Mean Tide Line
NAVD88	North American Vertical Datum of 1988
OC	On Center
SF	Square Feet
SY	Square Yards

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

DESIGNED BY:
DRAWN BY: TH
CHECKED BY: CP/AEM
SUBMITTED BY: PRINCETON HYDRO
SIZE: 11x17
ISSUE DATE: MAY 2018
SOLICITATION NO.:
CONTRACT NO.: W912DS-14-D-0001

U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT
26 FEDERAL PLAZA
NEW YORK, NEW YORK, 10278

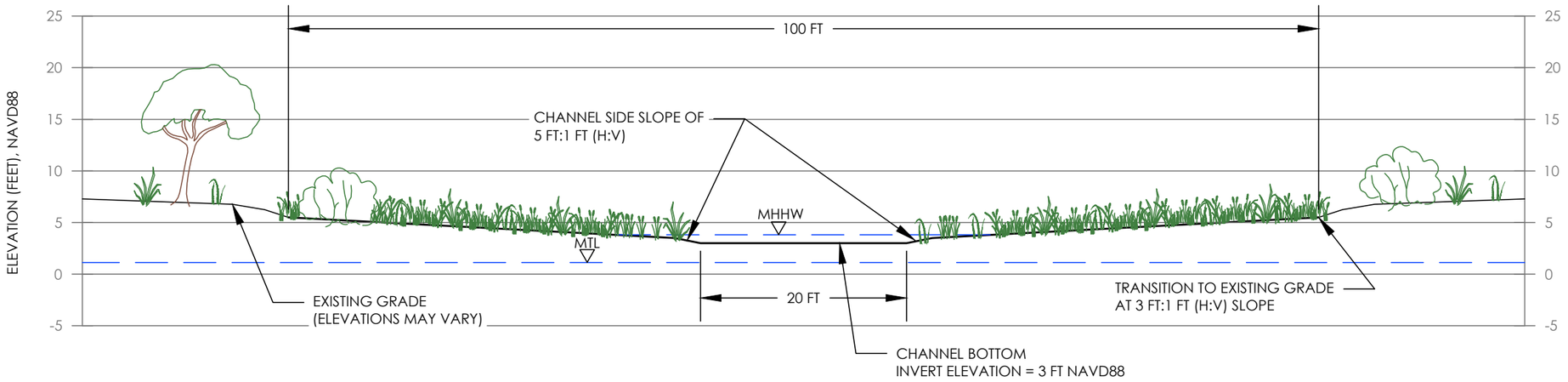
PRINCETON HYDRO, LLC
1108 OLD YORK ROAD
RINGOES, NEW JERSEY, 08551

HUDSON RIVER HABITAT RESTORATION
SCHODACK ISLAND STATE PARK
COLUMBIA, GREENE, AND RENSSELAER COUNTIES, NY

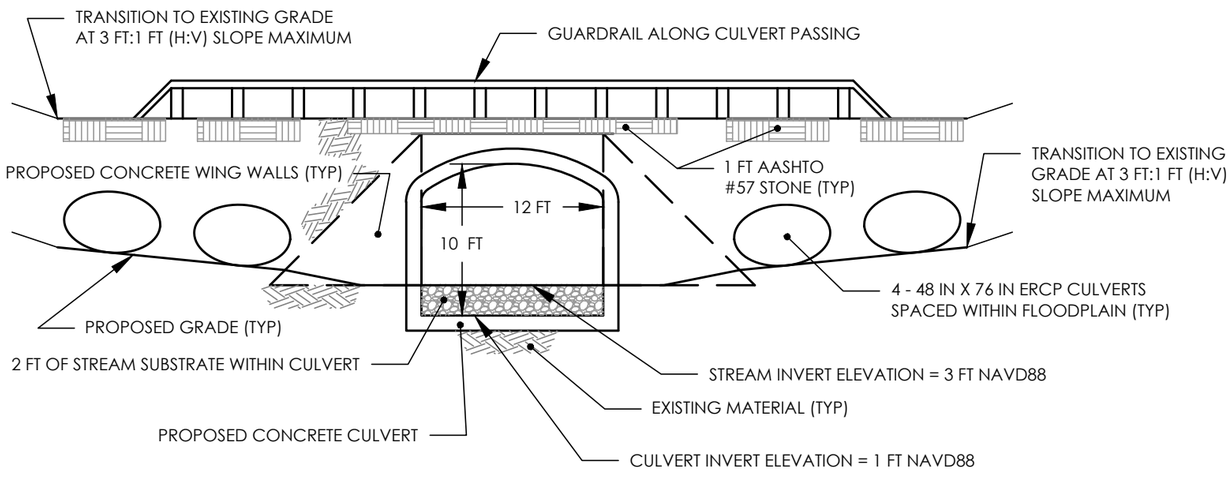
SCHODACK ISLAND SOUTH ALTERNATIVE 1
SITE LOCATION

SHEET ID
1

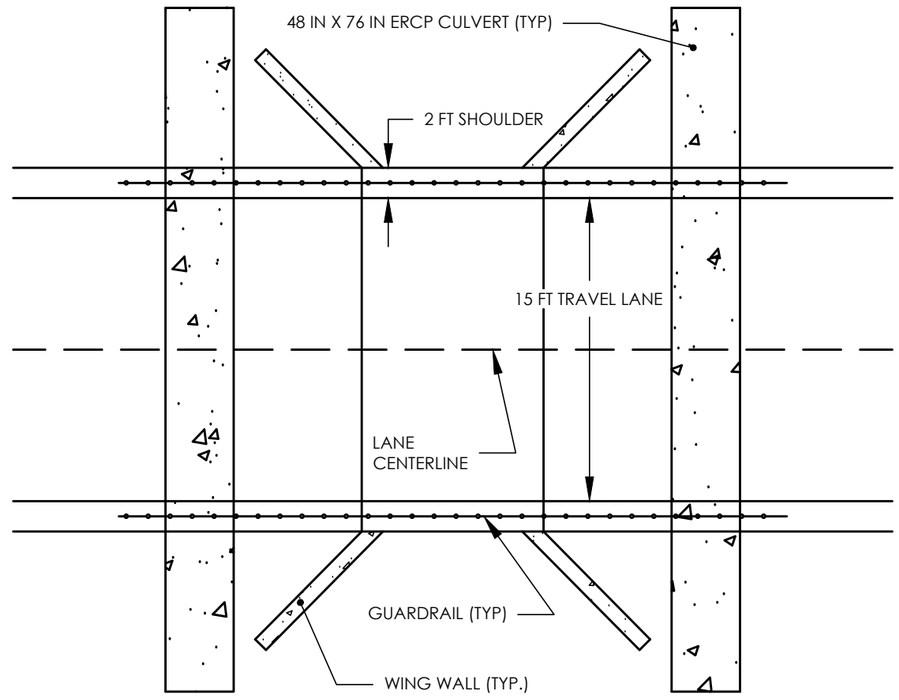
OCT.2018



A SIDE CHANNEL
SOUTH - ALTERNATIVE 1
SCHODACK ISLAND



B CROSSING - CROSS SECTION
SOUTH - ALTERNATIVE 1
SCHODACK ISLAND



C CROSSING - PLAN VIEW
SOUTH - ALTERNATIVE 1
SCHODACK ISLAND

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

ISSUE DATE: MAY 2018
SOLICITATION NO.:
CONTRACT NO.: W912DS-14-D-0001
DESIGNED BY:
DRAWN BY: CS
CHECKED BY: AEM/MJT
SUBMITTED BY: PRINCETON HYDRO
SIZE: 11x17

U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT
FEDERAL PLAZA
NEW YORK, NEW YORK, 10278

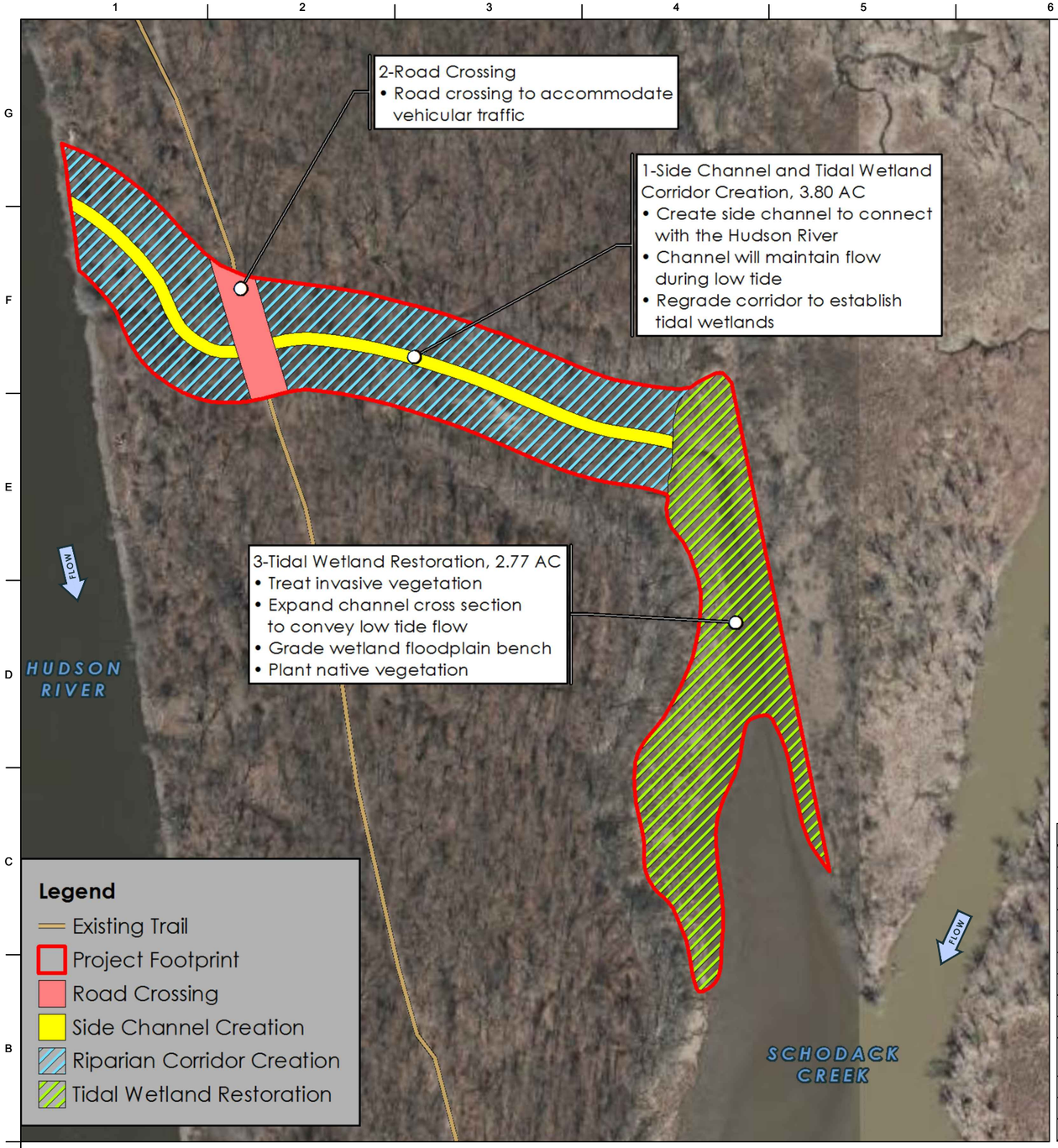
PRINCETON HYDRO, LLC
1108 OLD YORK ROAD
RINGOES, NEW JERSEY, 08551

HUDSON RIVER HABITAT RESTORATION
SCHODACK ISLAND STATE PARK
COLUMBIA, GREENE, AND RENSSELAER COUNTIES, NY

SCHODACK ISLAND SOUTH ALTERNATIVE 1
DETAILS

SHEET ID
2

OCT.2018



1 PLAN VIEW
South - Alternative 2
1" = 200'

GRAPHIC SCALE
0 50 100 150 200 400 600 800 FEET
SCALE: 1" = 200'

Acronym	Definition
AC	Acres
CY	Cubic Yards
EA	Each
FT	Feet
H:V	Horizontal:Vertical
IN	Inches
LF	Linear Feet
MHHW	Mean Higher High Water
MTL	Mean Tide Line
NAVD88	North American Vertical Datum of 1988
OC	On Center
SF	Square Feet
SY	Square Yards

1-Side Channel and Tidal Wetland Corridor

Item	Unit	Quantity
Excavation	CY	111,300
Grading	SF	178,600
Plantings (3FT OC)	EA	19,900
Select Amended Soil	CY	3,400
Herbivore Exclusion Fence - Deer	LF	4,800
Herbivore Exclusion Fence - Geese	AC	4.10
Shoreline Stabilization	LF	400

2-Roading Crossing

Item	Unit	Quantity
Box Culvert	LF	80
Concrete Headwall and Wingwalls	SF	320
Floodplain Culvert	LF	960
Floodplain Culvert End Treatments	EA	16
Stone Base Course	TON	60
Stream Substrate	SF	300
Guardrail	LF	1,040

3-Tidal Wetland Restoration

Item	Unit	Quantity
Excavation	CY	4,472
Grading	SF	13,500
Invasive Species Treatment	AC	2.77
Herbivore Exclusion Fence - Geese	AC	2.77
Plantings (3FT OC)	EA	13,500

General Construction

Item	Unit	Quantity
Turbidity Barrier	LF	950
Silt Fence	LF	3,900
Construction Stake Out	AC	6.87
Stabilized Construction Entrance	TON	50
Construction Access Matting	SF	53,300
Construction Access Reinforcement	TON	7,780
Temporary Bridge	TON	170
Clearing and Grubbing	AC	1.99

A SCHEDULE OF QUANTITIES
South - Alternative 2

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

DESIGNED BY:
DRAWN BY: TH
CHECKED BY: CP/AEM
SUBMITTED BY: PRINCETON HYDRO
SIZE: 11x17
ISSUE DATE: MAY 2018
SOLICITATION NO.:
CONTRACT NO.: W912DS-14-D-0001

U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT
26 FEDERAL PLAZA
NEW YORK, NEW YORK, 10278

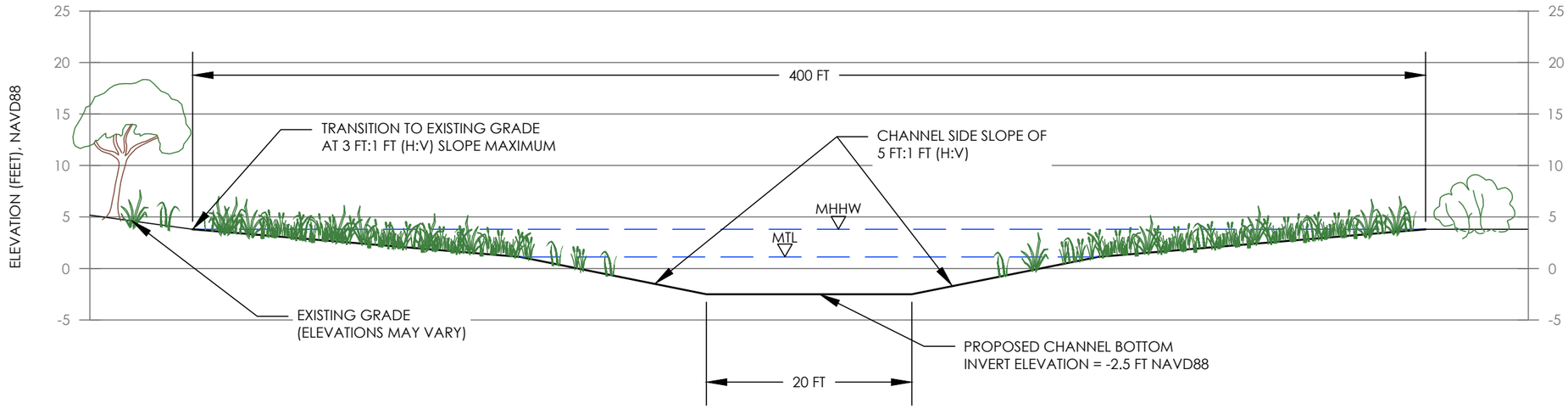
PRINCETON HYDRO, LLC
1108 OLD YORK ROAD
RINGOES, NEW JERSEY, 08551

HUDSON RIVER HABITAT RESTORATION
SCHODACK ISLAND STATE PARK
COLUMBIA, GREENE, AND RENSSELAER COUNTIES, NY

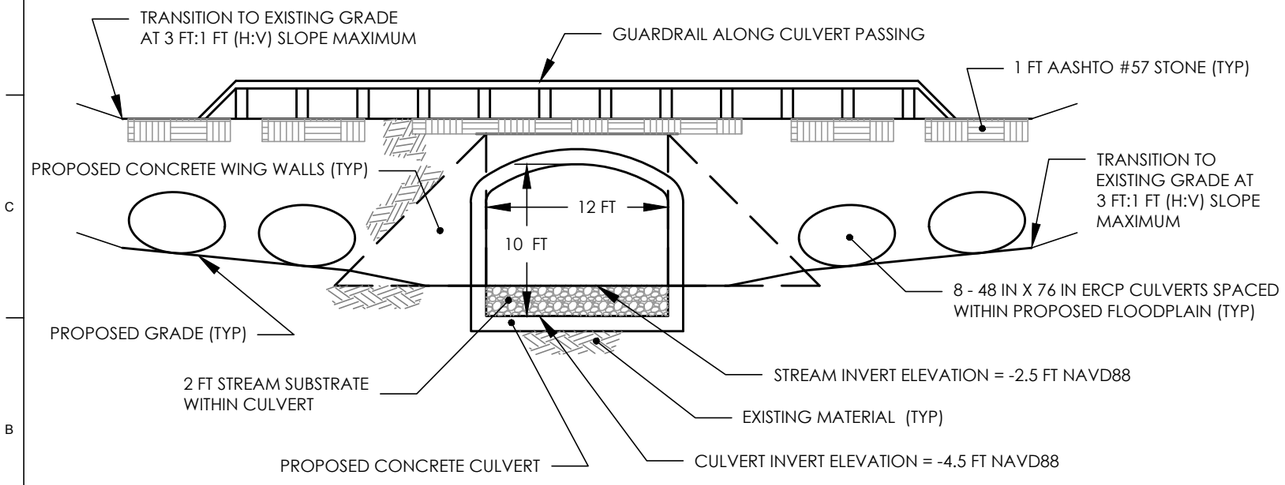
SCHODACK ISLAND SOUTH ALTERNATIVE 2
SITE LOCATION

SHEET ID
1

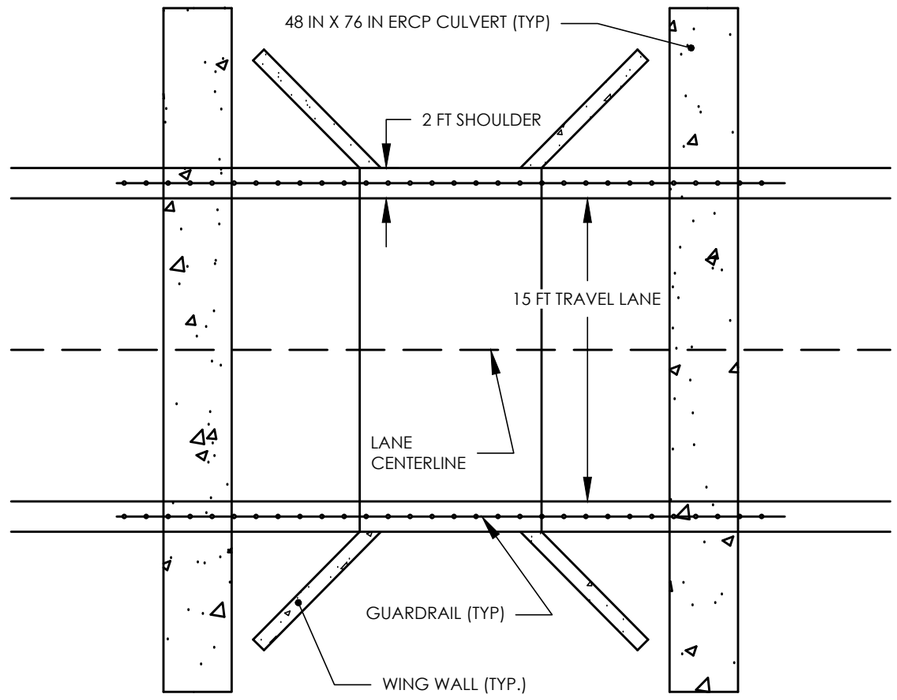
OCT.2018



A SIDE CHANNEL
SOUTH - ALTERNATIVE 2
SCHODACK ISLAND



B CROSSING - CROSS SECTION
SOUTH - ALTERNATIVE 2
SCHODACK ISLAND



C CROSSING - PLAN VIEW
SOUTH - ALTERNATIVE 2
SCHODACK ISLAND

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

ISSUE DATE: MAY 2018
SOLICITATION NO.:
CONTRACT NO.: W912DS-14-D-0001
DESIGNED BY:
DRAWN BY: CS
CHECKED BY: AEM/MJT
SUBMITTED BY: PRINCETON HYDRO
SIZE: 11x17

U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT
26 FEDERAL PLAZA
NEW YORK, NEW YORK, 10278

PRINCETON HYDRO, LLC
1108 OLD YORK ROAD
RINGOES, NEW JERSEY, 08551

HUDSON RIVER HABITAT RESTORATION
SCHODACK ISLAND STATE PARK
COLUMBIA, GREENE, AND RENSSELAER COUNTIES, NY

SCHODACK ISLAND SOUTH ALTERNATIVE 2
DETAILS

SHEET ID
2

OCT.2018

1 PLAN VIEW
Pocket Wetland - Alternative 1
1" = 600'

GRAPHIC SCALE
0 200 400 600 1200 1800 2400 FEET
SCALE: 1" = 600'

1-Tidal Wetland Restoration - A

Item	Unit	Quantity
Grading	SF	157,100
Tidal Connection Stabilization	LF	300
Select Amended Soil	CY	3,000
Invasive Species Treatment	AC	3.61
Herbivore Exclusion Fence - Deer	LF	1,900
Herbivore Exclusion Fence - Geese	AC	3.61
Plantings (3FT OC)	EA	17,500

2-Non-Tidal Wetland Restoration - B

Item	Unit	Quantity
Grading	SF	65,900
Select Amended Soil	CY	1,300
Invasive Species Treatment	AC	1.51
Herbivore Exclusion Fence - Deer	LF	1,000
Herbivore Exclusion Fence - Geese	AC	1.51
Plantings (3FT OC)	EA	7,400

3-Tidal Wetland Restoration - C

Item	Unit	Quantity
Grading	SF	89,900
Tidal Connection Stabilization	LF	200
Select Amended Soil	CY	1,700
Invasive Species Treatment	AC	2.06
Herbivore Exclusion Fence - Deer	LF	1,600
Herbivore Exclusion Fence - Geese	AC	2.06
Plantings (3FT OC)	EA	10,000

4-Tidal Wetland Creation -D

Item	Unit	Quantity
Earthwork	CY	12,600
Grading	SF	169,500
Tidal Connection Stabilization	LF	750
Select Amended Soil	CY	3,200
Invasive Species Treatment	AC	3.89
Herbivore Exclusion Fence - Deer	LF	2,500
Herbivore Exclusion Fence - Geese	AC	3.89
Plantings (3FT OC)	EA	18,900

General Construction

Item	Unit	Quantity
Turbidity Barrier	LF	320
Silt Fence	LF	6,600
Construction Stake Out	AC	11.07
Stabilized Construction Entrance	TON	50
Construction Access Matting	SF	55,700
Construction Access Reinforcement	TON	12,480
Clearing and Grubbing	AC	2.99

Acronym	Definition
AC	Acres
CY	Cubic Yards
EA	Each
FT	Feet
IN	Inches
LF	Linear Feet
OC	On Center
SF	Square Feet

A SCHEDULE OF QUANTITIES
Pocket Wetland - Alternative 1

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

DESIGNED BY:
DRAWN BY: TH
CHECKED BY: CP/AEM
SUBMITTED BY: PRINCETON HYDRO
SIZE: 11x17
ISSUE DATE: MAY 2018
SOLICITATION NO.:
CONTRACT NO.: W912DS-14-D-0001
TASK ORDER NO.:

U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT
26 FEDERAL PLAZA
NEW YORK, NEW YORK, 10278

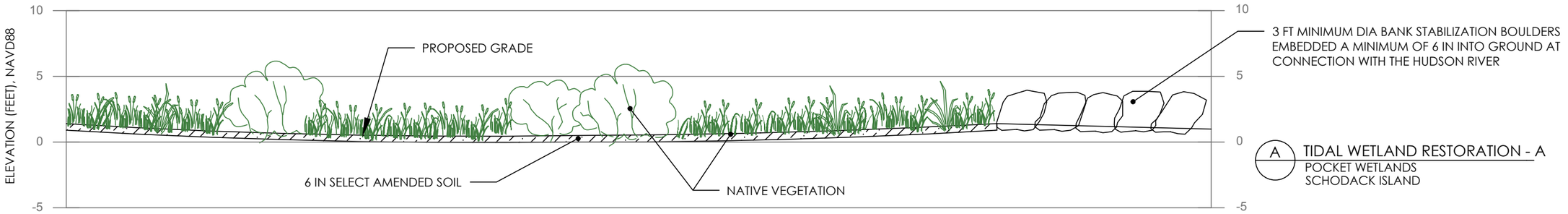
PRINCETON HYDRO, LLC
1108 OLD YORK ROAD
RINGOES, NEW JERSEY, 08551
PHONE: 908-237-5660

HUDSON RIVER HABITAT RESTORATION
SCHODACK ISLAND STATE PARK
COLUMBIA, GREENE, AND RENSSELAER COUNTIES, NY

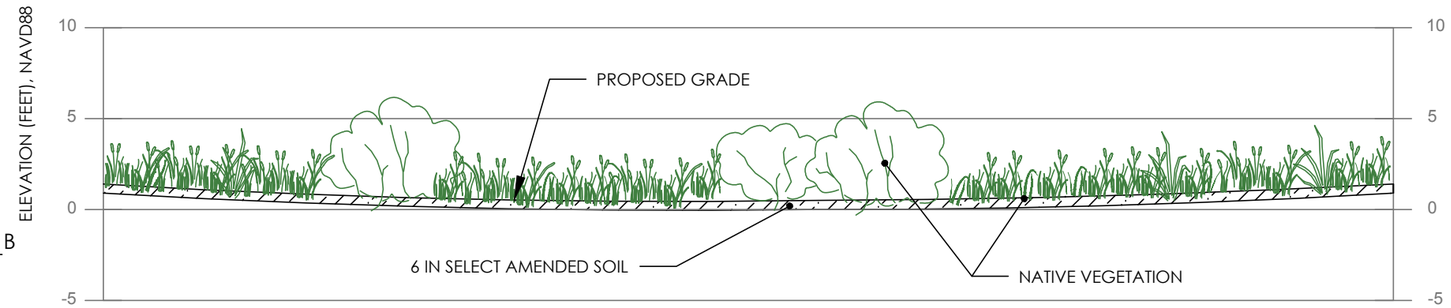
SCHODACK ISLAND POCKET WETLANDS
SITE LOCATION

SHEET ID
1

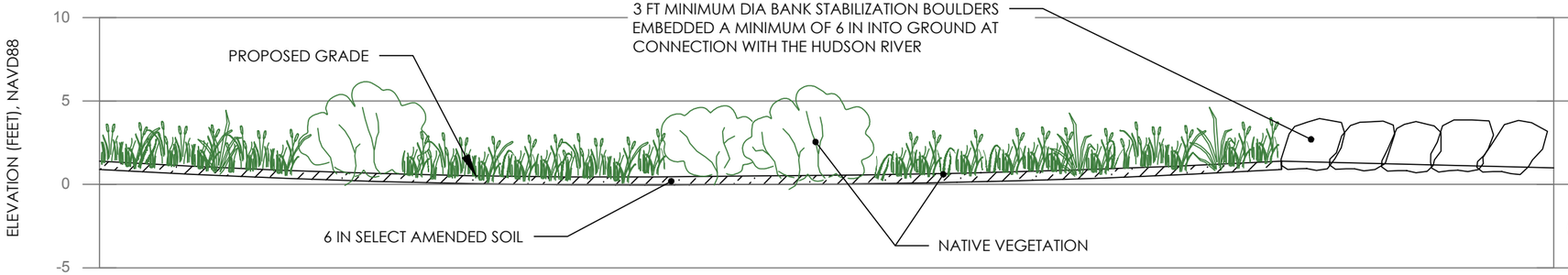
OCT.2018



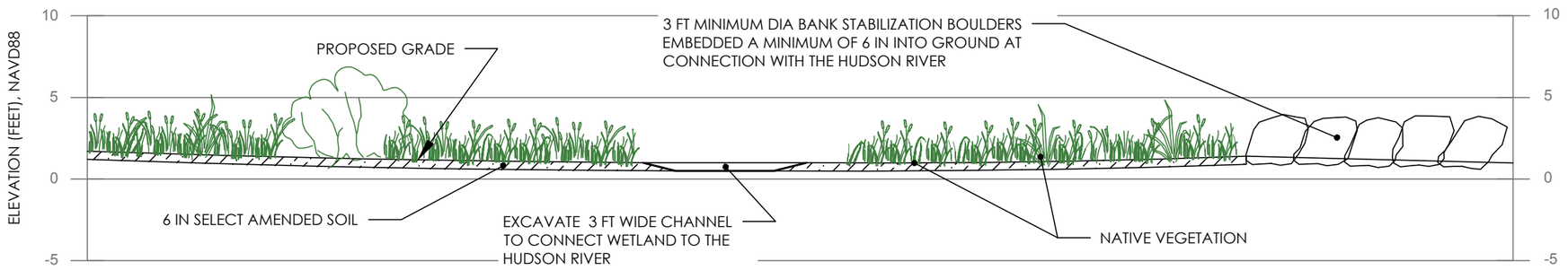
A TIDAL WETLAND RESTORATION - A
POCKET WETLANDS
SCHODACK ISLAND



B NON-TIDAL WETLAND RESTORATION - B
POCKET WETLANDS
SCHODACK ISLAND



C TIDAL WETLAND RESTORATION - C
POCKET WETLANDS
SCHODACK ISLAND



D TIDAL WETLAND RESTORATION - D
POCKET WETLANDS
SCHODACK ISLAND

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

DESIGNED BY:
DRAWN BY: CS
CHECKED BY: AEM/MJT
SUBMITTED BY: PRINCETON HYDRO
SIZE: 11x17

ISSUE DATE: MAY 2018
SOLICITATION NO.:
CONTRACT NO.: W912DS-14-D-0001

U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT
26 FEDERAL PLAZA
NEW YORK, NEW YORK, 10278

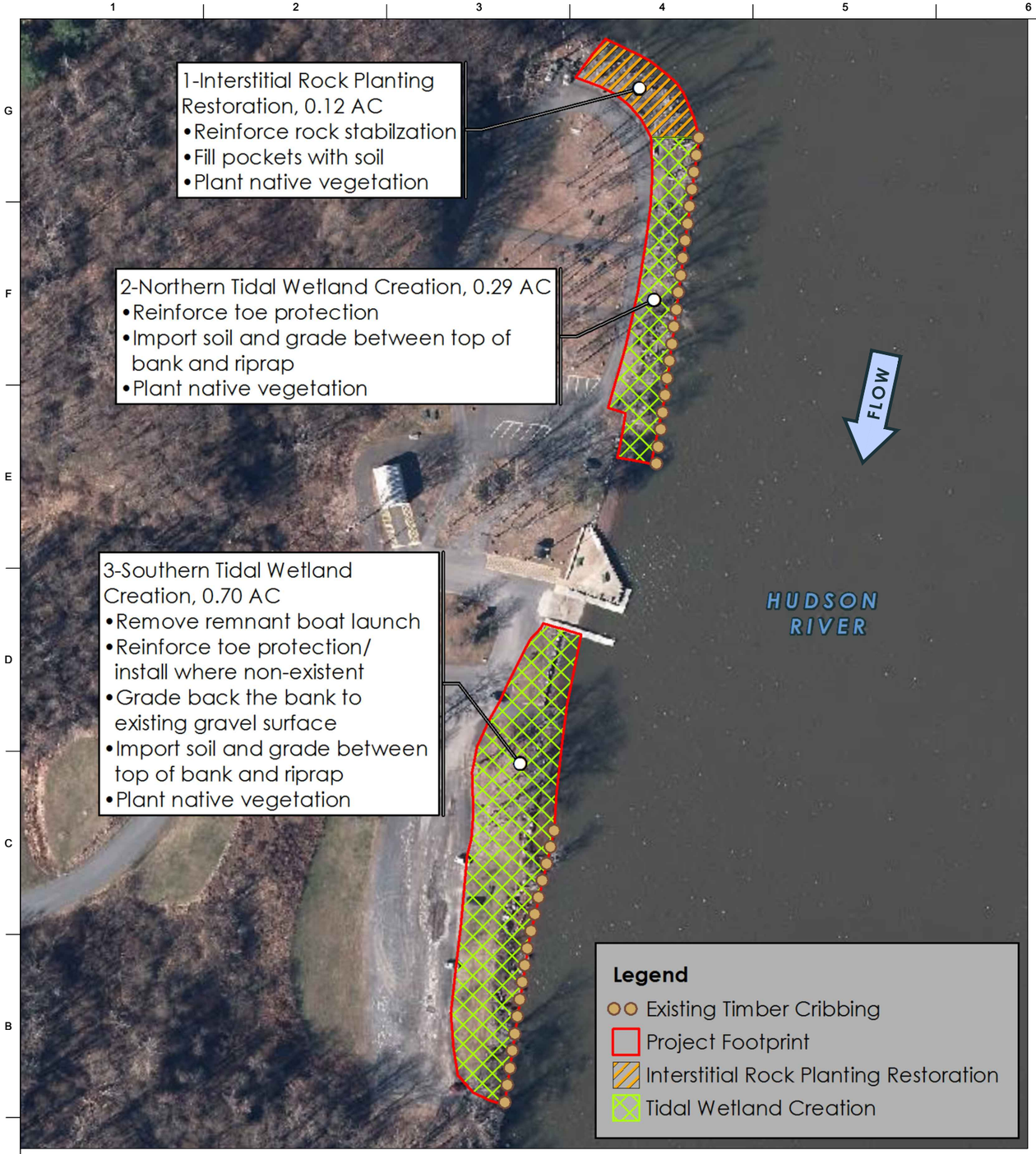
PRINCETON HYDRO, LLC
1108 OLD YORK ROAD
RINGOES, NEW JERSEY, 08551

HUDSON RIVER HABITAT RESTORATION
SCHODACK ISLAND STATE PARK
COLUMBIA, GREENE, AND RENSSELAER COUNTIES, NY

SCHODACK ISLAND POCKET WETLANDS DETAILS

SHEET ID
2

OCT.2018



1 PLAN VIEW
1" = 120'

GRAPHIC SCALE

0 40 80 120 240 360 480 FEET

SCALE: 1" = 120'

Acronym	Definition
AC	Acres
CY	Cubic Yards
EA	Each
FT	Feet
H:V	Horizontal:Vertical
IN	Inches
LF	Linear Feet
MTL	Mean Tide Line
OC	On Center
SF	Square Feet
SY	Square Yards

1-Interstitial Rock Planting Restoration

Item	*Unit*	*Quantity*
Grading	SF	5,350
Select Amended Soil	CY	100
Riprap (D50=12IN)	TON	890
Plantings (3FT OC)	EA	600

2-Northern Tidal Wetland Creation

Item	*Unit*	*Quantity*
Excavation	CY	800
Select Amended Soil	CY	400
Riprap (D50=12IN)	TON	1,800
Plantings (3FT OC)	EA	900
Bank Stabilization Boulders	TON	610

3-Southern Tidal Wetland Creation

Item	*Unit*	*Quantity*
Excavation	CY	6,474
Select Amended Soil	CY	1,600
Riprap (D50=12IN)	TON	3,100
Herbivore Exclusion Fence - Geese	AC	0.70
Plantings (3FT OC)	EA	2,400
Bank Stabilization Boulders	TON	895
Remnant Boat Ramp Demolition	SY	75

General Construction

Item	*Unit*	*Quantity*
Turbidity Barrier	LF	1,000
Silt Fence	LF	1,100
Construction Stake Out	AC	1.12
Stabilized Construction Access	TON	50
Clearing and Grubbing	AC	0.01

A SCHEDULE OF QUANTITIES
Alternative 1

US Army Corps of Engineers®

DATE | DESCRIPTION | MARK

ISSUE DATE: MAY 2018
SOLICITATION NO.:
CONTRACT NO.: W912DS-14-D-0001
DESIGNED BY:
DRAWN BY: TH
CHECKED BY: CPAEM
SUBMITTED BY: PRINCETON HYDRO
SIZE: 11x17

U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT
26 FEDERAL PLAZA
NEW YORK, NEW YORK, 10278

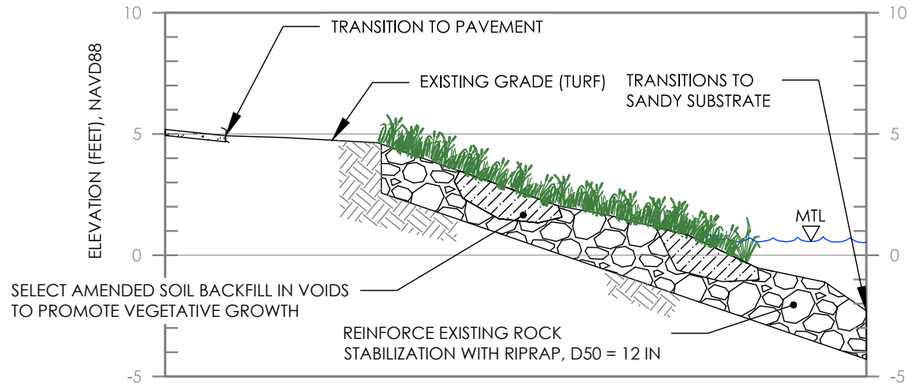
PRINCETON HYDRO, LLC
1108 OLD YORK ROAD
RINGOES, NEW JERSEY, 08551

HUDSON RIVER HABITAT RESTORATION
CHARLES RIDER PARK
ULSTER COUNTY, NY

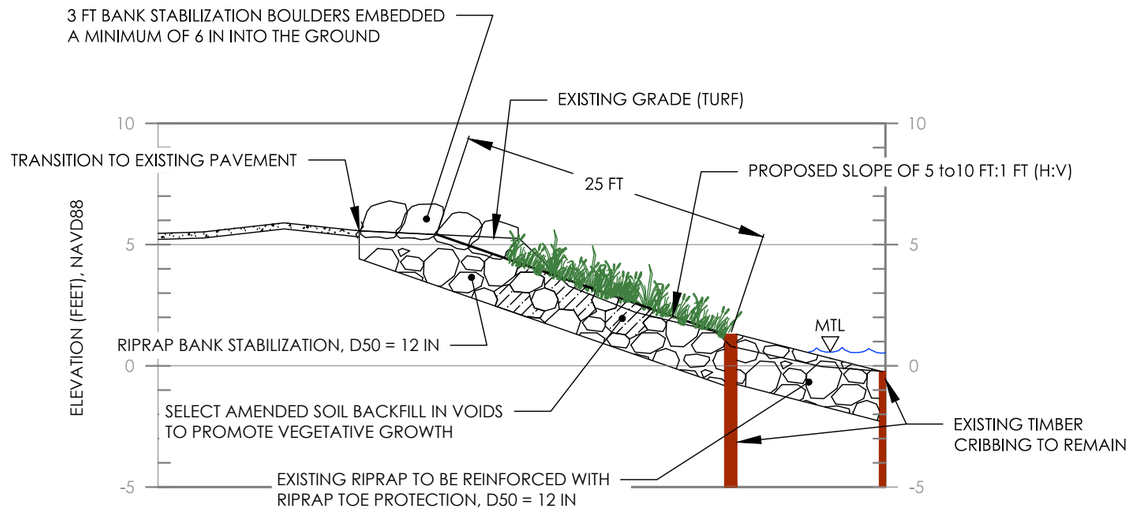
CHARLES RIDER PARK ALTERNATIVE 1
SITE LOCATION

SHEET ID
1

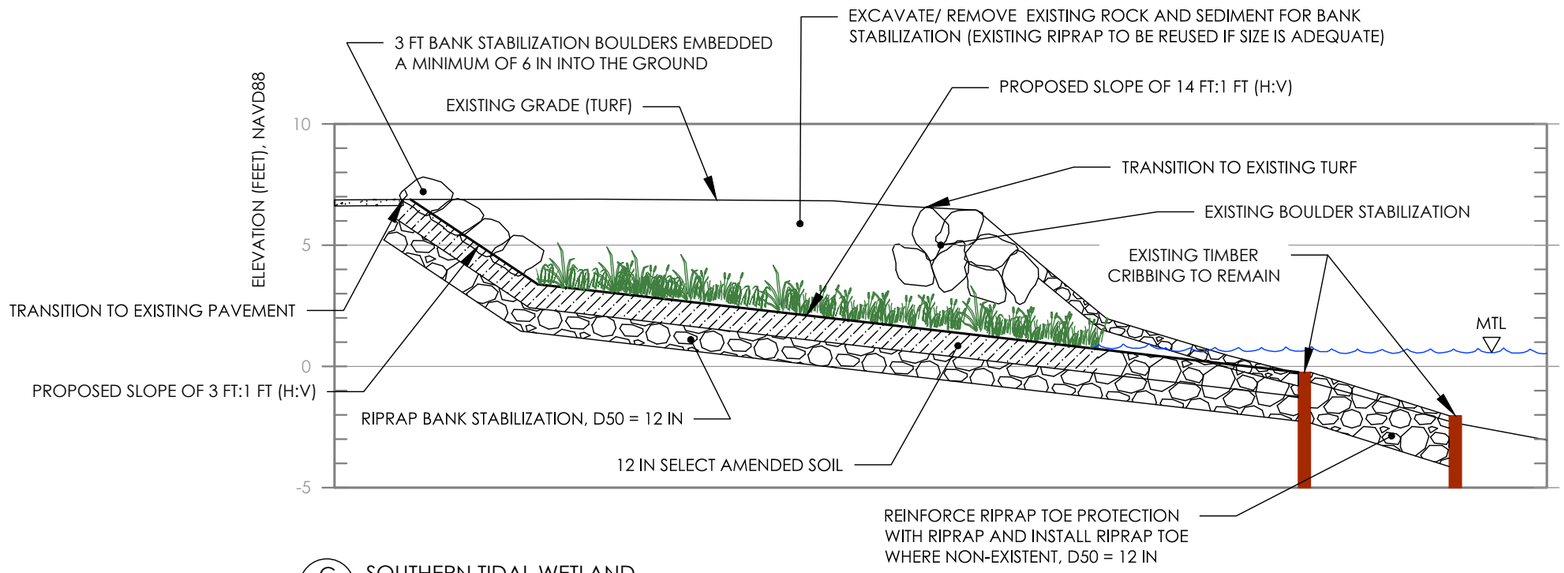
SEP.2018



A INTERSTITIAL ROCK PLANTING
ALTERNATIVE 1
CHARLES RIDER PARK



B NORTHERN TIDAL WETLAND
ALTERNATIVE 1
CHARLES RIDER PARK



C SOUTHERN TIDAL WETLAND
ALTERNATIVE 1
CHARLES RIDER PARK

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

DESIGNED BY:
DRAWN BY: CS
CHECKED BY: M.ITAEM
SUBMITTED BY: PRINCETON HYDRO
SIZE: 11x17
ISSUE DATE: MAY 2018
SOLICITATION NO.:
CONTRACT NO.: W912DS-14-D-0001

U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT
26 FEDERAL PLAZA
NEW YORK, NEW YORK, 10278

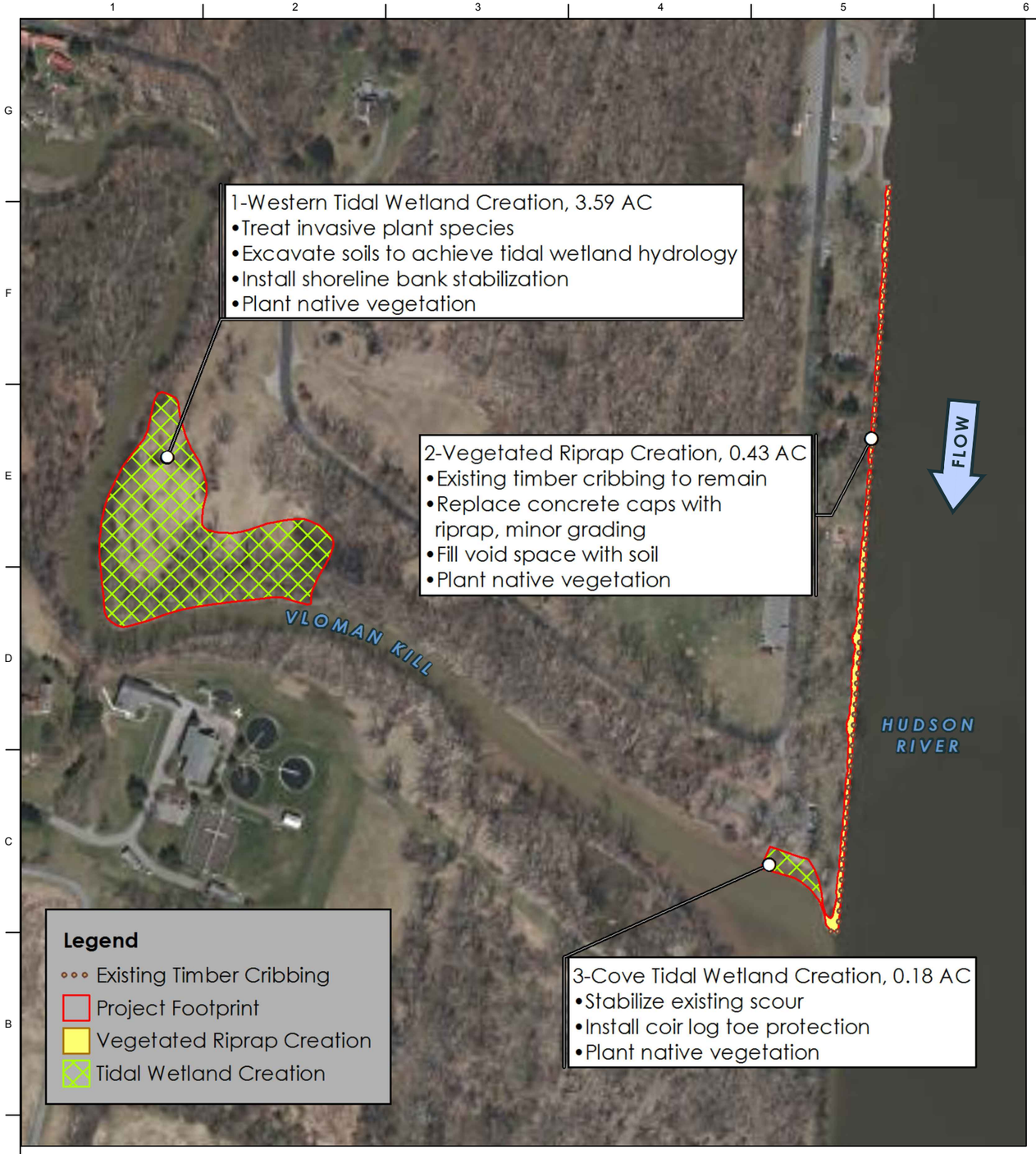
PRINCETON HYDRO, LLC
1108 OLD YORK ROAD
RINGOES, NEW JERSEY, 08551

HUDSON RIVER HABITAT RESTORATION
CHARLES RIDER PARK
ULSTER COUNTY, NY

CHARLES RIDER PARK ALTERNATIVE 1
DETAILS

SHEET ID
2

SEP.2018



1 PLAN VIEW
Alternative 1
1" = 300'

GRAPHIC SCALE
0 100 200 300 600 900 1200 FEET
SCALE: 1" = 300'

1-Western Tidal Wetland Creation

Item	Unit	Quantity
Invasive Species Treatment	AC	3.59
Excavation	CY	29,800
Select Amended Soil	CY	2,900
Grading	SF	156,400
Shoreline Bank Stabilization	TON	440
Plantings (3FT OC)	EA	17,400
Herbivore Exclusion Fence - Geese	AC	3.59
Herbivore Exclusion Fence - Deer	LF	2,000

2-Vegetated Riprap Creation

Item	Unit	Quantity
Excavation	CY	9,200
Riprap (D50=12IN)	TON	11,200
Plantings (3FT OC)	EA	2,100
Gravel	TON	4,500
Select Amended Soil	CY	2,500
Concrete Disposal	TON	1,100

3-Cove Tidal Wetland Creation

Item	Unit	Quantity
Bank Stabilization Boulders	TON	80
Select Amended Soil	CY	30
Herbivore Exclusion Fence - Geese	AC	0.18
Plantings (3FT OC)	EA	900
Toe Protection	LF	210

General Construction

Item	Unit	Quantity
Turbidity Barrier	LF	1,400
Silt Fence	LF	1,700
Construction Stake Out	AC	0.39
Stabilized Construction Entrance	TON	140
Construction Access Matting	SF	9,600
Clearing and Grubbing	AC	0.07

A SCHEDULE OF QUANTITIES
Alternative 1

Acronym	Definition
AC	Acres
CY	Cubic Yards
EA	Each
FT	Feet
H:V	Horizontal:Vertical
IN	Inches
LF	Linear Feet
MTL	Mean Tide Line
OC	On Center
SF	Square Feet
SY	Square Yards

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

DESIGNED BY:
DRAWN BY: TH
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SUBMITTED BY: PRINCETON HYDRO
SIZE: 11x17
ISSUE DATE: MAY 2018
SOLICITATION NO.:
CONTRACT NO.: W912DS-14-D-0001

U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT
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NEW YORK, NEW YORK, 10278

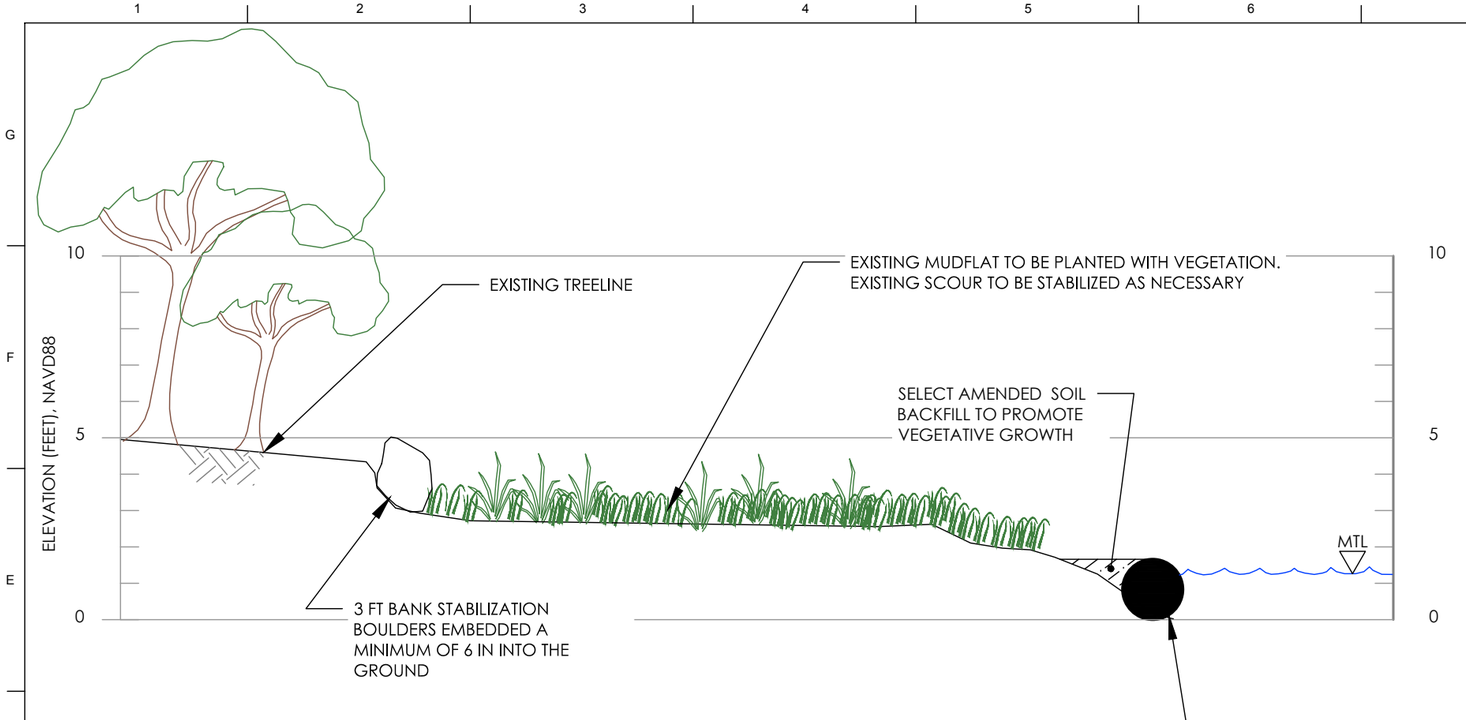
PRINCETON HYDRO, LLC
1108 OLD YORK ROAD
RINGOES, NEW JERSEY, 08551

HUDSON RIVER HABITAT RESTORATION
HENRY HUDSON PARK
ALBANY COUNTY, NY

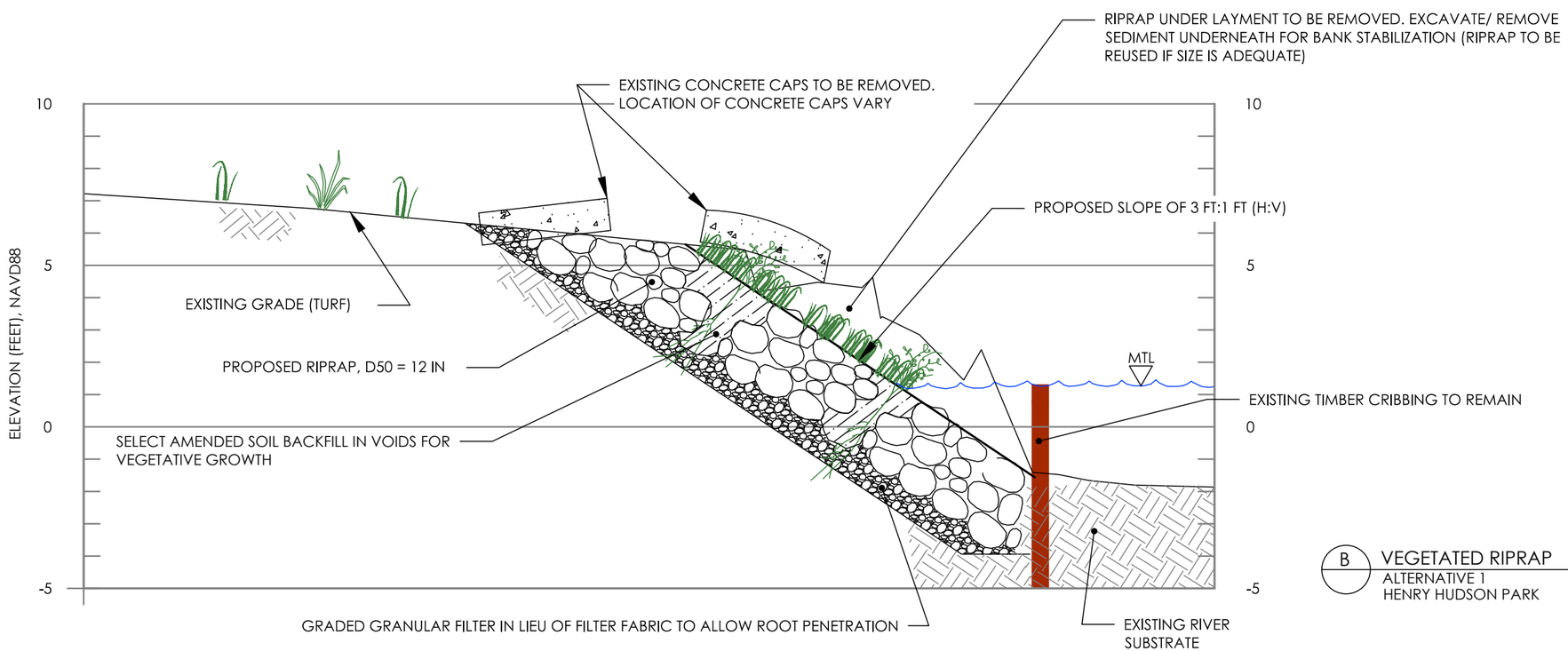
HENRY HUDSON PARK ALTERNATIVE 1
SITE LOCATION

SHEET ID
1

OCT.2018



A COVE TIDAL WETLAND
ALTERNATIVE 1
HENRY HUDSON PARK



B VEGETATED RIPRAP
ALTERNATIVE 1
HENRY HUDSON PARK

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

ISSUE DATE: MAY 2018
SOLICITATION NO.:
CONTRACT NO.: W912DS-14-D-0001
DESIGNED BY:
DRAWN BY: CS
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SUBMITTED BY: PRINCETON HYDRO
SIZE: 11x17

U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT
26 FEDERAL PLAZA
NEW YORK, NEW YORK, 10278

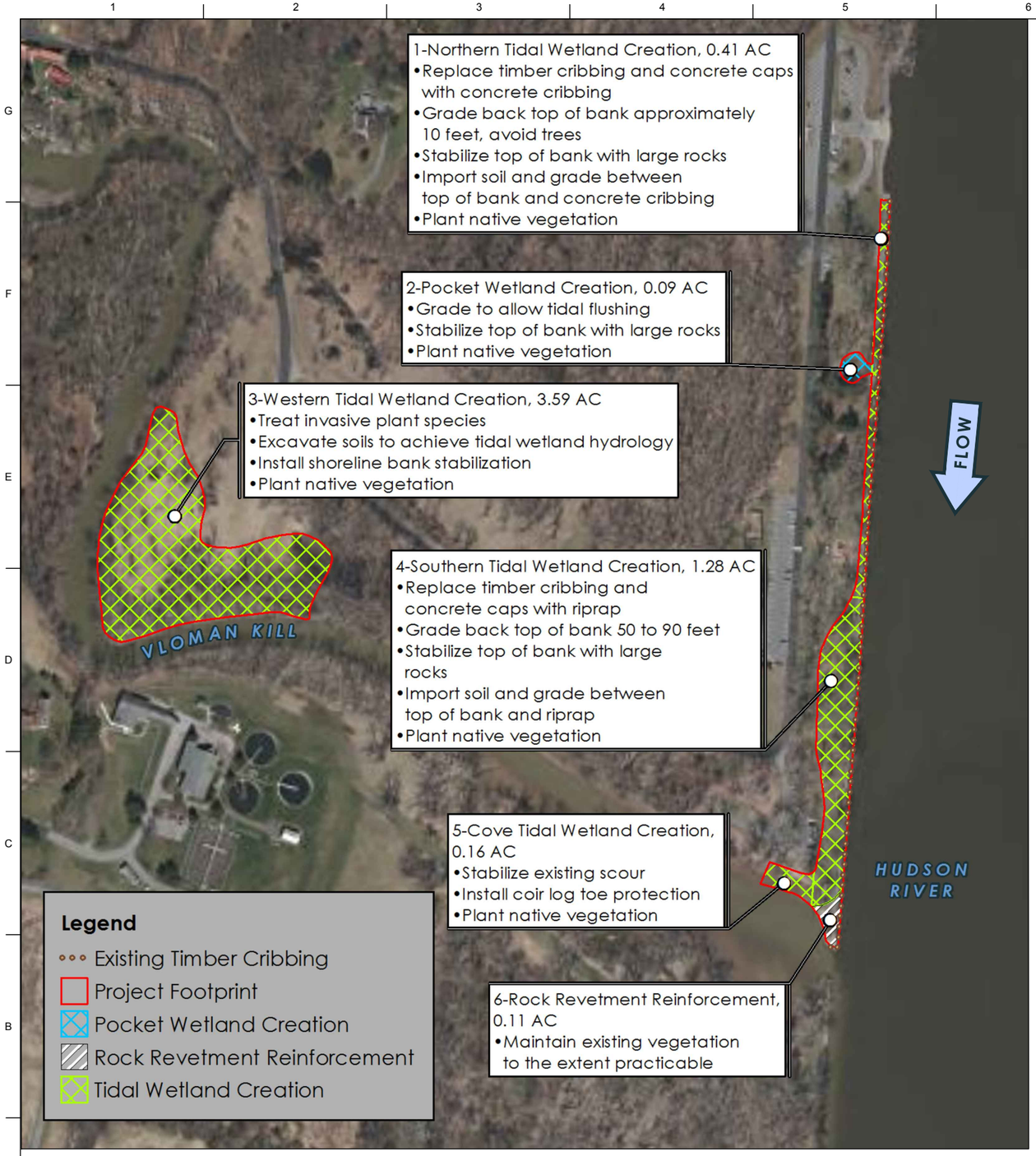
PRINCETON HYDRO, LLC
1108 OLD YORK ROAD
RINGOES, NEW JERSEY, 08551

HUDSON RIVER HABITAT RESTORATION
HENRY HUDSON PARK
ALBANY COUNTY, NY

HENRY HUDSON PARK ALTERNATIVE 1
DETAILS

SHEET ID
2

OCT.2018



1 PLAN VIEW
Alternative 2
1" = 300'

GRAPHIC SCALE

0 100 200 300 600 900 1200 FEET

SCALE: 1" = 300'

Acronym	Definition
AC	Acres
CY	Cubic Yards
EA	Each
FT	Feet
H:V	Horizontal:Vertical
IN	Inches
LF	Linear Feet
MTL	Mean Tide Line
OC	On Center
SF	Square Feet
SY	Square Yards

1-Northern Tidal Wetland Creation

Item	Unit	Quantity
Excavation	CY	16,670
Grading	SF	30,000
Bank Stabilization Boulders	TON	1,940
Riprap (D50=12IN)	TON	9,600
Select Amended Soil	CY	2,150
Herbivore Exclusion Fence - Geese	AC	0.42
Plantings (3FT OC)	EA	2,100
Concrete Cribbing	LF	1,000
Timber Cribbing Removal	LF	1,000
Concrete Cap Disposal	TON	600

2-Pocket Wetland Creation

Item	Unit	Quantity
Excavation	CY	500
Grading	SF	4,000
Bank Stabilization Boulders	TON	110
Select Amended Soil	CY	80
Herbivore Exclusion Fence - Geese	AC	0.09
Plantings (3FT OC)	EA	500

3-Western Tidal Wetland Creation

Item	Unit	Quantity
Invasive Species Treatment	AC	3.59
Excavation	CY	29,800
Select Amended Soil	CY	2,900
Grading	SF	156,400
Shoreline Bank Stabilization	TON	440
Plantings (3FT OC)	EA	17,400
Herbivore Exclusion Fence - Geese	AC	3.59
Herbivore Exclusion Fence - Deer	LF	2,000

4-Southern Tidal Wetland Creation

Item	Unit	Quantity
Excavation	CY	12,920
Grading	SF	54,250
Select Amended Soil	CY	2,300
Riprap (D50=12IN)	TON	7,100
Herbivore Exclusion Fence - Geese	AC	1.29
Plantings (3FT OC)	EA	6,100
Bank Stabilization Boulders	TON	1,520
Concrete Cap Disposal	TON	470

5-Cove Tidal Wetland Creation

Item	Unit	Quantity
Bank Stabilization Boulders	TON	80
Select Amended Soil	CY	30
Herbivore Exclusion Fence - Geese	AC	0.16
Plantings (3FT OC)	EA	800
Toe Protection	LF	210

6-Reinforced Rock Revetment

Item	Unit	Quantity
Riprap	TON	500
Plantings (3FT OC)	EA	600

General Construction

Item	Unit	Quantity
Turbidity Barrier	LF	2,100
Silt Fence	LF	1,900
Construction Stake Out	AC	1.79
Stabilized Construction Access	TON	140
Construction Access Matting	SF	6,300
Clearing and Grubbing	AC	0.04

A SCHEDULE OF QUANTITIES
Alternative 2

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

ISSUE DATE: MAY 2018
SOLICITATION NO.:
CONTRACT NO.: W912DS-14-D-0001
DESIGNED BY:
DRAWN BY: TH
CHECKED BY: CP/AEM
SUBMITTED BY: PRINCETON HYDRO
SIZE: 11x17

U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT
26 FEDERAL PLAZA
NEW YORK, NEW YORK, 10278

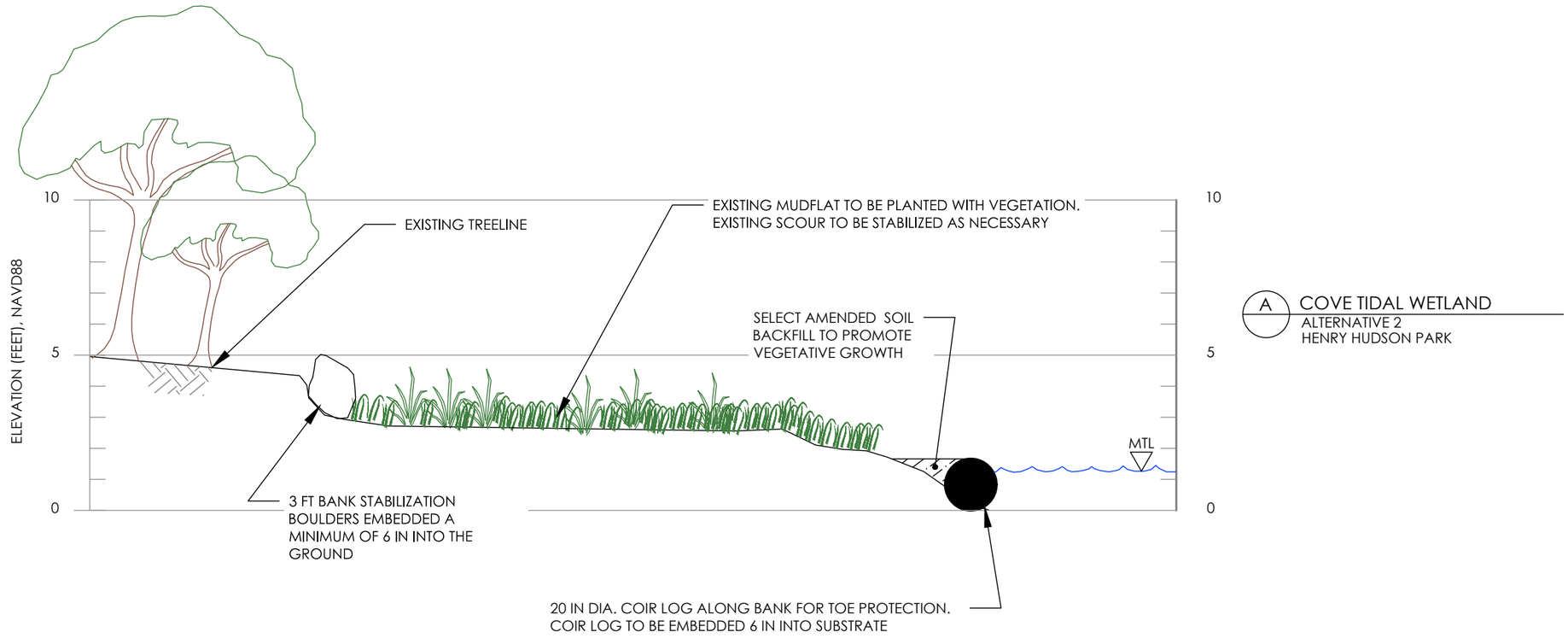
PRINCETON HYDRO, LLC
1108 OLD YORK ROAD
RINGOES, NEW JERSEY, 08551

HUDSON RIVER HABITAT RESTORATION
HENRY HUDSON PARK
ALBANY COUNTY, NY

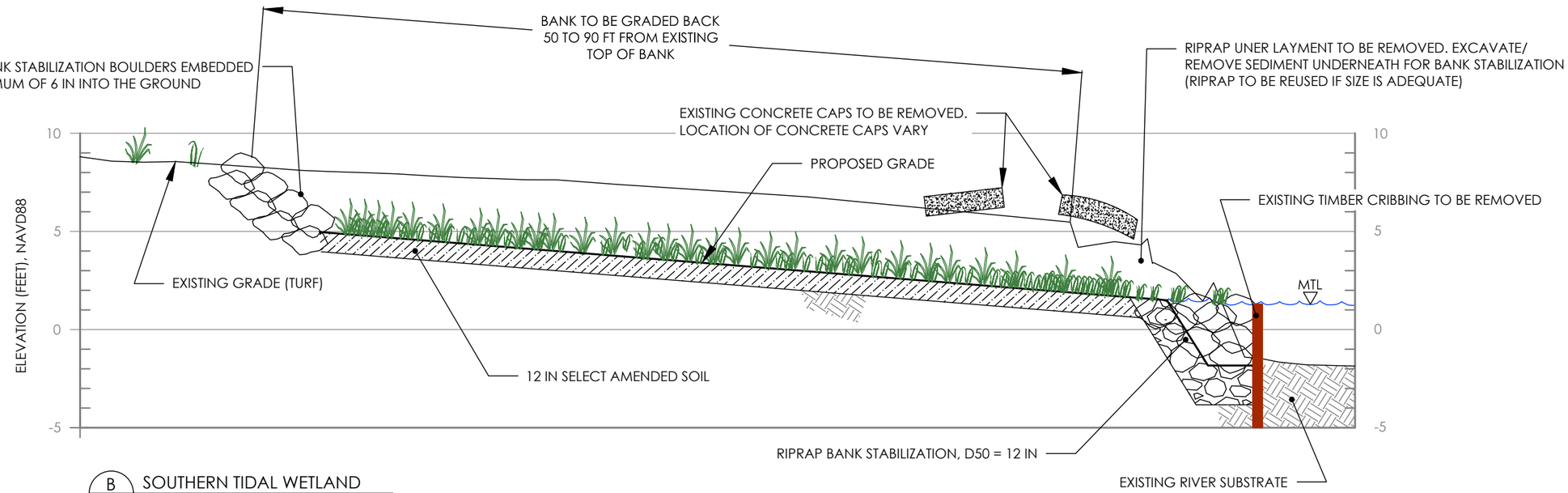
HENRY HUDSON PARK ALTERNATIVE 2
SITE LOCATION

SHEET ID
1

OCT.2018



A COVE TIDAL WETLAND
ALTERNATIVE 2
HENRY HUDSON PARK



B SOUTHERN TIDAL WETLAND
ALTERNATIVE 2
HENRY HUDSON PARK

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

DESIGNED BY:
DRAWN BY: CS
CHECKED BY: MJT/AEM
SUBMITTED BY: PRINCETON HYDRO
ISSUE DATE: MAY 2018
SOLICITATION NO.:
CONTRACT NO.: W912DS-14-D-0001
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U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT
26 FEDERAL PLAZA
NEW YORK, NEW YORK, 10278

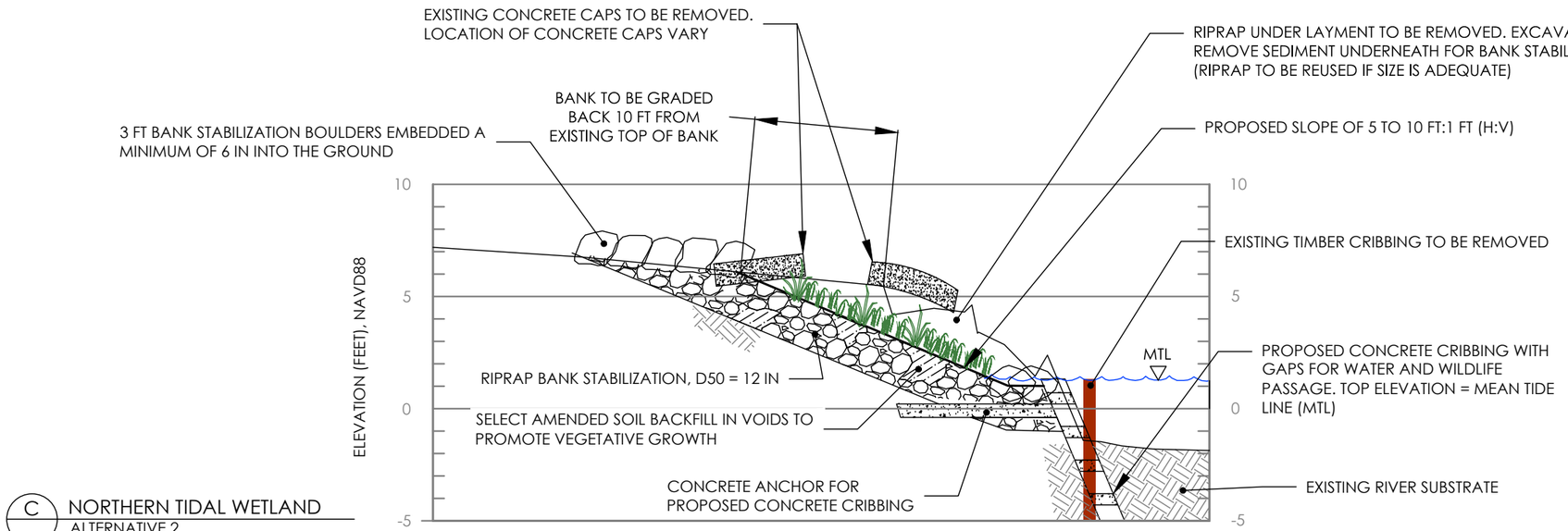
PRINCETON HYDRO, LLC
1108 OLD YORK ROAD
RINGOES, NEW JERSEY, 08551

HUDSON RIVER HABITAT RESTORATION
HENRY HUDSON PARK
ALBANY COUNTY, NY

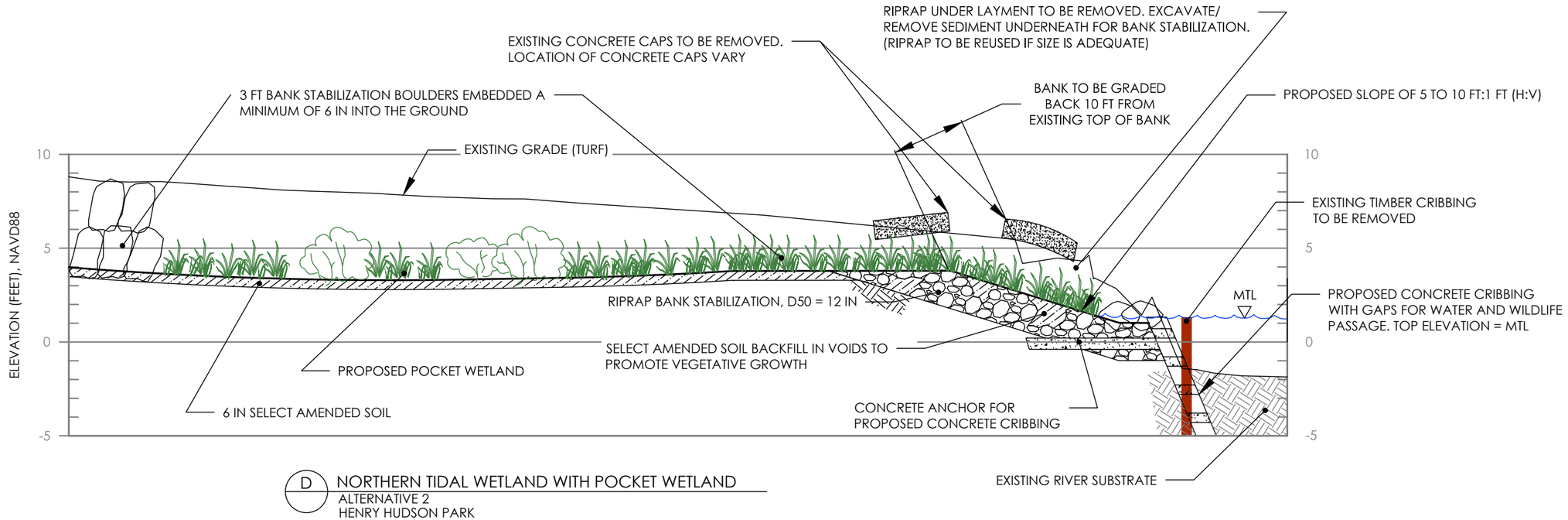
HENRY HUDSON PARK ALTERNATIVE 2
DETAILS

SHEET ID
2

OCT.2018



C NORTHERN TIDAL WETLAND
ALTERNATIVE 2
HENRY HUDSON PARK



D NORTHERN TIDAL WETLAND WITH POCKET WETLAND
ALTERNATIVE 2
HENRY HUDSON PARK

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

DESIGNED BY:
DRAWN BY: CS
CHECKED BY: M.IT/AEM
SUBMITTED BY: PRINCETON HYDRO
SIZE: 11x17
ISSUE DATE: MAY 2018
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CONTRACT NO.: W912DS-14-D-0001

U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT
26 FEDERAL PLAZA
NEW YORK, NEW YORK, 10278

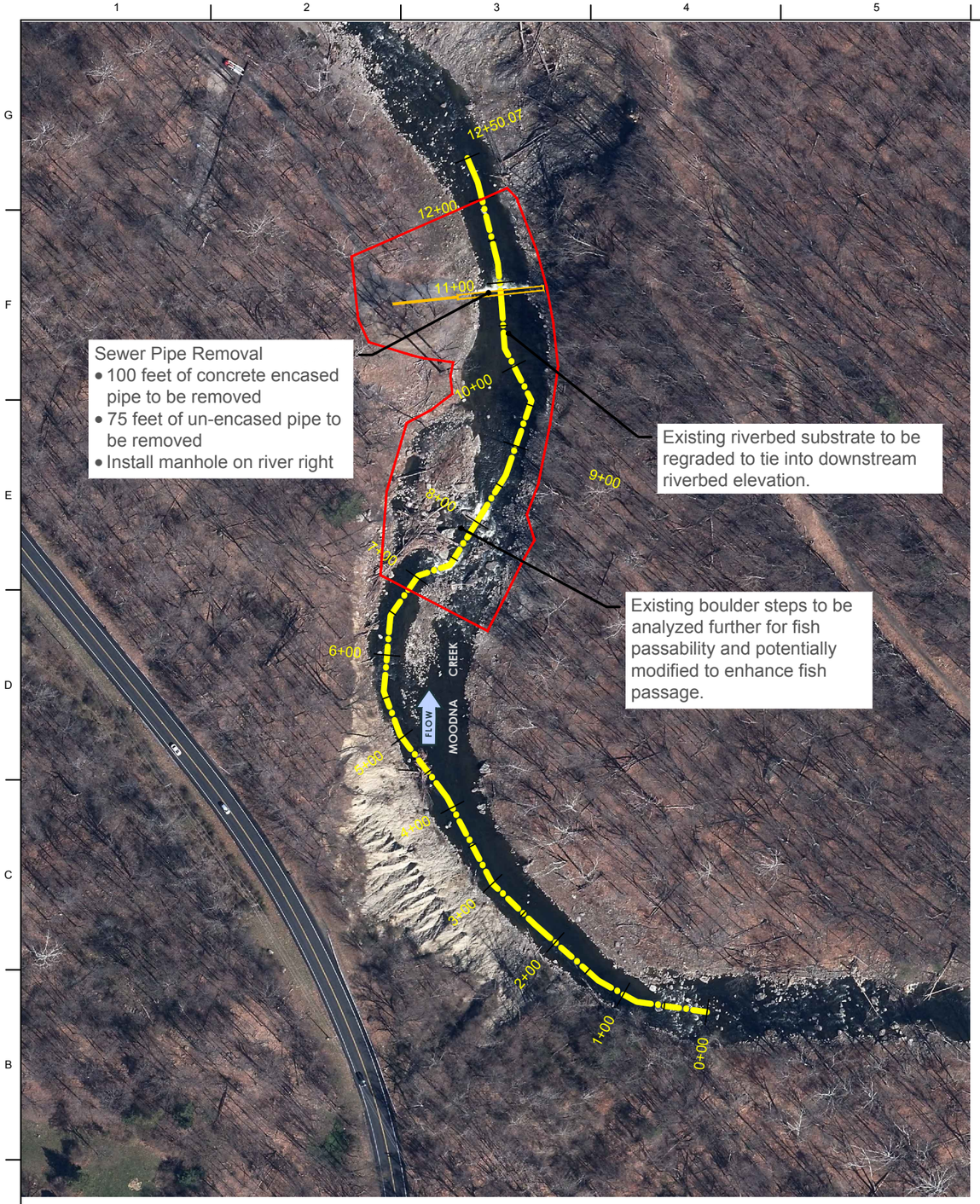
PRINCETON HYDRO, LLC
1108 OLD YORK ROAD
RINGOES, NEW JERSEY, 08551

HUDSON RIVER HABITAT RESTORATION
HENRY HUDSON PARK
ALBANY COUNTY, NY

HENRY HUDSON PARK ALTERNATIVE 2 DETAILS

SHEET ID
3

OCT.2018



1 PLAN VIEW
1" = 150'

0 30 60 90 120 150 300 450 600 FEET

SCALE: 1" = 150'

Legend
- River Profile
- Project Footprint
- Proposed Sewer Pipe Removal

MOODNA CREEK
AOP 1 - UTILITY CROSSING
ALTERNATIVE 1:
BARRIER REMOVAL

Barrier Removal

Item	*Unit*	*Quantity*
Water Control Materials (Sand-Filled BigBags)	LF	300
Water Control Installation & Modification	LS	1
Utility Removal	LF	175
Demolition / Excavation	lf	170
Backfill with soil	cy	113
Re-grade streambed	sy	833
Disposal of Concrete / Pipe Material	tons	227
Decomisssion Utility (includes manhole installation)	Ea	1
Upstream Boulder Step Modification:		
Boulders (delivered, 2 weirs, 40 boulders ea.)	TON	400

General Construction

Item	*Unit*	*Quantity*
Traffic Control	LS	1
Turbidity Barrier	LF	100
Silt Fence	LF	240
Stabilized Construction Entrance	TON	50
Construction Access Reinforcement	TON	210
Construction Access Ramp	TON	260
Clearing and Grubbing	AC	0.3

A SCHEDULE OF QUANTITIES
Alternative 1 - Barrier Removal

Acronym	Definition
AC	Acres
CY	Cubic Yards
EA	Each
FT	Feet
LF	Linear Feet
LS	Lump Sum
SY	Square Yards
WSEL	Water Surface Elevation

US Army Corps of Engineers®

DATE | DESCRIPTION | MARK

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DRAWN BY: AGU/DPW/TH
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ISSUE DATE: MAY 2018
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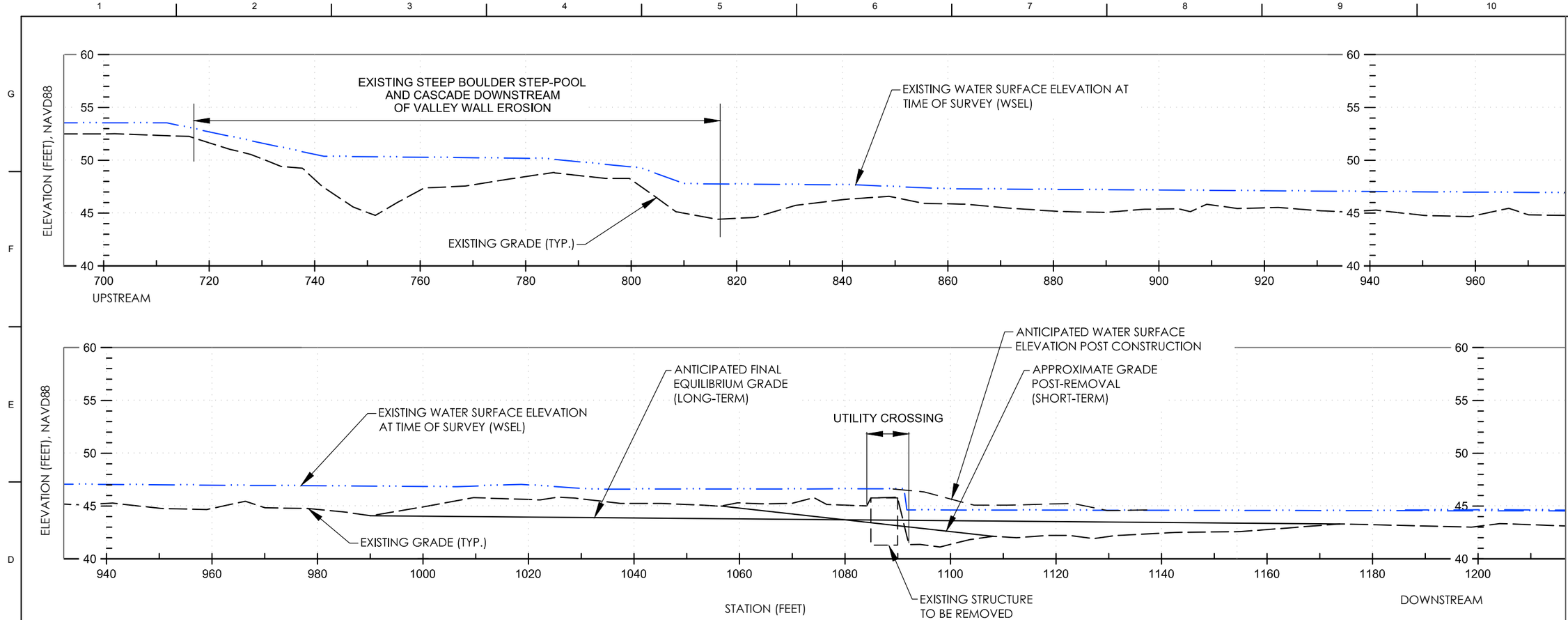
U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT
26 FEDERAL PLAZA
NEW YORK, NEW YORK, 10278

PRINCETON HYDRO, LLC
1108 OLD YORK ROAD
RINGOES, NEW JERSEY, 08551

HUDSON RIVER HABITAT RESTORATION
MOODNA CREEK
ORANGE COUNTY, NY
MOODNA CREEK
AOP 1 - UTILITY CROSSING
ALTERNATIVE 1 - BARRIER REMOVAL

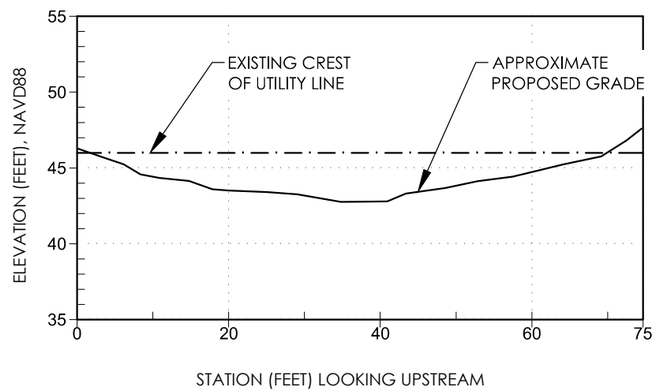
SHEET ID
1

OCT.2018



A AOP 1 - UTILITY CROSSING PROFILE
ALTERNATIVE 1: BARRIER REMOVAL
MOODNA CREEK

ELEVATIONS REFERENCED TO
NORTH AMERICAN VERTICAL
DATUM OF 1988 (NAVD88), FEET



B AOP 1 - UTILITY CROSSING CROSS SECTION AT STATION 1090
ALTERNATIVE 1: BARRIER REMOVAL
MOODNA CREEK

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

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U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT
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PRINCETON HYDRO, LLC
1108 OLD YORK ROAD
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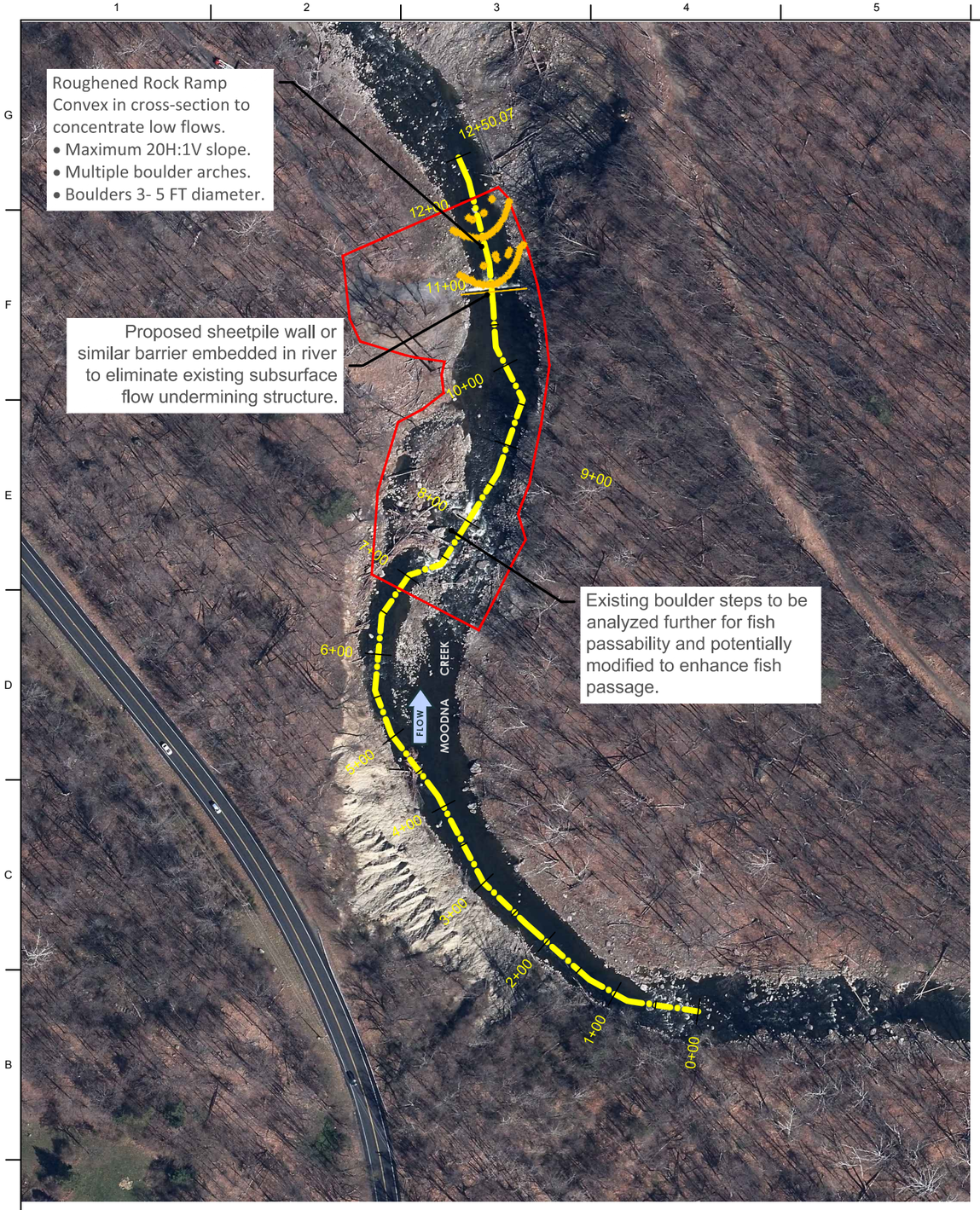
HUDSON RIVER HABITAT RESTORATION
MOODNA CREEK
ORANGE COUNTY, NY
MOODNA CREEK
AOP 1 - UTILITY CROSSING
ALTERNATIVE 1 - BARRIER REMOVAL

SHEET ID
2

OCT.2018



1 PLAN VIEW
1" = 150'

0 30 60 90 120 150 300 450 600 FEET

SCALE: 1" = 150'

Legend
- River Profile
- Project Footprint
- Proposed Fishway

MOODNA CREEK
AOP 1 - UTILITY CROSSING
ALTERNATIVE 2: FISHWAY

Acronym	Definition
AC	Acres
CY	Cubic Yards
EA	Each
FT	Feet
H:V	Horizontal:Vertical
LF	Linear Feet
LS	Lump Sum
SY	Square Yards
WSEL	Water Surface Elevation

Rock Ramp Fishway

Item	*Unit*	*Quantity*
Water Control Materials (Sand-Filled BigBags)	LF	300
Water Control Installation & Modification	LS	1
Rock Ramp: Boulders for rock veins	TON	480
Rock Ramp: Boulder/cobble/gravel infill	TON	800
Sheetpile	LF	560
Boulders (delivered, 2 weirs, 40 boulders ea.)	TON	400

General Construction

Item	*Unit*	*Quantity*
Traffic Control	LS	1
Turbidity Barrier	LF	100
Silt Fence	LF	240
Stabilized Construction Entrance	TON	50
Construction Access Reinforcement	TON	210
Construction Access Ramp	TON	260
Clearing and Grubbing	AC	0.23

A SCHEDULE OF QUANTITIES
Alternative 2 - Fishway

US Army Corps of Engineers®

DATE | MARK | DESCRIPTION

DESIGNED BY:
DRAWN BY: AG/JD/PW/TH
CHECKED BY: AEM/PW
ISSUE DATE: MAY 2018
SOLICITATION NO.:
CONTRACT NO.: W912DS-14-D-0001
SUBMITTED BY: PRINCETON HYDRO
SIZE: 11x17

U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT
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NEW YORK, NEW YORK, 10278

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1108 OLD YORK ROAD
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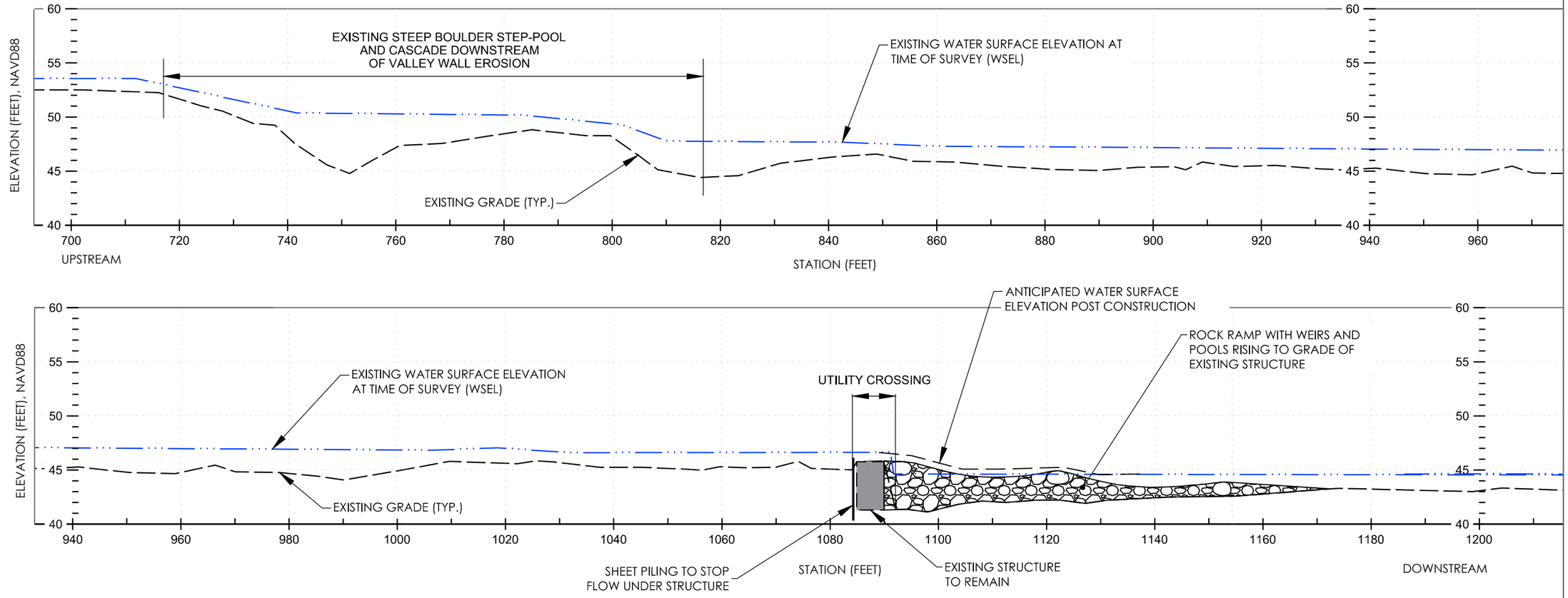
HUDSON RIVER HABITAT RESTORATION
MOODNA CREEK
ORANGE COUNTY, NY
MOODNA CREEK
AOP 1 - UTILITY CROSSING
ALTERNATIVE 2 - FISHWAY

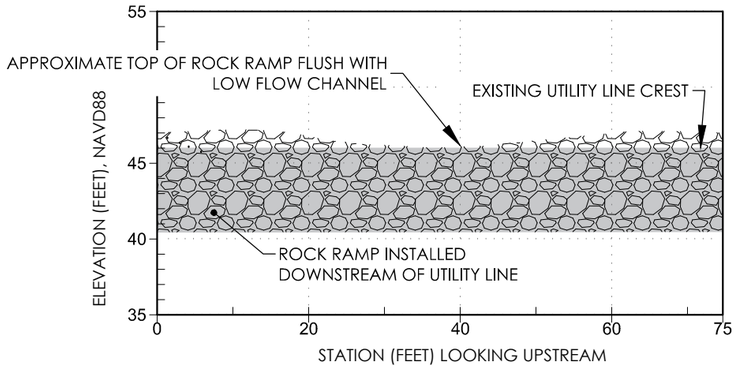
SHEET ID
1

OCT.2018



A AOP 1 - UTILITY CROSSING PROFILE
ALTERNATIVE 2: FISHWAY
MOODNA CREEK

ELEVATIONS REFERENCED TO
NORTH AMERICAN VERTICAL
DATUM OF 1988 (NAVD88), FEET



B AOP 1 - UTILITY CROSSING CROSS SECTION AT STATION 1090
ALTERNATIVE 2: FISHWAY
MOODNA CREEK

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MARK	DESCRIPTION	DATE

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DRAWN BY: AG/JD/PW/TH
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SUBMITTED BY: PRINCETON HYDRO
ISSUE DATE: MAY 2018
SOLICITATION NO.:
CONTRACT NO: W912DS-14-D-0001
SIZE: 11x17

U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT
26 FEDERAL PLAZA
NEW YORK, NEW YORK, 10278

PRINCETON HYDRO, LLC
1108 OLD YORK ROAD
RINGOES, NEW JERSEY, 08551

HUDSON RIVER HABITAT RESTORATION
MOODNA CREEK
ORANGE COUNTY, NY
MOODNA CREEK
AOP 1 - UTILITY CROSSING
ALTERNATIVE 2 - FISHWAY

SHEET ID
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MOODNA CREEK
AOP 2 - FIRTH CLIFF DAM
ALTERNATIVE 1:
DAM REMOVAL

A SCHEDULE OF QUANTITIES
Alternative 1 - Dam Removal

Dam Removal

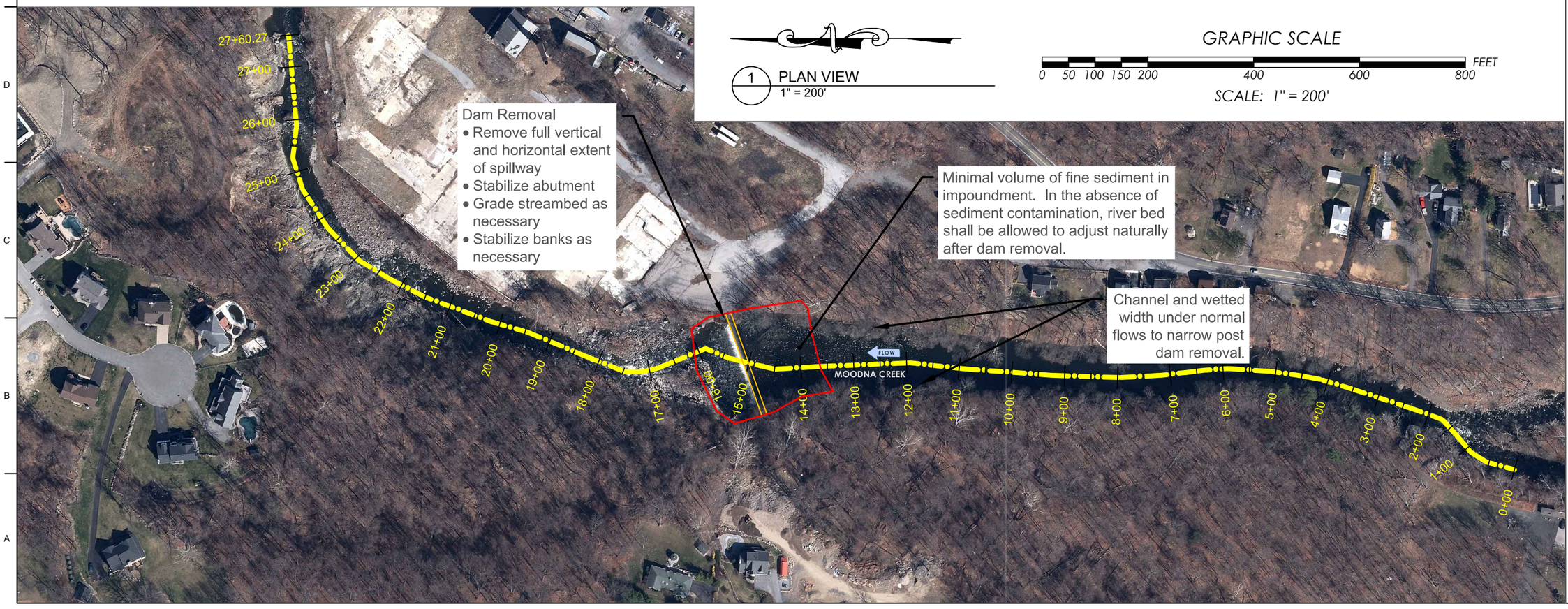
Item	Unit	Quantity
Water Control Materials (Sand-Filled BigBags)	LF	400
Water Control Installation & Modification	LS	1
Spillway Demolition / Excavation	CY	710
Re-grade Streambed	SY	840
Disposal of Concrete	TON	1,390
Abutment Stabilization	LS	1
Bank stabilization	LF	200

General Construction

Item	Unit	Quantity
Traffic Control	LS	1
Turbidity Barrier	LF	200
Silt Fence	LF	80
Stabilized Construction Entrance	TON	50
Construction Access Reinforcement	TON	90
Construction Access Ramp	TON	160
Construction Access Pad	TON	230
Clearing and Grubbing	AC	0.1

Acronym	Definition
AC	Acres
CY	Cubic Yards
FT	Feet
LF	Linear Feet
LS	Lump Sum
SY	Square Yards
WSEL	Water Surface Elevation

Legend
- River Profile
- Project Footprint
- Dam Removal



1 PLAN VIEW
1" = 200'

GRAPHIC SCALE
0 50 100 150 200 400 600 800 FEET
SCALE: 1" = 200'

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HUDSON RIVER HABITAT RESTORATION
MOODNA CREEK
ORANGE COUNTY, NY
MOODNA CREEK
AOP 2 - FIRTH CLIFF DAM
ALTERNATIVE 1 - DAM REMOVAL

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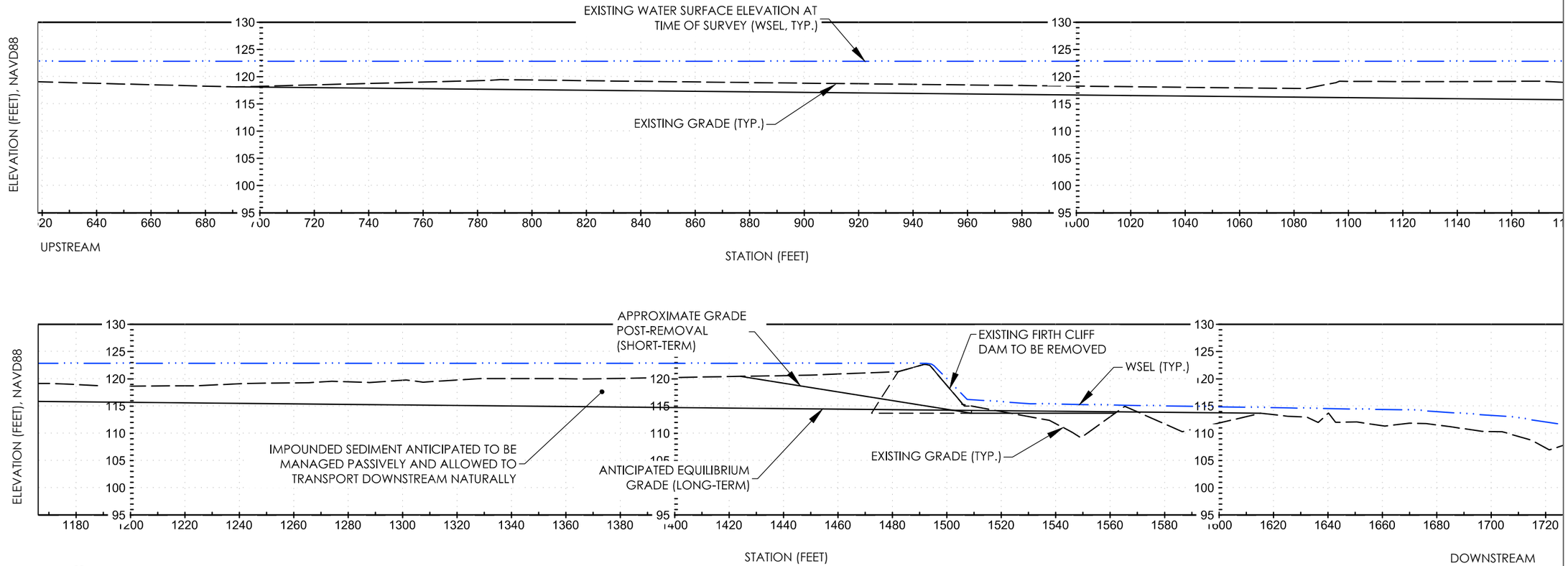
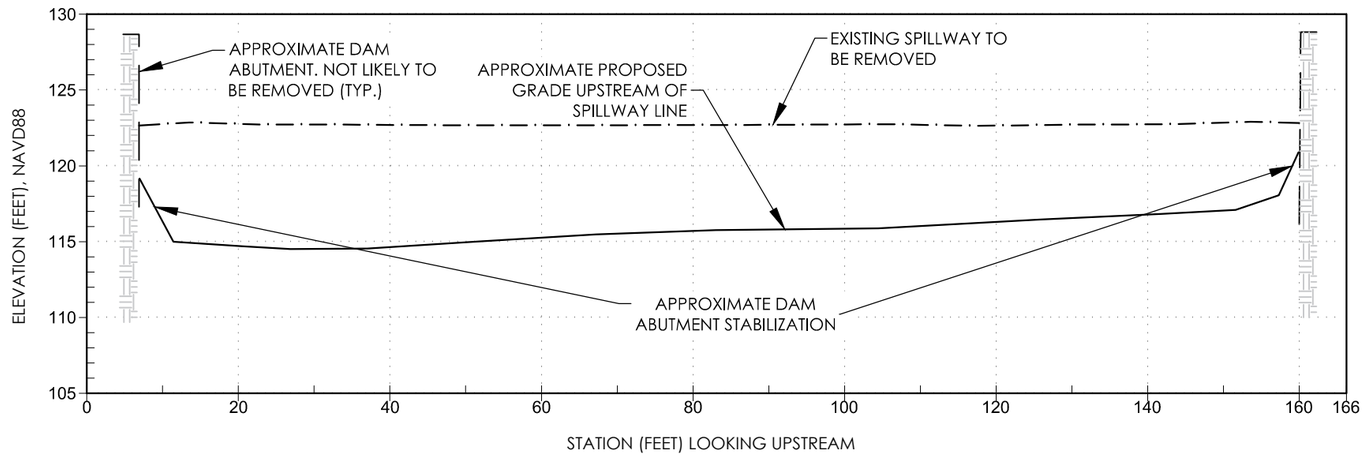


A AOP 2 - FIRTH CLIFF DAM PROFILE
ALTERNATIVE 1: DAM REMOVAL
MOODNA CREEK



B AOP 2 - FIRTH CLIFF DAM CROSS SECTION AT STATION 1500
ALTERNATIVE 1: DAM REMOVAL
MOODNA CREEK

ELEVATIONS REFERENCED TO NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88), FEET

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CONTRACT NO.: W912DS-14-D-0001
SIZE: 11x17

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HUDSON RIVER HABITAT RESTORATION
MOODNA CREEK
ORANGE COUNTY, NY
MOODNA CREEK
AOP 2 - FIRTH CLIFF DAM
ALTERNATIVE 1 - DAM REMOVAL

SHEET ID
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MOODNA CREEK
AOP 2 - FIRTH CLIFF DAM
ALTERNATIVE 2:
FISHWAY

A SCHEDULE OF QUANTITIES
Alternative 2 - Fishway

Fishway

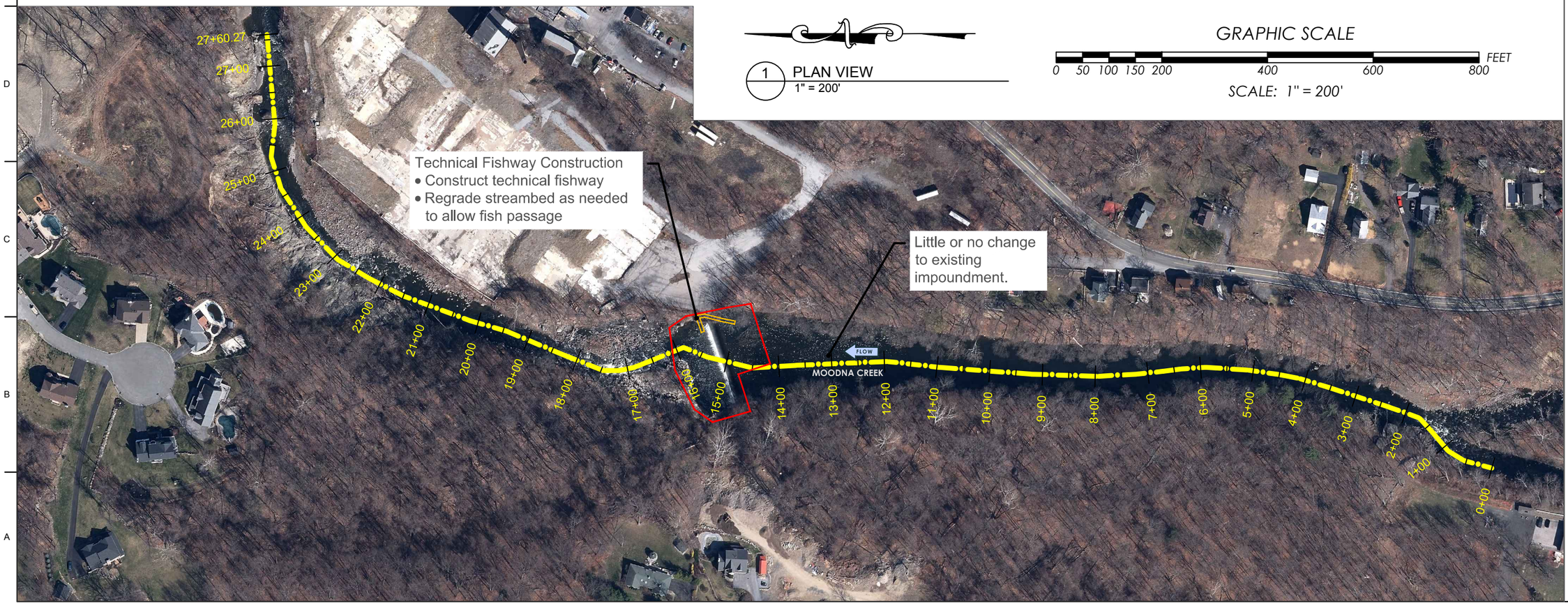
Item	Unit	Quantity
Water Control Materials (Sand-Filled BigBags)	LF	400
Water Control Installation & Modification	LS	1
Concrete Cutting (Sawcutting)	LF	1,550
Fishway Structure	VF	12

General Construction

Item	Unit	Quantity
Traffic Control	LS	1
Turbidity Barrier	LF	115
Silt Fence	LF	80
Stabilized Construction Entrance	TON	470
Construction Access Reinforcement	TON	8,570
Construction Access Ramp	TON	160
Clearing and Grubbing	AC	0.1

Acronym	Definition
AC	Acres
CY	Cubic Yards
FT	Feet
LF	Linear Feet
LS	Lump Sum
SY	Square Yards
VF	Vertical Foot
WSEL	Water Surface Elevation

Legend
- River Profile
- Project Footprint
- Proposed Fishway



1 PLAN VIEW
1" = 200'

GRAPHIC SCALE
0 50 100 150 200 400 600 800 FEET
SCALE: 1" = 200'

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HUDSON RIVER HABITAT RESTORATION
MOODNA CREEK
ORANGE COUNTY, NY
MOODNA CREEK
AOP 2 - FIRTH CLIFF DAM
ALTERNATIVE 2 - FISHWAY

SHEET ID
1

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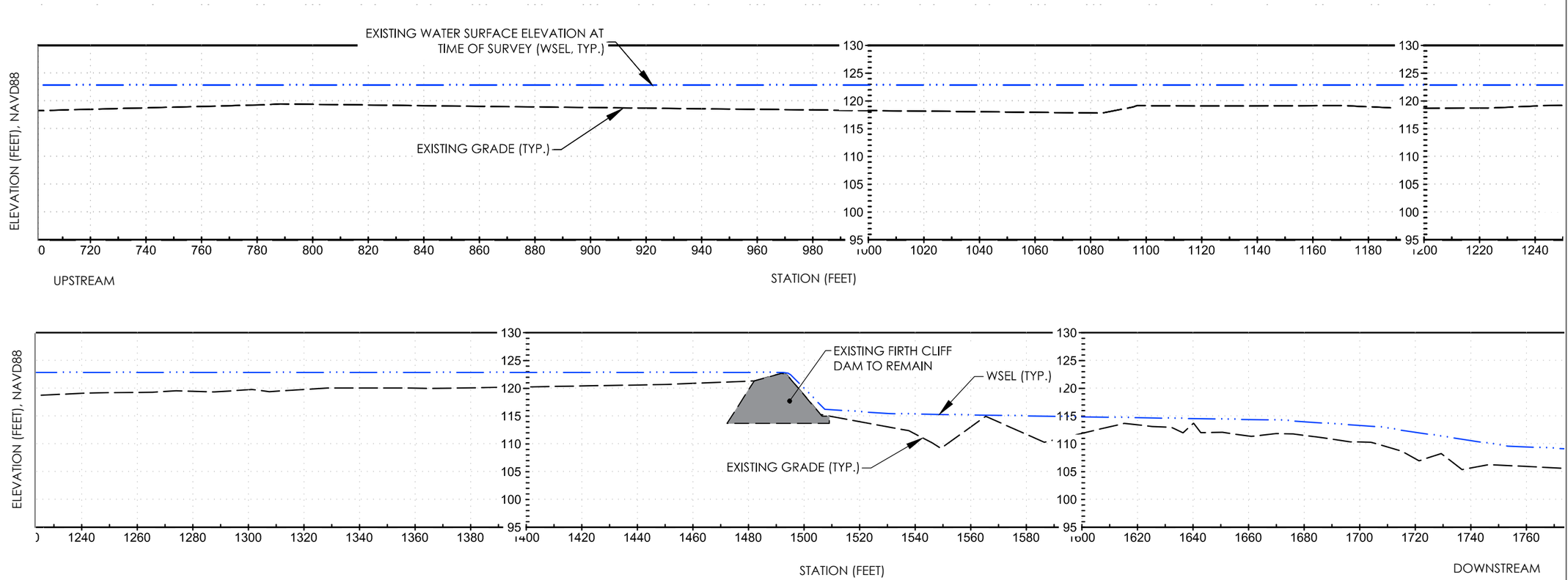
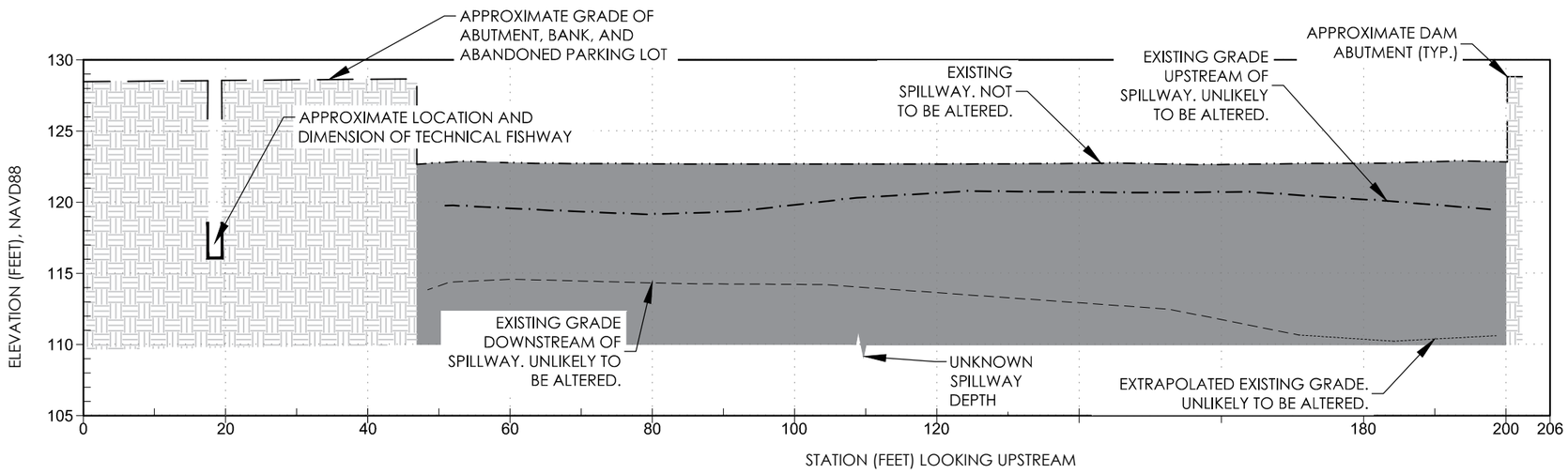


A AOP 2 - FIRTH CLIFF DAM PROFILE
ALTERNATIVE 2: FISHWAY
MOODNA CREEK



ELEVATIONS REFERENCED TO NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88), FEET

B AOP 2 - FIRTH CLIFF DAM CROSS SECTION AT STATION 1500
ALTERNATIVE 2: FISHWAY
MOODNA CREEK

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HUDSON RIVER HABITAT RESTORATION
MOODNA CREEK
ORANGE COUNTY, NY
MOODNA CREEK
AOP 2 - FIRTH CLIFF DAM
ALTERNATIVE 2 - FISHWAY

SHEET ID
2

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1 PLAN VIEW
1" = 150'

0 30 60 90 120 150 300 450 600 FEET

SCALE: 1" = 150'

Legend
- River Profile
- Project Footprint
- Dam Removal
- Proposed Boulder

MOODNA CREEK
AOP 3 - ORRS MILL DAM
ALTERNATIVE 1:
DAM REMOVAL

Acronym	Definition
AC	Acres
CY	Cubic Yards
FT	Feet
LF	Linear Feet
LS	Lump Sum
SY	Square Yards
WSEL	Water Surface Elevation

Dam Removal

Item	*Unit*	*Quantity*
Water Control Materials (Sand-Filled BigBags)	LF	400
Water Control Installation & Modification	LS	1
Spillway Demolition / Excavation	CY	1,250
Disposal of Spillway Concrete	TON	790
Abutment Removal (River Left)	CY	350
Disposal of Abutment Concrete/Masonry/Earth	TON	30
Re-grade Streambed	SY	3,340
Supplemental Boulders (12, 4x5x6ft, delivered)	TON	130
Grade Control Stabilization	LF	500
Tributary Confluence Stabilization (Boulders, 24, 3x4x5ft, delivered)	TON	130
Boulder Grade Control (Boulders, 40, 4x5x6ft, delivered)	TON	420

General Construction

Item	*Unit*	*Quantity*
Traffic Control	LS	1
Turbidity Barrier	LF	180
Silt Fence	LF	80
Stabilized Construction Entrance	TON	50
Construction Access Matting	SF	1600
Construction Access Ramp	TON	90
Construction Access Pad	TON	620
Clearing and Grubbing	AC	0.2

A SCHEDULE OF QUANTITIES
Alternative 1 - Dam Removal

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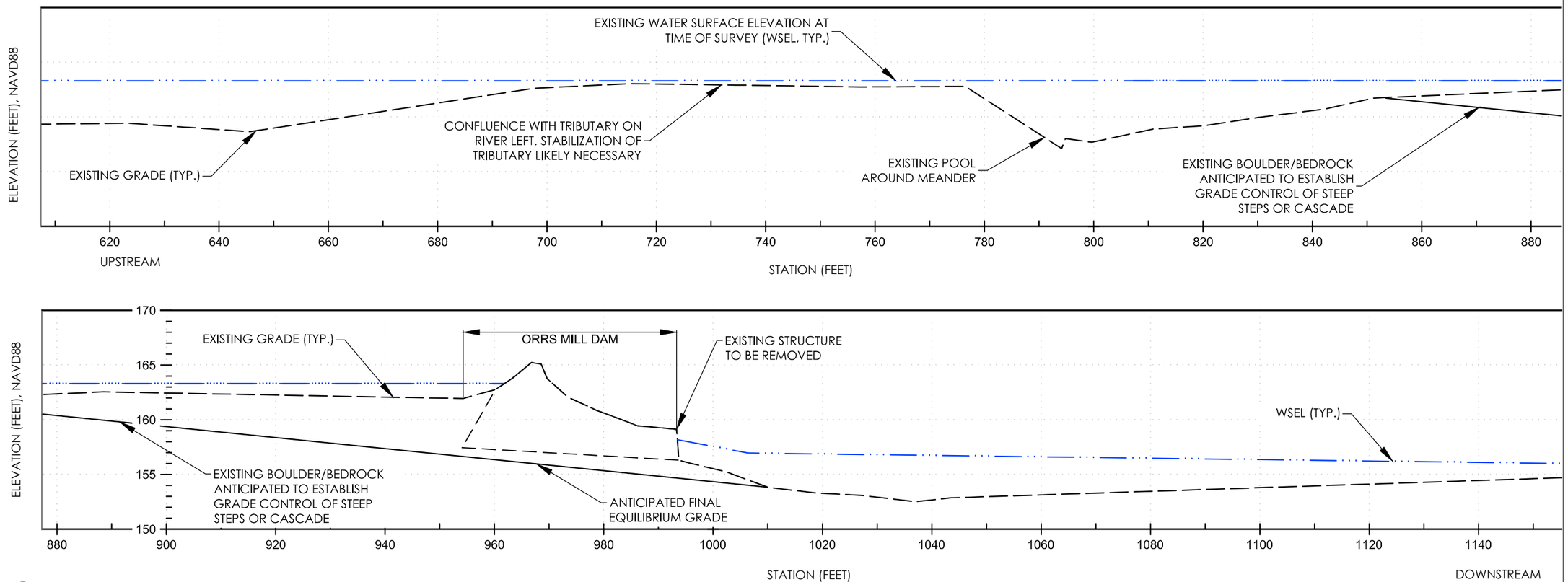
HUDSON RIVER HABITAT RESTORATION
MOODNA CREEK
ORANGE COUNTY, NY
MOODNA CREEK
AOP 3 - ORRS MILL DAM
ALTERNATIVE 1 - DAM REMOVAL

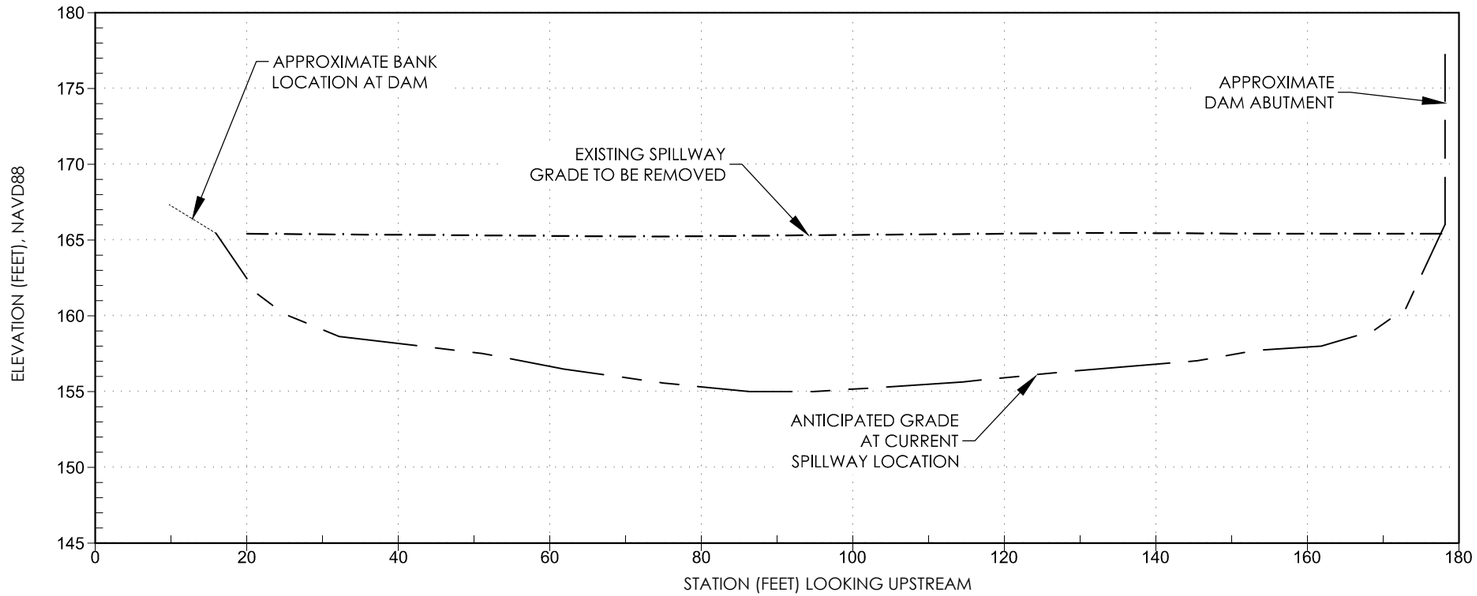
SHEET ID
1

OCT.2018



A AOP 3 - ORRS MILL DAM PROFILE
ALTERNATIVE 1: DAM REMOVAL
MOODNA CREEK

ELEVATIONS REFERENCED TO NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88), FEET



B AOP 3 - ORRS MILL DAM CROSS SECTION AT STATION 960
ALTERNATIVE 1: DAM REMOVAL
MOODNA CREEK

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HUDSON RIVER HABITAT RESTORATION
MOODNA CREEK
ORANGE COUNTY, NY

MOODNA CREEK
AOP 3 - ORRS MILL DAM
ALTERNATIVE 1 - DAM REMOVAL

SHEET ID
2

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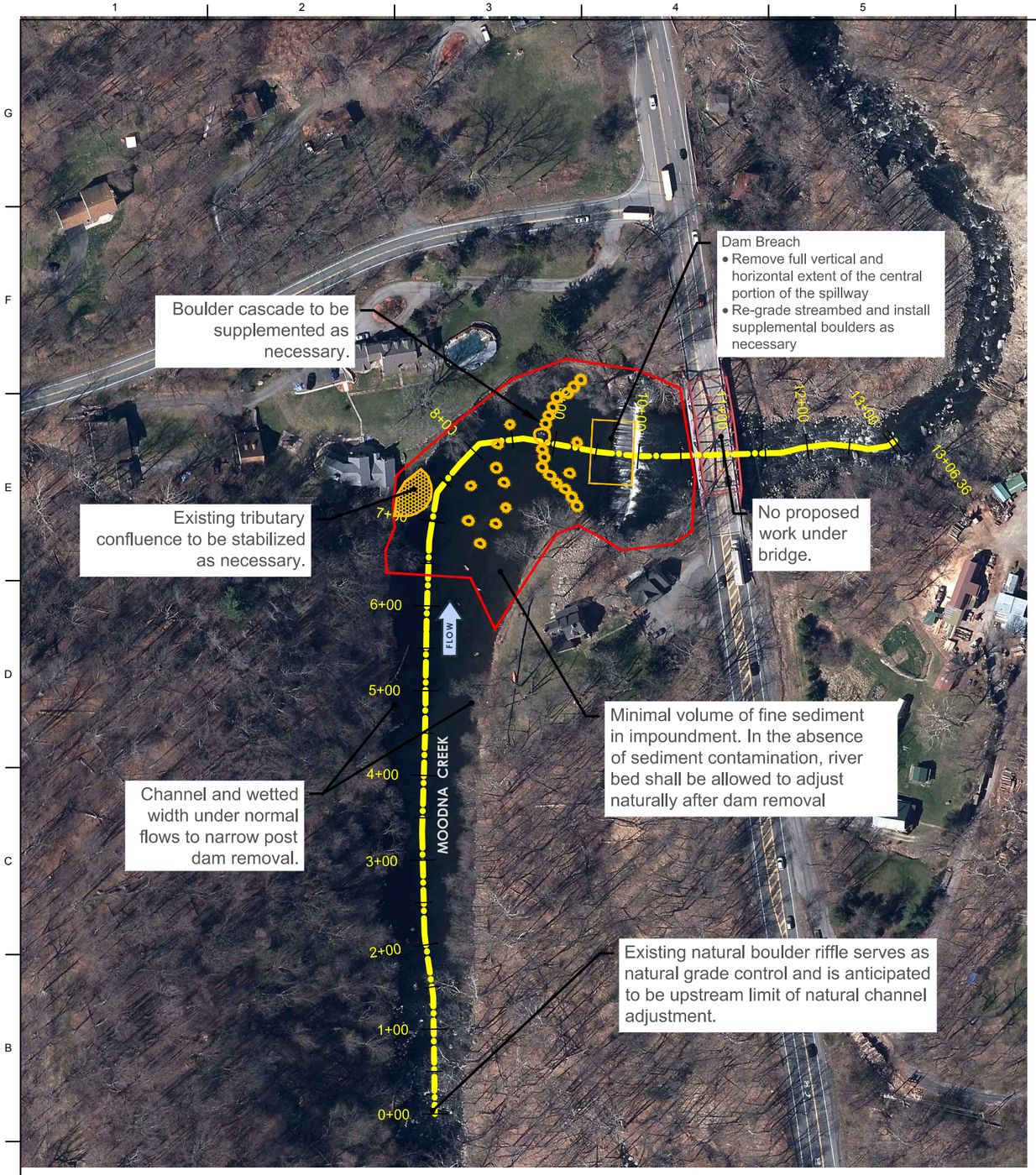

1 PLAN VIEW
1" = 150'

0 30 60 90 120 150 300 450 600 FEET

SCALE: 1" = 150'

Legend
- River Profile
- Project Footprint
- Dam Breach
- Proposed Boulder

MOODNA CREEK
AOP 3 - ORRS MILL DAM
ALTERNATIVE 2:
DAM BREACH

Acronym	Definition
AC	Acres
CY	Cubic Yards
FT	Feet
LF	Linear Feet
LS	Lump Sum
SY	Square Yards
WSEL	Water Surface Elevation

Dam Breach

Item	*Unit*	*Quantity*
Water Control Materials (Sand-Filled BigBags)	LF	400
Water Control Installation & Modification	LS	1
Access Ramp	CY	80
Spillway Breach Demolition / Excavation	CY	780
Disposal of Spillway Concrete	TON	490
Breach Stabilization (Boulder Toe)	TON	170
Abutment Removal (Optional)	CY	350
Disposal of Abutment Concrete/Masonry/Earth	TON	30
Re-grade Streambed	SY	3,340
Supplemental Boulders (12, 4x5x6ft, delivered)	TON	130
Grade Control Stabilization	LF	400
Tributary Confluence Stabilization (Boulders, 24, 3x4x5ft, delivered)	TON	130
Boulder Grade Control (Boulders, 40, 4x5x6ft, delivered)	TON	420

General Construction

Item	*Unit*	*Quantity*
Traffic Control	LS	1
Turbidity Barrier	LS	1
Silt Fence	LF	80
Stabilized Construction Entrance	TON	50
Construction Access Matting	SF	1600
Construction Access Ramp	TON	90
Construction Access Pad	TON	620
Clearing and Grubbing	AC	0.2

A SCHEDULE OF QUANTITIES
Alternative 2 - Dam Breach

US Army Corps of Engineers®

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CONTRACT NO.: W912DS-14-D-0001

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HUDSON RIVER HABITAT RESTORATION
MOODNA CREEK
ORANGE COUNTY, NY
MOODNA CREEK
AOP 3 - ORRS MILL DAM
ALTERNATIVE 2 - DAM BREACH

SHEET ID
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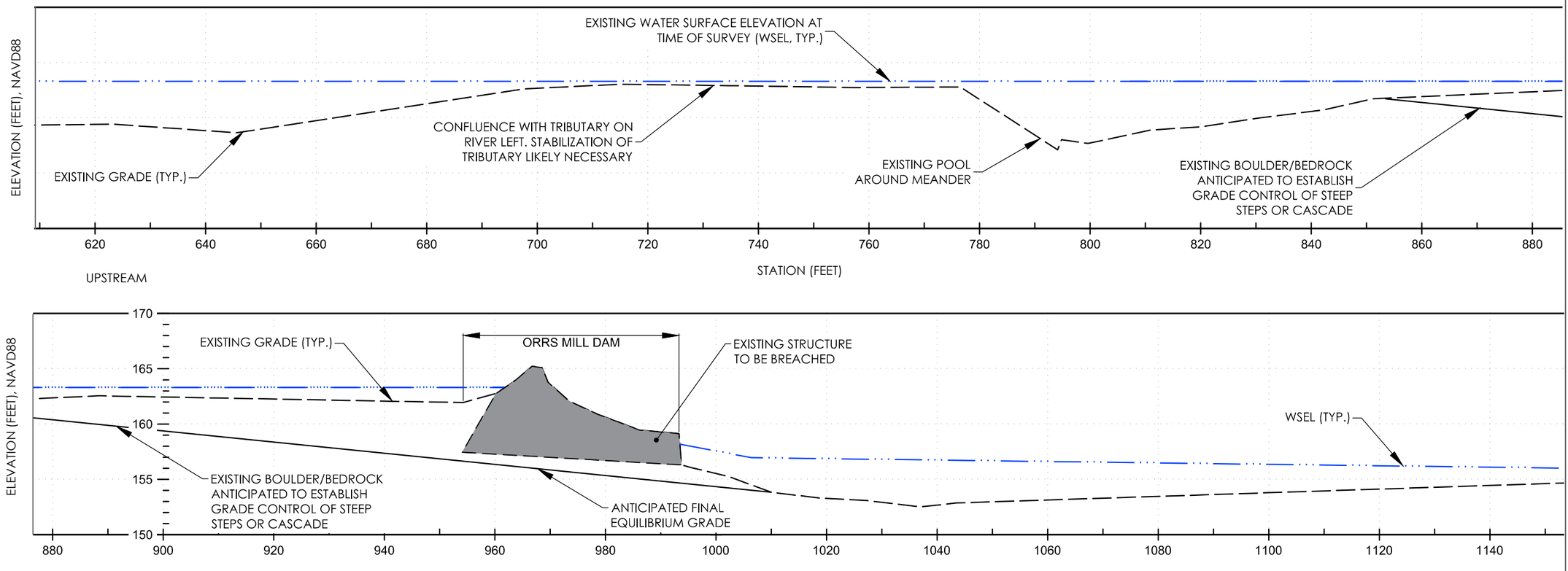
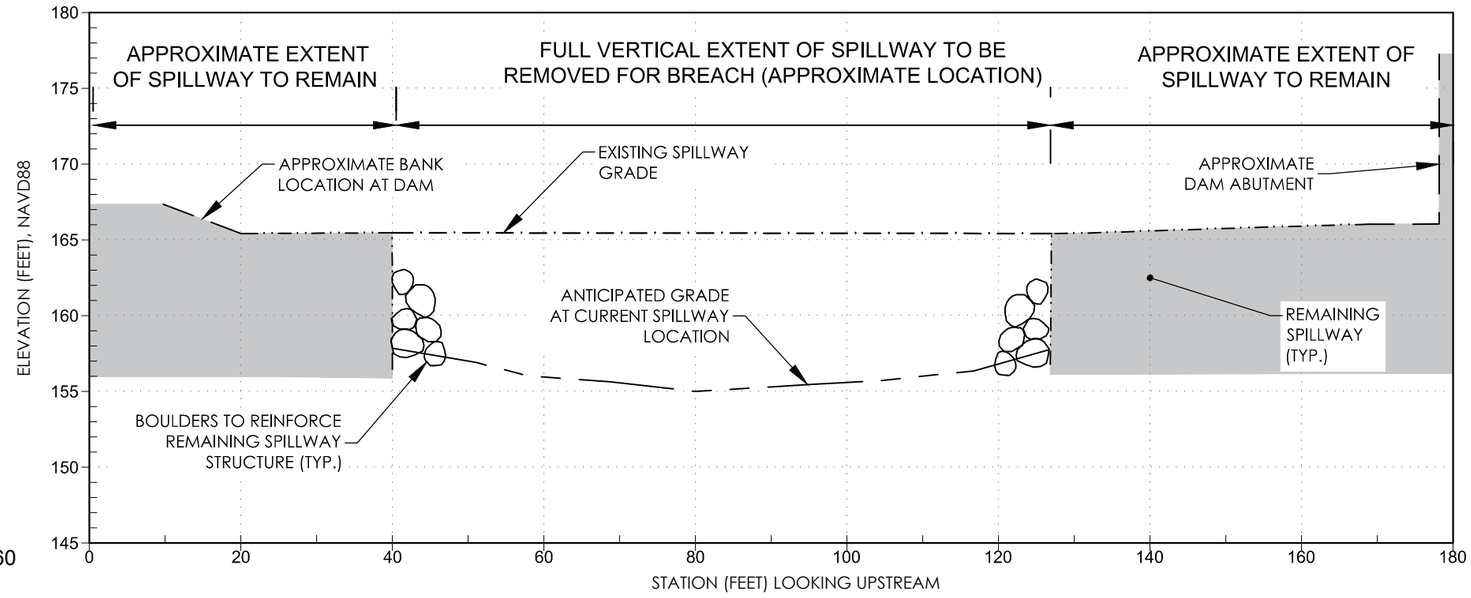


A AOP 3 - ORRS MILL DAM PROFILE
ALTERNATIVE 2: DAM BREACH
MOODNA CREEK

ELEVATIONS REFERENCED TO NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88), FEET



B AOP 3 - ORRS MILL DAM CROSS SECTION AT STATION 960
ALTERNATIVE 2: DAM BREACH
MOODNA CREEK

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HUDSON RIVER HABITAT RESTORATION
MOODNA CREEK
ORANGE COUNTY, NY
MOODNA CREEK
AOP 3 - ORRS MILL DAM
ALTERNATIVE 2 - DAM BREACH

SHEET ID
2

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1 PLAN VIEW
1" = 200'

GRAPHIC SCALE
0 50 100 150 200 400 600 800 FEET
SCALE: 1" = 200'

Legend
- Project Footprint
- Approximate extent of fishway

RONDOUT CREEK
EDDYVILLE DAM
ALTERNATIVE 1: FISHWAY

Acronym	Definition
AC	Acres
CY	Cubic Yards
FT	Feet
LF	Linear Feet
LS	Lump Sum
SY	Square Yards
WSEL	Water Surface Elevation

Fishway

Item	*Unit*	*Quantity*
Water Control Materials (Sand-Filled BigBags)	LF	400
Water Control Installation & Modification	LS	1
Spillway / Bedrock Notching (Sawcutting)	LF	10
Fishway Concrete Construction	FT	12

General Construction

Item	*Unit*	*Quantity*
Turbidity Barrier	LF	250
Silt Fence	LF	80
Construction Access Matting	SF	2100
Construction Access Ramp	TON	390
Clearing and Grubbing	AC	0.30
Stabilized Construction Entrance	TON	50

A SCHEDULE OF QUANTITIES
Alternative 1

US Army Corps of Engineers®

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HUDSON RIVER HABITAT RESTORATION
RONDOUT CREEK
ULSTER COUNTY, NY

RONDOUT CREEK
EDDYVILLE DAM
ALTERNATIVE 1 - FISHWAY

SHEET ID
1

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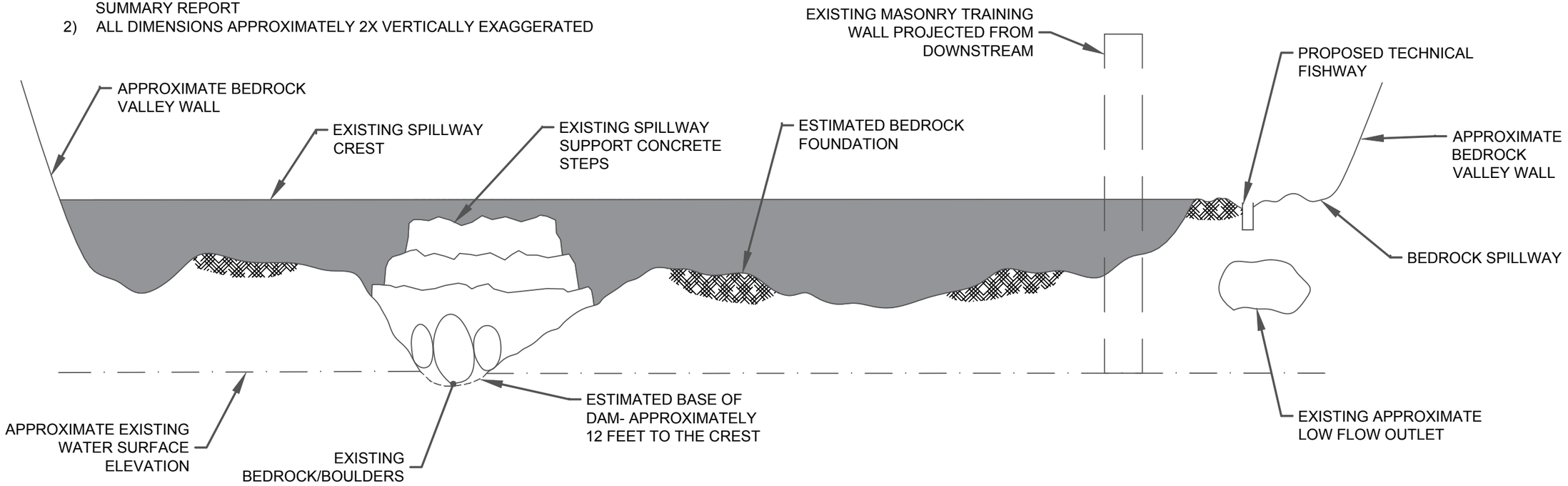
NOTES:
1) ESTIMATED FROM PICTURE TAKEN ON JULY 3, 2001. SEE FIGURE 19 IN RONDOUT SUMMARY REPORT
2) ALL DIMENSIONS APPROXIMATELY 2X VERTICALLY EXAGGERATED



A FISHWAY - CROSS SECTION
ALTERNATIVE 1
RONDOUT CREEK

US Army Corps of Engineers®

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SUBMITTED BY: PRINCETON HYDRO
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HUDSON RIVER HABITAT RESTORATION
RONDOUT CREEK
ULSTER COUNTY, NY

RONDOUT CREEK
EDDYVILLE DAM
ALTERNATIVE 1 - FISHWAY

SHEET ID
2

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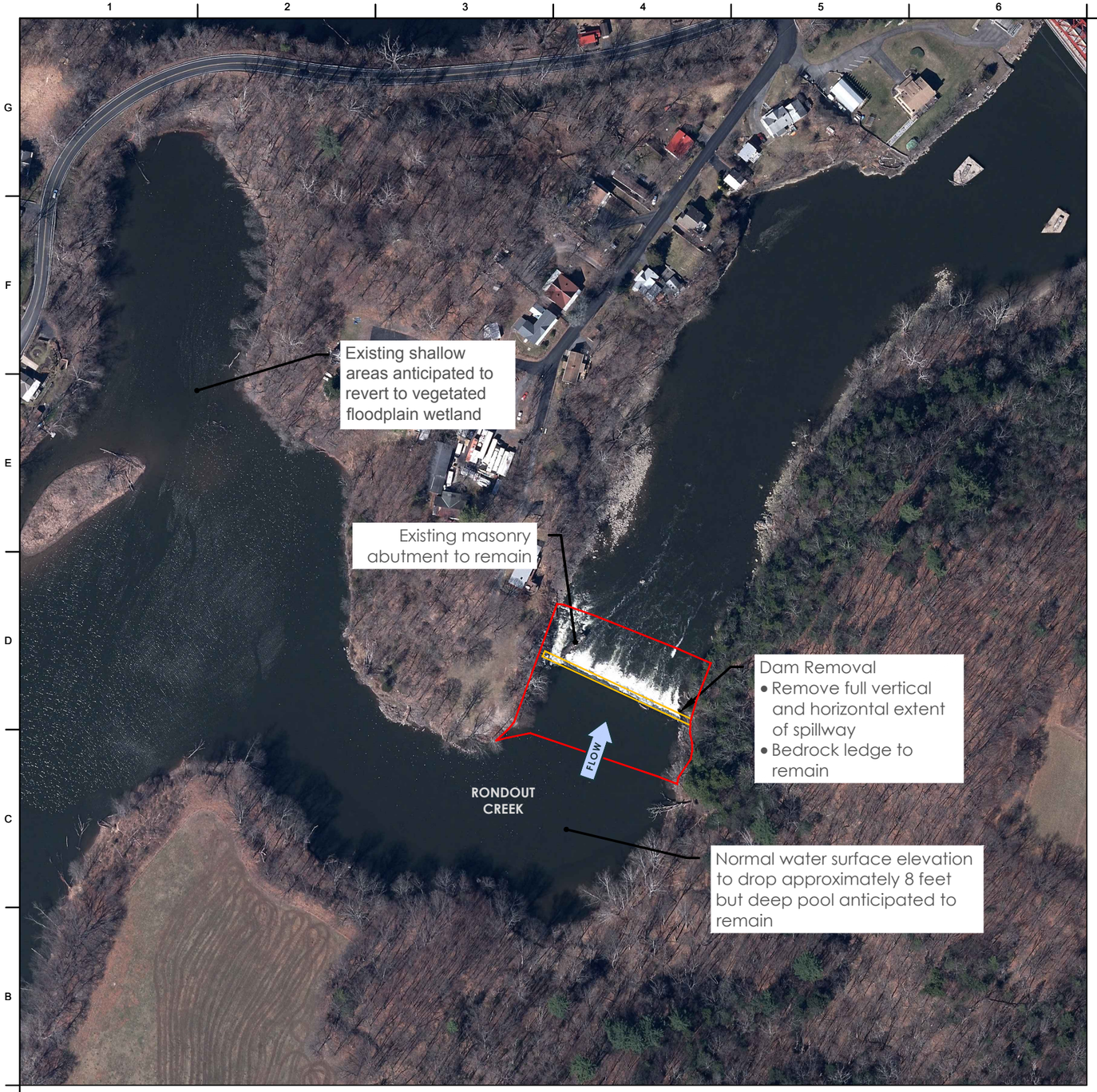

1 PLAN VIEW
1" = 200'

GRAPHIC SCALE
0 50 100 150 200 400 600 800 FEET
SCALE: 1" = 200'

Legend
- Project Footprint
- Approximate extent of dam to be removed

RONDOUT CREEK EDDYVILLE DAM ALTERNATIVE 2: DAM REMOVAL

Acronym	Definition
AC	Acres
CY	Cubic Yards
FT	Feet
LF	Linear Feet
LS	Lump Sum
SY	Square Yards
WSEL	Water Surface Elevation

Dam Removal

Item	*Unit*	*Quantity*
Water Control Materials (Sand-Filled BigBags)	LF	400
Water Control Installation & Modification	LS	1
Spillway Demolition / Excavation	CY	450
Disposal of Concrete	TON	890

General Construction

Item	*Unit*	*Quantity*
Turbidity Barrier	LF	320
Silt Fence	LF	80
Construction Access Pad	TON	4,560
Construction Access Matting	TON	2100
Construction Access Ramp	TON	390
Clearing and Grubbing	AC	0.30
Stabilized Construction Entrance	TON	410

A SCHEDULE OF QUANTITIES
Alternative 2

US Army Corps of Engineers®

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HUDSON RIVER HABITAT RESTORATION
RONDOUT CREEK
ULSTER COUNTY, NY

RONDOUT CREEK
EDDYVILLE DAM
ALTERNATIVE 2 - DAM REMOVAL

SHEET ID
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OCT.2018

NOTES:
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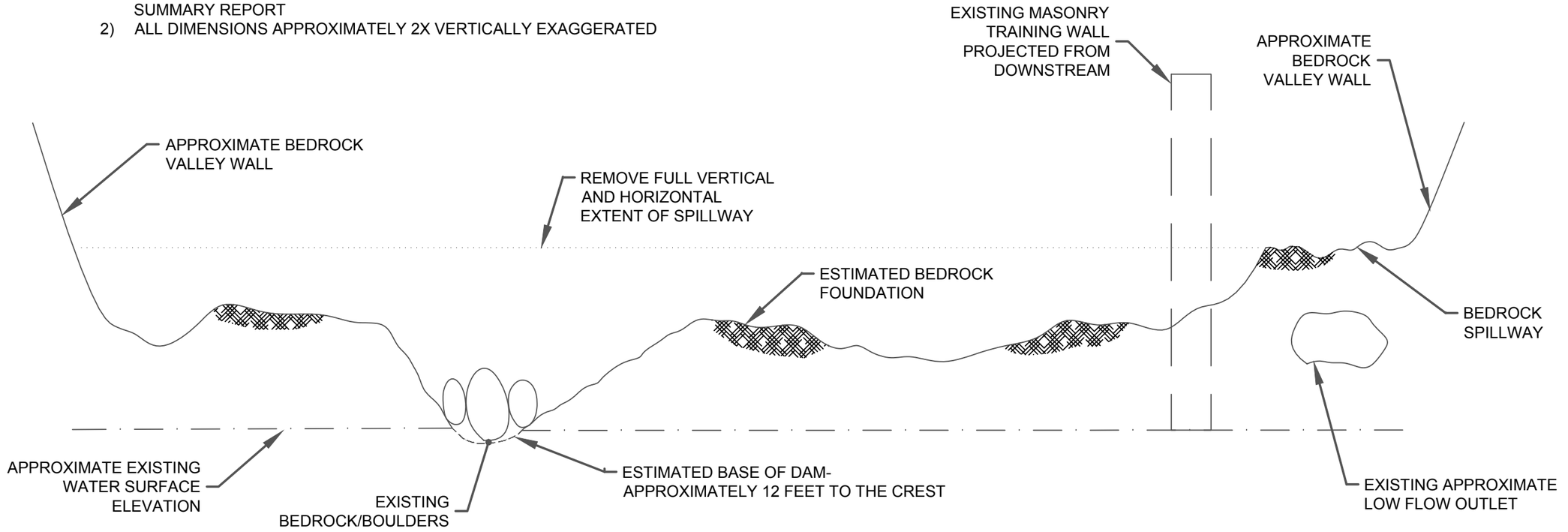

A DAM REMOVAL - CROSS SECTION
ALTERNATIVE 2
RONDOUT CREEK

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

DESIGNED BY:
DRAWN BY: AG/JD/PWTH
CHECKED BY: ADMEW
SUBMITTED BY: PRINCETON HYDRO
SIZE: 11x17
ISSUE DATE: MAY 2018
SOLICITATION NO.:
CONTRACT NO.: W912DS-14-D-0001

U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT
26 FEDERAL PLAZA
NEW YORK, NEW YORK, 10278

PRINCETON HYDRO, LLC
1108 OLD YORK ROAD
RINGOES, NEW JERSEY, 08551

HUDSON RIVER HABITAT RESTORATION
RONDOUT CREEK
ULSTER COUNTY, NY

RONDOUT CREEK
EDDYVILLE DAM
ALTERNATIVE 2 - DAM REMOVAL

SHEET ID
2

OCT.2018

1 PLAN VIEW
1" = 200'

GRAPHIC SCALE
0 50 100 150 200 400 600 800 FEET
SCALE: 1" = 200'

Legend
- Project Footprint
- Approximate extent of dam to be removed

RONDOUT CREEK EDDYVILLE DAM ALTERNATIVE 3: DAM NOTCHING

Acronym	Definition
AC	Acres
CY	Cubic Yards
FT	Feet
LF	Linear Feet
LS	Lump Sum
SY	Square Yards
WSEL	Water Surface Elevation

Dam Notching

Item	*Unit*	*Quantity*
Water Control Materials (Sand-Filled BigBags)	LF	400
Water Control Installation & Modification	LS	1
Spillway Notching Demolition / Excavation	CY	180
Disposal of Concrete	TON	360

General Construction

Item	*Unit*	*Quantity*
Turbidity Barrier	LF	320
Silt Fence	LF	80
Construction Access Pad	TON	4,560
Construction Access Matting	TON	2100
Construction Access Ramp	TON	390
Clearing and Grubbing	AC	0.30
Stabilized Construction Entrance	TON	410

A SCHEDULE OF QUANTITIES
Alternative 3

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

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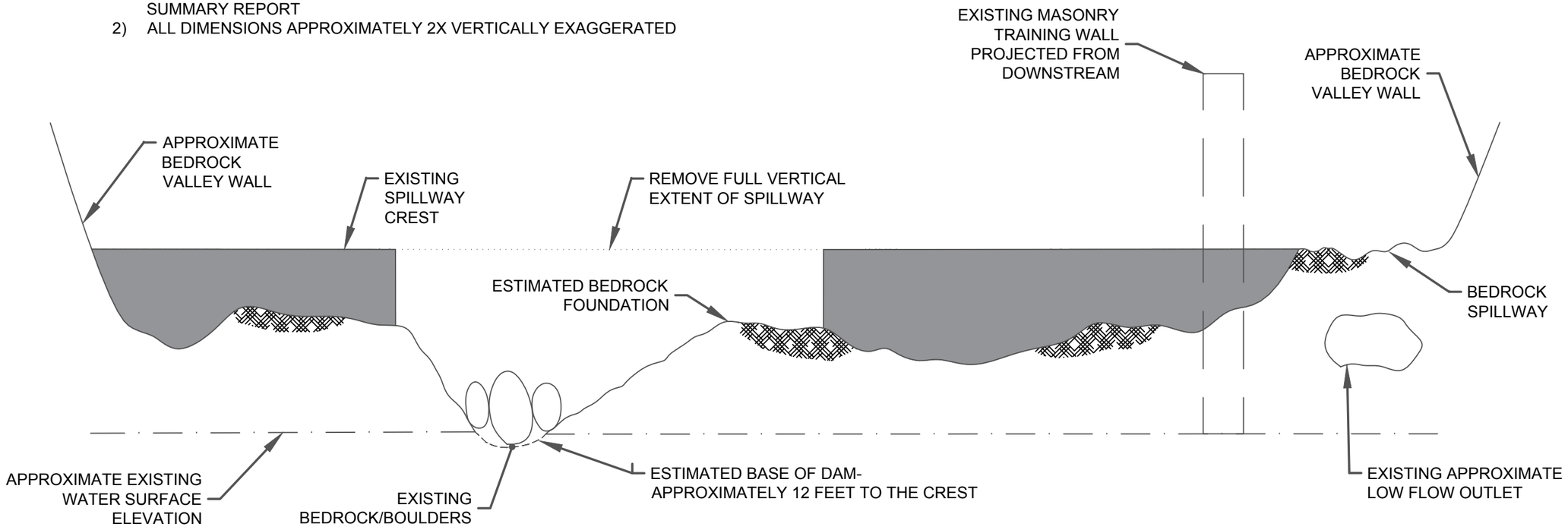
HUDSON RIVER HABITAT RESTORATION
RONDOUT CREEK
ULSTER COUNTY, NY

RONDOUT CREEK
EDDYVILLE DAM
ALTERNATIVE 3 - DAM NOTCHING

SHEET ID
1

OCT.2018

NOTES:
1) ESTIMATED FROM PICTURE TAKEN ON JULY 3, 2001. SEE FIGURE 19 IN RONDOUT SUMMARY REPORT
2) ALL DIMENSIONS APPROXIMATELY 2X VERTICALLY EXAGGERATED



A DAM NOTCHING - CROSS SECTION
ALTERNATIVE 3
RONDOUT CREEK

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

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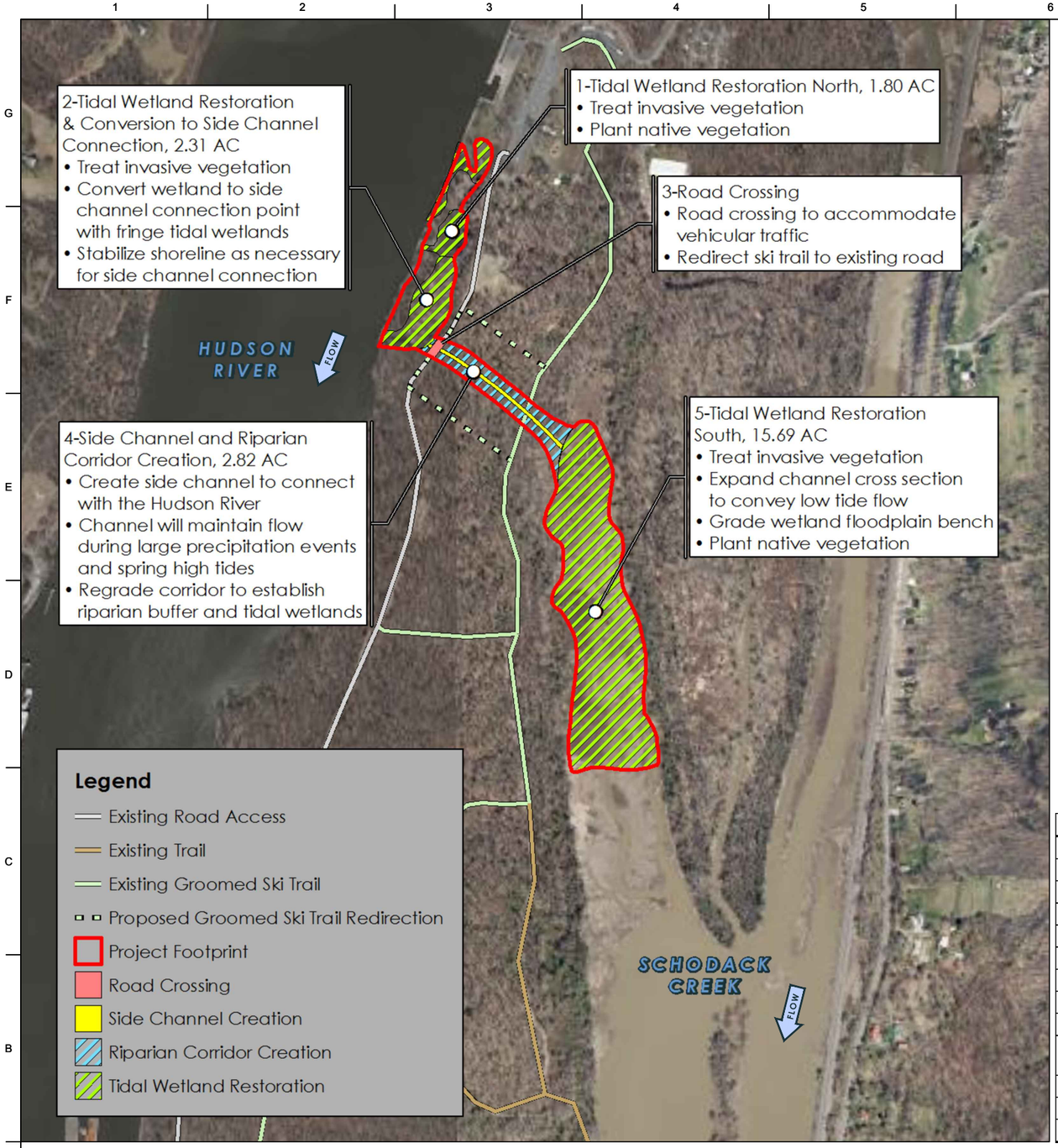
HUDSON RIVER HABITAT RESTORATION
RONDOUT CREEK
ULSTER COUNTY, NY

RONDOUT CREEK
EDDYVILLE DAM
ALTERNATIVE 3 - DAM NOTCHING

SHEET ID
2

OCT.2018



1 PLAN VIEW
North - Alternative 1
1" = 700'

GRAPHIC SCALE
0 350 700 1400 2100 2800 FEET
SCALE: 1" = 700'

1-Tidal Wetland Restoration North

Item	Unit	Quantity
Invasive Species Treatment	AC	1.80
Herbivore Exclusion Fence - Deer	LF	2,200
Herbivore Exclusion Fence - Geese	AC	1.80
Plantings (3FT OC)	EA	8,800

2-Tidal Wetland Restoration & Conversion to Side Channel Connection

Item	Unit	Quantity
Excavation	CY	820
Grading	SF	100,700
Shoreline Stabilization	LF	1,500
Invasive Species Treatment	AC	2.31
Select Amended Soil	CY	1,900
Herbivore Exclusion Fence - Deer	LF	1,600
Herbivore Exclusion Fence - Geese	AC	2.31
Plantings (3FT OC)	EA	11,200

3-Road Crossing

Item	Unit	Quantity
Box Culvert	LF	40
Concrete Headwall and Wingwalls	SF	320
Floodplain Culvert	LF	288
Floodplain Culvert End Treatments	EA	8
Stone Base Course	TON	60
Stream Substrate	SF	300
Guardrail	LF	380

4-Side Channel and Riparian Corridor

Item	Unit	Quantity
Excavation	CY	21,000
Grading	SF	128,600
Plantings (3FT OC)	EA	14,300
Select Amended Soil	CY	2,400
Herbivore Exclusion Fence - Deer	LF	4,400
Herbivore Exclusion Fence - Geese	AC	2.95

5-Tidal Wetland Restoration South

Item	Unit	Quantity
Excavation	CY	2,700
Grading	SF	683,500
Invasive Species Treatment	AC	15.69
Herbivore Exclusion Fence - Geese	AC	15.69
Plantings (3FT OC)	EA	76,000

General Construction

Item	Unit	Quantity
Turbidity Barrier	LF	1,700
Silt Fence	LF	7,700
Construction Stake Out	AC	30
Stabilized Construction Entrance	TON	50
Construction Access Matting	SF	86,300
Construction Access Reinforcement	TON	740
Temporary Bridge	TON	70
Clearing and Grubbing	AC	0.75

Acronym	Definition
AC	Acres
CY	Cubic Yards
EA	Each
FT	Feet
H:V	Horizontal:Vertical
IN	Inches
LF	Linear Feet
MHHW	Mean Higher High Water
MTL	Mean Tide Line
NAVD88	North American Vertical Datum of 1988
OC	On Center
SF	Square Feet
SY	Square Yards

A SCHEDULE OF QUANTITIES
North - Alternative 1

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

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NEW YORK DISTRICT
26 FEDERAL PLAZA
NEW YORK, NEW YORK, 10278

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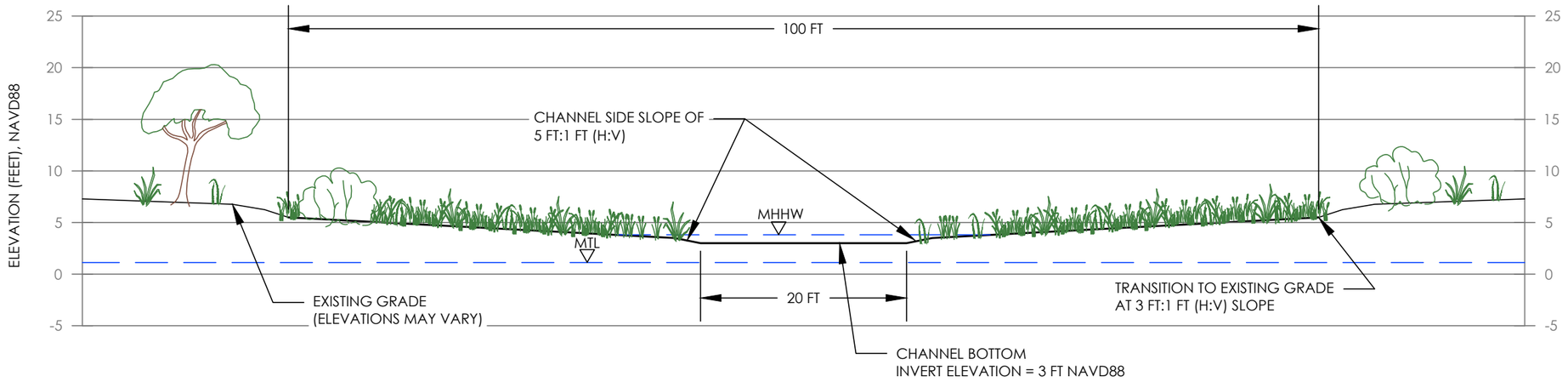
HUDSON RIVER HABITAT RESTORATION
SCHODACK ISLAND STATE PARK
COLUMBIA, GREENE, AND RENSSELAER COUNTIES, NY

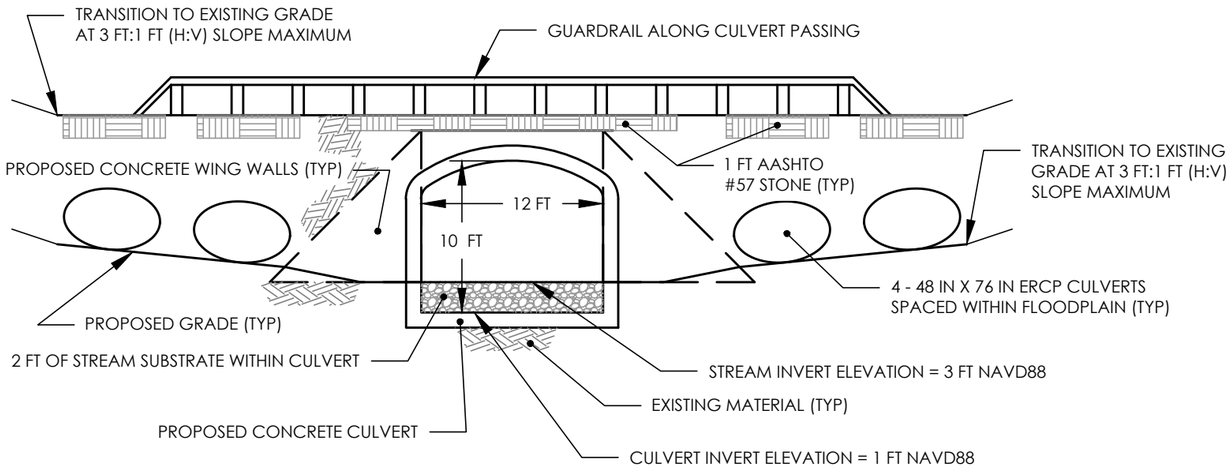
SCHODACK ISLAND NORTH ALTERNATIVE 1
SITE LOCATION

SHEET ID
1

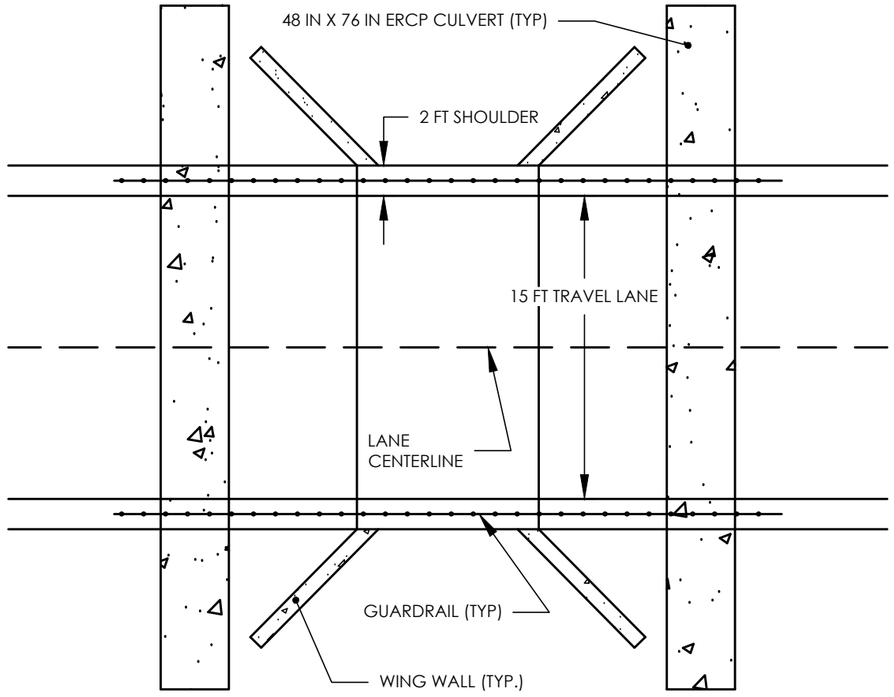
OCT.2018



A SIDE CHANNEL
NORTH - ALTERNATIVE 1
SCHODACK ISLAND



B CROSSING - CROSS SECTION
NORTH - ALTERNATIVE 1
SCHODACK ISLAND



C CROSSING - PLAN VIEW
NORTH - ALTERNATIVE 1
SCHODACK ISLAND

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

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SIZE: 11x17

U.S. ARMY CORPS OF ENGINEERS
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NEW YORK, NEW YORK, 10278

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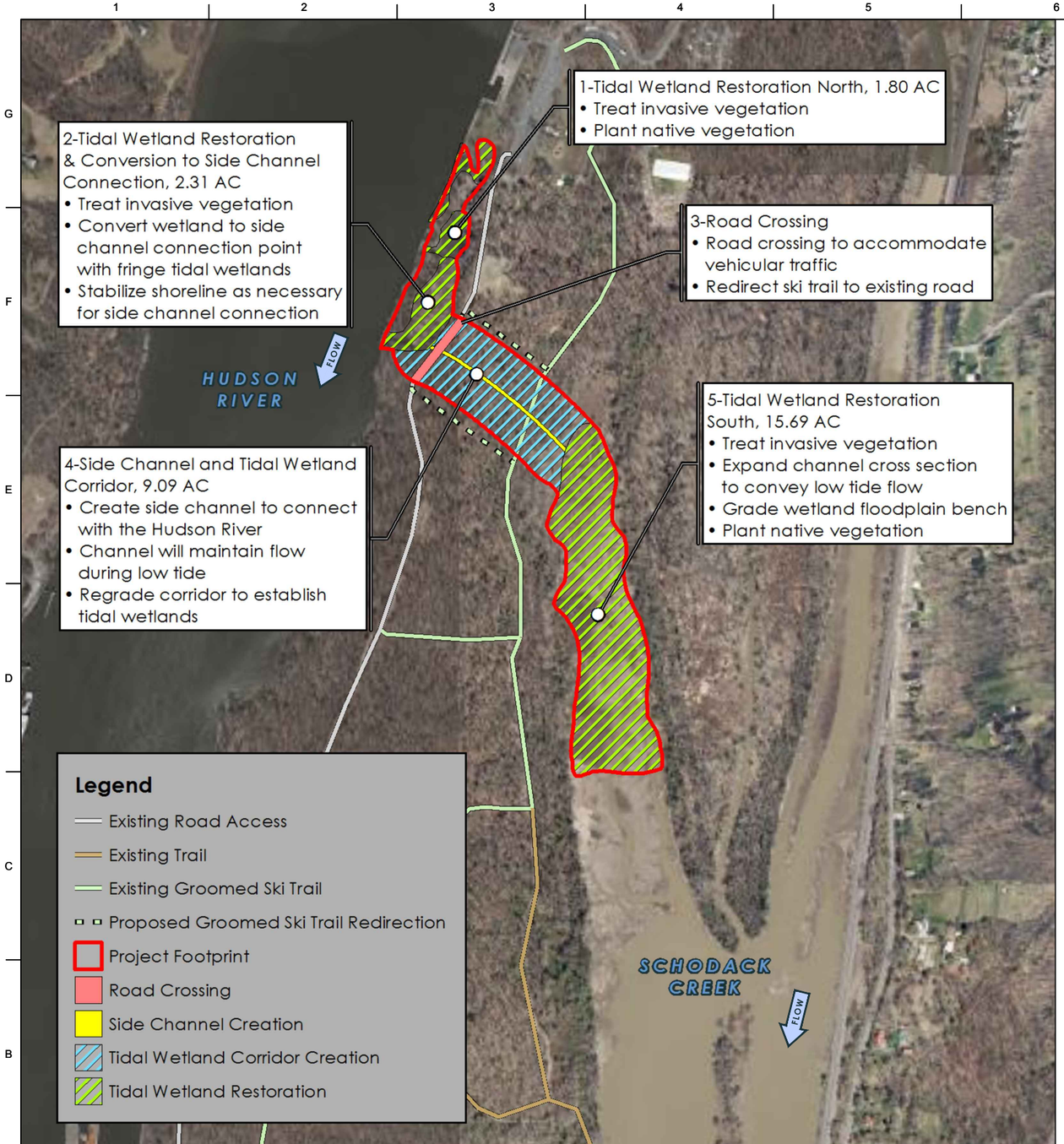
HUDSON RIVER HABITAT RESTORATION
SCHODACK ISLAND STATE PARK
COLUMBIA, GREENE, AND RENSSELAER COUNTIES, NY

SCHODACK ISLAND NORTH ALTERNATIVE 1
DETAILS

SHEET ID
2

OCT.2018



1 PLAN VIEW
North - Alternative 2
1" = 700'

GRAPHIC SCALE

0 350 700 1400 2100 2800 FEET

SCALE: 1" = 700'

1-Tidal Wetland Restoration North

Item	Unit	Quantity
Invasive Species Treatment	AC	1.79
Herbivore Exclusion Fence - Deer	LF	2,200
Herbivore Exclusion Fence - Geese	AC	1.79
Plantings (3FT OC)	EA	8,700

2-Tidal Wetland Restoration & Conversion to Side Channel Connection

Item	Unit	Quantity
Excavation	CY	815
Grading	SF	100,700
Shoreline Stabilization	LF	1,500
Invasive Species Treatment	AC	2.31
Select Amended Soil	CY	1,900
Herbivore Exclusion Fence - Deer	LF	1,600
Herbivore Exclusion Fence - Geese	AC	2.31
Plantings (3FT OC)	EA	11,200

3-Road Crossing

Item	Unit	Quantity
Box Culvert	LF	72
Concrete Headwall and Wingwalls	SF	320
Floodplain Culvert	LF	832
Floodplain Culvert End Treatments	EA	16
Stone Base Course	TON	60
Stream Substrate	SF	300
Guardrail	LF	1,040

4-Side Channel and Tidal Wetland Corridor

Item	Unit	Quantity
Excavation	CY	126,600
Grading	SF	418,200
Plantings (3FT OC)	EA	46,500
Select Amended Soil	CY	7,800
Herbivore Exclusion Fence - Deer	LF	5,600
Herbivore Exclusion Fence - Geese	AC	9.60

5-Tidal Wetland Restoration South

Item	Unit	Quantity
Excavation	CY	2,700
Grading	SF	683,500
Invasive Species Treatment	AC	15.69
Herbivore Exclusion Fence - Geese	AC	15.69
Plantings (3FT OC)	EA	76,000

General Construction

Item	Unit	Quantity
Turbidity Barrier	LF	1,700
Silt Fence	LF	7,400
Construction Stake Out	AC	30
Stabilized Construction Entrance	TON	50
Construction Access Matting	SF	89,200
Construction Access Reinforcement	TON	640
Temporary Bridge	TON	170
Clearing and Grubbing	AC	0.75

A SCHEDULE OF QUANTITIES
North - Alternative 2

Acronym	Definition
AC	Acres
CY	Cubic Yards
EA	Each
FT	Feet
H:V	Horizontal:Vertical
IN	Inches
LF	Linear Feet
MHHW	Mean Higher High Water
MTL	Mean Tide Line
NAVD88	North American Vertical Datum of 1988
OC	On Center
SF	Square Feet
SY	Square Yards

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

DESIGNED BY:
DRAWN BY: TH
CHECKED BY: CP/AEM
SUBMITTED BY: PRINCETON HYDRO
SIZE: 11x17
ISSUE DATE: MAY 2018
SOLICITATION NO.:
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U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT
26 FEDERAL PLAZA
NEW YORK, NEW YORK, 10278

PRINCETON HYDRO, LLC
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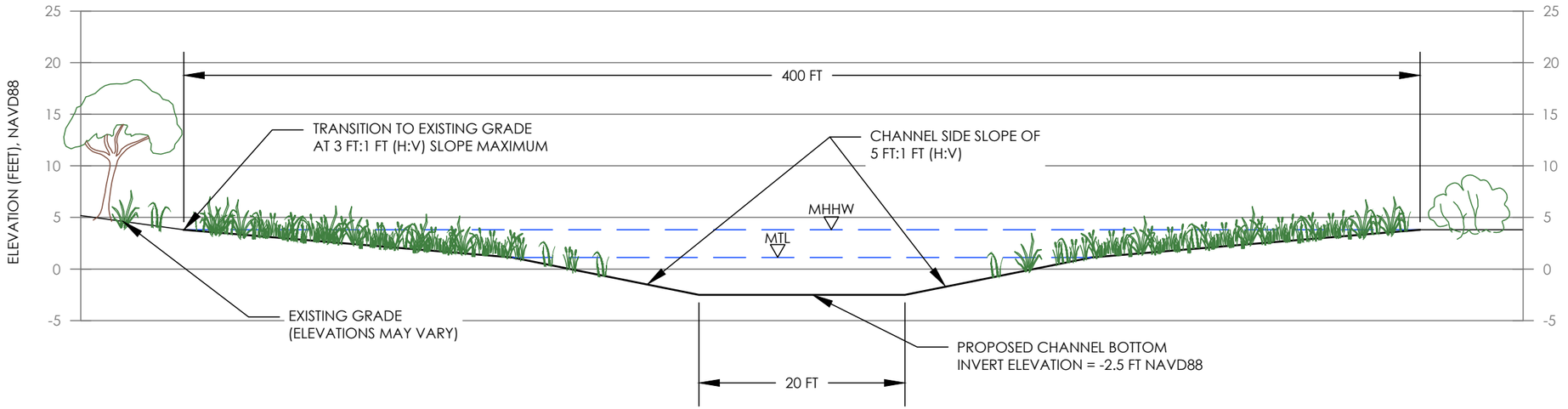
RINGOES, NEW JERSEY, 08551

HUDSON RIVER HABITAT RESTORATION
SCHODACK ISLAND STATE PARK
COLUMBIA, GREENE, AND RENSSELAER COUNTIES, NY

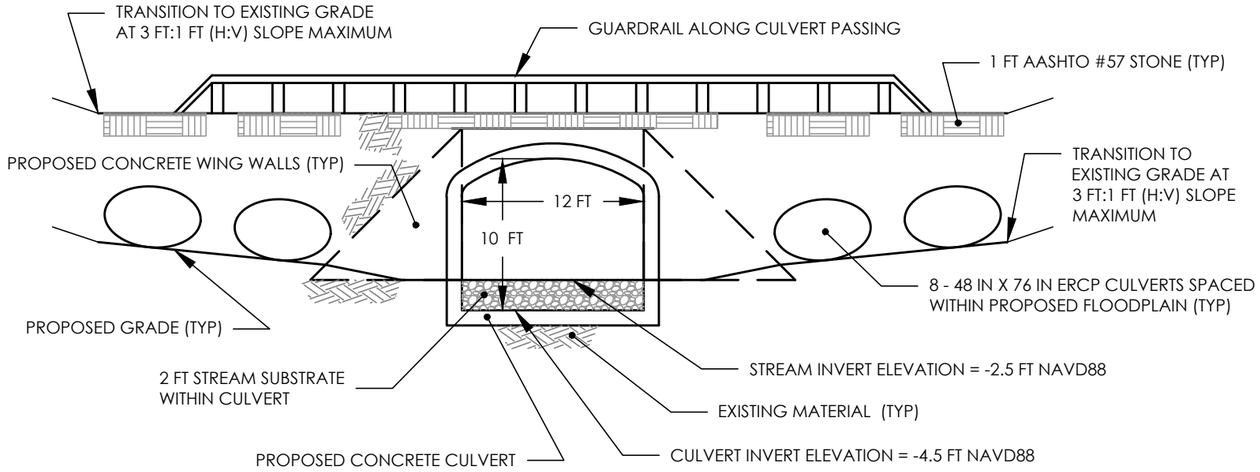
SCHODACK ISLAND NORTH ALTERNATIVE 2
SITE LOCATION

SHEET ID
1

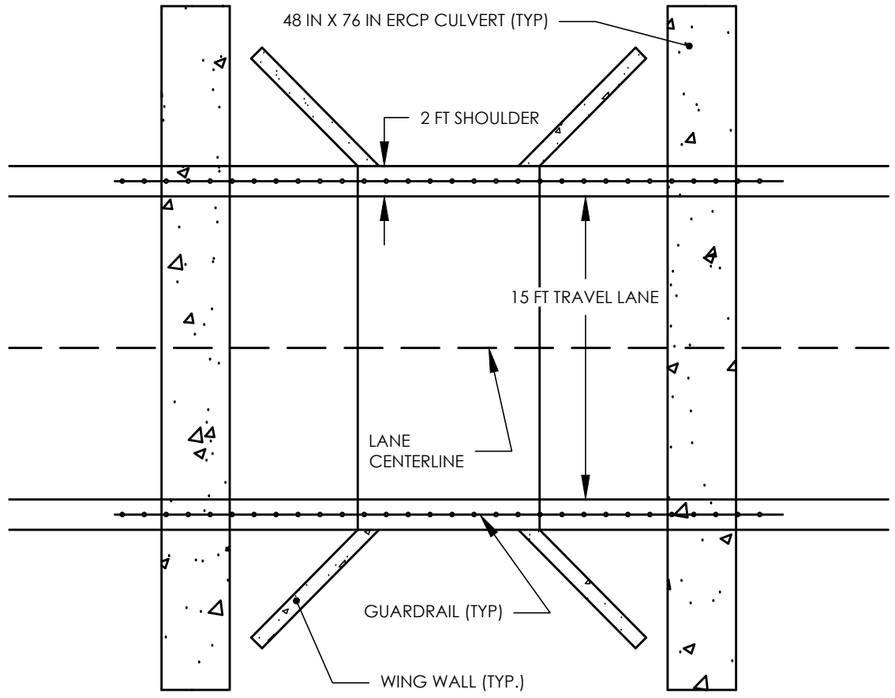
OCT.2018



A SIDE CHANNEL
NORTH - ALTERNATIVE 2
SCHODACK ISLAND



B CROSSING - CROSS SECTION
NORTH - ALTERNATIVE 2
SCHODACK ISLAND



C CROSSING - PLAN VIEW
NORTH - ALTERNATIVE 2
SCHODACK ISLAND

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

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U.S. ARMY CORPS OF ENGINEERS
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NEW YORK, NEW YORK, 10278

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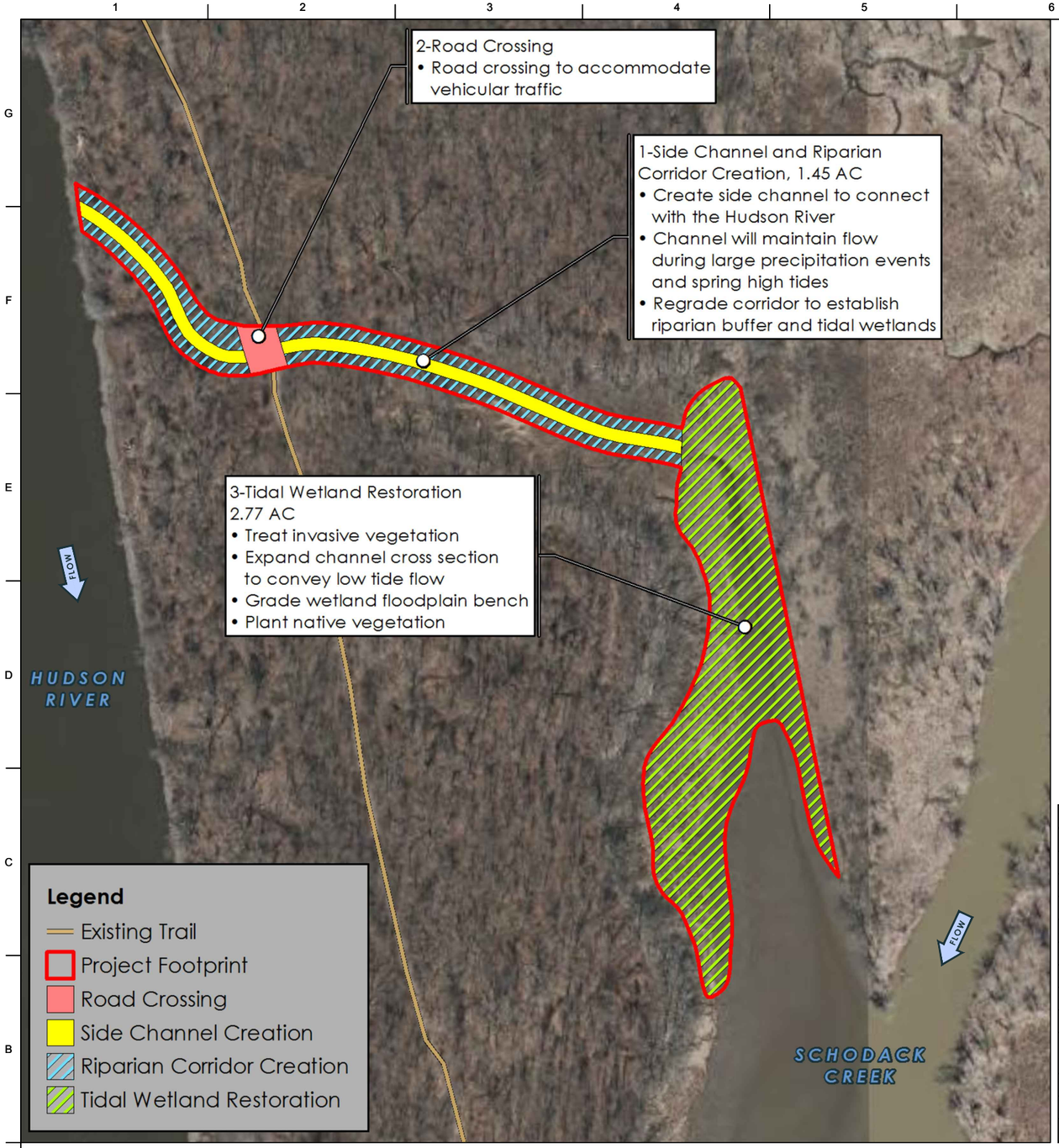
HUDSON RIVER HABITAT RESTORATION
SCHODACK ISLAND STATE PARK
COLUMBIA, GREENE, AND RENSSELAER COUNTIES, NY

SCHODACK ISLAND NORTH ALTERNATIVE 2 DETAILS

SHEET ID
2

OCT.2018



1 PLAN VIEW
South - Alternative 1
1" = 200'

GRAPHIC SCALE
0 50 100 150 200 400 600 800 FEET
SCALE: 1" = 200'

1-Side Channel and Riparian Corridor

Item	Unit	Quantity
Excavation	CY	8,000
Grading	SF	63,200
Plantings	EA	7,100
Select Amended Soil	CY	1,200
Herbivore Exclusion Fence - Deer	LF	4,300
Herbivore Exclusion Fence - Geese	AC	1.45
Shoreline Stabilization	LF	100

2-Road Crossing

Item	Unit	Quantity
Box Culvert	LF	48
Concrete Headwall and Wingwalls	SF	320
Floodplain Culvert	LF	352
Floodplain Culvert End Treatments	EA	8
Stone Base Course	TON	60
Stream Substrate	SF	300
Guardrail	LF	380

3-Tidal Wetland Restoration

Item	Unit	Quantity
Excavation	CY	4,500
Grading	SF	120,800
Invasive Species Treatment	AC	2.77
Herbivore Exclusion Fence - Geese	AC	2.77
Plantings	EA	13,500

General Construction

Item	Unit	Quantity
Turbidity Barrier	LF	830
Silt Fence	LF	4,000
Construction Stake Out	AC	4.22
Stabilized Construction Entrance	TON	50
Construction Access Matting	SF	51,800
Construction Access Reinforcement	TON	7,830
Temporary Bridge	TON	70
Clearing and Grubbing	AC	1.99

A SCHEDULE OF QUANTITIES
South - Alternative 1

Acronym	Definition
AC	Acres
CY	Cubic Yards
EA	Each
FT	Feet
H:V	Horizontal:Vertical
IN	Inches
LF	Linear Feet
MHHW	Mean Higher High Water
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NAVD88	North American Vertical Datum of 1988
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US Army Corps of Engineers®

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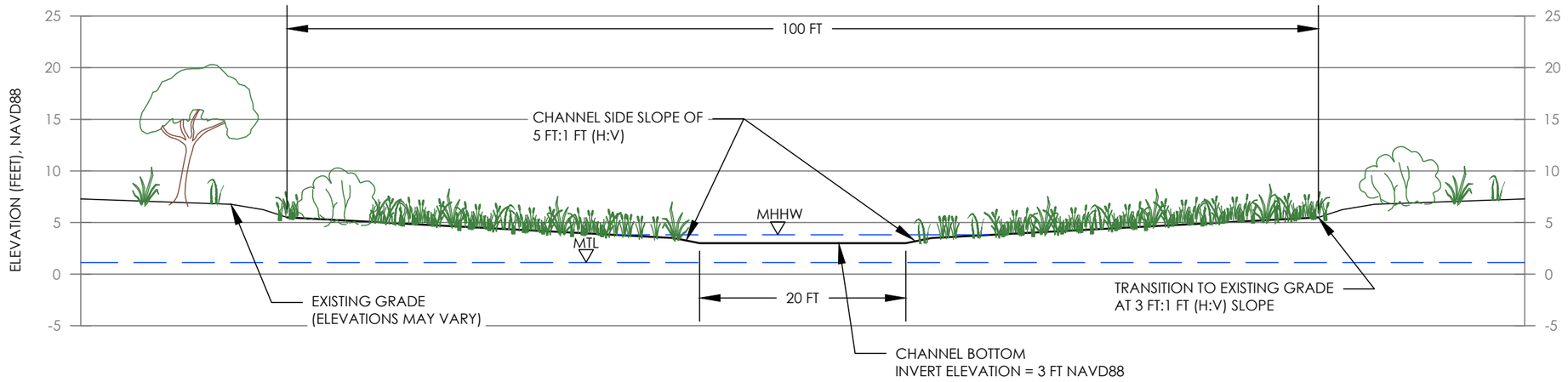
HUDSON RIVER HABITAT RESTORATION
SCHODACK ISLAND STATE PARK
COLUMBIA, GREENE, AND RENSSELAER COUNTIES, NY

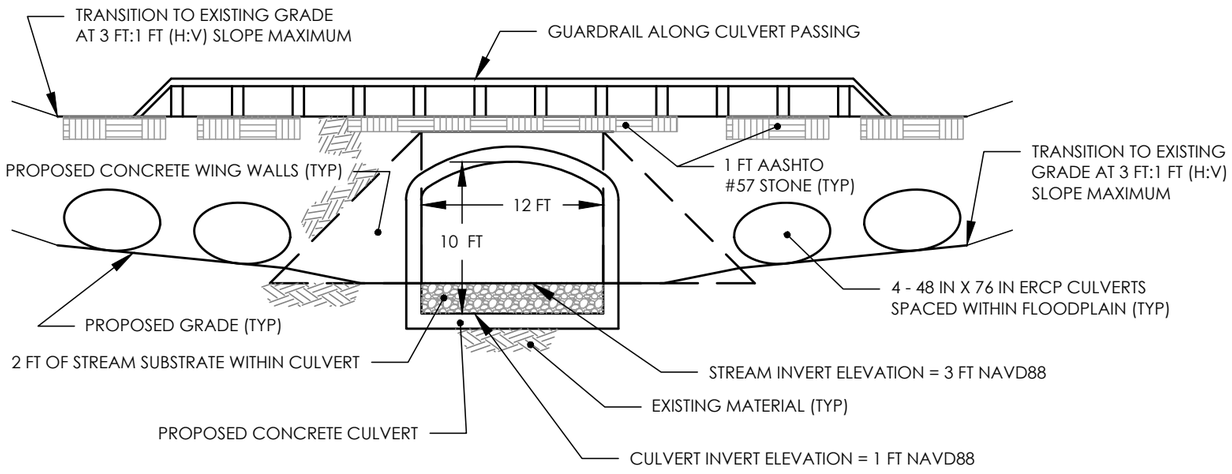
SCHODACK ISLAND SOUTH ALTERNATIVE 1
SITE LOCATION

SHEET ID
1

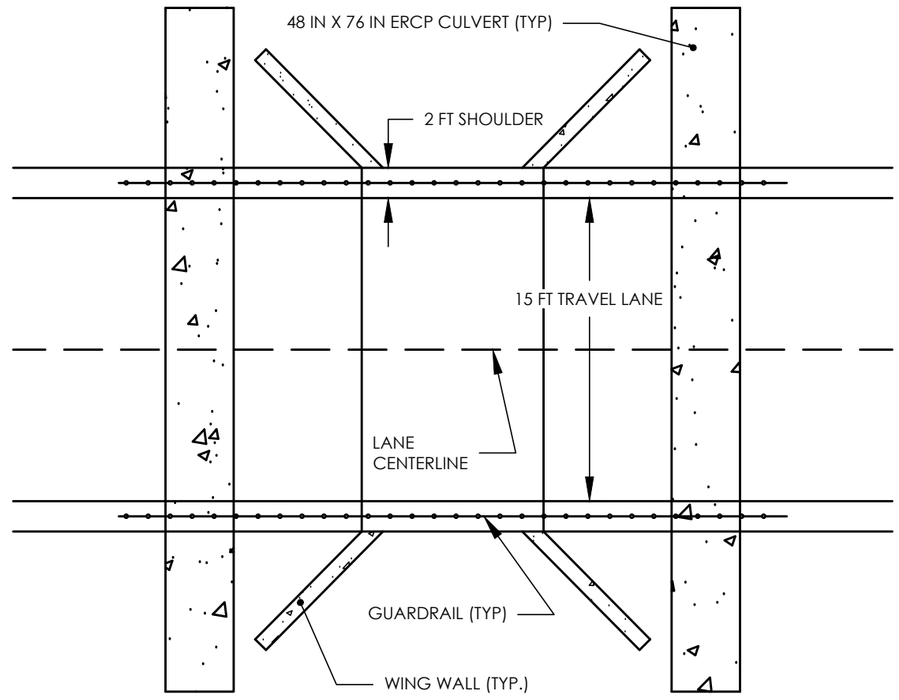
OCT.2018



A SIDE CHANNEL
SOUTH - ALTERNATIVE 1
SCHODACK ISLAND



B CROSSING - CROSS SECTION
SOUTH - ALTERNATIVE 1
SCHODACK ISLAND



C CROSSING - PLAN VIEW
SOUTH - ALTERNATIVE 1
SCHODACK ISLAND

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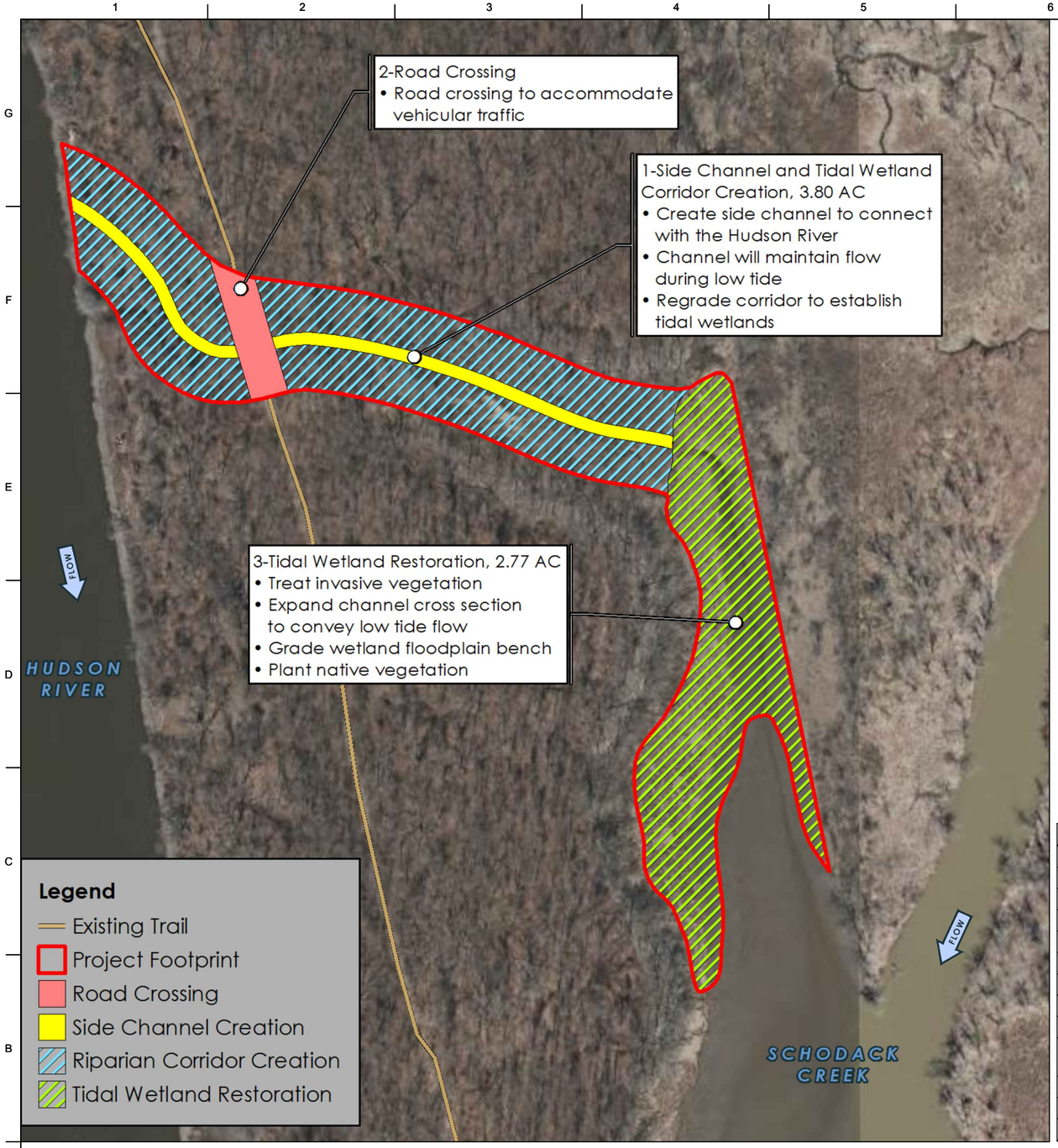
HUDSON RIVER HABITAT RESTORATION
SCHODACK ISLAND STATE PARK
COLUMBIA, GREENE, AND RENSSELAER COUNTIES, NY

SCHODACK ISLAND SOUTH ALTERNATIVE 1
DETAILS

SHEET ID
2

OCT.2018



1 PLAN VIEW
South - Alternative 2
1" = 200'

GRAPHIC SCALE
0 50 100 150 200 400 600 800 FEET
SCALE: 1" = 200'

Acronym	Definition
AC	Acres
CY	Cubic Yards
EA	Each
FT	Feet
H:V	Horizontal:Vertical
IN	Inches
LF	Linear Feet
MHHW	Mean Higher High Water
MTL	Mean Tide Line
NAVD88	North American Vertical Datum of 1988
OC	On Center
SF	Square Feet
SY	Square Yards

1-Side Channel and Tidal Wetland Corridor

Item	Unit	Quantity
Excavation	CY	111,300
Grading	SF	178,600
Plantings (3FT OC)	EA	19,900
Select Amended Soil	CY	3,400
Herbivore Exclusion Fence - Deer	LF	4,800
Herbivore Exclusion Fence - Geese	AC	4.10
Shoreline Stabilization	LF	400

2-Roading Crossing

Item	Unit	Quantity
Box Culvert	LF	80
Concrete Headwall and Wingwalls	SF	320
Floodplain Culvert	LF	960
Floodplain Culvert End Treatments	EA	16
Stone Base Course	TON	60
Stream Substrate	SF	300
Guardrail	LF	1,040

3-Tidal Wetland Restoration

Item	Unit	Quantity
Excavation	CY	4,472
Grading	SF	13,500
Invasive Species Treatment	AC	2.77
Herbivore Exclusion Fence - Geese	AC	2.77
Plantings (3FT OC)	EA	13,500

General Construction

Item	Unit	Quantity
Turbidity Barrier	LF	950
Silt Fence	LF	3,900
Construction Stake Out	AC	6.87
Stabilized Construction Entrance	TON	50
Construction Access Matting	SF	53,300
Construction Access Reinforcement	TON	7,780
Temporary Bridge	TON	170
Clearing and Grubbing	AC	1.99

A SCHEDULE OF QUANTITIES
South - Alternative 2

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

DESIGNED BY:
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NEW YORK DISTRICT
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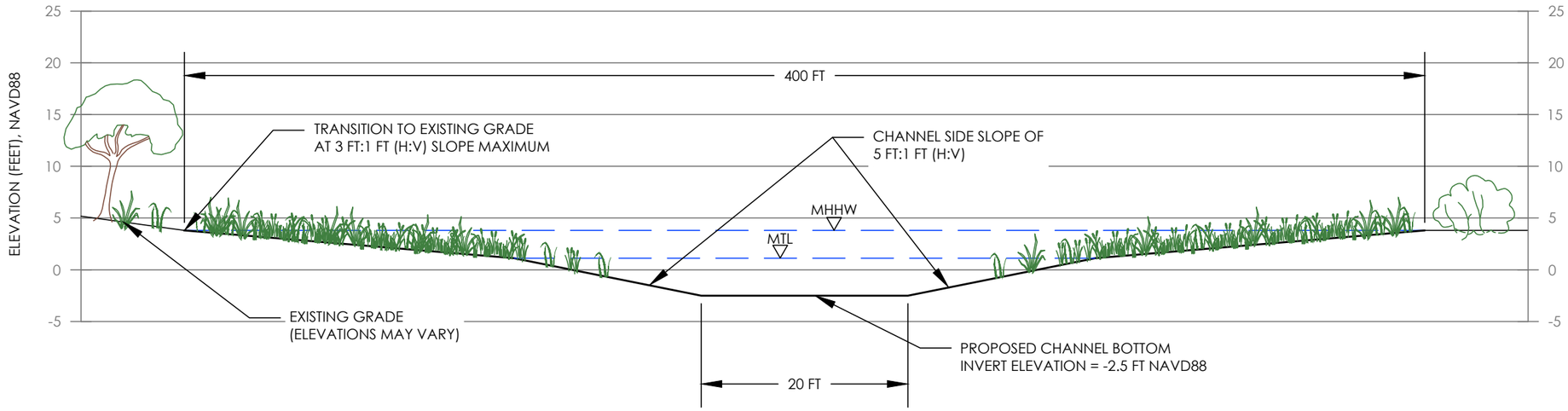
HUDSON RIVER HABITAT RESTORATION
SCHODACK ISLAND STATE PARK
COLUMBIA, GREENE, AND RENSSELAER COUNTIES, NY

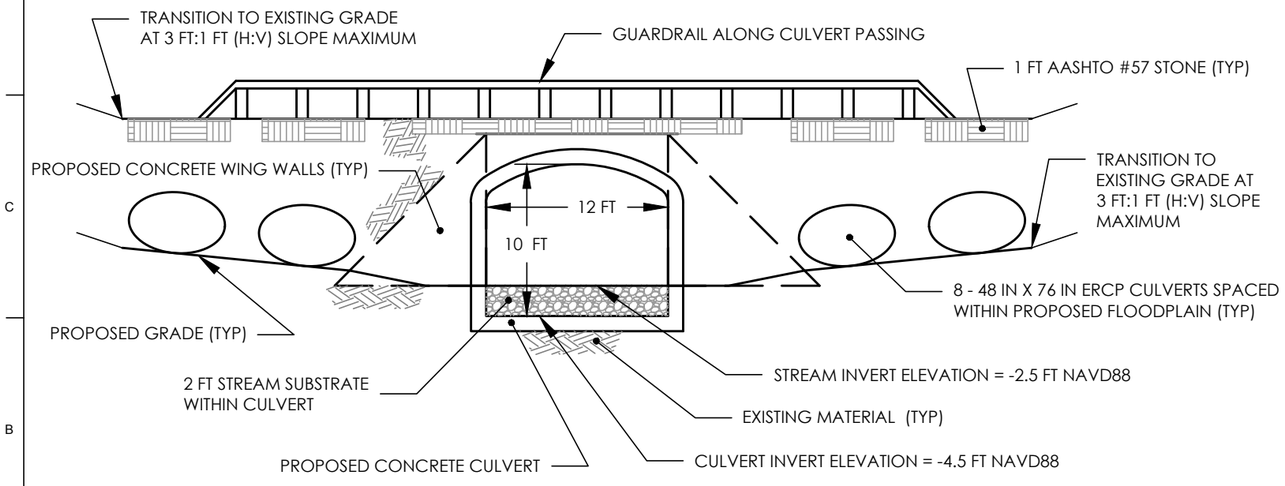
SCHODACK ISLAND SOUTH ALTERNATIVE 2
SITE LOCATION

SHEET ID
1

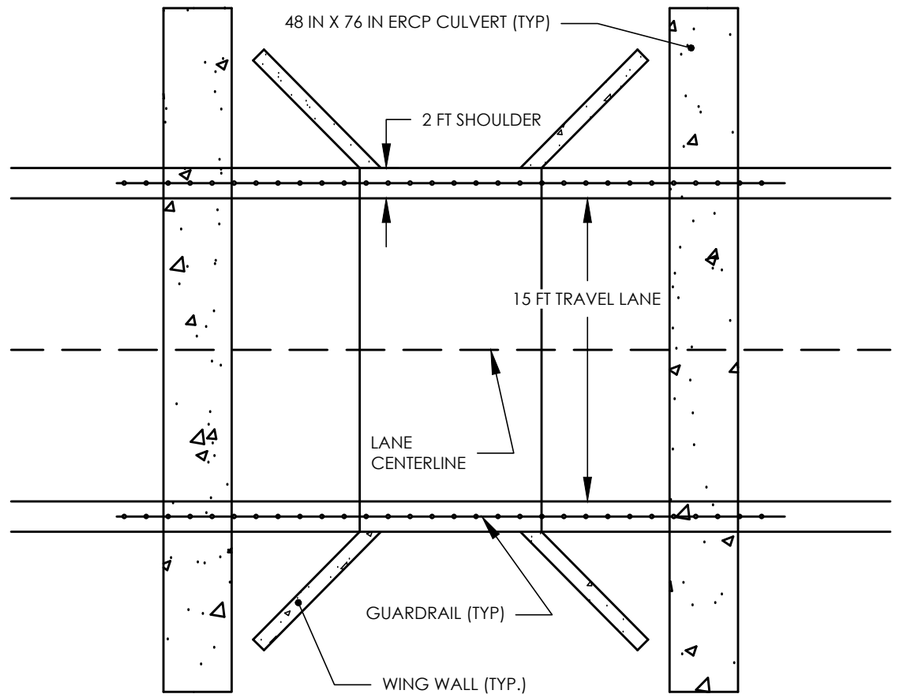
OCT.2018



A SIDE CHANNEL
SOUTH - ALTERNATIVE 2
SCHODACK ISLAND



B CROSSING - CROSS SECTION
SOUTH - ALTERNATIVE 2
SCHODACK ISLAND



C CROSSING - PLAN VIEW
SOUTH - ALTERNATIVE 2
SCHODACK ISLAND

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

ISSUE DATE: MAY 2018
SOLICITATION NO.:
CONTRACT NO.: W912DS-14-D-0001
DESIGNED BY:
DRAWN BY: CS
CHECKED BY: AEM/MJT
SUBMITTED BY: PRINCETON HYDRO
SIZE: 11x17

U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT
26 FEDERAL PLAZA
NEW YORK, NEW YORK, 10278

PRINCETON HYDRO, LLC
1108 OLD YORK ROAD
RINGOES, NEW JERSEY, 08551

HUDSON RIVER HABITAT RESTORATION
SCHODACK ISLAND STATE PARK
COLUMBIA, GREENE, AND RENSSELAER COUNTIES, NY

SCHODACK ISLAND SOUTH ALTERNATIVE 2
DETAILS

SHEET ID
2

OCT.2018

1 PLAN VIEW
Pocket Wetland - Alternative 1
1" = 600'

GRAPHIC SCALE
0 200 400 600 1200 1800 2400 FEET
SCALE: 1" = 600'

1-Tidal Wetland Restoration - A

Item	Unit	Quantity
Grading	SF	157,100
Tidal Connection Stabilization	LF	300
Select Amended Soil	CY	3,000
Invasive Species Treatment	AC	3.61
Herbivore Exclusion Fence - Deer	LF	1,900
Herbivore Exclusion Fence - Geese	AC	3.61
Plantings (3FT OC)	EA	17,500

2-Non-Tidal Wetland Restoration - B

Item	Unit	Quantity
Grading	SF	65,900
Select Amended Soil	CY	1,300
Invasive Species Treatment	AC	1.51
Herbivore Exclusion Fence - Deer	LF	1,000
Herbivore Exclusion Fence - Geese	AC	1.51
Plantings (3FT OC)	EA	7,400

3-Tidal Wetland Restoration - C

Item	Unit	Quantity
Grading	SF	89,900
Tidal Connection Stabilization	LF	200
Select Amended Soil	CY	1,700
Invasive Species Treatment	AC	2.06
Herbivore Exclusion Fence - Deer	LF	1,600
Herbivore Exclusion Fence - Geese	AC	2.06
Plantings (3FT OC)	EA	10,000

4-Tidal Wetland Creation -D

Item	Unit	Quantity
Earthwork	CY	12,600
Grading	SF	169,500
Tidal Connection Stabilization	LF	750
Select Amended Soil	CY	3,200
Invasive Species Treatment	AC	3.89
Herbivore Exclusion Fence - Deer	LF	2,500
Herbivore Exclusion Fence - Geese	AC	3.89
Plantings (3FT OC)	EA	18,900

General Construction

Item	Unit	Quantity
Turbidity Barrier	LF	320
Silt Fence	LF	6,600
Construction Stake Out	AC	11.07
Stabilized Construction Entrance	TON	50
Construction Access Matting	SF	55,700
Construction Access Reinforcement	TON	12,480
Clearing and Grubbing	AC	2.99

Acronym	Definition
AC	Acres
CY	Cubic Yards
EA	Each
FT	Feet
IN	Inches
LF	Linear Feet
OC	On Center
SF	Square Feet

A SCHEDULE OF QUANTITIES
Pocket Wetland - Alternative 1

US Army Corps of Engineers®

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DRAWN BY: TH
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SOLICITATION NO.:
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TASK ORDER NO.:

U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT
26 FEDERAL PLAZA
NEW YORK, NEW YORK, 10278

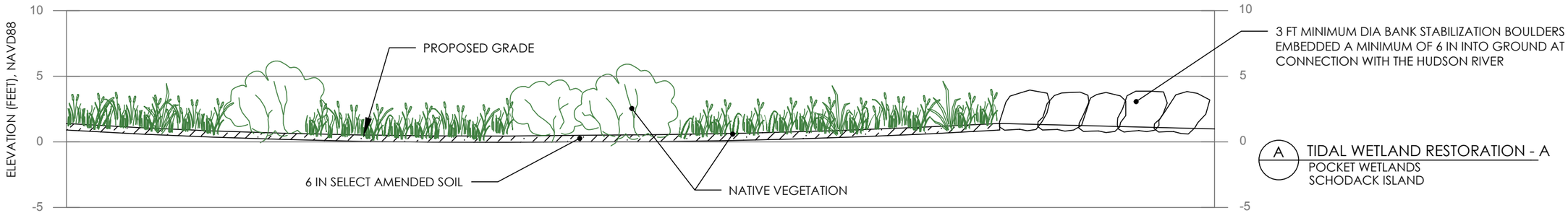
PRINCETON HYDRO, LLC
1108 OLD YORK ROAD
RINGOES, NEW JERSEY, 08551
PHONE: 908-237-5660

HUDSON RIVER HABITAT RESTORATION
SCHODACK ISLAND STATE PARK
COLUMBIA, GREENE, AND RENSSELAER COUNTIES, NY

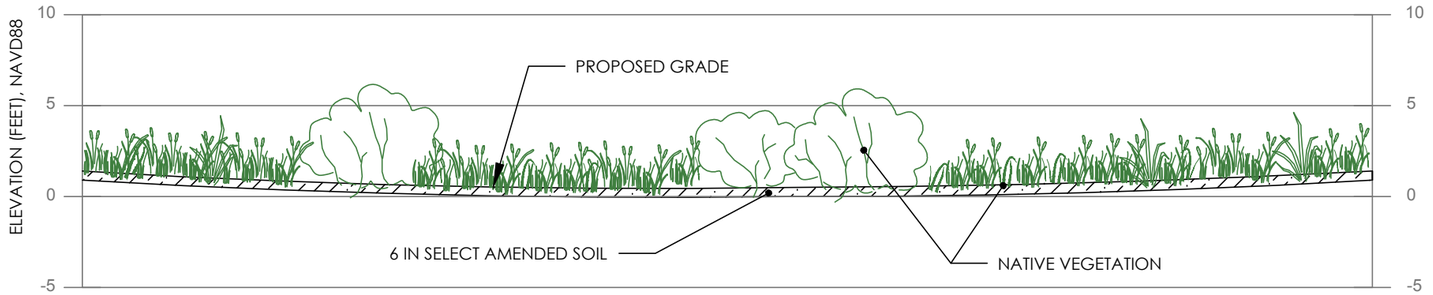
SCHODACK ISLAND POCKET WETLANDS
SITE LOCATION

SHEET ID
1

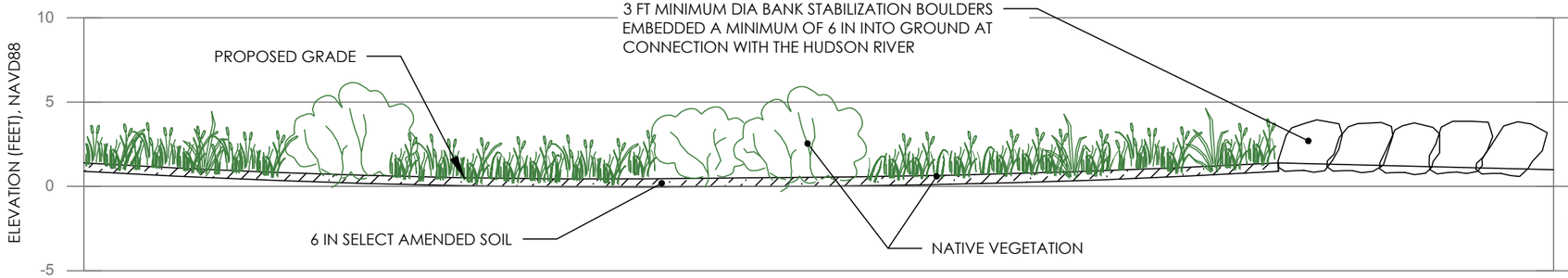
OCT.2018



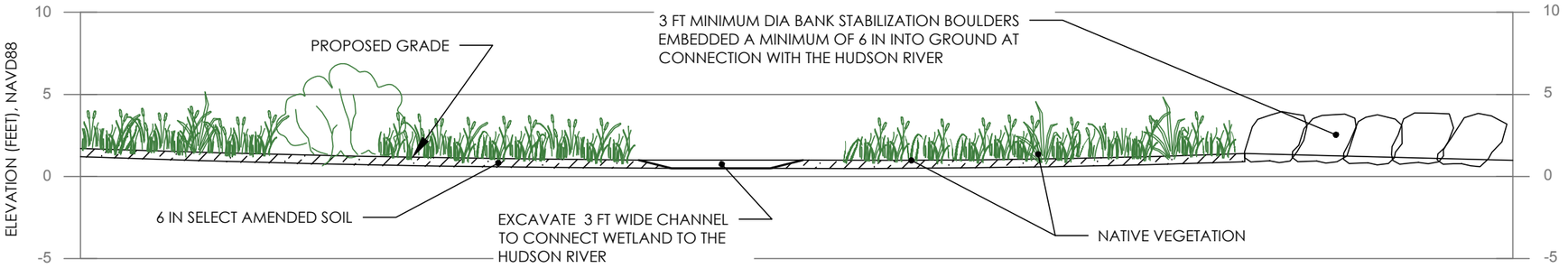
A TIDAL WETLAND RESTORATION - A
POCKET WETLANDS
SCHODACK ISLAND



B NON-TIDAL WETLAND RESTORATION - B
POCKET WETLANDS
SCHODACK ISLAND



C TIDAL WETLAND RESTORATION - C
POCKET WETLANDS
SCHODACK ISLAND



D TIDAL WETLAND RESTORATION - D
POCKET WETLANDS
SCHODACK ISLAND

US Army Corps of Engineers®

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U.S. ARMY CORPS OF ENGINEERS
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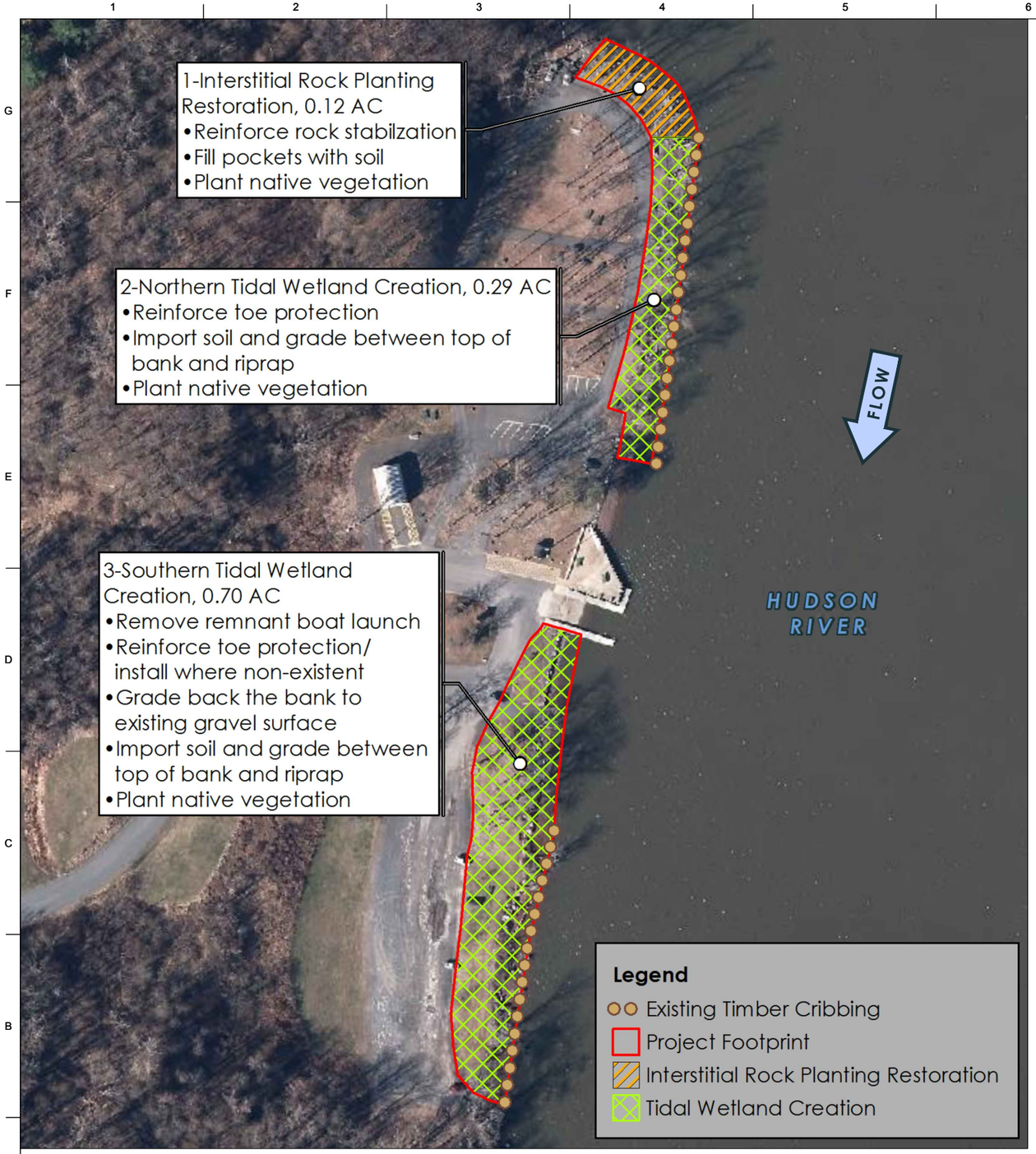
HUDSON RIVER HABITAT RESTORATION
SCHODACK ISLAND STATE PARK
COLUMBIA, GREENE, AND RENSSELAER COUNTIES, NY

SCHODACK ISLAND POCKET WETLANDS
DETAILS

SHEET ID
2

OCT.2018



1 PLAN VIEW
1" = 120'

GRAPHIC SCALE

0 40 80 120 240 360 480 FEET

SCALE: 1" = 120'

Acronym	Definition
AC	Acres
CY	Cubic Yards
EA	Each
FT	Feet
H:V	Horizontal:Vertical
IN	Inches
LF	Linear Feet
MTL	Mean Tide Line
OC	On Center
SF	Square Feet
SY	Square Yards

1-Interstitial Rock Planting Restoration

Item	*Unit*	*Quantity*
Grading	SF	5,350
Select Amended Soil	CY	100
Riprap (D50=12IN)	TON	890
Plantings (3FT OC)	EA	600

2-Northern Tidal Wetland Creation

Item	*Unit*	*Quantity*
Excavation	CY	800
Select Amended Soil	CY	400
Riprap (D50=12IN)	TON	1,800
Plantings (3FT OC)	EA	900
Bank Stabilization Boulders	TON	610

3-Southern Tidal Wetland Creation

Item	*Unit*	*Quantity*
Excavation	CY	6,474
Select Amended Soil	CY	1,600
Riprap (D50=12IN)	TON	3,100
Herbivore Exclusion Fence - Geese	AC	0.70
Plantings (3FT OC)	EA	2,400
Bank Stabilization Boulders	TON	895
Remnant Boat Ramp Demolition	SY	75

General Construction

Item	*Unit*	*Quantity*
Turbidity Barrier	LF	1,000
Silt Fence	LF	1,100
Construction Stake Out	AC	1.12
Stabilized Construction Access	TON	50
Clearing and Grubbing	AC	0.01

A SCHEDULE OF QUANTITIES
Alternative 1

US Army Corps of Engineers®

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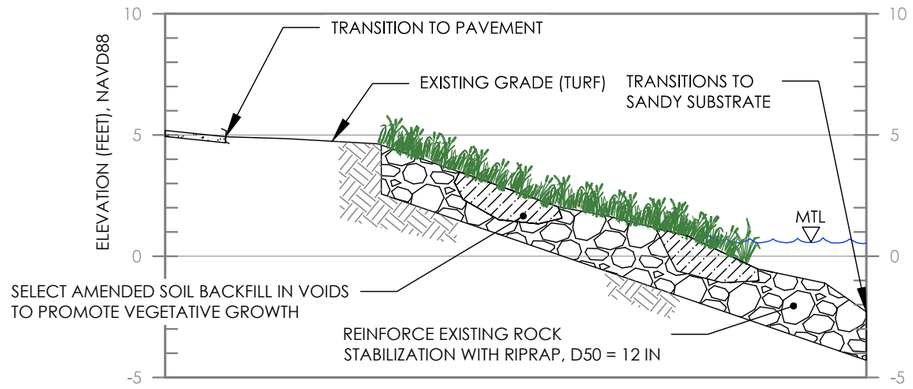
HUDSON RIVER HABITAT RESTORATION
CHARLES RIDER PARK
ULSTER COUNTY, NY

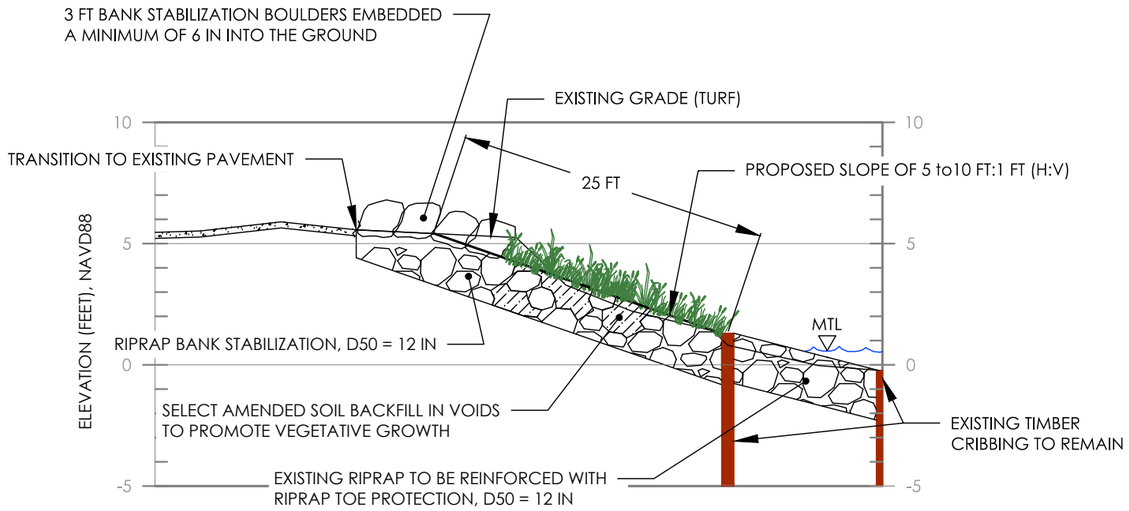
CHARLES RIDER PARK ALTERNATIVE 1
SITE LOCATION

SHEET ID
1

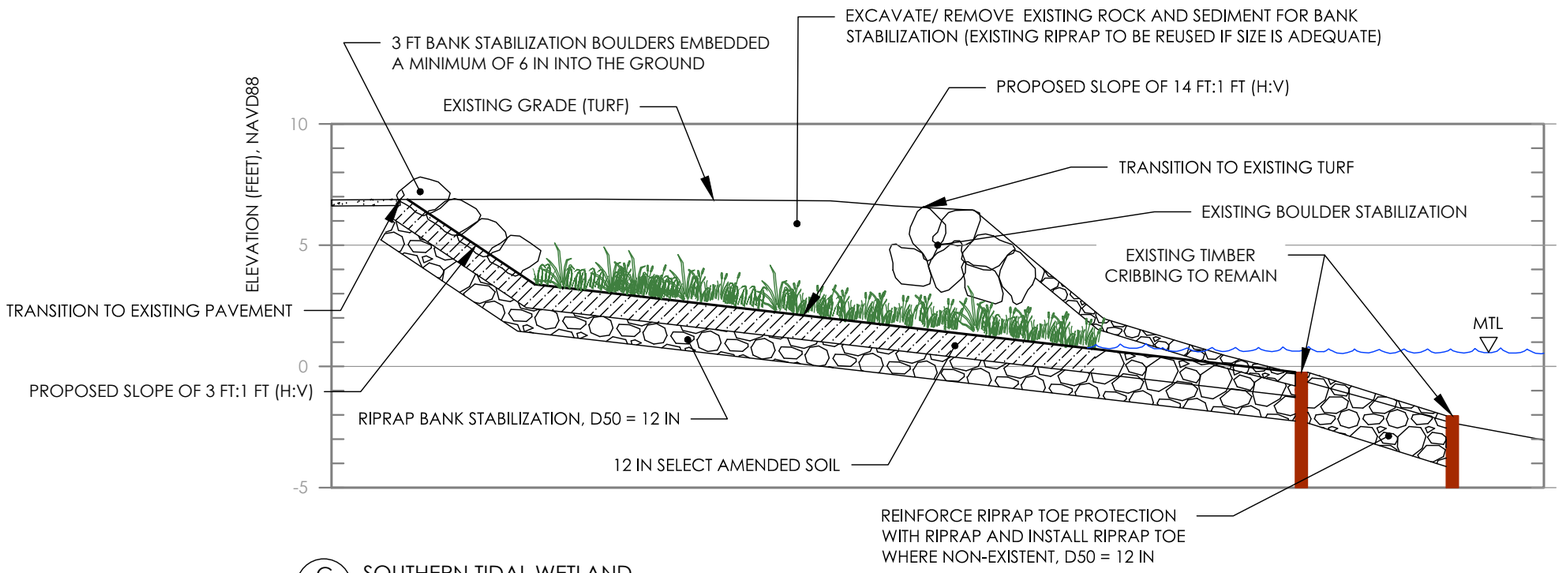
SEP.2018



A INTERSTITIAL ROCK PLANTING
ALTERNATIVE 1
CHARLES RIDER PARK



B NORTHERN TIDAL WETLAND
ALTERNATIVE 1
CHARLES RIDER PARK



C SOUTHERN TIDAL WETLAND
ALTERNATIVE 1
CHARLES RIDER PARK

US Army Corps of Engineers®

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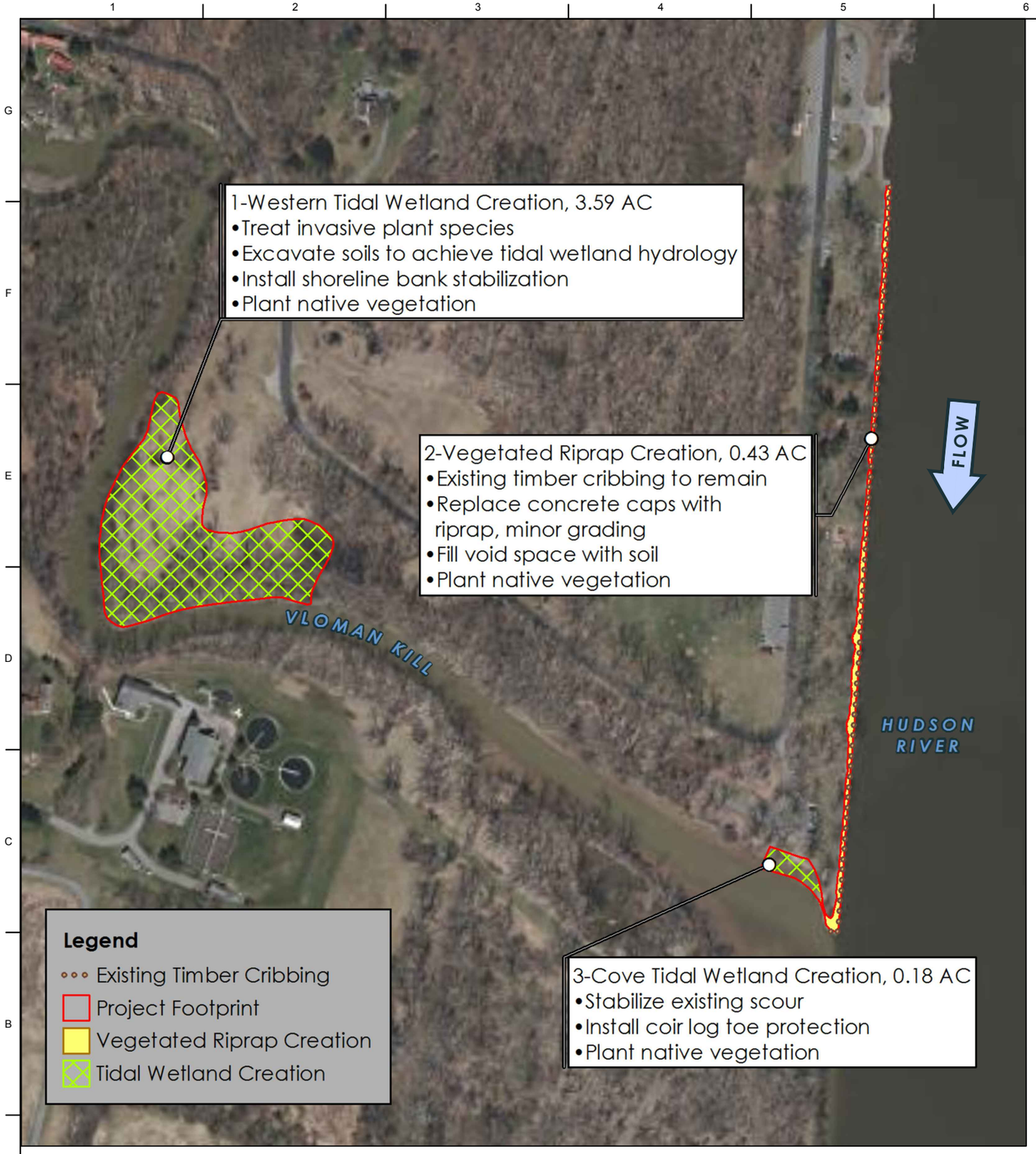
HUDSON RIVER HABITAT RESTORATION
CHARLES RIDER PARK
ULSTER COUNTY, NY

CHARLES RIDER PARK ALTERNATIVE 1
DETAILS

SHEET ID
2

SEP.2018



1 PLAN VIEW
Alternative 1
1" = 300'

GRAPHIC SCALE
0 100 200 300 600 900 1200 FEET
SCALE: 1" = 300'

1-Western Tidal Wetland Creation

Item	Unit	Quantity
Invasive Species Treatment	AC	3.59
Excavation	CY	29,800
Select Amended Soil	CY	2,900
Grading	SF	156,400
Shoreline Bank Stabilization	TON	440
Plantings (3FT OC)	EA	17,400
Herbivore Exclusion Fence - Geese	AC	3.59
Herbivore Exclusion Fence - Deer	LF	2,000

2-Vegetated Riprap Creation

Item	Unit	Quantity
Excavation	CY	9,200
Riprap (D50=12IN)	TON	11,200
Plantings (3FT OC)	EA	2,100
Gravel	TON	4,500
Select Amended Soil	CY	2,500
Concrete Disposal	TON	1,100

3-Cove Tidal Wetland Creation

Item	Unit	Quantity
Bank Stabilization Boulders	TON	80
Select Amended Soil	CY	30
Herbivore Exclusion Fence - Geese	AC	0.18
Plantings (3FT OC)	EA	900
Toe Protection	LF	210

General Construction

Item	Unit	Quantity
Turbidity Barrier	LF	1,400
Silt Fence	LF	1,700
Construction Stake Out	AC	0.39
Stabilized Construction Entrance	TON	140
Construction Access Matting	SF	9,600
Clearing and Grubbing	AC	0.07

A SCHEDULE OF QUANTITIES
Alternative 1

Acronym	Definition
AC	Acres
CY	Cubic Yards
EA	Each
FT	Feet
H:V	Horizontal:Vertical
IN	Inches
LF	Linear Feet
MTL	Mean Tide Line
OC	On Center
SF	Square Feet
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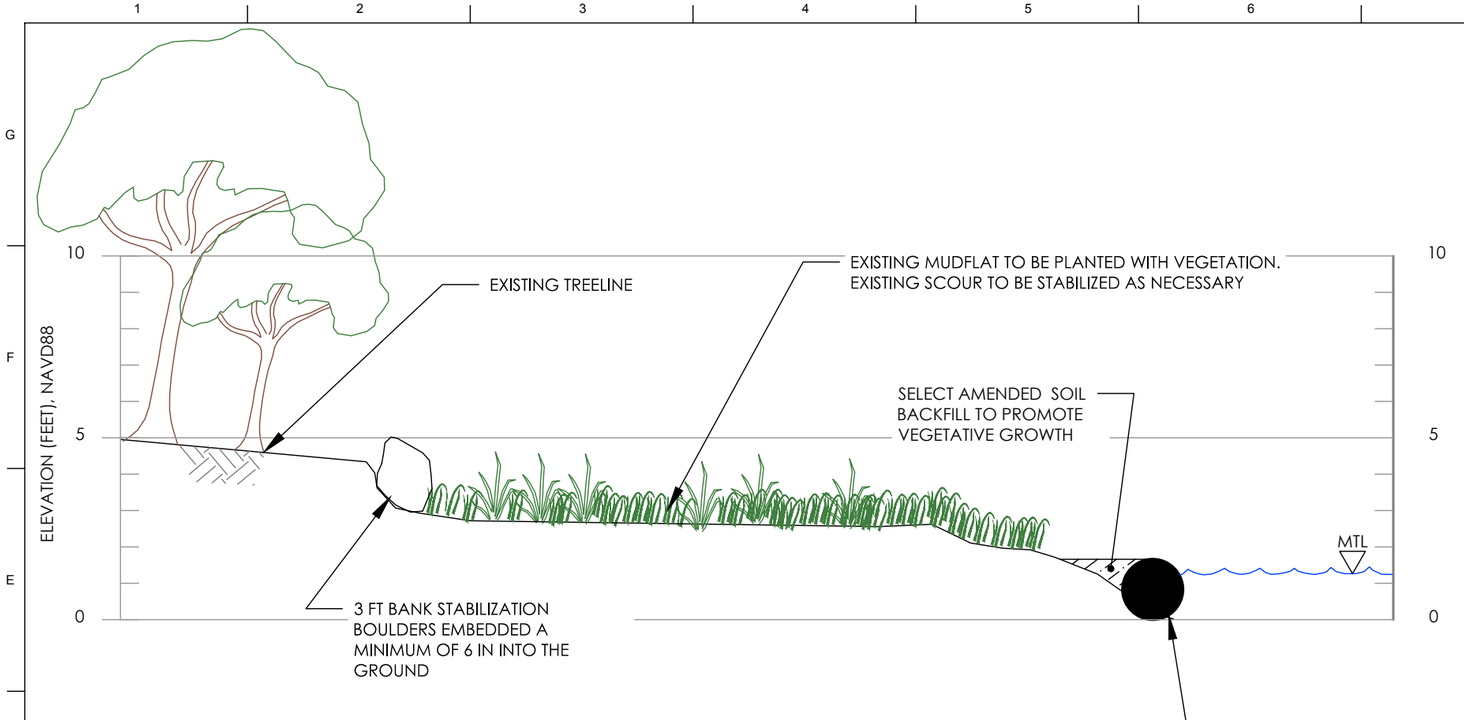
HUDSON RIVER HABITAT RESTORATION
HENRY HUDSON PARK
ALBANY COUNTY, NY

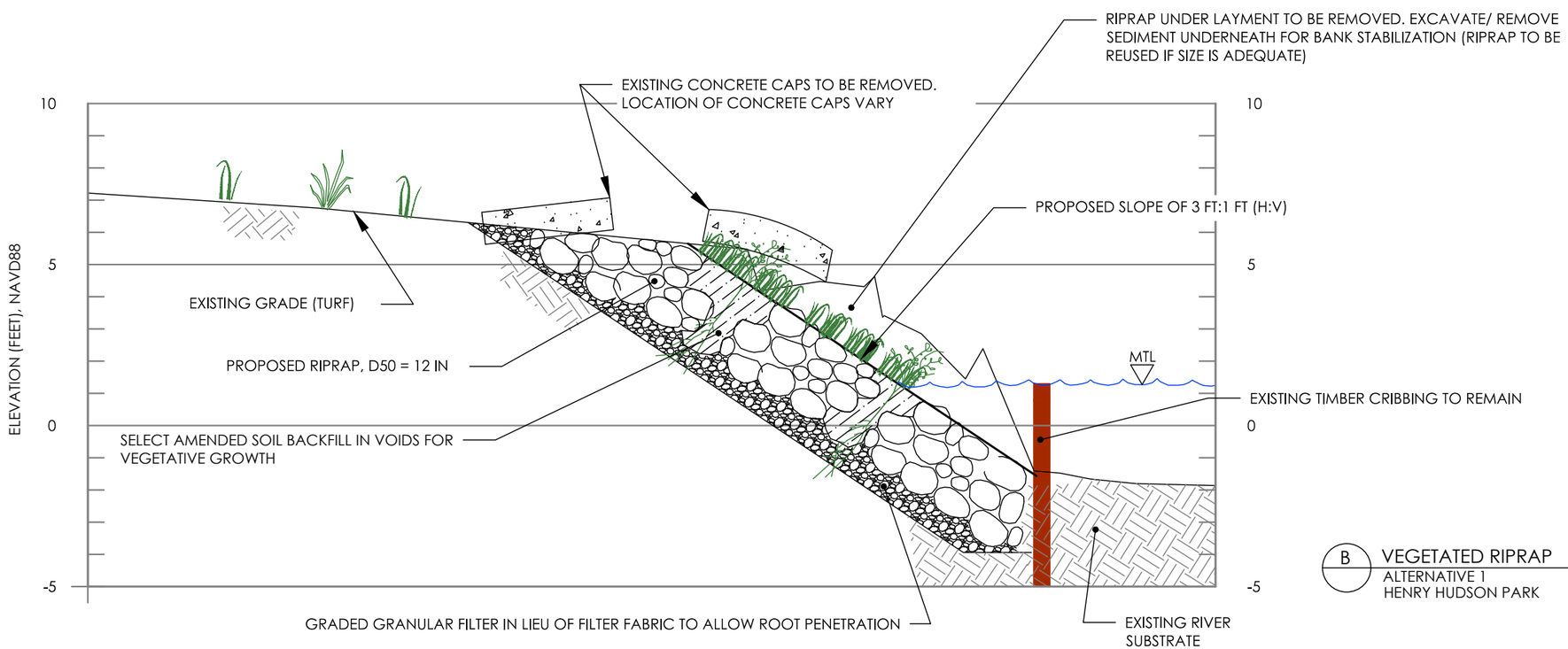
HENRY HUDSON PARK ALTERNATIVE 1
SITE LOCATION

SHEET ID
1

OCT.2018



A COVE TIDAL WETLAND
ALTERNATIVE 1
HENRY HUDSON PARK



B VEGETATED RIPRAP
ALTERNATIVE 1
HENRY HUDSON PARK

US Army Corps of Engineers®

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HENRY HUDSON PARK
ALBANY COUNTY, NY

HENRY HUDSON PARK ALTERNATIVE 1
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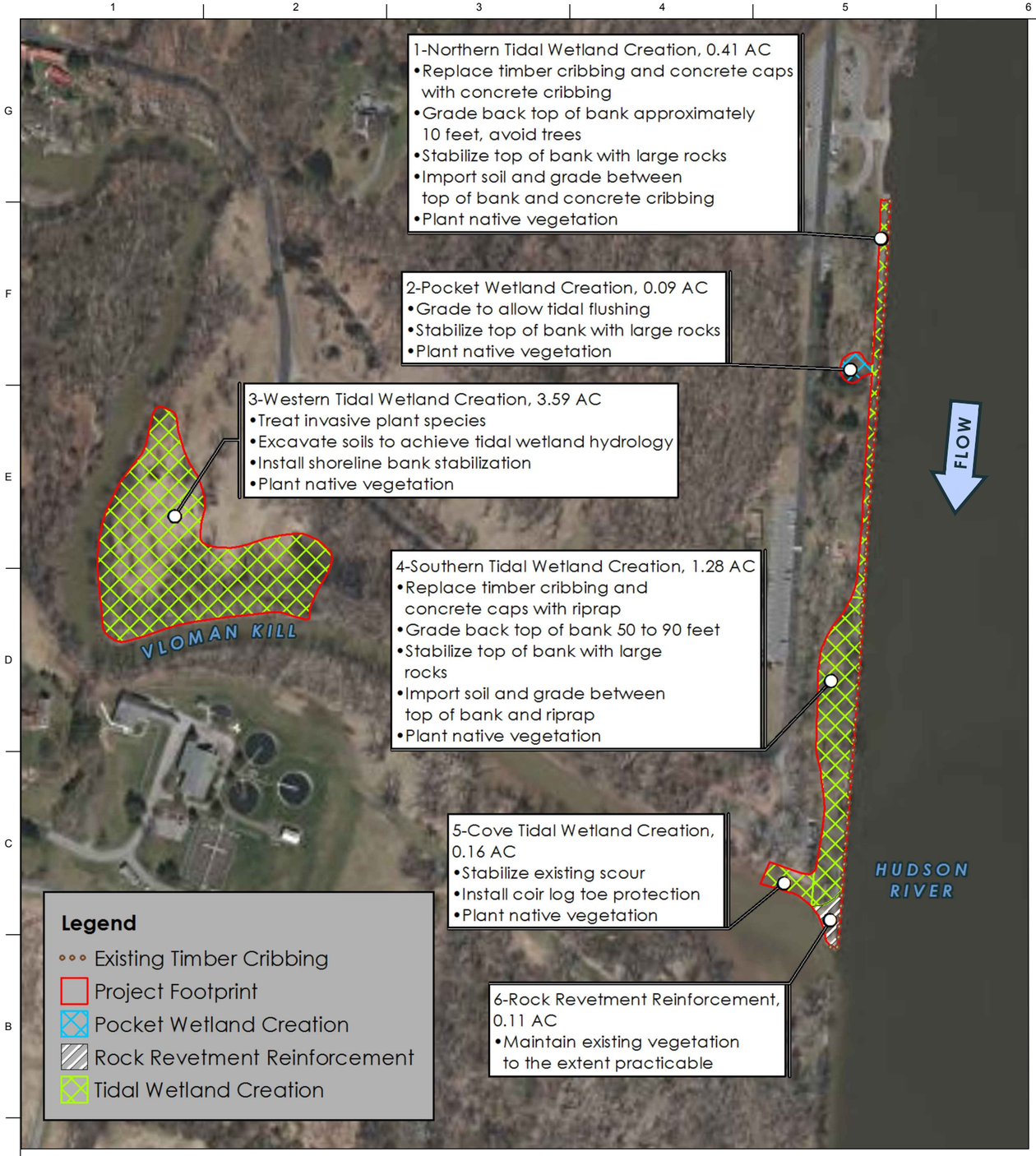

1 PLAN VIEW
Alternative 2
1" = 300'

GRAPHIC SCALE

0 100 200 300 600 900 1200 FEET

SCALE: 1" = 300'

Acronym	Definition
AC	Acres
CY	Cubic Yards
EA	Each
FT	Feet
H:V	Horizontal:Vertical
IN	Inches
LF	Linear Feet
MTL	Mean Tide Line
OC	On Center
SF	Square Feet
SY	Square Yards

1-Northern Tidal Wetland Creation

Item	Unit	Quantity
Excavation	CY	16,670
Grading	SF	30,000
Bank Stabilization Boulders	TON	1,940
Riprap (D50=12IN)	TON	9,600
Select Amended Soil	CY	2,150
Herbivore Exclusion Fence - Geese	AC	0.42
Plantings (3FT OC)	EA	2,100
Concrete Cribbing	LF	1,000
Timber Cribbing Removal	LF	1,000
Concrete Cap Disposal	TON	600

2-Pocket Wetland Creation

Item	Unit	Quantity
Excavation	CY	500
Grading	SF	4,000
Bank Stabilization Boulders	TON	110
Select Amended Soil	CY	80
Herbivore Exclusion Fence - Geese	AC	0.09
Plantings (3FT OC)	EA	500

3-Western Tidal Wetland Creation

Item	Unit	Quantity
Invasive Species Treatment	AC	3.59
Excavation	CY	29,800
Select Amended Soil	CY	2,900
Grading	SF	156,400
Shoreline Bank Stabilization	TON	440
Plantings (3FT OC)	EA	17,400
Herbivore Exclusion Fence - Geese	AC	3.59
Herbivore Exclusion Fence - Deer	LF	2,000

4-Southern Tidal Wetland Creation

Item	Unit	Quantity
Excavation	CY	12,920
Grading	SF	54,250
Select Amended Soil	CY	2,300
Riprap (D50=12IN)	TON	7,100
Herbivore Exclusion Fence - Geese	AC	1.29
Plantings (3FT OC)	EA	6,100
Bank Stabilization Boulders	TON	1,520
Concrete Cap Disposal	TON	470

5-Cove Tidal Wetland Creation

Item	Unit	Quantity
Bank Stabilization Boulders	TON	80
Select Amended Soil	CY	30
Herbivore Exclusion Fence - Geese	AC	0.16
Plantings (3FT OC)	EA	800
Toe Protection	LF	210

6-Reinforced Rock Revetment

Item	Unit	Quantity
Riprap	TON	500
Plantings (3FT OC)	EA	600

General Construction

Item	Unit	Quantity
Turbidity Barrier	LF	2,100
Silt Fence	LF	1,900
Construction Stake Out	AC	1.79
Stabilized Construction Access	TON	140
Construction Access Matting	SF	6,300
Clearing and Grubbing	AC	0.04

A SCHEDULE OF QUANTITIES
Alternative 2

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HUDSON RIVER HABITAT RESTORATION
HENRY HUDSON PARK
ALBANY COUNTY, NY

HENRY HUDSON PARK ALTERNATIVE 2
SITE LOCATION

SHEET ID
1

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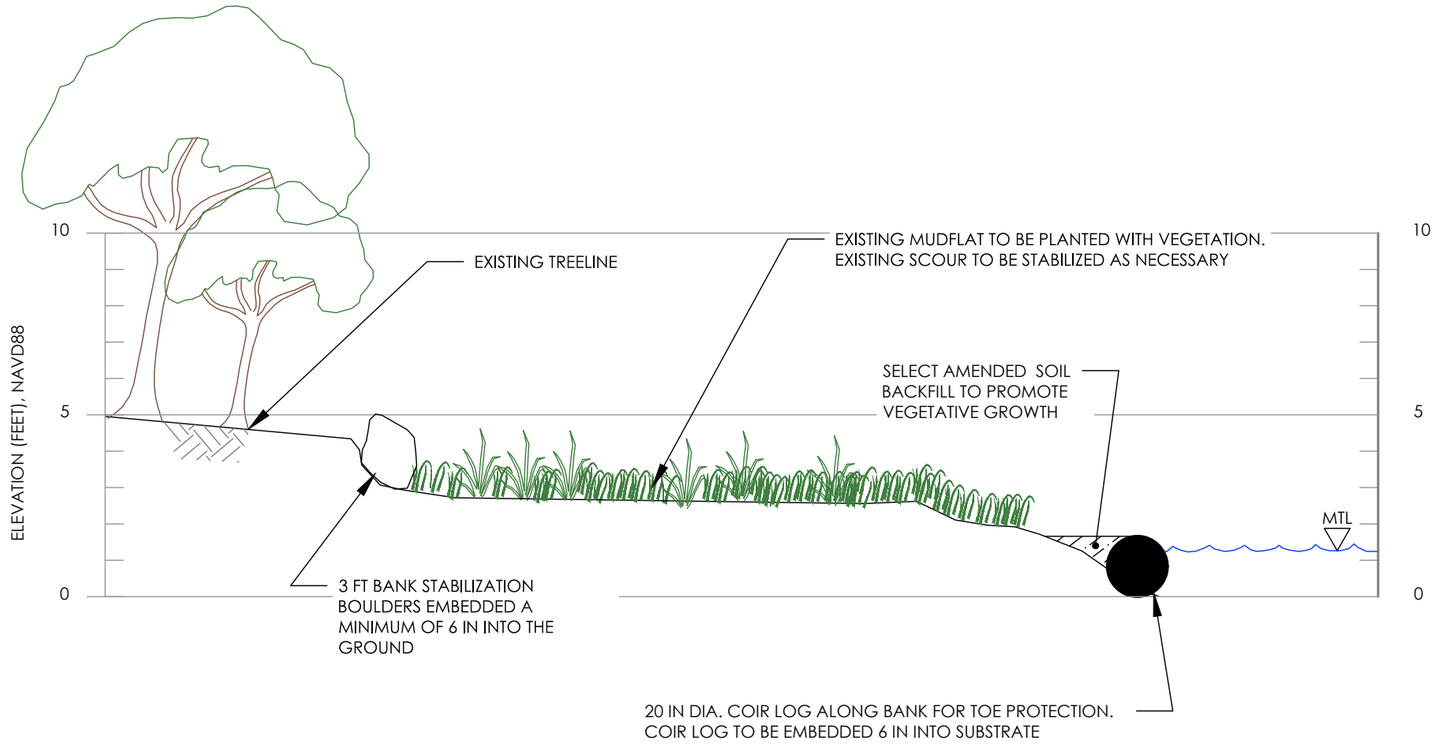
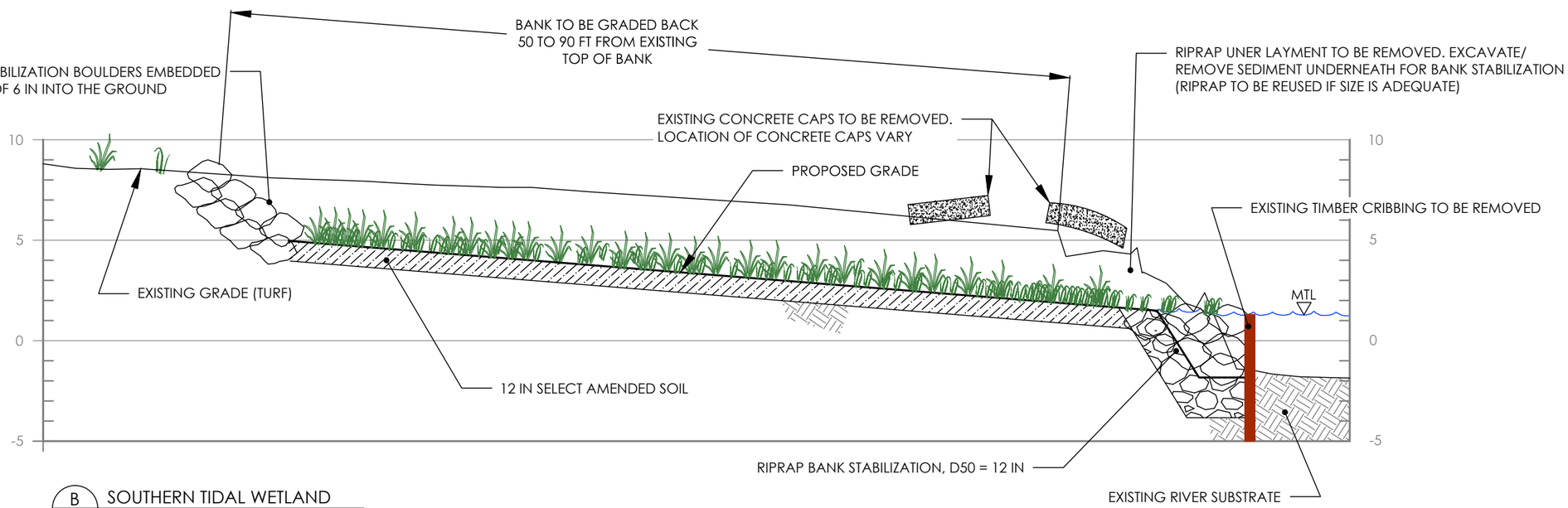


A COVE TIDAL WETLAND
ALTERNATIVE 2
HENRY HUDSON PARK



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ALTERNATIVE 2
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HENRY HUDSON PARK
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HENRY HUDSON PARK ALTERNATIVE 2
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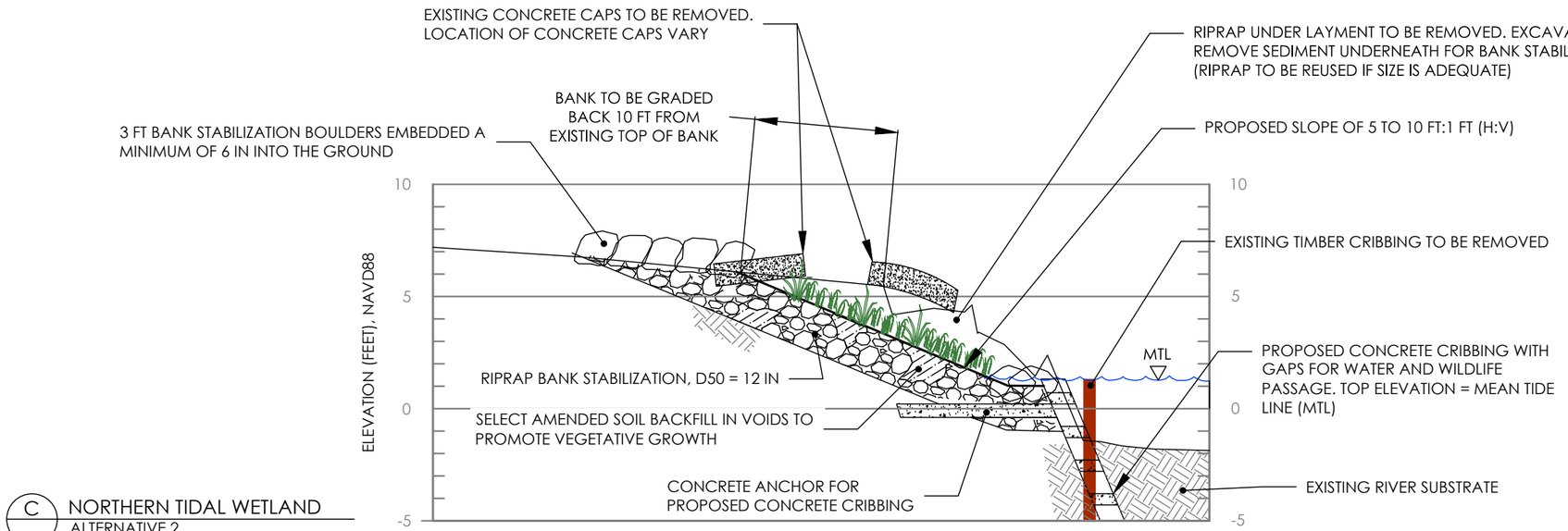
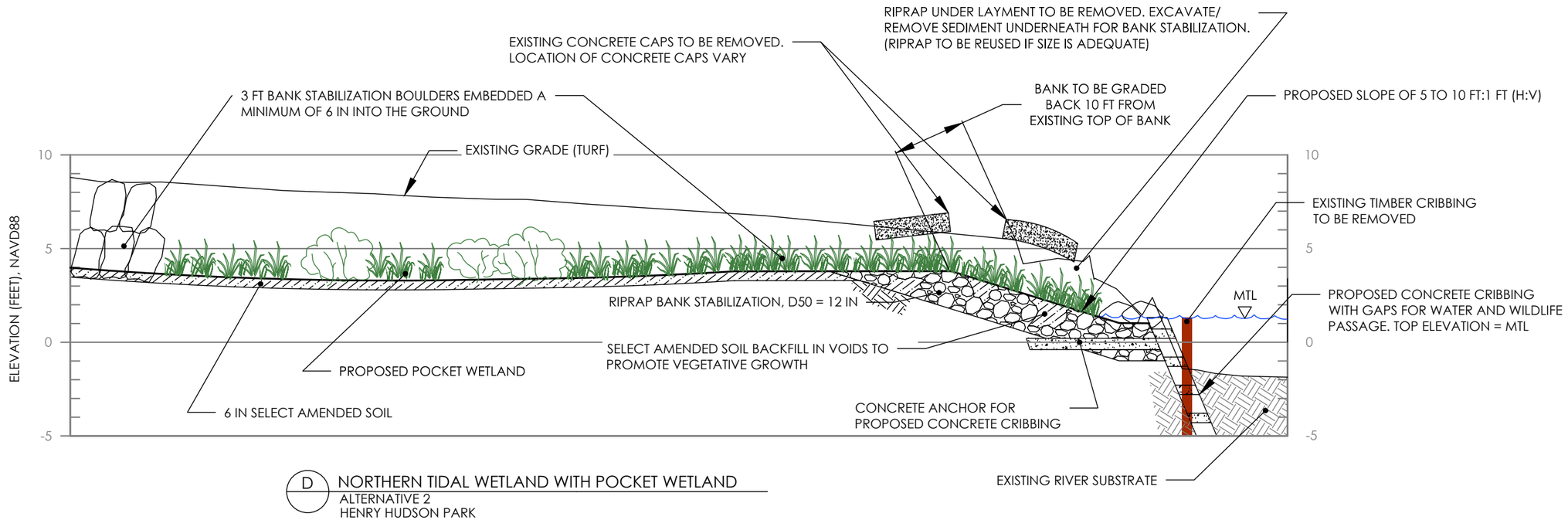


C NORTHERN TIDAL WETLAND
ALTERNATIVE 2
HENRY HUDSON PARK



D NORTHERN TIDAL WETLAND WITH POCKET WETLAND
ALTERNATIVE 2
HENRY HUDSON PARK

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ALBANY COUNTY, NY

HENRY HUDSON PARK ALTERNATIVE 2 DETAILS

SHEET ID
3

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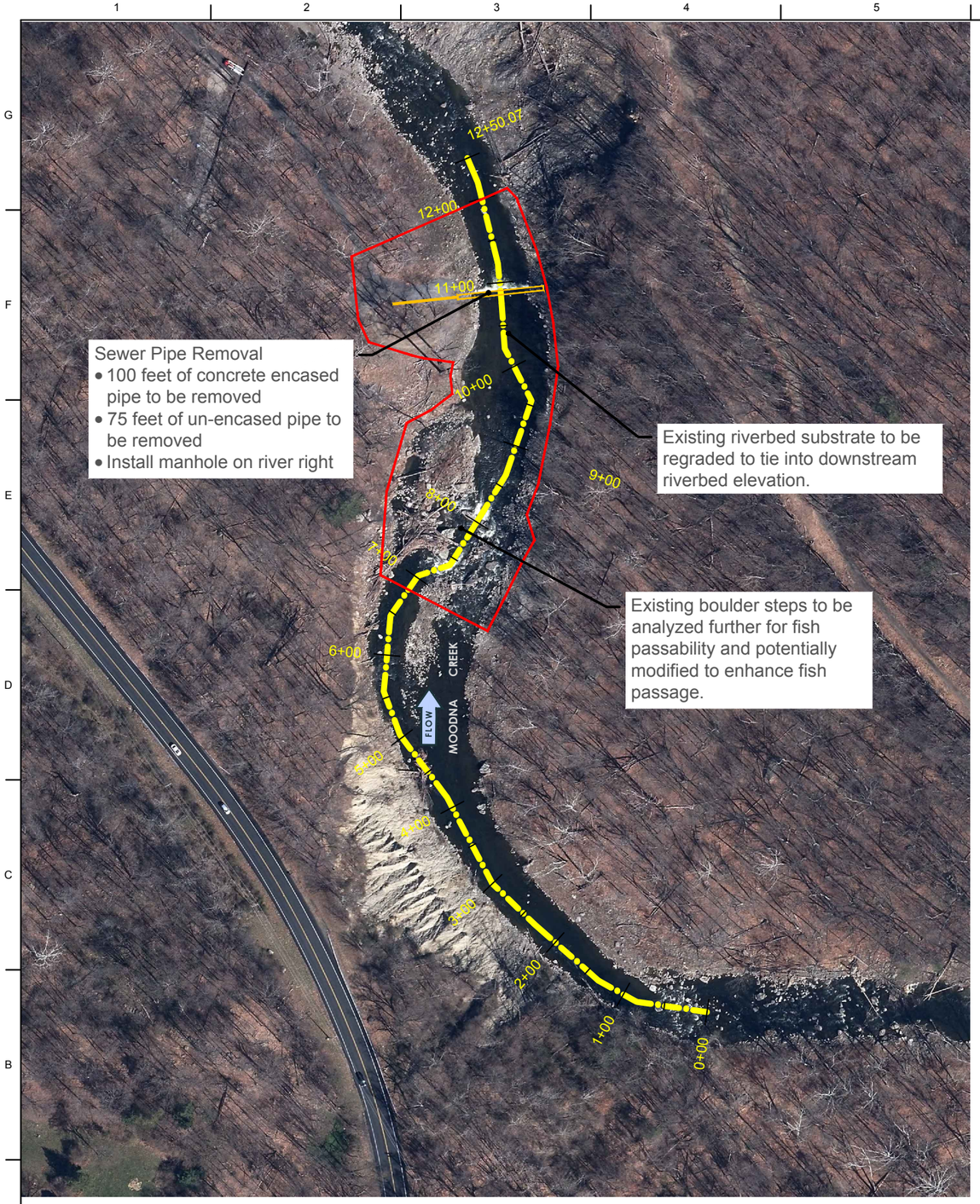


1 PLAN VIEW
1" = 150'

0 30 60 90 120 150 300 450 600 FEET

SCALE: 1" = 150'

Legend
- River Profile
- Project Footprint
- Proposed Sewer Pipe Removal

MOODNA CREEK
AOP 1 - UTILITY CROSSING
ALTERNATIVE 1:
BARRIER REMOVAL

Barrier Removal

Item	*Unit*	*Quantity*
Water Control Materials (Sand-Filled BigBags)	LF	300
Water Control Installation & Modification	LS	1
Utility Removal	LF	175
Demolition / Excavation	lf	170
Backfill with soil	cy	113
Re-grade streambed	sy	833
Disposal of Concrete / Pipe Material	tons	227
Decomisssion Utility (includes manhole installation)	Ea	1
Upstream Boulder Step Modification:		
Boulders (delivered, 2 weirs, 40 boulders ea.)	TON	400

General Construction

Item	*Unit*	*Quantity*
Traffic Control	LS	1
Turbidity Barrier	LF	100
Silt Fence	LF	240
Stabilized Construction Entrance	TON	50
Construction Access Reinforcement	TON	210
Construction Access Ramp	TON	260
Clearing and Grubbing	AC	0.3

A SCHEDULE OF QUANTITIES
Alternative 1 - Barrier Removal

Acronym	Definition
AC	Acres
CY	Cubic Yards
EA	Each
FT	Feet
LF	Linear Feet
LS	Lump Sum
SY	Square Yards
WSEL	Water Surface Elevation

US Army Corps of Engineers®

DATE | DESCRIPTION | MARK

DESIGNED BY:
DRAWN BY: AGU/DPW/TH
CHECKED BY:
ISSUE DATE: MAY 2018
SOLICITATION NO.:
CONTRACT NO.: W912DS-14-D-0001
SUBMITTED BY: PRINCETON HYDRO
SIZE: 11x17

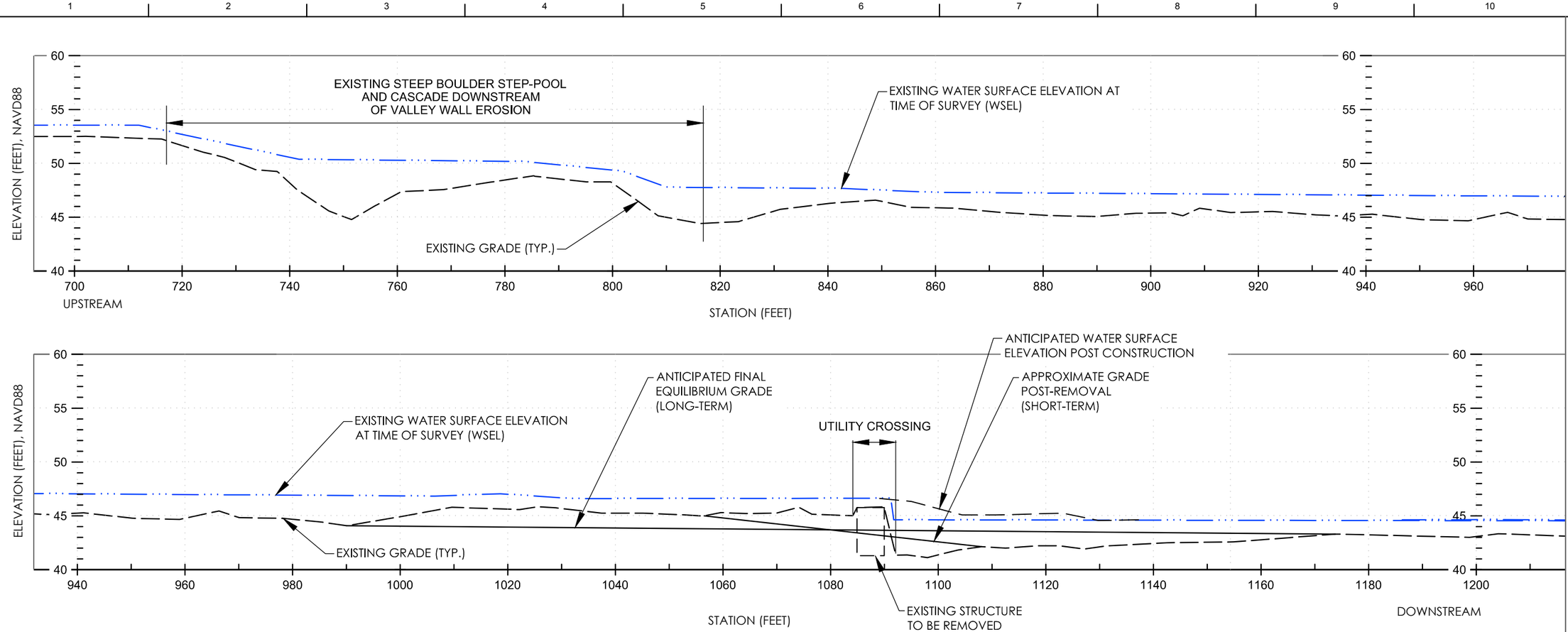
U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT
26 FEDERAL PLAZA
NEW YORK, NEW YORK, 10278

PRINCETON HYDRO, LLC
1108 OLD YORK ROAD
RINGOES, NEW JERSEY, 08551

HUDSON RIVER HABITAT RESTORATION
MOODNA CREEK
ORANGE COUNTY, NY
MOODNA CREEK
AOP 1 - UTILITY CROSSING
ALTERNATIVE 1 - BARRIER REMOVAL

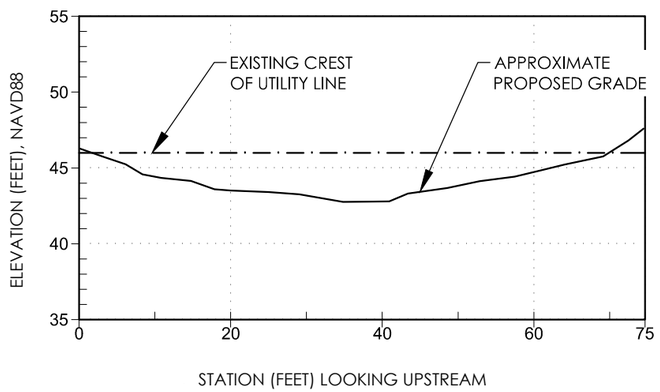
SHEET ID
1

OCT.2018



A AOP 1 - UTILITY CROSSING PROFILE
ALTERNATIVE 1: BARRIER REMOVAL
MOODNA CREEK

ELEVATIONS REFERENCED TO
NORTH AMERICAN VERTICAL
DATUM OF 1988 (NAVD88), FEET



B AOP 1 - UTILITY CROSSING CROSS SECTION AT STATION 1090
ALTERNATIVE 1: BARRIER REMOVAL
MOODNA CREEK

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MARK	DESCRIPTION	DATE

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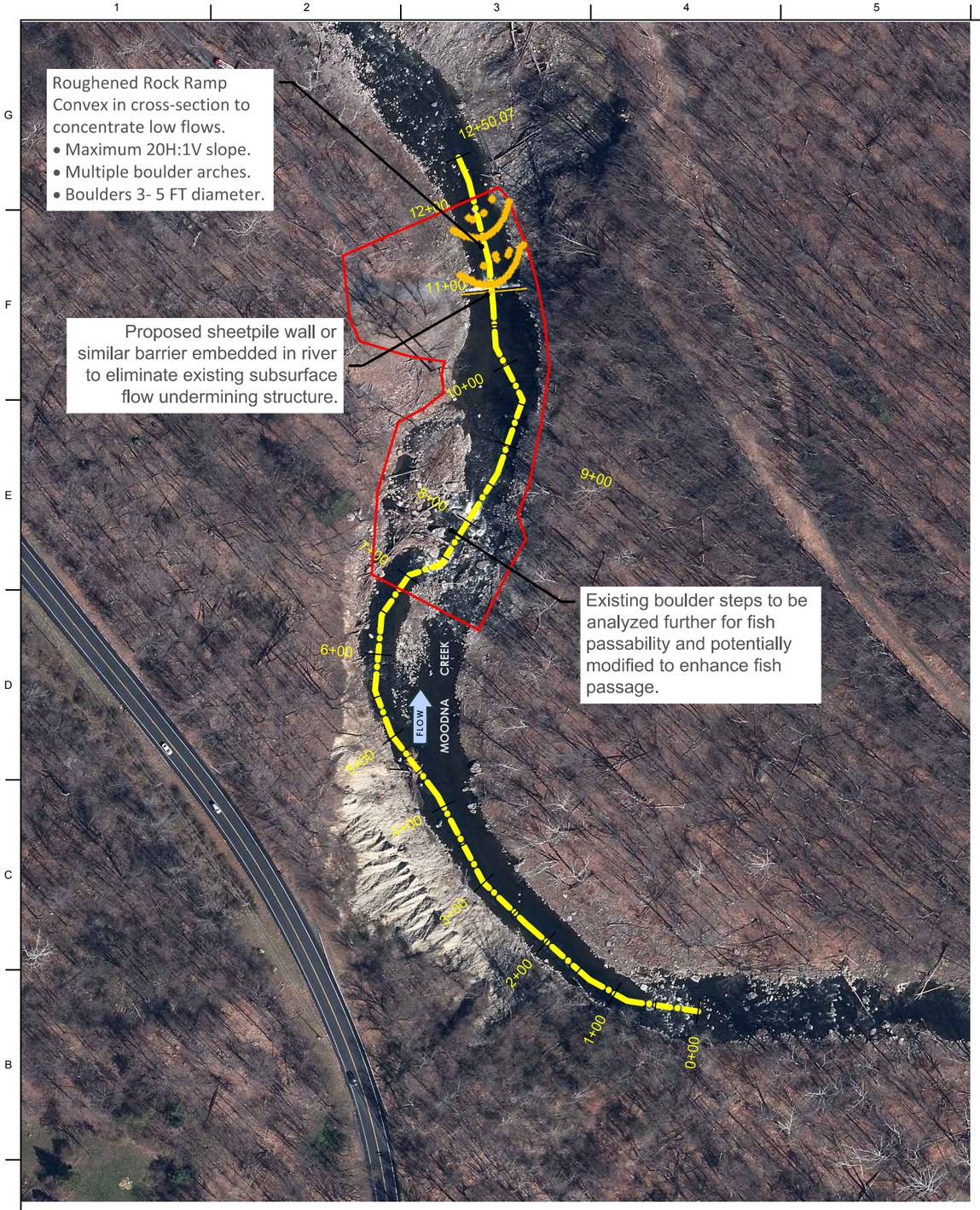
HUDSON RIVER HABITAT RESTORATION
MOODNA CREEK
ORANGE COUNTY, NY
MOODNA CREEK
AOP 1 - UTILITY CROSSING
ALTERNATIVE 1 - BARRIER REMOVAL

SHEET ID
2

OCT.2018



1 PLAN VIEW
1" = 150'

0 30 60 90 120 150 300 450 600 FEET

SCALE: 1" = 150'

Legend
- River Profile
- Project Footprint
- Proposed Fishway

MOODNA CREEK
AOP 1 - UTILITY CROSSING
ALTERNATIVE 2: FISHWAY

Acronym	Definition
AC	Acres
CY	Cubic Yards
EA	Each
FT	Feet
H:V	Horizontal:Vertical
LF	Linear Feet
LS	Lump Sum
SY	Square Yards
WSEL	Water Surface Elevation

Rock Ramp Fishway

Item	*Unit*	*Quantity*
Water Control Materials (Sand-Filled BigBags)	LF	300
Water Control Installation & Modification	LS	1
Rock Ramp: Boulders for rock veins	TON	480
Rock Ramp: Boulder/cobble/gravel infill	TON	800
Sheetpile	LF	560
Boulders (delivered, 2 weirs, 40 boulders ea.)	TON	400

General Construction

Item	*Unit*	*Quantity*
Traffic Control	LS	1
Turbidity Barrier	LF	100
Silt Fence	LF	240
Stabilized Construction Entrance	TON	50
Construction Access Reinforcement	TON	210
Construction Access Ramp	TON	260
Clearing and Grubbing	AC	0.23

A SCHEDULE OF QUANTITIES
Alternative 2 - Fishway

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DATE | MARK | DESCRIPTION

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U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT
26 FEDERAL PLAZA
NEW YORK, NEW YORK, 10278

PRINCETON HYDRO, LLC
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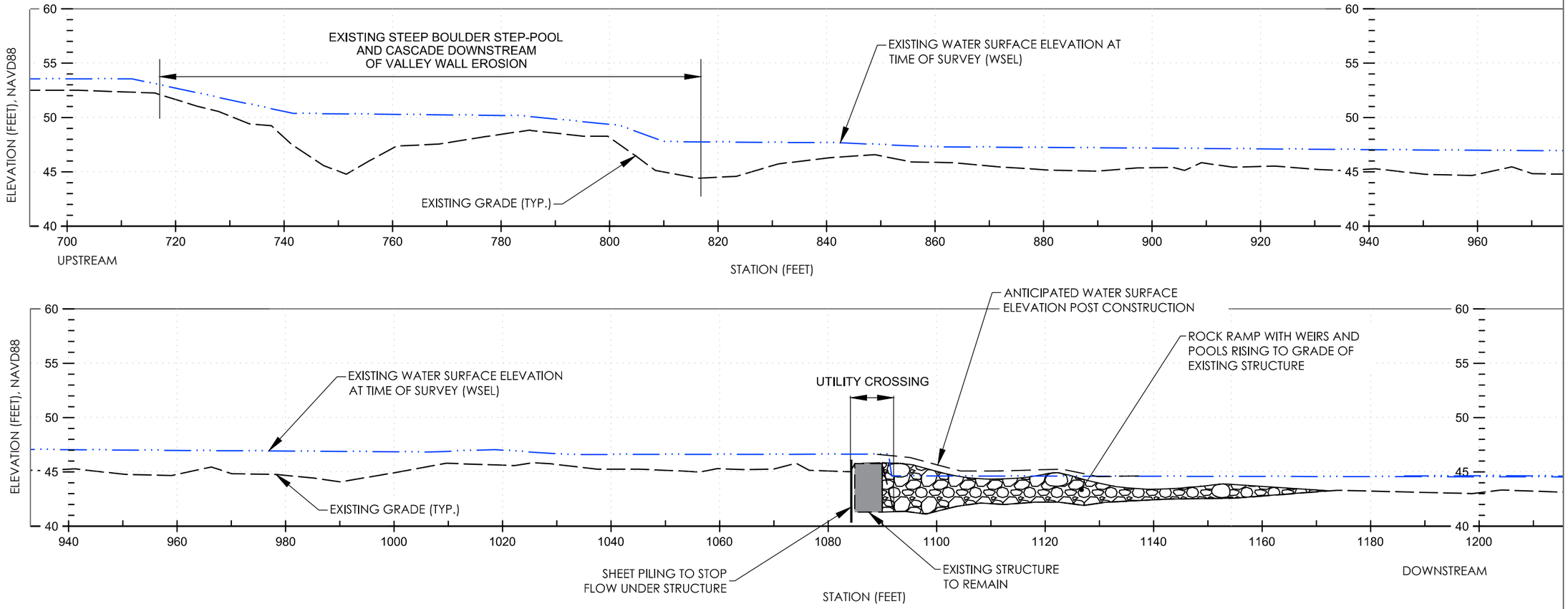
RINGOES, NEW JERSEY, 08551

HUDSON RIVER HABITAT RESTORATION
MOODNA CREEK
ORANGE COUNTY, NY
MOODNA CREEK
AOP 1 - UTILITY CROSSING
ALTERNATIVE 2 - FISHWAY

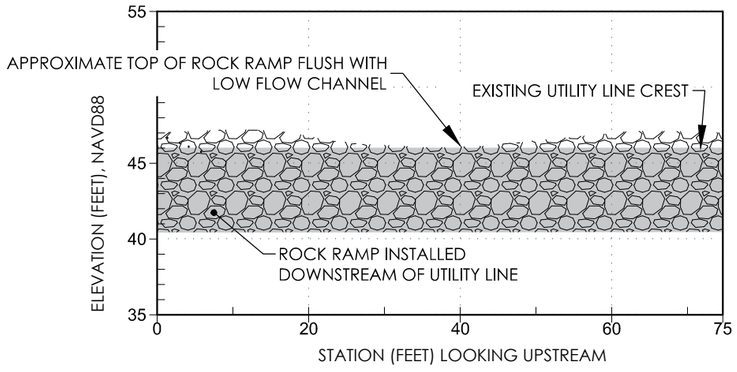
SHEET ID
1

OCT.2018



A AOP 1 - UTILITY CROSSING PROFILE
ALTERNATIVE 2: FISHWAY
MOODNA CREEK

ELEVATIONS REFERENCED TO
NORTH AMERICAN VERTICAL
DATUM OF 1988 (NAVD88), FEET



B AOP 1 - UTILITY CROSSING CROSS SECTION AT STATION 1090
ALTERNATIVE 2: FISHWAY
MOODNA CREEK

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

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DRAWN BY: AG/JD/PW/TH
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SIZE: 11x17
ISSUE DATE: MAY 2018
SOLICITATION NO.:
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U.S. ARMY CORPS OF ENGINEERS
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HUDSON RIVER HABITAT RESTORATION
MOODNA CREEK
ORANGE COUNTY, NY
MOODNA CREEK
AOP 1 - UTILITY CROSSING
ALTERNATIVE 2 - FISHWAY

SHEET ID
2

OCT.2018

MOODNA CREEK
AOP 2 - FIRTH CLIFF DAM
ALTERNATIVE 1:
DAM REMOVAL

A SCHEDULE OF QUANTITIES
Alternative 1 - Dam Removal

Dam Removal

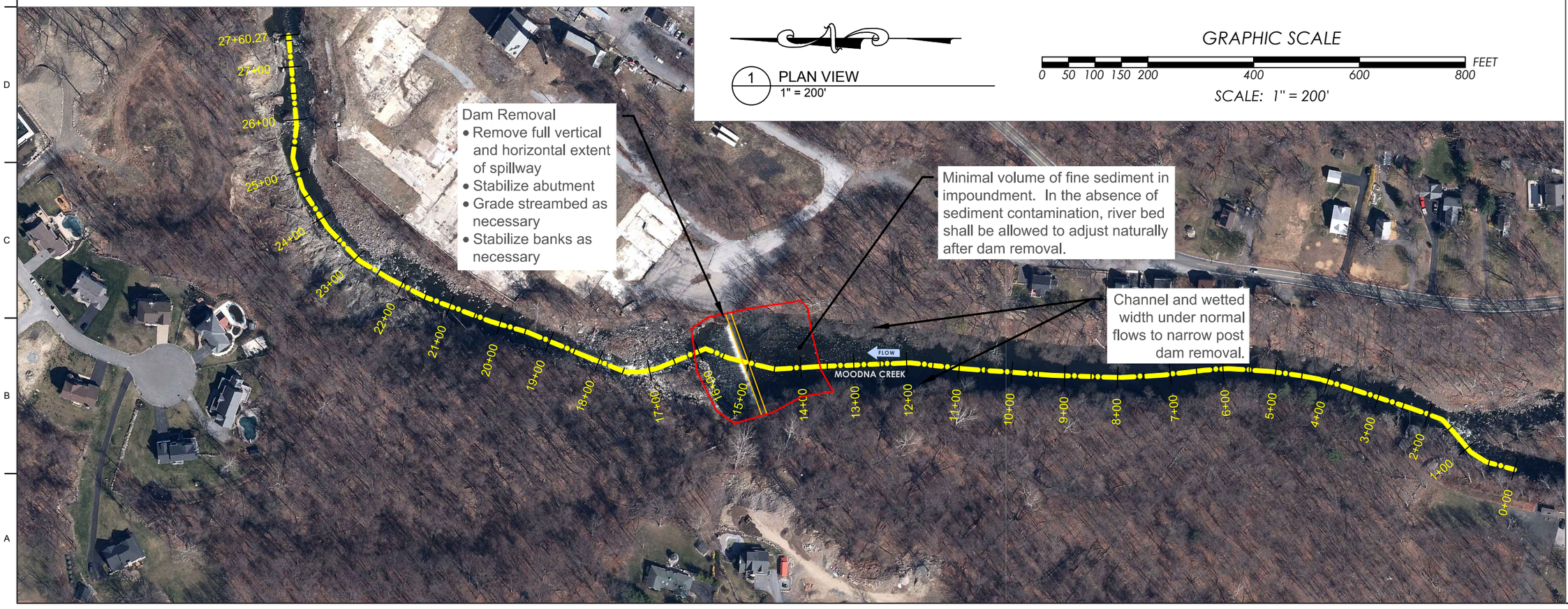
Item	Unit	Quantity
Water Control Materials (Sand-Filled BigBags)	LF	400
Water Control Installation & Modification	LS	1
Spillway Demolition / Excavation	CY	710
Re-grade Streambed	SY	840
Disposal of Concrete	TON	1,390
Abutment Stabilization	LS	1
Bank stabilization	LF	200

General Construction

Item	Unit	Quantity
Traffic Control	LS	1
Turbidity Barrier	LF	200
Silt Fence	LF	80
Stabilized Construction Entrance	TON	50
Construction Access Reinforcement	TON	90
Construction Access Ramp	TON	160
Construction Access Pad	TON	230
Clearing and Grubbing	AC	0.1

Acronym	Definition
AC	Acres
CY	Cubic Yards
FT	Feet
LF	Linear Feet
LS	Lump Sum
SY	Square Yards
WSEL	Water Surface Elevation

Legend
- River Profile
- Project Footprint
- Dam Removal



1 PLAN VIEW
1" = 200'

GRAPHIC SCALE
0 50 100 150 200 400 600 800 FEET
SCALE: 1" = 200'

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U.S. ARMY CORPS OF ENGINEERS
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26 FEDERAL PLAZA
NEW YORK, NEW YORK, 10278

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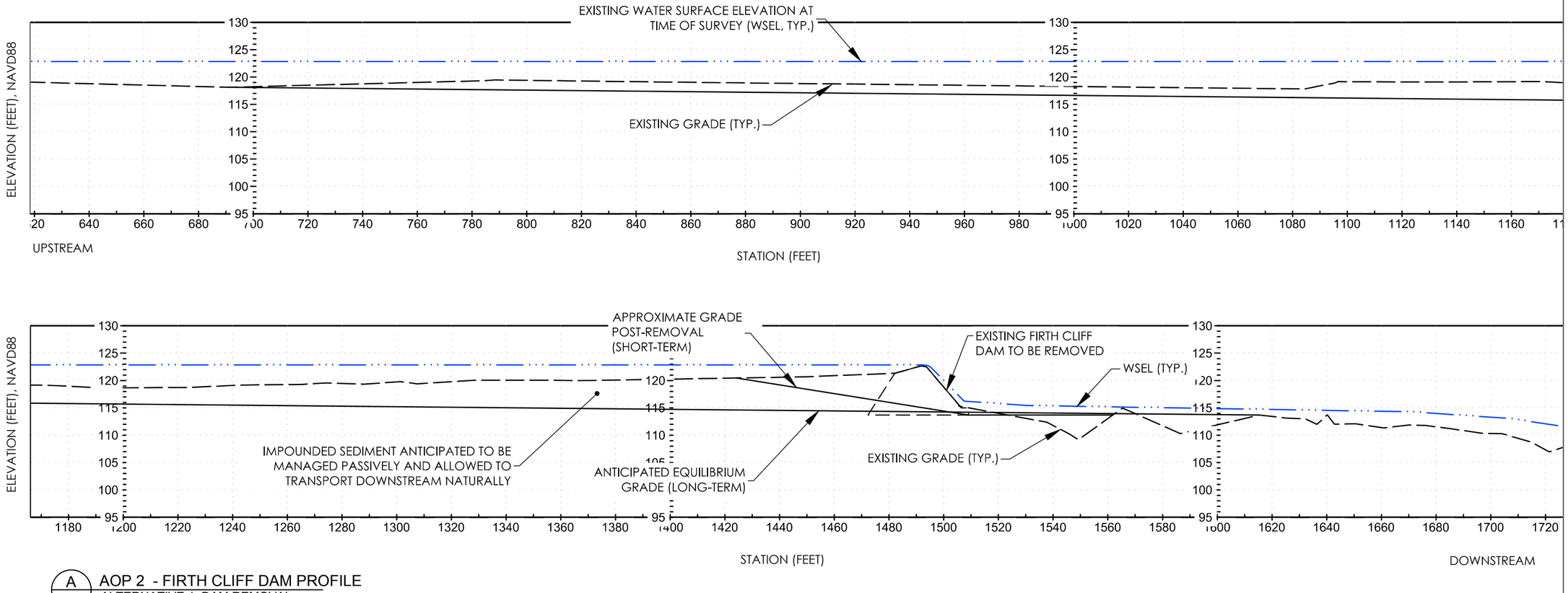
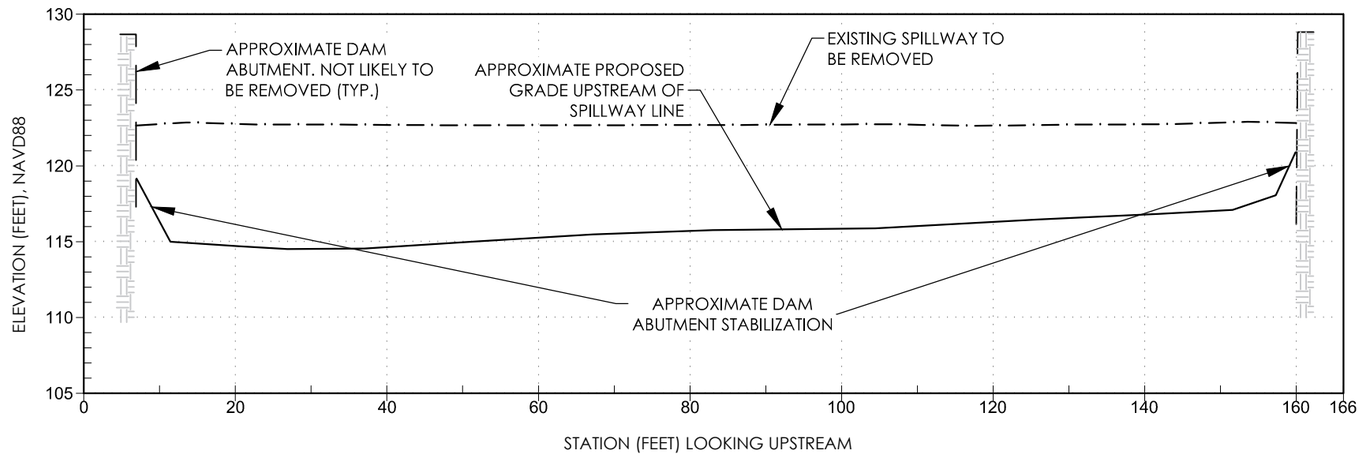
HUDSON RIVER HABITAT RESTORATION
MOODNA CREEK
ORANGE COUNTY, NY
MOODNA CREEK
AOP 2 - FIRTH CLIFF DAM
ALTERNATIVE 1 - DAM REMOVAL

SHEET ID
1

OCT.2018



A AOP 2 - FIRTH CLIFF DAM PROFILE
ALTERNATIVE 1: DAM REMOVAL
MOODNA CREEK



B AOP 2 - FIRTH CLIFF DAM CROSS SECTION AT STATION 1500
ALTERNATIVE 1: DAM REMOVAL
MOODNA CREEK

ELEVATIONS REFERENCED TO NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88), FEET

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HUDSON RIVER HABITAT RESTORATION
MOODNA CREEK
ORANGE COUNTY, NY
MOODNA CREEK
AOP 2 - FIRTH CLIFF DAM
ALTERNATIVE 1 - DAM REMOVAL

SHEET ID
2

OCT.2018

MOODNA CREEK
AOP 2 - FIRTH CLIFF DAM
ALTERNATIVE 2:
FISHWAY

A SCHEDULE OF QUANTITIES
Alternative 2 - Fishway

Fishway

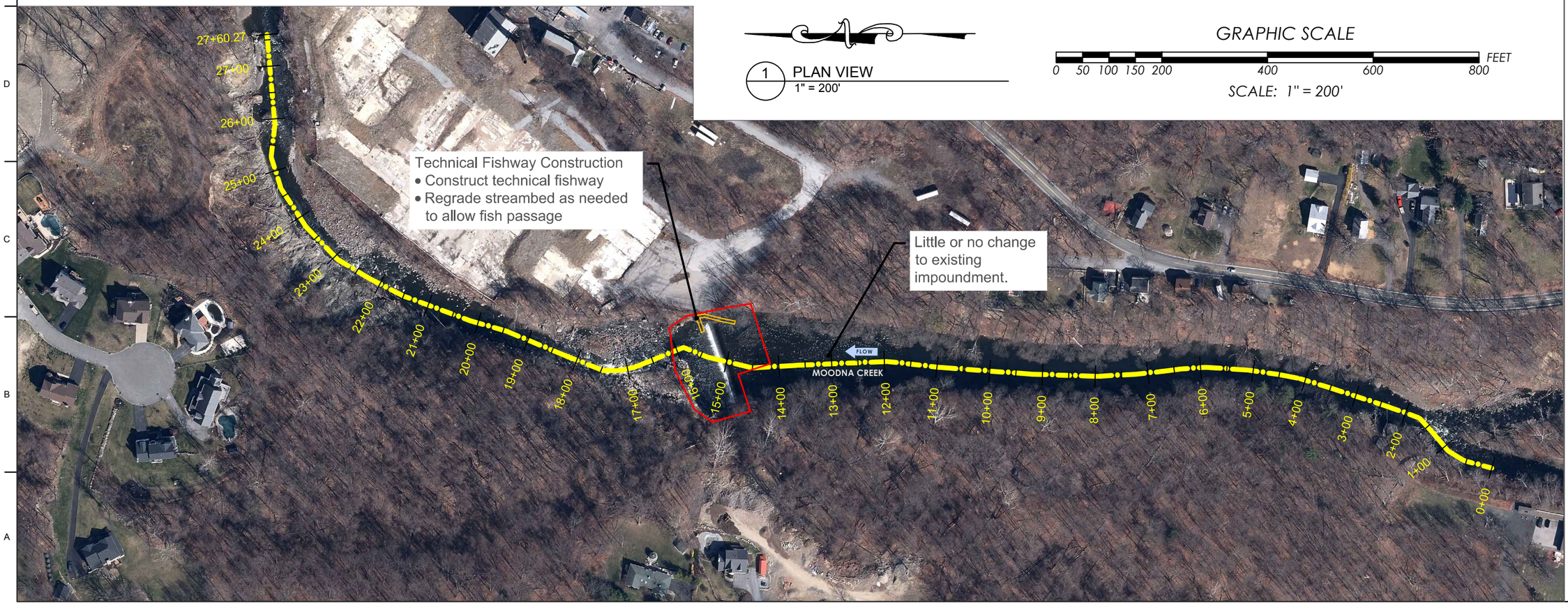
Item	Unit	Quantity
Water Control Materials (Sand-Filled BigBags)	LF	400
Water Control Installation & Modification	LS	1
Concrete Cutting (Sawcutting)	LF	1,550
Fishway Structure	VF	12

General Construction

Item	Unit	Quantity
Traffic Control	LS	1
Turbidity Barrier	LF	115
Silt Fence	LF	80
Stabilized Construction Entrance	TON	470
Construction Access Reinforcement	TON	8,570
Construction Access Ramp	TON	160
Clearing and Grubbing	AC	0.1

Acronym	Definition
AC	Acres
CY	Cubic Yards
FT	Feet
LF	Linear Feet
LS	Lump Sum
SY	Square Yards
VF	Vertical Foot
WSEL	Water Surface Elevation

Legend
- River Profile
- Project Footprint
- Proposed Fishway



1 PLAN VIEW
1" = 200'

GRAPHIC SCALE
0 50 100 150 200 400 600 800 FEET
SCALE: 1" = 200'

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U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT
26 FEDERAL PLAZA
NEW YORK, NEW YORK, 10278

PRINCETON HYDRO, LLC
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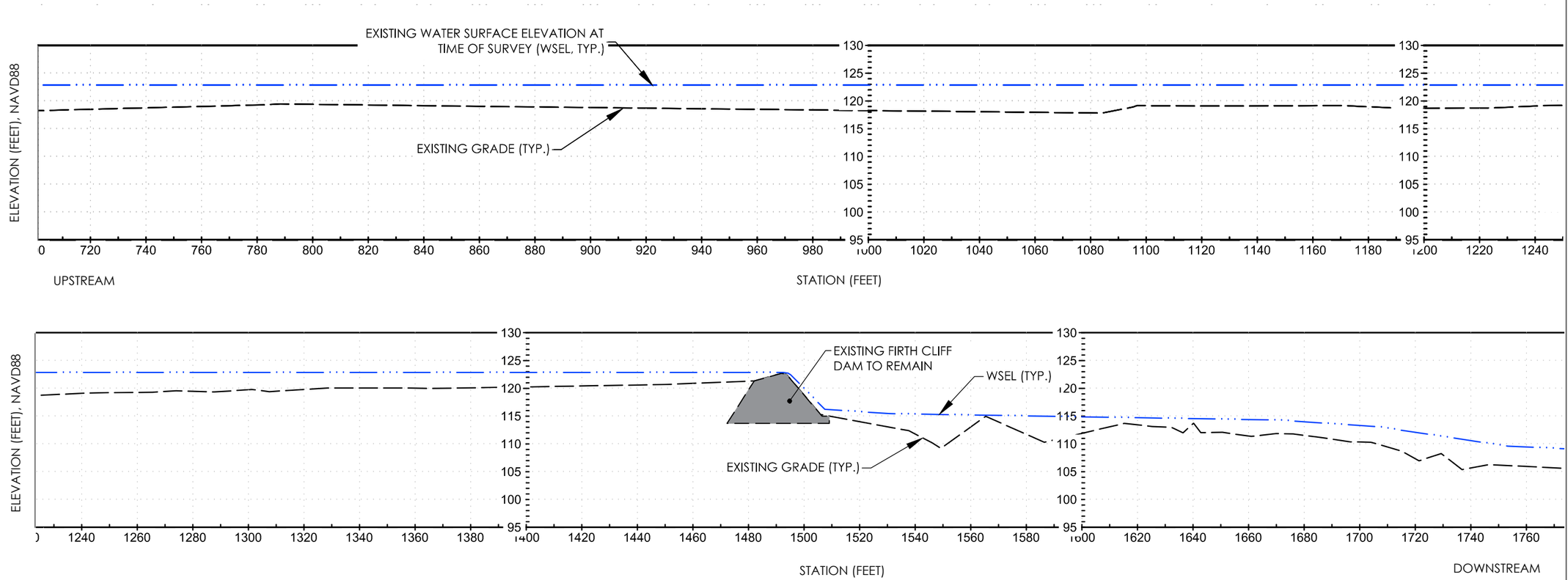
RINGOES, NEW JERSEY, 08551

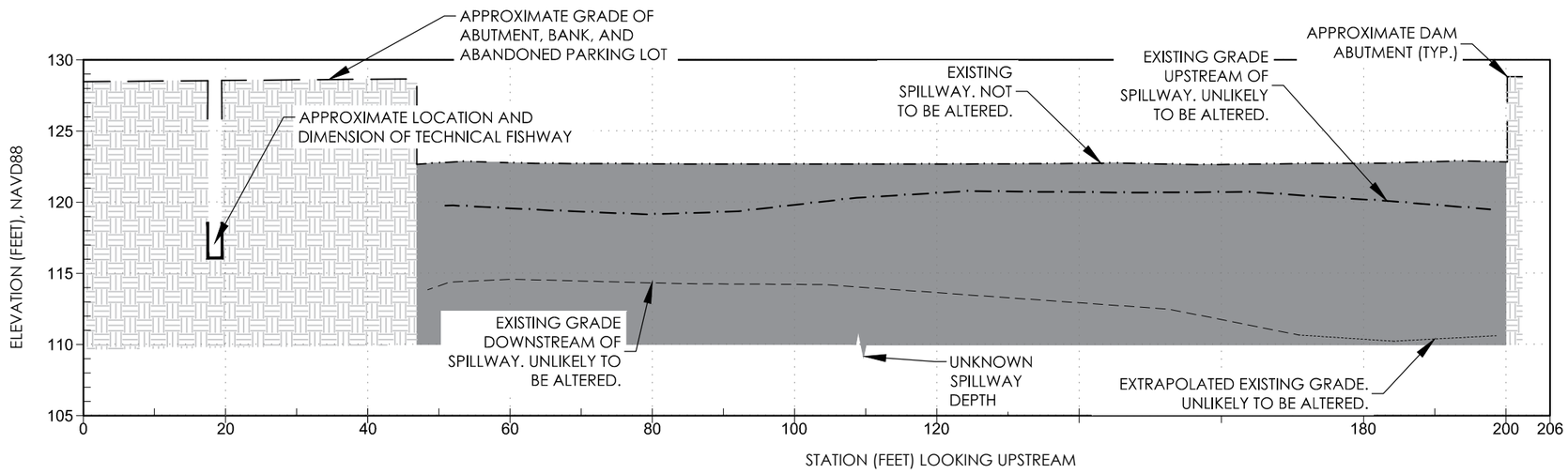
HUDSON RIVER HABITAT RESTORATION
MOODNA CREEK
ORANGE COUNTY, NY
MOODNA CREEK
AOP 2 - FIRTH CLIFF DAM
ALTERNATIVE 2 - FISHWAY

SHEET ID
1

OCT.2018



A AOP 2 - FIRTH CLIFF DAM PROFILE
ALTERNATIVE 2: FISHWAY
MOODNA CREEK



ELEVATIONS REFERENCED TO NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88), FEET

B AOP 2 - FIRTH CLIFF DAM CROSS SECTION AT STATION 1500
ALTERNATIVE 2: FISHWAY
MOODNA CREEK

US Army Corps of Engineers®

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U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT
26 FEDERAL PLAZA
NEW YORK, NEW YORK, 10278

PRINCETON HYDRO, LLC
1108 OLD YORK ROAD
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HUDSON RIVER HABITAT RESTORATION
MOODNA CREEK
ORANGE COUNTY, NY
MOODNA CREEK
AOP 2 - FIRTH CLIFF DAM
ALTERNATIVE 2 - FISHWAY

SHEET ID
2

OCT.2018

1 PLAN VIEW
1" = 150'

0 30 60 90 120 150 300 450 600 FEET

SCALE: 1" = 150'

Legend
- River Profile
- Project Footprint
- Dam Removal
- Proposed Boulder

MOODNA CREEK
AOP 3 - ORRS MILL DAM
ALTERNATIVE 1:
DAM REMOVAL

Acronym	Definition
AC	Acres
CY	Cubic Yards
FT	Feet
LF	Linear Feet
LS	Lump Sum
SY	Square Yards
WSEL	Water Surface Elevation

Dam Removal

Item	*Unit*	*Quantity*
Water Control Materials (Sand-Filled BigBags)	LF	400
Water Control Installation & Modification	LS	1
Spillway Demolition / Excavation	CY	1,250
Disposal of Spillway Concrete	TON	790
Abutment Removal (River Left)	CY	350
Disposal of Abutment Concrete/Masonry/Earth	TON	30
Re-grade Streambed	SY	3,340
Supplemental Boulders (12, 4x5x6ft, delivered)	TON	130
Grade Control Stabilization	LF	500
Tributary Confluence Stabilization (Boulders, 24, 3x4x5ft, delivered)	TON	130
Boulder Grade Control (Boulders, 40, 4x5x6ft, delivered)	TON	420

General Construction

Item	*Unit*	*Quantity*
Traffic Control	LS	1
Turbidity Barrier	LF	180
Silt Fence	LF	80
Stabilized Construction Entrance	TON	50
Construction Access Matting	SF	1600
Construction Access Ramp	TON	90
Construction Access Pad	TON	620
Clearing and Grubbing	AC	0.2

A SCHEDULE OF QUANTITIES
Alternative 1 - Dam Removal

US Army Corps of Engineers®

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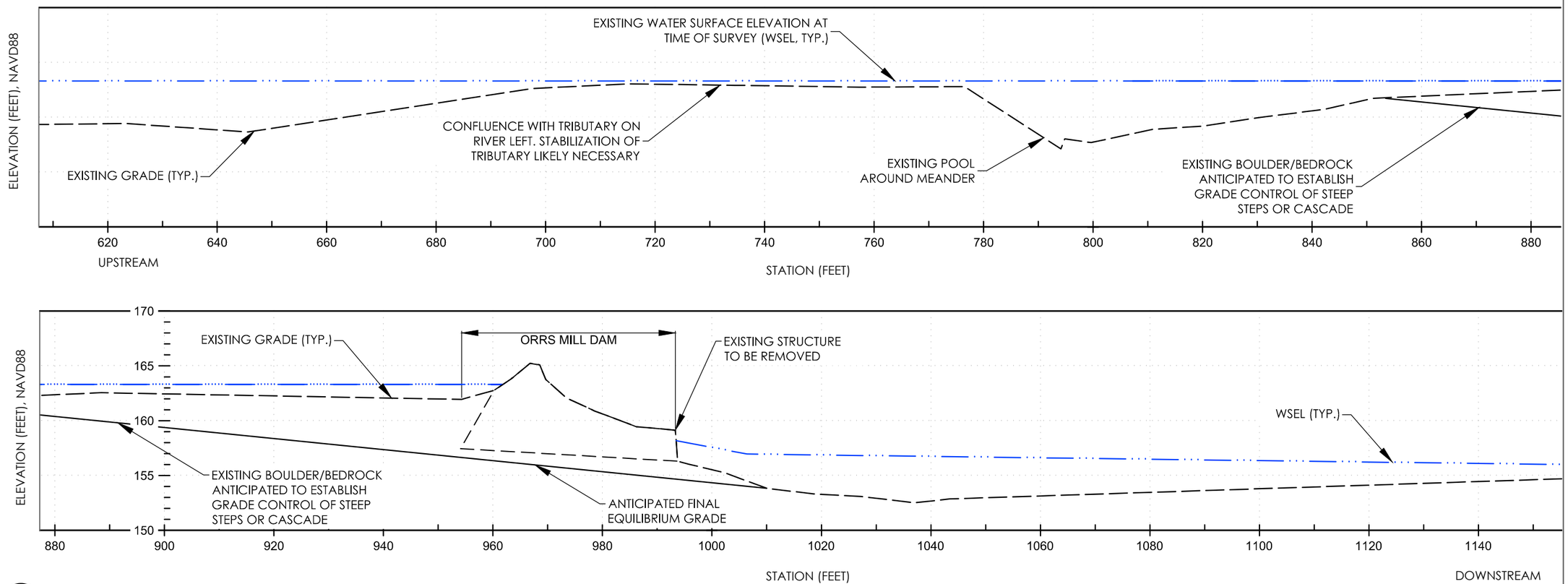
HUDSON RIVER HABITAT RESTORATION
MOODNA CREEK
ORANGE COUNTY, NY
MOODNA CREEK
AOP 3 - ORRS MILL DAM
ALTERNATIVE 1 - DAM REMOVAL

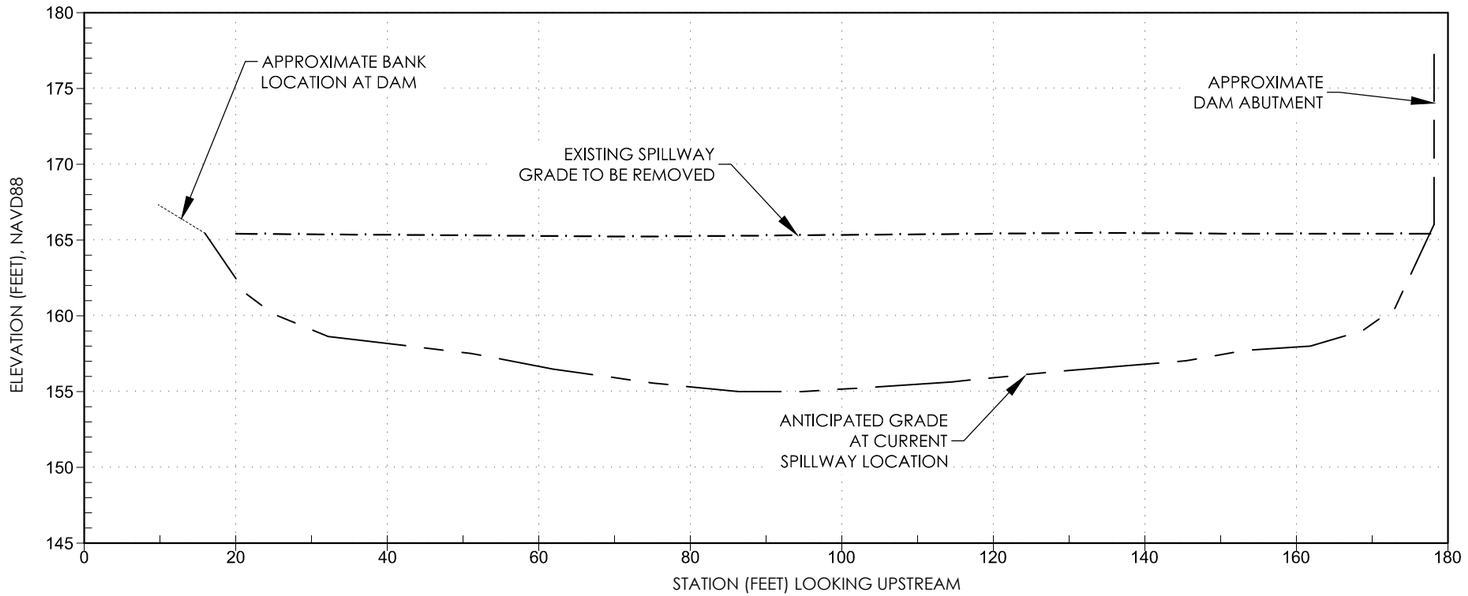
SHEET ID
1

OCT.2018



A AOP 3 - ORRS MILL DAM PROFILE
ALTERNATIVE 1: DAM REMOVAL
MOODNA CREEK

ELEVATIONS REFERENCED TO NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88), FEET



B AOP 3 - ORRS MILL DAM CROSS SECTION AT STATION 960
ALTERNATIVE 1: DAM REMOVAL
MOODNA CREEK

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

DESIGNED BY:
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U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT
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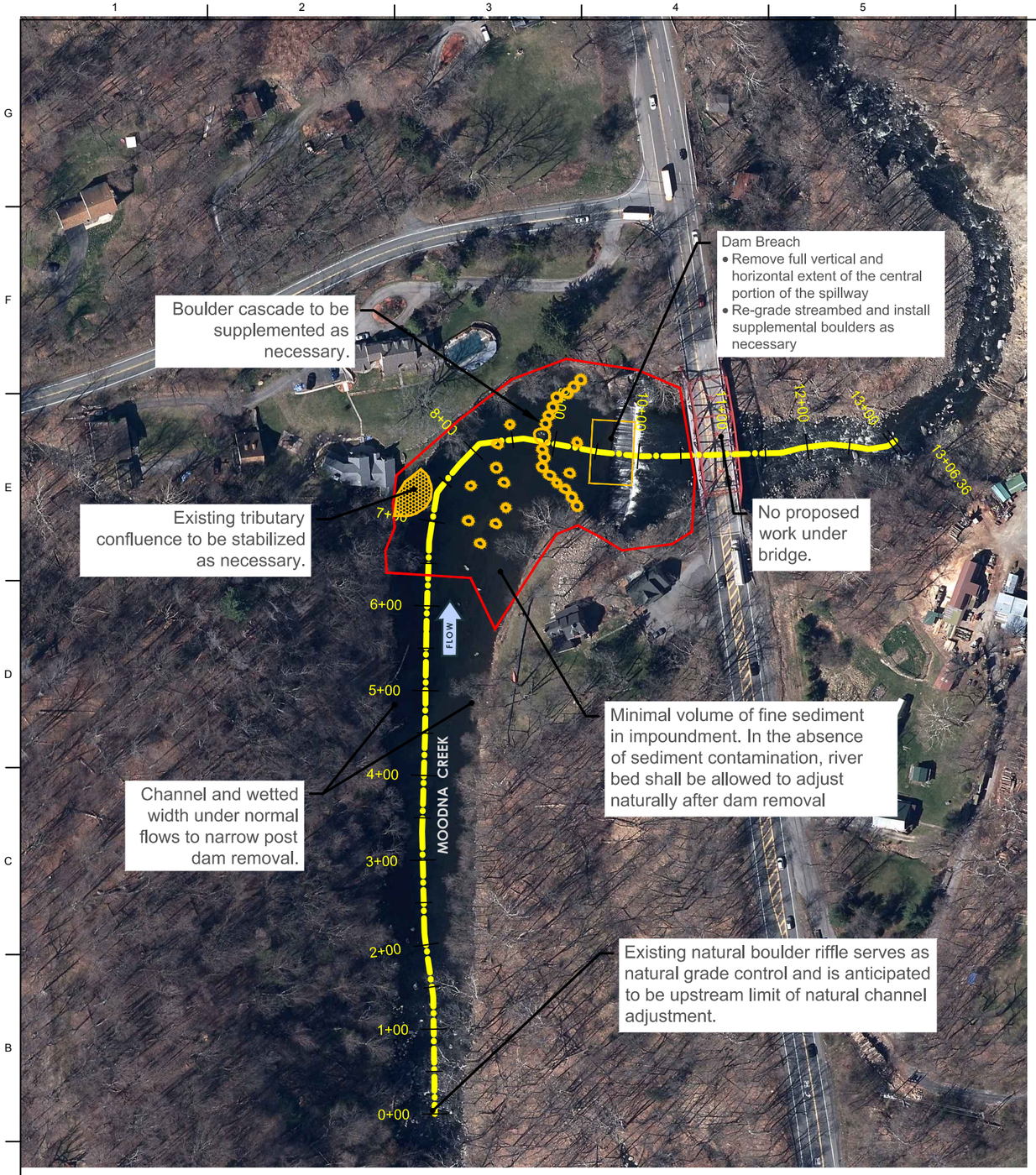
HUDSON RIVER HABITAT RESTORATION
MOODNA CREEK
ORANGE COUNTY, NY
MOODNA CREEK
AOP 3 - ORRS MILL DAM
ALTERNATIVE 1 - DAM REMOVAL

SHEET ID
2

OCT.2018



1 PLAN VIEW
1" = 150'

0 30 60 90 120 150 300 450 600 FEET

SCALE: 1" = 150'

Legend
- River Profile
- Project Footprint
- Dam Breach
- Proposed Boulder

MOODNA CREEK
AOP 3 - ORRS MILL DAM
ALTERNATIVE 2:
DAM BREACH

Acronym	Definition
AC	Acres
CY	Cubic Yards
FT	Feet
LF	Linear Feet
LS	Lump Sum
SY	Square Yards
WSEL	Water Surface Elevation

Dam Breach

Item	*Unit*	*Quantity*
Water Control Materials (Sand-Filled BigBags)	LF	400
Water Control Installation & Modification	LS	1
Access Ramp	CY	80
Spillway Breach Demolition / Excavation	CY	780
Disposal of Spillway Concrete	TON	490
Breach Stabilization (Boulder Toe)	TON	170
Abutment Removal (Optional)	CY	350
Disposal of Abutment Concrete/Masonry/Earth	TON	30
Re-grade Streambed	SY	3,340
Supplemental Boulders (12, 4x5x6ft, delivered)	TON	130
Grade Control Stabilization	LF	400
Tributary Confluence Stabilization (Boulders, 24, 3x4x5ft, delivered)	TON	130
Boulder Grade Control (Boulders, 40, 4x5x6ft, delivered)	TON	420

General Construction

Item	*Unit*	*Quantity*
Traffic Control	LS	1
Turbidity Barrier	LS	1
Silt Fence	LF	80
Stabilized Construction Entrance	TON	50
Construction Access Matting	SF	1600
Construction Access Ramp	TON	90
Construction Access Pad	TON	620
Clearing and Grubbing	AC	0.2

A SCHEDULE OF QUANTITIES
Alternative 2 - Dam Breach

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MARK	DESCRIPTION	DATE

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HUDSON RIVER HABITAT RESTORATION
MOODNA CREEK
ORANGE COUNTY, NY
MOODNA CREEK
AOP 3 - ORRS MILL DAM
ALTERNATIVE 2 - DAM BREACH

SHEET ID
1

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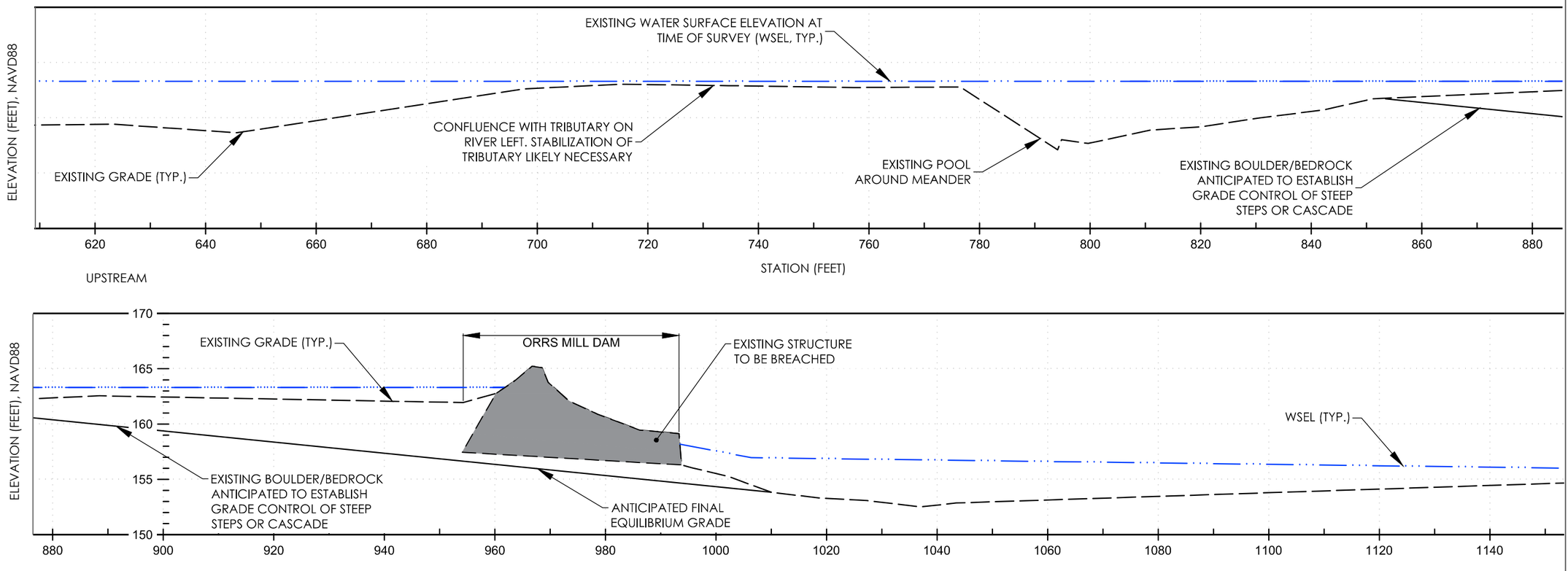
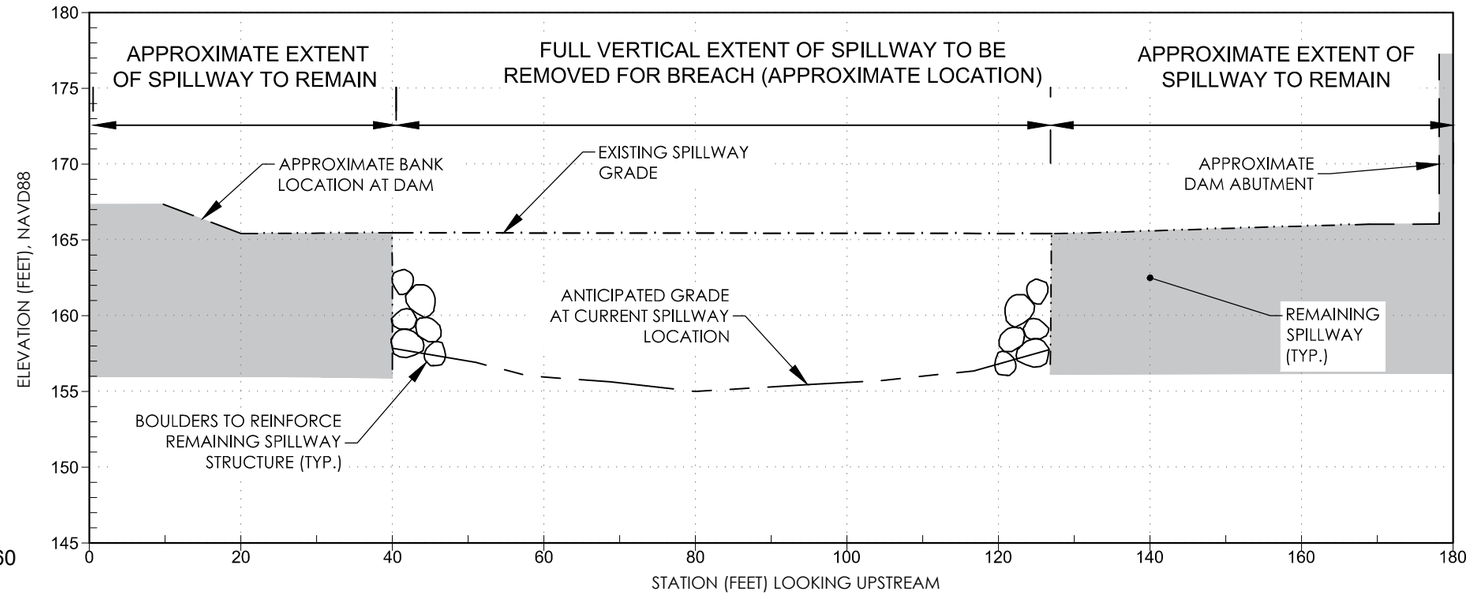


A AOP 3 - ORRS MILL DAM PROFILE
ALTERNATIVE 2: DAM BREACH
MOODNA CREEK

ELEVATIONS REFERENCED TO NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88), FEET



B AOP 3 - ORRS MILL DAM CROSS SECTION AT STATION 960
ALTERNATIVE 2: DAM BREACH
MOODNA CREEK

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

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HUDSON RIVER HABITAT RESTORATION
MOODNA CREEK
ORANGE COUNTY, NY
MOODNA CREEK
AOP 3 - ORRS MILL DAM
ALTERNATIVE 2 - DAM BREACH

SHEET ID
2

OCT.2018

1 PLAN VIEW
1" = 200'

GRAPHIC SCALE
0 50 100 150 200 400 600 800 FEET
SCALE: 1" = 200'

Legend
- Project Footprint
- Approximate extent of fishway

RONDOUT CREEK
EDDYVILLE DAM
ALTERNATIVE 1: FISHWAY

Acronym	Definition
AC	Acres
CY	Cubic Yards
FT	Feet
LF	Linear Feet
LS	Lump Sum
SY	Square Yards
WSEL	Water Surface Elevation

Fishway

Item	*Unit*	*Quantity*
Water Control Materials (Sand-Filled BigBags)	LF	400
Water Control Installation & Modification	LS	1
Spillway / Bedrock Notching (Sawcutting)	LF	10
Fishway Concrete Construction	FT	12

General Construction

Item	*Unit*	*Quantity*
Turbidity Barrier	LF	250
Silt Fence	LF	80
Construction Access Matting	SF	2100
Construction Access Ramp	TON	390
Clearing and Grubbing	AC	0.30
Stabilized Construction Entrance	TON	50

A SCHEDULE OF QUANTITIES
Alternative 1

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

DESIGNED BY:
DRAWN BY: AG/JD/PW/TH
CHECKED BY: AG/PW
SUBMITTED BY: PRINCETON HYDRO
ISSUE DATE: MAY 2018
SOLICITATION NO.:
CONTRACT NO.: W912DS-14-D-0001
SIZE: 11x17

U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT
26 FEDERAL PLAZA
NEW YORK, NEW YORK, 10278

PRINCETON HYDRO, LLC
1108 OLD YORK ROAD
RINGOES, NEW JERSEY, 08551

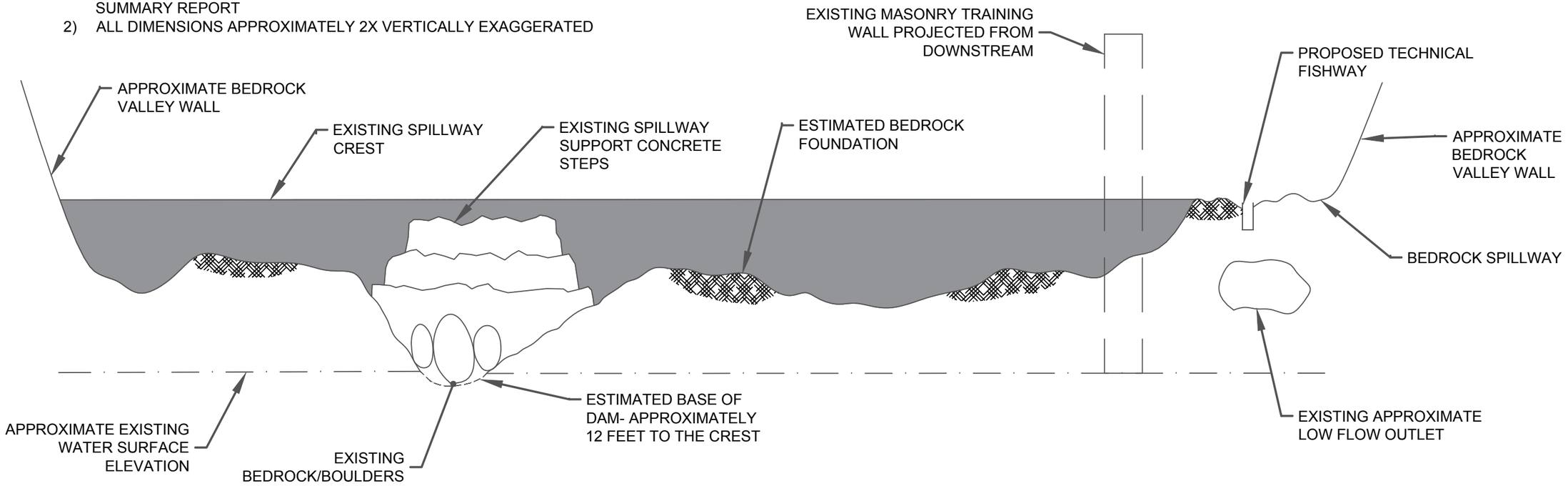
HUDSON RIVER HABITAT RESTORATION
RONDOUT CREEK
ULSTER COUNTY, NY

RONDOUT CREEK
EDDYVILLE DAM
ALTERNATIVE 1 - FISHWAY

SHEET ID
1

OCT.2018

NOTES:
1) ESTIMATED FROM PICTURE TAKEN ON JULY 3, 2001. SEE FIGURE 19 IN RONDOUT SUMMARY REPORT
2) ALL DIMENSIONS APPROXIMATELY 2X VERTICALLY EXAGGERATED



A FISHWAY - CROSS SECTION
ALTERNATIVE 1
RONDOUT CREEK

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

ISSUE DATE: MAY 2018
SOLICITATION NO.:
CONTRACT NO.: W912DS-14-D-0001
DESIGNED BY:
DRAWN BY: AG/JD/PW/TH
CHECKED BY: JEW/PW
SUBMITTED BY: PRINCETON HYDRO
SIZE: 11x17

U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT
26 FEDERAL PLAZA
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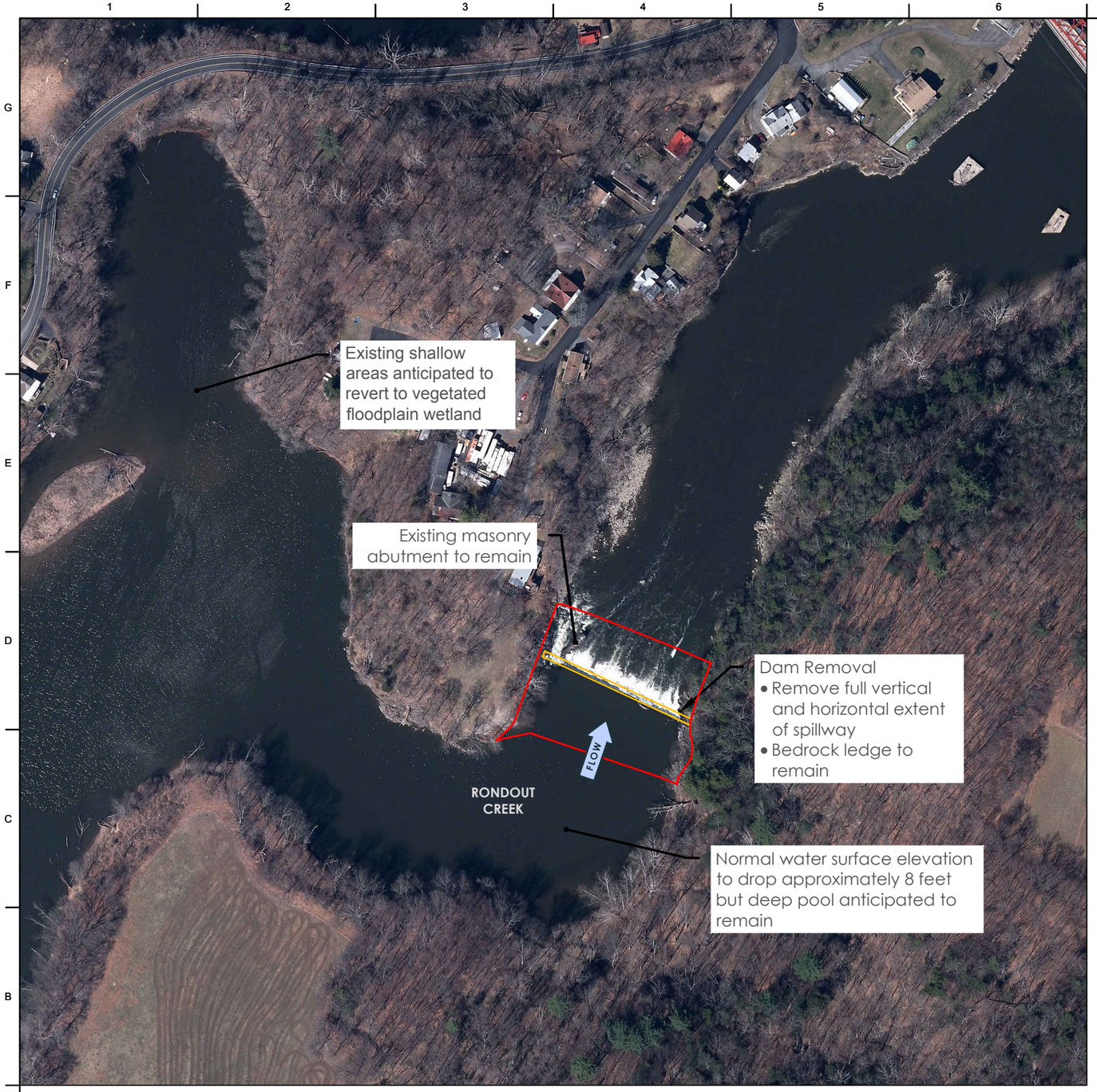
HUDSON RIVER HABITAT RESTORATION
RONDOUT CREEK
ULSTER COUNTY, NY

RONDOUT CREEK
EDDYVILLE DAM
ALTERNATIVE 1 - FISHWAY

SHEET ID
2

OCT.2018



1 PLAN VIEW
1" = 200'

GRAPHIC SCALE
0 50 100 150 200 400 600 800 FEET
SCALE: 1" = 200'

Legend
- Project Footprint
- Approximate extent of dam to be removed

RONDOUT CREEK EDDYVILLE DAM ALTERNATIVE 2: DAM REMOVAL

Acronym	Definition
AC	Acres
CY	Cubic Yards
FT	Feet
LF	Linear Feet
LS	Lump Sum
SY	Square Yards
WSEL	Water Surface Elevation

Dam Removal

Item	*Unit*	*Quantity*
Water Control Materials (Sand-Filled BigBags)	LF	400
Water Control Installation & Modification	LS	1
Spillway Demolition / Excavation	CY	450
Disposal of Concrete	TON	890

General Construction

Item	*Unit*	*Quantity*
Turbidity Barrier	LF	320
Silt Fence	LF	80
Construction Access Pad	TON	4,560
Construction Access Matting	TON	2100
Construction Access Ramp	TON	390
Clearing and Grubbing	AC	0.30
Stabilized Construction Entrance	TON	410

A SCHEDULE OF QUANTITIES
Alternative 2

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

DESIGNED BY:
DRAWN BY: AG/JD/PW/TH
CHECKED BY: AEMPW
SUBMITTED BY: PRINCETON HYDRO
SIZE: 11x17
ISSUE DATE: MAY 2018
SOLICITATION NO.:
CONTRACT NO.: W912DS-14-D-0001

U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT
26 FEDERAL PLAZA
NEW YORK, NEW YORK, 10278

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HUDSON RIVER HABITAT RESTORATION
RONDOUT CREEK
ULSTER COUNTY, NY

RONDOUT CREEK
EDDYVILLE DAM
ALTERNATIVE 2 - DAM REMOVAL

SHEET ID
1

OCT.2018

NOTES:
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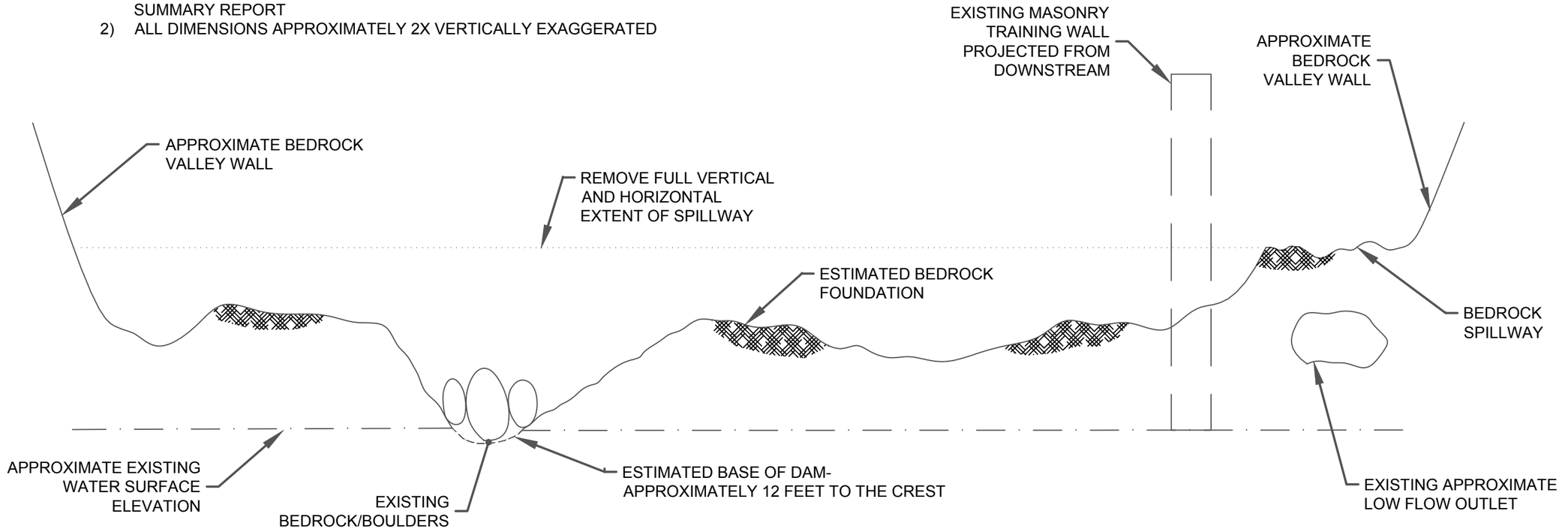

A DAM REMOVAL - CROSS SECTION
ALTERNATIVE 2
RONDOUT CREEK

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

DESIGNED BY:
DRAWN BY: AG/JD/PWTH
CHECKED BY: ADMEW
SUBMITTED BY: PRINCETON HYDRO
SIZE: 11x17
ISSUE DATE: MAY 2018
SOLICITATION NO.:
CONTRACT NO.: W912DS-14-D-0001

U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT
26 FEDERAL PLAZA
NEW YORK, NEW YORK, 10278

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RINGOES, NEW JERSEY, 08551

HUDSON RIVER HABITAT RESTORATION
RONDOUT CREEK
ULSTER COUNTY, NY

RONDOUT CREEK
EDDYVILLE DAM
ALTERNATIVE 2 - DAM REMOVAL

SHEET ID
2

OCT.2018

1 PLAN VIEW
1" = 200'

GRAPHIC SCALE
0 50 100 150 200 400 600 800 FEET
SCALE: 1" = 200'

Legend
- Project Footprint
- Approximate extent of dam to be removed

RONDOUT CREEK EDDYVILLE DAM ALTERNATIVE 3: DAM NOTCHING

Acronym	Definition
AC	Acres
CY	Cubic Yards
FT	Feet
LF	Linear Feet
LS	Lump Sum
SY	Square Yards
WSEL	Water Surface Elevation

Dam Notching

Item	*Unit*	*Quantity*
Water Control Materials (Sand-Filled BigBags)	LF	400
Water Control Installation & Modification	LS	1
Spillway Notching Demolition / Excavation	CY	180
Disposal of Concrete	TON	360

General Construction

Item	*Unit*	*Quantity*
Turbidity Barrier	LF	320
Silt Fence	LF	80
Construction Access Pad	TON	4,560
Construction Access Matting	TON	2100
Construction Access Ramp	TON	390
Clearing and Grubbing	AC	0.30
Stabilized Construction Entrance	TON	410

A SCHEDULE OF QUANTITIES
Alternative 3

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

DESIGNED BY:
DRAWN BY: AG/JD/PW/TH
CHECKED BY: AE/WPM
SUBMITTED BY: PRINCETON HYDRO
SIZE: 11x17
ISSUE DATE: MAY 2018
SOLICITATION NO.:
CONTRACT NO.: W912DS-14-D-0001

U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT
26 FEDERAL PLAZA
NEW YORK, NEW YORK, 10278

PRINCETON HYDRO, LLC
1108 OLD YORK ROAD
RINGOES, NEW JERSEY, 08551

HUDSON RIVER HABITAT RESTORATION
RONDOUT CREEK
ULSTER COUNTY, NY

RONDOUT CREEK
EDDYVILLE DAM
ALTERNATIVE 3 - DAM NOTCHING

SHEET ID
1

OCT.2018

NOTES:
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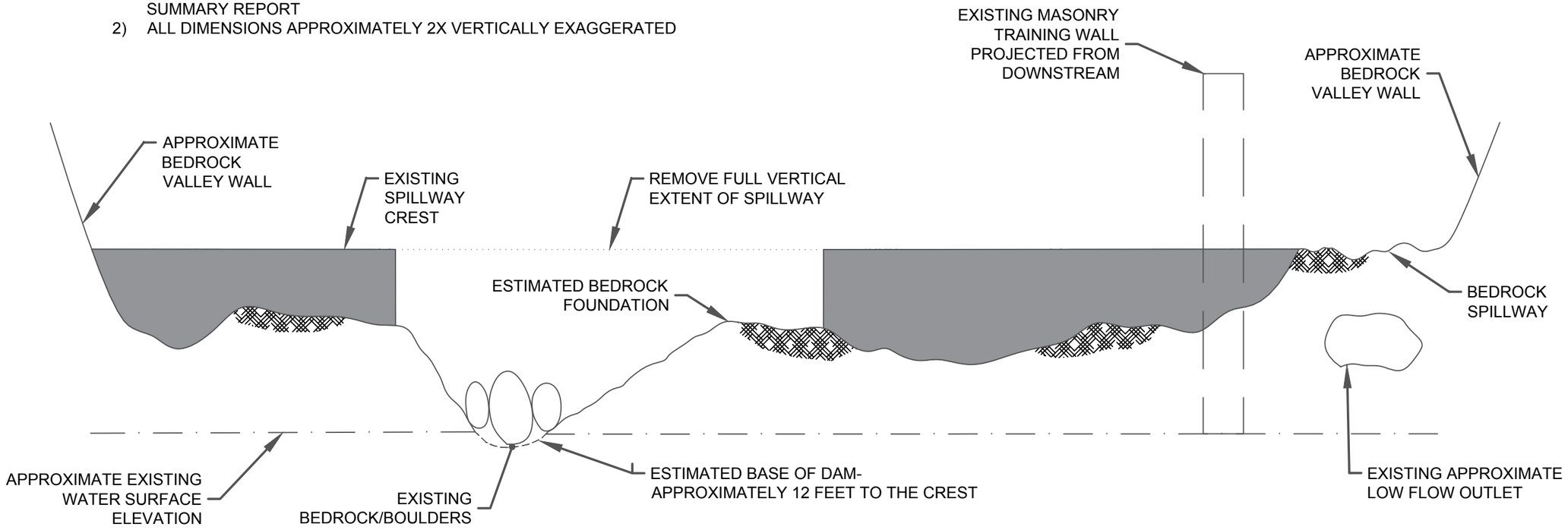
2) ALL DIMENSIONS APPROXIMATELY 2X VERTICALLY EXAGGERATED



A DAM NOTCHING - CROSS SECTION
ALTERNATIVE 3
RONDOUT CREEK

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

DESIGNED BY:
DRAWN BY: AG/JD/PW/TH
CHECKED BY: JEW/PW
SUBMITTED BY: PRINCETON HYDRO
ISSUE DATE: MAY 2018
SOLICITATION NO.:
CONTRACT NO.: W912DS-14-D-0001
SIZE: 11x17

U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT
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NEW YORK, NEW YORK, 10278

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1108 OLD YORK ROAD
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HUDSON RIVER HABITAT RESTORATION
RONDOUT CREEK
ULSTER COUNTY, NY

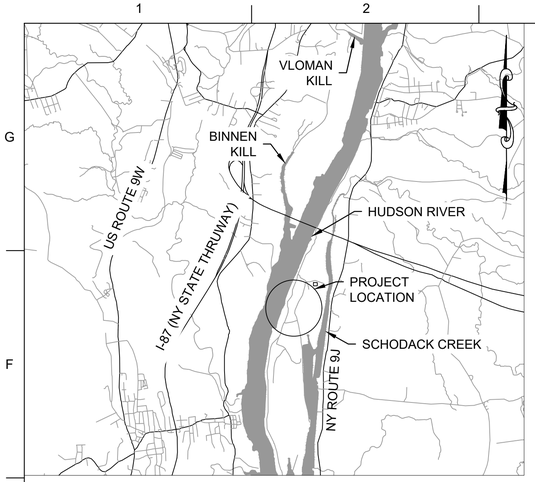
RONDOUT CREEK
EDDYVILLE DAM
ALTERNATIVE 3 - DAM NOTCHING

SHEET ID
2

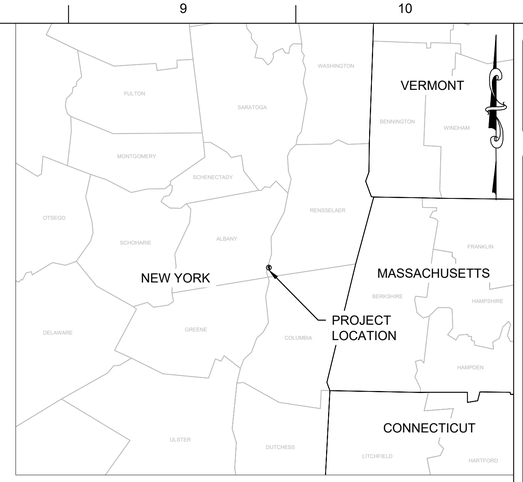
OCT.2018

ATTACHMENT F

RECOMMENDED DESIGNS AND QUANTITIES



VICINITY MAP
SCALE: 1" = 5,000'



LOCATION MAP
SCALE: 1" = 100,000'

HUDSON RIVER HABITAT RESTORATION

SCHODACK ISLAND STATE PARK

TOWN OF SCHODACK
RENSSELAER COUNTY, NEW YORK

MARCH 2020

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

DESIGNED BY: PH
DRAWN BY: TH/CPS
CHECKED BY: AEM
SUBMITTED BY: PRINCETON HYDRO
SIZE: ANSI D
ISSUE DATE: JAN 2020
SOLICITATION NO.: W912DS-20-F-0024
CONTRACT NO.: W912DS-19-D-0003

U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT
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NEW YORK, NEW YORK, 10278

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1108 OLD YORK ROAD
RINGOES, NEW JERSEY, 08551

HUDSON RIVER HABITAT RESTORATION
SCHODACK ISLAND STATE PARK
RENSSELAER COUNTY, NEW YORK

COVER SHEET

SHEET ID
G-001

GENERAL NOTES:

1. THE CONTRACTOR SHALL NOTE THAT IN THE CASE OF A DISCREPANCY BETWEEN THE SCALED AND FIGURED DIMENSIONS SHOWN ON THESE PLANS, THE FIGURED DIMENSIONS SHALL APPLY.
2. SINCE FIELD CONDITIONS MAY REQUIRE MODIFICATIONS TO PROPOSED TOPOGRAPHIC ELEVATIONS AND FACILITY LOCATIONS, THESE PLANS ARE NOT TO BE UTILIZED AS AS-BUILTS FOR ANY OTHER PURPOSE.
3. THESE PLANS ARE NOT TO BE UTILIZED FOR CONSTRUCTION UNTIL ALL REQUIRED LOCAL, STATE, AND FEDERAL PERMITS ARE OBTAINED.
4. THE CONTRACTOR MUST CONTACT THE NEW YORK ONE CALL NUMBER AT 1-800-962-7962, TWO FULL WORKING DAYS PRIOR TO THE START OF WORK TO HAVE ALL UTILITIES MARKED IN THE WORK AREA. ADDITIONALLY, THE CONTRACTOR MUST CONTACT ALL UTILITY OPERATORS NOT AFFILIATED WITH ONE CALL IN ORDER TO LOCATE ALL OTHER UTILITIES WITHIN THE PROJECT AREA. THE CONTRACTOR SHALL ESTABLISH A LIAISON WITH ALL UTILITIES AND ADVISE THE CONTRACTING OFFICER (CO) IN WRITING OF THE DETAILS.
5. ALL CONSTRUCTION SHALL ADHERE TO OSHA STANDARDS AND REGULATIONS.
6. IT SHALL BE DISTINCTLY NOTED THAT FAILURE TO MENTION SPECIFICALLY ANY WORK THAT WOULD NORMALLY BE REQUIRED TO COMPLETE THE PROJECT, SHALL NOT RELIEVE THE CONTRACTOR'S RESPONSIBILITY TO PERFORM THAT WORK.
7. THE APPROVAL AND USE OF THESE PLANS ARE FOR THE PROJECT SPONSOR . THIS PLAN IS NOT TO BE UTILIZED IN THE PREPARATION OF ANY OTHER PROJECTS.
8. CONTRACTOR SHALL VERIFY ALL DIMENSIONS AND EXISTING CONDITIONS IN THE FIELD PRIOR TO THE START OF CONSTRUCTION AND ERRORS OR DISCREPANCIES SHALL BE IMMEDIATELY BROUGHT TO THE ATTENTION OF THE CONTRACTING OFFICER (CO) OR CONTRACTING OFFICER'S REPRESENTATIVE (COR).
9. THE CONTRACTOR WILL BE REQUIRED TO PERFORM A MINIMUM OF THREE (3) INSPECTIONS DAILY AND PERFORM ROUTINE CLEAN UP DUTIES AS REQUIRED AND ALSO MAINTAIN ALL EXCAVATIONS, EMBANKMENTS, STOCKPILES, HAUL ROADS, PLANT SITES, WASTE AREAS, BORROW AREAS, AND ALL OTHER WORK AREAS WITHIN OR WITHOUT OF THE PROJECT BOUNDARIES FREE FROM DUST WHICH WOULD CAUSE A HAZARD OR NUISANCE TO OTHERS. DUST CONTROL SHALL BE PERFORMED AS THE WORK PROCEEDS AND WHENEVER A DUST NUISANCE OR HAZARD OCCURS.
10. ALL PLAN SHEETS ARE HORIZONTALLY REFERENCED TO THE NORTH AMERICAN DATUM OF 1983 (NAD83), PROJECTED TO THE NEW YORK STATE PLANE COORDINATE SYSTEM, AND VERTICALLY REFERENCED TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88). ALL UNITS ARE IN U.S. SURVEY FEET UNLESS OTHERWISE SPECIFIED..
11. ACCESS TO ALL PROPERTIES MUST BE MAINTAINED DURING CONSTRUCTION.
12. MAIL DELIVERY SHALL NOT BE DISRUPTED DURING CONSTRUCTION.
13. PROPERTY AND RIGHT-OF-WAY LINES SHOWN ON THESE PLANS WERE BASED ON INFORMATION PROVIDED BY E4SCIENCES. THE PROPERTY AND RIGHT OF WAY LINES SHOWN ON THESE DRAWINGS ARE APPROXIMATE, AND ARE NOT BASED ON METES AND BOUNDS FIELD RUN SURVEYS OR PROPERTY RECORDS. THE CONTRACTOR SHALL TAKE PRECAUTIONS TO LOCATE PROPERTY LINES AND RIGHT OF WAY LINES PRIOR TO CONSTRUCTION AND AVOID CONSTRUCTION ACTIVITIES ON PRIVATE PROPERTY AND/OR RIGHTS OF WAYS WHERE SAID CONSTRUCTION IS PROHIBITED. THE CONTRACTOR MAY CONDUCT CONSTRUCTION ACTIVITIES ON PRIVATE PROPERTY PROVIDED HE HAS OBTAINED PRIOR WRITTEN PERMISSION FROM THE PROPERTY OWNER AND HAS SUBMITTED A COPY OF SAID WRITTEN PERMISSION TO THE CO OR COR.
14. THE CONTRACTOR SHALL ALLOW SUFFICIENT TIME FOLLOWING EXCAVATIONS FOR INSPECTION AND EVALUATION OF EXISTING SOIL SUBGRADE CONDITIONS BY A COMPETENT PERSON PER 29 CFR 1926.32(f) AND THE CO OR COR.

SITE RESTORATION:

1. THE CONTRACTOR IS RESPONSIBLE TO RESTORE ALL GRASSY AREAS, PAVED AND CONCRETE AREAS, DRIVEWAYS AND CURBING DISTURBED DURING CONSTRUCTION TO THEIR PRE-CONSTRUCTION CONDITION AFTER COMPLETION OF CONSTRUCTION AND PRIOR TO FINAL ACCEPTANCE OF THE PROJECT.
2. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE REPAIR AND REPLACEMENT OF PROPERTY DAMAGE TO FENCES, SIGNS, STRUCTURES, VEGETATION, IRRIGATION, LANDSCAPING COMPONENTS, AND ANY OTHER PROPERTY ITEMS THAT ARE REMOVED FOR THE PURPOSES OF THE PROJECT LOGISTICS AND/OR ACCIDENTS.
3. ALL PAVED AND CONCRETE AREAS DISTURBED DURING CONSTRUCTION SHALL BE RESTORED TO A CONDITION AT LEAST EQUAL TO THAT WHICH EXISTED PRIOR TO THE START OF CONSTRUCTION.
4. ALL GRASSED OR WOODED AREAS DISTURBED DURING CONSTRUCTION SHALL BE TOPSOILED AND SEEDED.

SITEWORK:

1. EXCAVATIONS AND STOCKPILES SHALL HAVE SLOPES CONSISTENT WITH A SITE SHORING AND EXCAVATION PLAN SIGNED AND SEALED BY A LICENSED ENGINEER IN THE STATE OF NEW YORK.
2. THE CONTRACTOR IS RESPONSIBLE FOR THE REMOVAL AND PROPER DISPOSAL OF ALL STOCK-PILED SOIL, TRASH, CONSTRUCTION MATERIALS AND DEBRIS AFTER THE COMPLETION OF CONSTRUCTION. ALL DISPOSAL SHALL BE PERFORMED IN ACCORDANCE WITH APPLICABLE MUNICIPAL, COUNTY, STATE, AND FEDERAL REGULATIONS.
3. FOR INSTALLATION OF STABILIZED CONSTRUCTION ENTRANCE AND CONSTRUCTION ACCESS ROAD, CONTRACTOR SHALL AVOID TREE IMPACTS IN ACCORDANCE WITH SPECIFICATIONS.
4. ALL ELEVATIONS AND QUANTITIES ARE BASED ON IN-SITU CONDITIONS. ONCE DISTURBED, MATERIAL CONDITIONS CAN VARY SIGNIFICANTLY.
5. ALL PROPOSED CONSTRUCTION MUST BE SUPERVISED BY A PROFESSIONAL ENGINEER, LICENSED IN THE STATE OF NEW YORK, OR THEIR DULY APPOINTED REPRESENTATIVE.
6. ALL STOCKPILED MATERIAL PROPOSED FOR USE AS STRUCTURAL FILL WILL BE PROTECTED FROM EXCESSIVE LOSS OR GAIN OF MOISTURE USING SECURELY ANCHORED PLASTIC COVERS OR EQUIVALENT METHODS.
7. WHERE REQUIRED TO FACILITATE WORK, THE CONTRACTOR MAY NEED TO TEMPORARILY SHORE AND STABILIZE THE WORK AREA DEPENDING ON THE MEANS AND METHODS UTILIZED TO CONSTRUCT THE PROJECT. ANY REQUIRED SHEETING AND SHORING IS TO BE CONSISTENT WITH THE SITE SHORING AND EXCAVATION PLAN DESIGNED BY A LICENSED NEW YORK PROFESSIONAL ENGINEER AND SUBMITTED TO THE CO OR COR FOR REVIEW AND APPROVAL.
8. SOILS AND/OR OTHER MATERIALS TO BE UTILIZED FOR FILLING OR BACKFILLING TO GRADE SHALL BE CONSISTENT WITH THE CONTRACT DOCUMENTS.
9. PROXIMITY OF STOCKPILES TO THE EDGE OF EXCAVATIONS SHALL BE SUCH THAT THE INFLUENCE OF THE STOCKPILE SURCHARGE ON THE MODIFIED OR EXISTING SLOPE IS REDUCED. WHERE POSSIBLE STOCKPILES WILL BE PLACED A DISTANCE FROM THE EDGE OF EXCAVATION EQUAL TO (OR GREATER THAN) THE DEPTH OF THE EXCAVATION. STOCKPILES NEAR EXCAVATIONS SHALL MEET ALL THE REQUIREMENTS OF THE SIGNED/SEALED/APPROVED SHORING AND EXCAVATION PLAN.
10. ALL UNSUITABLE SOIL MATERIALS PRODUCED SHALL BE DISPOSED OF OFFSITE IN ACCORDANCE WITH LOCAL, COUNTY, STATE, AND FEDERAL REQUIREMENTS.
11. ALL EQUIPMENT STAGING AND STORAGE MUST BE LOCATED WITHIN THE LIMIT OF DISTURBANCE AND IN ACCORDANCE WITH THE REQUIREMENTS OF THE CONTRACT DOCUMENTS.
12. ALL FILL SHALL BE PLACED IN ACCORDANCE WITH THE CONTRACT DOCUMENTS. UNSUITABLE MATERIAL SHALL BE REMOVED AND REPLACED WITH CLEAN FILL MATERIAL, AS DEFINED AND IN ACCORDANCE WITH THE CONTRACT DOCUMENTS.

DATA SOURCE NOTES:

1. EXISTING CONTOURS DERIVED USING 2011-2012 LIDAR DATA OBTAINED FROM FROM THE NEW YORK STATE GIS CLEARINGHOUSE. ALL ELEVATIONS ARE REFERENCED TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88) IN U.S. SURVEY FEET.
2. TIDAL DATUMS CALCULATED BY USACE USING WATER LEVEL OBSERVATIONS OBTAINED FROM THE HUDSON RIVER ENVIRONMENTAL CONDITIONS OBSERVING SYSTEM (HRECOS), SCHODACK ISLAND STATION.

CALL BEFORE YOU DIG!
NEW YORK LAW REQUIRES
2 FULL WORKING DAYS NOTICE
PRIOR TO CONSTRUCTION - STOP CALL
CALL BEFORE YOU DIG, INC.
REFERENCE NEW YORK STATE
LAW INDUSTRIAL CODE 53
1-800-962-7962

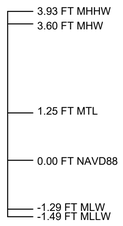
GENERAL CONSTRUCTION SEQUENCE:

1. MOBILIZATION
2. INSTALLATION OF SOIL EROSION AND SEDIMENT CONTROL FEATURES
3. INSTALLATION/MODIFICATION OF TEMPORARY WORK ACCESS ROAD(S)
4. SITE CLEARING, INCLUDING REMOVAL OF EXISTING VEGETATION AND INVASIVE SPECIES TREATMENT, WHERE APPLICABLE
5. INSTALLATION OF WATER CONTROL FEATURES, WHERE APPLICABLE
6. EARTHWORK; INCLUDING EXCAVATION, GRADING, AND IMPORT OF SELECT AMENDED SOILS, WHERE APPLICABLE
7. INSTALLATION OF FLOODPLAIN CULVERTS - INCLUDES ALL EIGHT (8) 48 IN x 76 IN ERCP CULVERTS AND MAIN 14 FT x 20 FT CULVERT WITH NATURAL STREAM BOTTOM.
8. INSTALLATION OF ROAD, GUARDRAIL AND ASSOCIATED COMPONENTS.
9. INSTALLATION OF HERBIVORE EXCLUSION FENCING
10. INSTALLATION OF PLANTS AND SEED
11. DEMOBILIZATION

EXPECTED CONSTRUCTION DURATION: 2 YEARS

NOTES:
1. ABOVE CONSTRUCTION ACTIVITIES MAY OCCUR CONCURRENTLY AS THE CONTRACTOR SEES FIT. ONE AREA MAY BE COMPLETED PRIOR TO THE START OF CONSTRUCTION IN ANOTHER AREA. HOWEVER, IN ALL AREAS, SOIL EROSION AND SEDIMENT CONTROL MEASURES MUST BE INSTALLED PRIOR TO CONSTRUCTION.
2. ACCESS TO THE EXISTING ROAD MUST BE MAINTAINED FROM AUGUST THROUGH DECEMBER

TIDAL RANGE



SHEET NO.	TITLE	SHEET REFERENCE NO.
	GENERAL	
1	COVER SHEET	G-001
2	GENERAL NOTES SHEET	G-002
	CIVIL	
3	KEY MAP	C-001
4	GENERAL PLAN SHEET 1	C-101
5	GENERAL PLAN SHEET 2	C-102
6	GENERAL PLAN SHEET 3	C-103
7	PROFILE SHEET 1	C-201
8	PROFILE SHEET 2	C-202
9	CROSS-SECTION SHEET 1	C-301
10	CROSS-SECTION SHEET 2	C-302
11	CROSS-SECTION SHEET 3	C-303
12	CROSS-SECTION SHEET 4	C-304
	LANDSCAPE	
13	LANDSCAPING NOTES	L-001
14	LANDSCAPE PLAN SHEET 1	L-101
15	LANDSCAPE PLAN SHEET 2	L-102
16	LANDSCAPE PLAN SHEET 3	L-103
	SURVEY	
17	EXISTING SURVEY PLAN SHEET 1	V-101
18	EXISTING SURVEY PLAN SHEET 2	V-102
19	EXISTING SURVEY PLAN SHEET 3	V-103

EXISTING FEATURES LEGEND

- 5 — EXISTING MAJOR CONTOUR
- 3 — EXISTING MINOR CONTOUR
- EXISTING RIVER EDGE (MEAN TIDE LINE)
- EXISTING EDGE OF PAVEMENT
- EXISTING PATH

PROPOSED FEATURES LEGEND

- 5 — PROPOSED MAJOR CONTOUR
- 3 — PROPOSED MINOR CONTOUR
- PROPOSED GUARDRAIL
- PROPOSED TRAIL CENTERLINE
- CP — PROPOSED FLOODPLAIN CULVERT CENTERLINE
- CROSS SECTION LINE
- PROFILE ALIGNMENT
- PROPOSED ROAD
- PROPOSED CULVERT SCOUR PROTECTION
- PROPOSED HEADWALL

PROPOSED PLANTING LEGEND

- PROPOSED UPLAND HERBACEOUS AREA
- PROPOSED UPLAND SHRUB AREA
- PROPOSED SCRUB SHRUB WETLAND AREA
- PROPOSED UPPER TIDAL WETLAND AREA
- PROPOSED LOWER TIDAL WETLAND AREA
- PROPOSED INVASIVE SPECIES TREATMENT AND SCRUB SHRUB WETLAND AREA
- PROPOSED INVASIVE SPECIES TREATMENT AND UPPER TIDAL WETLAND AREA
- PROPOSED INVASIVE SPECIES TREATMENT AND LOWER TIDAL WETLAND AREA

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

ISSUE DATE: JAN 2020
SOLICITATION NO.: W912DS-20-F-0024
CONTRACT NO.: W912DS-19-D-0003

DESIGNED BY: PH
DRAWN BY: TH/CPS
CHECKED BY: AEM
SUBMITTED BY: PRINCETON HYDRO
SIZE: ANSI D

U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT
26 FEDERAL PLAZA
NEW YORK, NEW YORK, 10278

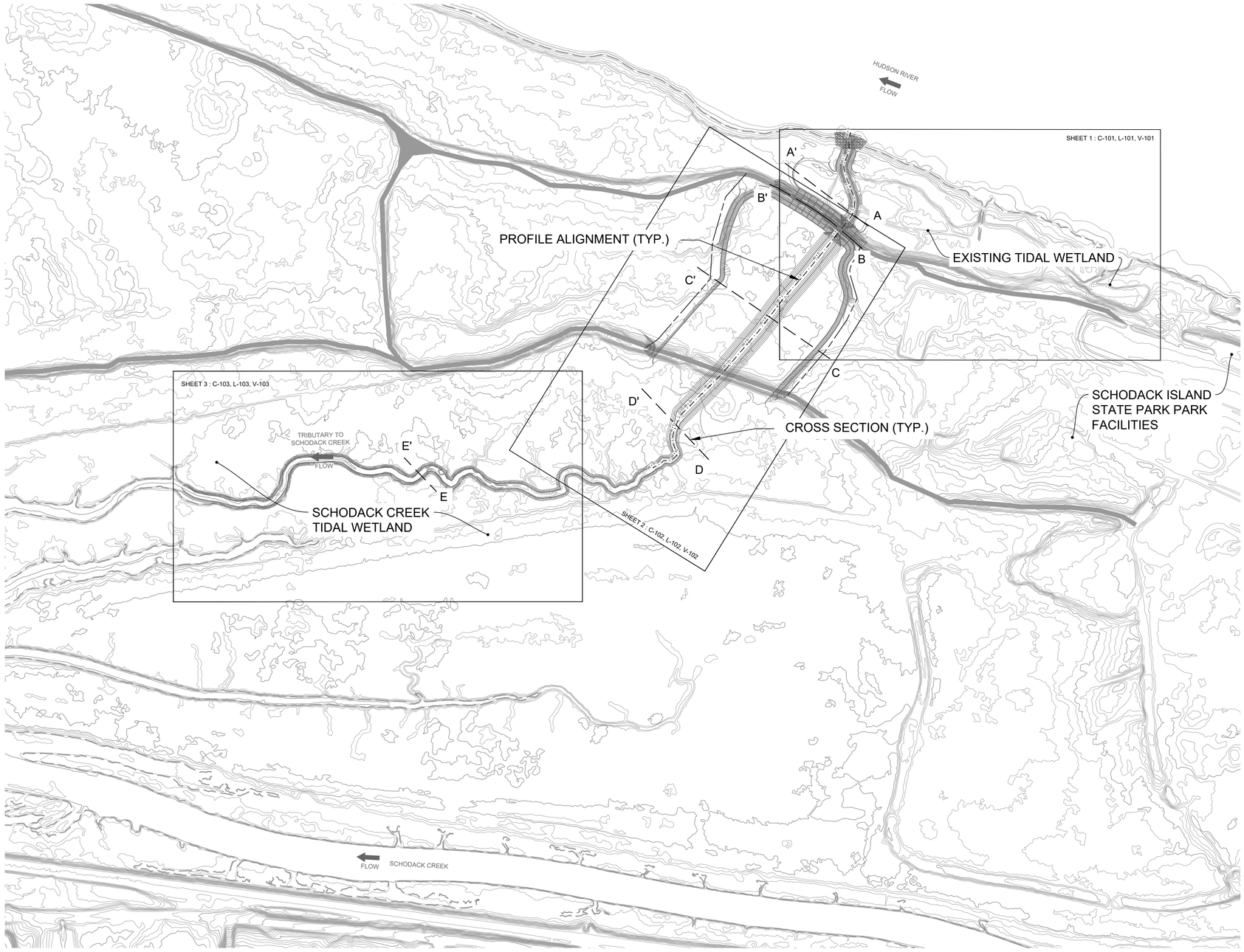
PRINCETON HYDRO, LLC
1108 OLD YORK ROAD
RINGOES, NEW JERSEY, 08551

HUDSON RIVER HABITAT RESTORATION
SCHODACK ISLAND STATE PARK
RENSSELAER COUNTY, NEW YORK

GENERAL NOTES

SHEET ID
G-002

MARCH 2020



GRAPHIC SCALE

0 100 200 400 600 800 FEET

SCALE: 1" = 200'

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

DESIGNED BY: PH	ISSUE DATE: JAN 2020
DRAWN BY: TH/CPS	SOLICITATION NO.: W912DS-20-F-0024
CHECKED BY: AEM	CONTRACT NO.: W912DS-19-D-0003
SUBMITTED BY: PRINCETON HYDRO	
SIZE: ANSI D	

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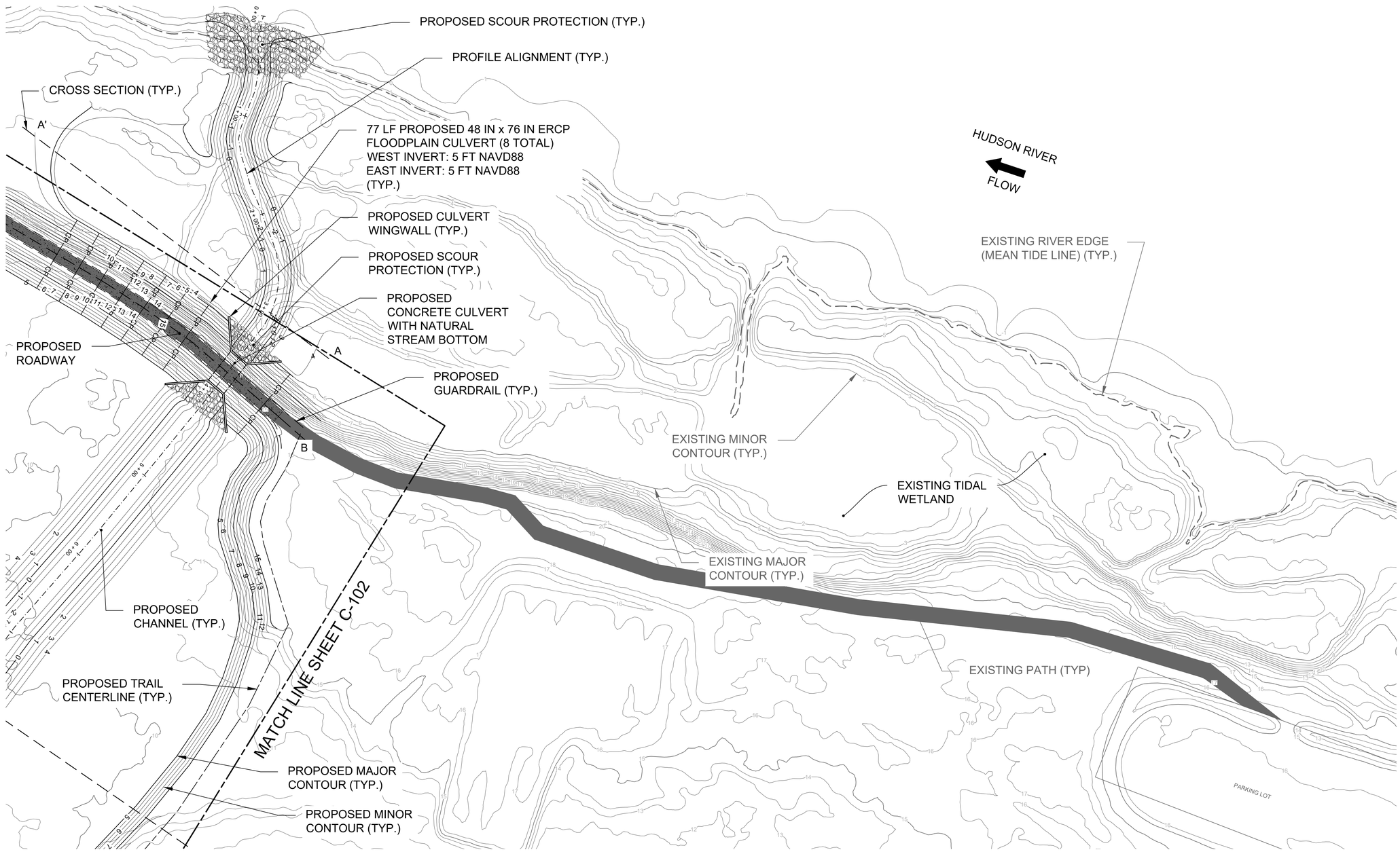
HUDSON RIVER HABITAT RESTORATION
SCHODACK ISLAND STATE PARK
RENSSELAER COUNTY, NEW YORK

KEY MAP

SHEET ID

C-001

MARCH 2020



GRAPHIC SCALE

0 25 50 100 150 200 FEET

SCALE: 1" = 50'

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

DESIGNED BY: PH
DRAWN BY: TH/CPS
CHECKED BY: AEM
SUBMITTED BY: PRINCETON HYDRO
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ISSUE DATE: JAN 2020
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U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT
26 FEDERAL PLAZA
NEW YORK, NEW YORK, 10278

PRINCETON HYDRO, LLC
1108 OLD YORK ROAD
RINGOES, NEW JERSEY, 08551

HUDSON RIVER HABITAT RESTORATION
SCHODACK ISLAND STATE PARK
RENSSELAER COUNTY, NEW YORK

GENERAL PLAN SHEET 1

SHEET ID

C-101

MARCH 2020

PROPOSED MAJOR CONTOUR (TYP.)

PROPOSED TRAIL CENTERLINE (TYP.)

PROPOSED SCOUR PROTECTION (TYP.)

PROPOSED CULVERT WINGWALL (TYP.)

PROPOSED CONCRETE CULVERT WITH NATURAL STREAM BOTTOM

PROFILE ALIGNMENT (TYP.)

PROPOSED ROADWAY

EXISTING TRAIL TO BE REDIRECTED

PROPOSED MINOR CONTOUR (TYP.)

CROSS SECTION (TYP.)

PROPOSED CHANNEL (TYP.)

MATCH LINE SHEET C-101

PROPOSED MINOR CONTOUR (TYP.)

PROPOSED CHANNEL EXPANSION
20 FT WIDE CHANNEL BOTTOM SET AT ELEV. 0.00 FT

77 LF PROPOSED 48 IN x 76 IN ERCP
FLOODPLAIN CULVERT (8 TOTAL)
WEST INVERT: 5 FT NAVD88
EAST INVERT: 5 FT NAVD88
(TYP.)

EXISTING TRAIL (TYP.)

EXISTING MAJOR CONTOUR (TYP.)

SIDE SLOPES FOR THE CHANNEL EXPANSION SHALL BE EXTENDED TO EXISTING GRADE. AT A SLOPE NO STEEPER THAN 3:1. NO FILL IS PROPOSED ALONG THIS CHANNEL (TYP.)

PROPOSED MAJOR CONTOUR (TYP.)

PROPOSED TRAIL CENTERLINE (TYP.)

EXISTING TRAIL (TYP.)

PROPOSED GUARDRAIL (TYP.)

MATCH LINE SHEET C-103

GRAPHIC SCALE
0 25 50 100 150 200 FEET
SCALE: 1" = 50'

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

ISSUE DATE: JAN 2020
SOLICITATION NO.: W912DS-20-F-0024
CONTRACT NO.: W912DS-19-D-0003

DESIGNED BY: PH
DRAWN BY: TH/CPS
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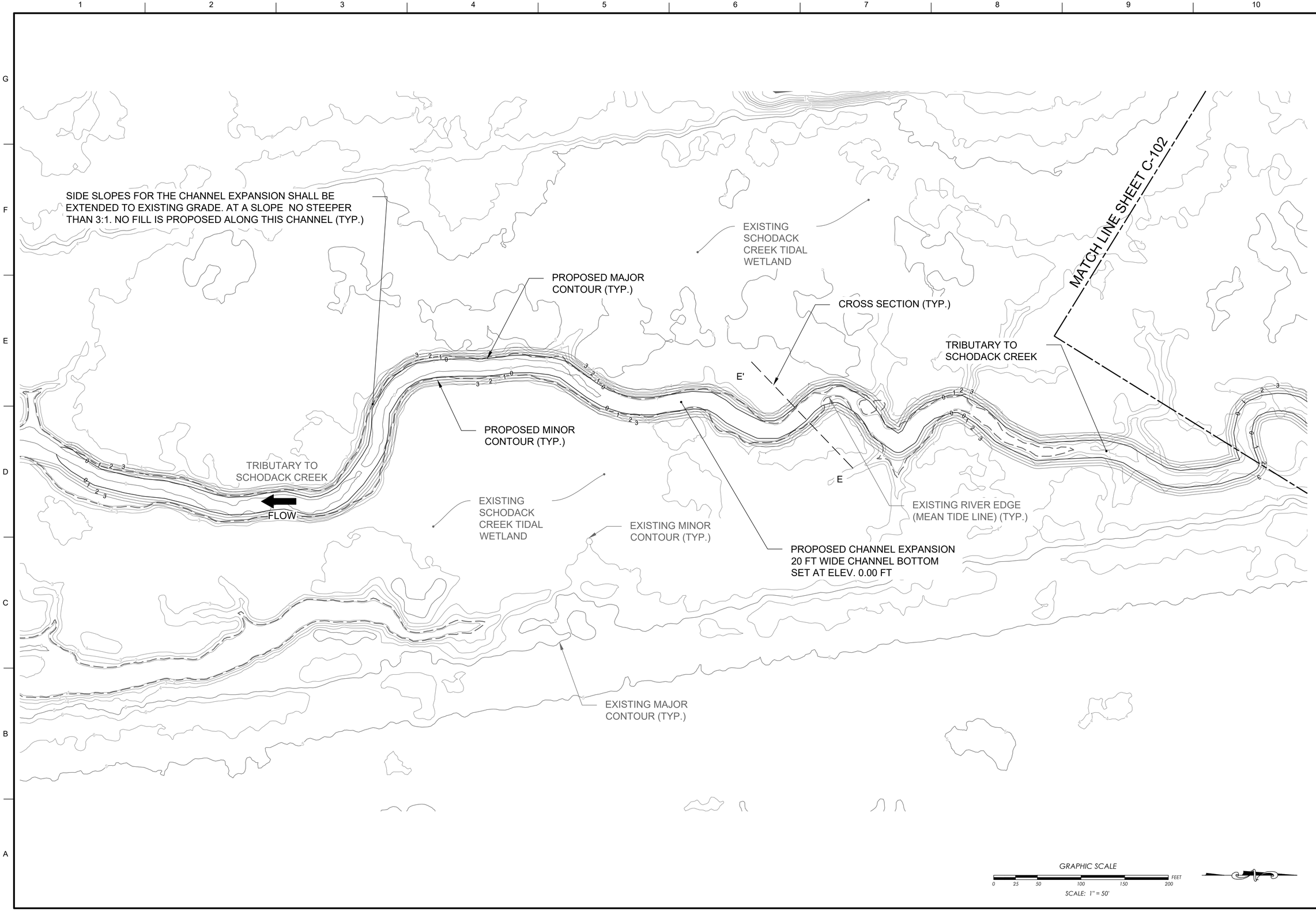
GENERAL PLAN SHEET 2

SHEET ID
C-102

MARCH 2020



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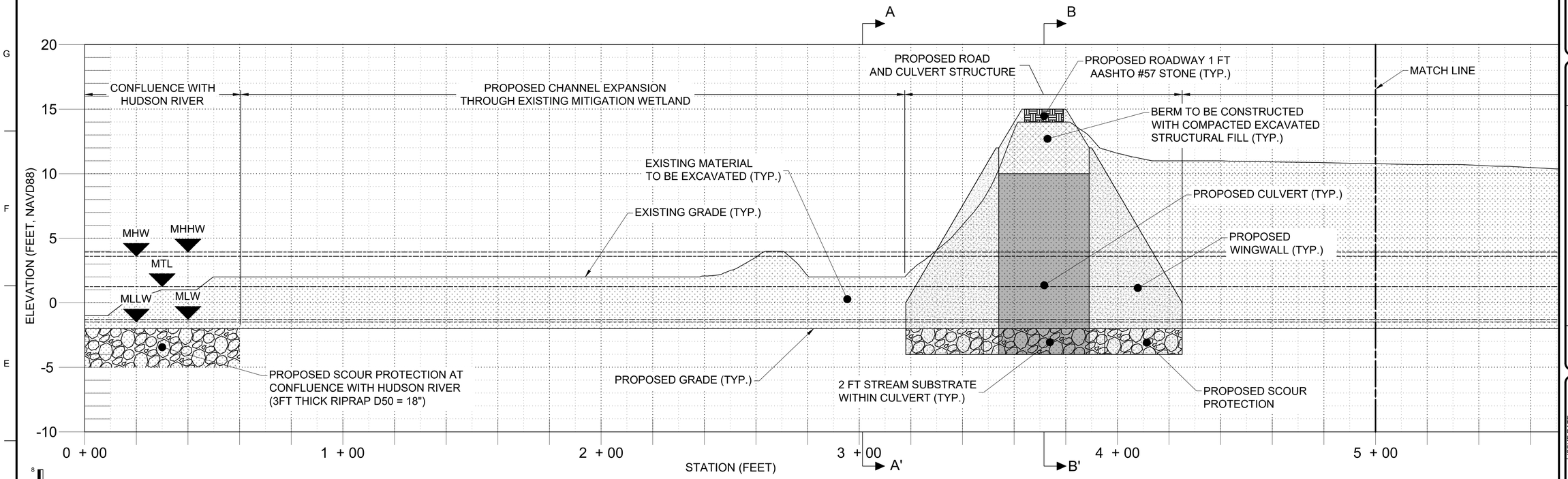
RENSSELAER COUNTY, NEW YORK

GENERAL PLAN SHEET 3

SHEET ID

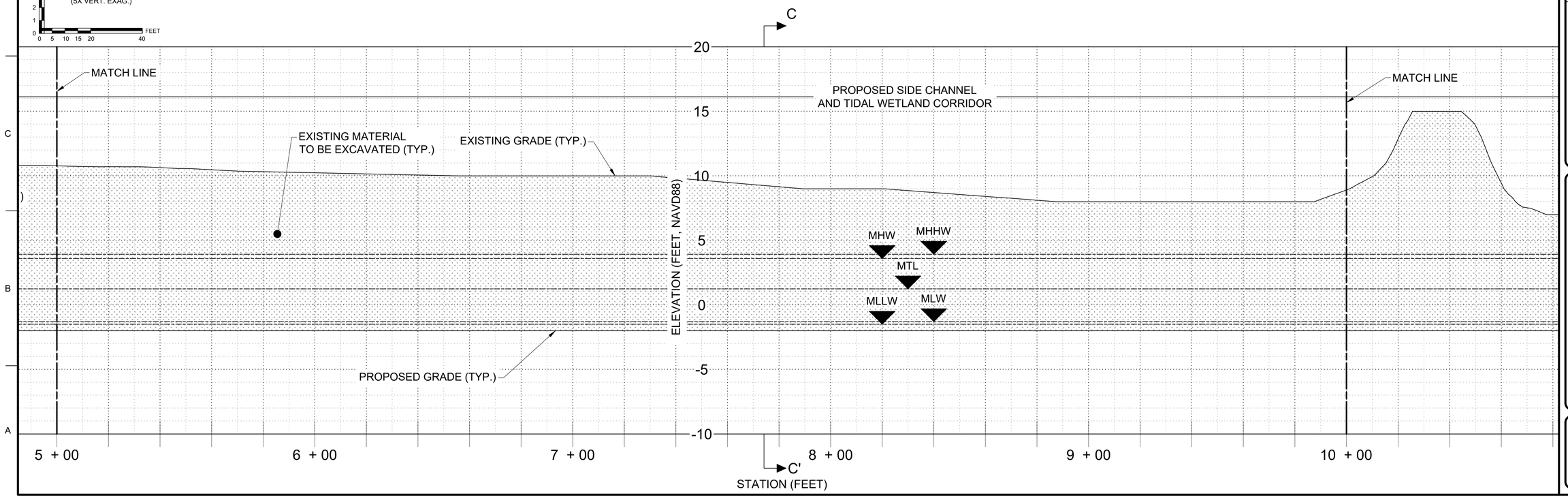
C-103

MARCH 2020



GRAPHIC SCALE
H: 1" = 20'
V: 1" = 4'
(5X VERT. EXAG.)

FEET
0 5 10 15 20 40



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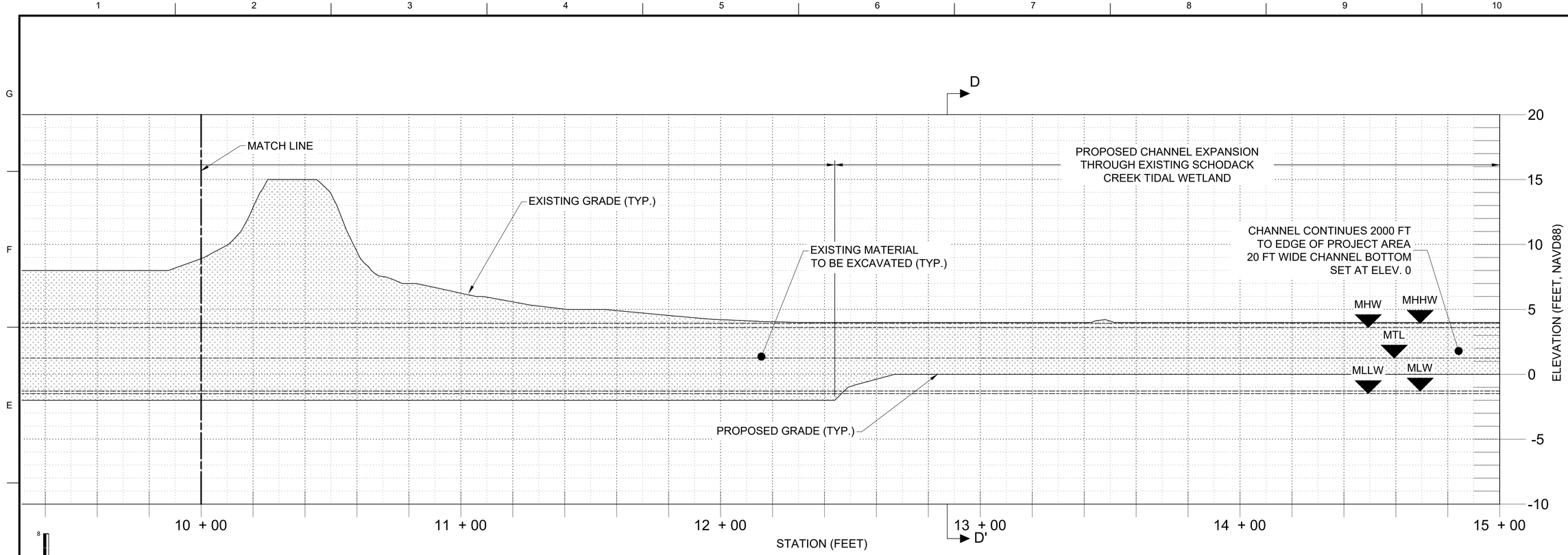
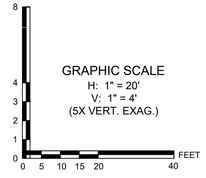
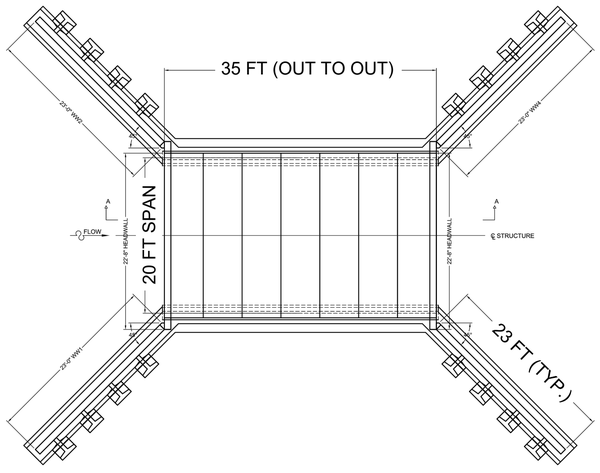
PROFILE SHEET 1

SHEET ID
C-201

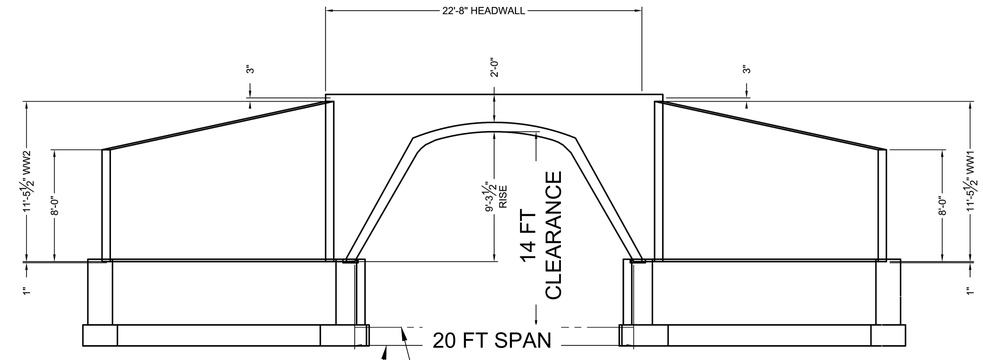
MARCH 2020







A CULVERT - PLAN VIEW
NOT TO SCALE
DETAIL PROVIDED BY CONTECH



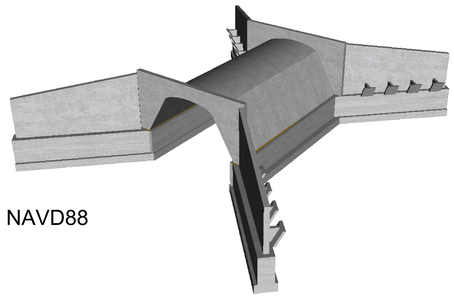
B CULVERT - CROSS SECTION
NOT TO SCALE
DETAIL PROVIDED BY CONTECH

NOTES:

CULVERT PLAN VIEW, CROSS SECTION AND 3D RENDERING PROVIDED BY CONTECH ENGINEERED SOLUTIONS AS SUPPORTING DOCUMENTATION FOR THEIR CULVERT COST ESTIMATE. THESE DESIGNS ARE NOT TO BE USED FOR CONSTRUCTION IMPLEMENTATION WITHOUT FURTHER INPUT FROM CONTECH ENGINEERED SOLUTIONS.

STREAM INVERT ELEVATION = -2.0 FT NAVD88

CULVERT INVERT ELEVATION = -4.0 FT NAVD88



C CULVERT - 3D RENDERING
NOT TO SCALE
RENDERING PROVIDED BY CONTECH

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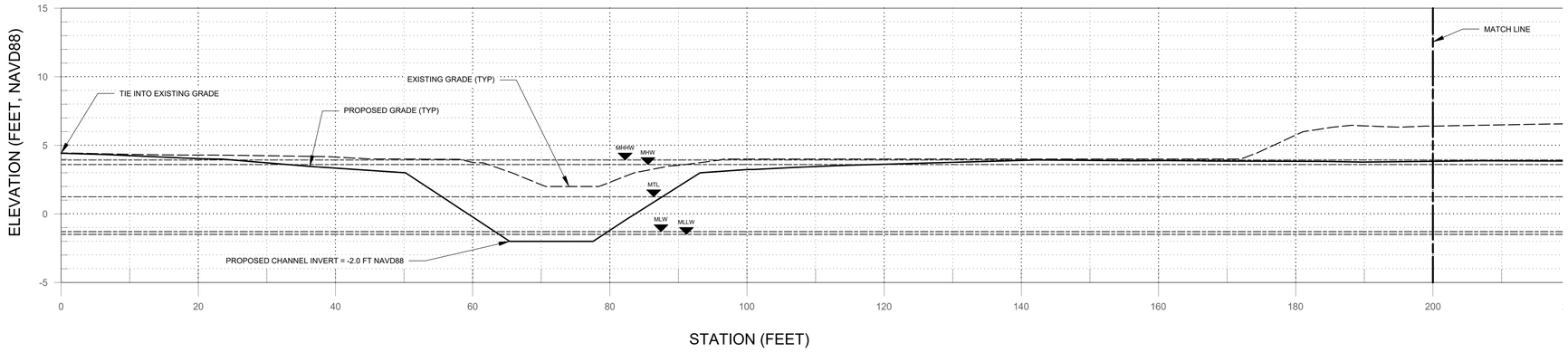
SCHODACK ISLAND STATE PARK
RENSSELAER COUNTY, NEW YORK

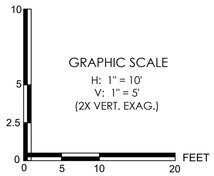
PROFILE SHEET 2

SHEET ID
C-202

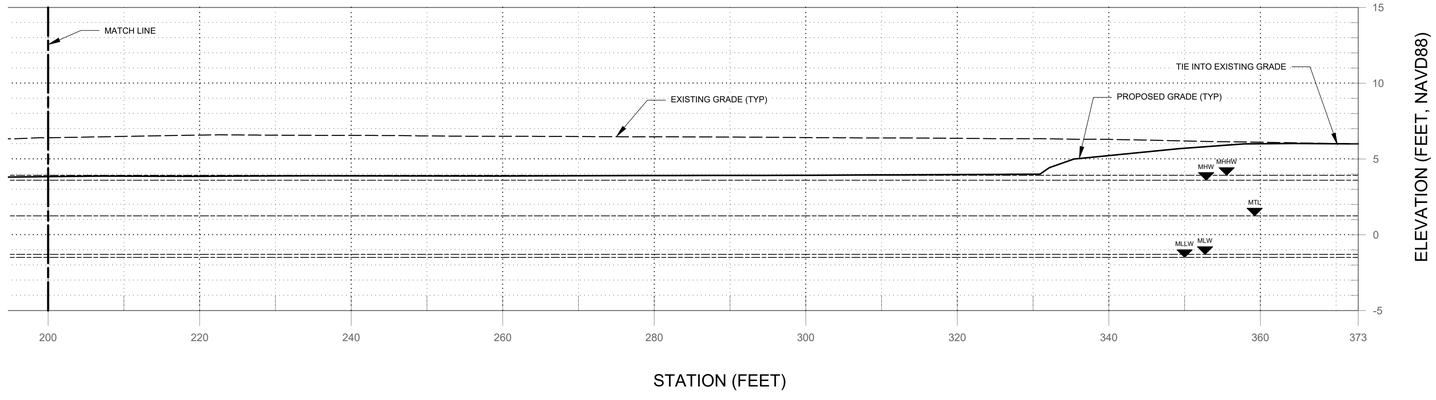
MARCH 2020

CROSS SECTION A - A' STA. 0 - 200





CROSS SECTION A - A' STA. 200 - 373



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RENSSELAER COUNTY, NEW YORK

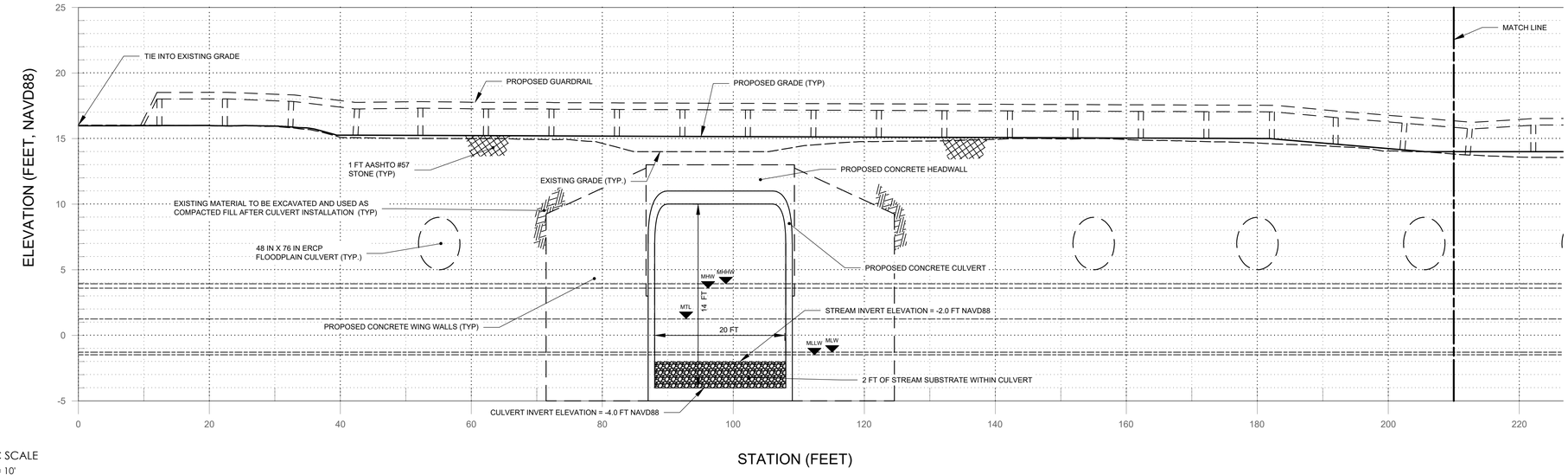
CROSS SECTION SHEET 1

SHEET ID

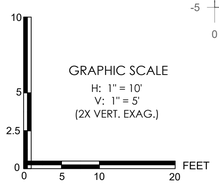
C-301

MARCH 2020

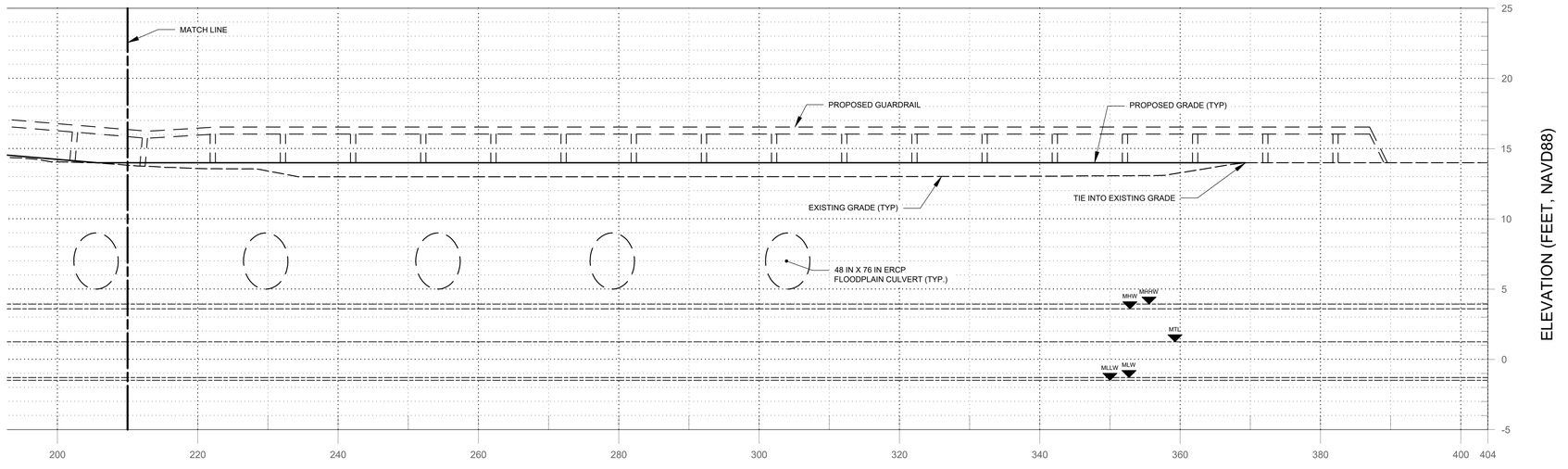
CROSS SECTION B - B' STA. 0 - 200



GRAPHIC SCALE
H: 1" = 10'
V: 1" = 5'
(2X VERT. EXAG.)



CROSS SECTION B - B' STA. 200 - 404



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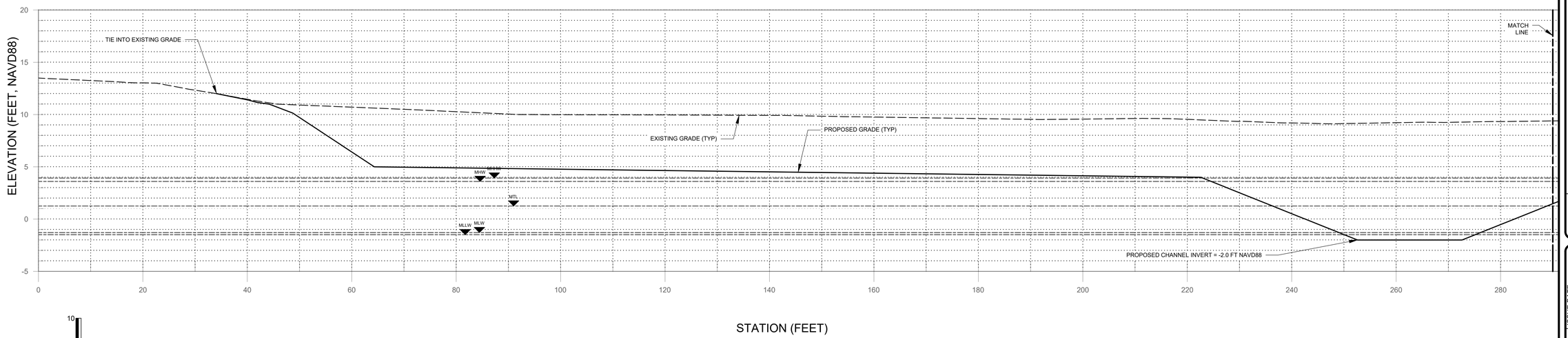
CROSS SECTION SHEET 2

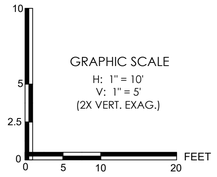
SHEET ID

C-302

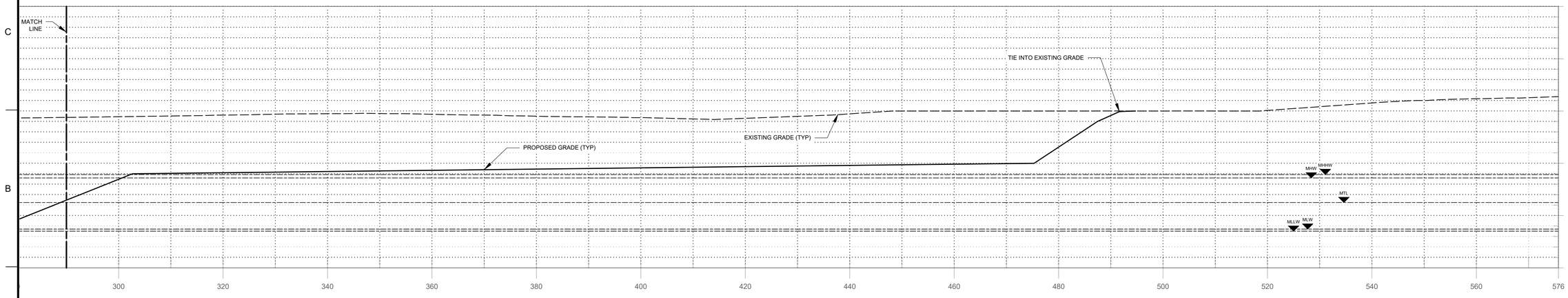
MARCH 2020

CROSS SECTION C - C' STA. 0 - 290





CROSS SECTION C - C' STA. 290 - 576



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TH/CPS	W912DS-20-F-0024
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SUBMITTED BY:	
PRINCETON HYDRO	
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RENSSELAER COUNTY, NEW YORK

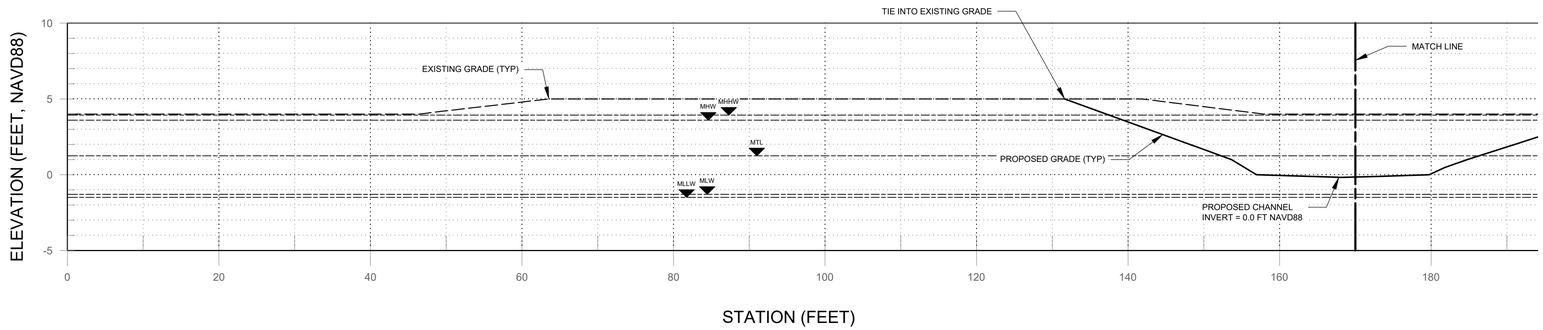
CROSS SECTION SHEET 3

SHEET ID

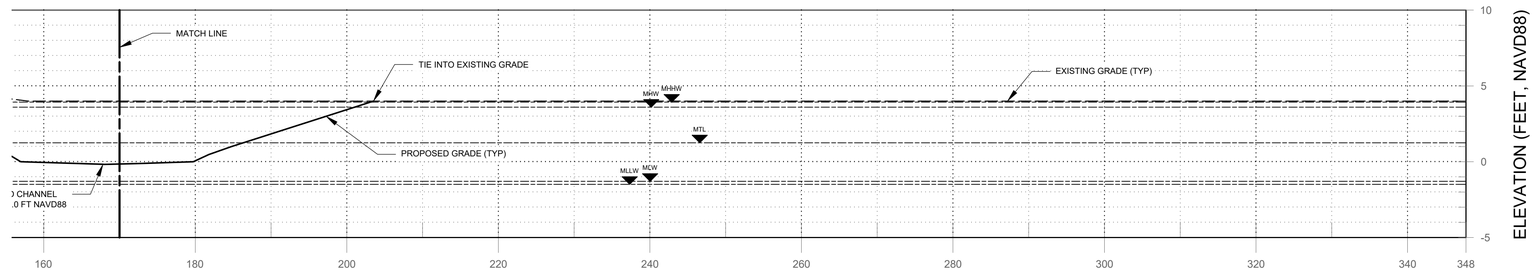
C-303

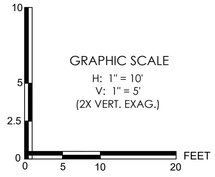
MARCH 2020

CROSS SECTION D - D' STA. 0 - 180

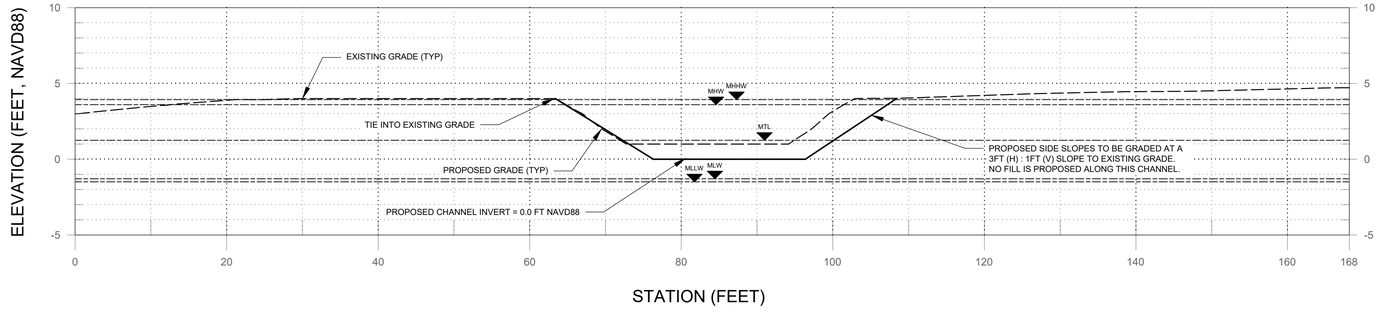


CROSS SECTION D - D' STA. 180 - 348





CROSS SECTION E-E'



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CROSS SECTION SHEET 4

SHEET ID

C-304

MARCH 2020

LOWER TIDAL WETLAND PLANTING SCHEDULE

LOWER TIDAL WETLAND SEED MIX (1.15 AC): SEED TO BE SPREAD OVER ENTIRE LOWER TIDAL WETLAND AREA AT A RATE OF 20 POUNDS PER ACRE.

BOTANICAL NAME:	SPECIES NAME:	SEEDING RATE (LBS PURE LIVE SEED/ACRE)	INDICATOR STATUS:	QUANTITY:
ASCLEPIAS INCARNATA	SWAMP MILKWEED	0.9	OBL	4.5%
CAREX LURIDA	LURID SEDGE	0.9	OBL	4.5%
CAREX SCOPARIA	BLUNT BROOM SEDGE	5	FACW	25.0%
CAREX VULPINOIDEA	FOX SEDGE	6	OBL	30.0%
ELYMUS VIRGINICUS	VIRGINIA WILDRYE	2.5	FACW	12.5%
HELENIUM AUTUMNALE	COMMON SNEEZEWEED	0.8	FACW	4.0%
JUNCUS EFFUSUS	SOFT RUSH	0.8	OBL	4.0%
SCIRPUS ATROVIRENS	GREEN BULRUSH	0.8	OBL	4.0%
SPARGANIUM AMERICANUM	EASTERN BUR REED	0.5	OBL	2.5%
SYMPHYOTRICHUM NOVAE-ANGLIAE	NEW ENGLAND ASTER	1	FACW	5.0%
VERBENA HASTATA	BLUE VERVAIN	0.8	FACW	4.0%

LOWER TIDAL WETLAND HERBS (1.15 AC): TO BE INSTALLED 3' ON CENTER OVER ENTIRE LOWER TIDAL WETLAND AREA

BOTANICAL NAME:	SPECIES NAME:	PLANTING TYPE:	INDICATOR STATUS:	QUANTITY:
ACORUS AMERICANUS	SWEETFLAG	2" PLUG	OBL	500
BIDENS LAEVIS	BEGGAR-TICKS	2" PLUG	OBL	500
BOLBOSCHOENUS FLUVIATILIS	RIVER BULRUSH	2" PLUG	OBL	500
CAREX VULPINOIDEA	FOX SEDGE	2" PLUG	OBL	700
CAREX LACUSTRIS	HAIRY SEDGE	2" PLUG	OBL	500
IRIS VERSICOLOR	BLUE FLAG IRIS	2" PLUG	OBL	550
LEERSIA ORYZOIDES	RICE CUTGRASS	2" PLUG	OBL	550
SAGITTARIA LATIFOLIA	ARROWHEAD	2" PLUG	OBL	450
SCHOENOPLECTUS TABERNAEMONTANI	SOFT STEM BULRUSH	2" PLUG	OBL	650
ZIZANIA AQUATICA	WILD RICE	2" PLUG	OBL	650
			TOTAL	5,550

UPPER TIDAL WETLAND PLANTING SCHEDULE

UPPER TIDAL WETLAND SEED MIX (7.54 AC): SEED TO BE SPREAD OVER ENTIRE UPPER TIDAL WETLAND AREA AT A RATE OF 20 POUNDS PER ACRE.

BOTANICAL NAME:	SPECIES NAME:	SEEDING RATE (LBS PURE LIVE SEED/ACRE)	INDICATOR STATUS:	QUANTITY:
ASCLEPIAS INCARNATA	SWAMP MILKWEED	0.9	OBL	4.5%
CAREX LURIDA	LURID SEDGE	0.9	OBL	4.5%
CAREX SCOPARIA	BLUNT BROOM SEDGE	5	FACW	25.0%
CAREX VULPINOIDEA	FOX SEDGE	6	OBL	30.0%
ELYMUS VIRGINICUS	VIRGINIA WILDRYE	2.5	FACW	12.5%
HELENIUM AUTUMNALE	COMMON SNEEZEWEED	0.8	FACW	4.0%
JUNCUS EFFUSUS	SOFT RUSH	0.8	OBL	4.0%
SCIRPUS ATROVIRENS	GREEN BULRUSH	0.8	OBL	4.0%
SPARGANIUM AMERICANUM	EASTERN BUR REED	0.5	OBL	2.5%
SYMPHYOTRICHUM NOVAE-ANGLIAE	NEW ENGLAND ASTER	1	FACW	5.0%
VERBENA HASTATA	BLUE VERVAIN	0.8	FACW	4.0%

UPPER TIDAL WETLAND HERBS (7.54 AC): TO BE INSTALLED 3' ON CENTER OVER ENTIRE UPPER TIDAL WETLAND AREA

BOTANICAL NAME:	SPECIES NAME:	PLANTING TYPE:	INDICATOR STATUS:	QUANTITY:
EUTROCHIUM MACULATUM	SPOTTED JOE PYE-WEED	2" PLUG	OBL	3,650
HELENIUM AUTUMNALE	SNEEZEWEED	2" PLUG	FACW	5,100
IMPATIENS CAPENSIS	SPOTTED JEWELWEED	2" PLUG	FACW	4,350
JUNCUS EFFUSUS	SOFT RUSH	2" PLUG	OBL	5,500
SCIRPUS ATROVIRENS	GREEN BULRUSH	2" PLUG	OBL	5,500
SCIRPUS CYPERINUS	WOOL GRASS	2" PLUG	OBL	5,500
SPARGANIUM EURYCARPUM	BUR-REED	2" PLUG	OBL	4,350
TYPHA LATIFOLIA	NARROWLEAF CATTAIL	2" PLUG	OBL	2,600
			TOTAL	36,550

UPPER TIDAL WETLAND SHRUBS (7.54 AC): TO BE INSTALLED 8' ON CENTER OVER THE UPPER PORTIONS OF THE UPPER TIDAL WETLAND AREA, ABOVE ELEVATION 3.0 FEET (NAVD88)

BOTANICAL NAME:	SPECIES NAME:	PLANTING TYPE:	INDICATOR STATUS:	QUANTITY:
ALNUS INCANA	SPECKLED ALDER	24" - 36" CONTAINER	-	769
CEPHALANTHUS OCCIDENTALIS	BUTTONBUSH	24" - 36" CONTAINER	OBL	1,026
CORNUS AMOMUM	SILKY DOGWOOD	24" - 36" CONTAINER	FACW	769
CORNUS SERICEA	RED OSIER DOGWOOD	24" - 36" CONTAINER	-	1,026
SALIX DISCOLOR	PUSSY WILLOW	24" - 36" CONTAINER	FACW	1,026
SPIRAEA ALBA	MEADOW-SWEET	24" - 36" CONTAINER	FACW	513
			TOTAL	5,129

UPLAND SHRUB PLANTING SCHEDULE

UPLAND SHRUB SEED MIX (1.18 AC): SEED TO BE SPREAD OVER ENTIRE UPLAND SHRUB AREA AT A RATE OF 20 POUNDS PER ACRE.

BOTANICAL NAME:	SPECIES NAME:	SEEDING RATE (LBS PURE LIVE SEED/ACRE)	INDICATOR STATUS:	QUANTITY:
CAREX SCOPARIA	BLUNT BROOM SEDGE	2	FACW	10.0%
ELYMUS CANADENSIS	CANADA WILDRYE	3.6	FACU	18.0%
ELYMUS VIRGINICUS	VIRGINIA WILDRYE	2.4	FACW	12.0%
HELENIUM AUTUMNALE	COMMON SNEEZEWEED	1.4	FACW	7.0%
PANICUM CLANDESTINUM	DEERTONGUE	2	FACW	10.0%
PANICUM VIRGATUM	SWITCHGRASS	2.6	FAC	13.0%
SCHIZACHYRIUM SCOPARIUM	LITTLE BLUE STEM	4	FAC	20.0%
SYMPHYOTRICHUM NOVAE-ANGLIAE	NEW ENGLAND ASTER	1	FACW	5.0%
VERBENA HASTATA	BLUE VERVAIN	1	FACW	5.0%

UPLAND SHRUBS (1.18 AC): TO BE INSTALLED 8' ON CENTER OVER ENTIRE UPLAND SHRUB AREA

BOTANICAL NAME:	SPECIES NAME:	PLANTING TYPE:	INDICATOR STATUS:	QUANTITY:
ALNUS INCANA	SPECKLED ALDER	24" - 36" CONTAINER	-	192
ARONIA MELANOCARPA	BLACK CHOKEBERRY	24" - 36" CONTAINER	FAC	192
CORNUS SERICEA	RED OSIER DOGWOOD	24" - 36" CONTAINER	-	144
SPIRAEA ALBA	MEADOW-SWEET	24" - 36" CONTAINER	FACW	80
VIBURNUM LENTAGO	NANNYBERRY	24" - 36" CONTAINER	FAC	192
			TOTAL	801

UPLAND HERBACEOUS PLANTING SCHEDULE

UPLAND HERB SEED MIX (0.50 AC): SEED TO BE SPREAD OVER ENTIRE UPLAND HERBACEOUS AREA AT A RATE OF 20 POUNDS PER ACRE.

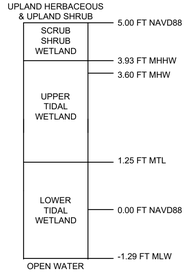
BOTANICAL NAME:	SPECIES NAME:	SEEDING RATE (LBS PURE LIVE SEED/ACRE)	INDICATOR STATUS:	QUANTITY:
CAREX SCOPARIA	BLUNT BROOM SEDGE	2	FACW	10.0%
ELYMUS CANADENSIS	CANADA WILDRYE	3.6	FACU	18.0%
ELYMUS VIRGINICUS	VIRGINIA WILDRYE	2.4	FACW	12.0%
HELENIUM AUTUMNALE	COMMON SNEEZEWEED	1.4	FACW	7.0%
PANICUM CLANDESTINUM	DEERTONGUE	2	FACW	10.0%
PANICUM VIRGATUM	SWITCHGRASS	2.6	FAC	13.0%
SCHIZACHYRIUM SCOPARIUM	LITTLE BLUE STEM	4	FAC	20.0%
SYMPHYOTRICHUM NOVAE-ANGLIAE	NEW ENGLAND ASTER	1	FACW	5.0%
VERBENA HASTATA	BLUE VERVAIN	1	FACW	5.0%

SCRUB SHRUB WETLAND PLANTING SCHEDULE

SCRUB SHRUB WETLAND (4.06 AC): TO BE INSTALLED 8' ON CENTER OVER ENTIRE SCRUB SHRUB WETLAND AREA

BOTANICAL NAME:	SPECIES NAME:	PLANTING TYPE:	INDICATOR STATUS:	QUANTITY:
ALNUS INCANA	SPECKLED ALDER	24" - 36" CONTAINER	FACW	965
ARONIA MELANOCARPA	BLACK CHOKEBERRY	24" - 36" CONTAINER	FAC	1,378
CARPINUS CAROLINIANA	AMERICAN HORNBEAM	24" - 36" CONTAINER	FAC	276
CORNUS SERICEA	RED OSIER DOGWOOD	24" - 36" CONTAINER	-	827
SALIX DISCOLOR	PUSSY WILLOW	24" - 36" CONTAINER	FACW	827
SALIX INTERIOR	SANDBAR WILLOW	24" - 36" CONTAINER	FACW	551
SPIRAEA ALBA	MEADOW-SWEET	24" - 36" CONTAINER	FACW	689
VIBURNUM LENTAGO	NANNYBERRY	24" - 36" CONTAINER	FAC	1,378
			TOTAL	6,889

PLANTING AREAS BY TIDAL RANGE



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MARK	DESCRIPTION	DATE

DESIGNED BY: PH
DRAWN BY: TH/CPS
CHECKED BY: AEM
SUBMITTED BY: PRINCETON HYDRO
SIZE: ANSI D
ISSUE DATE: JAN 2020
SOLICITATION NO.: W912DS-20-F-0024
CONTRACT NO.: W912DS-19-D-0003

U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT
26 FEDERAL PLAZA
NEW YORK, NEW YORK, 10278

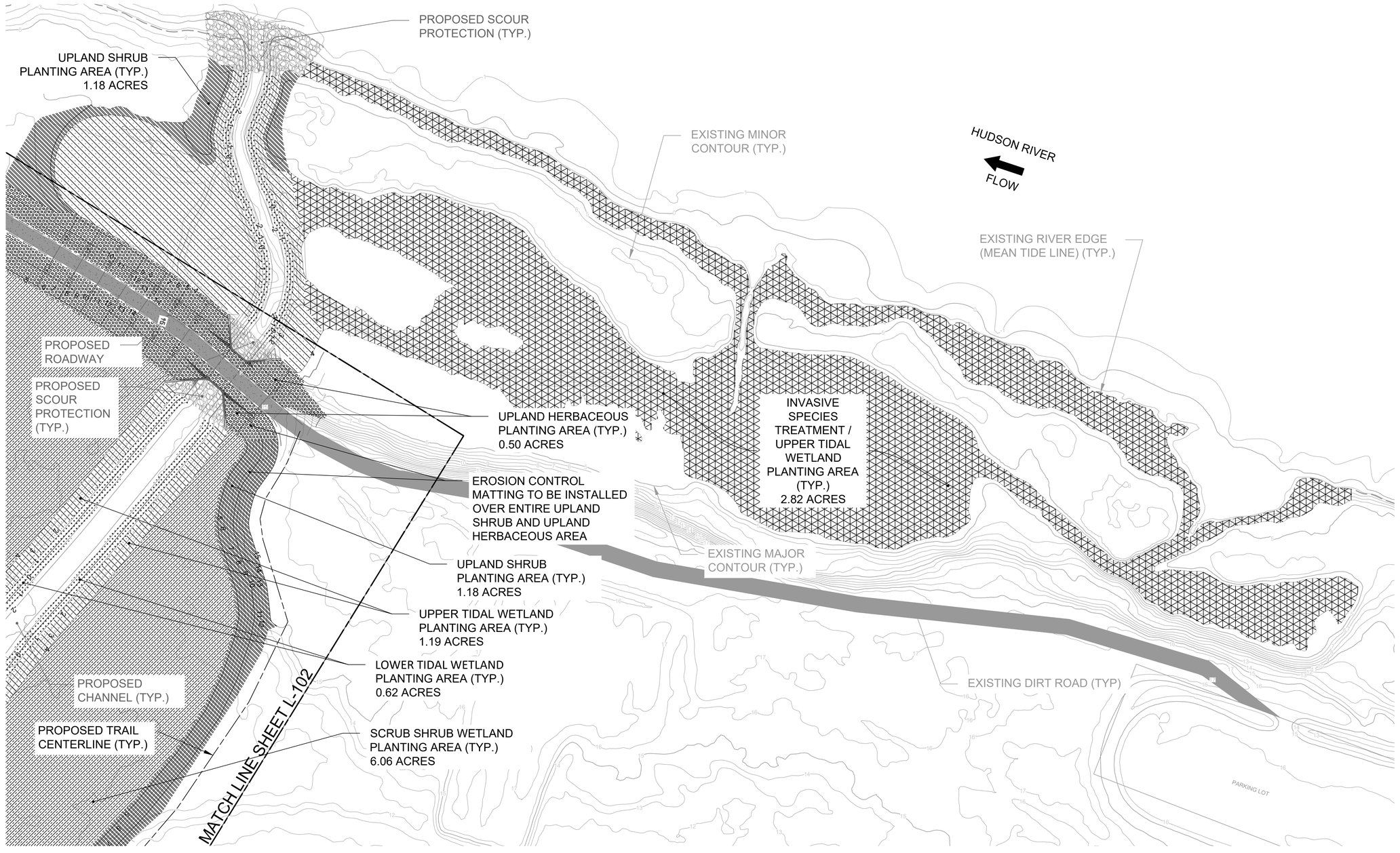
PRINCETON HYDRO, LLC
1108 OLD YORK ROAD
RINGOES, NEW JERSEY, 08551

HUDSON RIVER HABITAT RESTORATION
SCHODACK ISLAND STATE PARK
RENSSELAER COUNTY, NEW YORK

LANDSCAPING NOTES

SHEET ID
L-001

MARCH 2020



GRAPHIC SCALE
0 25 50 100 150 200 FEET
SCALE: 1" = 50'

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HUDSON RIVER HABITAT RESTORATION
SCHODACK ISLAND STATE PARK
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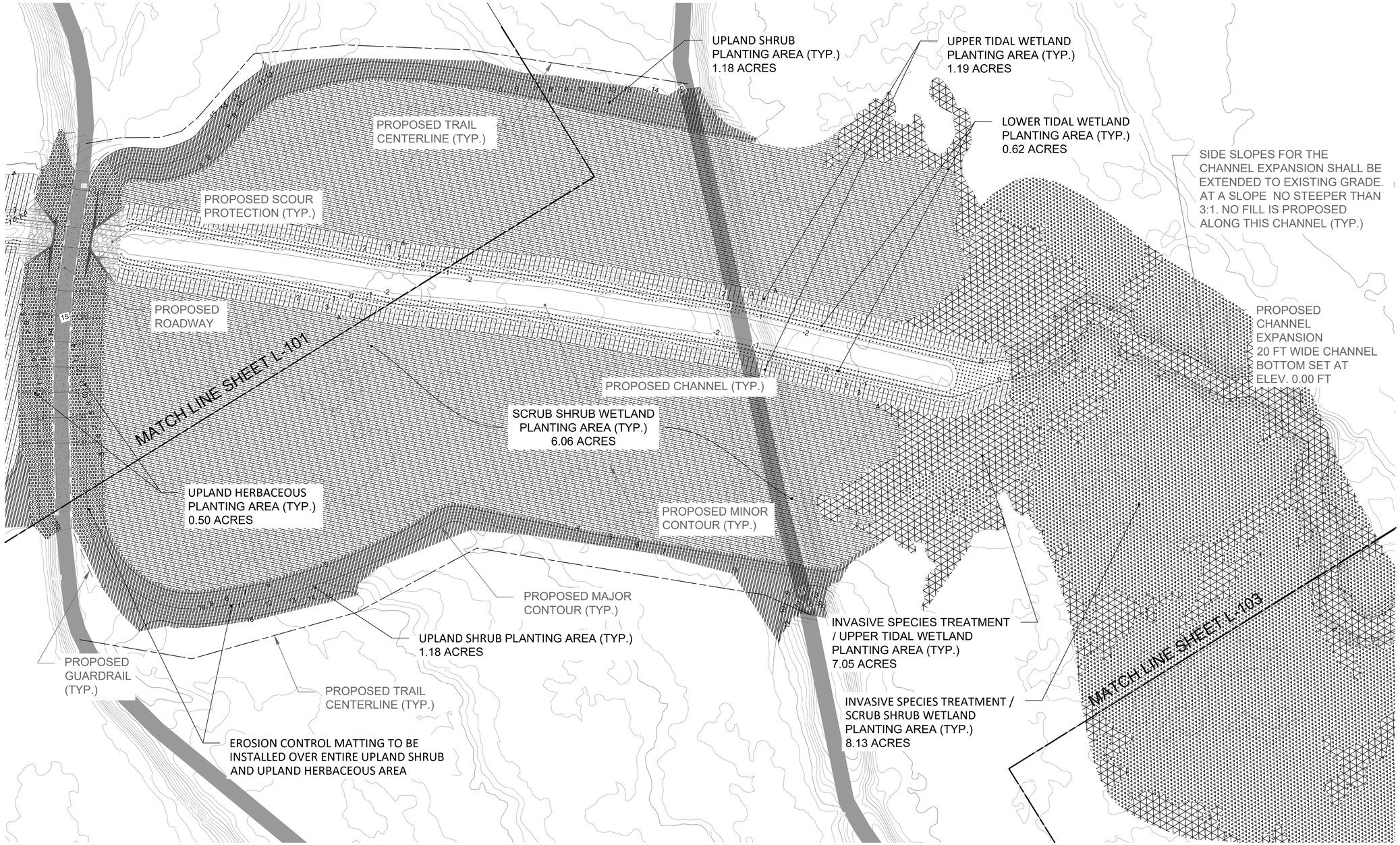
LANDSCAPE PLAN SHEET 1

SHEET ID
L-101

MARCH 2020



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HUDSON RIVER HABITAT RESTORATION
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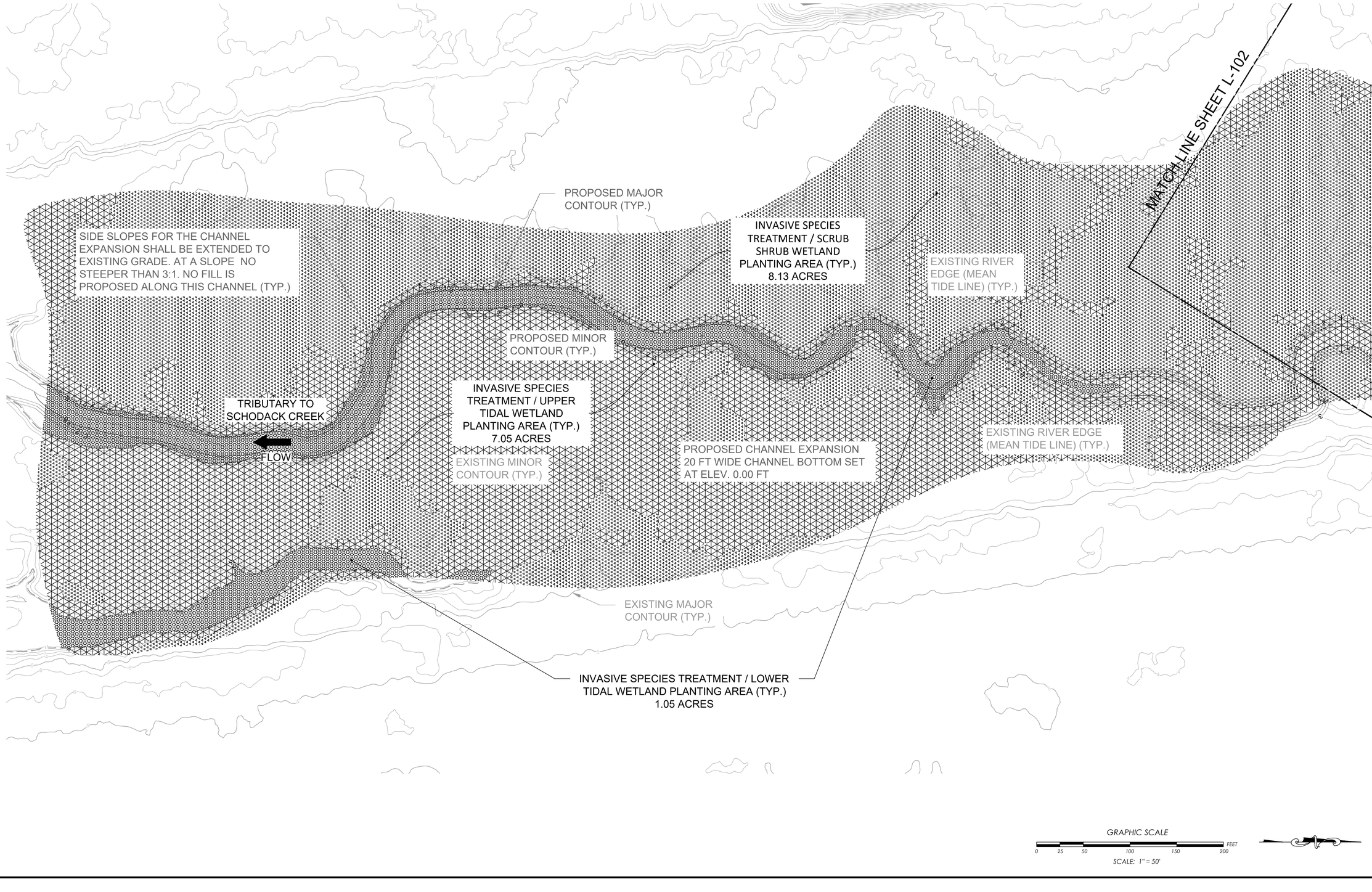
LANDSCAPE PLAN SHEET 2

SHEET ID
L-102

MARCH 2020



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HUDSON RIVER HABITAT RESTORATION
SCHODACK ISLAND STATE PARK
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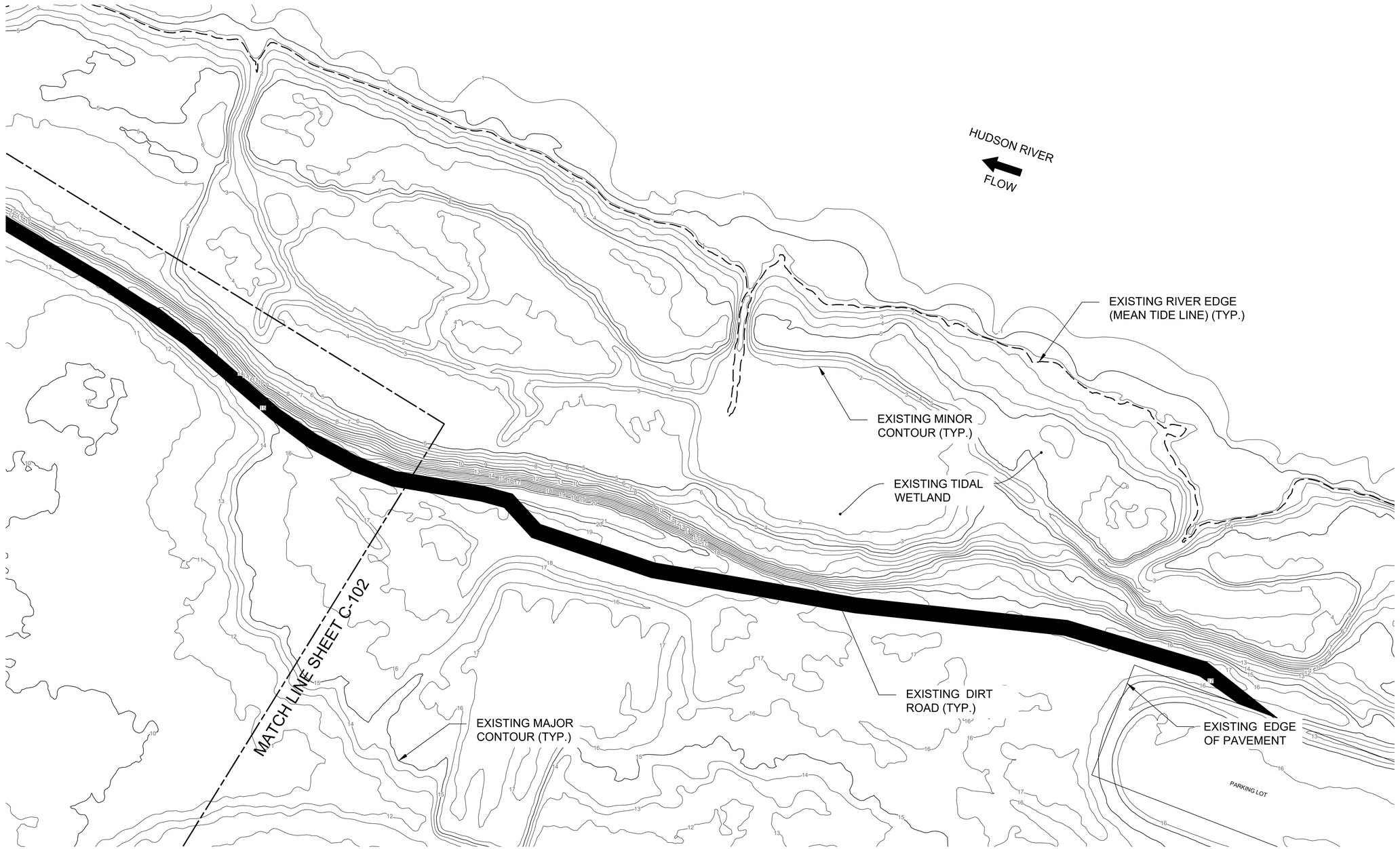
LANDSCAPE PLAN SHEET 3

SHEET ID
L-103

MARCH 2020



GRAPHIC SCALE
0 25 50 100 150 200 FEET
SCALE: 1" = 50'

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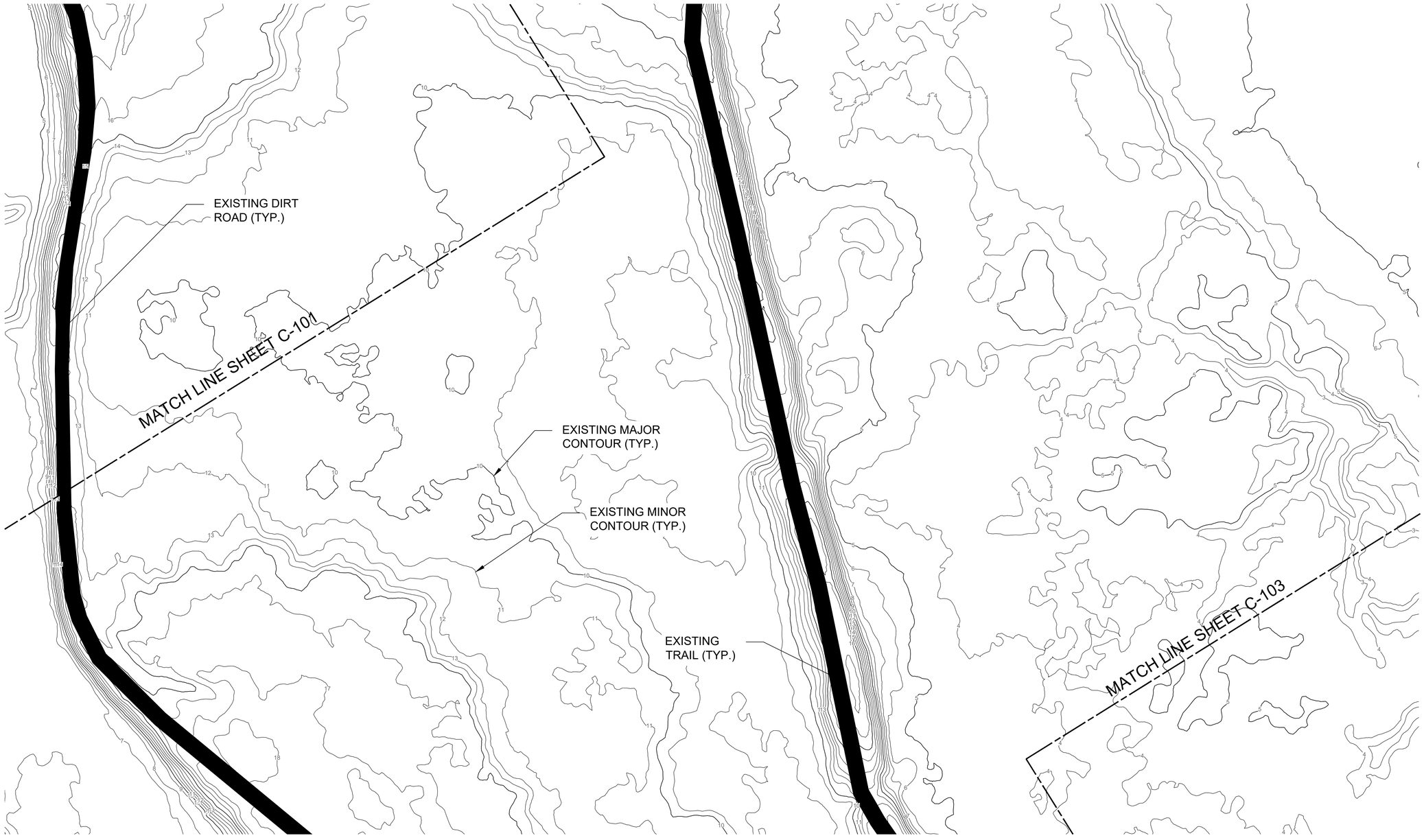
EXISTING SURVEY PLAN SHEET 1

SHEET ID
V-101

MARCH 2020



GRAPHIC SCALE

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SCALE: 1" = 50'

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HUDSON RIVER HABITAT RESTORATION
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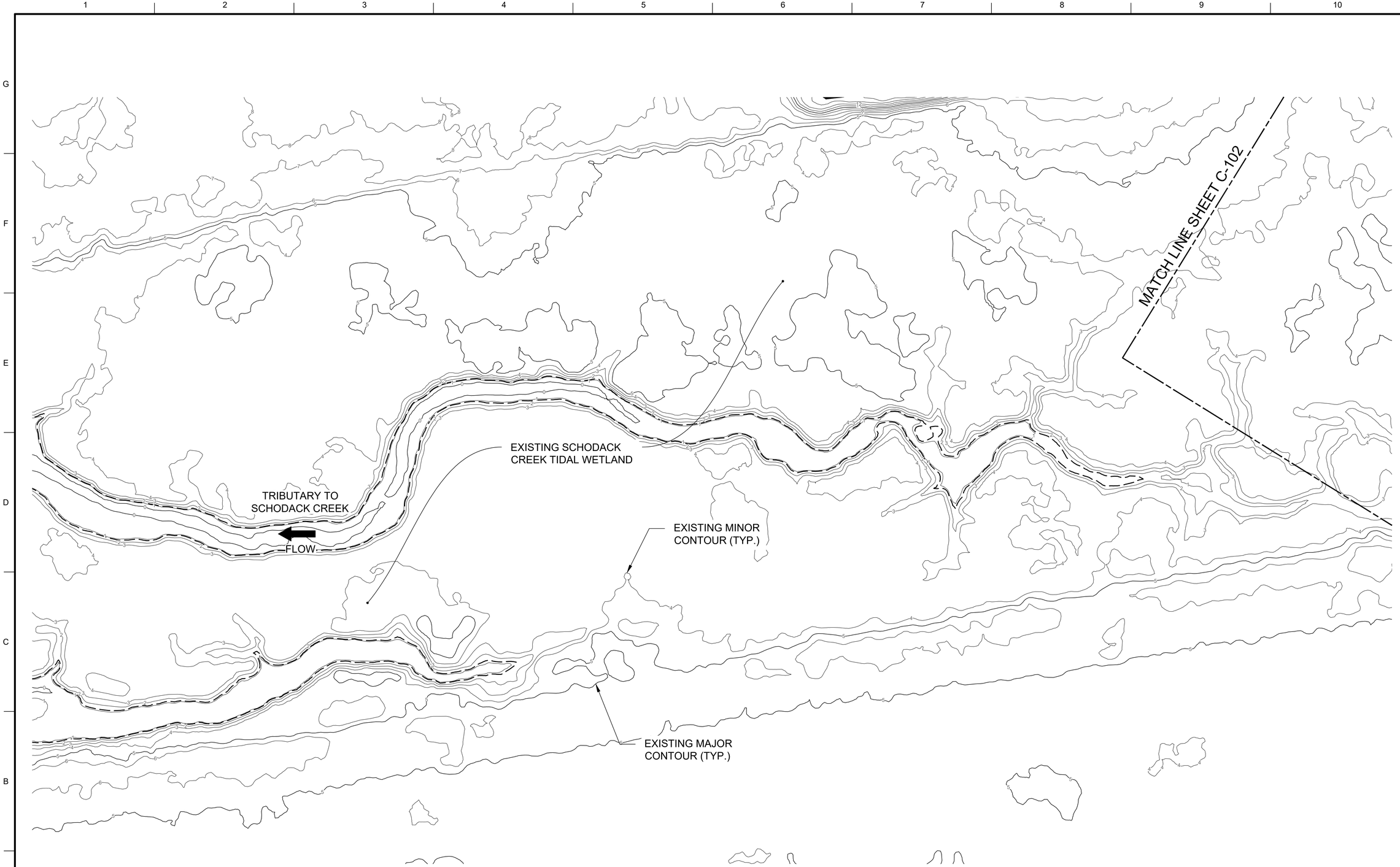
EXISTING SURVEY PLAN SHEET 2

SHEET ID

V-102

MARCH 2020



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HUDSON RIVER HABITAT RESTORATION
SCHODACK ISLAND STATE PARK
RENSSELAER COUNTY, NEW YORK

EXISTING SURVEY PLAN SHEET 3

SHEET ID

V-103

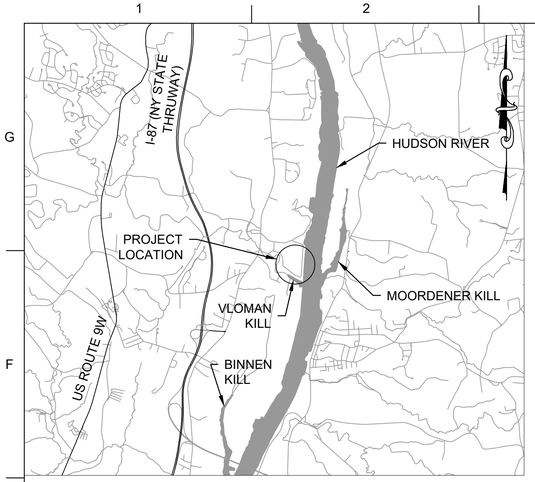
MARCH 2020

HUDSON RIVER HABITAT RESTORATION SCHODACK ISLAND - CONSTRUCTION QUANITTIES						
COMPONENT	**ITEM**	**QTY**	**UNIT**	**CONVERTED QTY**	**CONVERTED UNIT**	**DESCRIPTION**
General Construction	LOD Area	1,399,311	SQFT	155,479	SQYD	Total area of Project LOD
	LOD Perimeter	10,071	LF			Total perimeter of Project LOD
	Stabilized Construction Entrance Area	1,125	SQFT	125	SQYD	Total length at least 50-ft as per NY standard for stabilized construction entrance, All rock to be reused onsite for channel and bank stabilization
	Stabilized Construction Entrance Volume	750	CUFT	30	CUYD	Area of stabilized construction entrance multiplied by the depth of rock (assumed 8")
	Construction Access - Road Reinforcement Area	19,350	SQFT	2,150	SQYD	20-FT wide road along the preexisting access road; 4" gravel depth assumed for reinforcement rather than an 8" depth for full construction of a road. Assumed 30% of the total reinforced road area needs pruning and clearing/grubbing
	Construction Access - Matting Length	1,487	LF			$350/lf for installation and use and addition $30/lf for removal from site; 1/3 of the total matting length (4,460 LF) was used; it is assumed that matting can be relocated and reused onsite to access all areas of the proposed project
	Turbidity Barrier	800	LF			Length along both ends of the wetland enhancement adjacent to the Hudson River and Schodack Creek
	Silt Fence	7,400	LF			Length along the perimeter of the enhancement area, excluding segments where turbidity barriers are installed
	Traffic Control	2	EA			Assumed 2 traffic control signs needed in the adjacent parking lot
	Survey Stakeout	33	AC			Total project area
	Clearing and Grubbing, Stumps	5.5	AC			11 acres assumed to be completely cleared and grubbed; Assumed half of the area is wooded and half is brush.
	Clearing and Grubbing, Brush	5.5	AC			11 acres assumed to be completely cleared and grubbed; Assumed half of the area is wooded and half is brush.
	Project Duration	24	MO			Project duration in months
	Field Office	1	EA			Includes field trailer and other misc. costs (e.g. supplies, telephone bill, portable toilet, Storage box, etc..)
	Dewatering	1	EA			Sump hole, 15-ft assumed height; Assumed duration of 18 months
	Temporary Cofferdam Length	500	LF	3,000	SQFT	Assuming 6 ft height, extending around portion of work area to divert flow to one side of channel

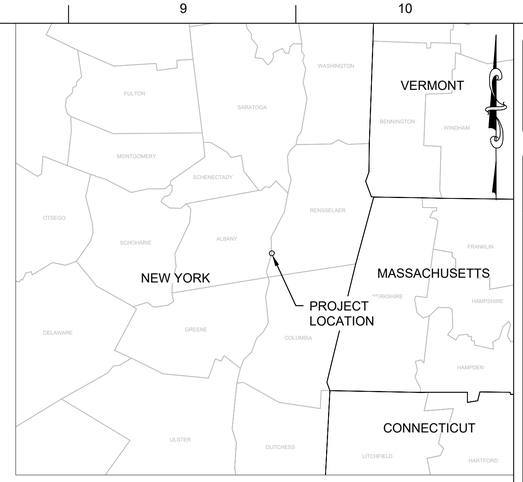
COMPONENT	ITEM	QTY	UNIT	CONVERTED QTY	CONVERTED UNIT	DESCRIPTION
Hudson Channel	Excavation	90,026	CUFT	3,334	CUYD	Cut Fill From GIS, proposed surface vs. existing LiDAR.
	Grading	50,248	SQFT	5,583	SQYD	Total area of earthwork
Side Channel and Floodplain	Excavation	2,040,411	CUFT	75,571	CUYD	Cut Fill From GIS, proposed surface vs. existing LiDAR.
	Grading	375,552	SQFT	41,728	SQYD	Total area of earthwork
Schodack Tributary Channel	Excavation	123,366	CUFT	4,569	CUYD	Cut Fill From GIS, proposed surface vs. existing LiDAR.
	Grading	94,988	SQFT	10,554	SQYD	Total area of earthwork
Road Crossing	Box Culvert Foundation	55	CY			Cast-in-place foundation; 3x3 concrete foundation along the entire length of the wingwalls and culvert edge (81 LF each side)
	Contech Culvert and Wingwalls	1	LS			Quote per Contech received - April 5, 2020; cost for material and delivery to the site
	Box Culvert Stream Bottom	700	SQFT	156	CUYD	2 ft thick stream bottom inside box culvert (20ft x 35 ft). Assumed that 50% would be rip-rap and rock lining and 50% would be aggregate river stone
	Mobilization/Demobilization of Crane	2	EA			1 mobilization, 1 demobilization
	Crane Crew Labor	3	DAYS			2 8-ft section of culvert per day, 5 total culvert sections
	Temporary Bridge	1	EA			1 temporary bridge needed for the project
	Guard Rail	805	LF			Guard rail along proposed roadway
	Guard Rail Anchorage Units	65	LF			Assumed 65 anchorage units (1 per post; 1 post every 12.5' for 805 LF)
	Floodplain Pipe Culverts	704	LF			8 floodplain pipes, 8-ft increments, total length = 704 feet
	Floodplain Pipe End Sections	16	EA			8 floodplain pipes, end section on each pipe on each side
	Floodplain Pipe Gaskets	96	EA			8 floodplain pipes, 11 segments pers culvert, 12 gaskets per culvert
	Base Course	840	SQYD			Base course assumed under all culverts, including 2ft on either side of the culverts
	Scour Protection	260	SQYD	130	CUYD	Riprap for scour protection, depth 18 inches
	Excavation	249,890	CUFT	9,255	CUYD	Calculated based on proposed subgrade vs. existing grade cut/fill analysis
	Fill	228,906	CUFT	8,478	CUYD	Calculated based on proposed subgrade vs. proposed grade cut/fill analysis (8,025 CUYD) excluding volume of culverts (960 CUYD), plus 20% to account for compaction.
	Grading	30,501	SQFT	3,389	SQYD	Total area of earthwork
	On-site Soil Hauling	457,812	CUFT	16,956	CUYD	Volume of roadway fill multiplied by 2 to account for hauling soil from excavation to subgrade, followed by hauling back in fill material to reach final grade

COMPONENT	ITEM	QTY	UNIT	CONVERTED QTY	CONVERTED UNIT	DESCRIPTION
Plantings	Lower Tidal Wetland Planting Area	27,075	SQFT	3,008	SQYD	Planting areas between Elev -1.29 - 1.25 (2027 MLW - MTL)
	Upper Tidal Wetland Planting Area	174,675	SQFT	19,408	SQYD	Planting areas between Elev 1.25 - 3.93 (2027 MTL - MHHW)
	Scrub Shrub Wetland Planting Area	263,946	SQFT	29,327	SQYD	Planting areas between Elev 3.93 - 5.00 (2027 MHHW - 5.0 NAVD88)
	Upland Shrub Planting Area	51,238	SQFT	5,693	SQYD	Planting areas above Elev 5.00 (2027 MHHW)
	Upland Herbaceous Seeding Area	21,641	SQFT	2,405	SQYD	Planting areas above Elev 5.00 (2027 MHHW)
	Lower Tidal Wetland Restoration Area	45,715	SQFT	5,079	SQYD	Pre-existing lower tidal wetlands which will be treated for invasive species and re-planted as necessary; assumed half of the total restoration area will require treatment and re-planting
	Upper Tidal Wetland Restoration Area	307,201	SQFT	34,133	SQYD	Pre-existing upper tidal wetlands which will be treated for invasive species and re-planted as necessary; assumed half of the total restoration area will require treatment and re-planting
	Scrub Shrub Wetland Restoration Area	353,955	SQFT	39,328	SQYD	Pre-existing scrub shrub wetlands which will be treated for invasive species and re-planted as necessary; assumed half of the total restoration area will require treatment and re-planting
	Seeds (Wetland)	174	LBS	42,023	SQYD	Seeds applied at a rate of 20 lb/acre over entire lower and upper tidal wetland planting areas, and half of the lower and upper tidal wetland restoration areas
	Plugs (Wetland)	42,023	EA			2" Herb plugs Installed 3 feet on center over entire lower and upper tidal wetland planting areas, and half of the lower and upper tidal wetland restoration areas
	Shrubs (Wetland)	12,019	EA			24" - 36" container shrubs Installed 8 feet on center over entire upper tidal wetland and scrub shrub planting areas, and half of the upper tidal wetland and scrub shrub restoration areas
	Seeds (Upland)	33	LBS	8,098	SQYD	Seeds applied at a rate of 20 lb/acre over entire upland herbaceous seeding area and upland shrub planting area
	Shrubs (Upland)	801	EA			24" - 36" container shrubs Installed 8 feet on center over entire upland shrub planting area
	Soil Preparation (Straw Mulching)	451,087	SQFT	50,121	SQYD	Soil preparations over all seeded areas including the entire lower tidal wetland, upper tidal wetland, upland herbaceous, and upland shrub planting areas, and half of the lower and upper tidal wetland restoration areas
	Erosion Control Matting	72,879	SQFT	8,098	SQYD	Erosion control matting installed over entire upland herbaceous seeding area and upland shrub planting area
	Invasive Species Treatment	353,436	SQFT	8	AC	Invasive species treatment assumed to be required over half of the restoration area
	Deer Fence	2,200	LF			Upland perimeter of planting areas
	Goose Fence Area	1,190,647	SQFT	27	AC	Wetland area
	Goose Fence Perimeter	18,121	LF			Waters edge and wetland perimeter of planting areas

COMPONENT	ITEM	QTY	UNIT	CONVERTED QTY	CONVERTED UNIT	DESCRIPTION
Soil Disposal	Loading and Hauling of Soil Material	2,295,000	CUFT	85,000	CUYD	Loading, hauling, and disposal of material; 10 miles round trip to Houghtaling Disposal Facility; excludes compaction; No tipping fees were added as none are assumed for disposal at Houghtaling disposal facility
	Disposal Site Silt Fence	4,000	LF			Length around the soil disposal cell A.1
	Disposal Site Grading	510,000	SQFT	56,667	SQYD	Assumes 510,00 SF of grading; area obtained from map of Houghtaling disposal facility Cell A.1



VICINITY MAP
SCALE: 1" = 5,000'



LOCATION MAP
SCALE: 1" = 100,000'

HUDSON RIVER HABITAT RESTORATION

HENRY HUDSON PARK

TOWN OF BETHLEHEM
ALBANY COUNTY, NEW YORK

MARCH 2020

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

DESIGNED BY: PRINCETON HYDRO
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HUDSON RIVER HABITAT RESTORATION
HENRY HUDSON PARK
TOWN OF BETHLEHEM
ALBANY COUNTY, NEW YORK

COVER SHEET

SHEET ID
G-001

GENERAL NOTES:

1. THE CONTRACTOR SHALL NOTE THAT IN THE CASE OF A DISCREPANCY BETWEEN THE SCALED AND FIGURED DIMENSIONS SHOWN ON THESE PLANS, THE FIGURED DIMENSIONS SHALL APPLY.
2. SINCE FIELD CONDITIONS MAY REQUIRE MODIFICATIONS TO PROPOSED TOPOGRAPHIC ELEVATIONS AND FACILITY LOCATIONS, THESE PLANS ARE NOT TO BE UTILIZED AS AS-BUILTS FOR ANY OTHER PURPOSE.
3. THESE PLANS ARE NOT TO BE UTILIZED FOR CONSTRUCTION UNTIL ALL REQUIRED LOCAL, STATE, AND FEDERAL PERMITS ARE OBTAINED.
4. THE CONTRACTOR MUST CONTACT THE NEW YORK ONE CALL NUMBER AT 1-800-962-7962, TWO FULL WORKING DAYS PRIOR TO THE START OF WORK TO HAVE ALL UTILITIES MARKED IN THE WORK AREA. ADDITIONALLY, THE CONTRACTOR MUST CONTACT ALL UTILITY OPERATORS NOT AFFILIATED WITH ONE CALL IN ORDER TO LOCATE ALL OTHER UTILITIES WITHIN THE PROJECT AREA. THE CONTRACTOR SHALL ESTABLISH A LIAISON WITH ALL UTILITIES AND ADVISE THE CONTRACTING OFFICER (CO) IN WRITING OF THE DETAILS.
5. ALL CONSTRUCTION SHALL ADHERE TO OSHA STANDARDS AND REGULATIONS.
6. IT SHALL BE DISTINCTLY NOTED THAT FAILURE TO MENTION SPECIFICALLY ANY WORK THAT WOULD NORMALLY BE REQUIRED TO COMPLETE THE PROJECT, SHALL NOT RELIEVE THE CONTRACTOR'S RESPONSIBILITY TO PERFORM THAT WORK.
7. THE APPROVAL AND USE OF THESE PLANS ARE FOR THE PROJECT SPONSOR . THIS PLAN IS NOT TO BE UTILIZED IN THE PREPARATION OF ANY OTHER PROJECTS.
8. CONTRACTOR SHALL VERIFY ALL DIMENSIONS AND EXISTING CONDITIONS IN THE FIELD PRIOR TO THE START OF CONSTRUCTION AND ERRORS OR DISCREPANCIES SHALL BE IMMEDIATELY BROUGHT TO THE ATTENTION OF THE CONTRACTING OFFICER (CO) OR CONTRACTING OFFICER'S REPRESENTATIVE (COR).
9. THE CONTRACTOR WILL BE REQUIRED TO PERFORM A MINIMUM OF THREE (3) INSPECTIONS DAILY AND PERFORM ROUTINE CLEAN UP DUTIES AS REQUIRED AND ALSO MAINTAIN ALL EXCAVATIONS, EMBANKMENTS, STOCKPILES, HAUL ROADS, PLANT SITES, WASTE AREAS, BORROW AREAS, AND ALL OTHER WORK AREAS WITHIN OR WITHOUT OF THE PROJECT BOUNDARIES FREE FROM DUST WHICH WOULD CAUSE A HAZARD OR NUISANCE TO OTHERS. DUST CONTROL SHALL BE PERFORMED AS THE WORK PROCEEDS AND WHENEVER A DUST NUISANCE OR HAZARD OCCURS.
10. ALL PLAN SHEETS ARE HORIZONTALLY REFERENCED TO THE NORTH AMERICAN DATUM OF 1983 (NAD83), PROJECTED TO THE NEW YORK STATE PLANE COORDINATE SYSTEM, AND VERTICALLY REFERENCED TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88). ALL UNITS ARE IN U.S. SURVEY FEET UNLESS OTHERWISE SPECIFIED..
11. ACCESS TO ALL PROPERTIES MUST BE MAINTAINED DURING CONSTRUCTION.
12. MAIL DELIVERY SHALL NOT BE DISRUPTED DURING CONSTRUCTION.
13. PROPERTY AND RIGHT-OF-WAY LINES SHOWN ON THESE PLANS WERE BASED ON INFORMATION PROVIDED BY E4SCIENCES. THE PROPERTY AND RIGHT OF WAY LINES SHOWN ON THESE DRAWINGS ARE APPROXIMATE, AND ARE NOT BASED ON METES AND BOUNDS FIELD RUN SURVEYS OR PROPERTY RECORDS. THE CONTRACTOR SHALL TAKE PRECAUTIONS TO LOCATE PROPERTY LINES AND RIGHT OF WAY LINES PRIOR TO CONSTRUCTION AND AVOID CONSTRUCTION ACTIVITIES ON PRIVATE PROPERTY AND/OR RIGHTS OF WAYS WHERE SAID CONSTRUCTION IS PROHIBITED. THE CONTRACTOR MAY CONDUCT CONSTRUCTION ACTIVITIES ON PRIVATE PROPERTY PROVIDED HE HAS OBTAINED PRIOR WRITTEN PERMISSION FROM THE PROPERTY OWNER AND HAS SUBMITTED A COPY OF SAID WRITTEN PERMISSION TO THE CO OR COR.
14. THE CONTRACTOR SHALL ALLOW SUFFICIENT TIME FOLLOWING EXCAVATIONS FOR INSPECTION AND EVALUATION OF EXISTING SOIL SUBGRADE CONDITIONS BY A COMPETENT PERSON PER 29 CFR 1926.32(f) AND THE CO OR COR.

SITE RESTORATION:

1. THE CONTRACTOR IS RESPONSIBLE TO RESTORE ALL GRASSY AREAS, PAVED AND CONCRETE AREAS, DRIVEWAYS AND CURBING DISTURBED DURING CONSTRUCTION TO THEIR PRE-CONSTRUCTION CONDITION AFTER COMPLETION OF CONSTRUCTION AND PRIOR TO FINAL ACCEPTANCE OF THE PROJECT.
2. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE REPAIR AND REPLACEMENT OF PROPERTY DAMAGE TO FENCES, SIGNS, STRUCTURES, VEGETATION, IRRIGATION, LANDSCAPING COMPONENTS, AND ANY OTHER PROPERTY ITEMS THAT ARE REMOVED FOR THE PURPOSES OF THE PROJECT LOGISTICS AND/OR ACCIDENTS.
3. ALL PAVED AND CONCRETE AREAS DISTURBED DURING CONSTRUCTION SHALL BE RESTORED TO A CONDITION AT LEAST EQUAL TO THAT WHICH EXISTED PRIOR TO THE START OF CONSTRUCTION.
4. ALL GRASSED OR WOODED AREAS DISTURBED DURING CONSTRUCTION SHALL BE TOPSOILED AND SEEDED.

SITEWORK:

1. EXCAVATIONS AND STOCKPILES SHALL HAVE SLOPES CONSISTENT WITH A SITE SHORING AND EXCAVATION PLAN SIGNED AND SEALED BY A LICENSED ENGINEER IN THE STATE OF NEW YORK.
2. THE CONTRACTOR IS RESPONSIBLE FOR THE REMOVAL AND PROPER DISPOSAL OF ALL STOCK-PILED SOIL, TRASH, CONSTRUCTION MATERIALS AND DEBRIS AFTER THE COMPLETION OF CONSTRUCTION. ALL DISPOSAL SHALL BE PERFORMED IN ACCORDANCE WITH APPLICABLE MUNICIPAL, COUNTY, STATE, AND FEDERAL REGULATIONS.
3. FOR INSTALLATION OF STABILIZED CONSTRUCTION ENTRANCE AND CONSTRUCTION ACCESS ROAD, CONTRACTOR SHALL AVOID TREE IMPACTS IN ACCORDANCE WITH SPECIFICATIONS SECTION 01 57 19.
4. ALL ELEVATIONS AND QUANTITIES ARE BASED ON IN-SITU CONDITIONS. ONCE DISTURBED, MATERIAL CONDITIONS CAN VARY SIGNIFICANTLY.
5. ALL PROPOSED CONSTRUCTION MUST BE SUPERVISED BY A PROFESSIONAL ENGINEER, LICENSED IN THE STATE OF NEW YORK, OR THEIR DULY APPOINTED REPRESENTATIVE.
6. ALL STOCKPILED MATERIAL PROPOSED FOR USE AS STRUCTURAL FILL WILL BE PROTECTED FROM EXCESSIVE LOSS OR GAIN OF MOISTURE USING SECURELY ANCHORED PLASTIC COVERS OR EQUIVALENT METHODS.
7. WHERE REQUIRED TO FACILITATE WORK, THE CONTRACTOR MAY NEED TO TEMPORARILY SHORE AND STABILIZE THE WORK AREA DEPENDING ON THE MEANS AND METHODS UTILIZED TO CONSTRUCT THE PROJECT. ANY REQUIRED SHEETING AND SHORING IS TO BE CONSISTENT WITH THE SITE SHORING AND EXCAVATION PLAN DESIGNED BY A LICENSED NEW YORK PROFESSIONAL ENGINEER AND SUBMITTED TO THE CO OR COR FOR REVIEW AND APPROVAL.
8. SOILS AND/OR OTHER MATERIALS TO BE UTILIZED FOR FILLING OR BACKFILLING TO GRADE SHALL BE CONSISTENT WITH THE CONTRACT DOCUMENTS.
9. PROXIMITY OF STOCKPILES TO THE EDGE OF EXCAVATIONS SHALL BE SUCH THAT THE INFLUENCE OF THE STOCKPILE SURCHARGE ON THE MODIFIED OR EXISTING SLOPE IS REDUCED. WHERE POSSIBLE STOCKPILES WILL BE PLACED A DISTANCE FROM THE EDGE OF EXCAVATION EQUAL TO (OR GREATER THAN) THE DEPTH OF THE EXCAVATION. STOCKPILES NEAR EXCAVATIONS SHALL MEET ALL THE REQUIREMENTS OF THE SIGNED/SEALED/APPROVED SHORING AND EXCAVATION PLAN.
10. ALL UNSUITABLE SOIL MATERIALS PRODUCED SHALL BE DISPOSED OF OFFSITE IN ACCORDANCE WITH LOCAL, COUNTY, STATE, AND FEDERAL REQUIREMENTS.
11. ALL EQUIPMENT STAGING AND STORAGE MUST BE LOCATED WITHIN THE LIMIT OF DISTURBANCE AND IN ACCORDANCE WITH THE REQUIREMENTS OF THE CONTRACT DOCUMENTS.
12. ALL FILL SHALL BE PLACED IN ACCORDANCE WITH THE CONTRACT DOCUMENTS. UNSUITABLE MATERIAL SHALL BE REMOVED AND REPLACED WITH CLEAN FILL MATERIAL, AS DEFINED AND IN ACCORDANCE WITH THE CONTRACT DOCUMENTS.

DATA SOURCE NOTES:

1. EXISTING CONTOURS DERIVED USING 2011-2012 LIDAR DATA OBTAINED FROM FROM THE NEW YORK STATE GIS CLEARINGHOUSE. ALL ELEVATIONS ARE REFERENCED TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88) IN U.S. SURVEY FEET
2. 2017 PROPERTY BOUNDARIES OBTAINED FROM ALBANY COUNTY REAL PROPERTY TAX SERVICE AGENCY.
3. TIDAL DATUMS CALCULATED BY USACE USING WATER LEVEL OBSERVATIONS OBTAINED FROM THE HUDSON RIVER ENVIRONMENTAL CONDITIONS OBSERVING SYSTEM (HRECOS), SCHODACK ISLAND STATION.

CALL BEFORE YOU DIG!
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2 FULL WORKING DAYS NOTICE
PRIOR TO CONSTRUCTION - STOP CALL
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1-800-962-7962

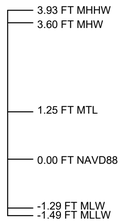
GENERAL CONSTRUCTION SEQUENCE:

1. MOBILIZATION
2. INSTALLATION OF SOIL EROSION AND SEDIMENT CONTROL FEATURES
3. INSTALLATION/MODIFICATION OF TEMPORARY WORK ACCESS ROAD(S)
4. SITE CLEARING, INCLUDING REMOVAL OF EXISTING VEGETATION AND INVASIVE SPECIES TREATMENT, WHERE APPLICABLE
5. INSTALLATION OF WATER CONTROL FEATURES, WHERE APPLICABLE
6. EARTHWORK; INCLUDING EXCAVATION, GRADING, AND IMPORT OF SELECT AMENDED SOILS, WHERE APPLICABLE
7. INSTALLATION OF SHORELINE STABILIZATION STRUCTURES, WHERE APPLICABLE; INCLUDES THE IMPORT OF SOIL AND BANK STABILIZATION BOULDERS
8. INSTALLATION OF HERBIVORE EXCLUSION FENCING
9. INSTALLATION OF PLANTS AND SEED
10. DEMOBILIZATION

EXPECTED CONSTRUCTION DURATION PER PROJECT COMPONENT

WESTERN TIDAL WETLAND:	3 - 6 MONTHS
COVE TIDAL WETLAND:	1 - 2 MONTHS
VEGETATED RIPRAP:	6 - 8 MONTHS

TIDAL RANGE



SHEET NO.	TITLE	SHEET REFERENCE NO.
	GENERAL	
1	COVER SHEET	G-001
2	GENERAL NOTES SHEET	G-002
	CIVIL	
3	KEY MAP	C-001
4	GENERAL PLAN SHEET 1	C-101
5	GENERAL PLAN SHEET 2	C-102
6	GENERAL PLAN SHEET 3	C-103
7	CROSS-SECTION SHEET 1	C-301
	LANDSCAPE	
8	LANDSCAPING NOTES	L-001
9	LANDSCAPE PLAN SHEET 1	L-101
10	LANDSCAPE PLAN SHEET 2	L-102
11	LANDSCAPE PLAN SHEET 3	L-103
	SURVEY	
12	EXISTING SURVEY PLAN SHEET 1	V-101
13	EXISTING SURVEY PLAN SHEET 2	V-102
14	EXISTING SURVEY PLAN SHEET 3	V-103

EXISTING FEATURES LEGEND

- 5 — EXISTING MAJOR CONTOUR
- 3 — EXISTING MINOR CONTOUR
- EXISTING RIVER EDGE (MEAN TIDE LINE)
- EXISTING CURB
- EXISTING BUILDING
- EXISTING REVETMENT STRUCTURE

PROPOSED FEATURES LEGEND

- 5 — PROPOSED MAJOR CONTOUR
- 3 — PROPOSED MINOR CONTOUR
- CROSS SECTION LINE
- PROPOSED BOULDER PLACEMENT
- PROPOSED VEGETATED RIPRAP

PROPOSED PLANTING LEGEND

- PROPOSED UPLAND SHRUB AREA
- PROPOSED UPLAND HERBACEOUS AREA
- PROPOSED UPPER TIDAL WETLAND AREA
- PROPOSED LOWER TIDAL WETLAND AREA
- PROPOSED INTERSTITIAL PLANTING AREA

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CHECKED BY: AEM
SUBMITTED BY: PRINCETON HYDRO
SIZE: ANSI D
ISSUE DATE: JAN 2020
SOLICITATION NO.: W912DS-20-F-0024
CONTRACT NO.: W912DS-19-D-0003

U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT
26 FEDERAL PLAZA
NEW YORK, NEW YORK, 10278

PRINCETON HYDRO, LLC
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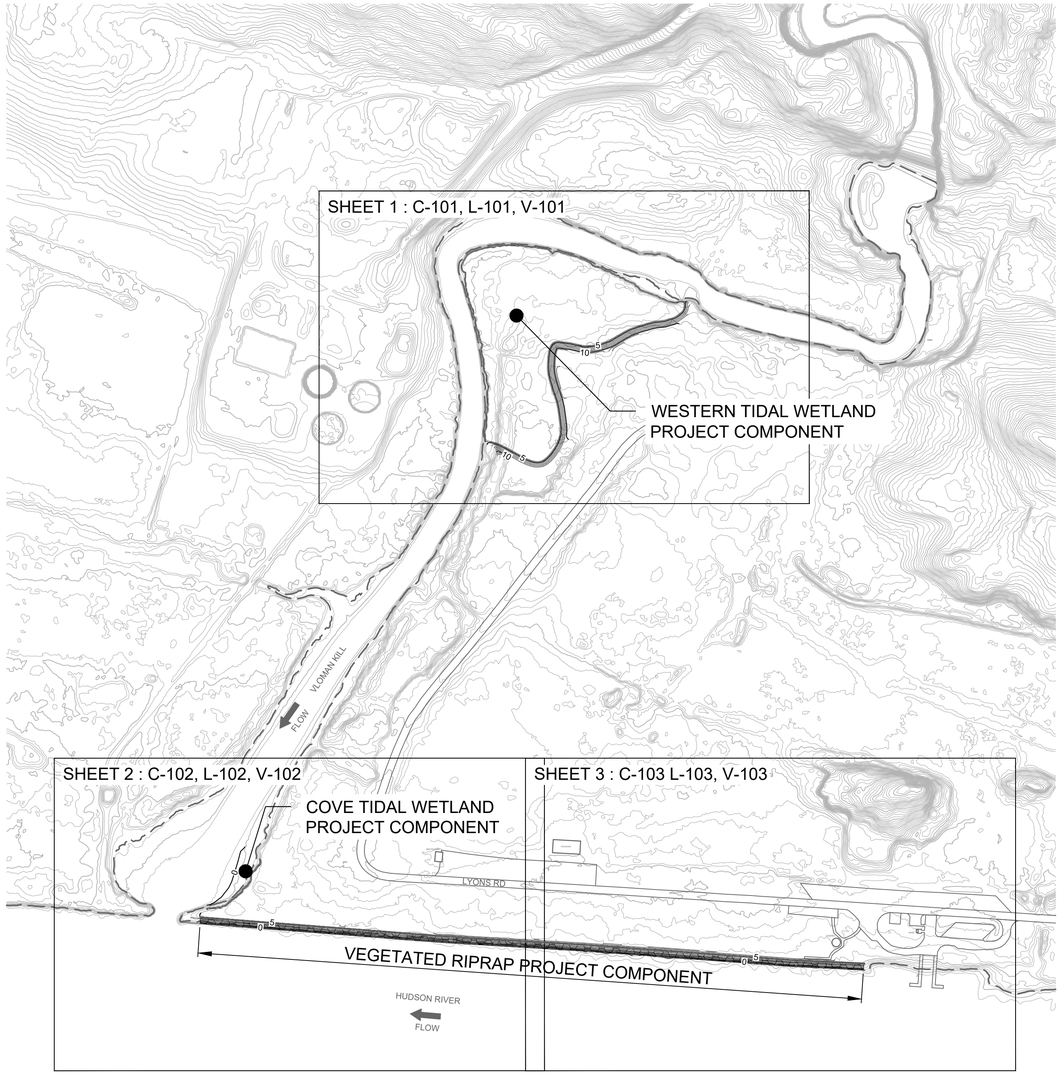
RINGOES, NEW JERSEY, 08551

HUDSON RIVER HABITAT RESTORATION
HENRY HUDSON PARK
TOWN OF BETHLEHEM
ALBANY COUNTY, NEW YORK

GENERAL NOTES

SHEET ID
G-002

MARCH 2020



GRAPHIC SCALE

0 100 200 400 600 800 FEET

SCALE: 1" = 200'

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HUDSON RIVER HABITAT RESTORATION
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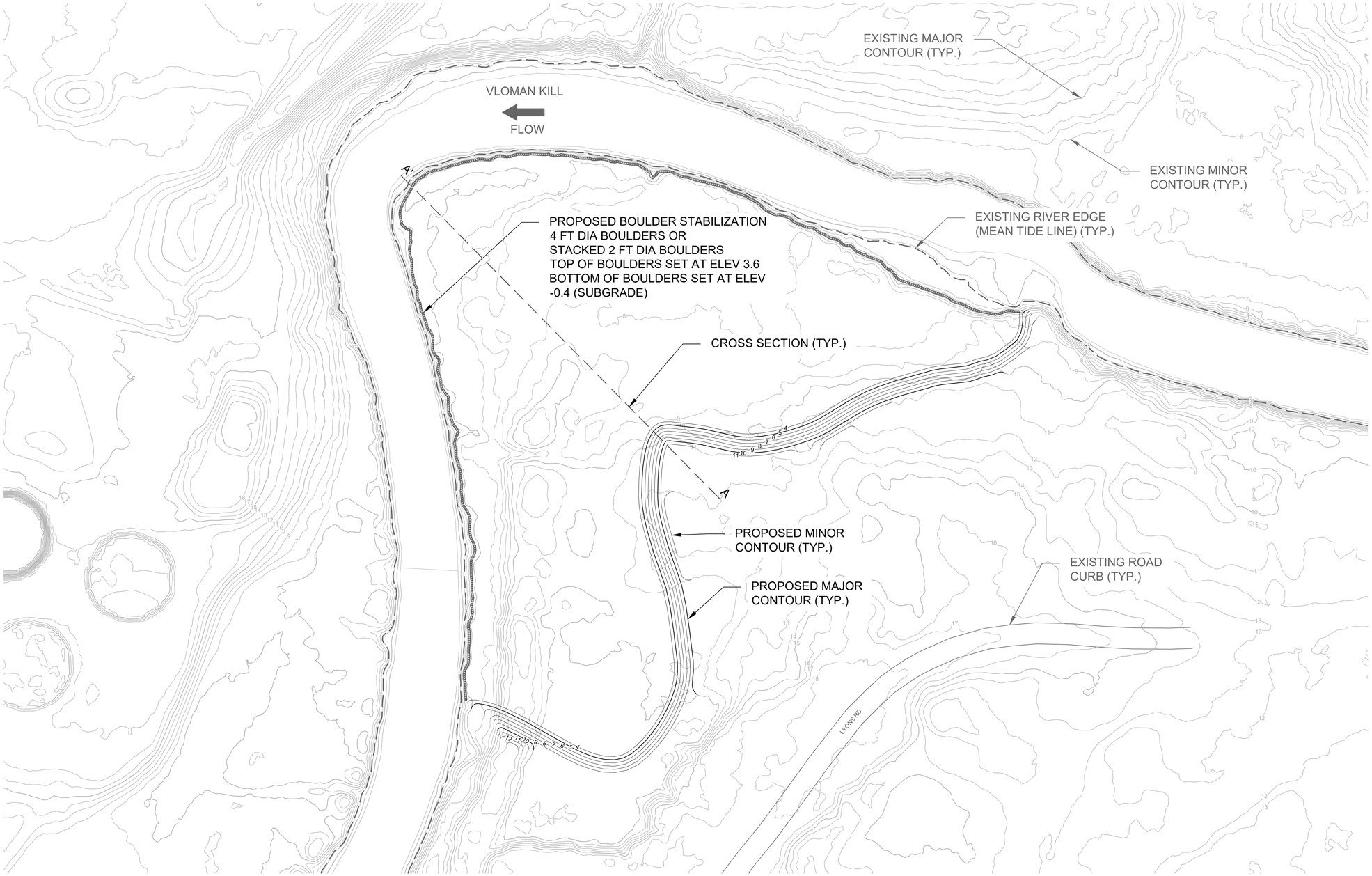
KEY MAP

SHEET ID

C-001

MARCH 2020



GRAPHIC SCALE

0 25 50 100 150 200 FEET

SCALE: 1" = 50'

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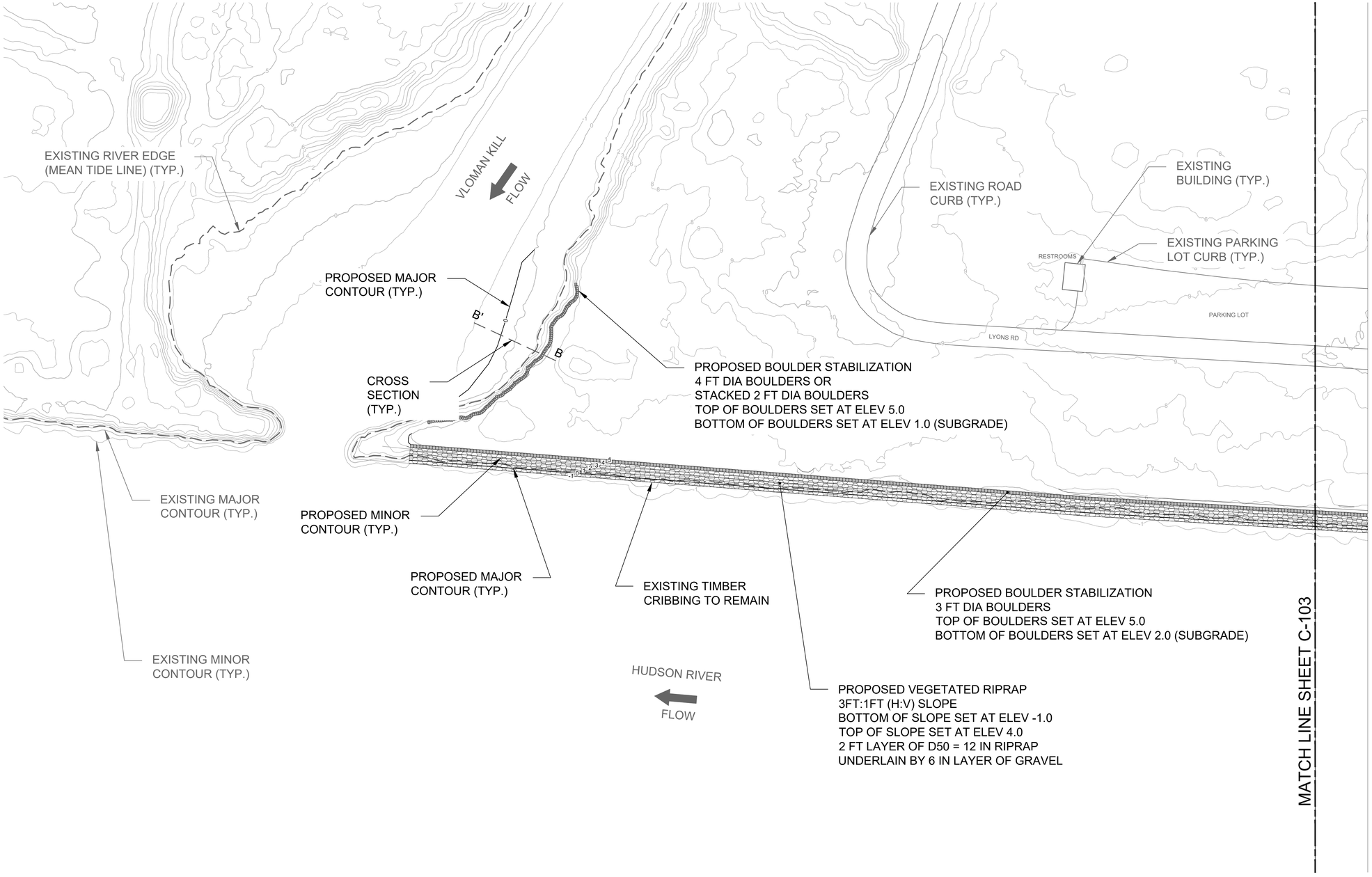
GENERAL PLAN SHEET 1

SHEET ID

C-101

MARCH 2020



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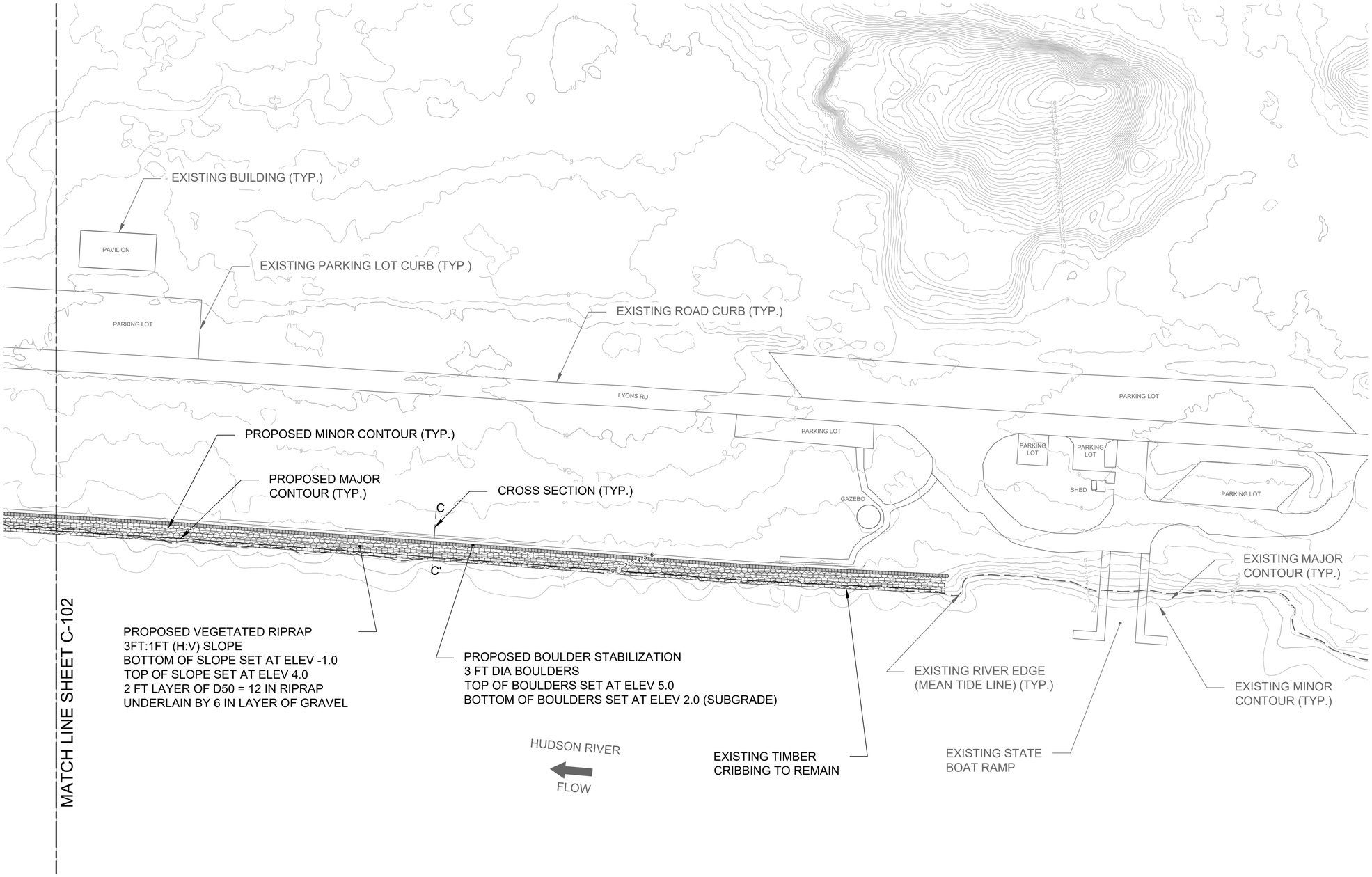
GENERAL PLAN SHEET 2

SHEET ID
C-102

MARCH 2020



GRAPHIC SCALE
0 25 50 100 150 200 FEET
SCALE: 1" = 50'

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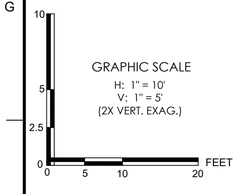
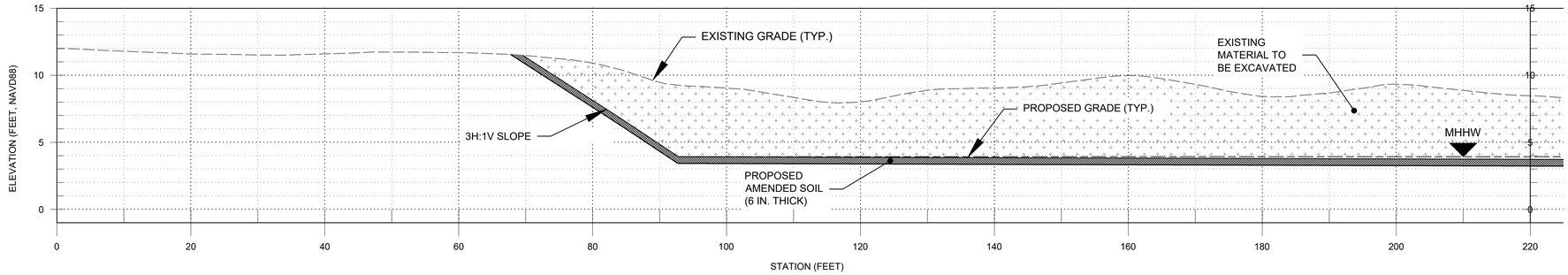
GENERAL PLAN SHEET 3

SHEET ID
C-103

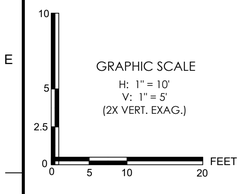
MARCH 2020

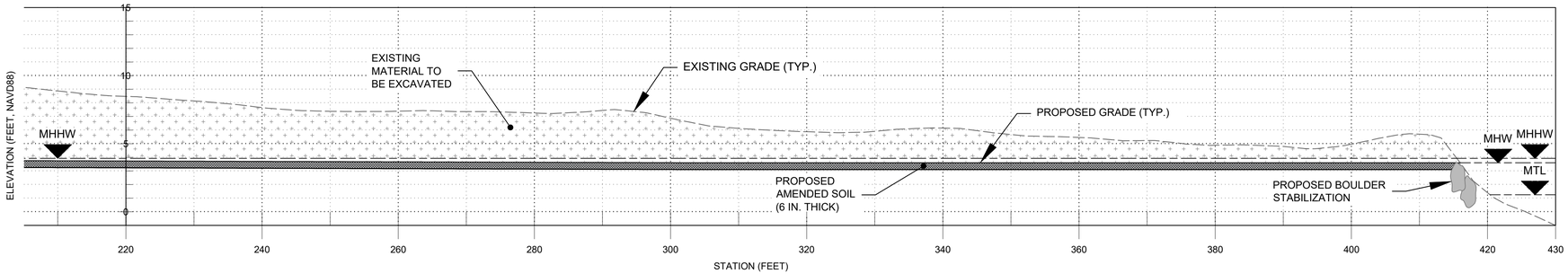
CROSS SECTION A - A' STA. 0 - 220
WESTERN TIDAL WETLAND



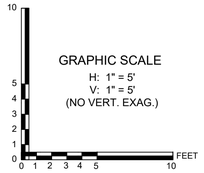


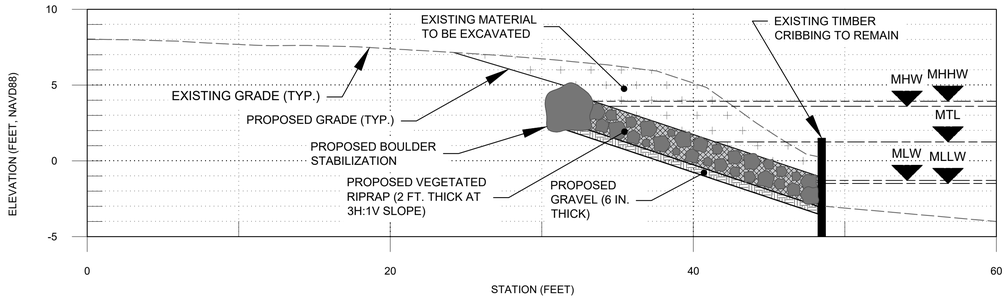
CROSS SECTION A - A' STA. 220 - 430
WESTERN TIDAL WETLAND



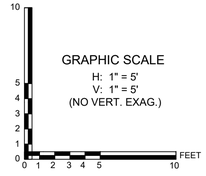


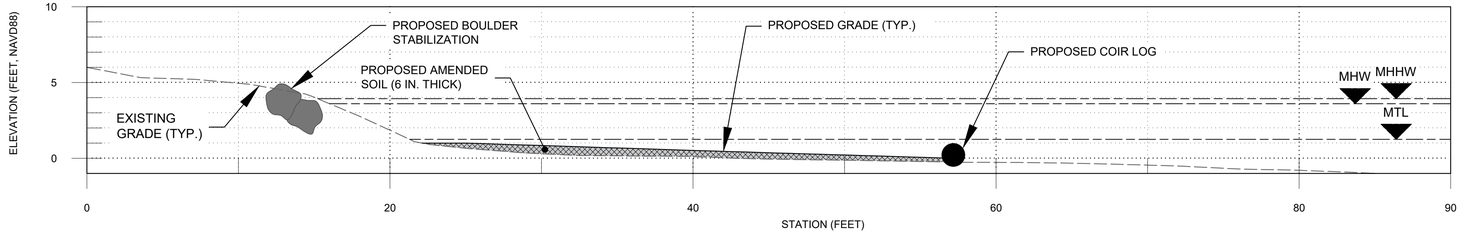
CROSS SECTION 3
VEGETATED RIPRAP





CROSS SECTION 2
COVE TIDAL WETLAND





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TOWN OF BETHLEHEM
ALBANY COUNTY, NEW YORK

CROSS SECTION SHEET 1

SHEET ID
C-301

MARCH 2020

WESTERN TIDAL WETLAND PLANTING SCHEDULE

WESTERN UPPER TIDAL WETLAND SEED MIX (3.59 AC): SEED TO BE SPREAD OVER ENTIRE WESTERN UPPER TIDAL WETLAND AREA AT A RATE OF 20 POUNDS PER ACRE.

BOTANICAL NAME:	SPECIES NAME:	SEEDING RATE (LBS PURE LIVE SEED/ACRE)	INDICATOR STATUS:	QUANTITY:
ASCLEPIAS INCARNATA	SWAMP MILKWEED	0.9	**OBL**	4.5%
CAREX LURIDA	LURID SEDGE	0.9	**OBL**	4.5%
CAREX SCOPARIA	BLUNT BROOM SEDGE	5	FACW	25.0%
CAREX VULPINOIDEA	FOX SEDGE	6	OBL	30.0%
ELYMUS VIRGINICUS	VIRGINIA WILDRYE	2.5	FACW	12.5%
HELENIUM AUTUMNALE	COMMON SNEEZEWEED	0.8	FACW	4.0%
JUNCUS EFFUSUS	SOFT RUSH	0.8	OBL	4.0%
SCIRPUS ATROVIRENS	GREEN BULRUSH	0.8	OBL	4.0%
SPARGANIUM AMERICANUM	EASTERN BUR REED	0.5	OBL	2.5%
SYMPHYOTRICHUM NOVAE-ANGLIAE	NEW ENGLAND ASTER	0.9	FACW	4.5%
VERBENA HASTATA	BLUE VERVAIN	0.9	FACW	4.5%

WESTERN UPPER TIDAL WETLAND HERBS (3.59 AC): TO BE INSTALLED 3' ON CENTER OVER ENTIRE WESTERN UPPER TIDAL WETLAND AREA

BOTANICAL NAME:	SPECIES NAME:	PLANTING TYPE:	INDICATOR STATUS:	QUANTITY:
EUTROCHIUM MACULATUM	SPOTTED JOE PYE-WEED	2" PLUG	OBL	1,750
HELENIUM AUTUMNALE	SNEEZEWEED	2" PLUG	FACW	2,450
IMPATIENS CAPENSIS	SPOTTED JEWELWEED	2" PLUG	FACW	2,100
JUNCUS EFFUSUS	SOFT RUSH	2" PLUG	OBL	2,600
SCIRPUS ATROVIRENS	GREEN BULRUSH	2" PLUG	OBL	2,600
SCIRPUS CYPERINUS	WOOL GRASS	2" PLUG	OBL	2,600
SPARGANIUM EURYCARPUM	BUR-REED	2" PLUG	OBL	2,100
TYPHA LATIFOLIA	NARROWLEAF CATTAIL	2" PLUG	OBL	1,200

WESTERN UPPER TIDAL WETLAND SHRUBS (3.59 AC): TO BE INSTALLED 8' ON CENTER OVER THE UPPER PORTIONS OF THE WESTERN UPPER TIDAL WETLAND AREA, ABOVE ELEVATION 3.0 FEET (NAVD88)

BOTANICAL NAME:	SPECIES NAME:	PLANTING TYPE:	INDICATOR STATUS:	QUANTITY:
ALNUS INCANA	SPECKLED ALDER	24" - 36" CONTAINER	-	366
CEPHALANTHUS OCCIDENTALIS	BUTTONBUSH	24" - 36" CONTAINER	OBL	488
CORNUS AMOMUM	SILKY DOGWOOD	24" - 36" CONTAINER	FACW	366
CORNUS SERICEA	RED OSIER DOGWOOD	24" - 36" CONTAINER	-	488
SALIX DISCOLOR	PUSSY WILLOW	24" - 36" CONTAINER	FACW	488
SPIRAEA ALBA	MEADOW-SWEET	24" - 36" CONTAINER	FACW	244

WESTERN UPLAND SEED MIX (0.46 AC): SEED TO BE SPREAD OVER ENTIRE WESTERN UPLAND SHRUB AREA AT A RATE OF 20 POUNDS PER ACRE.

BOTANICAL NAME:	SPECIES NAME:	SEEDING RATE (LBS PURE LIVE SEED/ACRE)	INDICATOR STATUS:	QUANTITY:
CAREX SCOPARIA	BLUNT BROOM SEDGE	2	FACW	10.0%
ELYMUS CANADENSIS	CANADA WILDRYE	3.6	FACU	18.0%
ELYMUS VIRGINICUS	VIRGINIA WILDRYE	2.4	FACW	12.0%
HELENIUM AUTUMNALE	COMMON SNEEZEWEED	1.4	FACW	7.0%
PANICUM CLANDESTINUM	DEERTONGUE	2	FACW	10.0%
PANICUM VIRGATUM	SWITCHGRASS	2.6	FAC	13.0%
SCHIZACHYRIUM SCOPARIUM	LITTLE BLUE STEM	4	FAC	20.0%
SYMPHYOTRICHUM NOVAE-ANGLIAE	NEW ENGLAND ASTER	1	FACW	5.0%
VERBENA HASTATA	BLUE VERVAIN	1	FACW	5.0%

WESTERN UPLAND SHRUBS (0.46 AC): TO BE INSTALLED 8' ON CENTER OVER ENTIRE WESTERN UPLAND SHRUB AREA

BOTANICAL NAME:	SPECIES NAME:	PLANTING TYPE:	INDICATOR STATUS:	QUANTITY:
ALNUS INCANA	SPECKLED ALDER	24" - 36" CONTAINER	-	75
ARONIA MELANOCARPA	BLACK CHOKEBERRY	24" - 36" CONTAINER	FAC	75
CORNUS SERICEA	RED OSIER DOGWOOD	24" - 36" CONTAINER	-	56
SPIRAEA ALBA	MEADOW-SWEET	24" - 36" CONTAINER	FACW	31
VIBURNUM LENTAGO	NANNYBERRY	24" - 36" CONTAINER	FAC	75

COVE TIDAL WETLAND PLANTING SCHEDULE

COVE TIDAL WETLAND SEED MIX (0.15 AC): SEED TO BE SPREAD OVER COVE LOWER AND UPPER TIDAL WETLAND AREAS AT A RATE OF 20 POUNDS PER ACRE.

BOTANICAL NAME:	SPECIES NAME:	SEEDING RATE (LBS PURE LIVE SEED/ACRE)	INDICATOR STATUS:	QUANTITY:
ASCLEPIAS INCARNATA	SWAMP MILKWEED	0.9	**OBL**	4.5%
CAREX LURIDA	LURID SEDGE	0.9	**OBL**	4.5%
CAREX SCOPARIA	BLUNT BROOM SEDGE	5	FACW	25.0%
CAREX VULPINOIDEA	FOX SEDGE	6	OBL	30.0%
ELYMUS VIRGINICUS	VIRGINIA WILDRYE	2.5	FACW	12.5%
HELENIUM AUTUMNALE	COMMON SNEEZEWEED	0.8	FACW	4.0%
JUNCUS EFFUSUS	SOFT RUSH	0.8	OBL	4.0%
SCIRPUS ATROVIRENS	GREEN BULRUSH	0.8	OBL	4.0%
SPARGANIUM AMERICANUM	EASTERN BUR REED	0.5	OBL	2.5%
SYMPHYOTRICHUM NOVAE-ANGLIAE	NEW ENGLAND ASTER	0.9	FACW	4.5%
VERBENA HASTATA	BLUE VERVAIN	0.9	FACW	4.5%

COVE LOWER TIDAL WETLAND HERBS (0.12 AC): TO BE INSTALLED 3' ON CENTER OVER ENTIRE COVE LOWER TIDAL WETLAND AREA

BOTANICAL NAME:	SPECIES NAME:	PLANTING TYPE:	INDICATOR STATUS:	QUANTITY:
ACORUS AMERICANUS	SWEETFLAG	2" PLUG	OBL	50
BIDENS LAEVIS	BEGGAR-TICKS	2" PLUG	OBL	50
BOLBOSCHOENUS FLUVIATILIS	RIVER BULRUSH	2" PLUG	OBL	50
CAREX VULPINOIDEA	FOX SEDGE	2" PLUG	OBL	100
CAREX LACUSTRIS	HAIRY SEDGE	2" PLUG	OBL	50
IRIS VERSICOLOR	BLUE FLAG IRIS	2" PLUG	OBL	50
LEERSIA ORYZOIDES	RICE CUTGRASS	2" PLUG	OBL	50
SAGITTARIA LATIFOLIA	ARROWHEAD	2" PLUG	OBL	50
SCHOENOPLECTUS TABERNAEMONTANI	SOFT STEM BULRUSH	2" PLUG	OBL	100
ZIZANIA AQUATICA	WILD RICE	2" PLUG	OBL	50

COVE UPPER TIDAL WETLAND HERBS (0.03 AC): TO BE INSTALLED 3' ON CENTER OVER ENTIRE COVE UPPER TIDAL WETLAND AREA

BOTANICAL NAME:	SPECIES NAME:	PLANTING TYPE:	INDICATOR STATUS:	QUANTITY:
EUTROCHIUM MACULATUM	SPOTTED JOE PYE-WEED	2" PLUG	OBL	50
HELENIUM AUTUMNALE	SNEEZEWEED	2" PLUG	FACW	50
SCIRPUS ATROVIRENS	GREEN BULRUSH	2" PLUG	OBL	50
SCIRPUS CYPERINUS	WOOL GRASS	2" PLUG	OBL	50

COVE UPPER TIDAL WETLAND SHRUBS (0.03 AC): TO BE INSTALLED 8' ON CENTER OVER THE UPPER PORTIONS OF THE COVE UPPER TIDAL WETLAND AREA, ABOVE ELEVATION 3.0 FEET (NAVD88)

BOTANICAL NAME:	SPECIES NAME:	PLANTING TYPE:	INDICATOR STATUS:	QUANTITY:
ALNUS INCANA	SPECKLED ALDER	24" - 36" CONTAINER	-	3
CEPHALANTHUS OCCIDENTALIS	BUTTONBUSH	24" - 36" CONTAINER	OBL	5
CORNUS AMOMUM	SILKY DOGWOOD	24" - 36" CONTAINER	FACW	3
CORNUS SERICEA	RED OSIER DOGWOOD	24" - 36" CONTAINER	-	5
SALIX DISCOLOR	PUSSY WILLOW	24" - 36" CONTAINER	FACW	5
SPIRAEA ALBA	MEADOW-SWEET	24" - 36" CONTAINER	FACW	2

COVE UPLAND SEED MIX (0.05 AC): SEED TO BE SPREAD OVER ENTIRE COVE UPLAND HERBACEOUS AREA AT A RATE OF 20 POUNDS PER ACRE.

BOTANICAL NAME:	SPECIES NAME:	SEEDING RATE (LBS PURE LIVE SEED/ACRE)	INDICATOR STATUS:	QUANTITY:
CAREX SCOPARIA	BLUNT BROOM SEDGE	2	FACW	10.0%
ELYMUS CANADENSIS	CANADA WILDRYE	3.6	FACU	18.0%
ELYMUS VIRGINICUS	VIRGINIA WILDRYE	2.4	FACW	12.0%
HELENIUM AUTUMNALE	COMMON SNEEZEWEED	1.4	FACW	7.0%
PANICUM CLANDESTINUM	DEERTONGUE	2	FACW	10.0%
PANICUM VIRGATUM	SWITCHGRASS	2.6	FAC	13.0%
SCHIZACHYRIUM SCOPARIUM	LITTLE BLUE STEM	4	FAC	20.0%
SYMPHYOTRICHUM NOVAE-ANGLIAE	NEW ENGLAND ASTER	1	FACW	5.0%
VERBENA HASTATA	BLUE VERVAIN	1	FACW	5.0%

VEGETATED RIPRAP PLANTING SCHEDULE

VEGETATED RIPRAP SEED MIX (0.60 AC): SEED TO BE SPREAD OVER ENTIRE VEGETATED RIPRAP INTERSTITIAL PLANTING AREA AT A RATE OF 20 POUNDS PER ACRE.

BOTANICAL NAME:	SPECIES NAME:	SEEDING RATE (LBS PURE LIVE SEED/ACRE)	INDICATOR STATUS:	QUANTITY:
ASCLEPIAS INCARNATA	SWAMP MILKWEED	1	OBL	5.0%
CAREX LURIDA	LURID SEDGE	1	OBL	5.0%
CAREX SCOPARIA	BLUNT BROOM SEDGE	5	FACW	25.0%
CAREX VULPINOIDEA	FOX SEDGE	6	OBL	30.0%
ELYMUS VIRGINICUS	VIRGINIA WILDRYE	2.5	FACW	12.5%
HELENIUM AUTUMNALE	COMMON SNEEZEWEED	0.9	FACW	4.5%
JUNCUS EFFUSUS	SOFT RUSH	0.9	OBL	4.5%
SPARGANIUM AMERICANUM	EASTERN BUR REED	0.6	OBL	3.0%
SYMPHYOTRICHUM NOVAE-ANGLIAE	NEW ENGLAND ASTER	1.1	FACW	5.5%
VERBENA HASTATA	BLUE VERVAIN	1	FACW	5.0%

VEGETATED RIPRAP HERBS (0.60 AC): TO BE INSTALLED 3' ON CENTER OVER ENTIRE VEGETATED RIPRAP INTERSTITIAL PLANTING AREA

BOTANICAL NAME:	SPECIES NAME:	PLANTING TYPE:	INDICATOR STATUS:	QUANTITY:
ACORUS AMERICANUS	SWEET FLAG	2" PLUG	OBL	300
BIDENS LAEVIS	BEGGAR-TICKS	2" PLUG	OBL	200
BOLBOSCHOENUS FLUVIATILIS	RIVER BULRUSH	2" PLUG	OBL	450
CAREX LACUSTRIS	HAIRY SEDGE	2" PLUG	OBL	150
CAREX SCOPARIA	BLUNT BROOM SEDGE	2" PLUG	FACW	150
CAREX VULPINOIDEA	FOX SEDGE	2" PLUG	OBL	100
JUNCUS EFFUSUS	SOFT RUSH	2" PLUG	OBL	150
IRIS VERSICOLOR	BLUE FLAG IRIS	2" PLUG	OBL	300
LEERSIA ORYZOIDES	RICE CUTGRASS	2" PLUG	OBL	350
SAGITTARIA LATIFOLIA	ARROWHEAD	2" PLUG	OBL	300
SCHOENOPLECTUS TABERNAEMONTANI	SOFT STEM BULRUSH	2" PLUG	OBL	300
ZIZANIA AQUATICA	WILD RICE	2" PLUG	OBL	250

VEGETATED RIPRAP SHRUBS (0.12 AC): TO BE INSTALLED 6' ON CENTER OVER THE UPPER PORTIONS OF THE VEGETATED RIPRAP INTERSTITIAL PLANTING AREA, ABOVE ELEVATION 3.0 FEET (NAVD88)

BOTANICAL NAME:	SPECIES NAME:	PLANTING TYPE:	INDICATOR STATUS:	QUANTITY:
ALNUS INCANA	SPECKLED ALDER	LIVE STAKE / BARE ROOT	-	29
CEPHALANTHUS OCCIDENTALIS	BUTTONBUSH	LIVE STAKE / BARE ROOT	OBL	44
CORNUS AMOMUM	SILKY DOGWOOD	LIVE STAKE / BARE ROOT	FACW	29
SALIX DISCOLOR	PUSSY WILLOW	LIVE STAKE / BARE ROOT	FACW	44

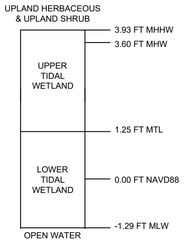
VEGETATED RIPRAP UPLAND SEED MIX (0.40 AC): SEED TO BE SPREAD OVER ENTIRE VEGETATED RIPRAP UPLAND HERBACEOUS AREA AT A RATE OF 20 POUNDS PER ACRE.

BOTANICAL NAME:	SPECIES NAME:	SEEDING RATE (LBS PURE LIVE SEED/ACRE)	INDICATOR STATUS:	QUANTITY:
CAREX SCOPARIA	BLUNT BROOM SEDGE	2	FACW	10.0%
ELYMUS CANADENSIS	CANADA WILDRYE	3.6	FACU	18.0%
ELYMUS VIRGINICUS	VIRGINIA WILDRYE	2.4	FACW	12.0%
HELENIUM AUTUMNALE	COMMON SNEEZEWEED	1.4	FACW	7.0%
PANICUM CLANDESTINUM	DEERTONGUE	2	FACW	10.0%
PANICUM VIRGATUM	SWITCHGRASS	2.6	FAC	13.0%
SCHIZACHYRIUM SCOPARIUM	LITTLE BLUE STEM	4	FAC	20.0%
SYMPHYOTRICHUM NOVAE-ANGLIAE	NEW ENGLAND ASTER	1	FACW	5.0%
VERBENA HASTATA	BLUE VERVAIN	1	FACW	5.0%

PLANTING NOTES:

TO ACCOMMODATE THE PROPOSED PLANTING MATERIAL THE RIPRAP WILL BE INSTALLED IN SINGLE LAYER LIFTS. UPON THE COMPLETION OF EACH LIFT, APPROVED SOIL MATERIAL WILL BE PLACED OVER THE RIPRAP AND THEN SWEPT INTO PLACE TO ENSURE VOID SPACE BETWEEN THE RIPRAP IS FILLED. THIS PROCESS WILL BE REPLICATED UNTIL THE FINISHED GRADE IS REACHED. ONCE THE FINAL APPLICATION OF APPROVED SOIL MATERIAL IS PLACED, LIVE STAKES AND HERBACEOUS MATERIAL WILL BE PLACED IN THE BACKFILLED RIPRAP. NOTE, BACKFILL MATERIAL SHALL NOT EXCEED THE FINISHED ELEVATION TO PREVENT UNNECESSARY MATERIAL LOSS DUE TO TIDES AND CURRENTS.

PLANTING AREAS BY TIDAL RANGE



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CONTRACT NO.: W912DS-19-D-0003
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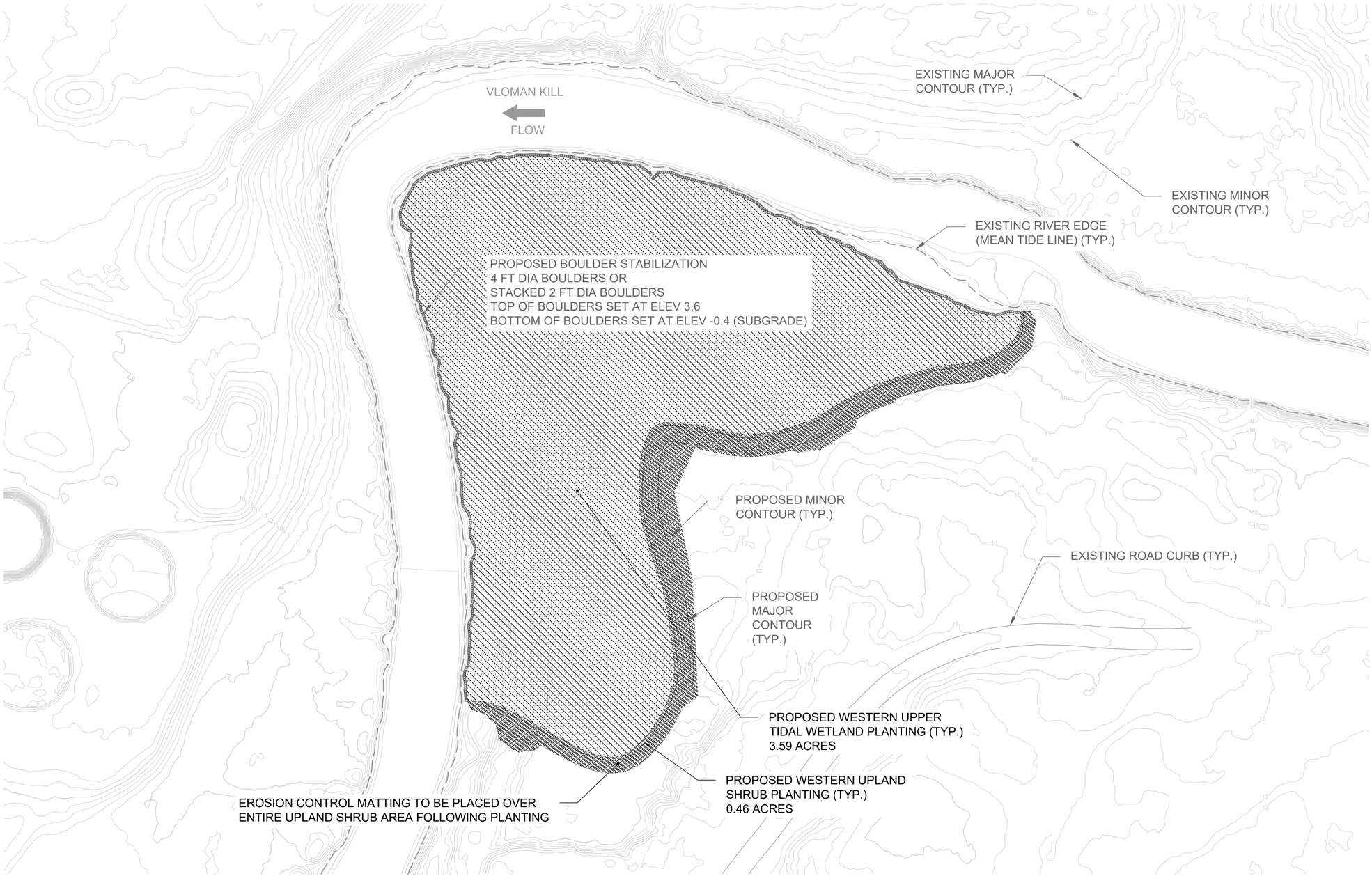
HUDSON RIVER HABITAT RESTORATION
HENRY HUDSON PARK
TOWN OF BETHLEHEM
ALBANY COUNTY, NEW YORK

LANDSCAPING NOTES

SHEET ID
L-001

MARCH 2020



GRAPHIC SCALE
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SCALE: 1" = 50'

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LANDSCAPING PLAN SHEET 1

SHEET ID
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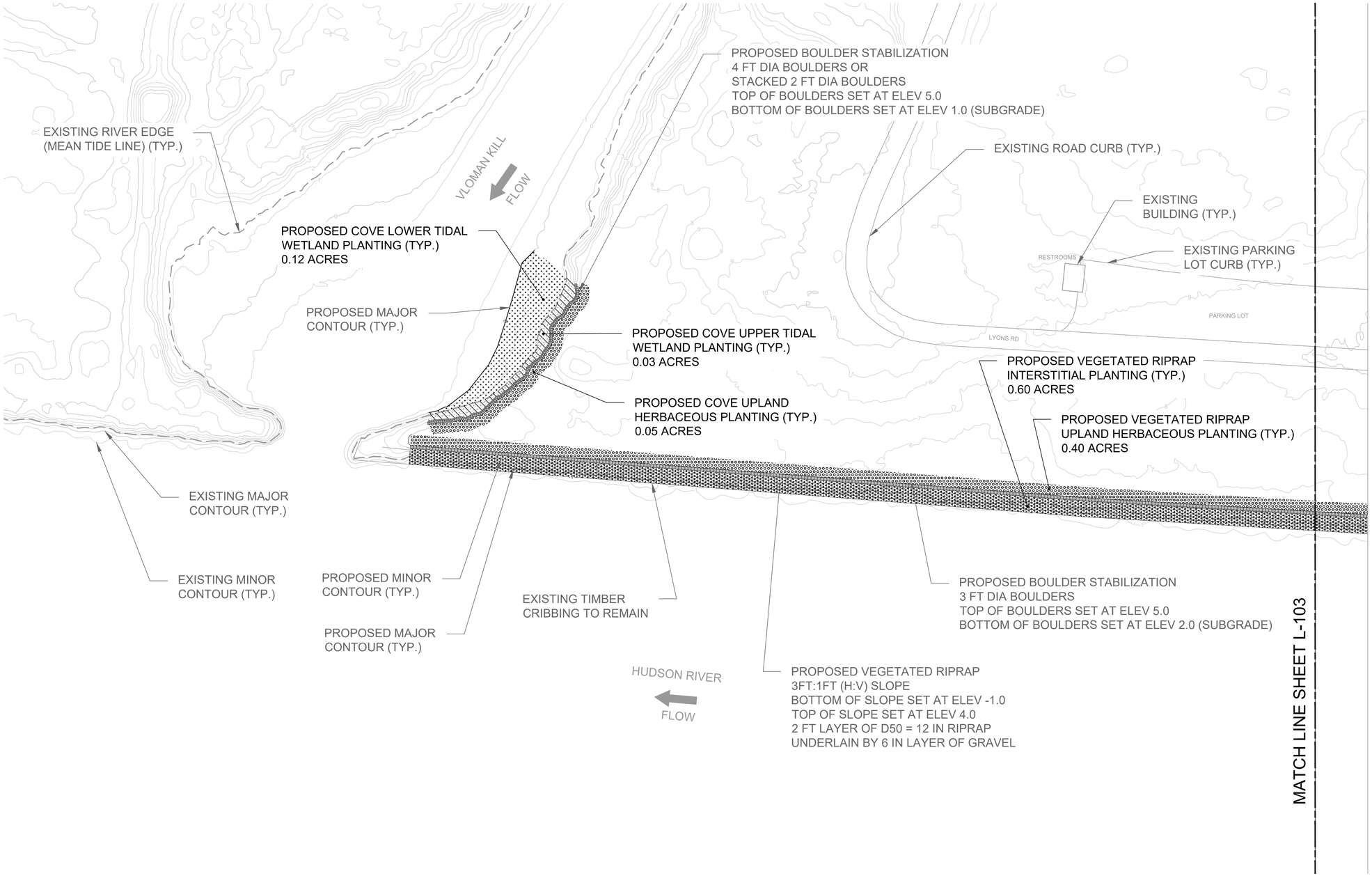
MARCH 2020



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LANDSCAPING PLAN SHEET 2

SHEET ID

L-102

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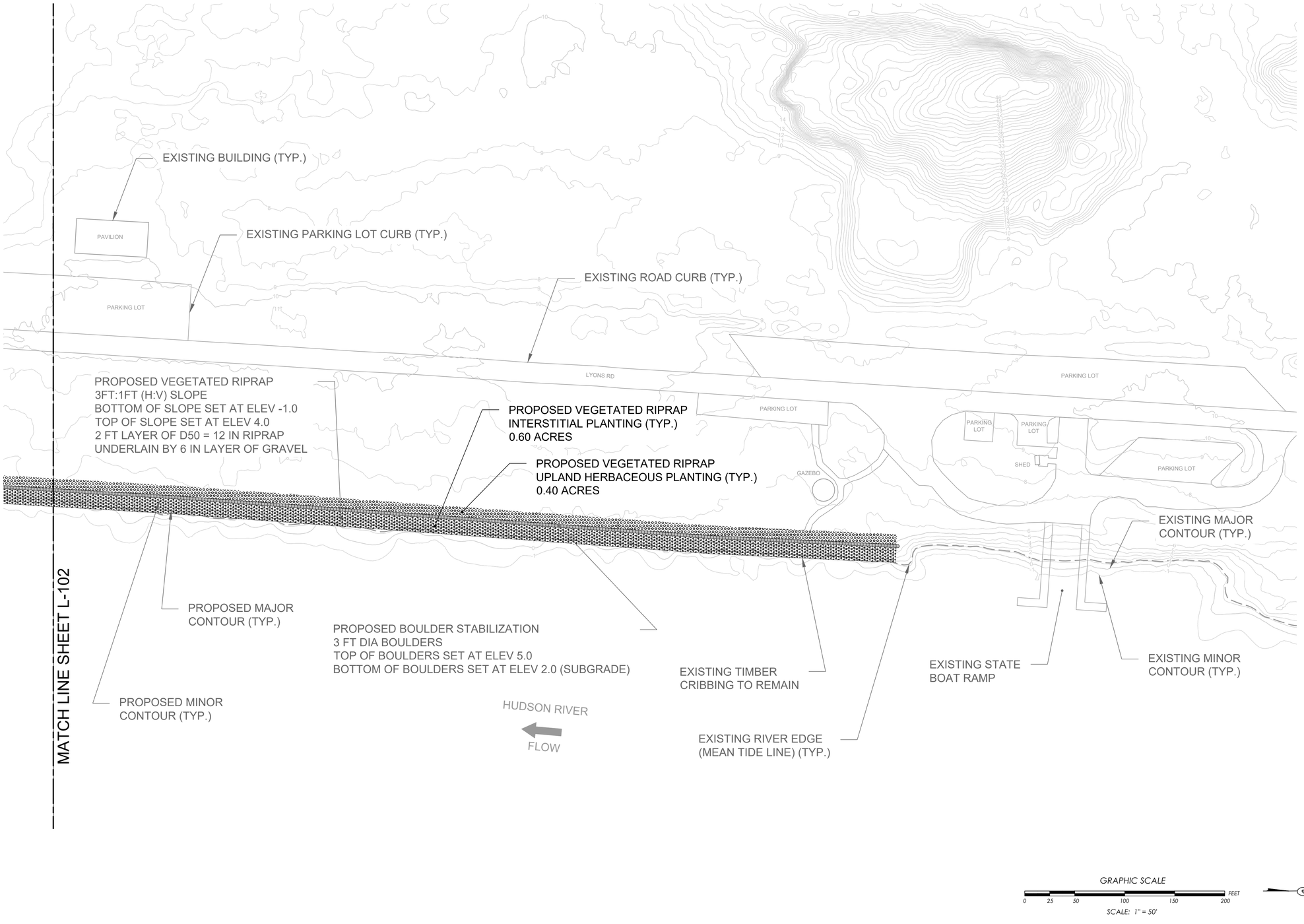

GRAPHIC SCALE
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LANDSCAPING PLAN SHEET 3

SHEET ID
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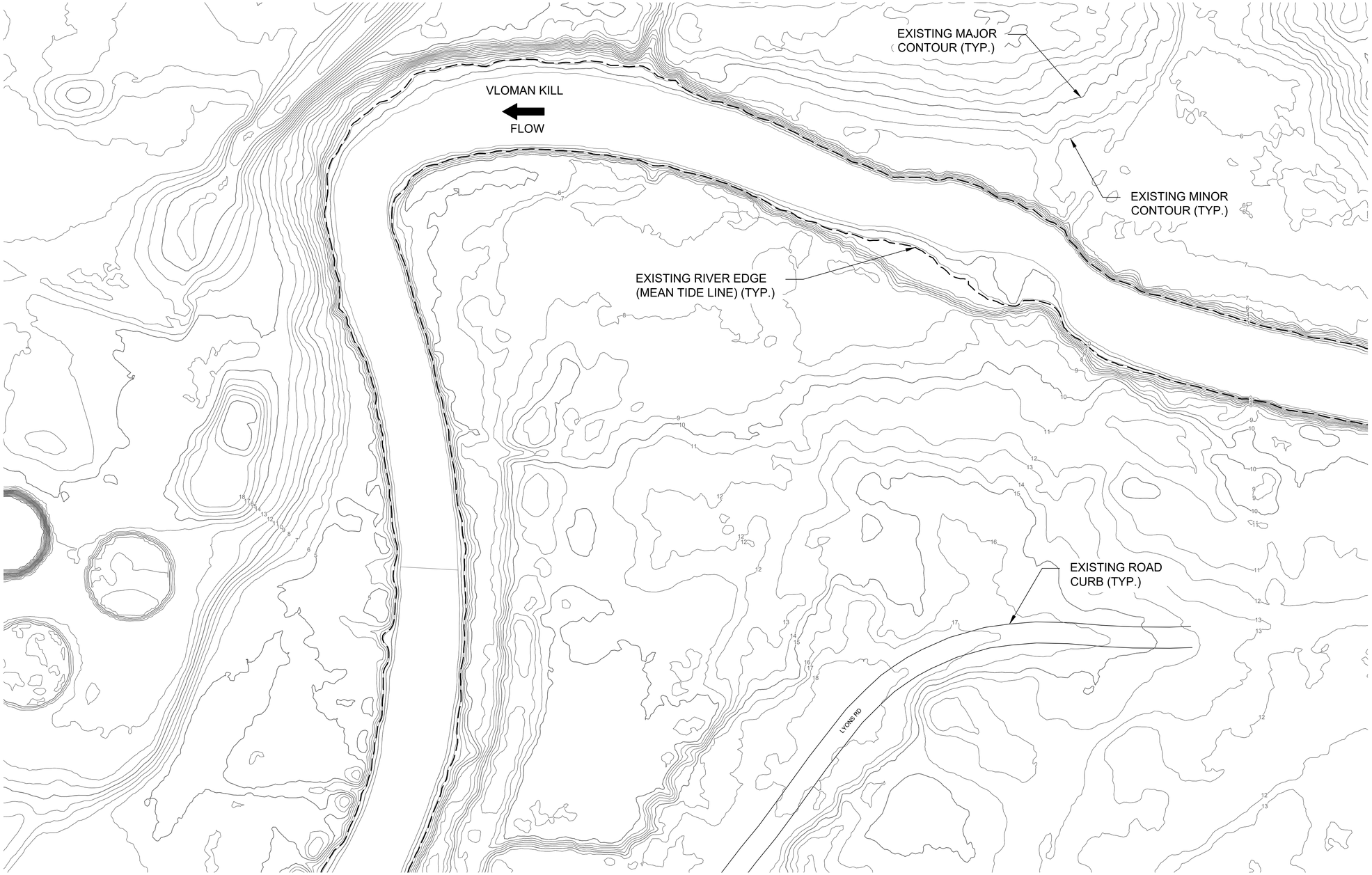

GRAPHIC SCALE

0 25 50 100 150 200 FEET

SCALE: 1" = 50'

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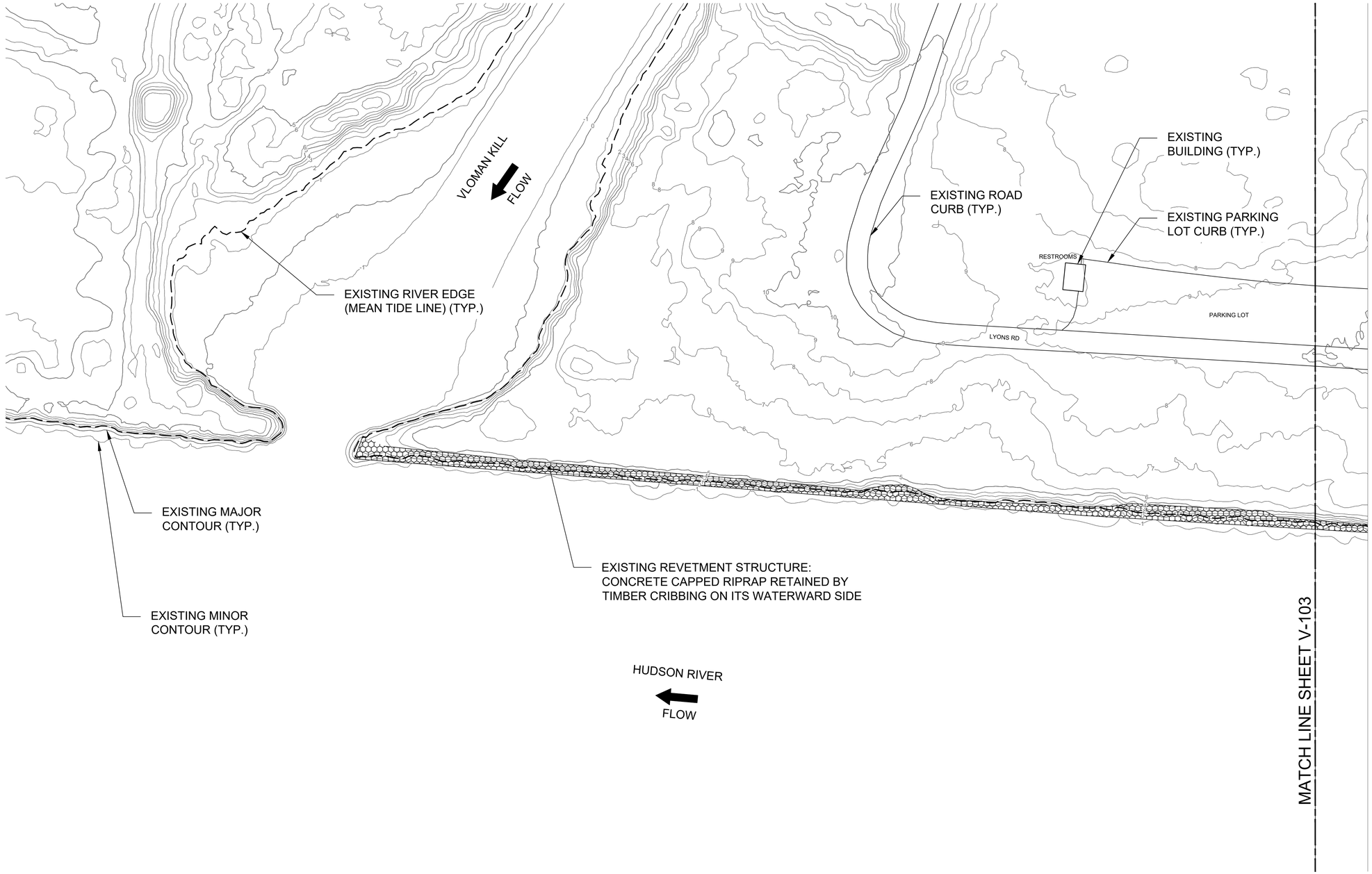
EXISTING SURVEY PLAN SHEET 1

SHEET ID

V-101



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EXISTING SURVEY PLAN SHEET 2

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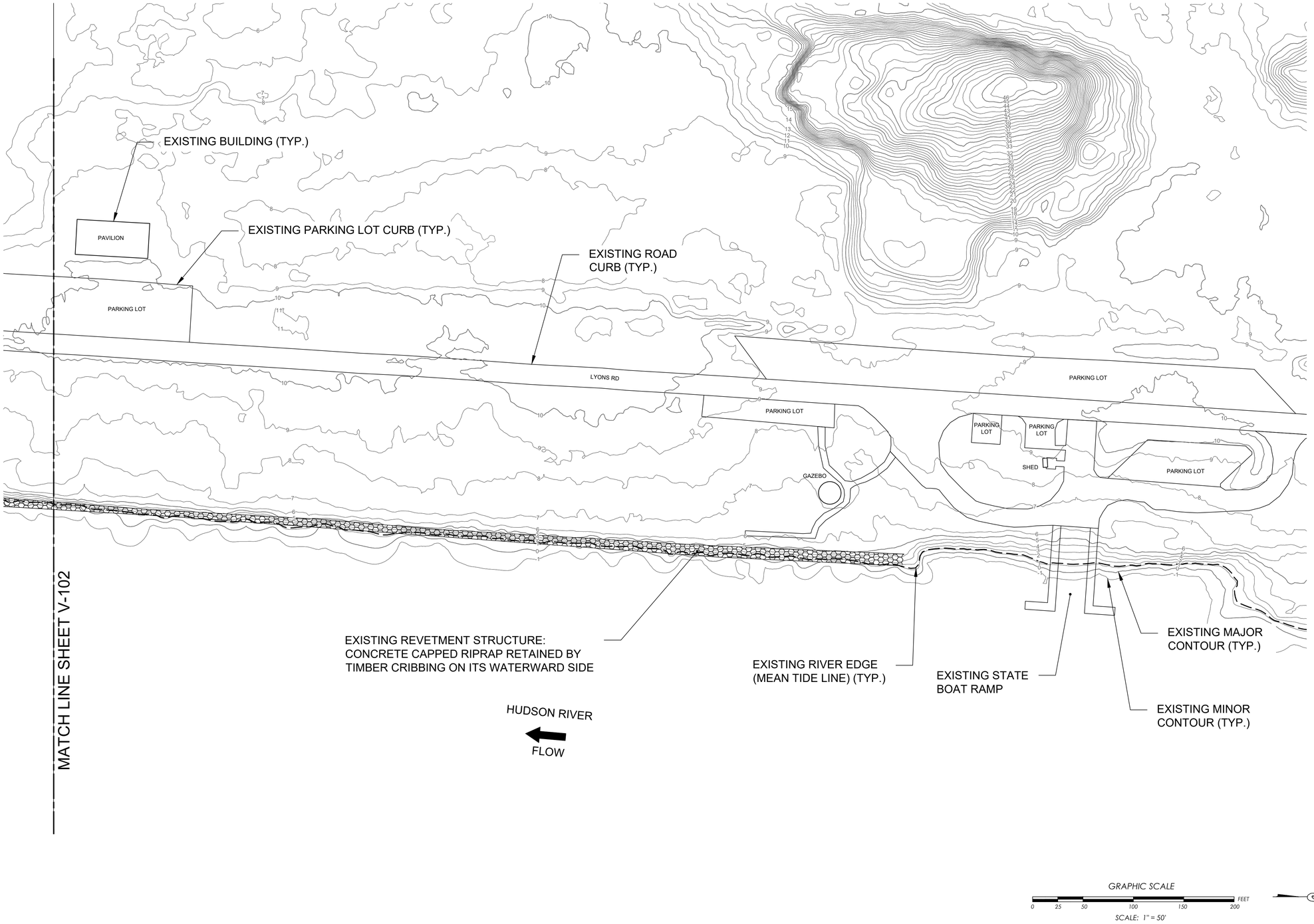

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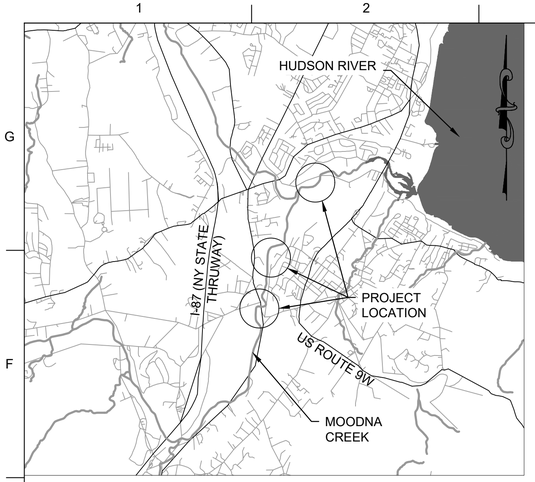
MARCH 2020

HUDSON RIVER HABITAT RESTORATION
HENRY HUDSON - CONSTRUCTION QUANITTIES

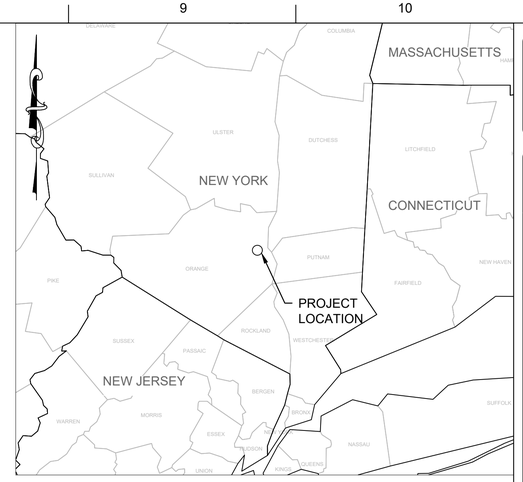
COMPONENT	COMPONENT	QTY	UNIT	CONVERTED QTY	CONVERTED UNIT	DESCRIPTION
General Construction	Stabilized Construction Entrance Area	11,829	SQFT	1,314	SQYD	Total length at least 50-ft as per NY standard for stabilized construction entrance
	Stabilized Construction Entrance Volume	7,886	CUFT	295	CUYD	Area of stabilized construction entrance multiplied by the depth of rock (assumed 8")
	Construction Access - Matting Length	480	LF			$350/lf for installation and use and addition $30/lf for removal from site; Assumed matting throughout the restoration area where a traditional construction access road will not be sufficient
	Turbidity Barrier	3,130	LF			Water edge length along all 3 project components
	Silt Fence	6,173	LF			LOD Perimeter for all 3 project components
	Traffic Control	2	EA			Assumed 2 detour signs needed in the adjacent parking lot
	Survey Stakeout	237,969	SQFT	5.46	AC	Total LOD area
	Project Duration	16	MO			Project duration in months
	Field Office	1	EA			Includes field trailer and other misc. costs (e.g. supplies, telephone bill, portable toilet, Storage box, etc..)
	Dewatering	1	EA			Sump hole, 15-ft assumed height; Assumed duration of 12 months
	Excavated Material Disposal Volume	36,600	CY			Loading, hauling, and disposal of material; Material for this line was updated to reflect tipping fees for soil based on a verbal quote from WB Biers disposal facility near the Port of Coeymans
Western Tidal Wetland	LOD Area	178,723	SQFT	19,858	SQYD	Total area of component LOD
	LOD Perimeter	2,069	LF			Total perimeter of component LOD
	Excavation (Final Grade)	755,510	CUFT	27,982	CUYD	Cut Fill From GIS, proposed surface vs. existing LiDAR. **Does not include** the trench that will need to be excavated to include the boulder toe or the 6" subgrade excavation
	Excavation (Subgrade)	88,212	CUFT	3,267	CUYD	6" deep over excavation across whole site excluding the 2' wide strip of boulder toe.
	Excavation (Boulder Toe Trench)	9,200	CUFT	341	CUYD	4' deep trench for boulder toe installation
	Boulder Toe/Rock Sill Length/Area	1,150	LF	2,300	SQFT	2 layers of 2ft dia. boulders or 1 layer of 4ft dia boulders, top elevation set at 3.6 bottom set at -0.4
	Boulder Toe/Rock Sill Volume	9,200	CUFT	341	CUYD	Assuming a cube-shape (imbricated rock)
	Boulder Toe/Rock Sill Material	1,150	EA	569	TONS	Assuming 1.67 tons/CY

Western Tidal Wetland (Con't)	Amended Soils + 10% Settlement Factor	97,043 CUFT	3,594 CUYD	6" across Planting Areas, 10% settlement factor added
	Upland Shrub Planting Area	20,219 SQFT	2,247 SQYD	Plantings above Elev 3.93 (2027 MHHW)
	Upper Tidal Wetland planting Area	156,222 SQFT	17,358 SQYD	Plantings between Elev 1.25 - 3.93 (2027 MTL - MHHW)
	Plugs (Wetland)	17,400 EA		2" Herb plugs Installed 3 feet on center over Upper Tidal Wetland Area
	Shrubs (Wetland)	1,562 EA		24" - 36" container shrubs Installed 10 feet on center over upper portions of Upper Tidal Wetland Planting Area (Elev 3.0 to 4.0)
	Shrubs (Upland)	313 EA		24" - 36" container shrubs Installed 8 feet on center over Upland Shrub Planting Area
	Seeds (Wetland)	72 LBS		Seeds applied at a rate of 20 lb/acre over Upper Tidal Wetland Area
	Seeds (Upland)	9 LBS		Seeds applied at a rate of 20 lb/acre over Upland Shrub Planting Area
	Deer fence	919 LF		Total Perimeter minus length of boulder toe
	Goose fence	156,222 SQFT	3.59 AC	Installed along upper tidal wetland
	Erosion Control Matting	20,219 SQFT	2,247 SQYD	Installed along entire upland shrub planting area
Cove Tidal Wetland	LOD Area	9,797 SQFT	1,089 SQYD	Total area of component LOD
	LOD Perimeter	533 LF		Total perimeter of component LOD
	Boulder Stabilization Length	220 LF		2 layers of 2ft dia. boulders or 1 layer of 4ft dia boulders, top elevation set at 5.0 bottom set at 1.0
	Boulder Stabilization Volume	1,760 CUFT	65 CUYD	Assuming a cube-shape (imbricated rock)
	Boulder Stabilization Material	220 EA	109 TONS	Assuming 1.67 tons/CY
	Coir Log	195 LF		20" dia.
	Amended Soil	3,330 CUFT	123 CUYD	6 inches over wetland areas
	Upland Grass Seeding Area	2,188 SQFT	243 SQYD	Seeding above Elev 3.93 (2027 MHHW)
	Upper Tidal Wetland Planting Area	1,466 SQFT	163 SQYD	Plantings between Elev 1.25 - 3.93 (2027 MTL - MHHW)
	Lower Tidal Wetland Planting Area	5,194 SQFT	577 SQYD	Plantings between Elev -1.29 to 1.25 (2027 MLW - MTL)
	Plugs (Wetland)	800 EA		2" Herb plugs Installed 3 feet on center over Upper and Lower Tidal Wetland Areas
	Shrubs	23 EA		24" - 36" container shrubs Installed 8 feet on center over upper portions of Upper Tidal Wetland Planting Area (Elev 3.0 to 4.0)
	Seeds (Wetland)	3 LBS		Seeds applied at a rate of 20 lb/acre over Upper and Lower Tidal Wetland Areas
	Seeds (Upland)	1 LBS		Seeds applied at a rate of 20 lb/acre over Upland Grass Seeding Area
	Goose fence	6,660 SQFT	0.153 AC	Installed along entire Wetland area.

Vegetated Riprap	LOD Area	49,449 SQFT	5,494 SQYD	Total area of component LOD
	LOD Perimeter	3,571 LF		Total perimeter of component LOD
	Excavation	124,200 CUFT	4,600 CUYD	Cut Fill From GIS, proposed subgrade surface vs. existing LiDAR. Includes the trench that will need to be excavated to include the boulder toe, 24" deep riprap along slope, and the 6" subgrade excavation for upland areas
	Boulder Stabilization Length/Area	1,760 LF		1 layer of 3ft dia. Boulders, top elevation set at 5 bottom set at 2. Riverward slope intersects with riprap at elevation 4
	Boulder Stabilization Volume	15,840 CUFT	587 CUYD	Assuming a cube-shape (imbricated rock)
	Boulder Stabilization Material	590 EA	980 TONS	Assuming 1.67 tons/CY
	Riprap Area	26,330 SQFT	2,926 SQYD	24" thick layer of D50 - 12" riprap
	Riprap Volume	52,660 CUFT	1,950 CUYD	24" thick layer of D50 - 12" riprap
	Gravel Area	26,330 SQFT		6" thick layer of gravel underneath the riprap
	Gravel Volume + 30% Compaction Factor	17,115 CUFT	634 CUYD	6" thick layer of gravel underneath the riprap, 30% compaction factor added
	Amended Soil	26,330 SQFT	975 CUYD	Assumes 50% of riprap is void space to be filled with soil
	Upland Grass Seeding Area	17,549 SQFT	1,950 SQYD	Seeding above Elev 3.93 (2027 MHHW)
	Interstitial Planting Area (Seeds and Herbs)	26,330 SQFT	2,926 SQYD	Interstitial plantings between Elev -1.0 to 4.0
	Interstitial Planting Area (Shrubs)	5,266 SQFT	585 SQYD	Upper portions of vegetated riprap area between Elev 3.0 to 4.0
	Plugs (Interstitial Planting)	3,000 EA		2" Herb plugs Installed 3 feet on center over Interstitial Planting Area (Seeds and Herbs)
	Livestakes (Interstitial Planting)	150 EA		Shrub livestakes Installed 6 feet on center over Interstitial Planting Area (Shrubs)
	Seeds (Interstitial Planting)	20 LBS		Seeds applied at a rate of 20 lb/acre over Interstitial Planting Area (Seeds and Herbs)
	Seeds (Upland)	8 LBS		Seeds applied at a rate of 20 lb/acre over Upland Grass Seeding Area



VICINITY MAP
SCALE: 1" = 5,000'



LOCATION MAP
SCALE: 1" = 100,000'

HUDSON RIVER HABITAT RESTORATION

MOODNA CREEK

TOWNS OF CORNWALL AND NEW WINDSOR
ORANGE COUNTY, NEW YORK

MARCH 2020

US Army Corps of Engineers®

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1108 OLD YORK ROAD
RINGOES, NEW JERSEY, 08551

HUDSON RIVER HABITAT RESTORATION
MOODNA CREEK
TOWNS OF CORNWALL AND NEW WINDSOR
ORANGE COUNTY, NEW YORK

COVER SHEET

SHEET ID
G-001

GENERAL NOTES:

1. THE CONTRACTOR SHALL NOTE THAT IN THE CASE OF A DISCREPANCY BETWEEN THE SCALED AND FIGURED DIMENSIONS SHOWN ON THESE PLANS, THE FIGURED DIMENSIONS SHALL APPLY.
2. SINCE FIELD CONDITIONS MAY REQUIRE MODIFICATIONS TO PROPOSED TOPOGRAPHIC ELEVATIONS AND FACILITY LOCATIONS, THESE PLANS ARE NOT TO BE UTILIZED AS AS-BUILTS FOR ANY OTHER PURPOSE.
3. THESE PLANS ARE NOT TO BE UTILIZED FOR CONSTRUCTION UNTIL ALL REQUIRED LOCAL, STATE, AND FEDERAL PERMITS ARE OBTAINED.
4. THE CONTRACTOR MUST CONTACT THE NEW YORK ONE CALL NUMBER AT 1-800-962-7962, TWO FULL WORKING DAYS PRIOR TO THE START OF WORK TO HAVE ALL UTILITIES MARKED IN THE WORK AREA. ADDITIONALLY, THE CONTRACTOR MUST CONTACT ALL UTILITY OPERATORS NOT AFFILIATED WITH ONE CALL IN ORDER TO LOCATE ALL OTHER UTILITIES WITHIN THE PROJECT AREA. THE CONTRACTOR SHALL ESTABLISH A LIAISON WITH ALL UTILITIES AND ADVISE THE CONTRACTING OFFICER (CO) IN WRITING OF THE DETAILS.
5. ALL CONSTRUCTION SHALL ADHERE TO OSHA STANDARDS AND REGULATIONS.
6. IT SHALL BE DISTINCTLY NOTED THAT FAILURE TO MENTION SPECIFICALLY ANY WORK THAT WOULD NORMALLY BE REQUIRED TO COMPLETE THE PROJECT, SHALL NOT RELIEVE THE CONTRACTOR'S RESPONSIBILITY TO PERFORM THAT WORK.
7. THE APPROVAL AND USE OF THESE PLANS ARE FOR THE PROJECT SPONSOR . THIS PLAN IS NOT TO BE UTILIZED IN THE PREPARATION OF ANY OTHER PROJECTS.
8. CONTRACTOR SHALL VERIFY ALL DIMENSIONS AND EXISTING CONDITIONS IN THE FIELD PRIOR TO THE START OF CONSTRUCTION AND ERRORS OR DISCREPANCIES SHALL BE IMMEDIATELY BROUGHT TO THE ATTENTION OF THE CONTRACTING OFFICER (CO) OR CONTRACTING OFFICER'S REPRESENTATIVE (COR).
9. THE CONTRACTOR WILL BE REQUIRED TO PERFORM A MINIMUM OF THREE (3) INSPECTIONS DAILY AND PERFORM ROUTINE CLEAN UP DUTIES AS REQUIRED AND ALSO MAINTAIN ALL EXCAVATIONS, EMBANKMENTS, STOCKPILES, HAUL ROADS, PLANT SITES, WASTE AREAS, BORROW AREAS, AND ALL OTHER WORK AREAS WITHIN OR WITHOUT OF THE PROJECT BOUNDARIES FREE FROM DUST WHICH WOULD CAUSE A HAZARD OR NUISANCE TO OTHERS. DUST CONTROL SHALL BE PERFORMED AS THE WORK PROCEEDS AND WHENEVER A DUST NUISANCE OR HAZARD OCCURS.
10. ALL PLAN SHEETS ARE HORIZONTALLY REFERENCED TO THE NORTH AMERICAN DATUM OF 1983 (NAD83), PROJECTED TO THE NEW YORK STATE PLANE COORDINATE SYSTEM, AND VERTICALLY REFERENCED TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88). ALL UNITS ARE IN U.S. SURVEY FEET UNLESS OTHERWISE SPECIFIED..
11. ACCESS TO ALL PROPERTIES MUST BE MAINTAINED DURING CONSTRUCTION.
12. MAIL DELIVERY SHALL NOT BE DISRUPTED DURING CONSTRUCTION.
13. THE CONTRACTOR SHALL TAKE PRECAUTIONS TO LOCATE PROPERTY LINES AND RIGHT OF WAY LINES PRIOR TO CONSTRUCTION AND AVOID CONSTRUCTION ACTIVITIES ON PRIVATE PROPERTY AND/OR RIGHTS OF WAYS WHERE SAID CONSTRUCTION IS PROHIBITED. THE CONTRACTOR MAY CONDUCT CONSTRUCTION ACTIVITIES ON PRIVATE PROPERTY PROVIDED HE HAS OBTAINED PRIOR WRITTEN PERMISSION FROM THE PROPERTY OWNER AND HAS SUBMITTED A COPY OF SAID WRITTEN PERMISSION TO THE CO OR COR.
14. THE CONTRACTOR SHALL ALLOW SUFFICIENT TIME FOLLOWING EXCAVATIONS FOR INSPECTION AND EVALUATION OF EXISTING SOIL SUBGRADE CONDITIONS BY A COMPETENT PERSON PER 29 CFR 1926.32(f) AND THE CO OR COR.

SITE RESTORATION:

1. THE CONTRACTOR IS RESPONSIBLE TO RESTORE ALL GRASSY AREAS, PAVED AND CONCRETE AREAS, DRIVEWAYS AND CURBING DISTURBED DURING CONSTRUCTION TO THEIR PRE-CONSTRUCTION CONDITION AFTER COMPLETION OF CONSTRUCTION AND PRIOR TO FINAL ACCEPTANCE OF THE PROJECT.
2. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE REPAIR AND REPLACEMENT OF PROPERTY DAMAGE TO FENCES, SIGNS, STRUCTURES, VEGETATION, IRRIGATION, LANDSCAPING COMPONENTS, AND ANY OTHER PROPERTY ITEMS THAT ARE REMOVED FOR THE PURPOSES OF THE PROJECT LOGISTICS AND/OR ACCIDENTS.
3. ALL GRASSED OR WOODED AREAS DISTURBED DURING CONSTRUCTION SHALL BE TOPSOILED AND SEEDED.

SITEWORK:

1. EXCAVATIONS AND STOCKPILES SHALL HAVE SLOPES CONSISTENT WITH THE ENGINEERING DESIGN SIGNED AND SEALED BY A LICENSED ENGINEER IN THE STATE OF NEW YORK.
2. THE CONTRACTOR IS RESPONSIBLE FOR THE REMOVAL AND PROPER DISPOSAL OF ALL STOCK-PILED SOIL, TRASH, CONSTRUCTION MATERIALS AND DEBRIS AFTER THE COMPLETION OF CONSTRUCTION. ALL DISPOSAL SHALL BE PERFORMED IN ACCORDANCE WITH APPLICABLE MUNICIPAL, COUNTY, STATE, AND FEDERAL REGULATIONS.
3. FOR INSTALLATION OF STABILIZED CONSTRUCTION ENTRANCE AND CONSTRUCTION ACCESS ROAD, CONTRACTOR SHALL AVOID TREE IMPACTS IN ACCORDANCE WITH SPECIFICATIONS SECTION 01 57 19.
4. ALL ELEVATIONS AND QUANTITIES ARE BASED ON IN-SITU CONDITIONS. ONCE DISTURBED, MATERIAL CONDITIONS CAN VARY SIGNIFICANTLY.
5. ALL PROPOSED CONSTRUCTION MUST BE SUPERVISED BY A PROFESSIONAL ENGINEER, LICENSED IN THE STATE OF NEW YORK, OR THEIR DULY APPOINTED REPRESENTATIVE.
6. ALL STOCKPILED MATERIAL PROPOSED FOR USE AS STRUCTURAL FILL WILL BE PROTECTED FROM EXCESSIVE LOSS OR GAIN OF MOISTURE USING SECURELY ANCHORED PLASTIC COVERS OR EQUIVALENT METHODS.
7. WHERE REQUIRED TO FACILITATE WORK, THE CONTRACTOR MAY NEED TO TEMPORARILY SHORE AND STABILIZE THE WORK AREA DEPENDING ON THE MEANS AND METHODS UTILIZED TO CONSTRUCT THE PROJECT. ANY REQUIRED SHEETING AND SHORING IS TO BE CONSISTENT WITH THE SITE SHORING AND EXCAVATION PLAN DESIGNED BY A LICENSED NEW YORK PROFESSIONAL ENGINEER AND SUBMITTED TO THE CO OR COR FOR REVIEW AND APPROVAL.
8. SOILS AND/OR OTHER MATERIALS TO BE UTILIZED FOR FILLING OR BACKFILLING TO GRADE SHALL BE CONSISTENT WITH THE CONTRACT DOCUMENTS.
9. PROXIMITY OF STOCKPILES TO THE EDGE OF EXCAVATIONS SHALL BE SUCH THAT THE INFLUENCE OF THE STOCKPILE SURCHARGE ON THE MODIFIED OR EXISTING SLOPE IS REDUCED. WHERE POSSIBLE STOCKPILES WILL BE PLACED A DISTANCE FROM THE EDGE OF EXCAVATION EQUAL TO (OR GREATER THAN) THE DEPTH OF THE EXCAVATION. STOCKPILES NEAR EXCAVATIONS SHALL MEET ALL THE REQUIREMENTS OF THE SIGNED/SEALED/APPROVED SHORING AND EXCAVATION PLAN.
10. ALL UNSUITABLE SOIL MATERIALS PRODUCED SHALL BE DISPOSED OF OFFSITE IN ACCORDANCE WITH LOCAL, COUNTY, STATE, AND FEDERAL REQUIREMENTS.
11. ALL EQUIPMENT STAGING AND STORAGE MUST BE LOCATED WITHIN THE LIMIT OF DISTURBANCE AND IN ACCORDANCE WITH THE REQUIREMENTS OF THE CONTRACT DOCUMENTS.
12. ALL FILL SHALL BE PLACED IN ACCORDANCE WITH THE CONTRACT DOCUMENTS. UNSUITABLE MATERIAL SHALL BE REMOVED AND REPLACED WITH CLEAN FILL MATERIAL, AS DEFINED AND IN ACCORDANCE WITH THE CONTRACT DOCUMENTS.

FLOOD CONTINGENCY PLAN DURING CONSTRUCTION

1. THIS EMERGENCY OPERATION PLAN IS INTENDED TO PROVIDE THE CONTRACTOR GUIDELINES IN PREPARATION FOR A SIGNIFICANT RAIN AND/OR FLOOD EVENT IN ORDER TO PROTECT THE SITE, CONTRACTOR, EQUIPMENT, AND SURROUNDING COMMUNITY.
2. THE CONTRACTOR SHALL MONITOR THE WEATHER FORECASTS AND PLAN CONSTRUCTION ACCORDINGLY.
3. IF THE WEATHER FORECASTS INDICATE THE POSSIBILITY OF A SIGNIFICANT RAIN AND/OR FLOOD EVENT WITHIN 24 TO 48 HOURS, THE CONTRACTOR SHALL NOTIFY THE ENGINEER AND OWNER, AND SHALL PLAN FOR THE POSSIBILITY OF HIGH WATER LEVELS AT THE SITE.
4. TO PLAN FOR THE POSSIBILITY OF HIGH WATER LEVELS AT THE SITE, THE CONTRACTOR SHALL REMOVE ALL EQUIPMENT, CONSTRUCTION MATERIALS (I.E. FUELS, SOLVENTS, HYDRAULIC FLUIDS, ETC.) AND STOCKPILES FROM THE FLOODPLAIN. ALL EROSION AND SEDIMENT CONTROLS SHALL BE INSPECTED, REPAIRED/REINSTALLED IF NECESSARY, AND MAINTAINED IN PROPER WORKING CONDITION. ALL DISTURBED SOILS SHALL BE STABILIZED.
5. THE CONTRACTOR SHALL MAINTAIN SUFFICIENT EQUIPMENT AND MANPOWER AT THE SITE IN ORDER TO REACT TO A FLOOD EMERGENCY.
6. THE CONTRACTOR MAY REQUEST COMPENSATION FOR EXTENSIVE ADDITIONAL FLOOD DAMAGE REPAIR WORK, THAT IS ABOVE AND BEYOND THE CONTRACT AND SCOPE OF WORK, AS DETERMINED BY THE ENGINEER OR OWNER, BY MEANS OF A CHANGE ORDER PER CONTRACT CONDITIONS. ALL STEPS MUST BE FOLLOWED TO QUALIFY THE CONTRACTOR FOR COMPENSATION. COMPENSATION SHALL NOT BE PROVIDED IN THE CASE OF INADEQUATE PREPARATIONS, OR INCOMPLETE/DEFECTIVE INSTALLATION, AS DETERMINED BY THE ENGINEER.

BEST MANAGEMENT PRACTICES FOR PROTECTING THE ENVIRONMENT

1. NO CONSTRUCTION SHALL PROCEED UNTIL PROPER SEDIMENTATION AND EROSION CONTROL METHODS HAVE BEEN INSTALLED AS THE SEQUENCE OF CONSTRUCTION NECESSITATES.
2. NO EQUIPMENT OR MACHINERY SHALL BE STORED, CLEANED, REFUELED, MAINTAINED, OR REPAIRED WITHIN TWENTY-FIVE (25) FEET OF ANY WETLAND OR WATERCOURSE.
3. NO CONSTRUCTION SHALL PROCEED UNTIL A METHOD TO PREVENT CONSTRUCTION DEBRIS OR OTHER MATERIALS FROM ENTERING THE WETLAND OR WATERCOURSE HAS BEEN IMPLEMENTED AS THE SEQUENCE OF CONSTRUCTION NECESSITATES. THESE MATERIALS SHALL BE COLLECTED AND DISPOSED OF IN AN ENVIRONMENTALLY SAFE MANNER AS DETERMINED BY FEDERAL, STATE, AND LOCAL LAWS AT NO ADDITIONAL COST TO THE OWNER. THE APPLICANT SHALL MONITOR WIND VELOCITIES AND STORM EVENTS DURING THE CONDUCT OF SUCH WORK, AND SHALL CAUSE SUCH ACTIVITY TO CEASE IF STORM OR WIND CONDITIONS THREATEN TO CAUSE DEPOSITS OF MATERIALS IN THE WATERWAY.
4. NO OBJECTIONABLE MATERIALS RESULTING FROM ANY CLEARING ACTIVITY SHALL BE DISPOSED OF IN ANY WETLAND OR WATERCOURSE. THIS INCLUDES BUT IS NOT LIMITED TO: STUMPS, TREE ROOTS, MATTED ROOTS, WOOD CHIPS, AND OTHER DEBRIS.
5. NO FILL OR MATERIAL SHALL BE DEPOSITED IN SURROUNDING WETLANDS OR WATERCOURSES, UNLESS SPECIFIED ON THE CONTRACT DRAWINGS.
6. A WATER HANDLING PLAN INCLUDING A CONTINGENCY PLAN FOR FLOOD EVENTS SHALL BE IMPLEMENTED AS SEQUENCE OF CONSTRUCTION NECESSITATES PRIOR TO COMMENCEMENT OF ANY CONSTRUCTION IN THE WATERWAY. AT ALL TIMES, WATER SHALL BE KEPT DEEP ENOUGH IN THE CHANNEL TO ALLOW THE PASSAGE OF FISH AND CONTINUOUS FLOW OF THE WATERCOURSE WHEREVER NECESSARY.
7. WORK WITHIN AND ADJACENT TO WATERCOURSES SHALL BE CONDUCTED DURING PERIODS OF LOW FLOW, WHENEVER POSSIBLE. THE APPLICANT SHALL REMAIN AWARE OF FLOW CONDITIONS DURING THE CONDUCT OF SUCH WORK, AND SHALL CAUSE SUCH ACTIVITY TO CEASE SHOULD FLOW CONDITIONS THREATEN TO CAUSE EXCESSIVE EROSION, SILTATION OR TURBIDITY. DURING STORMS EVERY EFFORT SHALL BE TAKEN TO SECURE THE WORK SITE.
8. ALL TEMPORARY FILL, SUCH AS THAT USED FOR PERMITTED ACCESS ROADS AND/OR COFFERDAMS, SHALL BE PROPERLY STABILIZED DURING USE TO PREVENT EROSION, AND, WHEN NO LONGER NEEDED, MUST BE DISPOSED OF AT AN UPLAND SITE, AND SUITABLY CONTAINED TO PREVENT TURBID RUNOFF FROM REENTERING A WETLAND OR WATERCOURSE. ALL AREAS AFFECTED BY TEMPORARY FILLS MUST BE RESTORED TO THEIR ORIGINAL CONTOURS, AND REVEGETATED WITH SUITABLE VEGETATION. THE AREA EXTENT OF TEMPORARY FILL OR EXCAVATION SHALL BE MINIMIZED TO THAT AREA NECESSARY TO PERFORM THE REQUIRED WORK.
9. DUMPING OF OIL OR OTHER DELETERIOUS MATERIALS ON THE GROUND IS FORBIDDEN. THE APPLICANT SHALL PROVIDE A MEANS OF CATCHING, RETAINING, AND PROPERLY DISPOSING OF DRAINED OIL, REMOVED OIL FILTERS, OR OTHER DELETERIOUS MATERIAL. ALL OIL SPILLS SHALL BE REPORTED IMMEDIATELY TO THE DEP/HAZARDOUS MATERIALS OFFICE AT (860) 424-3338 OR (860) 424-3023. FAILURE TO DO SO MAY RESULT IN THE IMPOSITION OF A FINE UNDER SECTION 22A-450 OF THE CONNECTICUT GENERAL STATUTES.
10. EVERY PRECAUTION SHALL BE USED WHILE WORKING IN THE VICINITY OF A WATERWAY TO PREVENT AND MINIMIZE DEGRADATIONS OF THE EXISTING WATER QUALITY. ALL ACTIVITIES SHALL CONFORM AND BE AT ALL TIMES CONSISTENT WITH APPLICABLE WATER QUALITY STANDARDS, AND MANAGEMENT PRACTICES OF THE FEDERAL CLEAN WATER ACT (1972), CONNECTICUT'S WATER QUALITY STANDARDS AND OTHER APPLICABLE STATE LAWS.
11. ALL EQUIPMENT BEING USED IN OR AROUND THE WATER SHALL BE FREE OF LEAKS INCLUDING BUT NOT LIMITED TO OIL, HYDRAULIC FLUIDS, RADIATOR FLUIDS, GREASE, AND FUEL. ALL EQUIPMENT TO BE USED IN THE WATER SHALL BE APPROVED BY THE ENGINEER. THE ENGINEER HAS THE AUTHORITY TO ORDER THE CONTRACTOR TO REMOVE ANY EQUIPMENT FROM THE WATER THAT THE ENGINEER FEELS IS DETRIMENTAL TO THE ENVIRONMENT
12. SHOULD ANY EQUIPMENT BREAKDOWN IN THE WATER, THE CONTRACTOR SHALL HAVE A PLAN TO IMMEDIATELY REMOVE THE EQUIPMENT.

DATA SOURCE NOTES:

1. EXISTING CONTOURS DERIVED USING 2011-2012 LIDAR DATA OBTAINED FROM THE NEW YORK STATE GIS CLEARINGHOUSE. ALL ELEVATIONS ARE REFERENCED TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88) IN U.S. SURVEY FEET.

SHEET NO.	TITLE	SHEET REFERENCE NO.
	GENERAL	
1	COVER SHEET	G-001
2	GENERAL NOTES SHEET	G-002
	CIVIL	
3	KEY MAP	C-001
4	GENERAL PLAN SHEET 1 - AOP 1	C-101
5	GENERAL PLAN SHEET 2 - AOP 2	C-102
6	GENERAL PLAN SHEET 3 - AOP 3	C-103
7	PROFILE SHEET 1 - AOP 1	C-201
8	PROFILE SHEET 2 - AOP 2	C-202
9	PROFILE SHEET 3 - AOP 3	C-203
10	CROSS-SECTION SHEET 1	C-301

GENERAL SEQUENCE OF CONSTRUCTION, AND CONTROL OF WATER, SOIL EROSION & SEDIMENTATION

1. CONSTRUCTION TIMING RESTRICTIONS: IN-WATER WORK SHALL BE PERFORMED DURING DRY WEATHER AND LOW FLOWS TO MINIMIZE RIVER HAZARDS AND DURING OUTSIDE OF TIME OF YEAR RESTRICTIONS TO PROTECT FISHERIES RESOURCES AS PER PERMIT CONDITIONS.
2. MOBILIZATION AND INSTALLATION OF EROSION CONTROL MEASURES.
3. INSTALLATION OF ACCESS RAMP TO RIVER AND INSTALLATION OF ANY WATER CONTROL AS APPLICABLE.
4. DEMOLITION AND REMOVAL OF CONCRETE BARRIER / DAM SPILLWAY.
5. CHANNEL GRADING AND BANK STABILIZATION.
6. INSTALLATION OF PLANTS AND SEED
7. DEMOBILIZATION

EXPECTED CONSTRUCTION DURATION

AOP1: 3 MONTHS
AOP2: 6 MONTHS
AOP3: 6 MONTHS

EXISTING FEATURES LEGEND

- 5 — EXISTING CONTOUR
- PROFILE LINE
- CROSS SECTION
- EXISTING WATER SURFACE ELEVATION (WSEL)
- EXISTING STRUCTURE

PROPOSED FEATURES LEGEND

- PROPOSED WATER SURFACE ELEVATION (WSEL)
- PROPOSED PROJECT AREA
- PROPOSED IN-STREAM FEATURE

CALL BEFORE YOU DIG!
NEW YORK LAW REQUIRES
2 FULL WORKING DAYS NOTICE
PRIOR TO CONSTRUCTION - STOP CALL
CALL BEFORE YOU DIG, INC.
REFERENCE NEW YORK STATE
LAW INDUSTRIAL CODE 53
1-800-962-7962

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

DESIGNED BY: PRINCETON HYDRO
DRAWN BY: BS
CHECKED BY: PWCP
SUBMITTED BY: PRINCETON HYDRO
SIZE: ANSI D
ISSUE DATE: MARCH 2020
SOLICITATION NO.: W912DS-20-F-0024
CONTRACT NO.: W912DS-19-D-0003

U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT
26 FEDERAL PLAZA
NEW YORK, NEW YORK, 10278

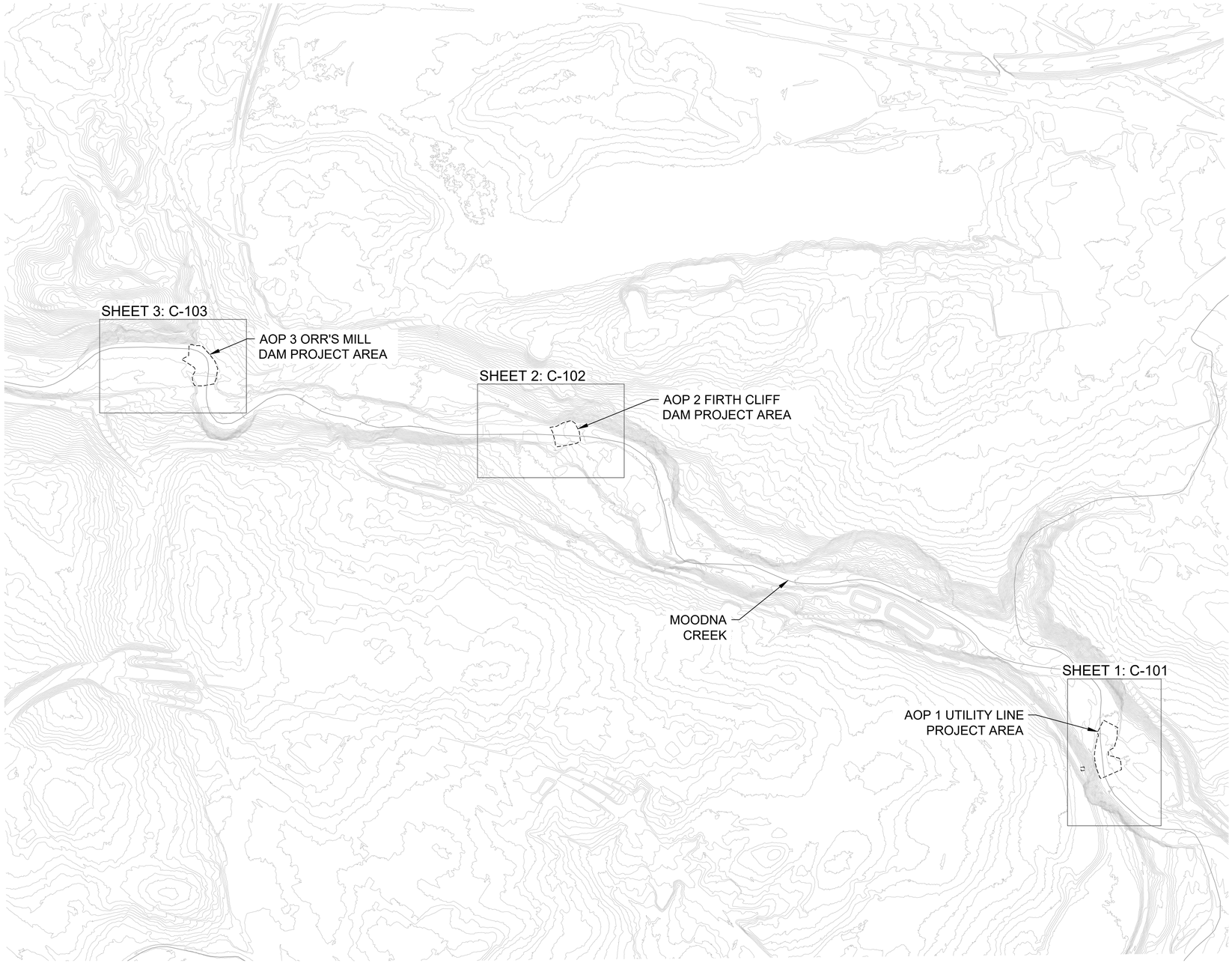
PRINCETON HYDRO, LLC
1108 OLD YORK ROAD
RINGOES, NEW JERSEY, 08551

HUDSON RIVER HABITAT RESTORATION
MOODNA CREEK
TOWNS OF CORNWALL AND NEW WINDSOR
ORANGE COUNTY, NEW YORK

GENERAL NOTES

SHEET ID
G-002

MARCH 2020



GRAPHIC SCALE

0 100 300 600 1000 1500 2000 FEET

SCALE: 1" = 500'

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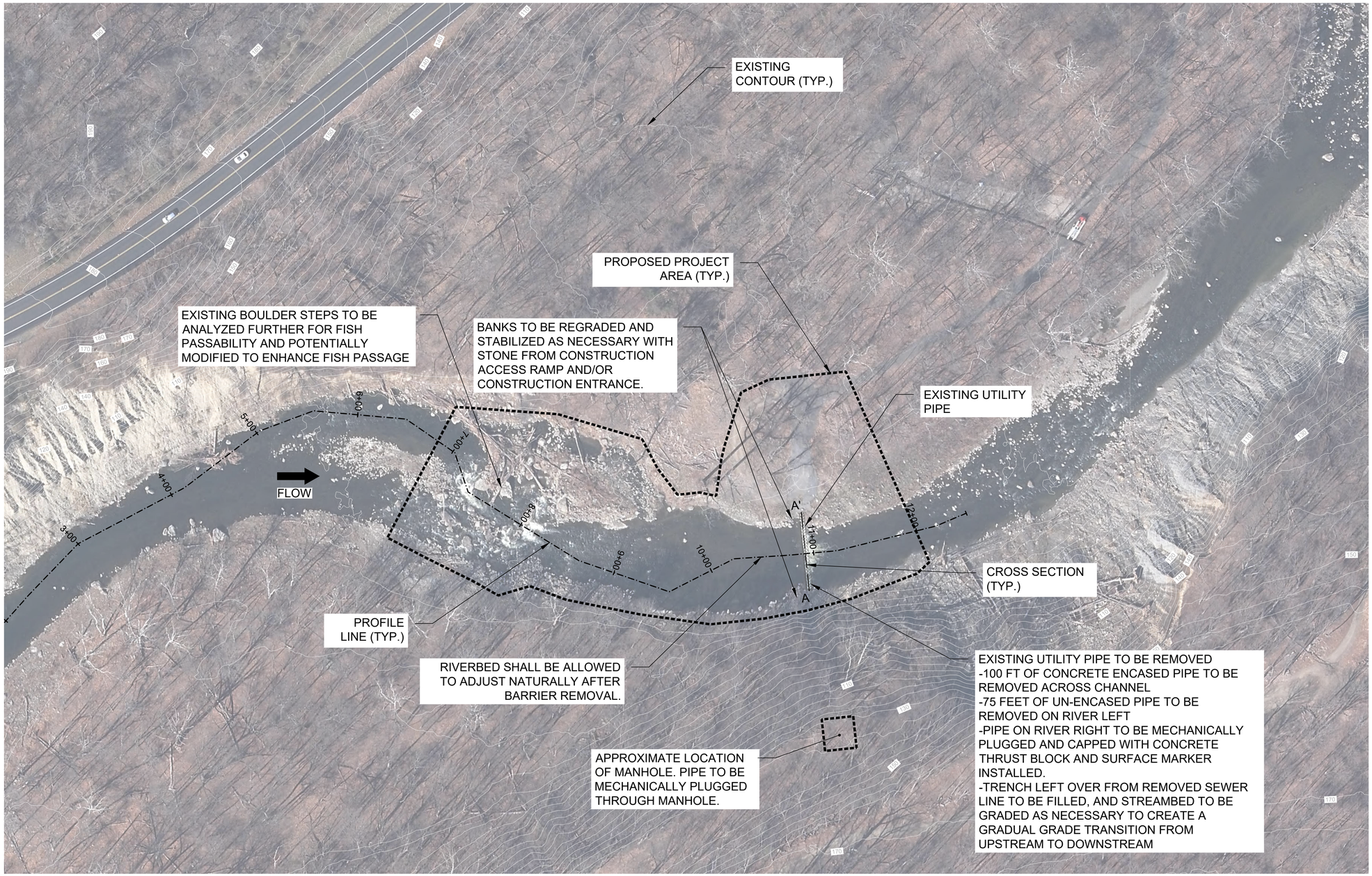
ORANGE COUNTY, NEW YORK

KEY MAP

SHEET ID

C-001

MARCH 2020



GRAPHIC SCALE
0 25 50 100 150 200 FEET
SCALE: 1" = 50'

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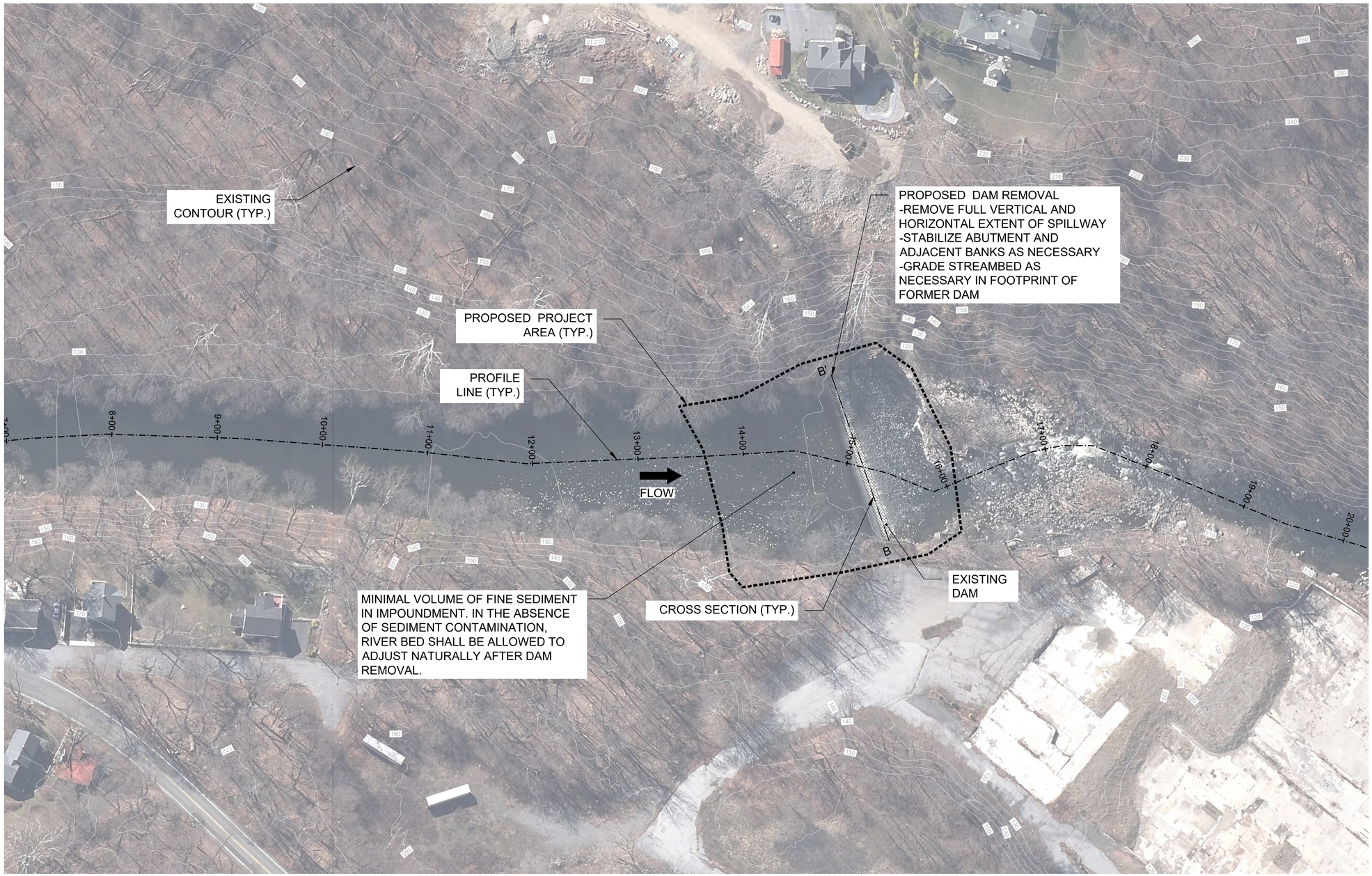
GENERAL PLAN SHEET 1 - AOP 1

SHEET ID
C-101

MARCH 2020



GRAPHIC SCALE

0 25 50 100 150 200 FEET

SCALE: 1" = 50'

MARCH 2020

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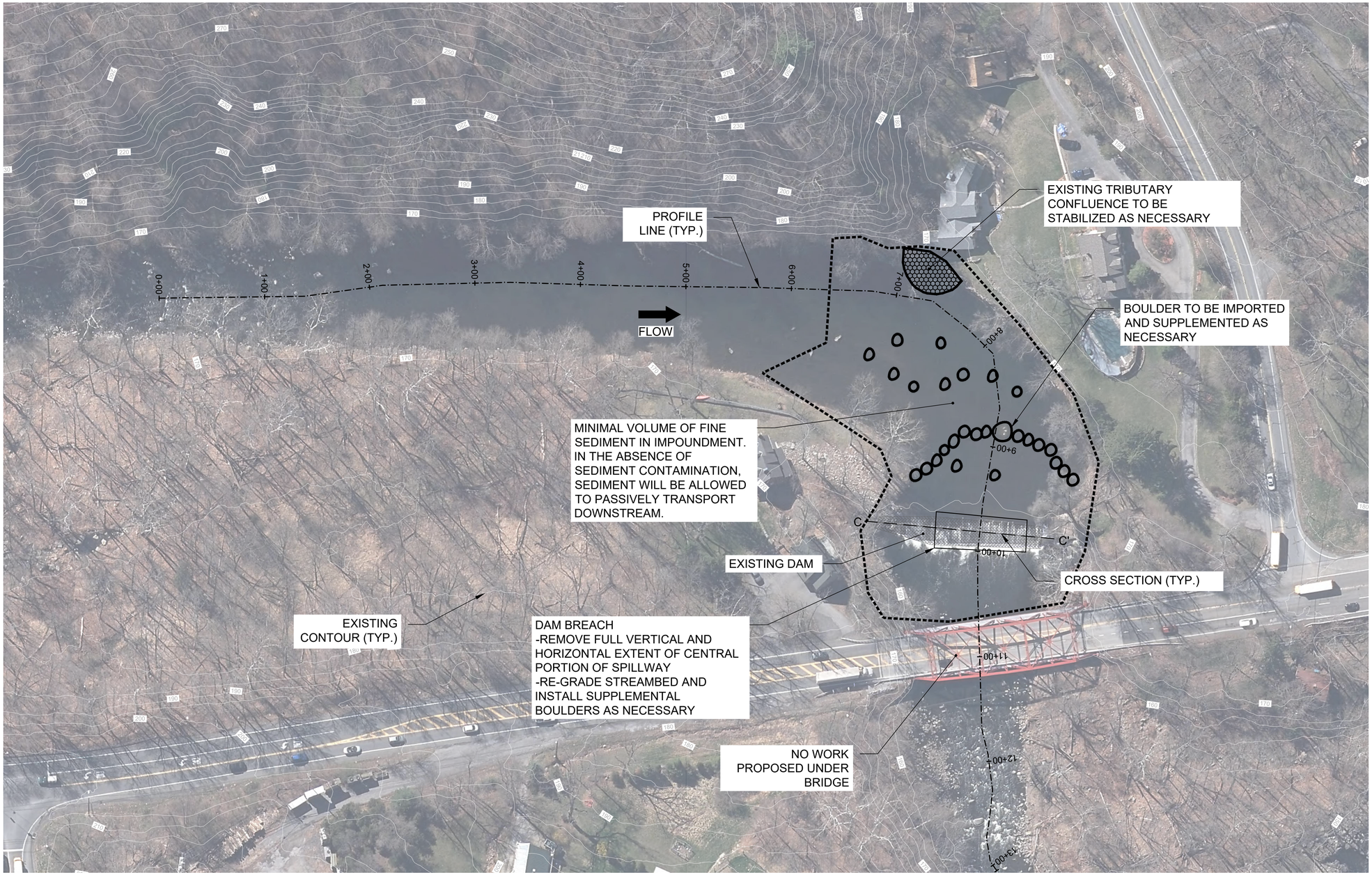
GENERAL PLAN SHEET 2 - AOP 2

SHEET ID

C-102



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0 25 50 100 150 200 FEET
SCALE: 1" = 50'

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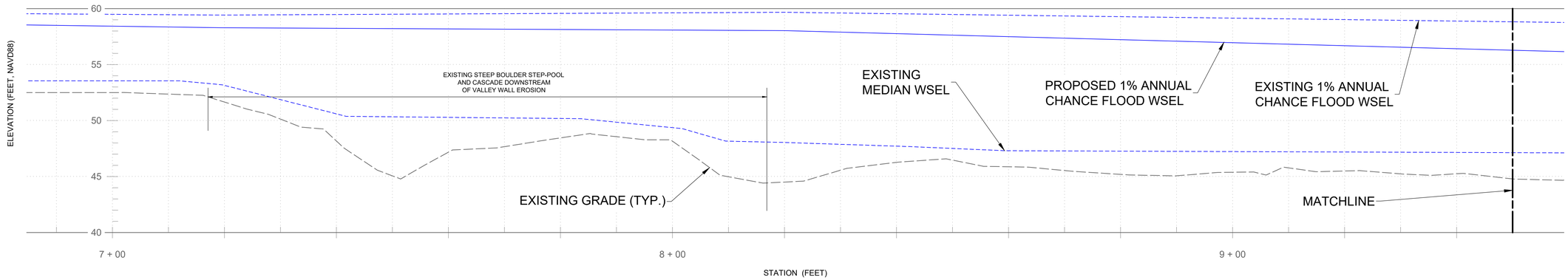
ORANGE COUNTY, NEW YORK

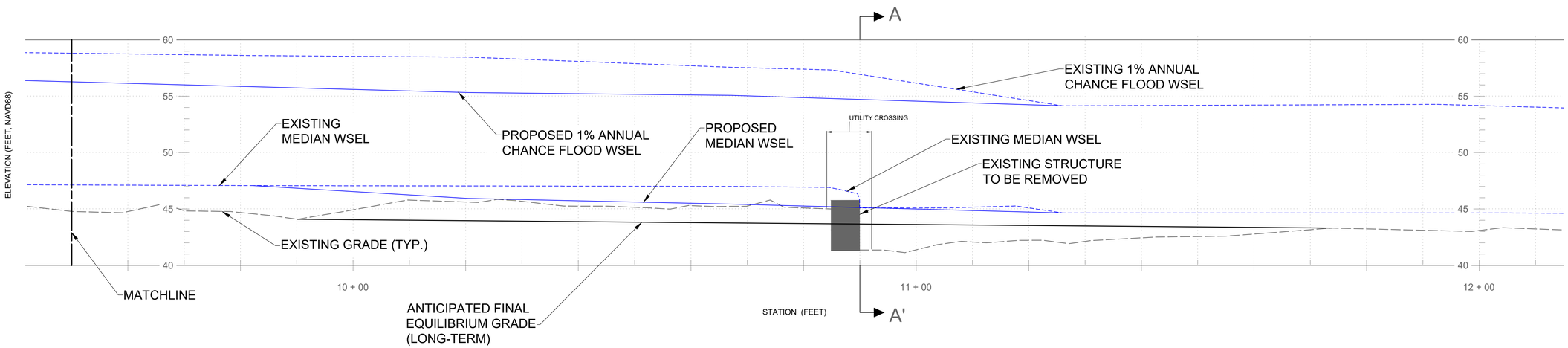
GENERAL PLAN SHEET 3 - AOP 3

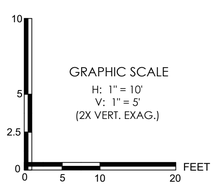
SHEET ID
C-103

MARCH 2020

AOP 1 UTILITY CROSSING: STREAM PROFILE







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ORANGE COUNTY, NEW YORK

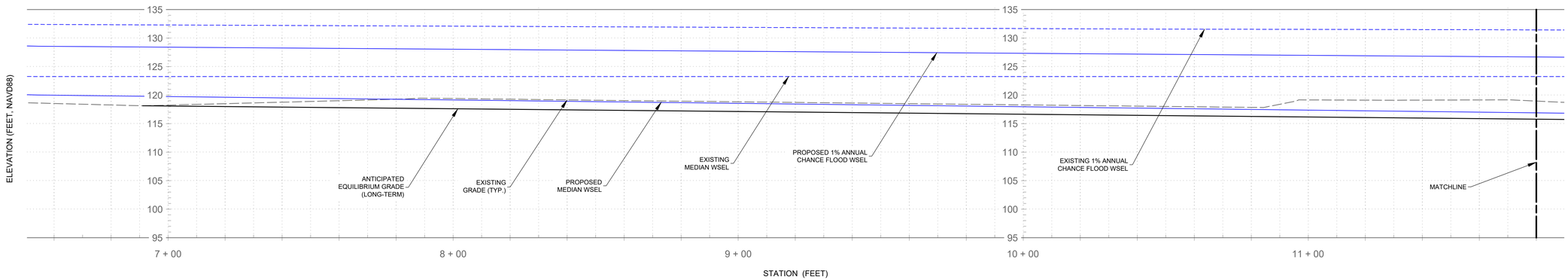
PROFILE SHEET 1 - AOP 1

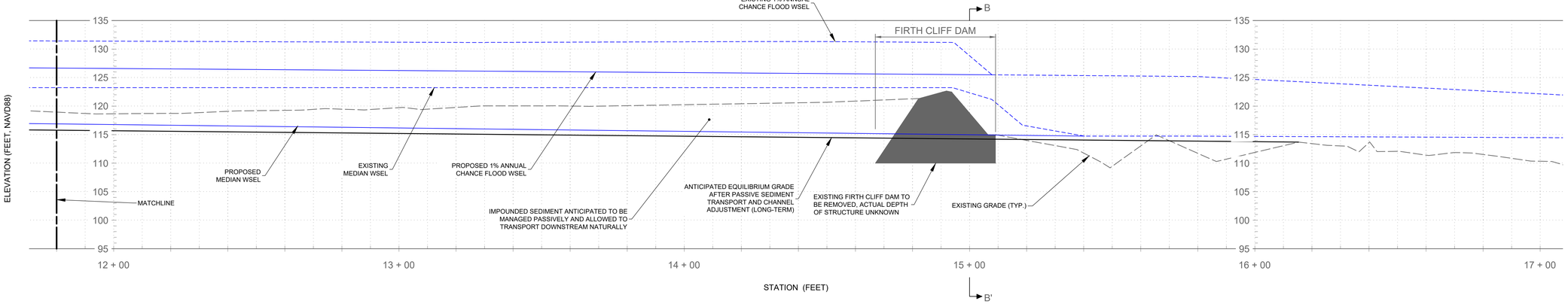
SHEET ID

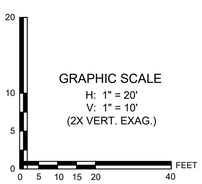
C-201

MARCH 2020

AOP 2 FIRTH CLIFF DAM: STREAM PROFILE







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HUDSON RIVER HABITAT RESTORATION
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ORANGE COUNTY, NEW YORK

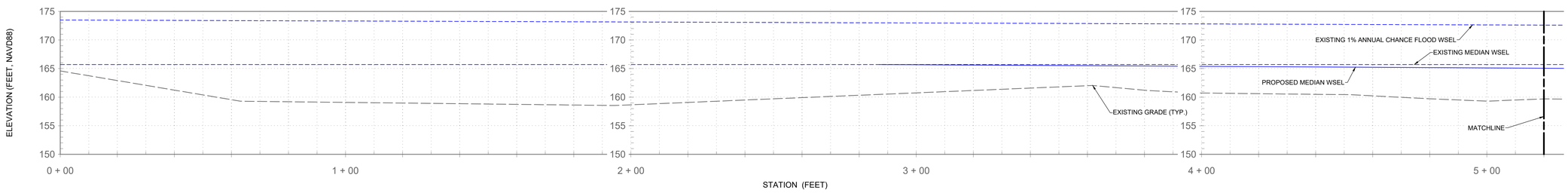
PROFILE SHEET 2 - AOP 2

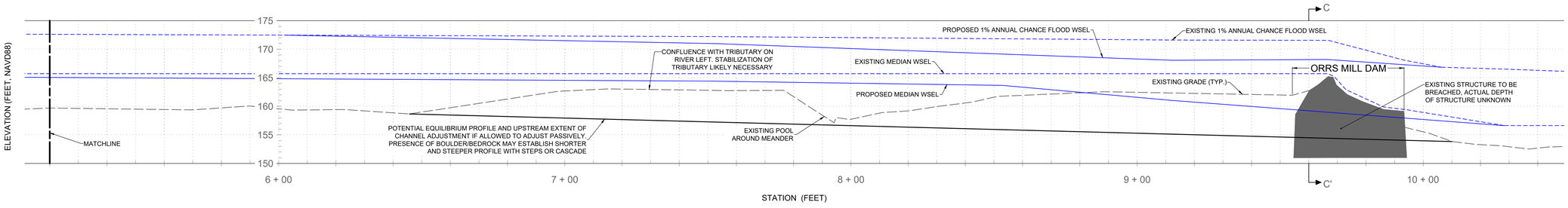
SHEET ID

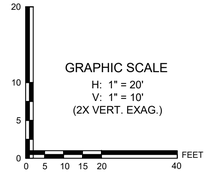
C-202

MARCH 2020

AOP 3 ORR'S MILL DAM: STREAM PROFILE







US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

ISSUE DATE:
MARCH 2020

SOLICITATION NO.:
W912DS-20-F-0024

CONTRACT NO.:
W912DS-19-D-0003

DESIGNED BY:
PRINCETON HYDRO

DRAWN BY:
BS

CHECKED BY:
PW/CP

SUBMITTED BY:
PRINCETON HYDRO

SIZE
ANSI D

U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT
26 FEDERAL PLAZA
NEW YORK, NEW YORK, 10278

PRINCETON HYDRO, LLC
1108 OLD YORK ROAD
RINGOES, NEW JERSEY, 08551

HUDSON RIVER HABITAT RESTORATION
MOODNA CREEK
TOWNS OF CORNWALL AND NEW WINDSOR
ORANGE COUNTY, NEW YORK

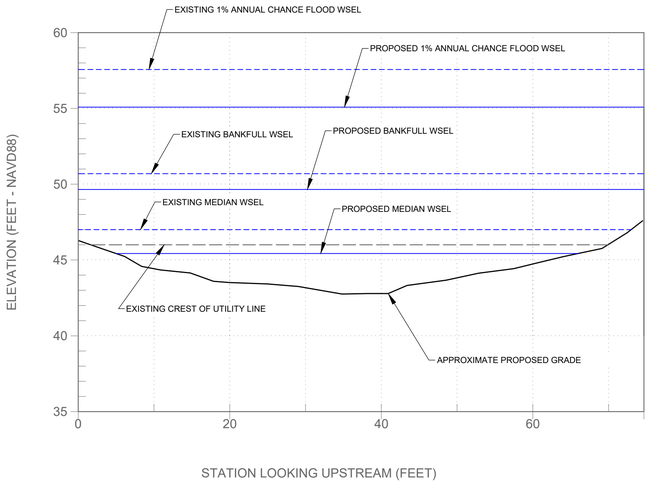
PROFILE SHEET 3 - AOP 3

SHEET ID

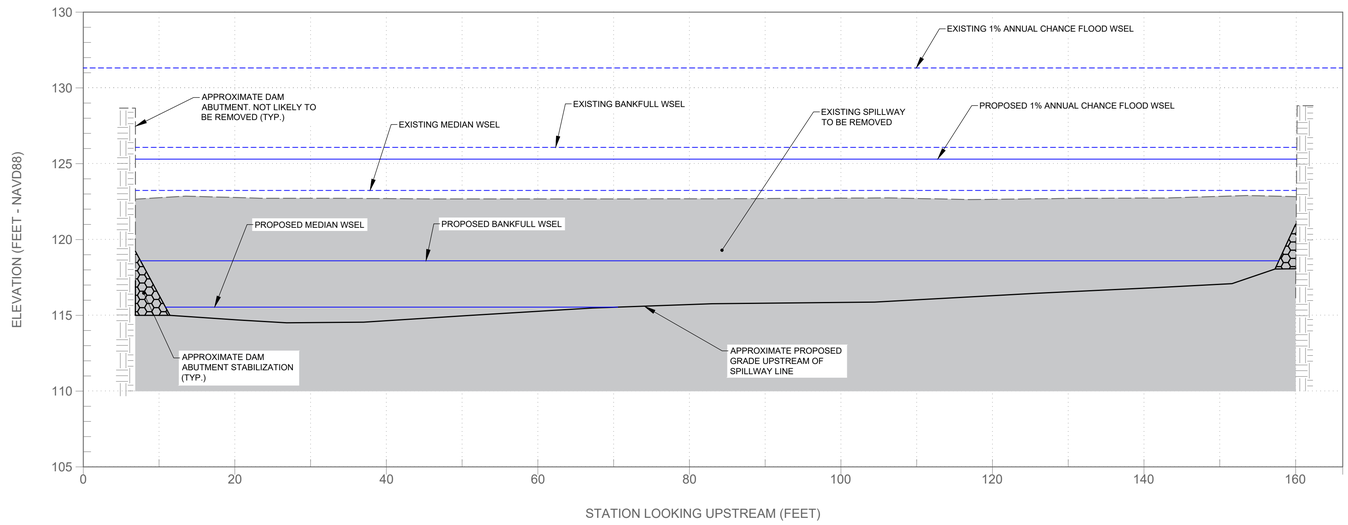
C-203

MARCH 2020

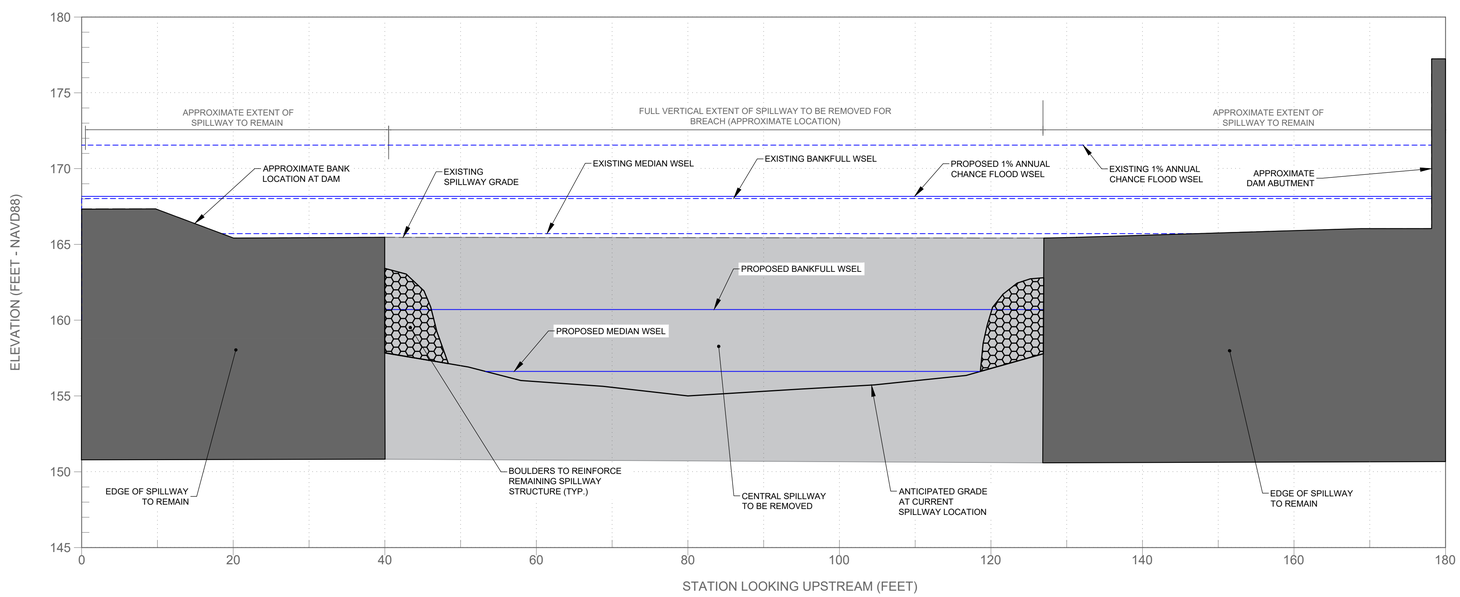
CROSS SECTION A-A'
AOP 1 UTILITY CROSSING

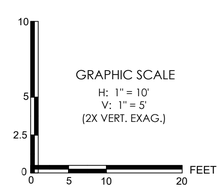


CROSS SECTION B-B'
AOP 2 FIRTH CLIFF DAM



CROSS SECTION C-C'
AOP 3 ORR'S MILL DAM





US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

DESIGNED BY: PRINCETON HYDRO
DRAWN BY: BS
CHECKED BY: PWCP
SUBMITTED BY: PRINCETON HYDRO
SIZE: ANSI D

ISSUE DATE: MARCH 2020
SOLICITATION NO.: W912DS-20-F-0024
CONTRACT NO.: W912DS-19-D-0003

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HUDSON RIVER HABITAT RESTORATION
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CROSS SECTION SHEET 1

SHEET ID

C-301

MARCH 2020

HUDSON RIVER HABITAT RESTORATION MOODNA CREEK - CONSTRUCTION QUANITTIES					
COMPONENT	**ITEM**	**QTY**	**UNIT**	**CONVERTED QTY CONVERTED UNIT**	**DESCRIPTION**
Utility Crossing (AOP1) - General Construction	Traffic Control	2	EA		Assumed 2 signs are needed in the adjacent existing road.
	Field Office	1	EA		Includes field trailer and other misc. costs (e.g. supplies, telephone bill, portable toilet, etc..)
	Project Duration	3	MO		Project duration in months
	Stabilized Construction Entrance	1,125	SQFT	125 SQYD	Total length at least 50-ft as per NY standard for stabilized construction entrance, All rock to be reused onsite for maintained access road, stabilization, or in channel and bank stabilization.
	Construction Access Road Reinforcement and Repair	824	LF	1,831 SQYD	20-FT wide construction access road along the preexisting access road; 4" gravel depth assumed for reinforcement rather than an 8" depth for full construction of a road
	Turbidity Barrier	100	LF		Across channel downstream of the dam
	Silt Fence	300	LF		Silt Fence assumed to run perpendicular to access near water, perpendicular to stream around proposed utility pipe plug, and along both sides of the main section of the construction entrance
	Construction Access Ramp Volume	205	CY	342 TONS	Assuming 1.67 tons/CY; includes void space; All rock to be reused onsite for channel and bank stabilization
Utility Crossing (AOP1) - Barrier Removal	Demolition of Existing Pipe	175	LF		Removal of existing utility pipe. 100 ft inside concrete casing, 75 feet underground
	Demolition of Existing Concrete Barrier	115	CY		Removal of existing utility pipe concrete casing. Concrete to be broken up, then disposed of off-site
	Utility Decommission Plug	2	EA		Includes 2 mechanical plugs, 1 CY of concrete, and 1 thrust block
	Utility Decommission Excavation	90	CY		Assumes 15x15 by 10 feet deep excavation
	Temporary Cofferdam Length	300	LF		Assuming 6 ft height, extending around portion of work area to divert flow to one side of channel
	Streambed Grading Area	7,500	SQFT	833 SQYD	In-stream re-grading using excavator following removal of utility structure. 75ft x 100ft
	Bank Stabilization	720	CF	27 CY	Assuming 1.67 tons/CY; includes void space; Re-used rock from construction access ramp or construction entrance; 40 ft in length on both left and right banks, extending 3 ft upslope, with a thickness of 3ft.
Firth Cliff Dam (AOP2) - General Construction	Traffic Control	2	EA		Assumed 2 signs are needed in the adjacent existing road.
	Field Office	1	EA		Includes field trailer and other misc. costs (e.g. supplies, telephone bill, portable toilet, etc..)
	Project Duration	6	MO		Project duration in months
	Stabilized Construction Entrance	1,125	SQFT	125 SQYD	Total length at least 50-ft as per NY standard for stabilized construction entrance, All rock to be reused onsite for channel and bank stabilization

COMPONENT	ITEM	QTY	UNIT	CONVERTED QTY	CONVERTED UNIT	DESCRIPTION
Firth Cliff Dam (AOP2) - General Construction (Con't)	Construction Access Road Reinforcement and Repair	1,080	LF	2,400	SQYD	20-FT wide construction access road along the preexisting access road; 4" gravel depth assumed for reinforcement rather than an 8" depth for full construction of a road
	Turbidity Barrier	200	LF			Across channel downstream of the dam
	Silt Fence	100	LF			Silt Fence assumed along both sides of the main section of the construction entrance
	Construction Access Ramp Volume	130	CY	217	TONS	Assuming 1.67 tons/CY; includes void space; All rock to be reused onsite for general stabilization, or in-channel and bank stabilization.
	In-River Construction Access Pad Volume	185	CY	309	TONS	Assuming 1.67 tons/CY; includes void space; All rock to be reused onsite for general stabilization, or in-channel and bank stabilization.
Firth Cliff Dam (AOP2) - Dam Removal	Demolition of Existing Dam	18,000	CF	667	CY	Demo of dam: 180 ft long x 12 ft high x 8 ft thick = 17280 CF rounded up to 18000 CF. Concrete to be broken up, then reused onsite for general stabilization, or in-channel and bank stabilization.
	Break-up and Removal of Dam Concrete	733	CY			Volume of demolished material + 10% to account for void space
	Temporary Cofferdam Length	300	LF	1,800	SQFT	Assuming 6 ft height, extending around portion of work area to divert flow to one side of channel
	Abutment Stabilization Riprap Area	6,030	SQFT	670	SQYD	12" riprap, 150-LF on each bank, 20-ft slope, 2ft depth
	Streambed Grading Area	7,500	SQFT	833	SQYD	In-stream re-grading using excavator following removal of dam spillway. 75ft x 100ft
	Bank Stabilization Boulders	95	CY	159	TONS	Assuming 1.67 tons/CY; includes void space. 4x5x6ft boulders; 2 boulder weirs in central flow path; 50 ft in length
Orr's Mill Dam (AOP3) - General Construction	Traffic Control	2	EA			Assumed 2 signs are needed in the adjacent existing road.
	Field Office	1	EA			Includes field trailer and other misc. costs (e.g. supplies, telephone bill, portable toilet, etc..)
	Project Duration	6	MO			Project duration in months
	Stabilized Construction Entrance	1,125	SQFT	125	SQYD	Total length at least 50-ft as per NY standard for stabilized construction entrance.
	Construction Access Road Reinforcement and Repair	80	LF	178	SQYD	20-FT wide construction access road along the preexisting access road; 4" gravel depth assumed for reinforcement rather than an 8" depth for full construction of a road
	Turbidity Barrier	180	LF			Across channel downstream of the dam
	Silt Fence	100	LF			Silt Fence assumed along both sides of the main section of the construction entrance
	Construction Access Ramp Volume	75	CY	125	TONS	Assuming 1.67 tons/CY; includes void space; All rock to be reused onsite for channel and bank stabilization
	In-River Construction Access Pad Volume	490	CY	818	TONS	Assuming 1.67 tons/CY; includes void space; All rock to be reused onsite for channel and bank stabilization

COMPONENT	ITEM	QTY	UNIT	CONVERTED QTY	CONVERTED UNIT	DESCRIPTION
Orr's Mill Dam (AOP3) - Dam Removal	Demolition of Existing Dam (Concrete)	6,750	CF	250	CY	Demo of dam spillway. Concrete to be broken up, then reused onsite for channel and bank stabilization. Dam is not entirely concrete, but concrete capped timber crib. Concrete is 45ft length x 100ft width x 1.5ft thickness.
	Demolition of Existing Dam (Timber)	28,250	CF	1,046	CY	Demo of timber under concrete spillway. Total dam area (350 sqft cross sectional area x 100 ft length) subtracted by the volume of spillway concrete.
	Temporary Cofferdam Length	300	LF	1,800	SQFT	Assuming 6 ft height, extending around portion of work area to divert flow to one side of channel
	Streambed Grading Area	30,000	SQFT	3,333	SQYD	In-stream re-grading using excavator following removal of dam spillway. Grading to occur in the channel segment between spillway footprint and tributary confluence.
	Bank Stabilization Boulders	670	CY	1,119	TONS	Assuming 1.67 tons/CY; includes void space. Combined value for 36" boulders needed for tributary confluence stabilization, boulder grade control, supplemental boulders, and breach stabilization