HUDSON RIVER HABITAT RESTORATION

ECOSYSTEM RESTORATION
DRAFT INTEGRATED FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT

Appendix B: Engineering Appendix

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Table of Contents

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) (South) and the Troy Lock and Dam (North) and generally encompasses 125 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

The Binnen Kill site is located on the west shore of the Hudson River 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 creation of side channels.

Schodack Island project site is part of the Schodack Island State Park located along the eastern shore of the Hudson River 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 creation of side channels.

Charles Rider Park is located on the west shore of the Hudson River 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. 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 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 (Figure 1).

Eddyville Dam is located on Rondout Creek, 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 detailed 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 1). 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 1); 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.

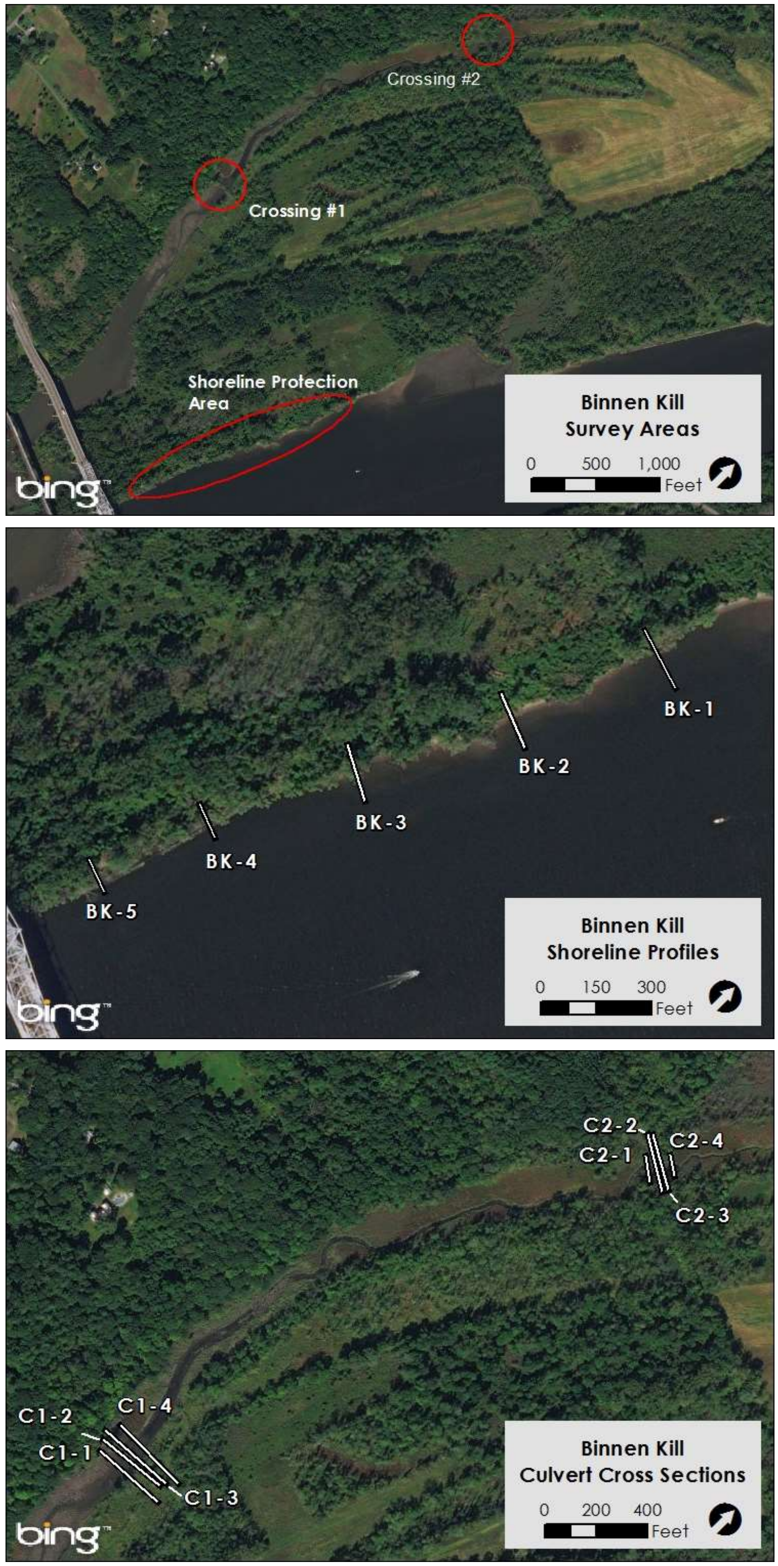


Figure 1: (Top) Three survey areas at Binnen Kill; (Middle) Shoreline profile locations collected along the Hudson River; (Lower) Cross section locations at each stream crossing.

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 2). 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

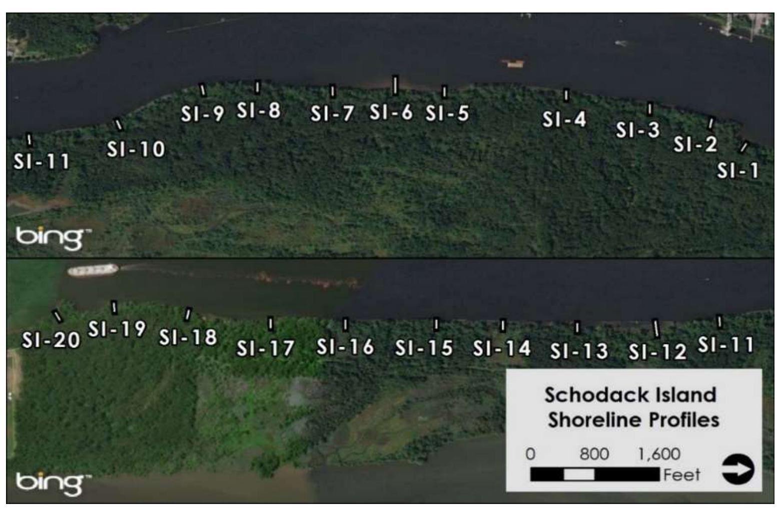


Figure 2: Surveyed Shoreline Profile location at Schodack Island.

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 3: 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 3). 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 4). 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.

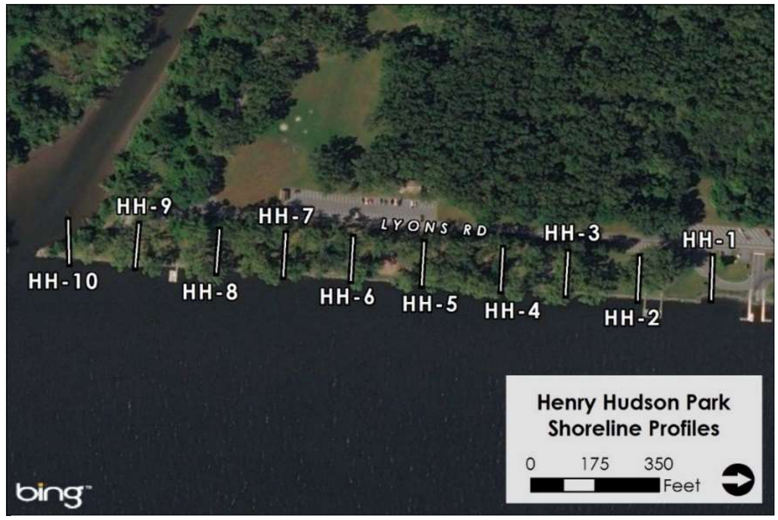


Figure 4: Surveyed Shoreline Profile locations at Henry Hudson Park

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.

Between June 21 and June 22, 2018, a more detailed site investigation was completed upon review of the FEMA profiles, aerial photos, and discussion after the May site visit. 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;
- Gather data on the upstream rapids to 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 riffle upstream of the utility crossing at the location of the upstream landslide, 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 riffle which may be a natural AOP barrier.

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

<u>*AOP 2: Firth Cliff Dam*</u>

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;
- Assess if the dam is fixed on bedrock; and
- Verify grade control downstream and upstream of the dam.

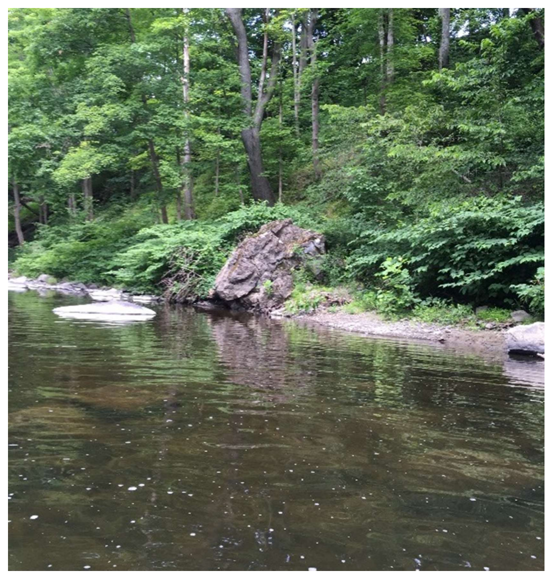
The impoundment was deep enough that the survey profile and cross sections in this area were completed from a jon boat. While low-flow was evident at the other sites on Moodna Creek, water was spilling over Firth Cliff dam. Impoundment water depths were less than an inch over the crest of the dam, suggesting that the dam is not leaking; no other 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 additional one-foot estimated lip on the edge 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 between two and five inches with the exception of a downstream log debris area where fine sediment deposited was approximately two 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 clearly see 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;
- 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 of this downstream edge of the spillway clearly indicating 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 five to ten-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

There are large five to ten-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

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

construction for this project since there is a development at the top of the hill.

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.

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; however, hydrologic and hydraulic modeling was not completed during this project phase. Each of the project sites, excluding Moodna Creek, 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 5) 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

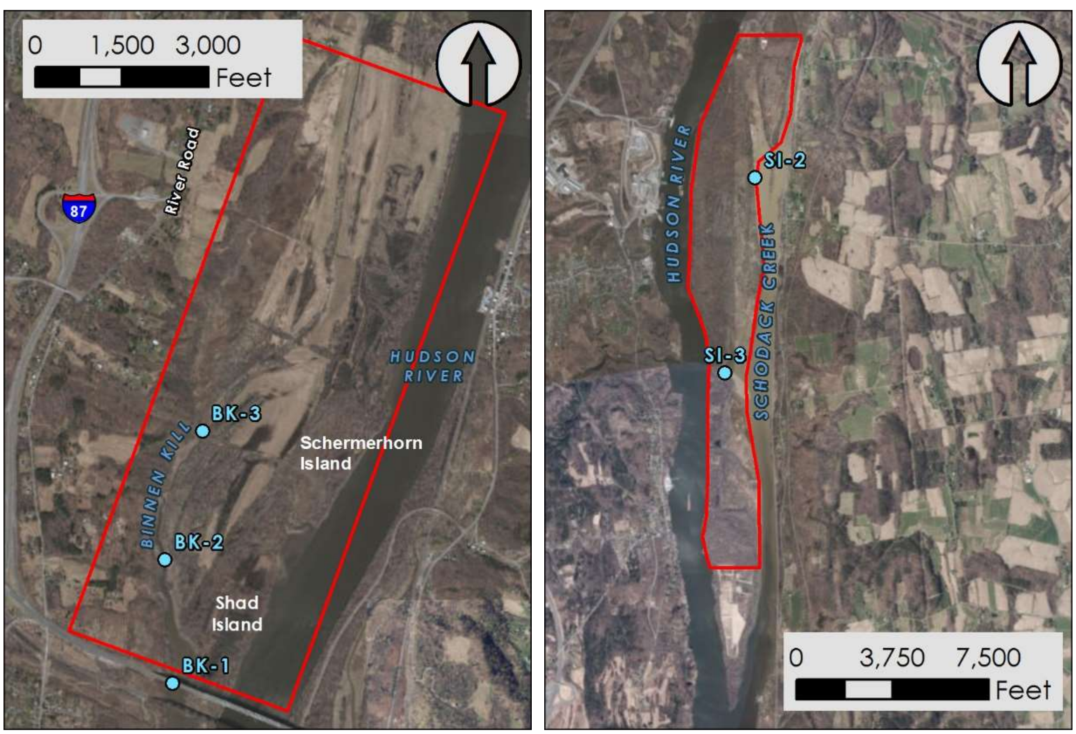


Figure 5: Supplemental data logger locations (blue points) at Binnen Kill (Left) and Schodack Island (Right). Approximate site boundaries in red outline.

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.

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.

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 were selected as the design datums for the Henry Hudson Park, Binnen Kill and Schodack Island sites, as this was the best available data. 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.

Table 2.1: Tide Gauge Data Collection and Design Tidal Datums

Site		Charles Rider	Henry Hudson	Binnen Kill Henry Hudson Shoreline	Rondout Creek	Schodack Island Hudson River Shoreline
Station		USGS Poughkeepsie Sta. 01372058	HECROS Schodack Island Station	HECROS Schodack Island Station	NOAA Hyde Park Station	HECROS Schodack Island Station
Datum Source		USACE Analysis 1/1/2013 – 9/25/2018	USACE Analysis 1/1/2013 – 9/25/2018	USACE Analysis 1/1/2013 – 9/25/2018	NOAA Published Datums (1983-2001 Epoch)	USACE Analysis 1/1/2013 – 9/25/2018
Proximity to Site		18 miles downstream	3.2 miles upstream	3,000 feet downstream	11.5 miles downstream of Rondout/Hudson confluence	700 feet upstream
2018 Tidal Datums	**MHHW**	2.47	3.80	3.80	2.4	3.80
	MHW	2.17	3.47	3.47	2.01	3.47
	MTL	0.54	1.12	1.12	0.26	1.12
	MLW	-1.19	-1.42	-1.42	na	-1.42
	MLLW	-1.39	-1.63	-1.63	na	-1.63

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 6) based on HRECOS monitoring station located at Schodack Island approximately 1,300 feet downstream of the Binnen Kill confluence with the Hudson River.

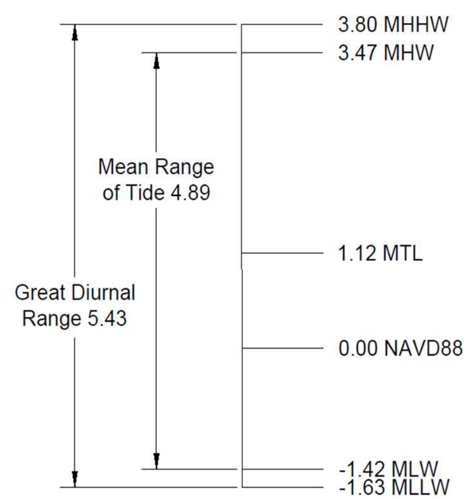


Figure 6: Henry Hudson Park, Binnen Kill, and Schodack Island Tidal Datum Relative to NAVD88, feet.

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.

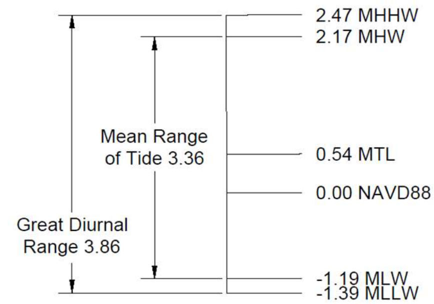


Figure 7: Charles Rider Tidal Datum Relative to NAVD88, feet.

Schodack Island

Semidiurnal tides at the site range in elevation from 3.80 feet at MHHW to -1.63 feet at MLLW (Figure 6) 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 6) based on the HRECOS, Schodack Island Station.

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.

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.

Semidiurnal tides at the Park, range in elevation from 2.47 feet at MHHW to -1.39 feet at MLLW (Figure 7).

Rondout Creek – Eddyville Dam

The Eddyville Dam serves as the upstream limit of tidal influence in Rondout Creek. Tidal influence at the site was inconsequential at this stage of design, and thus not considered. If the installation of a technical fishway were the selected alternative for this site, tidal elevations would need to be considered during final design development to determine the appropriate elevation of the downstream fishway entrance.

2.4 Discharge, Velocity, and Wave Action

Discharge, velocity, and wave/wake action calculations were not completed during this phase of the project.

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. Sea Level Change Analysis

The Department of the Army Engineering Circular EC-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 ETL 1100-2-1 (Jun 2014.) 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. Figure 8 shows the sea level trend at The Battery, NY:

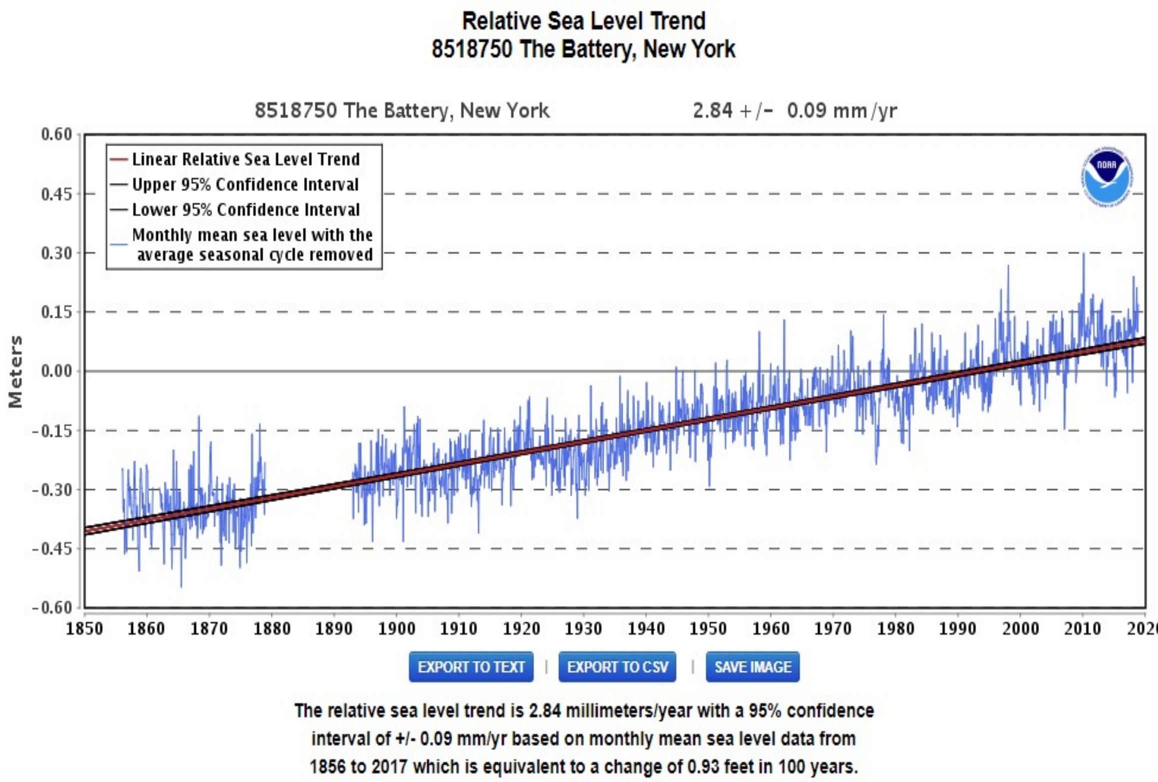


Figure 8. Relative sea level trend for the NOAA gauge station at The Battery, NY

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 3-1 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)			2045 (ft, NAVD88)			2075 (ft, NAVD88)		
		LOW	INT	HIGH	LOW	INT	HIGH	LOW	INT	HIGH
MHHW	3.80	3.88	3.93	4.09	4.05	4.24	4.84	4.32	4.87	6.62
MHW	3.47	3.55	3.60	3.76	3.72	3.91	4.51	3.99	4.54	6.29
MTL	1.12	1.20	1.25	1.41	1.37	1.56	2.16	1.64	2.19	3.94
MLW	-1.42	-1.34	-1.29	-1.13	1.17	0.98	-0.38	0.90	0.35	1.40
MLLW	-1.63	-1.55	-1.50	-1.34	1.38	1.19	-0.59	1.11	0.56	1.19

Table 3-2: 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)		
		LOW	INT	HIGH	LOW	INT	HIGH	LOW	INT	HIGH
MHHW	2.47	2.55	2.6	2.76	2.72	2.91	3.51	2.99	3.54	5.29
MHW	2.17	2.25	2.3	2.46	2.42	2.61	3.21	2.69	3.24	4.99
MTL	0.54	0.62	0.67	0.83	0.79	0.98	1.58	1.06	1.61	3.36
MLW	-1.19	-1.11	-1.06	-0.9	0.94	0.75	-0.15	0.67	0.12	1.63
MLLW	-1.39	-1.31	-1.26	-1.1	1.14	0.95	-0.35	0.87	0.32	1.43

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).

4. Analysis and Design of Restoration Alternatives

4.1 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 8). 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.

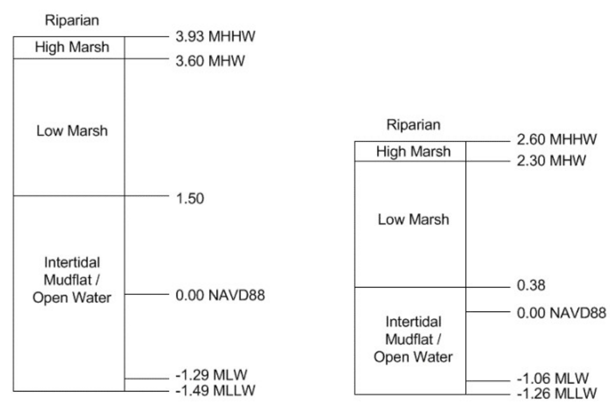


Figure 8: Relationship between wetland plant community and tidal datum elevation for Schodack Island, Binnen Kill, and Henry Hudson (left) and Charles Rider Park (left).

Discussion of Measures

The implementation of side channel restoration, wetland restoration/creation, and shoreline restoration as well as the removal of aquatic organism passage barriers are the primary methods proposed to achieve the project goals. Measures are presented for each restoration alternative at a site/component (Attachment B).

<u>Side Channel Restoration</u>

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 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 would be 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.

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

Side Channel and Riparian Corridor Creation
This feature is proposed at Binnen Kill South Alternative 1, Schodack Island North Alternative 1, and Schodack Island South Alternative 1. At each if 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 Creation
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.

<u>Wetland Restoration/Creation</u>
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 and creation 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 Creation
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 Creation
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 Creation
This feature is proposed at Henry Hudson Park Alternatives 1 and 2. Tidal wetland creation 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 Creation – 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 creation 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 Creation
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 Creation
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.

<u>*Shoreline Restoration*</u>
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.

<u>*Invasive Species Control*</u>
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.

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 creation 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 would be 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. Removal of the entire utility line extending off-site would not serve the ecological goals of this project, and would likely exceed funding capacity for design, permitting, and construction. The recommended approach to 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 recommended approach to decommissioning this sewer line is to break the existing line at the base of the slope and install a manhole in connection with upgradient line, but with no outlet toward the Creek. The installation of the manhole on river right creates a stable and secure closure to the existing sewer line, and prevents any inadvertent leakage or discharge of fluid into the Creek, in the event of any unknown inflow or infiltration into the sewer line. The proposed manhole could potentially be used to re-install the line in the future, if necessary.

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. Furthermore, 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 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 boulder riffle approximately 900 feet upstream of the dam would serve as a natural grade control that would limit the upstream extent of any vertical channel adjustment in the main channel if the dam is notched. The multiple extremely large boulders (i.e. five to ten feet in diameter) that are situated immediately upstream of the spillway are anticipated to form boulder-dominated steps or a cascade. Following dam notching, finer sediment would transport downstream, while the larger cobble and boulder may shift position. Due to the steep slope that is anticipated to re-form, full fish passage conditions for the full range of target fish could not be guaranteed; some active re-grading and re-positioning of boulders may be necessary to facilitate the formation of a stable grade control and fish passability. If *in situ* boulders are insufficient to maintain a stable grade change and/or fish passage conditions, this alternative also includes supplementing this reach with large boulders to establish grade control. Boulder size would be determined during detailed topographic survey, and hydrologic and hydraulic analysis, and rock sizing calculations; however, onsite boulders serve as reasonable estimates. Boulders are an abundant, natural component of Moodna Creek and thus additional use would provide a natural aesthetic that blends with adjacent reaches.

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. 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 floes, 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.

5. 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 B). Development of the excavation quantities as well as assumptions that informed the concept development are described below. The Cost Engineering Appendix details the development of quantities and cost assumptions and describes in further detail the item descriptions associated with the restoration measures outlined above.

Excavation Volumes

Wetland Creation

The excavation required to create the wetlands is based on the proposed area of wetland multiplied by the elevation difference between existing grade and the 2075 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 in 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.

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.

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.

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.

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 accord to local regulations, the costs shall be modified to account for hauling and disposal fees.

6. Cross Section Designs

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

7. 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.

Detailed river hydrologic and hydraulic analyses shall be completed for all sites, particularly for the side channels and AOP barriers which require a detailed design to accommodate low flow conditions. Stormwater hydrology and hydraulic studies should also be performed.

Further investigation is required for Eddyville Dam including collection of more detailed dam geometry, channel geomorphology, and topography data. Sediment modeling and chemical analysis should also be performed for each barrier.

Project elements with direct exposure to the Hudson River shall have wave/wake calculations performed to confirm the stability and resistance to energy created by these forces.

8. Operations and Maintenance

A detailed description of operation and maintenance requirements as well as monitoring and adaptive management can be found in the Monitoring and Adaptive Management Report Appendix.

9. Conclusions

The observations and data collected as well as engineering judgment summarized in this report were used to prepare the concept designs in Attachment B and cost estimates included in the Cost Engineering Appendix H.

10. References

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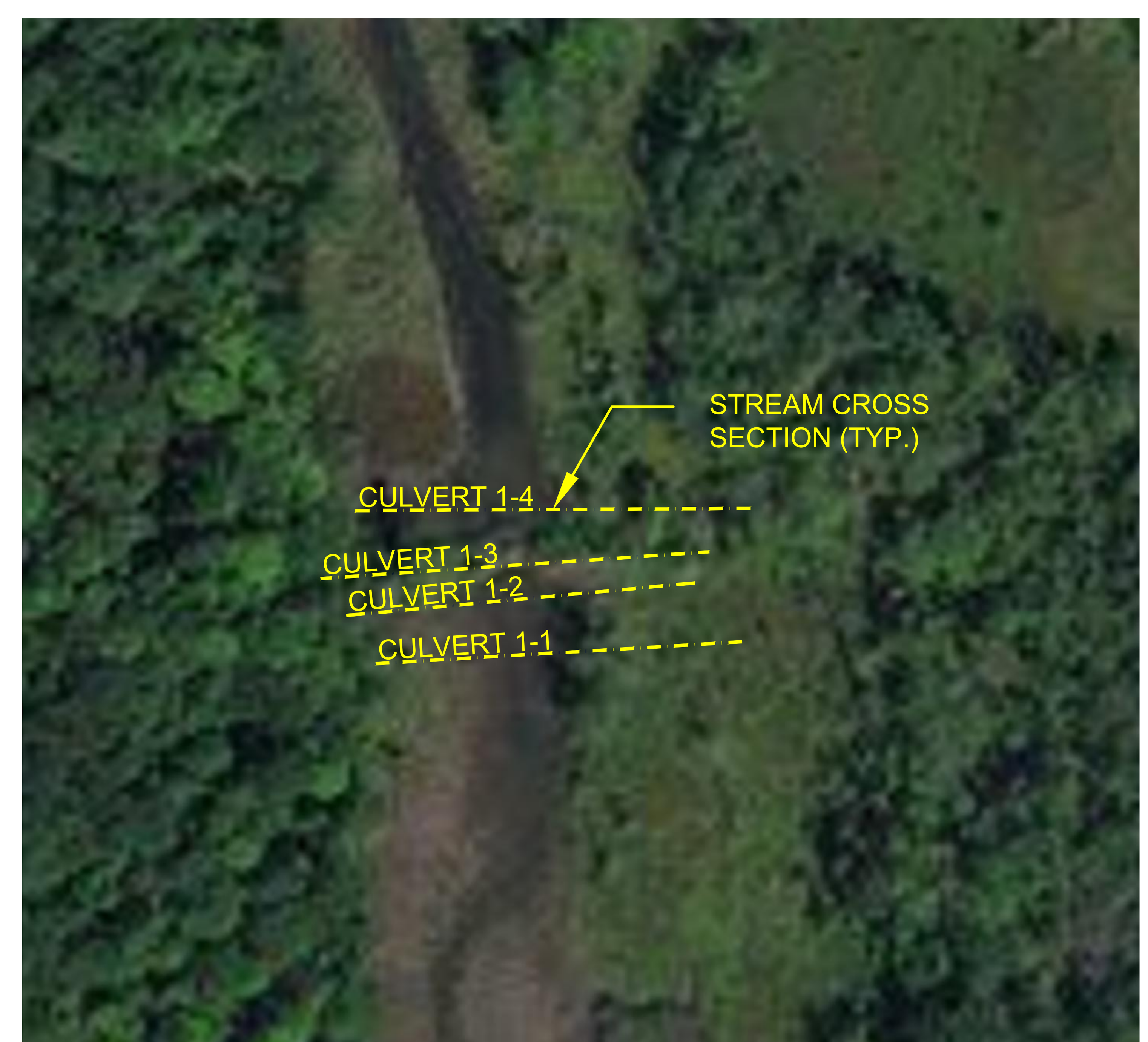
ATTACHMENT A

DETAILED CROSS SECTIONS AND PROFILES



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BK-1 — SHORELINE PROFILE / STREAM CROSS SECTION

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ISSUE DATE: MAY 2018

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CHECKED BY:

SUBMITTED BY: PRINCETON HYDRO

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BINNEN KILL
ALBANY COUNTY, NY

BINNEN KILL
SHORELINE PROFILE AND
STREAM CROSS SECTION PLAN

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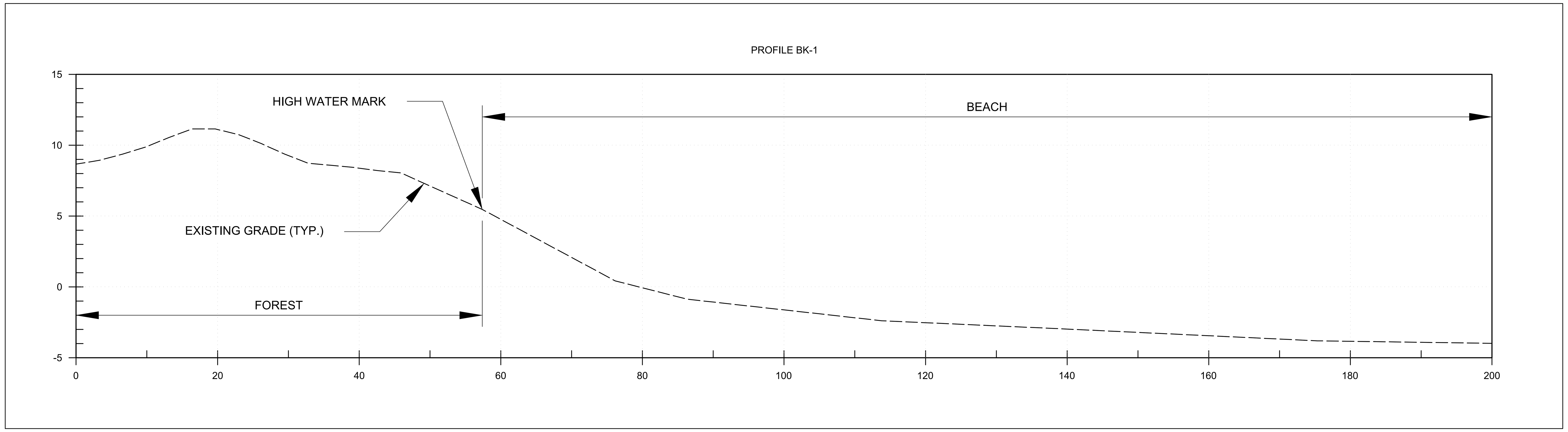
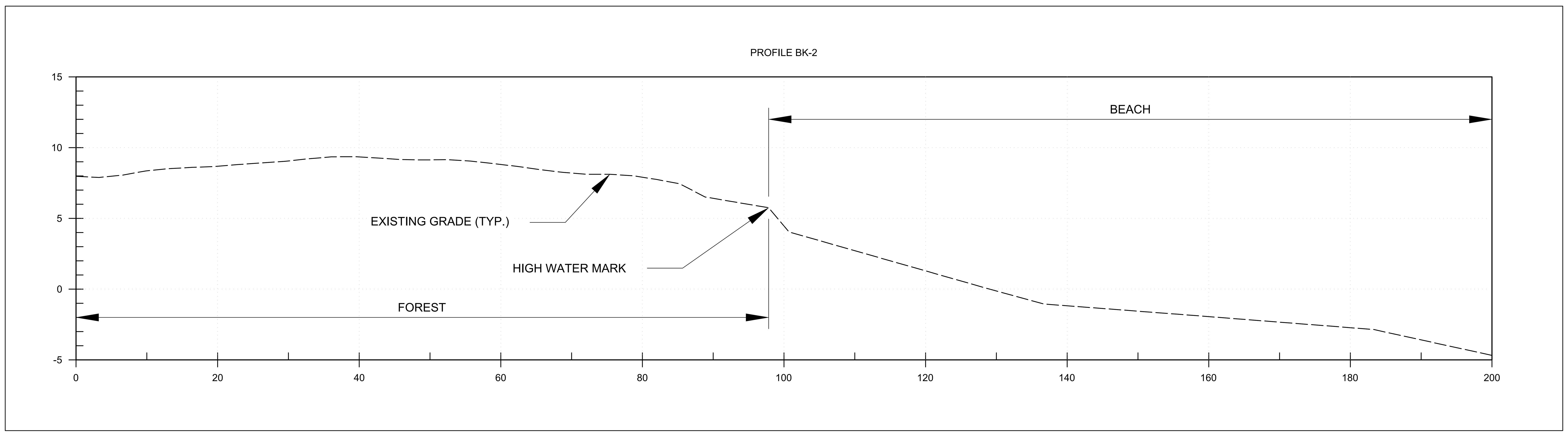
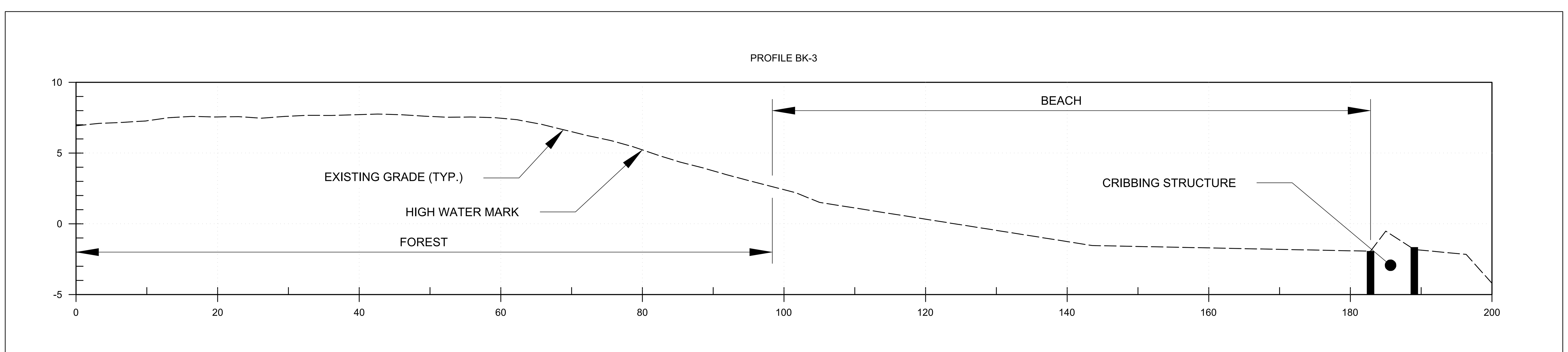
JUL.2018







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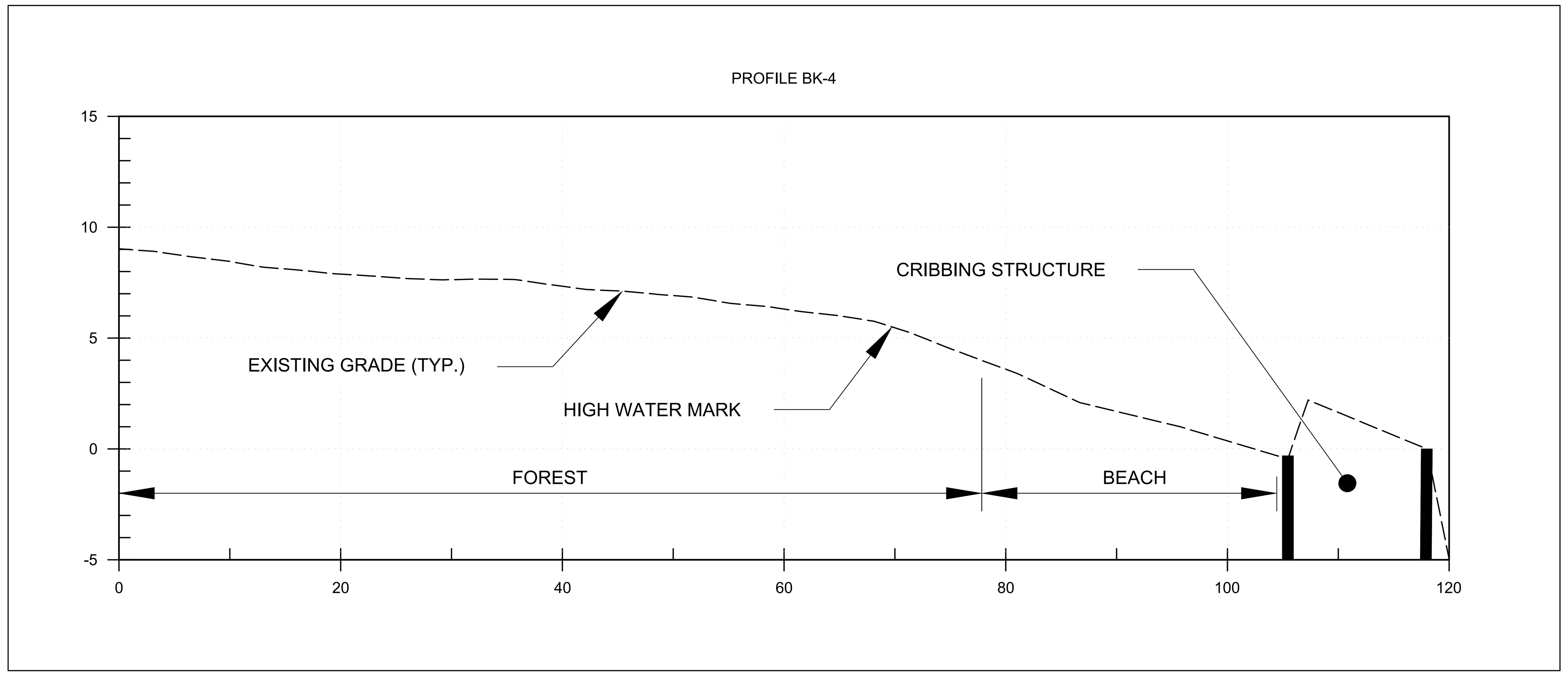

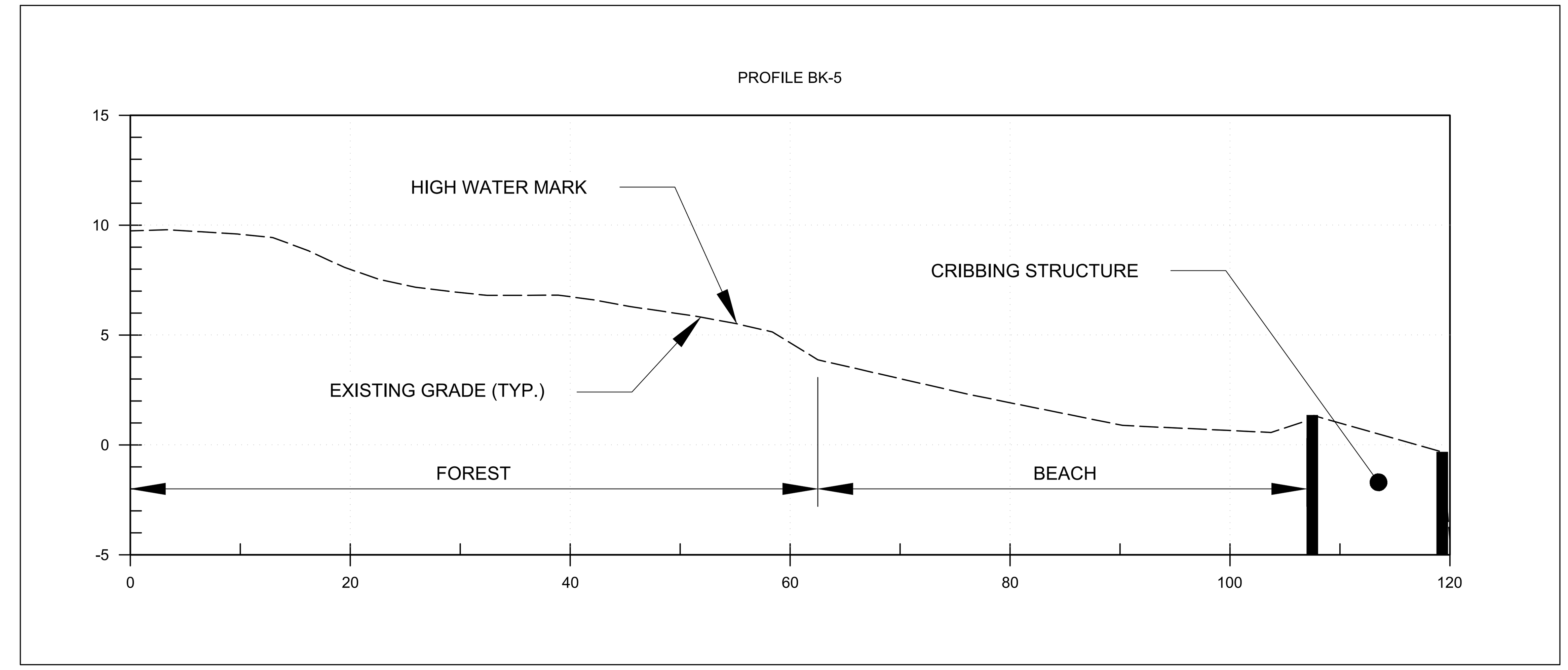

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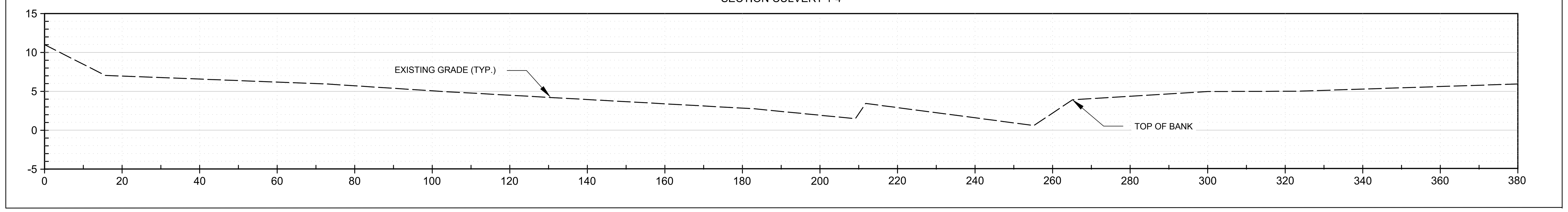

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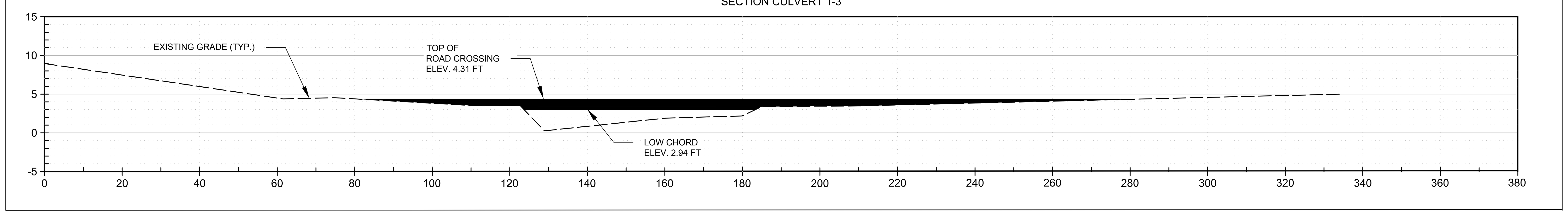

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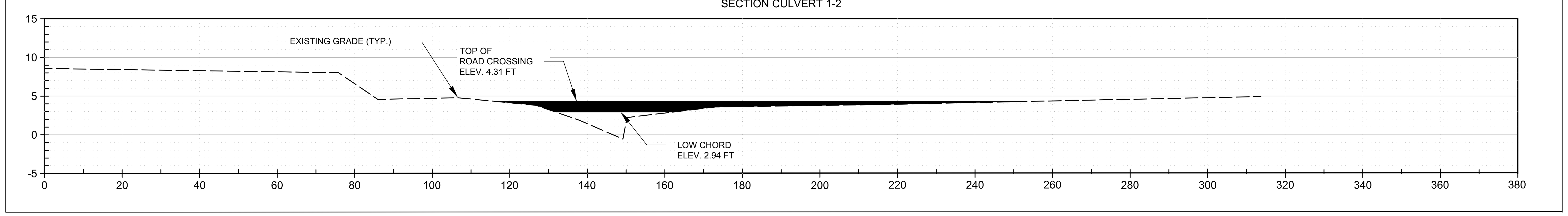

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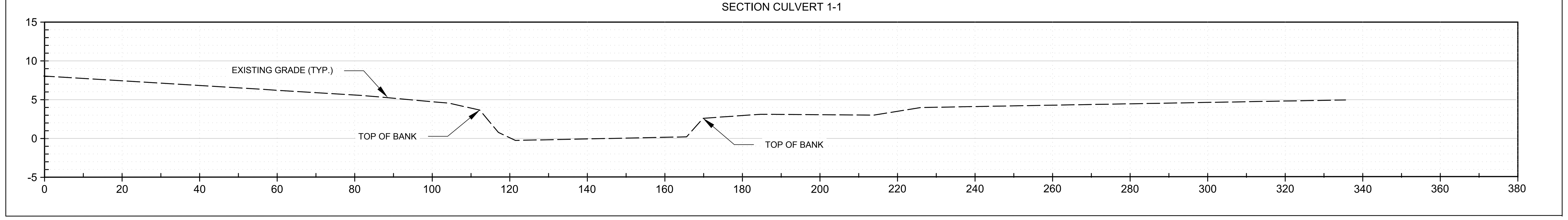

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ALBANY COUNTY, NY

BINNEN KILL
CROSSING 1
STREAM CROSS SECTION SHEET 1

SHEET ID

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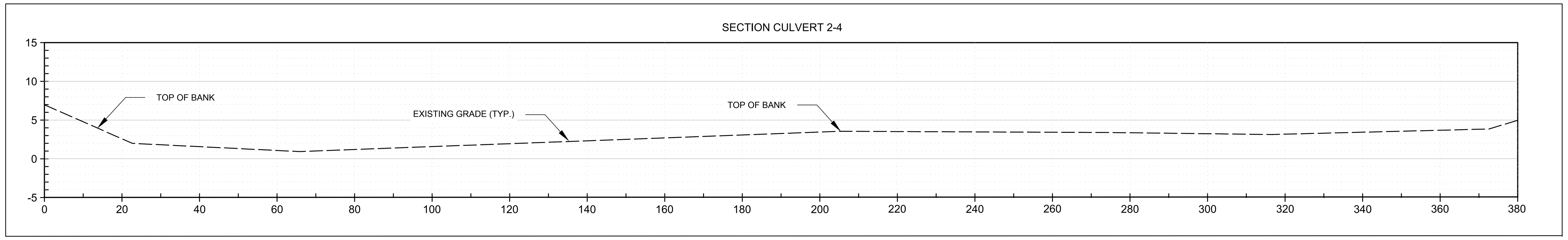

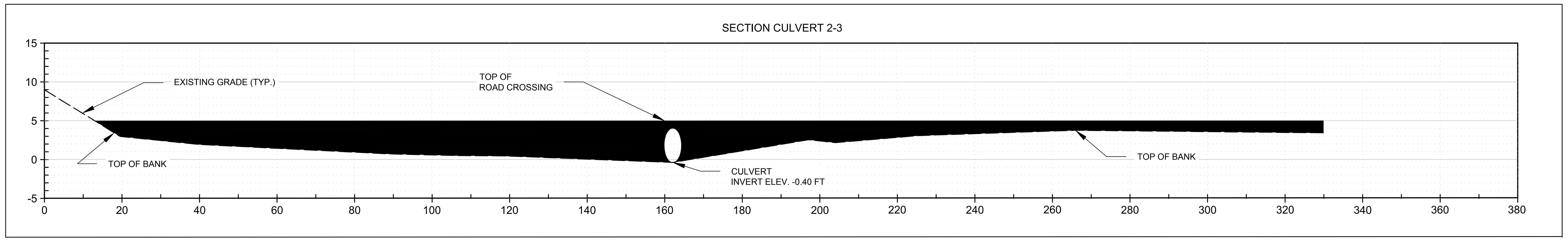

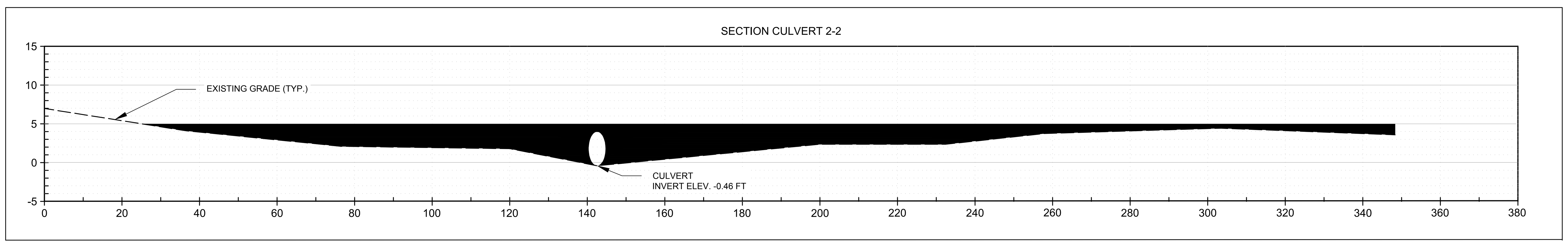

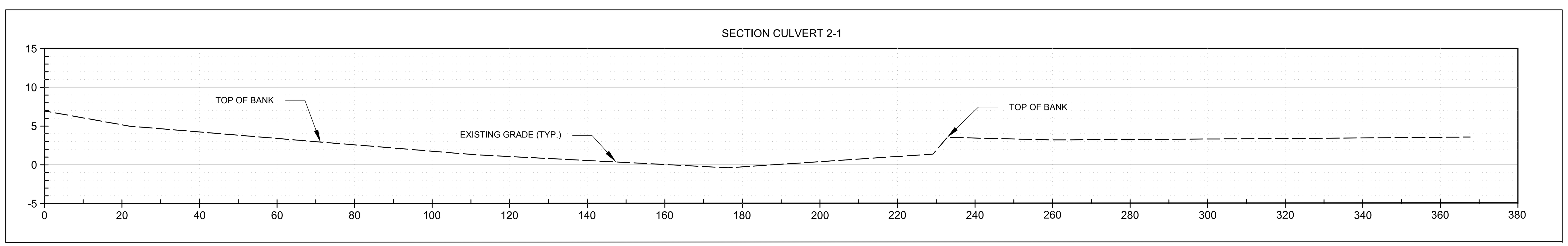

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NEW YORK, NEW YORK, 10278

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

HUDSON RIVER HABITAT RESTORATION
BINNEN KILL
ALBANY COUNTY, NY

BINNEN KILL
CROSSING 2
STREAM CROSS SECTION SHEET 2

SHEET ID

V-304

JUL.2018

LEGEND

SI-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:

DRAWN BY: VM

CHECKED BY:

SUBMITTED BY: PRINCETON HYDRO

SIZE: ANSI D

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
SHORELINE PROFILE PLAN SHEET 1

SHEET ID

V-101

JUL.2018

LEGEND

SI-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

U.S. ARMY CORPS OF ENGINEERS NEW YORK DISTRICT 26 FEDERAL PLAZA NEW YORK, NEW YORK, 10278	DESIGNED BY:	ISSUE DATE: MAY 2018
	DRAWN BY: VM	SOLICITATION NO.:
PRINCETON HYDRO, LLC 1108 OLD YORK ROAD RINGOES, NEW JERSEY, 08551	CHECKED BY:	CONTRACT NO.: W912DS-14-D-0001
	SUBMITTED BY: PRINCETON HYDRO	
	SIZE: ANSI D	

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

SCHODACK ISLAND
SHORELINE PROFILE PLAN SHEET 2

SHEET ID

V-102

JUL.2018

LEGEND

SI-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

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

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

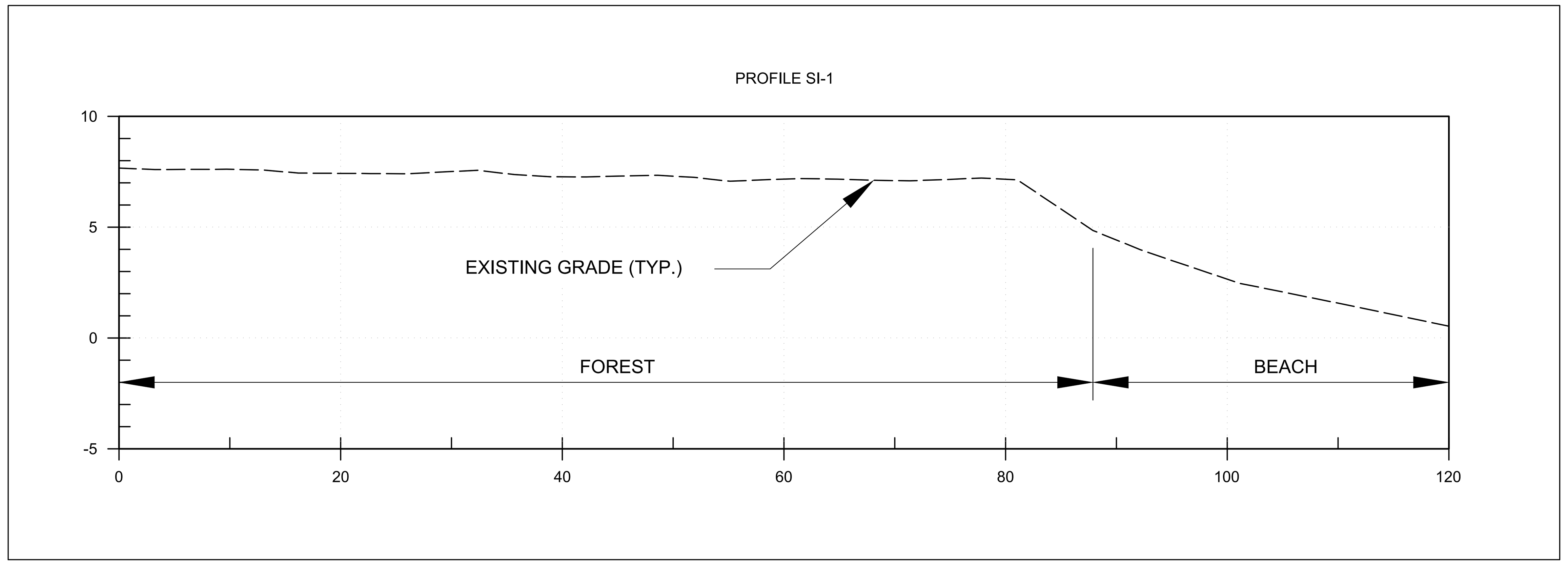
HUDSON RIVER HABITAT RESTORATION
SCHODACK ISLAND STATE PARK
COLUMBIA, GREENE, AND RENSSELAER COUNTIES, NY

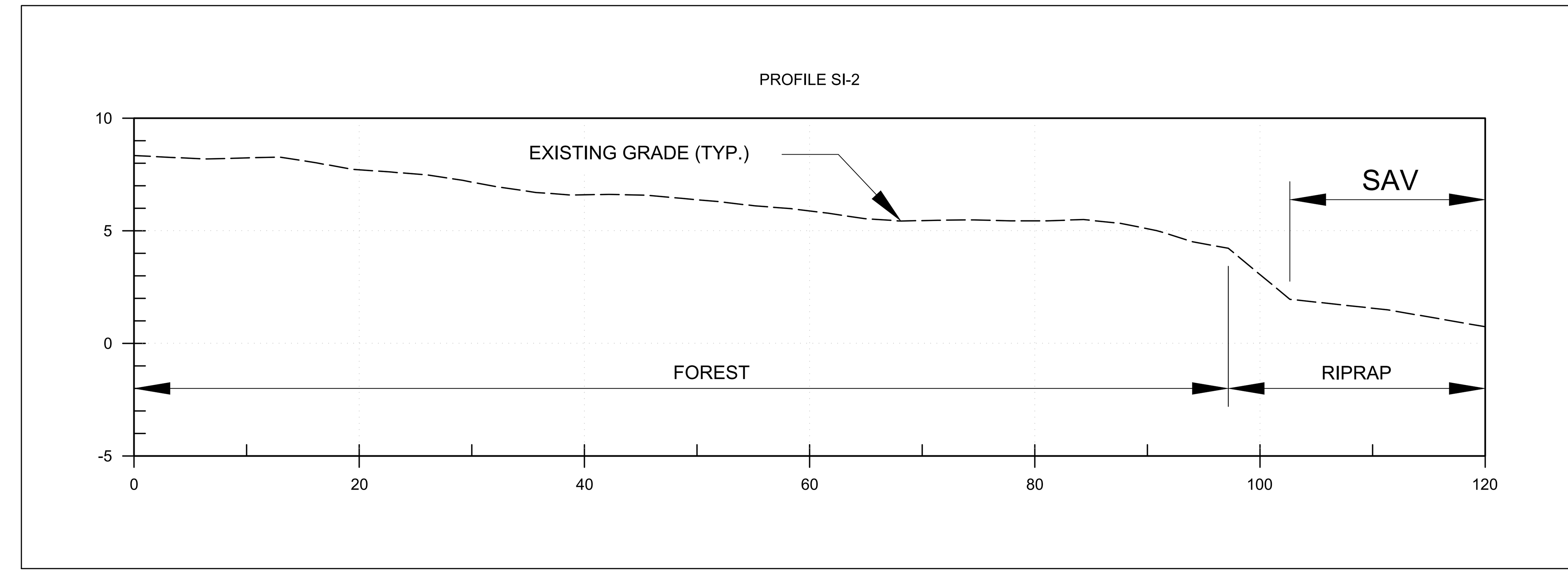
SCHODACK ISLAND
SHORELINE PROFILE PLAN SHEET 3

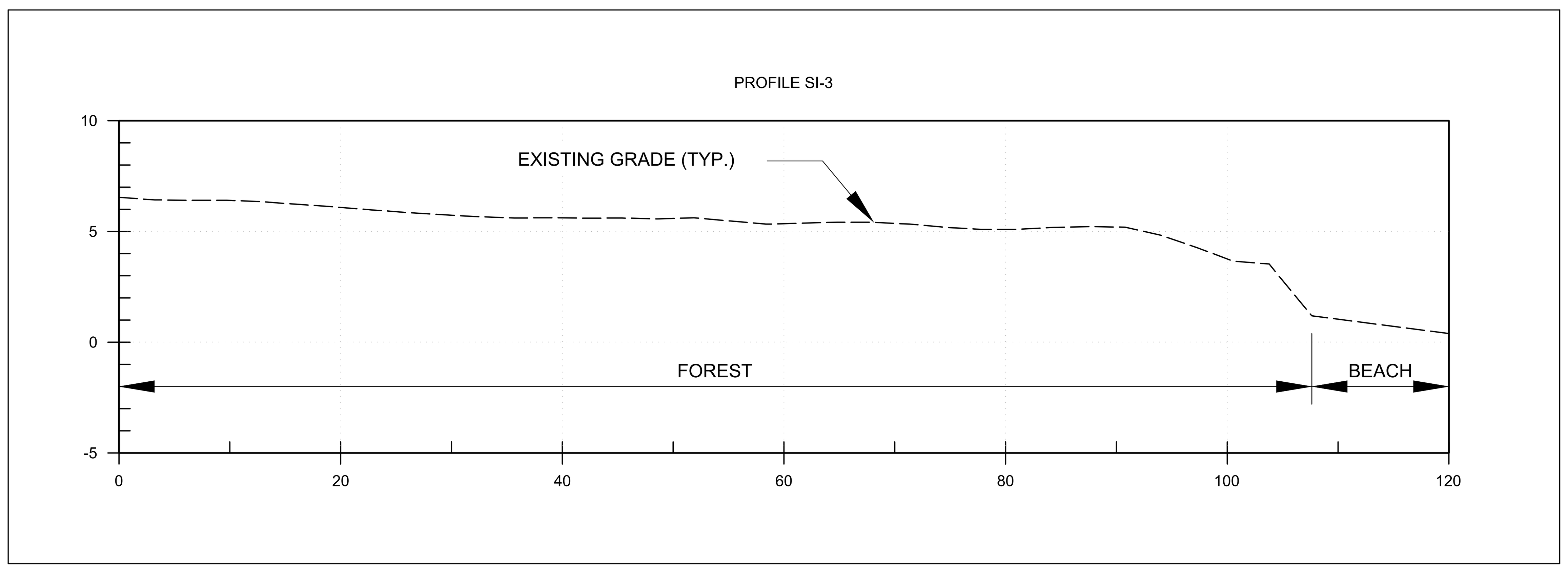
SHEET ID

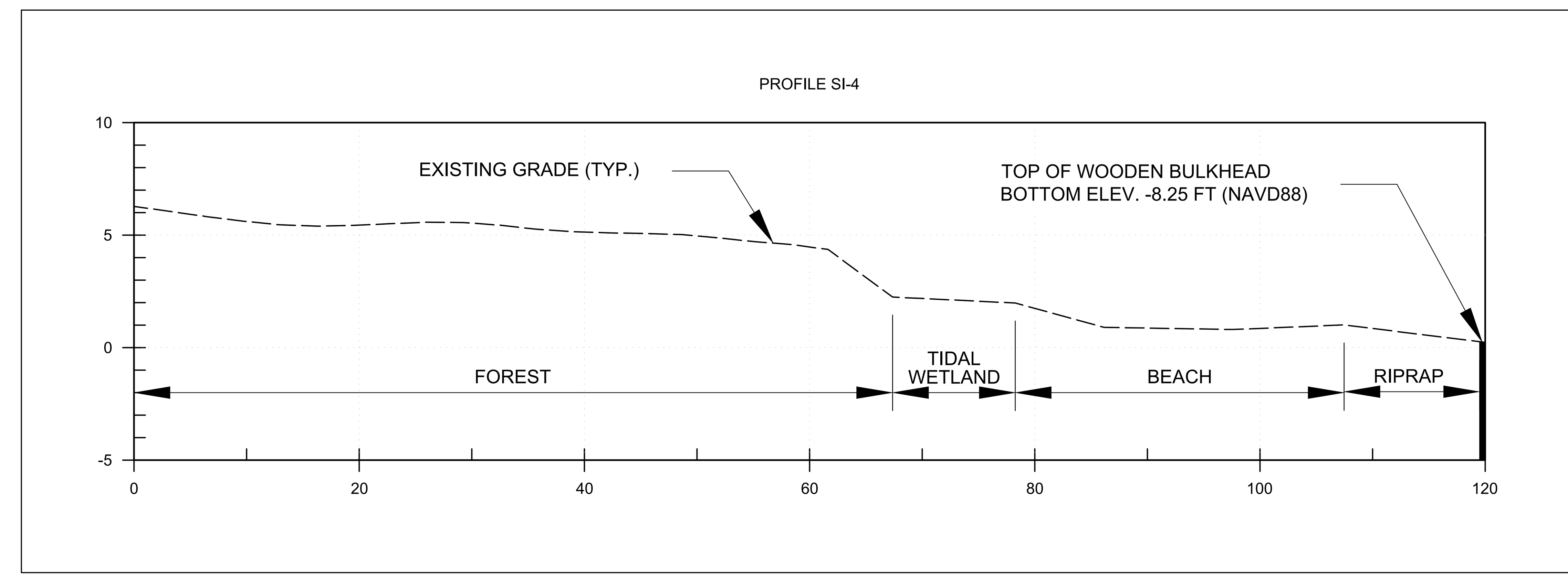
V-103

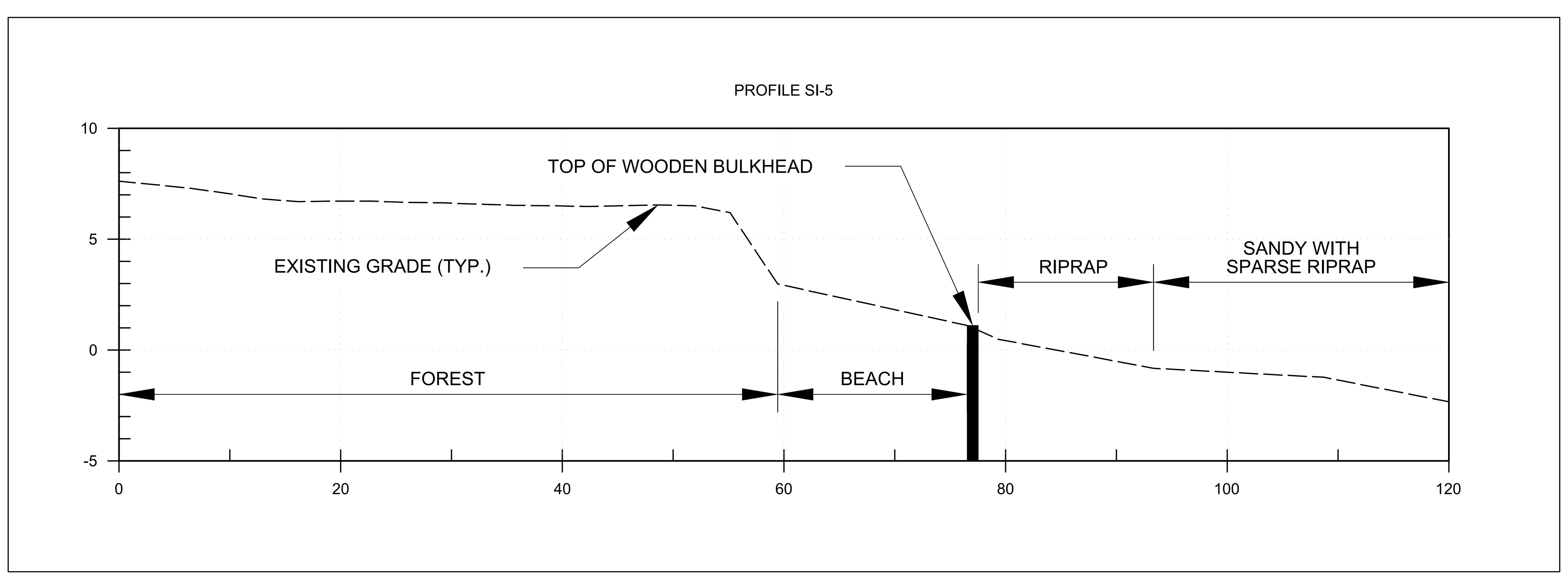
JUL.2018











LEGEND

- - - - - - EXISTING GRADE

US Army Corps of Engineers®

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DESIGNED BY:	ISSUE DATE: MAY 2018
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U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT
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HUDSON RIVER HABITAT RESTORATION
SCHODACK ISLAND STATE PARK
COLUMBIA, GREENE, AND RENSSELAER COUNTIES, NY

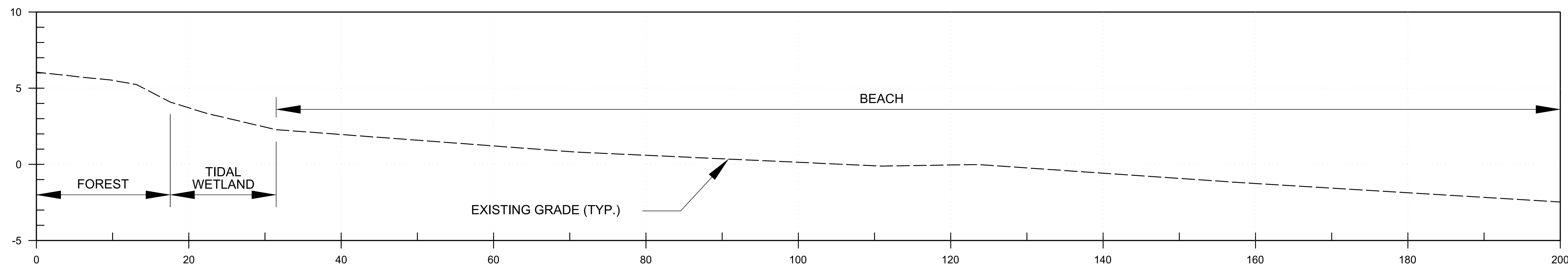
SCHODACK ISLAND
SHORELINE PROFILE SHEET 1

SHEET ID

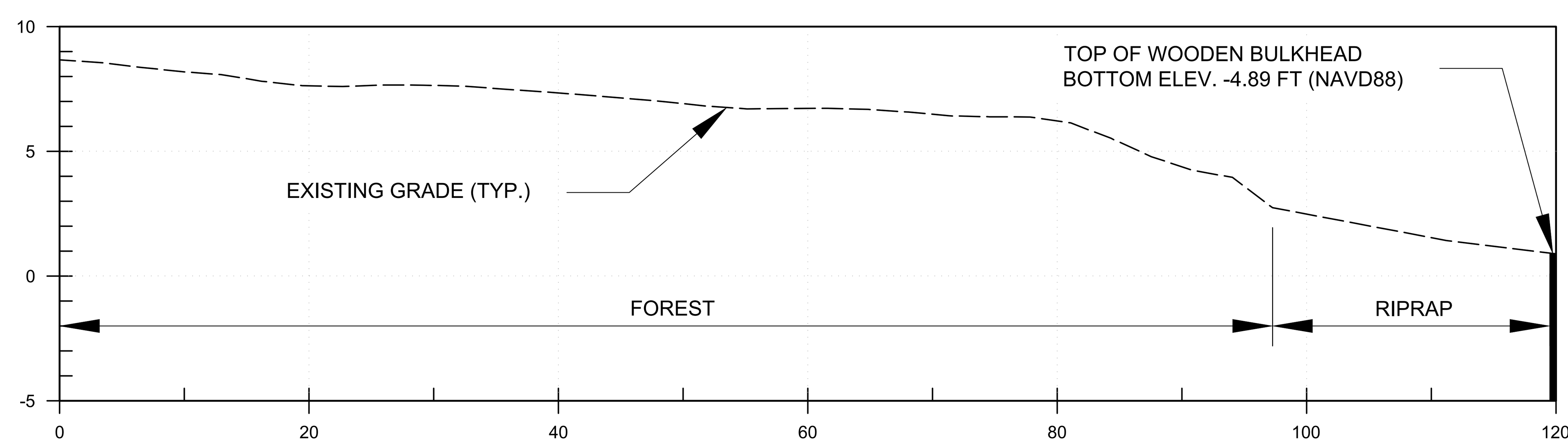
V-301

JUL.2018

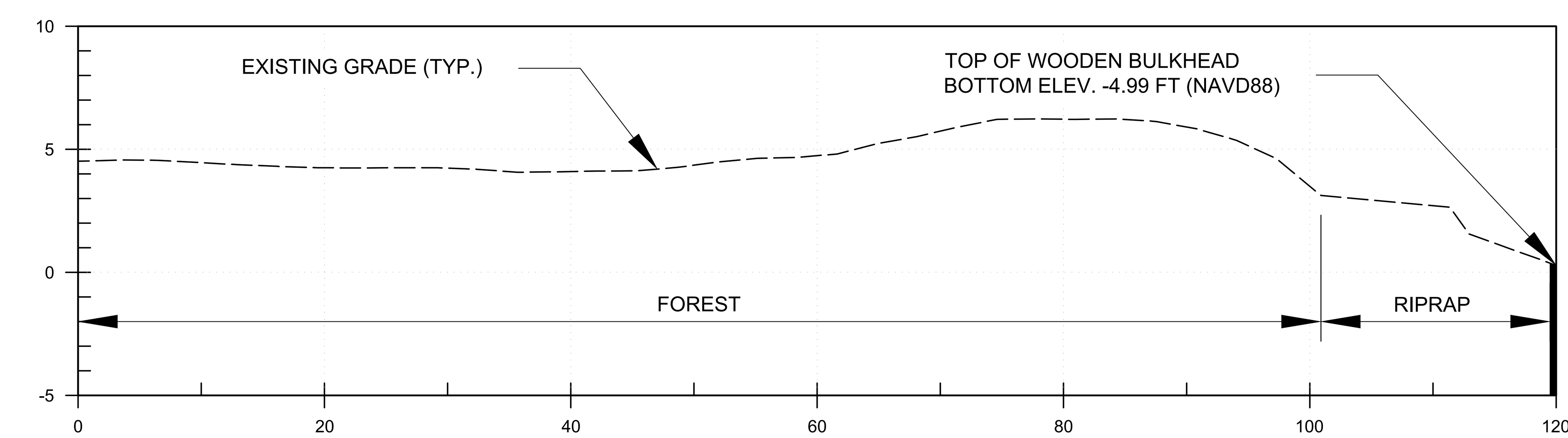
PROFILE SI-6



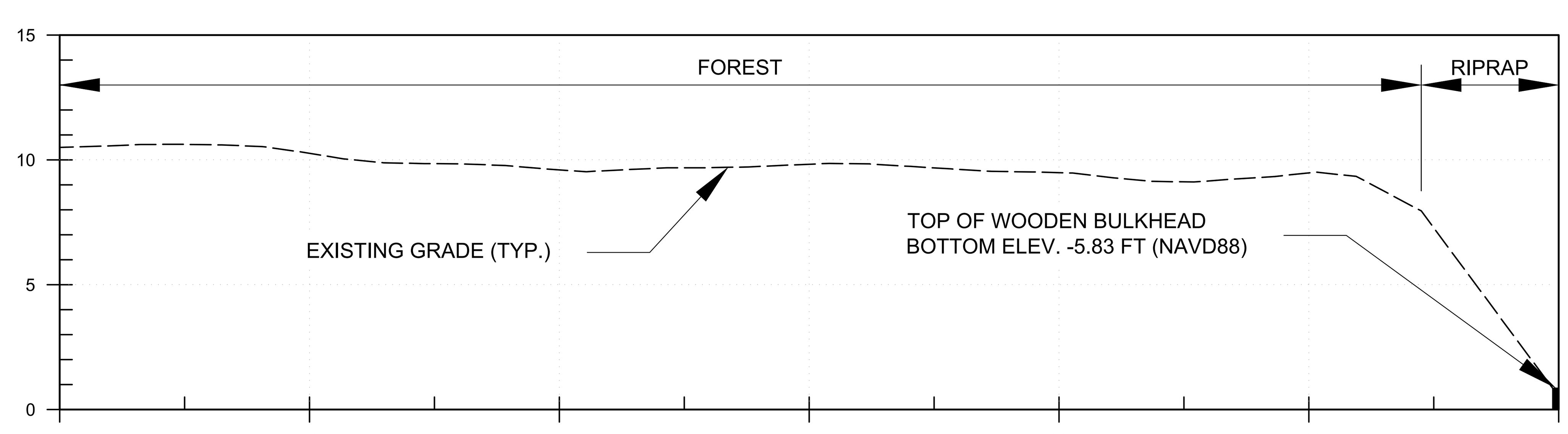
PROFILE SI-7



PROFILE SI-8



PROFILE SI-9



LEGEND

- - - - - - EXISTING GRADE

VERT. SCALE: 1" = 5' (FEET)

HORIZ. SCALE: 1" = 10' (FEET)

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

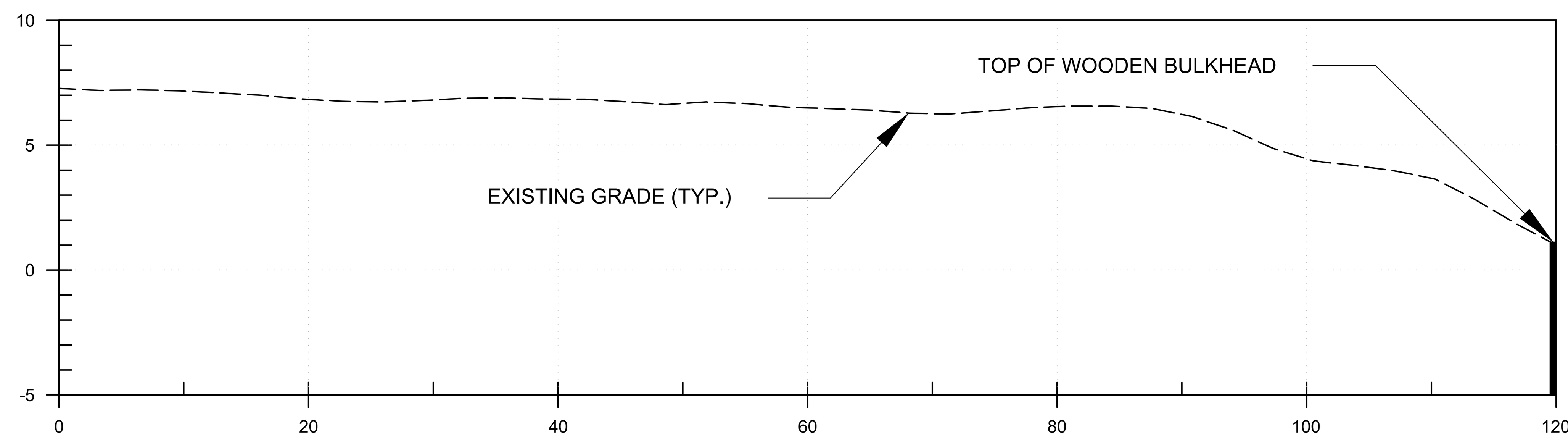
SCHODACK ISLAND
SHORELINE PROFILE SHEET 2

SHEET ID

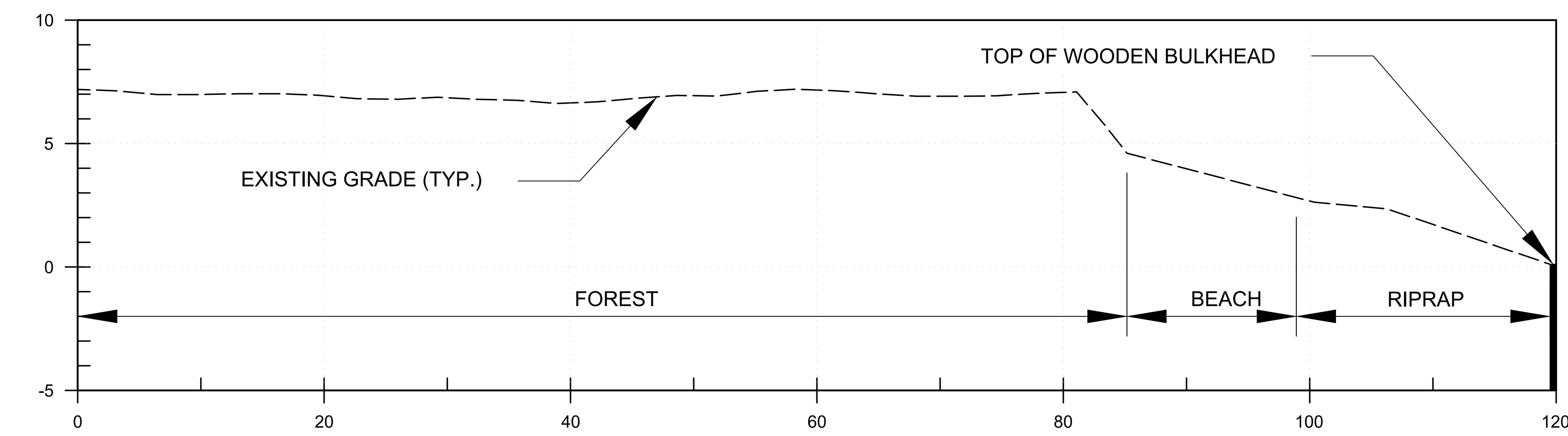
V-302

JUL.2018

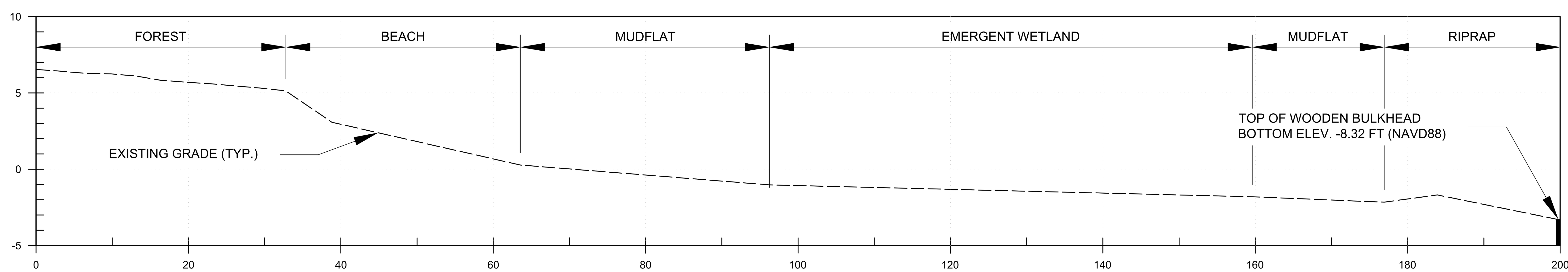
PROFILE SI-10



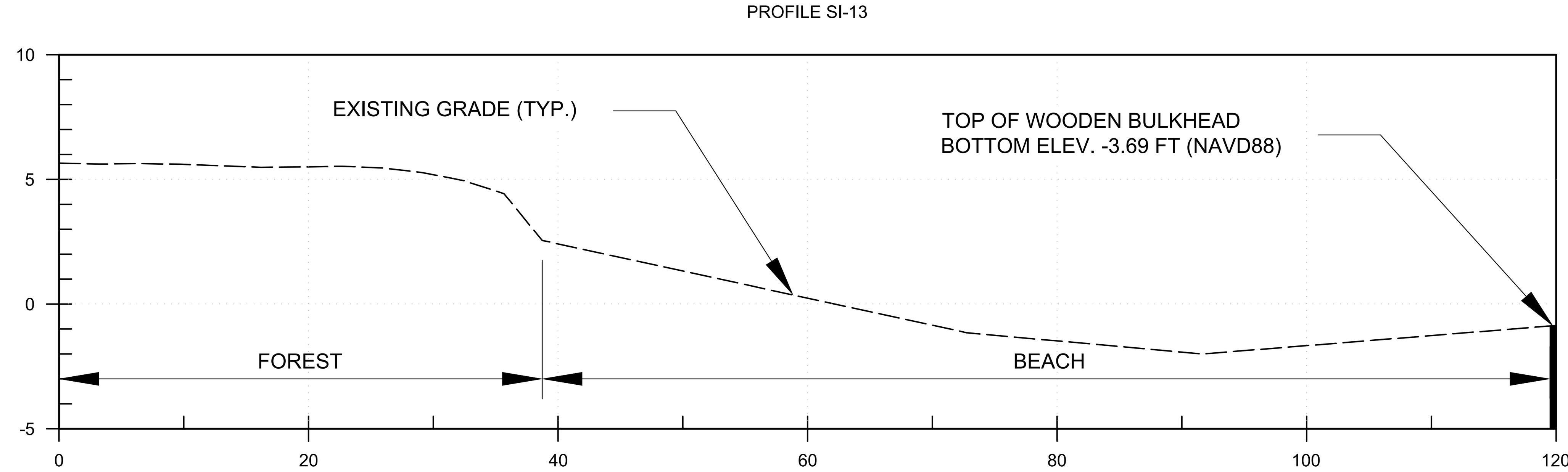
PROFILE SI-11



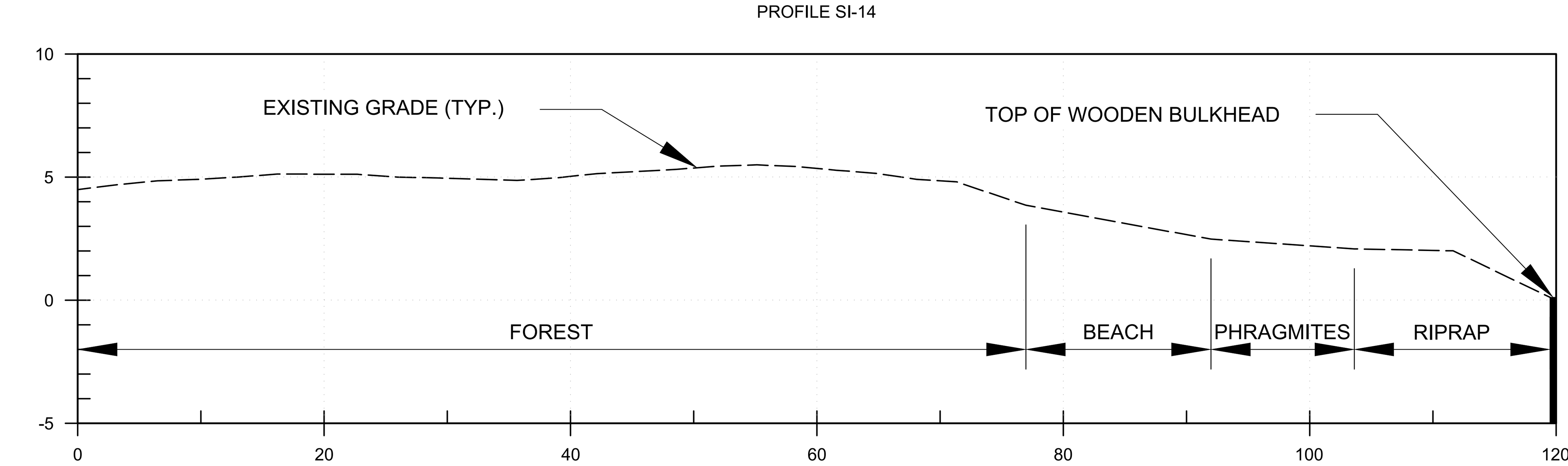
PROFILE SI-12



PROFILE SI-13



PROFILE SI-14



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

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

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

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

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SUBMITTED BY: PRINCETON HYDRO
SIZE: ANSI D
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CONTRACT NO.: W912DS-14-D-0001

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

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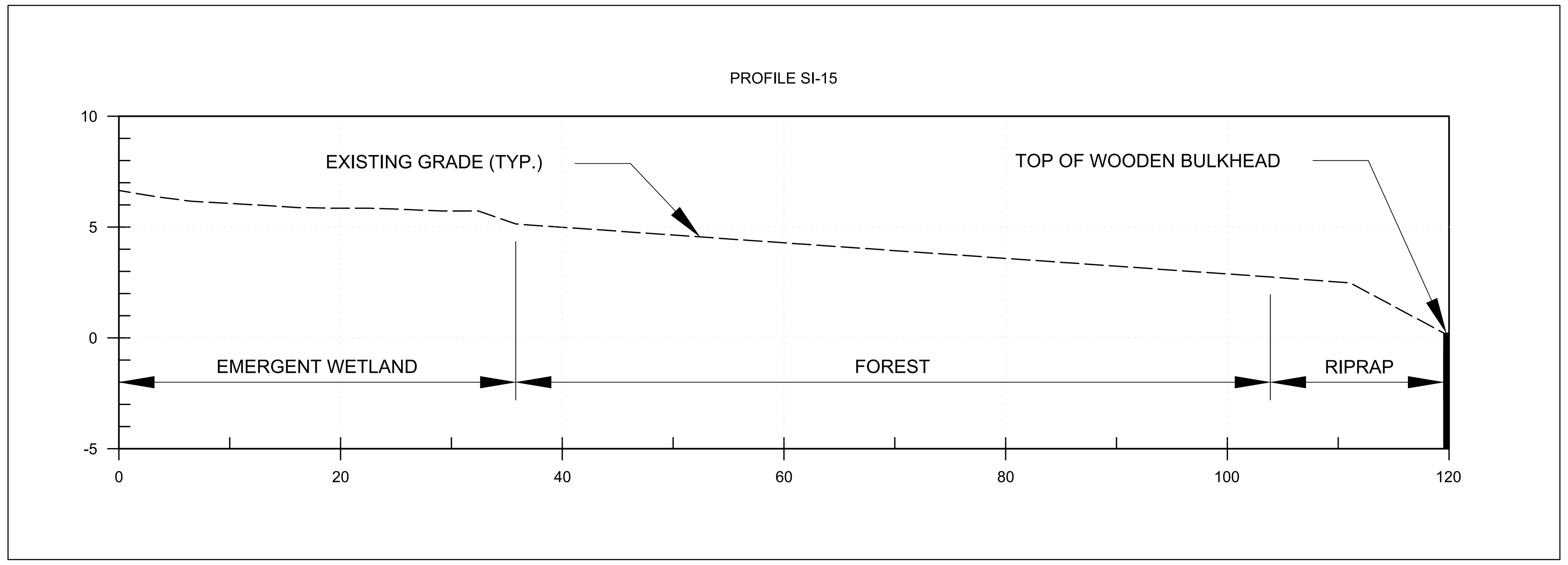
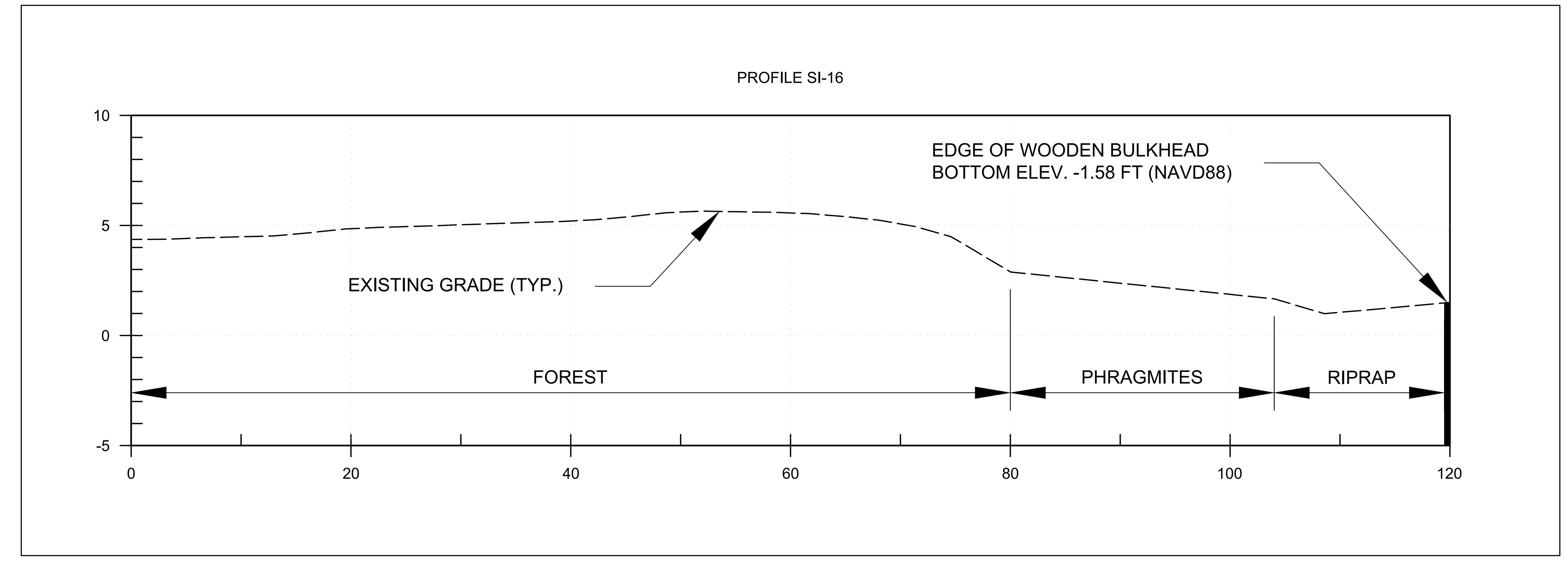
HUDSON RIVER HABITAT RESTORATION
SCHODACK ISLAND STATE PARK
COLUMBIA, GREENE, AND RENSSELAER COUNTIES, NY

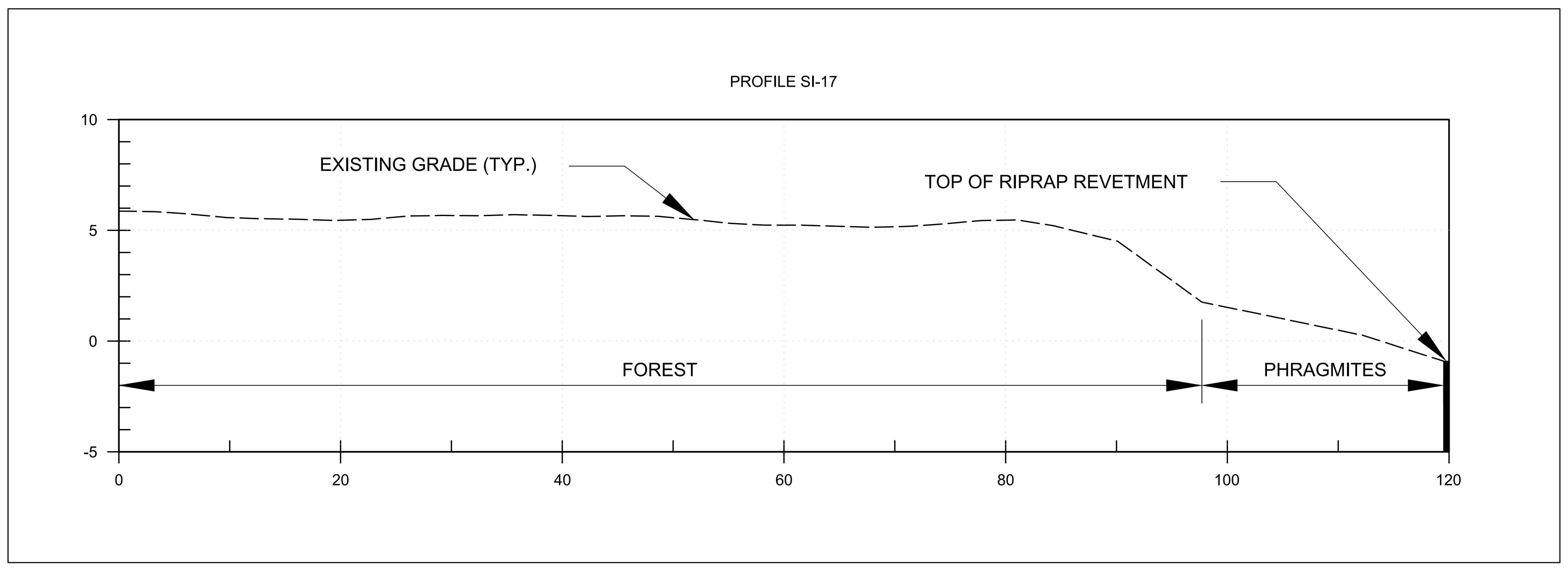
SCHODACK ISLAND
SHORELINE PROFILE SHEET 3

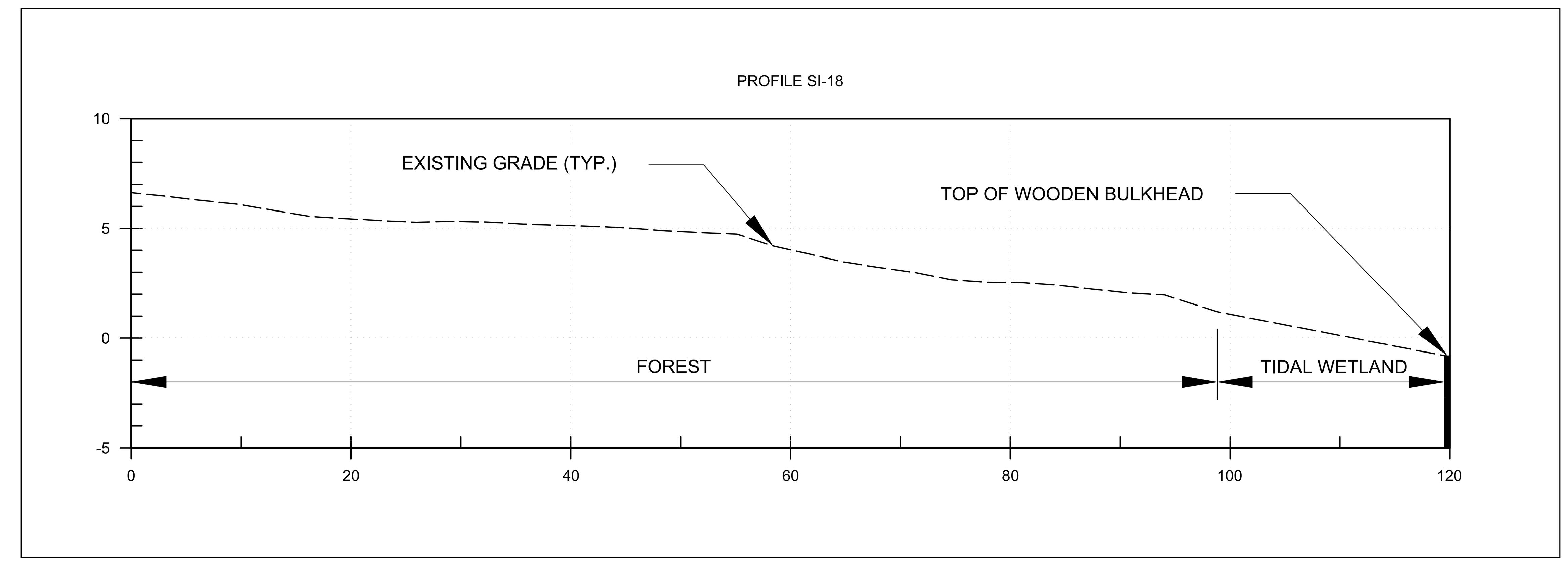
SHEET ID
V-303

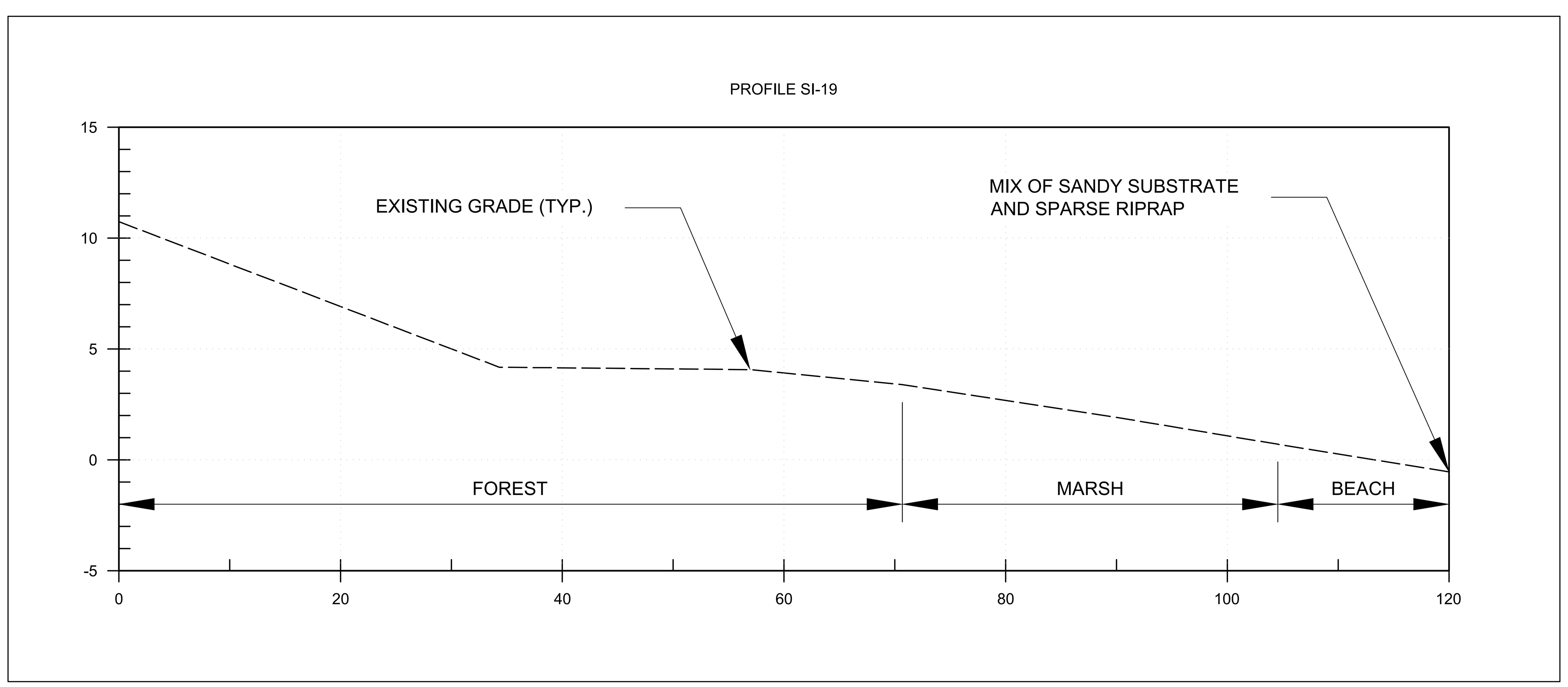
JUL.2018

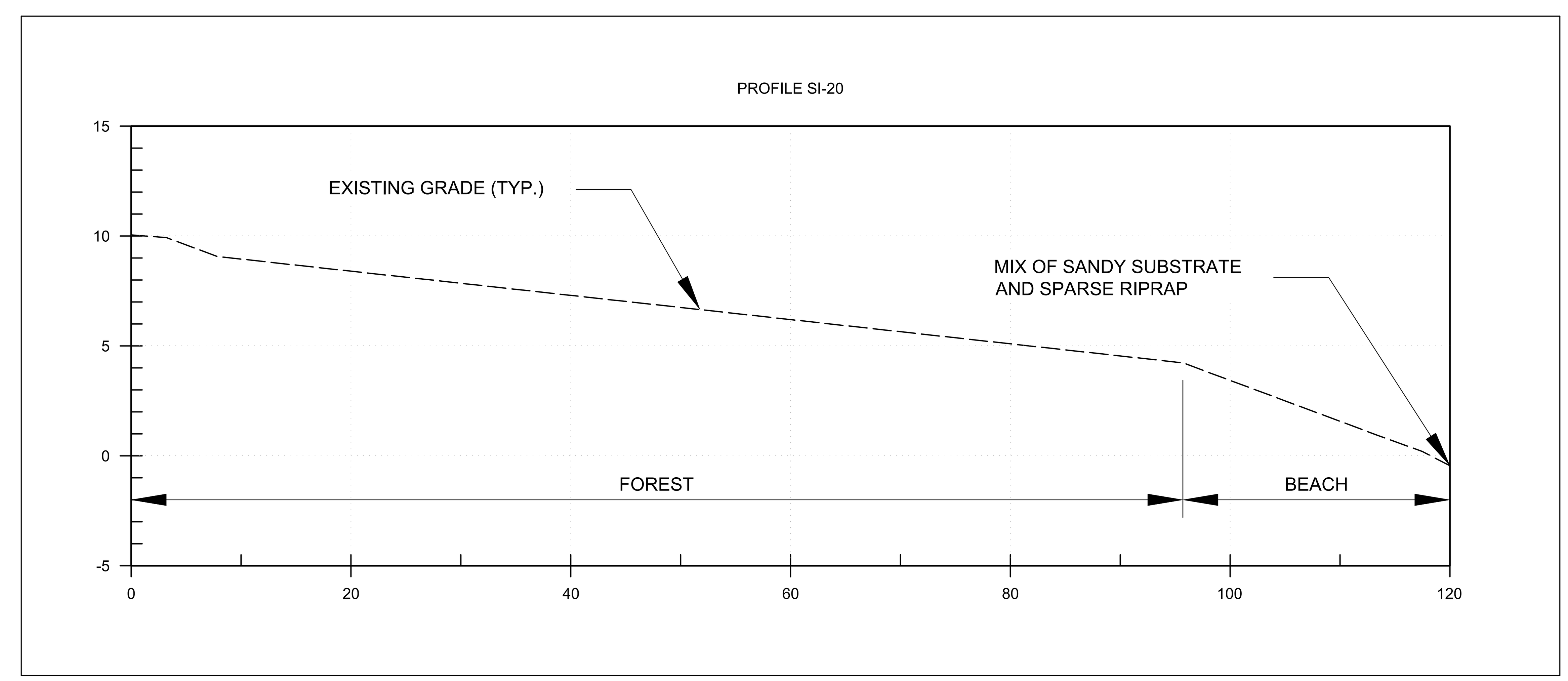












LEGEND

- - - - - - EXISTING GRADE

VERT. SCALE: 1" = 5' (FEET)

HORIZ. SCALE: 1" = 10' (FEET)

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

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CONTRACT NO.: W912DS-14-D-0001

DESIGNED BY:
DRAWN BY: TH
CHECKED BY:
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

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

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

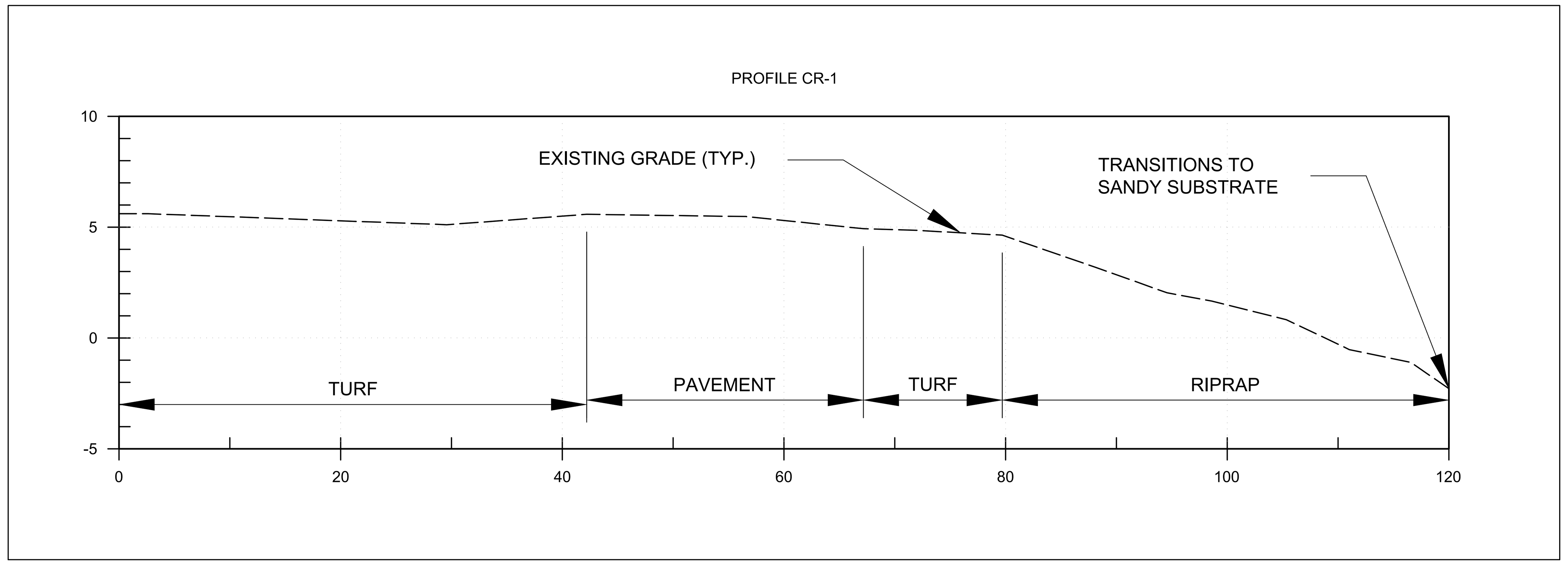
HUDSON RIVER HABITAT RESTORATION
CHARLES RIDER PARK
ULSTER COUNTY, NY

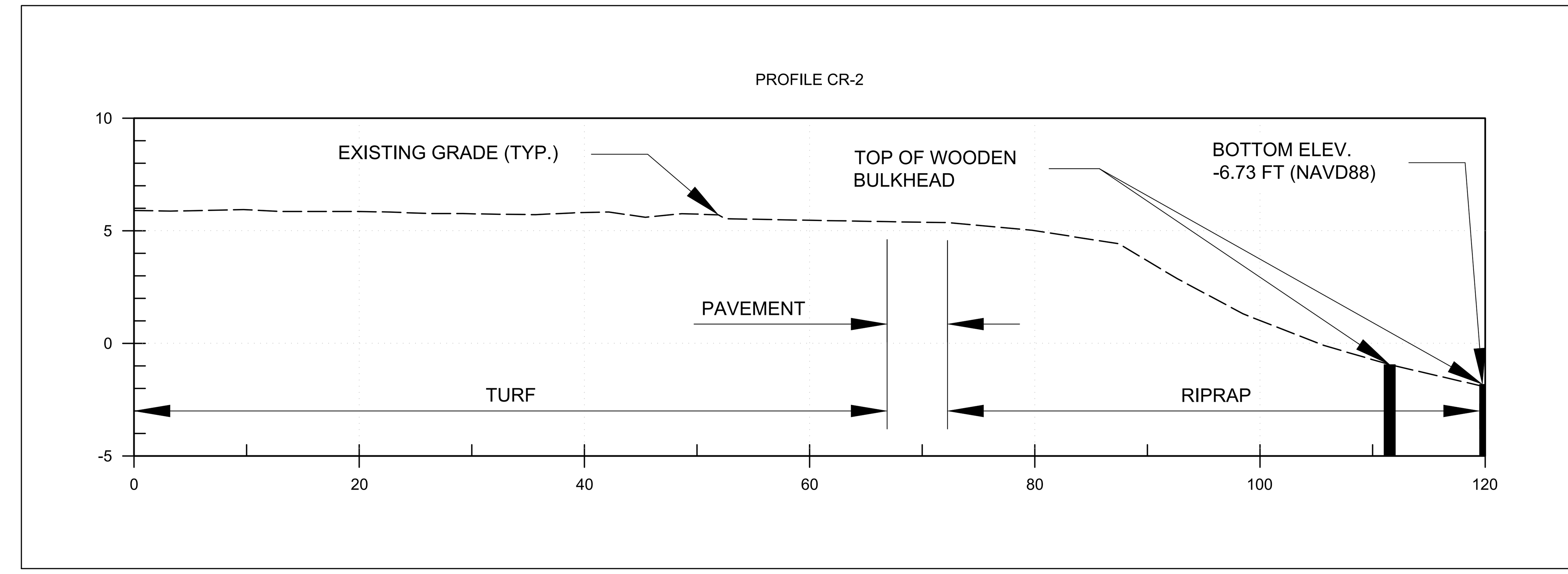
CHARLES RIDER PARK SHORELINE PROFILE PLAN

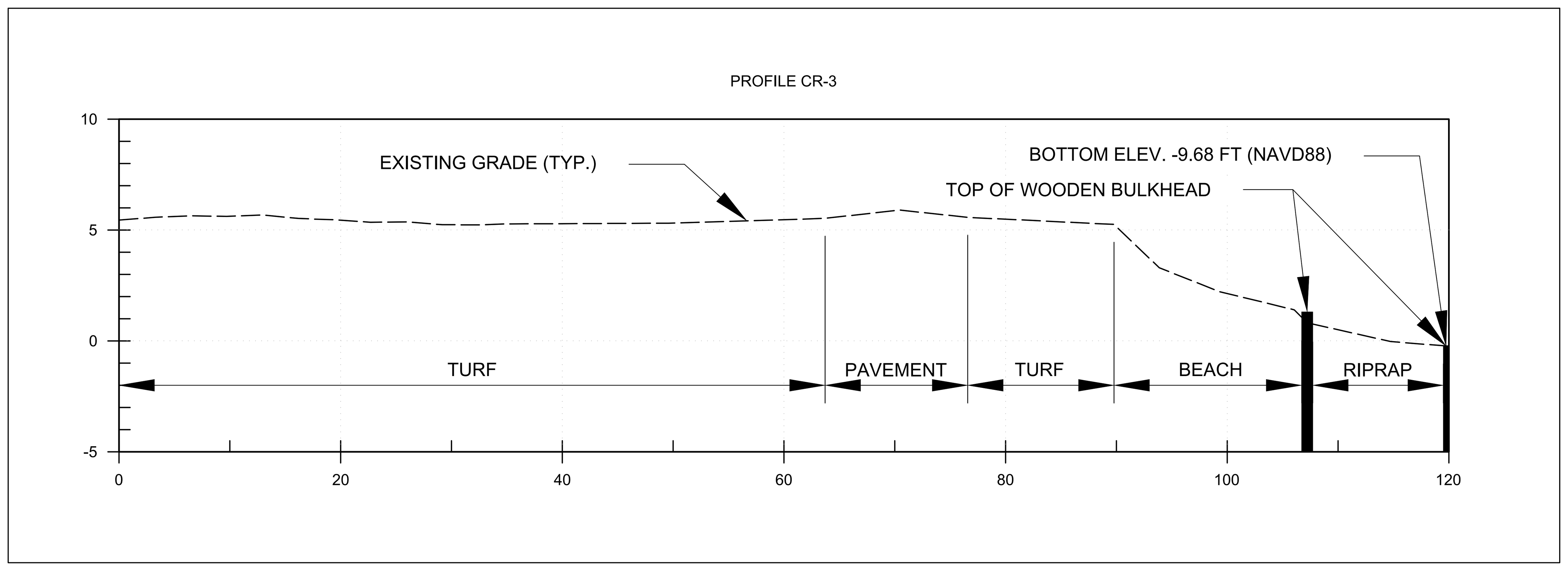
SHEET ID

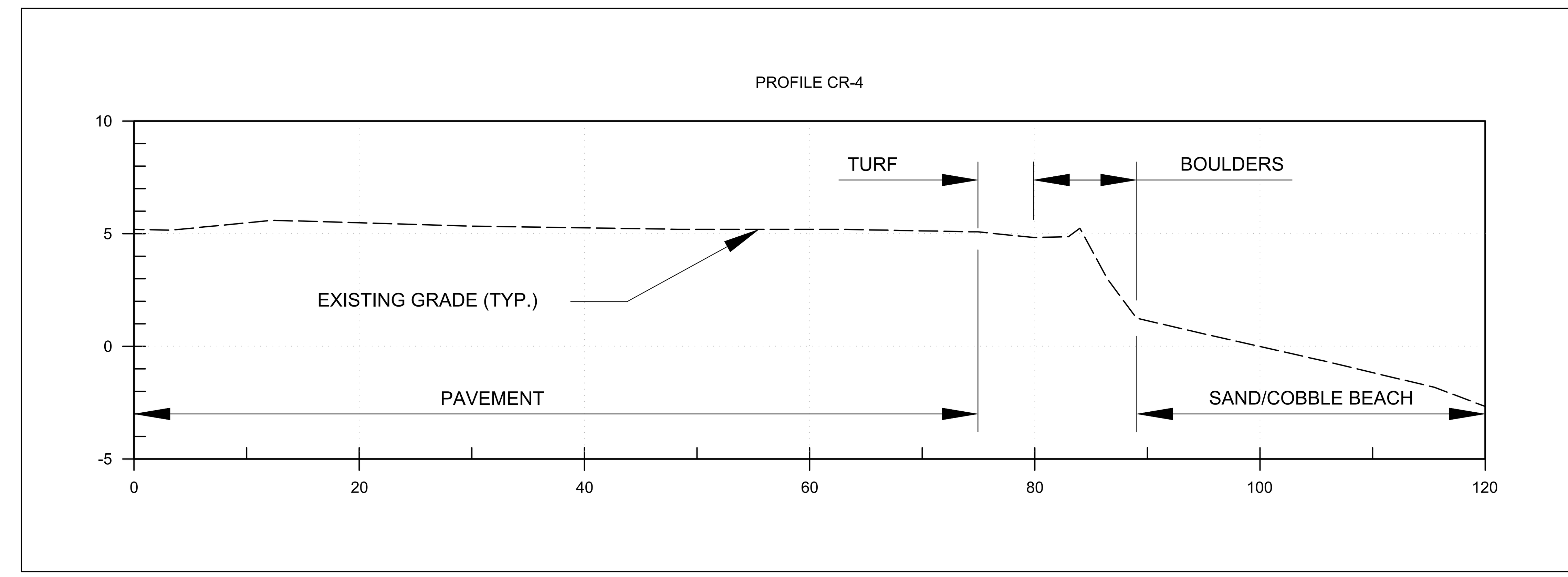
V-101

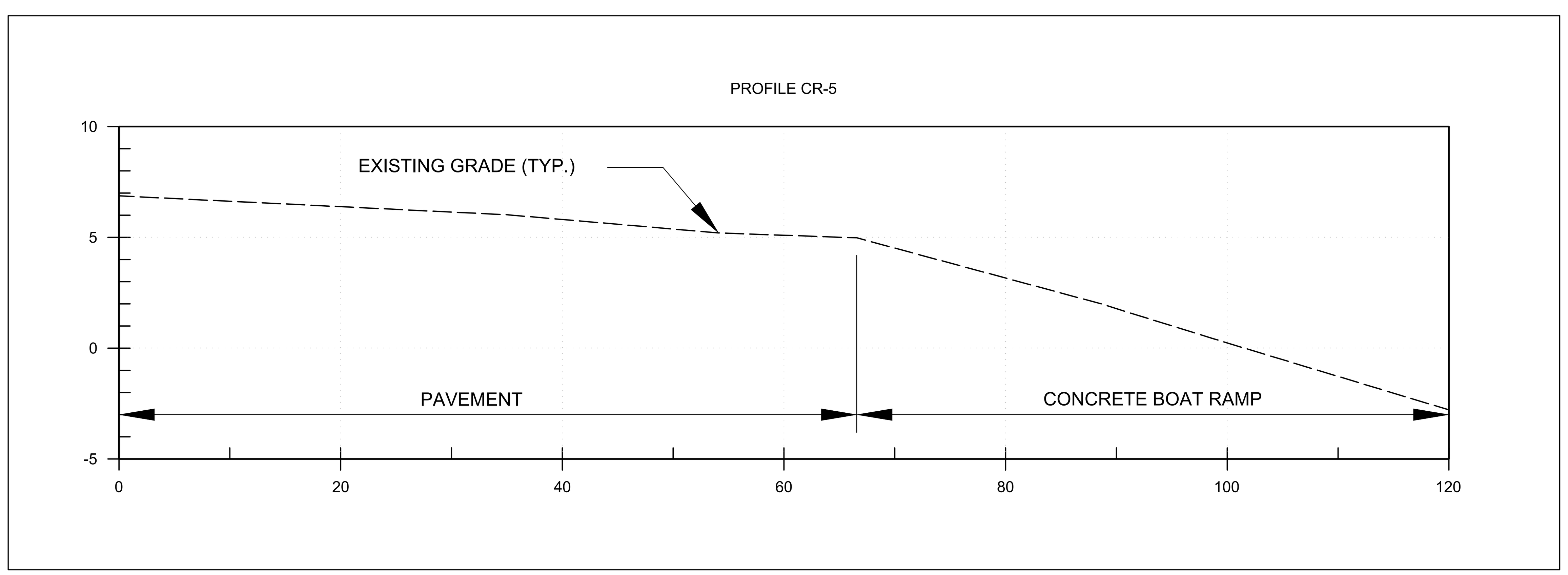
JUL.2018











VERT. SCALE: 1" = 5' (FEET)

HORIZ. SCALE: 1" = 10' (FEET)

LEGEND

EXISTING GRADE

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

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

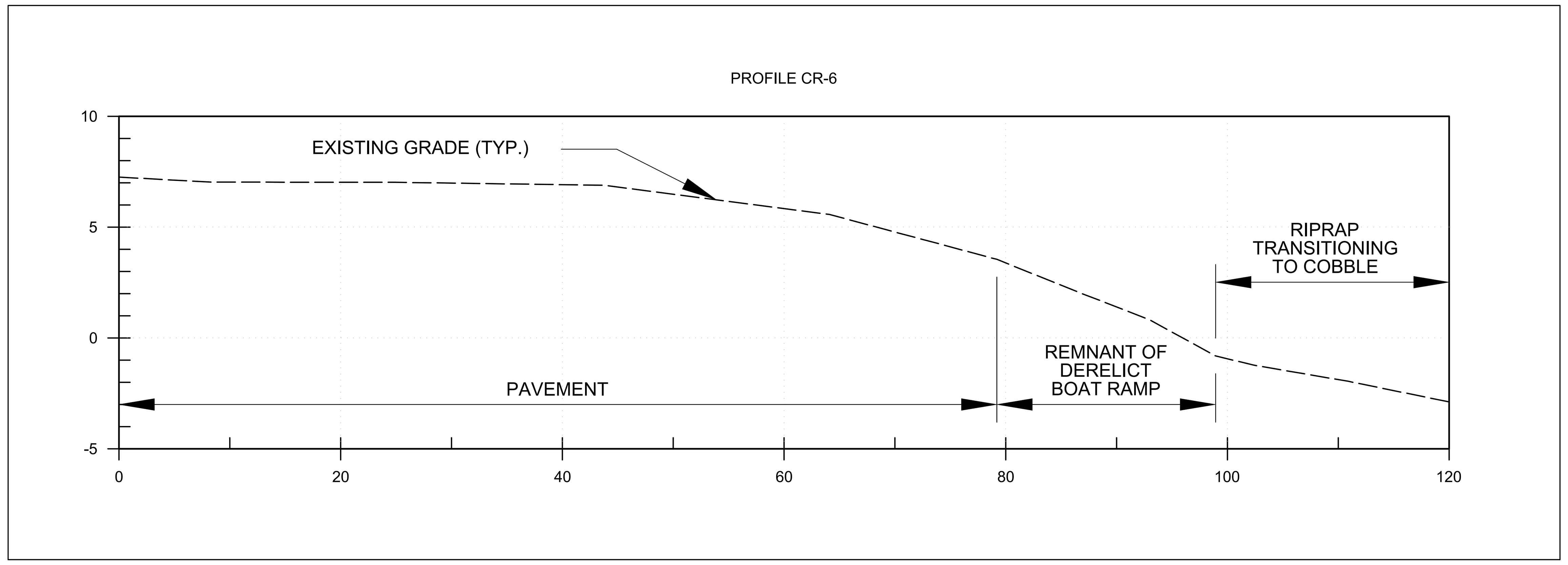
PRINCETON HYDRO, LLC
1108 OLD YORK ROAD
RINGOES, NEW JERSEY, 08551

HUDSON RIVER HABITAT RESTORATION
CHARLES RIDER PARK
ULSTER COUNTY, NY

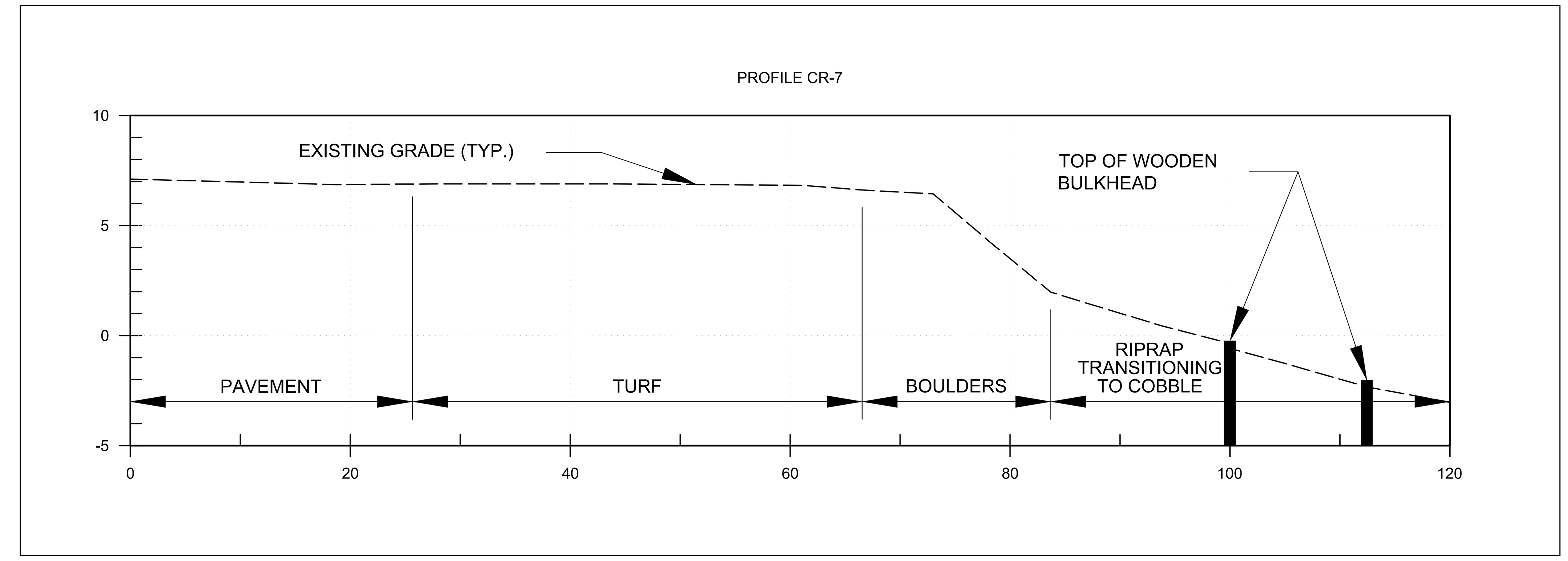
CHARLES RIDER PARK
SHORELINE PROFILE SHEET 1

SHEET ID
V-301

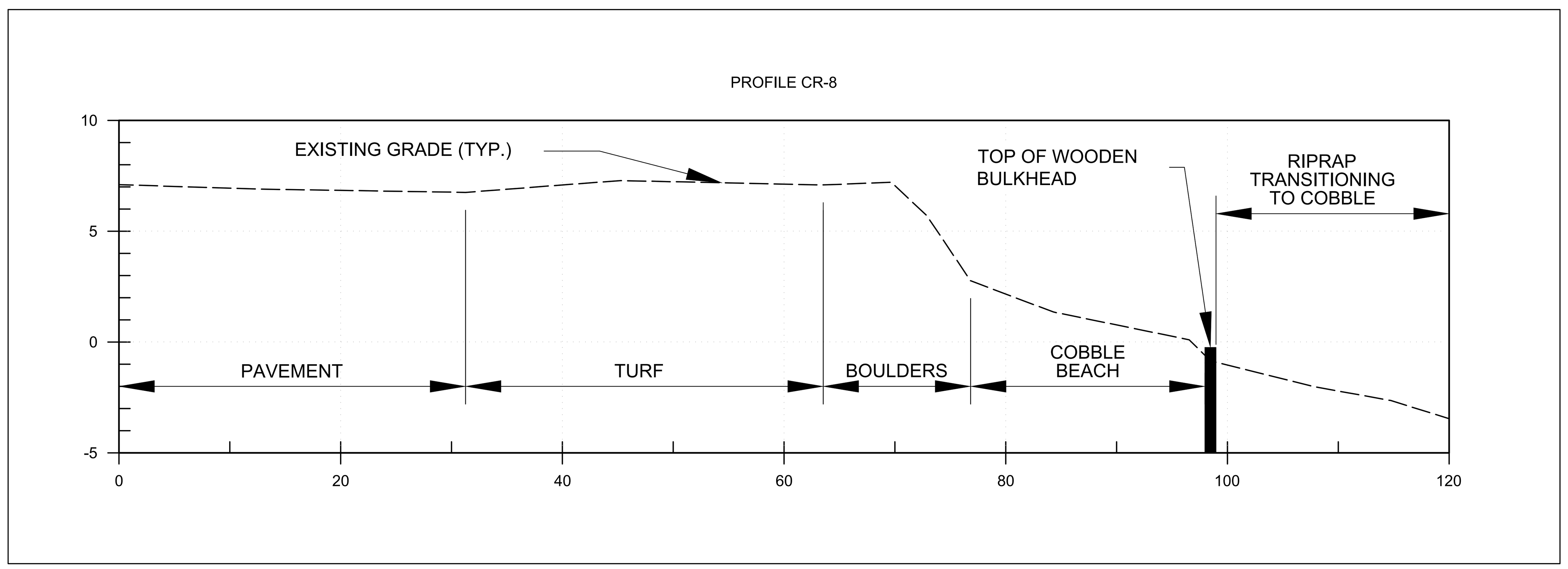
JUL.2018



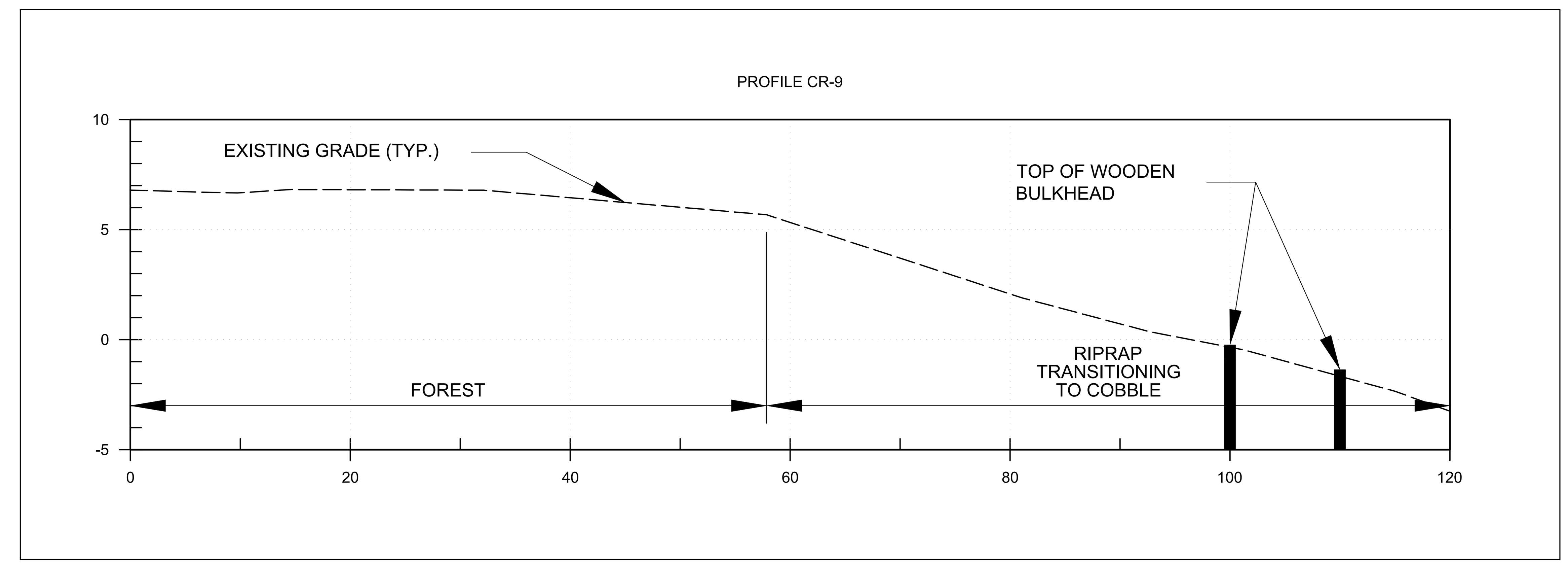
PROFILE CR-6



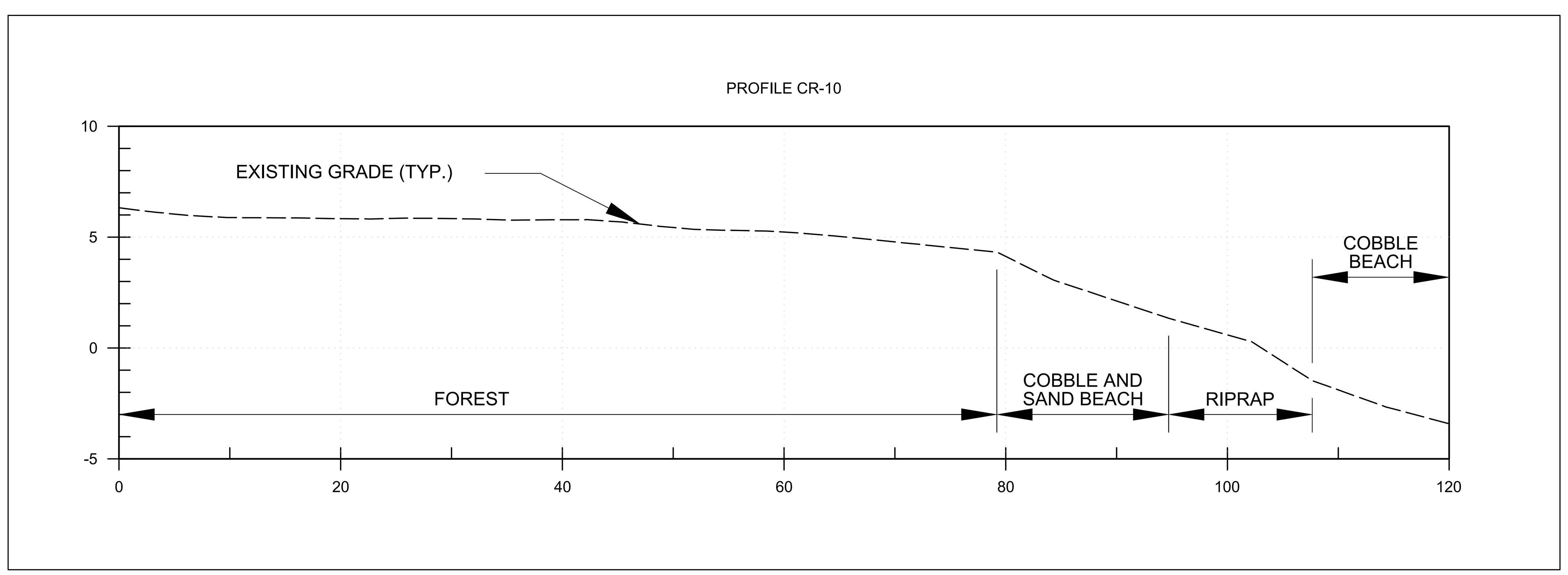
PROFILE CR-7



PROFILE CR-8



PROFILE CR-9



PROFILE CR-10

VERT. SCALE: 1" = 5' (FEET)

HORIZ. SCALE: 1" = 10' (FEET)

LEGEND

- - - - - EXISTING GRADE

US Army Corps of Engineers®

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

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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®

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U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT
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1108 OLD YORK ROAD
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HUDSON RIVER HABITAT RESTORATION
HENRY HUDSON PARK
ALBANY COUNTY, NY

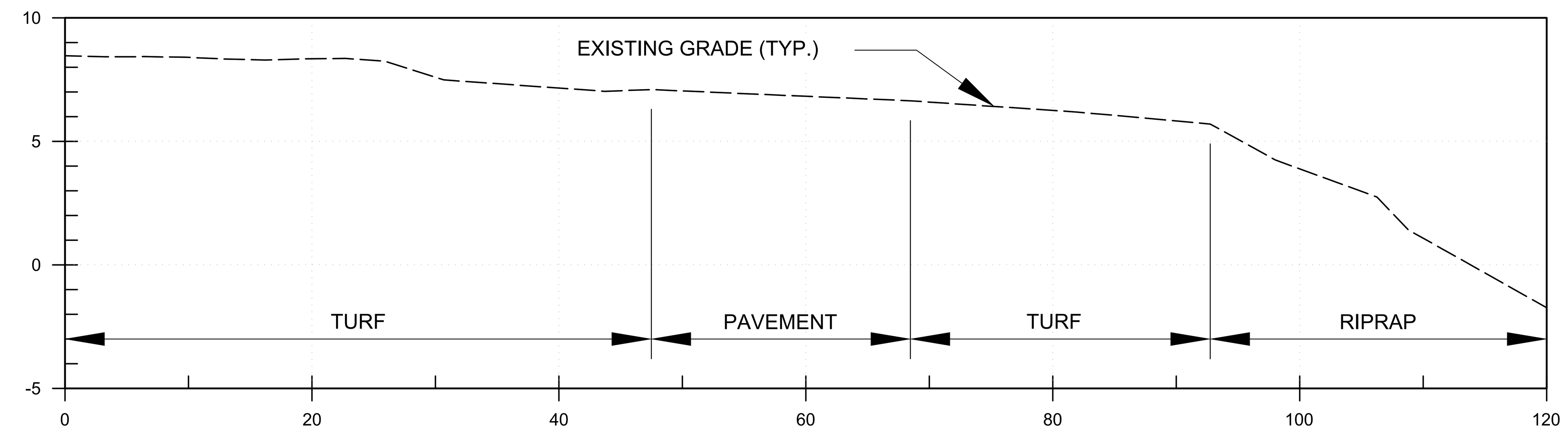
HENRY HUDSON PARK
SHORELINE PROFILE PLAN

SHEET ID

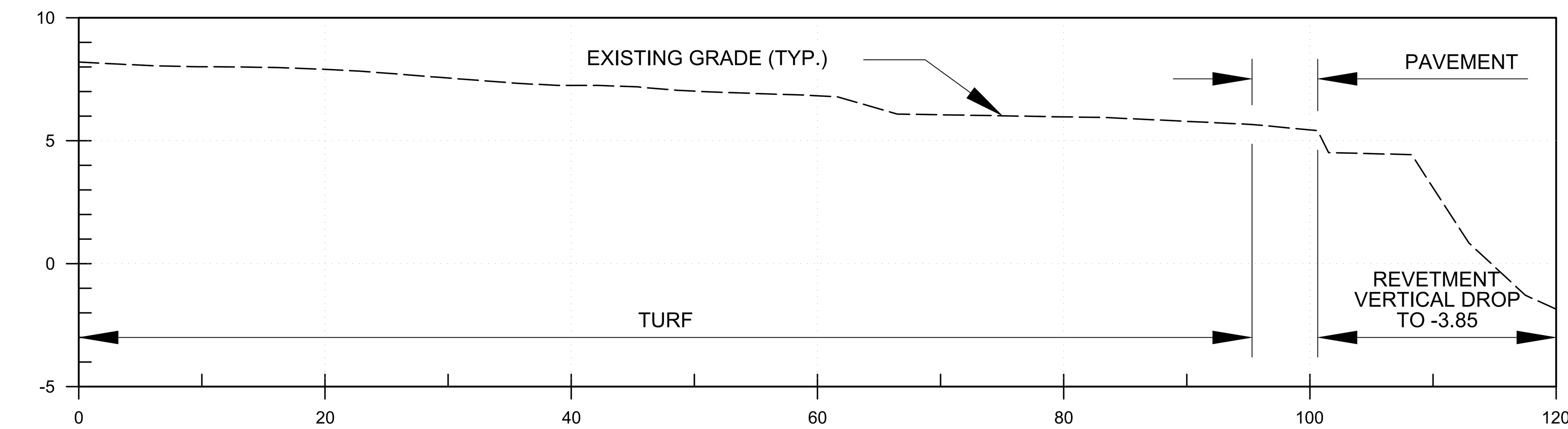
V-101

JUL.2018

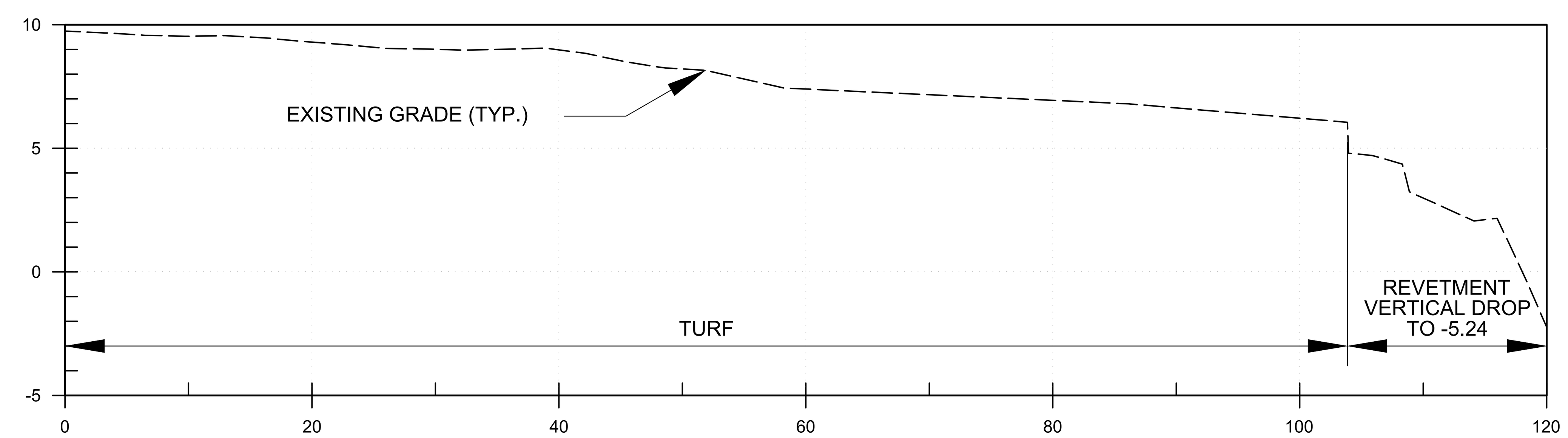
PROFILE HH-1



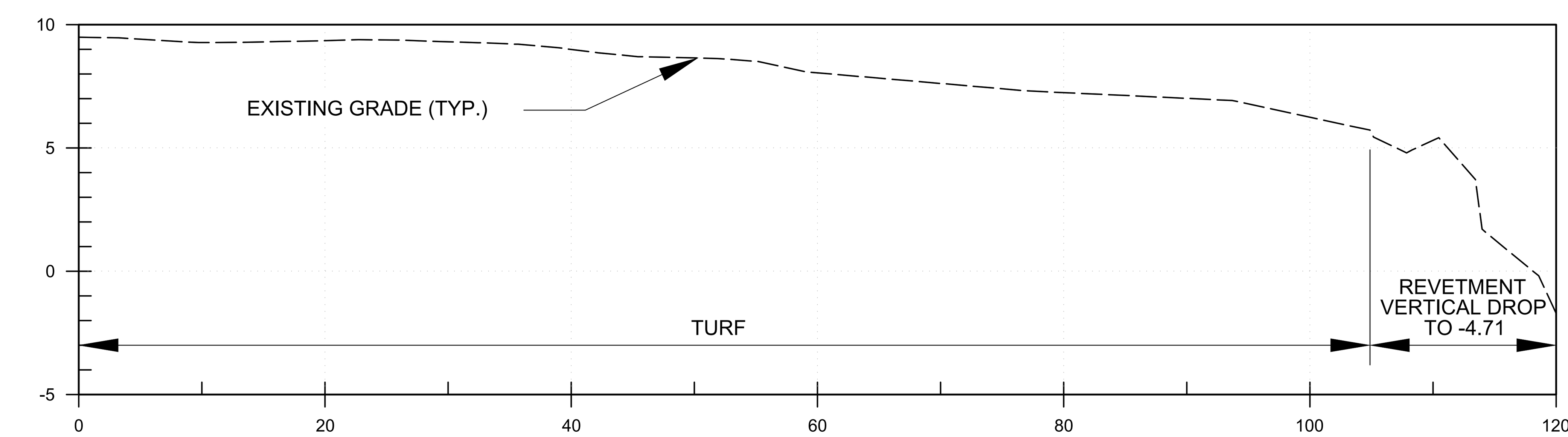
PROFILE HH-2



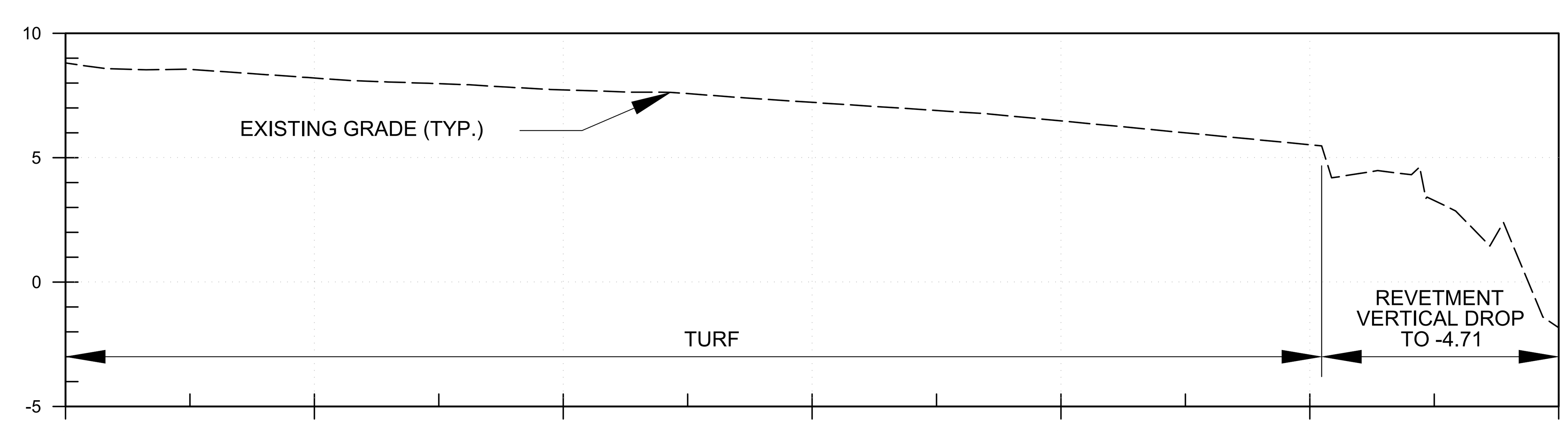
PROFILE HH-3



PROFILE HH-4



PROFILE HH-5



LEGEND

- - - - - - - EXISTING GRADE

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

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

US Army Corps of Engineers®

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HUDSON RIVER HABITAT RESTORATION
HENRY HUDSON PARK
ALBANY COUNTY, NY

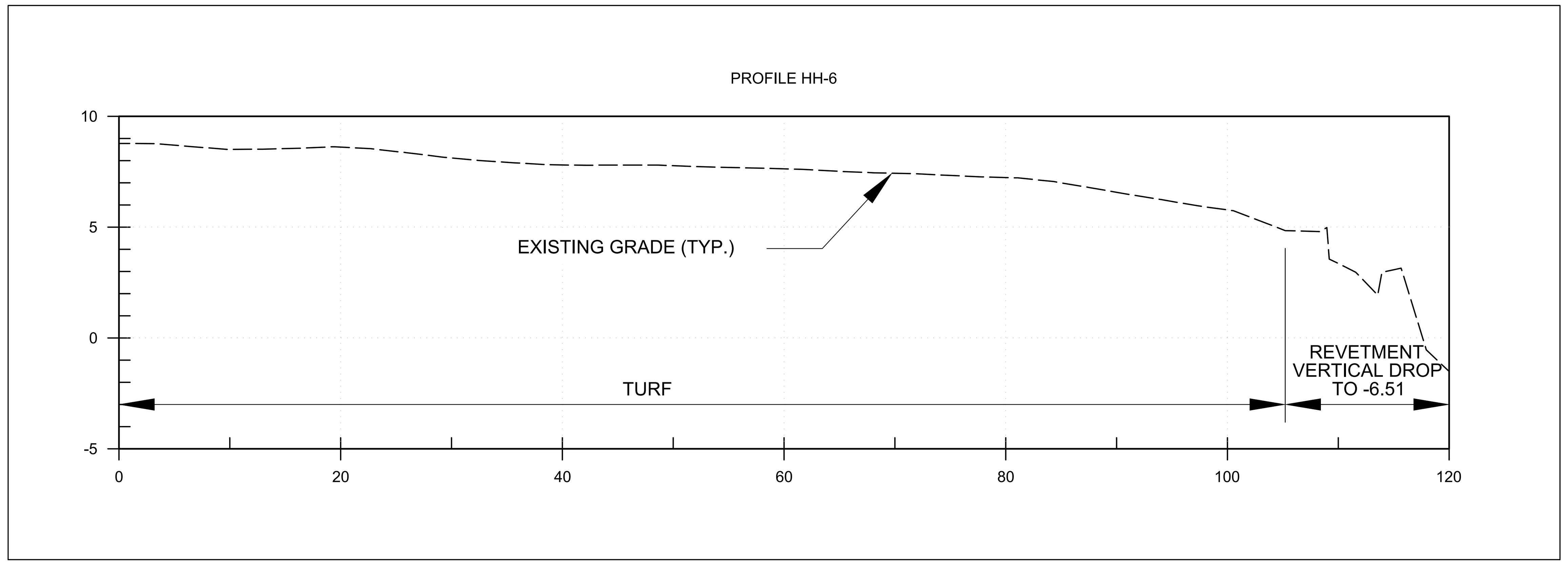
HENRY HUDSON PARK SHORELINE PROFILE SHEET 1

SHEET ID

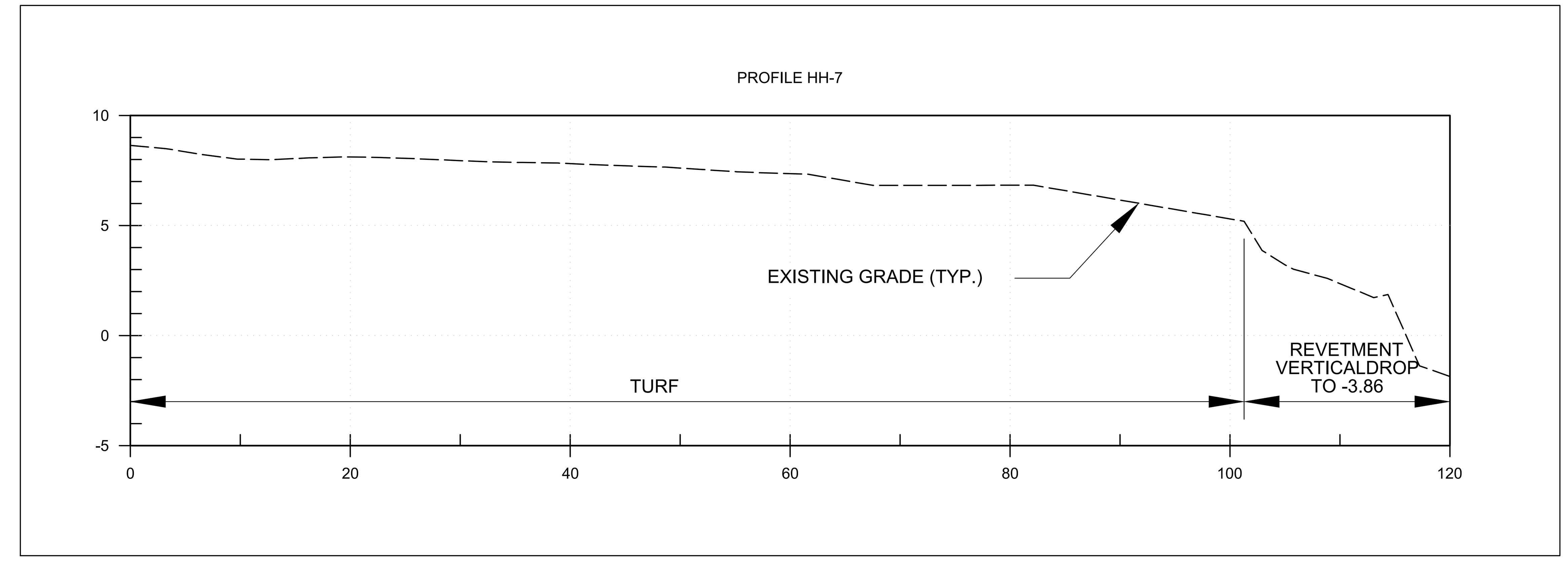
V-301

JUL.2018

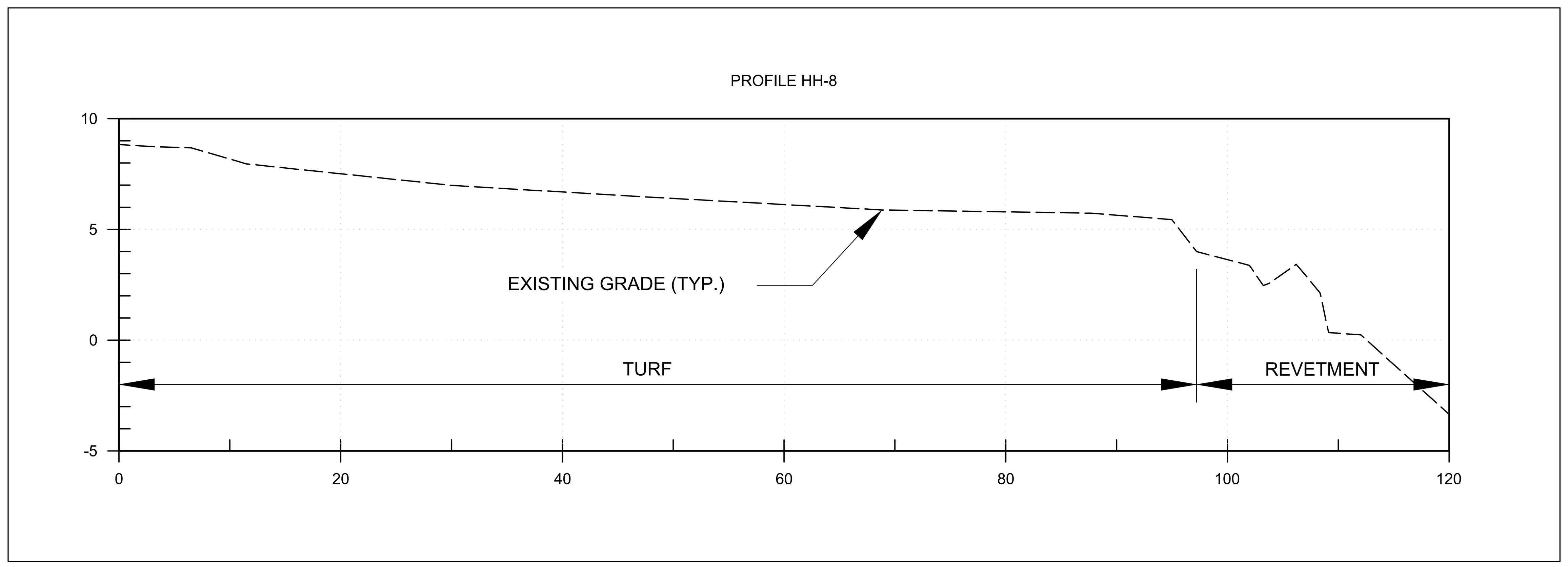
PROFILE HH-6



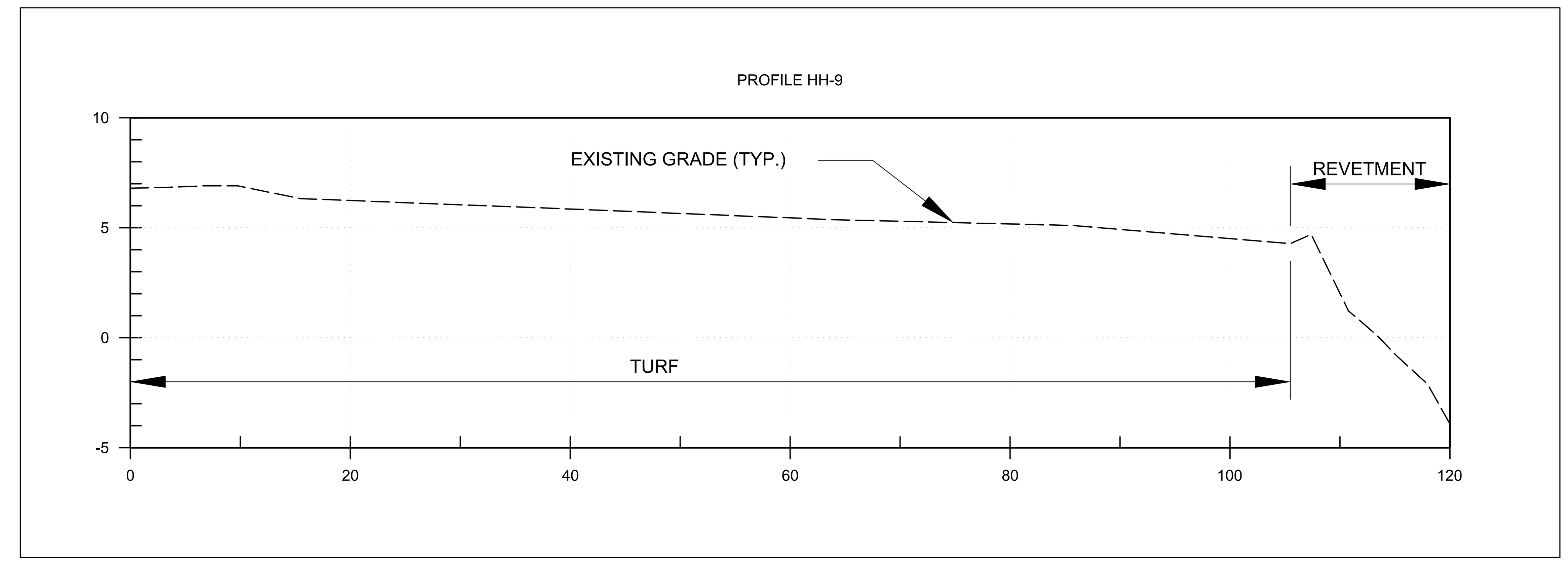
PROFILE HH-7



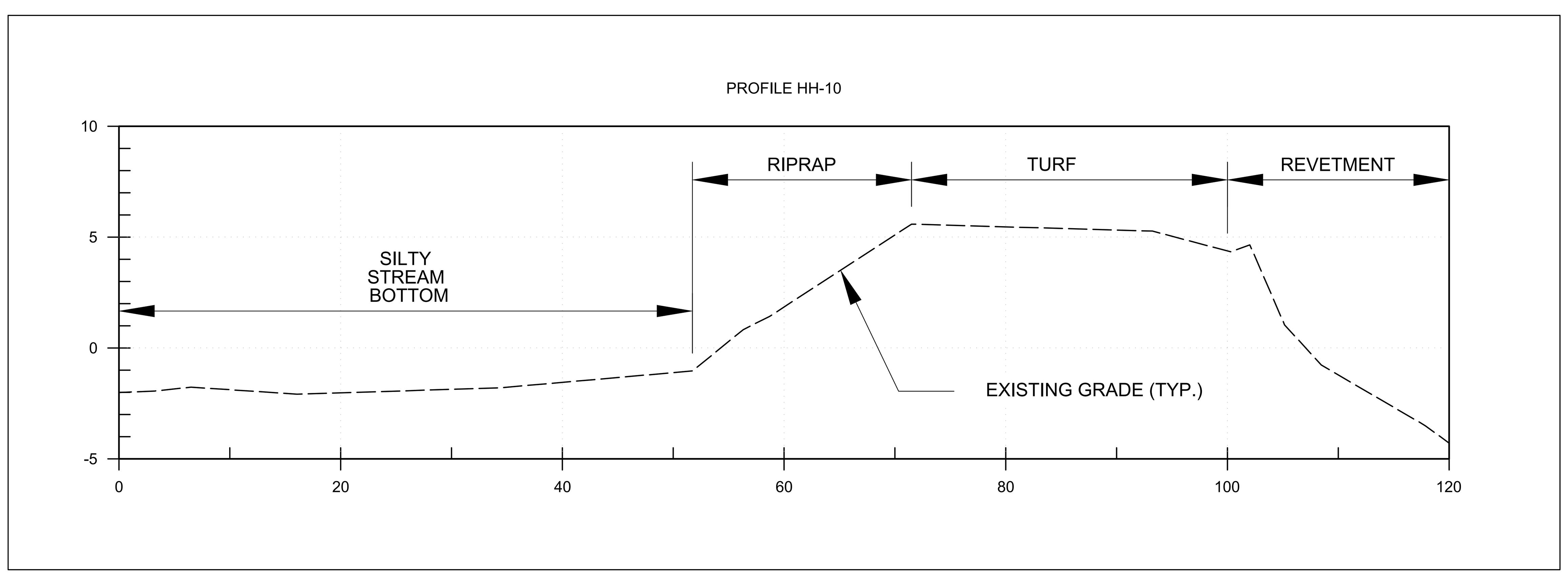
PROFILE HH-8



PROFILE HH-9



PROFILE HH-10



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

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

LEGEND

- - - - - - - EXISTING GRADE

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HENRY HUDSON PARK
ALBANY COUNTY, NY

HENRY HUDSON PARK
SHORELINE PROFILE SHEET 2

SHEET ID
V-302

JUL.2018

LEGEND

MC-AOP1-1 (yellow dashed line)	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:

DRAWN BY: VM

CHECKED BY:

SUBMITTED BY: PRINCETON HYDRO

SIZE: ANSI D

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

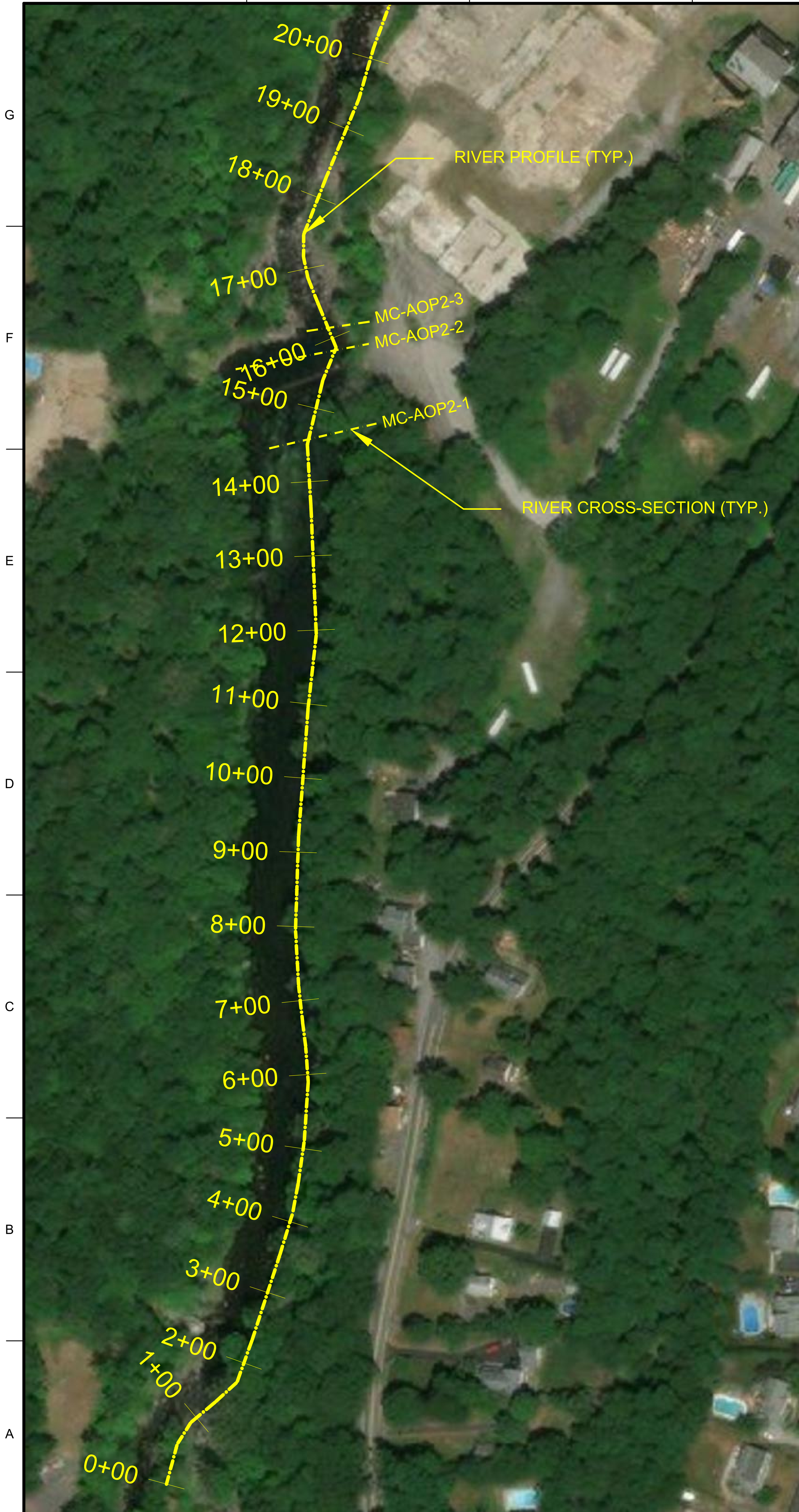
HUDSON RIVER HABITAT RESTORATION
MOODNA CREEK
ORANGE COUNTY, NY

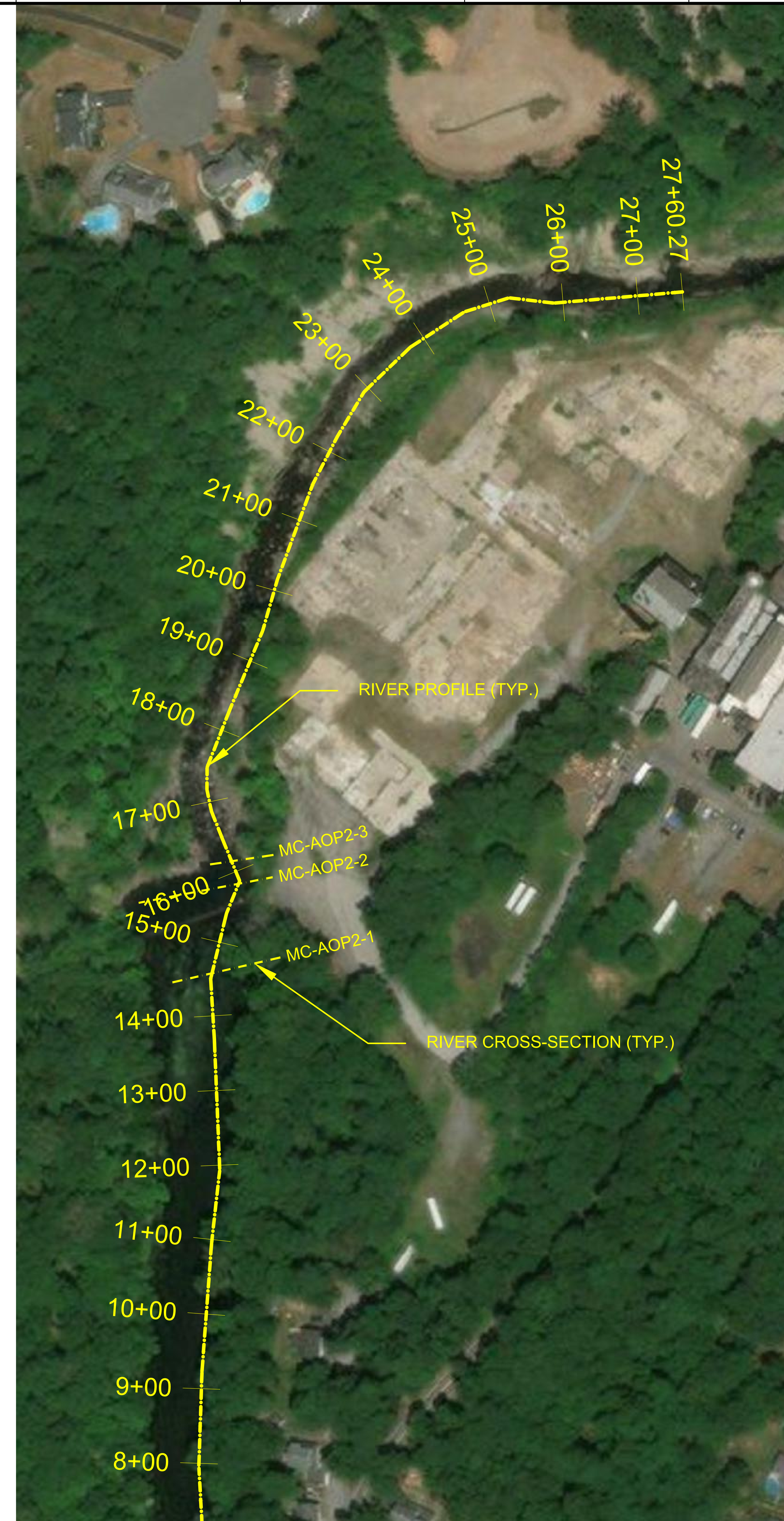
MOODNA CREEK
AOP 1 - UTILITY CROSSING
PROFILE PLAN 1

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'

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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'

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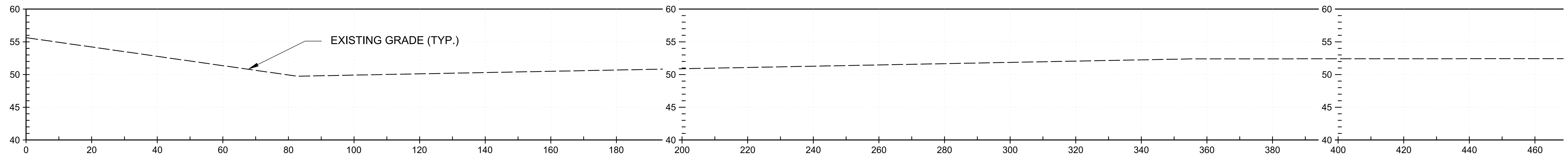
HUDSON RIVER HABITAT RESTORATION
MOODNA CREEK
ORANGE COUNTY, NY

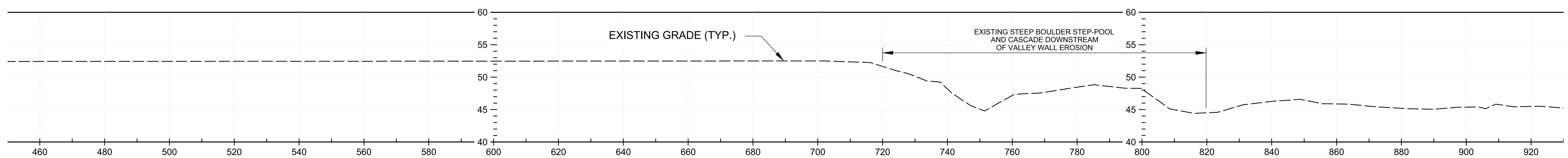
MOODNA CREEK
AOP 3 - ORRS MILL DAM
PROFILE PLAN 1

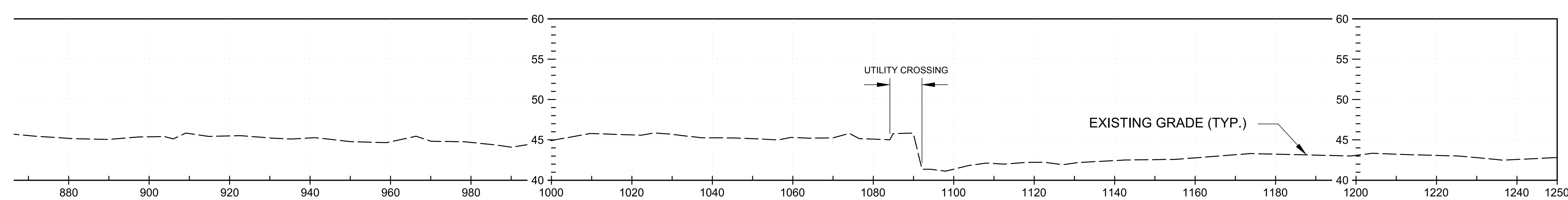
SHEET ID

V-103

JUL.2018







LEGEND

- - - - - - EXISTING GRADE

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

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

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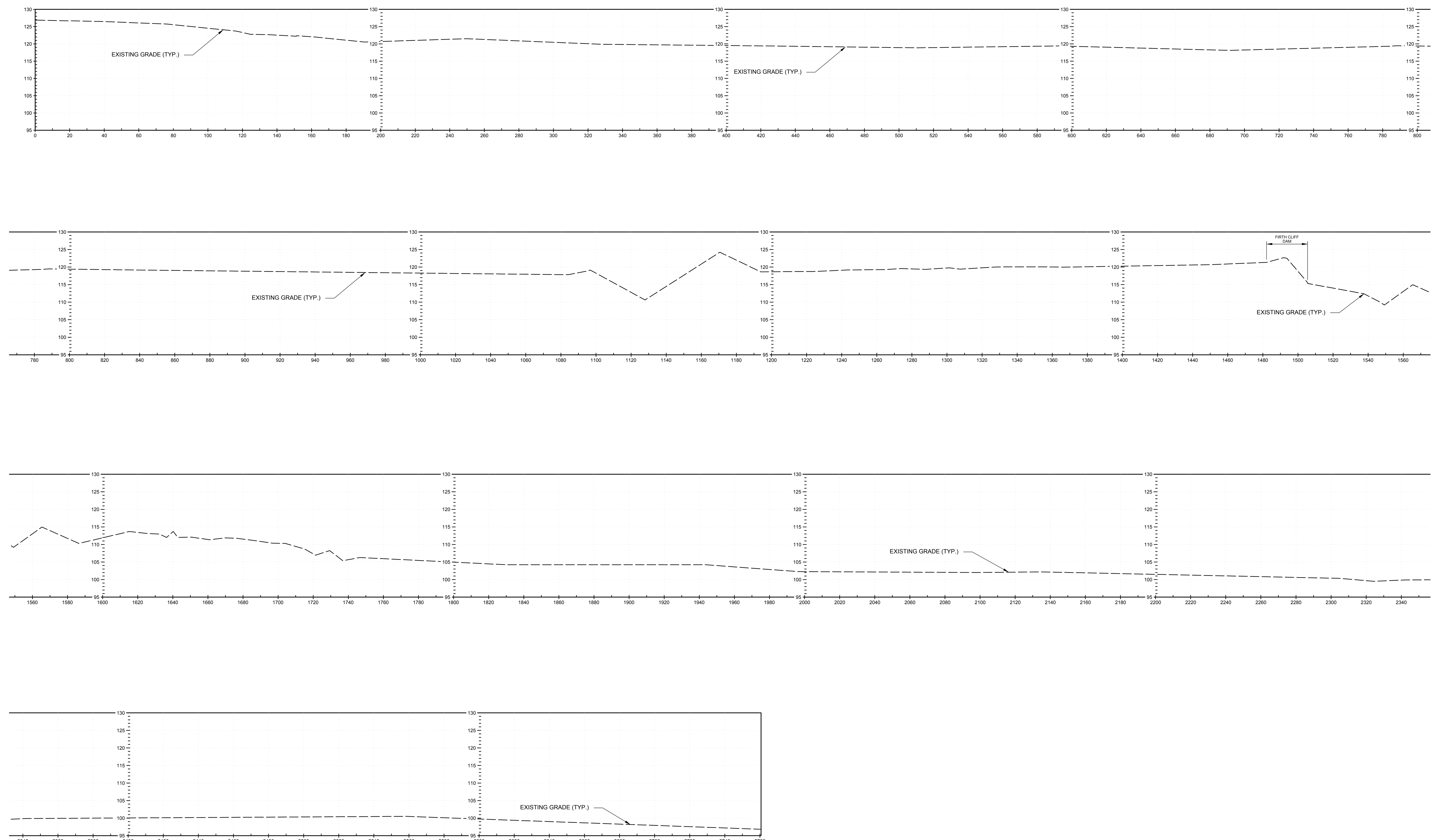
HUDSON RIVER HABITAT RESTORATION
MOODNA CREEK
ORANGE COUNTY, NY

MOODNA CREEK
AOP 1 - UTILITY CROSSING
PROFILE SHEET 1

SHEET ID
V-201

JUL.2018



LEGEND

EXISTING GRADE

0 7.5 15 30 45 60 FEET
VERT. SCALE: 1" = 15'

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

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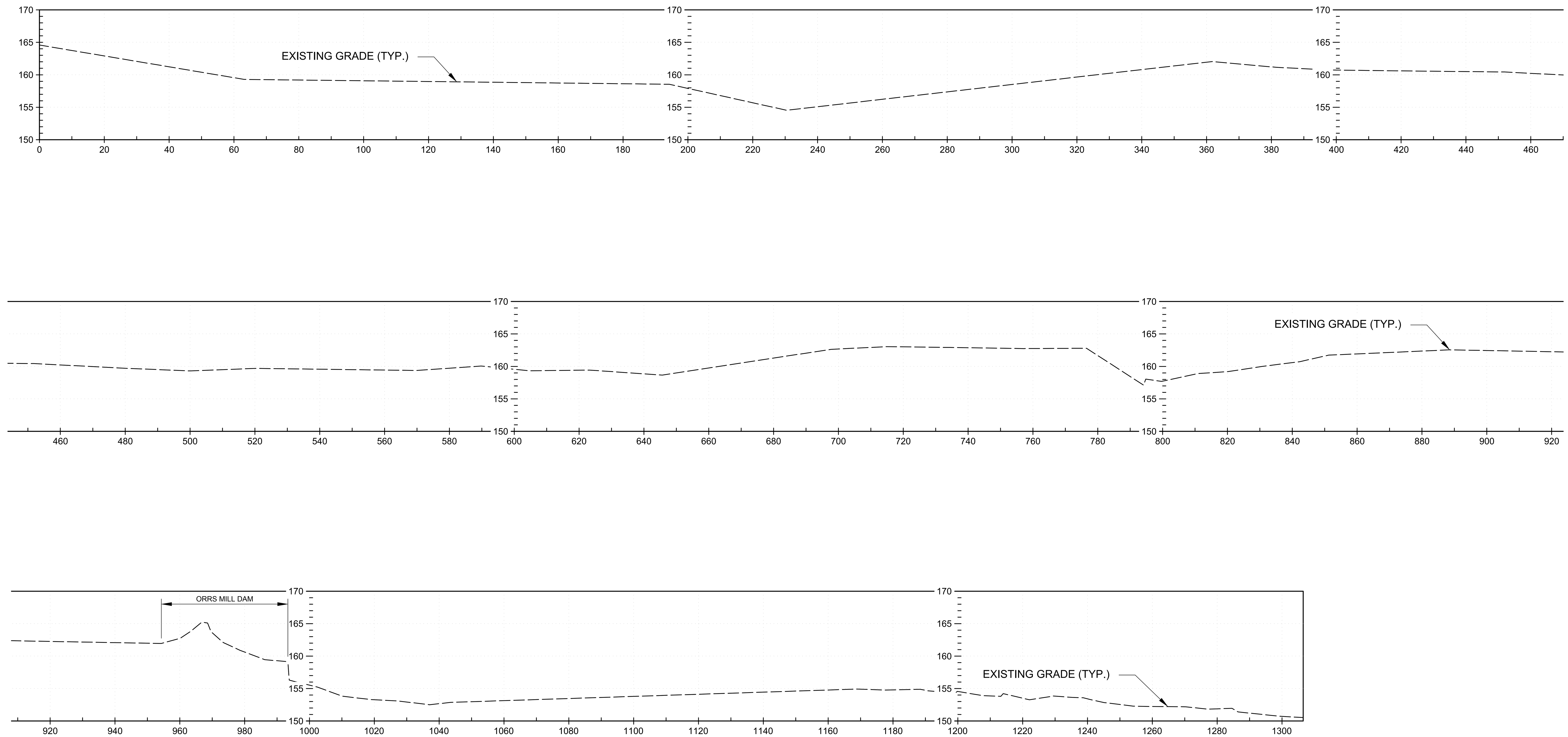
HUDSON RIVER HABITAT RESTORATION
MOODNA CREEK
ORANGE COUNTY, NY

MOODNA CREEK
AOP 2 - FIRTH CLIFF DAM
PROFILE SHEET 2

SHEET ID
V-202

JUL.2018



LEGEND

– – – – – EXISTING GRADE

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

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

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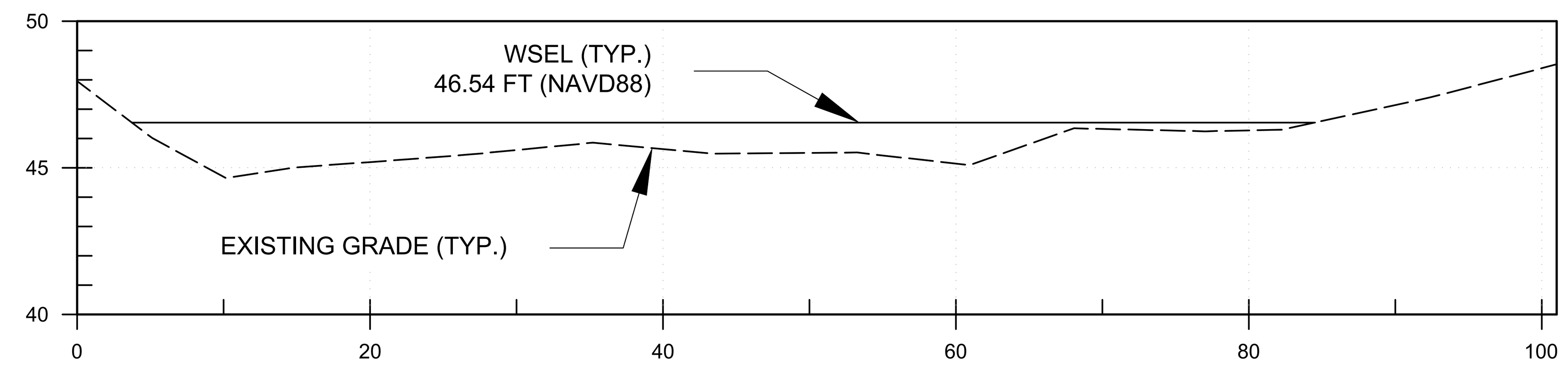
HUDSON RIVER HABITAT RESTORATION
MOODNA CREEK
ORANGE COUNTY, NY

MOODNA CREEK
AOP 3 - ORRS MILL DAM
PROFILE SHEET 3

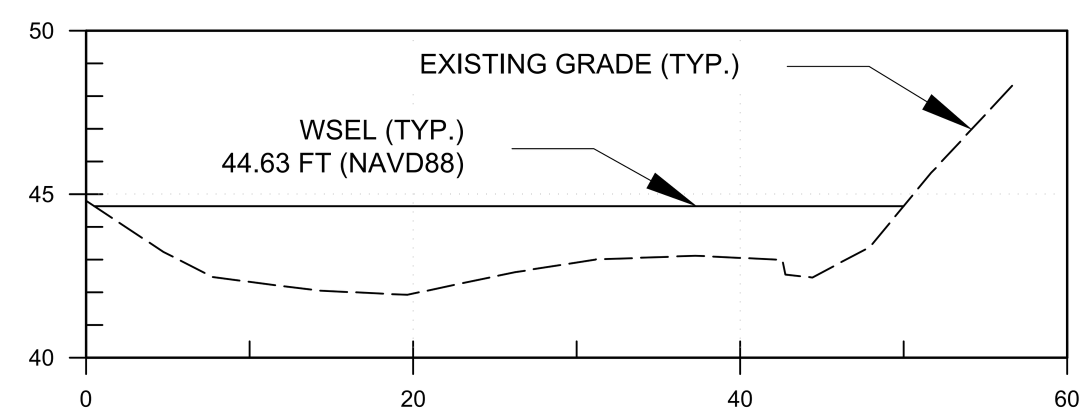
SHEET ID
V-203

JUL.2018

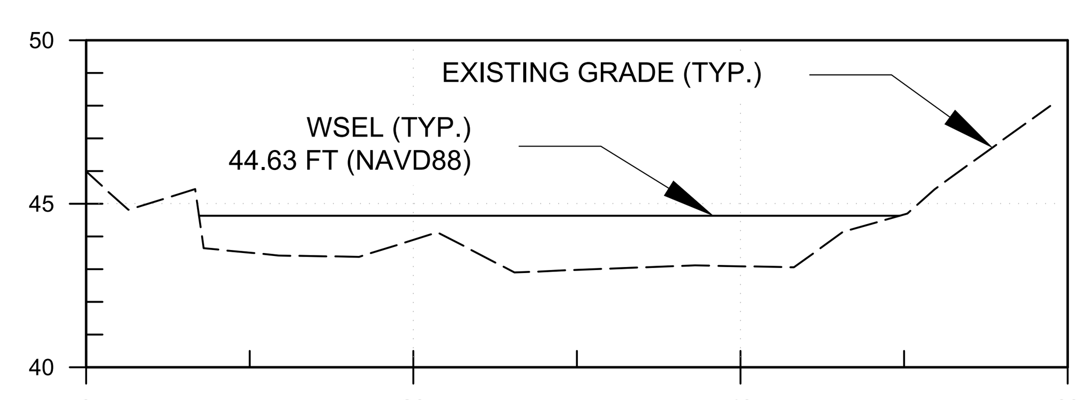
SECTION MC-AOP1-1



SECTION MC-AOP1-2



SECTION MC-AOP1-3



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

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

LEGEND

- - - - - - - EXISTING GRADE

——— WATER SURFACE ELEVATION (WSEL)

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

ISSUE DATE: MAY 2018
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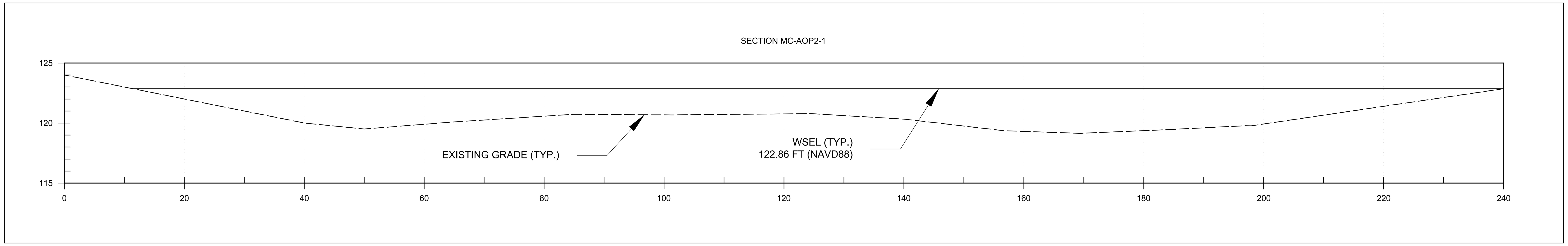
HUDSON RIVER HABITAT RESTORATION
MOODNA CREEK
ORANGE COUNTY, NY

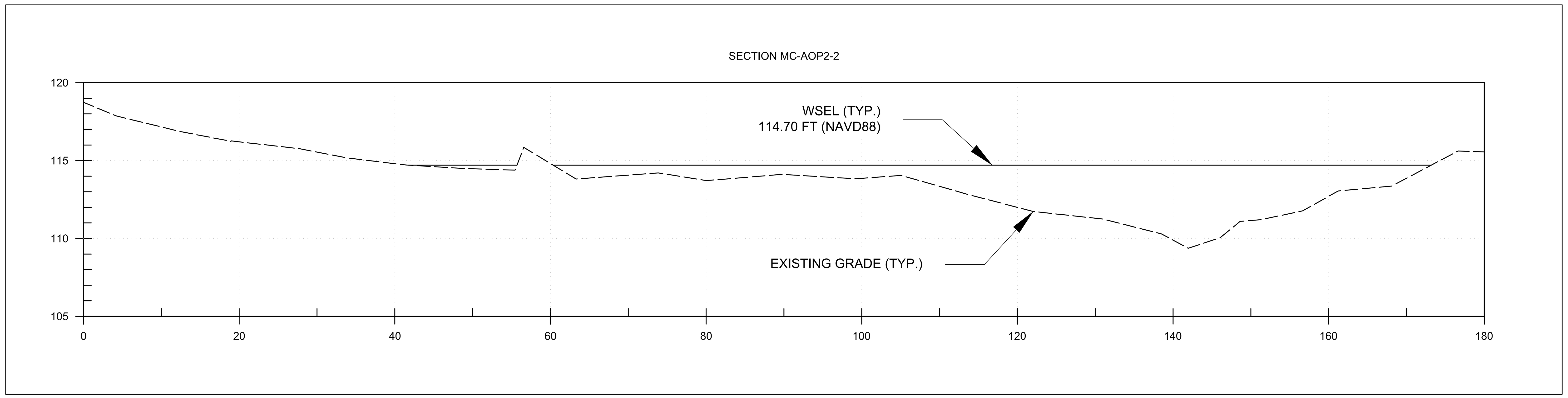
MOODNA CREEK
AOP 1 - UTILITY CROSSING
CROSS SECTION SHEET 1

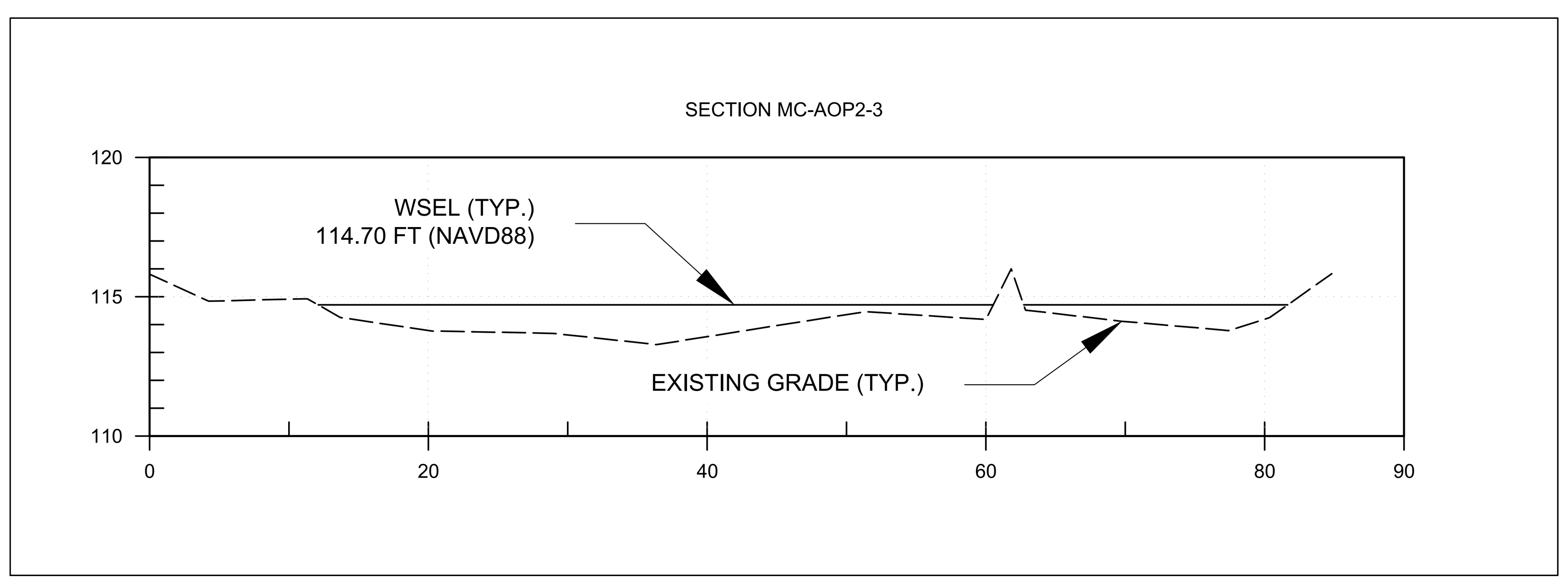
SHEET ID

V-301

JUL.2018







VERT. SCALE: 1" = 5' (FEET)

HORIZ. SCALE: 1" = 10' (FEET)

LEGEND

- - - - - EXISTING GRADE

——— WATER SURFACE ELEVATION (WSEL)

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

ISSUE DATE: MAY 2018
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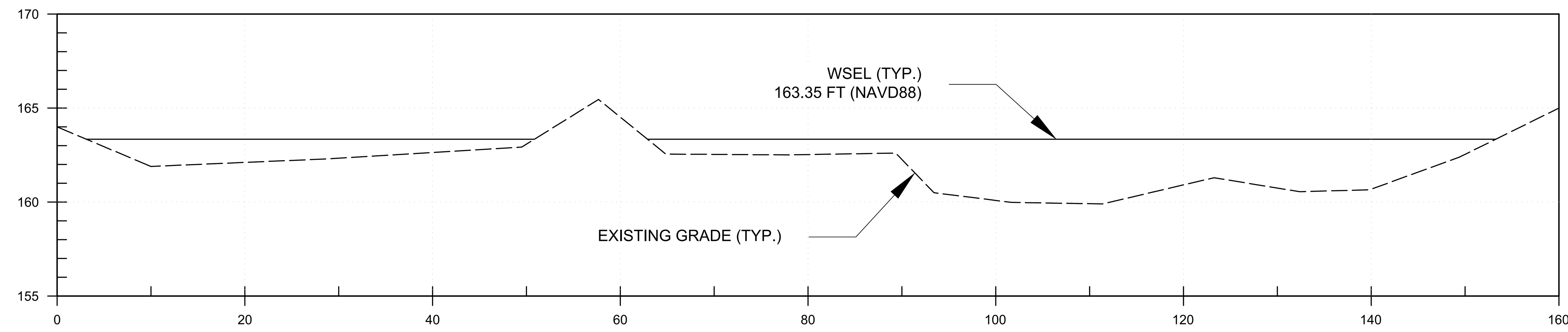
HUDSON RIVER HABITAT RESTORATION
MOODNA CREEK
ORANGE COUNTY, NY

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

SHEET ID
V-302

JUL.2018

SECTION MC-AOP3-1



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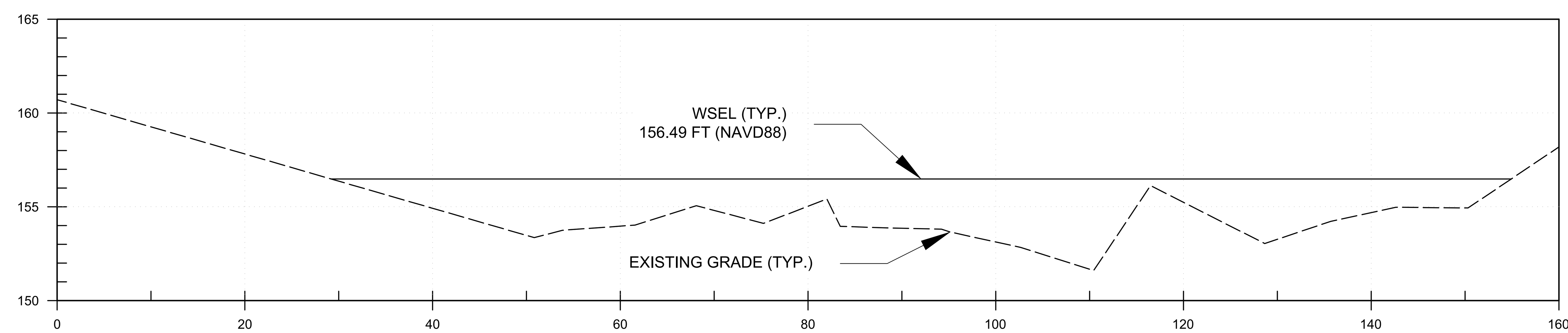

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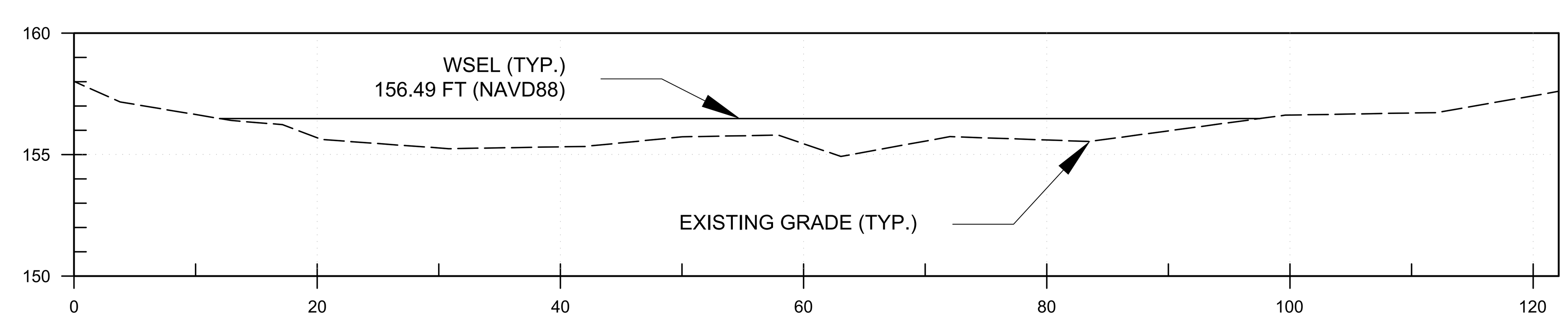

VERT. SCALE: 1" = 5'

HORIZ. SCALE: 1" = 10'

LEGEND

- - - - - - EXISTING GRADE

——— WATER SURFACE ELEVATION (WSEL)

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
CROSS SECTION SHEET 3

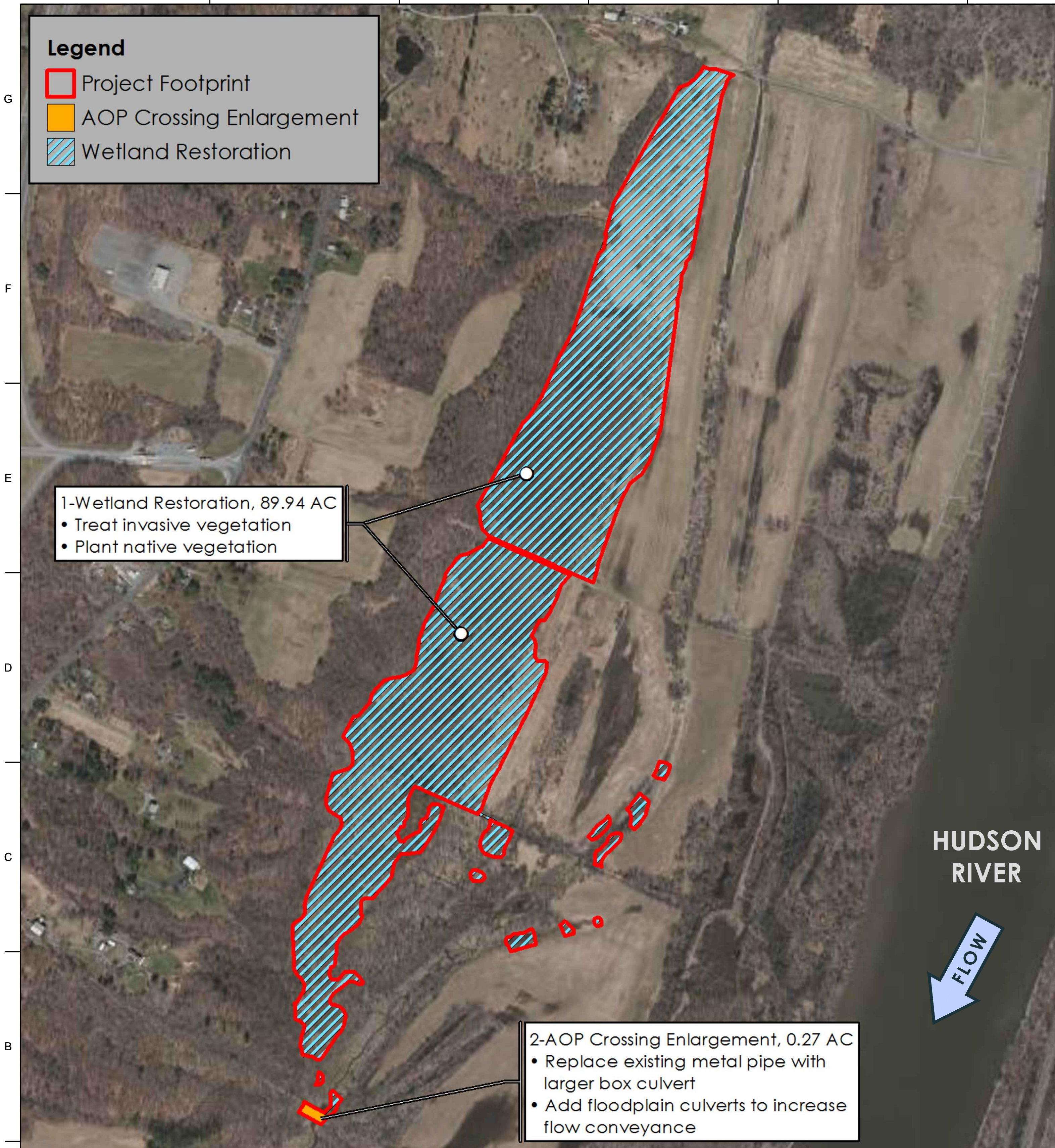
SHEET ID

V-303

JUL.2018

ATTACHMENT B

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

US Army Corps of Engineers®

MARK | DESCRIPTION | DATE

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ISSUE DATE: MAY 2018
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U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT
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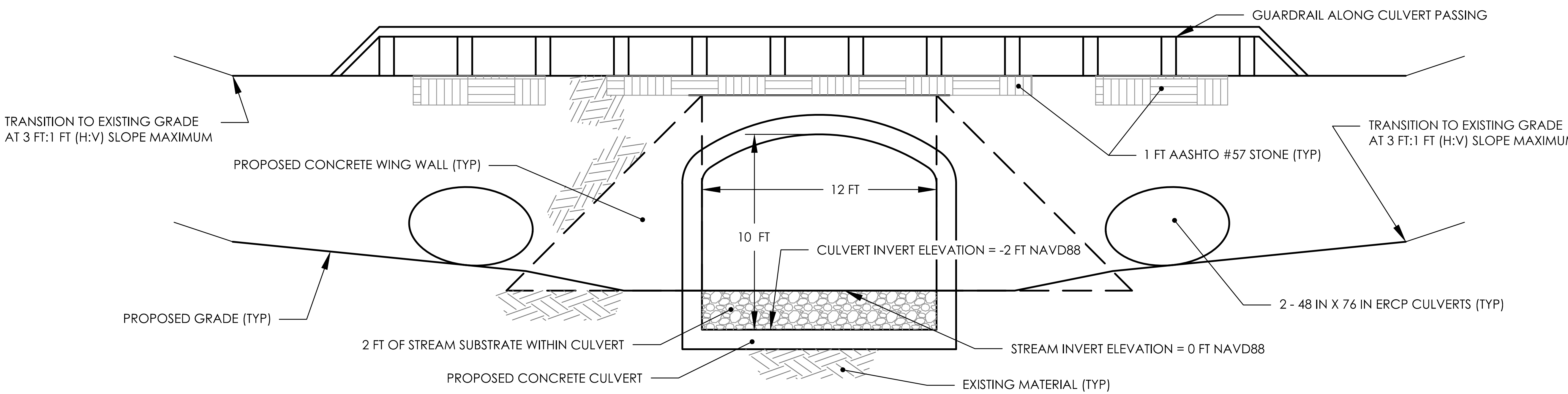
HUDSON RIVER HABITAT RESTORATION
BINNEN KILL
ALBANY COUNTY, NY

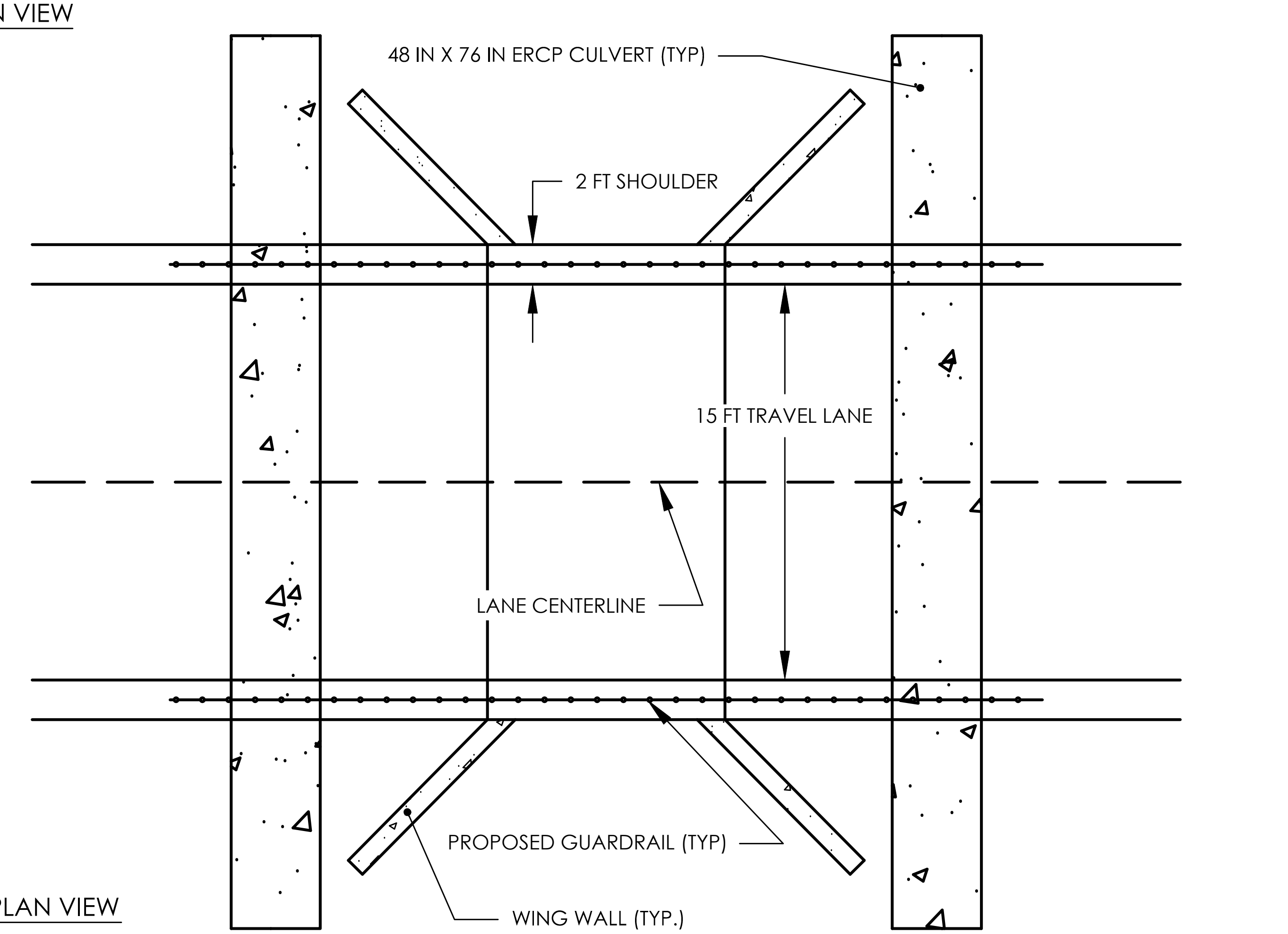
BINNEN KILL NORTH ALTERNATIVE 1
SITE LOCATION

SHEET ID
1

OCT.2018



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



B AOP #2 - ENLARGE CROSSING - PLAN VIEW
NORTH - ALTERNATIVE 1
BINNEN KILL

US Army Corps of Engineers

MARK	DESCRIPTION	DATE

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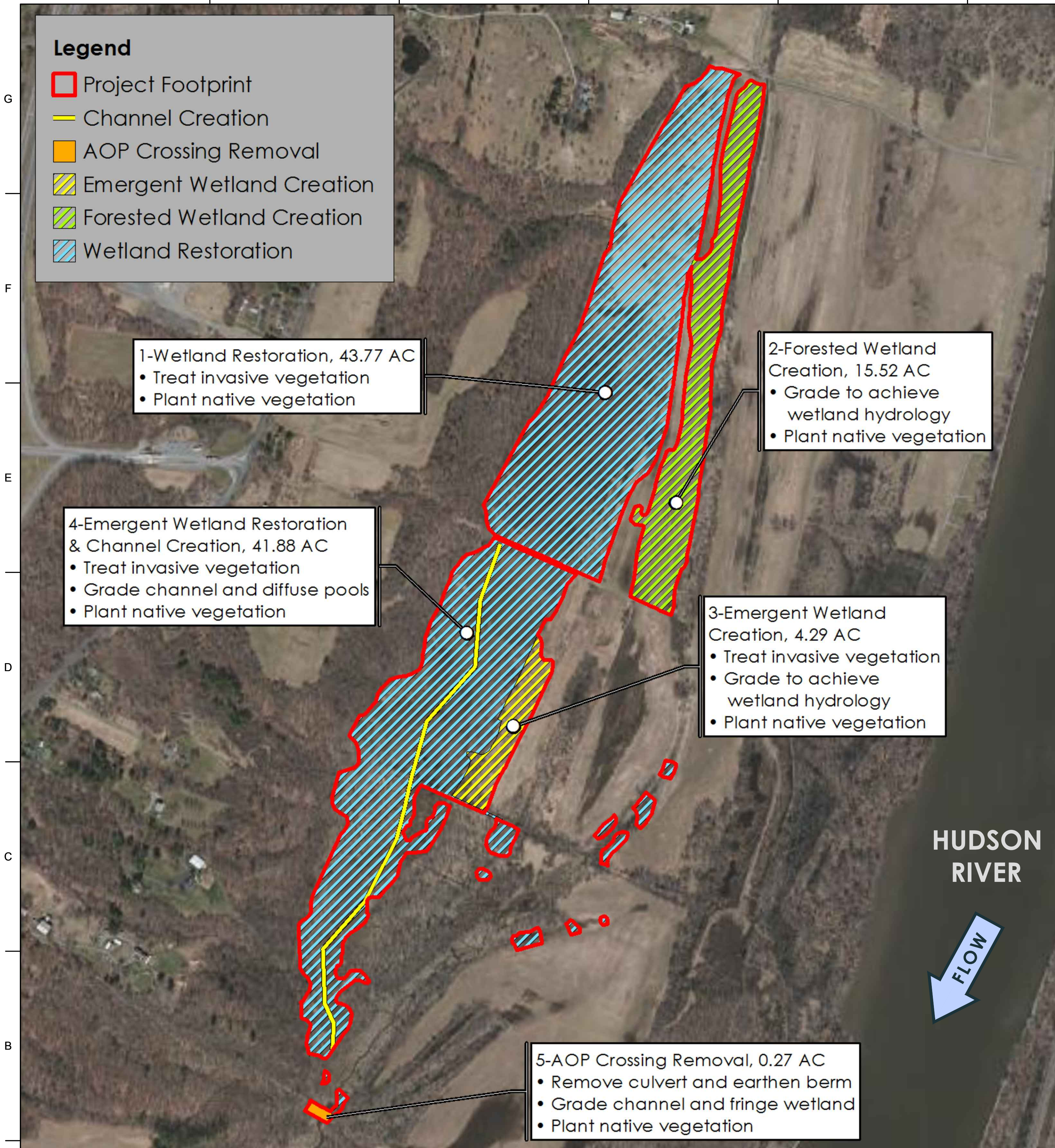
HUDSON RIVER HABITAT RESTORATION
BINNEN KILL
ALBANY COUNTY, NY

BINNEN KILL NORTH ALTERNATIVE 1
DETAILS

SHEET ID
2

OCT.2018



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

US Army Corps of Engineers®

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NEW YORK DISTRICT
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NEW YORK, NEW YORK, 10278

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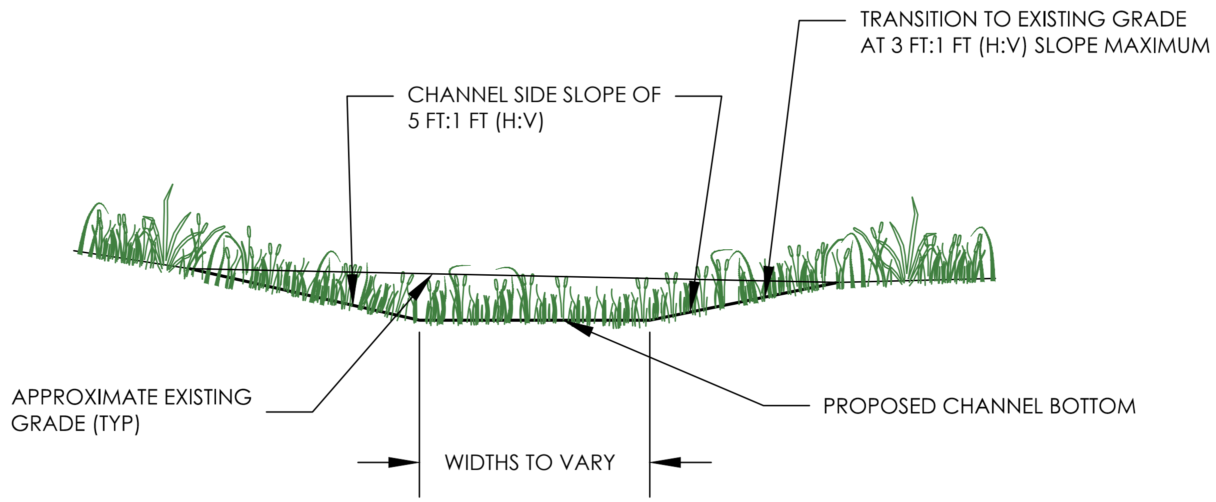
1108 OLD YORK ROAD
RINGOES, NEW JERSEY, 08551

HUDSON RIVER HABITAT RESTORATION
BINNEN KILL
ALBANY COUNTY, NY

BINNEN KILL NORTH ALTERNATIVE 2
SITE LOCATION

SHEET ID
1

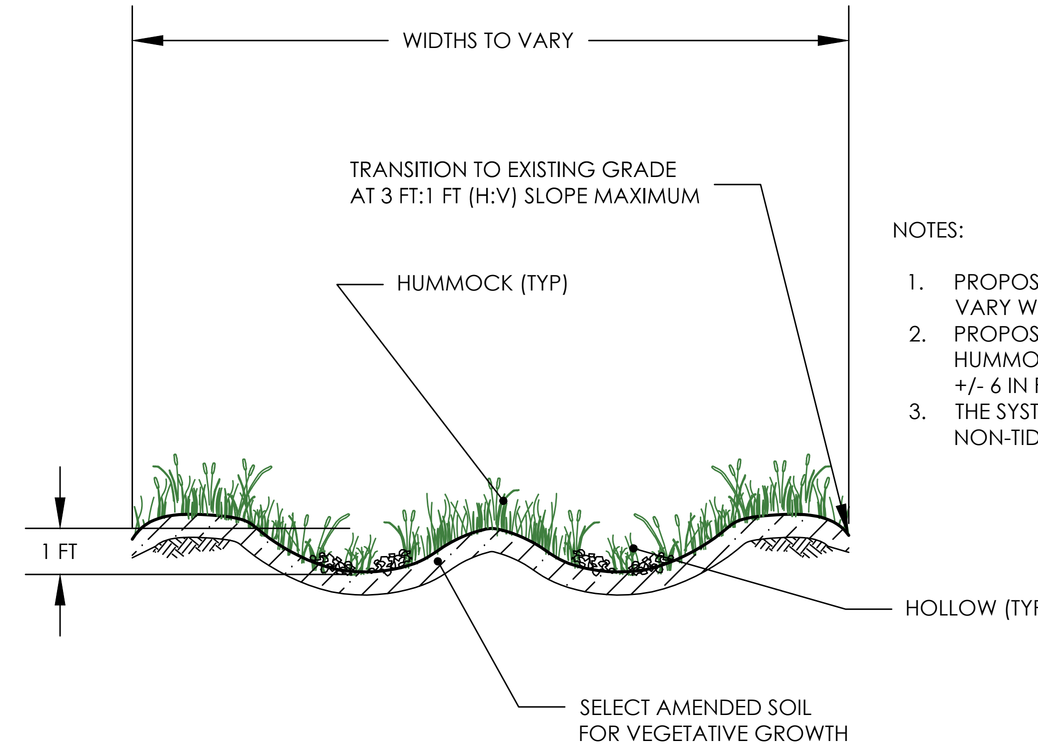
OCT.2018



A CHANNEL CREATION
NORTH - ALTERNATIVE 2
BINNEN KILL

NOTES:

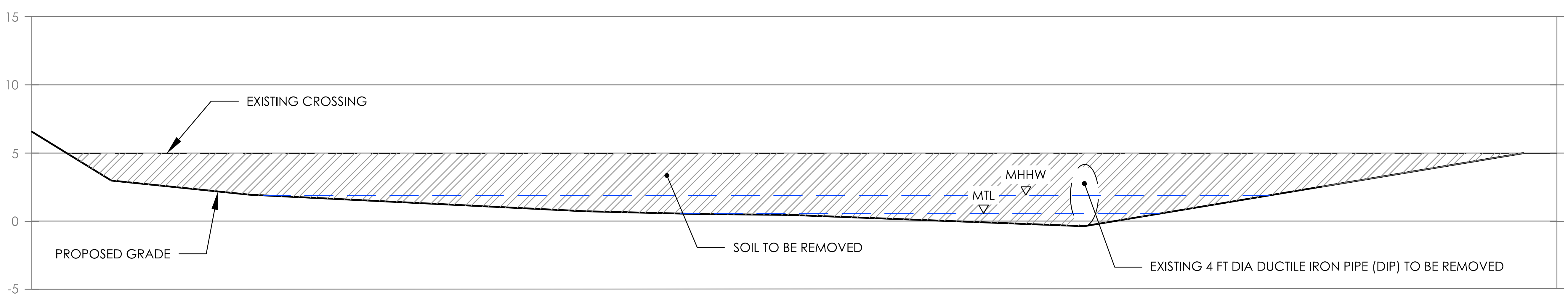
1. CHANNEL TO BE STABILIZED WITH MATTING AND VEGETATION



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

US Army Corps of Engineers®

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NEW YORK DISTRICT
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NEW YORK, NEW YORK, 10278

PRINCETON HYDRO, LLC
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RINGOES, NEW JERSEY, 08551

HUDSON RIVER HABITAT RESTORATION
BINNEN KILL
ALBANY COUNTY, NY

BINNEN KILL NORTH ALTERNATIVE 2
DETAILS

SHEET ID
2

OCT.2018

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

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

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-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

A SCHEDULE OF QUANTITIES
South - Alternative 1

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

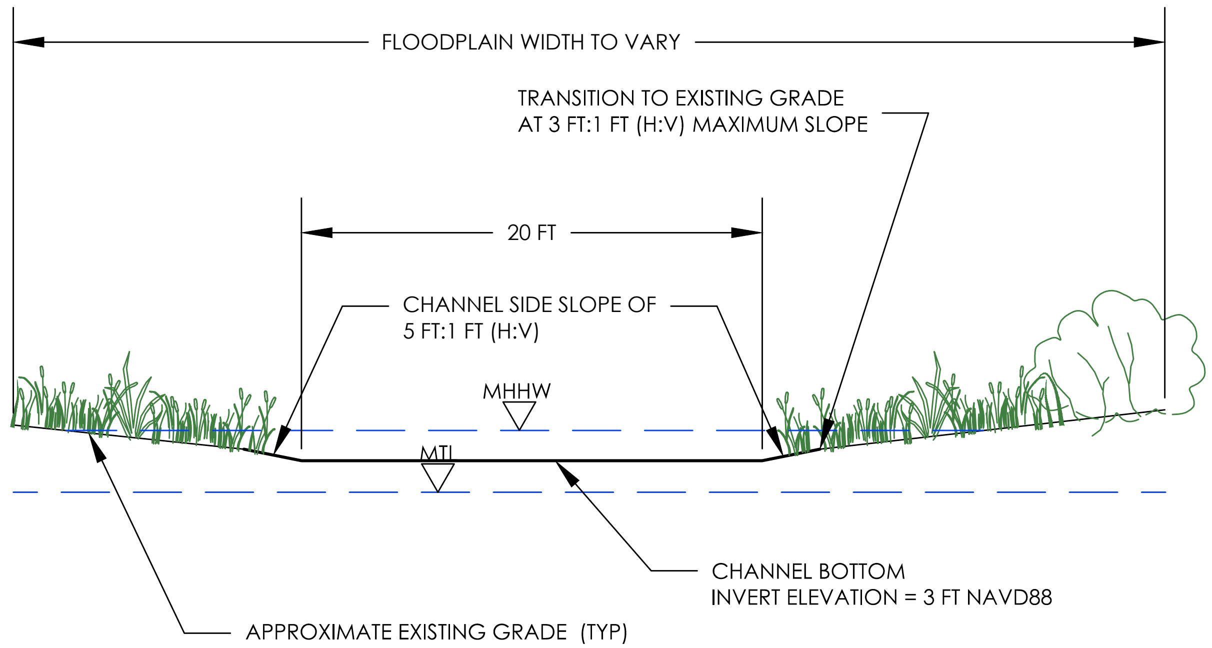
PRINCETON HYDRO, LLC
1108 OLD YORK ROAD
RINGOES, NEW JERSEY, 08551

HUDSON RIVER HABITAT RESTORATION
BINNEN KILL
ALBANY COUNTY, NY

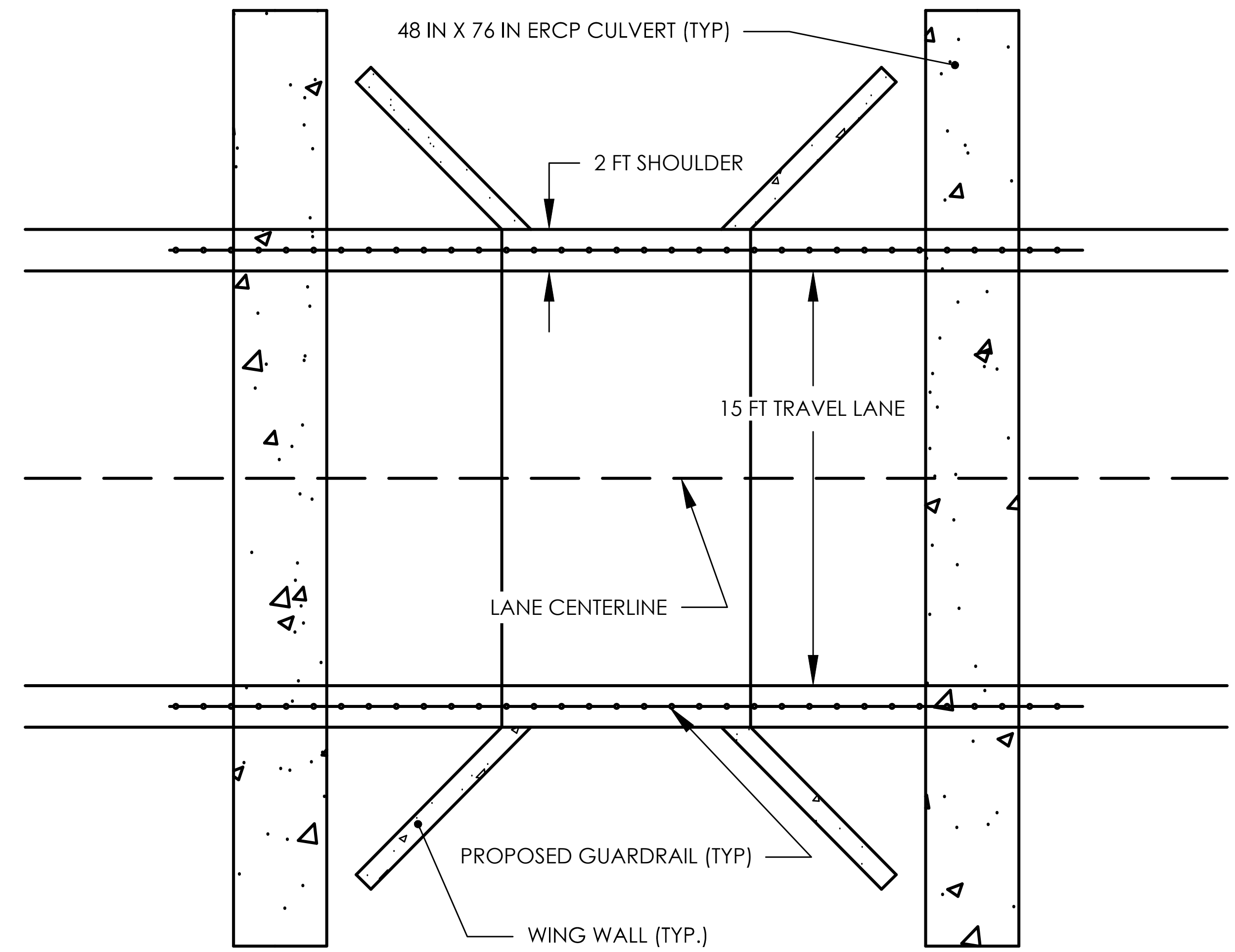
BINNEN KILL SOUTH ALTERNATIVE 1
SITE LOCATION

SHEET ID
1

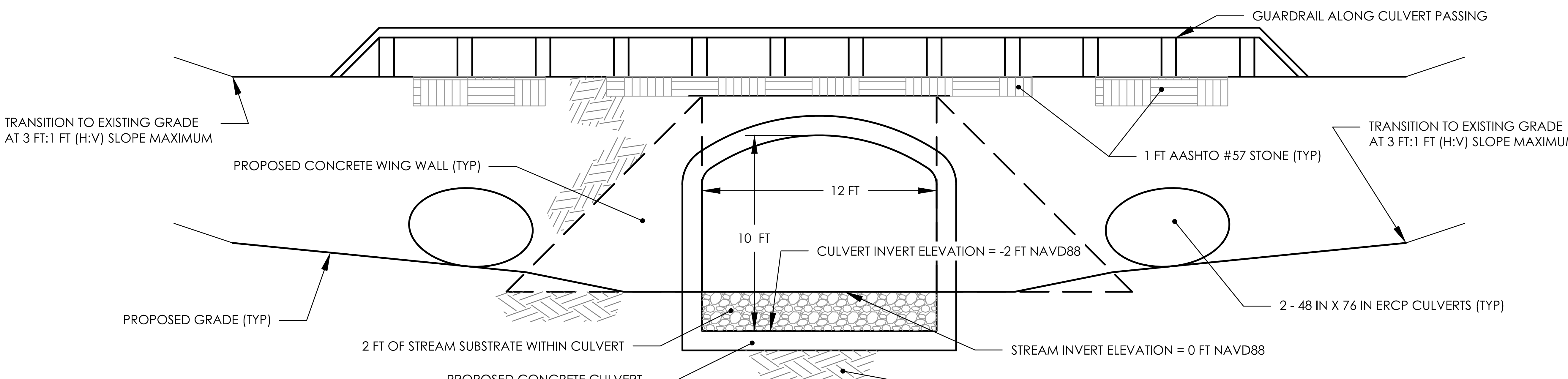
OCT.2018



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

US Army Corps of Engineers

MARK	DESCRIPTION	DATE

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NEW YORK DISTRICT
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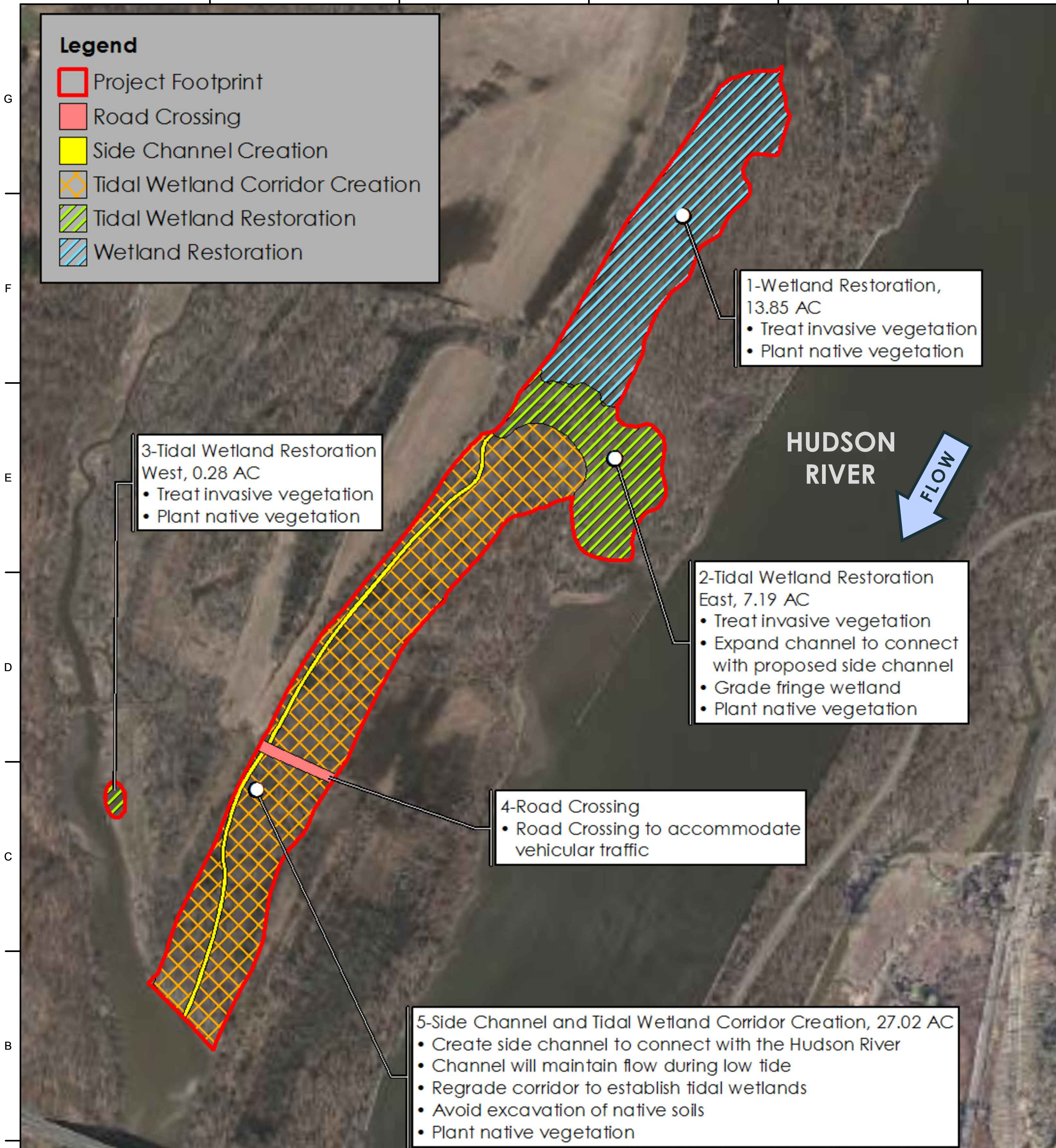
HUDSON RIVER HABITAT RESTORATION
BINNEN KILL
ALBANY COUNTY, NY

BINNEN KILL SOUTH ALTERNATIVE 1
DETAILS

SHEET ID
2

OCT.2018



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

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

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-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

A SCHEDULE OF QUANTITIES
South - Alternative 2

US Army Corps of Engineers®

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NEW YORK DISTRICT
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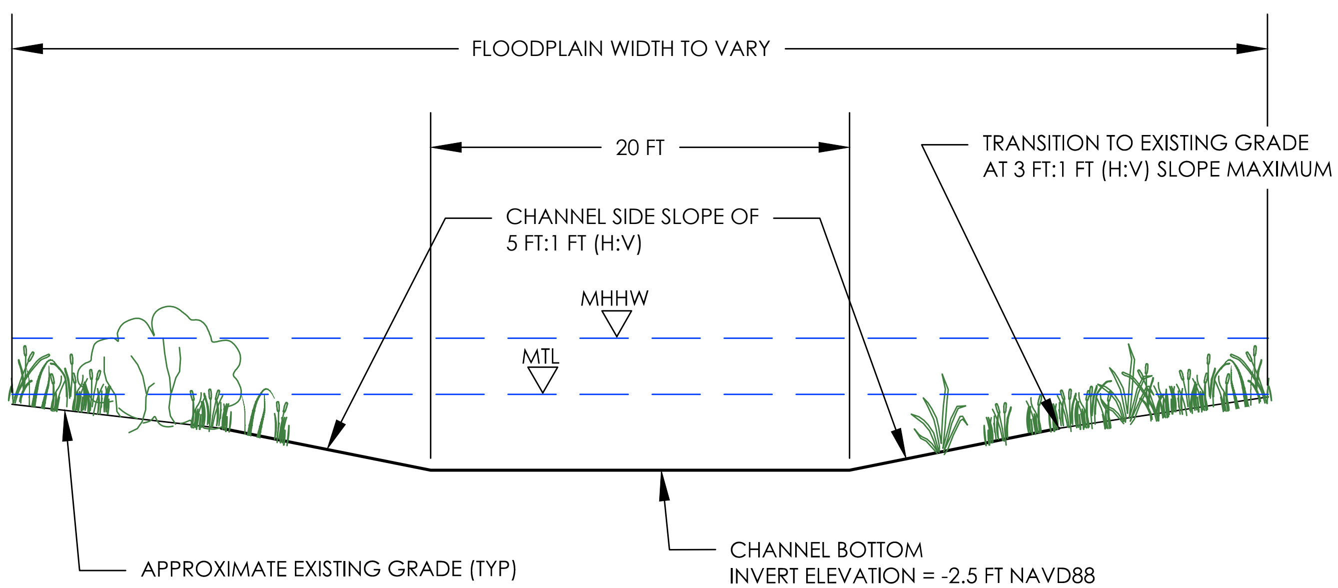
HUDSON RIVER HABITAT RESTORATION
BINNEN KILL
ALBANY COUNTY, NY

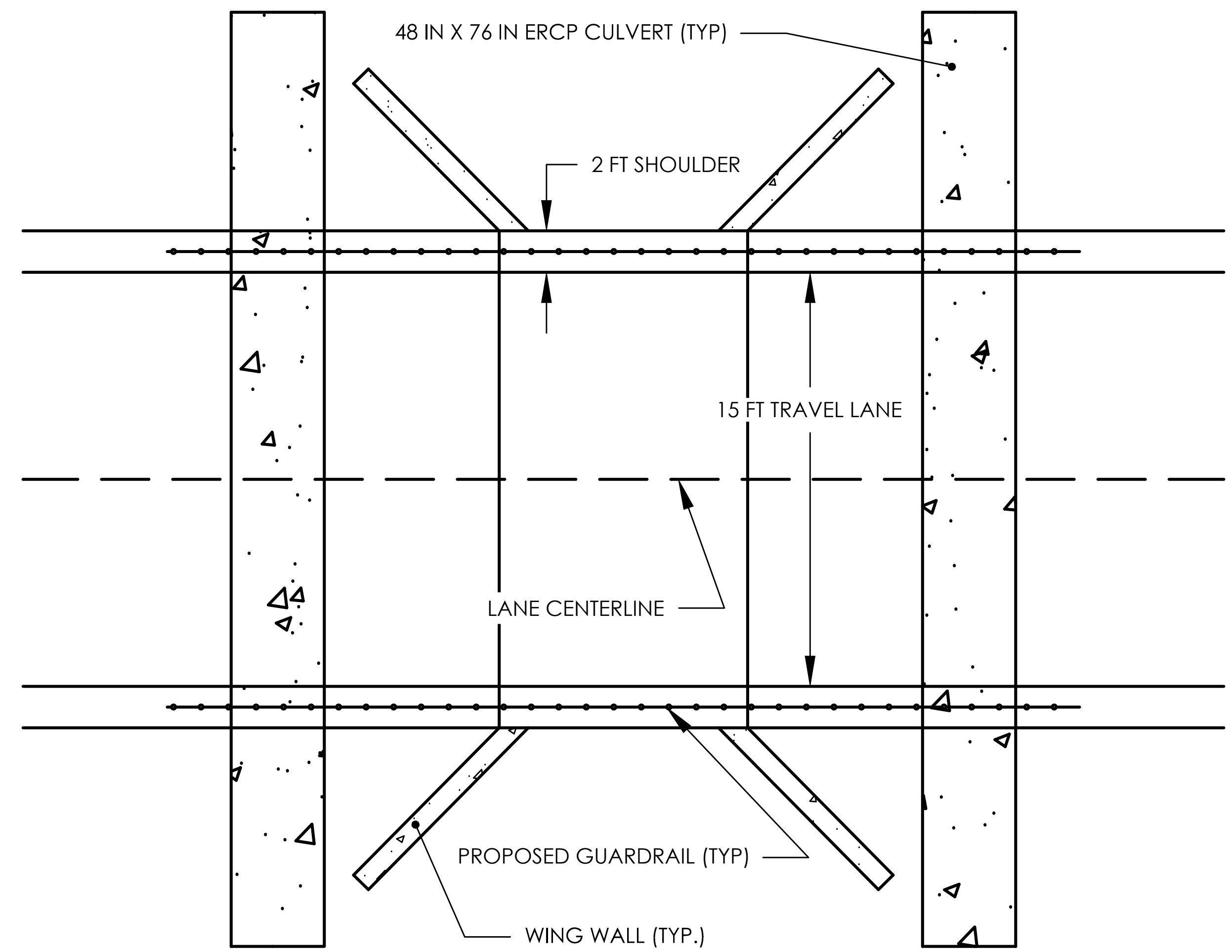
BINNEN KILL SOUTH ALTERNATIVE 2
SITE LOCATION

SHEET ID
1

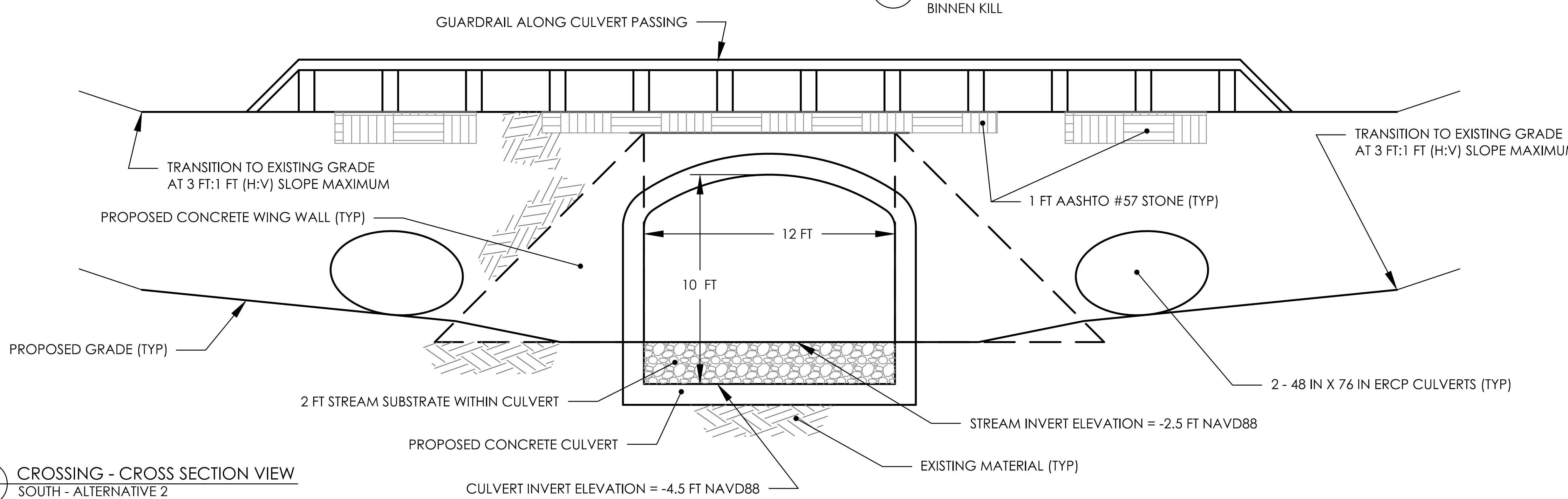
OCT.2018



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

US Army Corps of Engineers®

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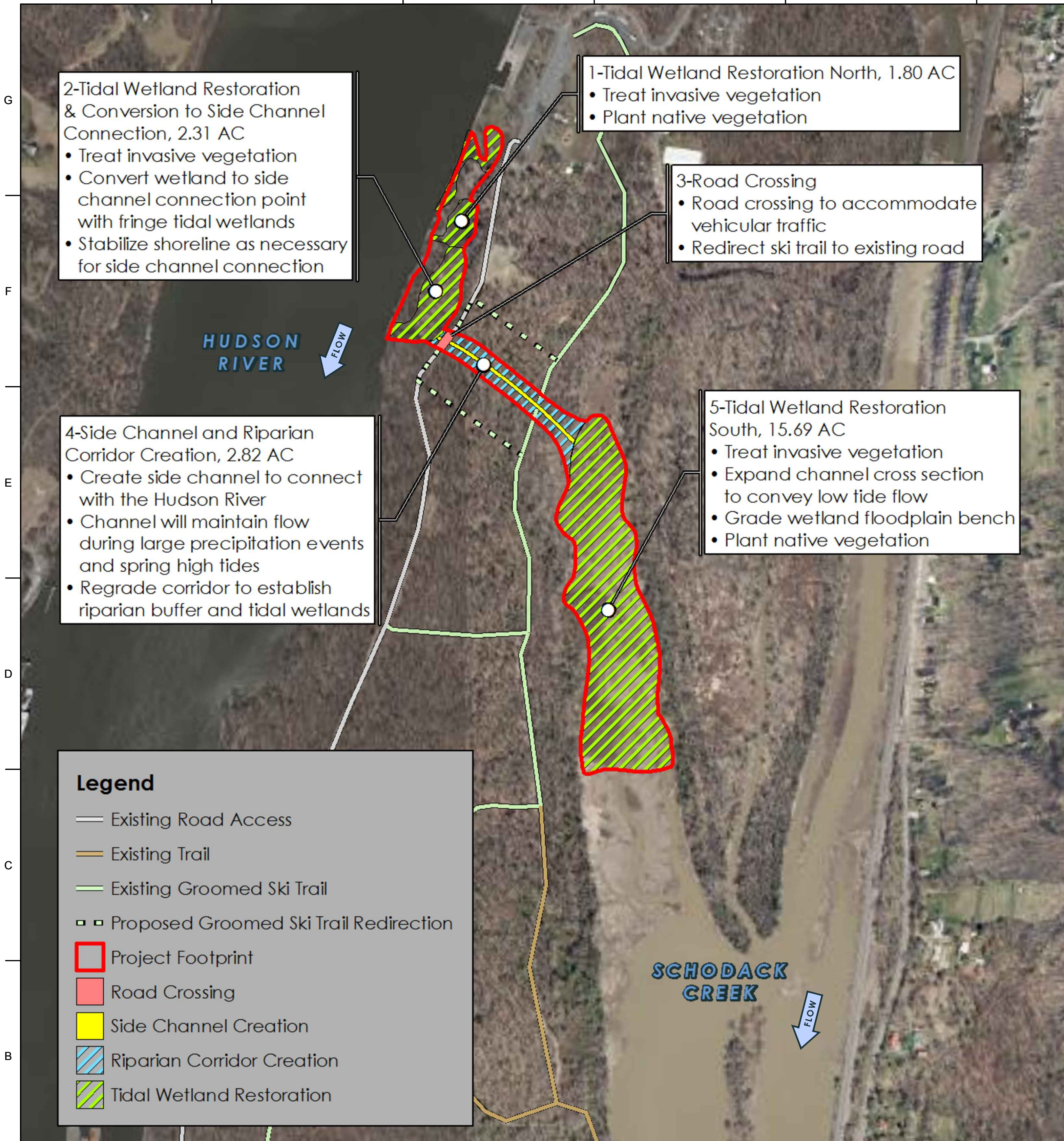
HUDSON RIVER HABITAT RESTORATION
BINNEN KILL
ALBANY COUNTY, NY

BINNEN KILL SOUTH ALTERNATIVE 2
DETAILS

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'

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-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

A SCHEDULE OF QUANTITIES
North - Alternative 1

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
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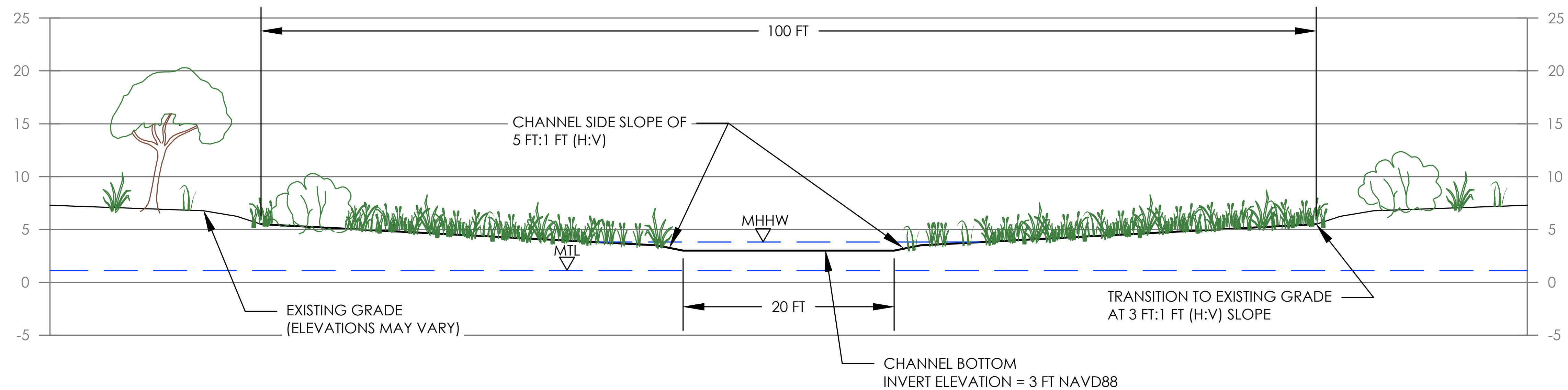
RINGOES, NEW JERSEY, 08551

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

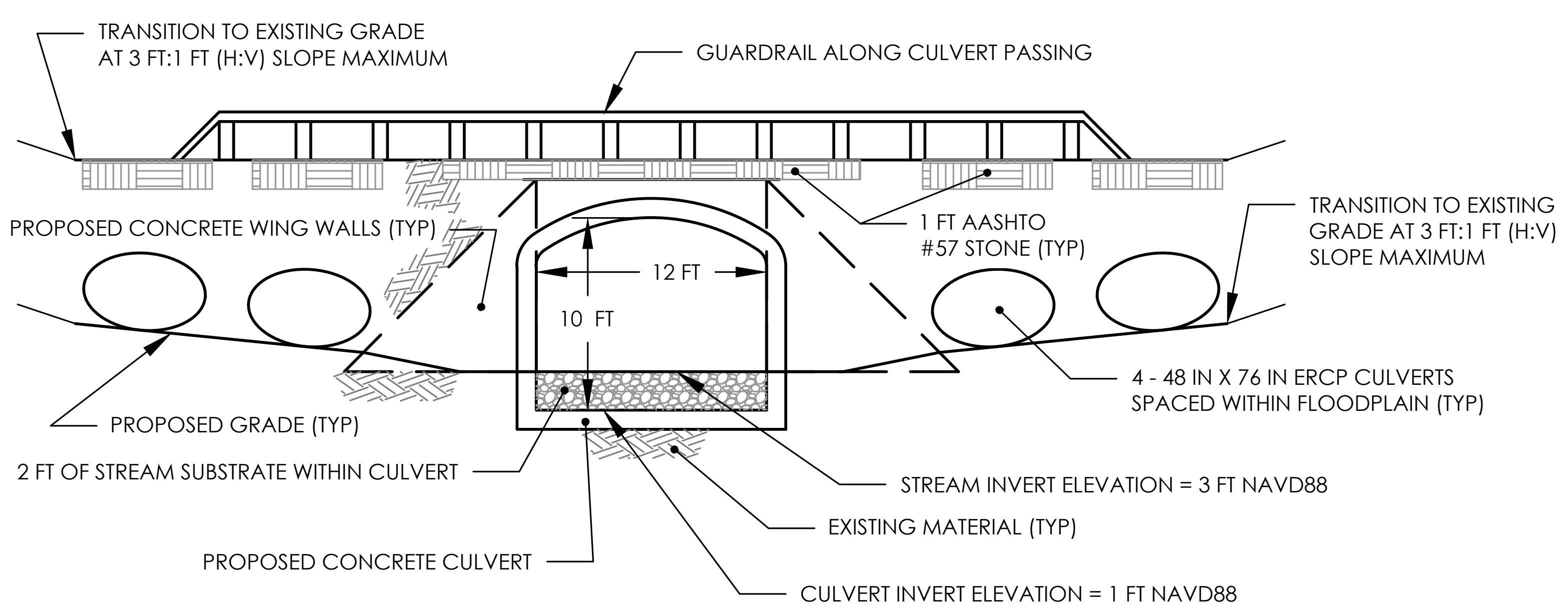
SCHODACK ISLAND NORTH ALTERNATIVE 1
SITE LOCATION

SHEET ID
1

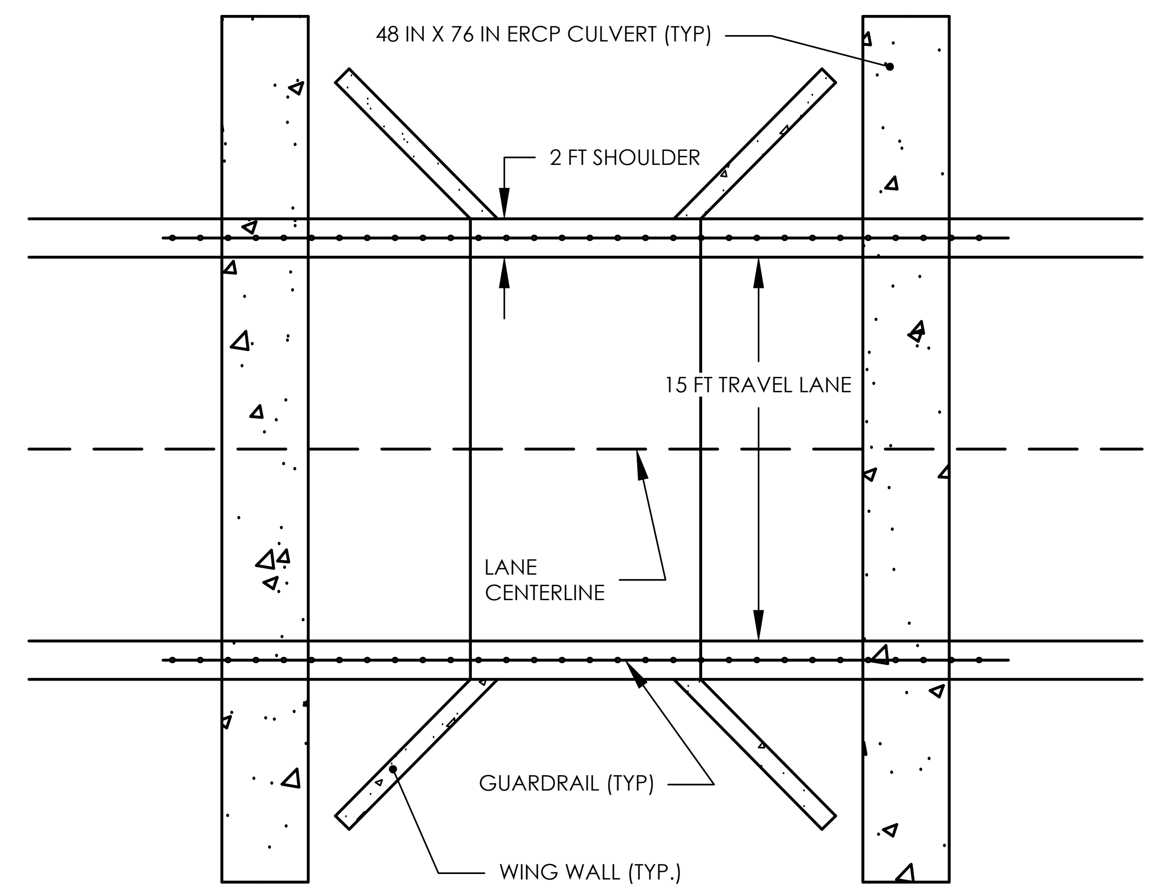
OCT.2018



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

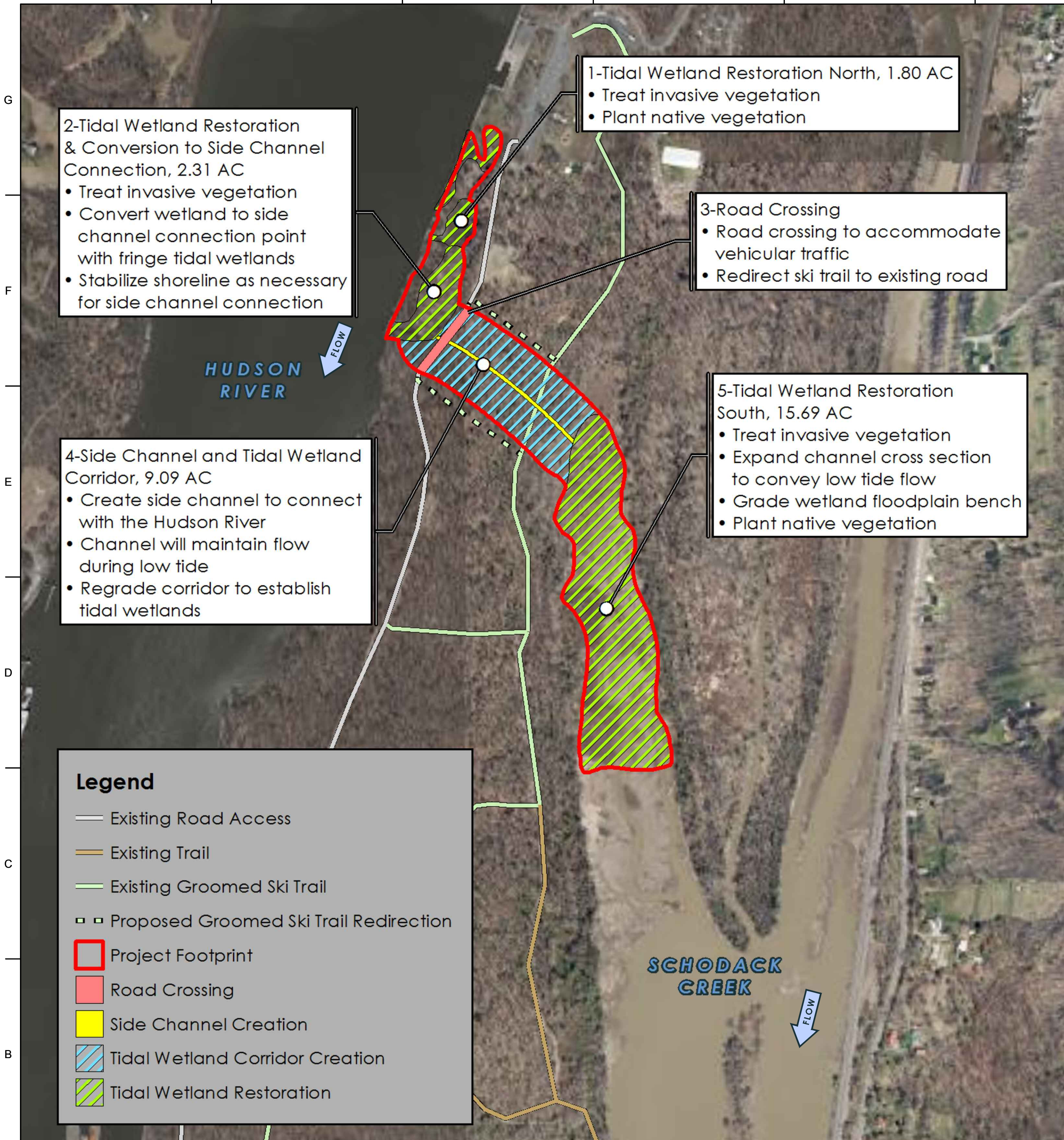
PRINCETON HYDRO, LLC
1108 OLD YORK ROAD
RINGOES, NEW JERSEY, 08551

HUDSON RIVER HABITAT RESTORATION
SCHODACK ISLAND STATE PARK
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'

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-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

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

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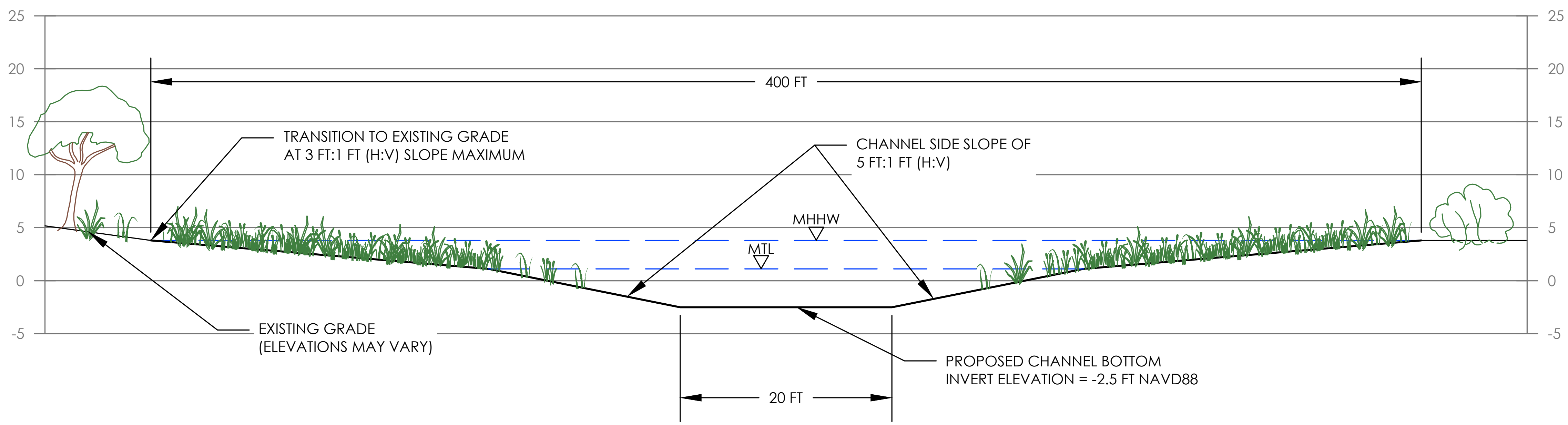
HUDSON RIVER HABITAT RESTORATION
SCHODACK ISLAND STATE PARK
COLUMBIA, GREENE, AND RENSSELAER COUNTIES, NY

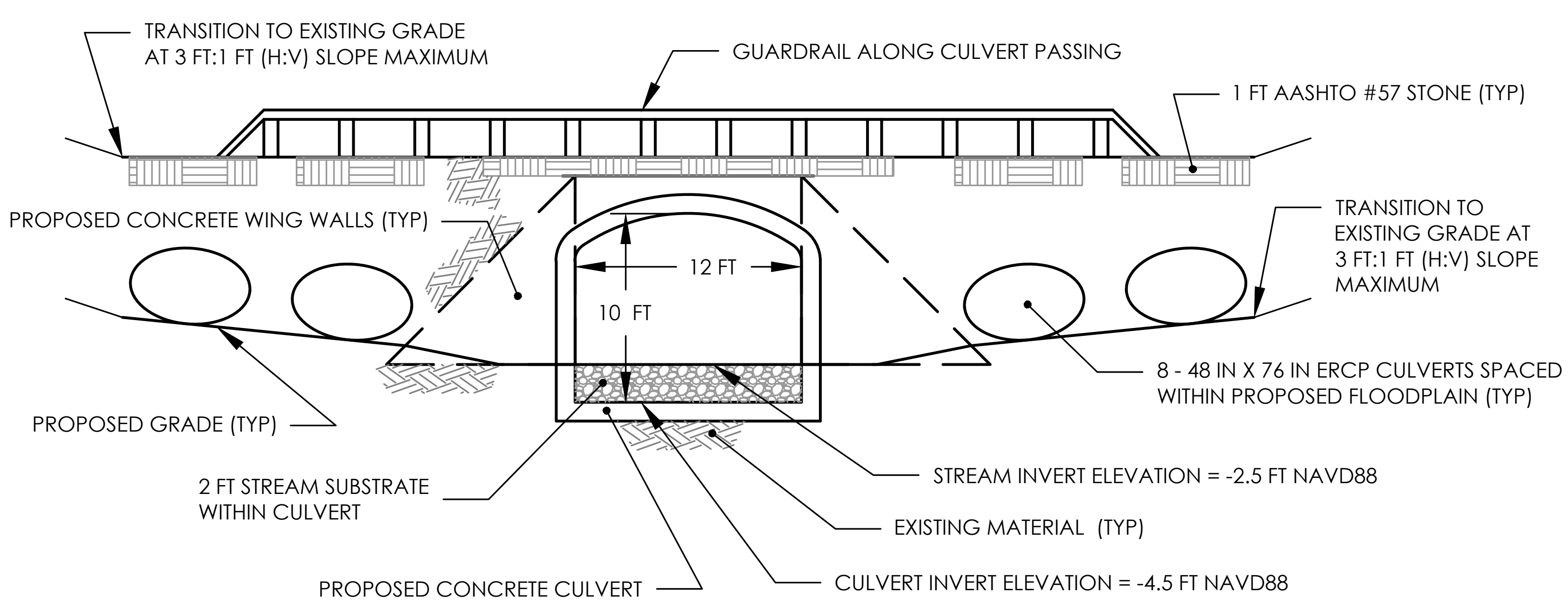
SCHODACK ISLAND NORTH ALTERNATIVE 2
SITE LOCATION

SHEET ID
1

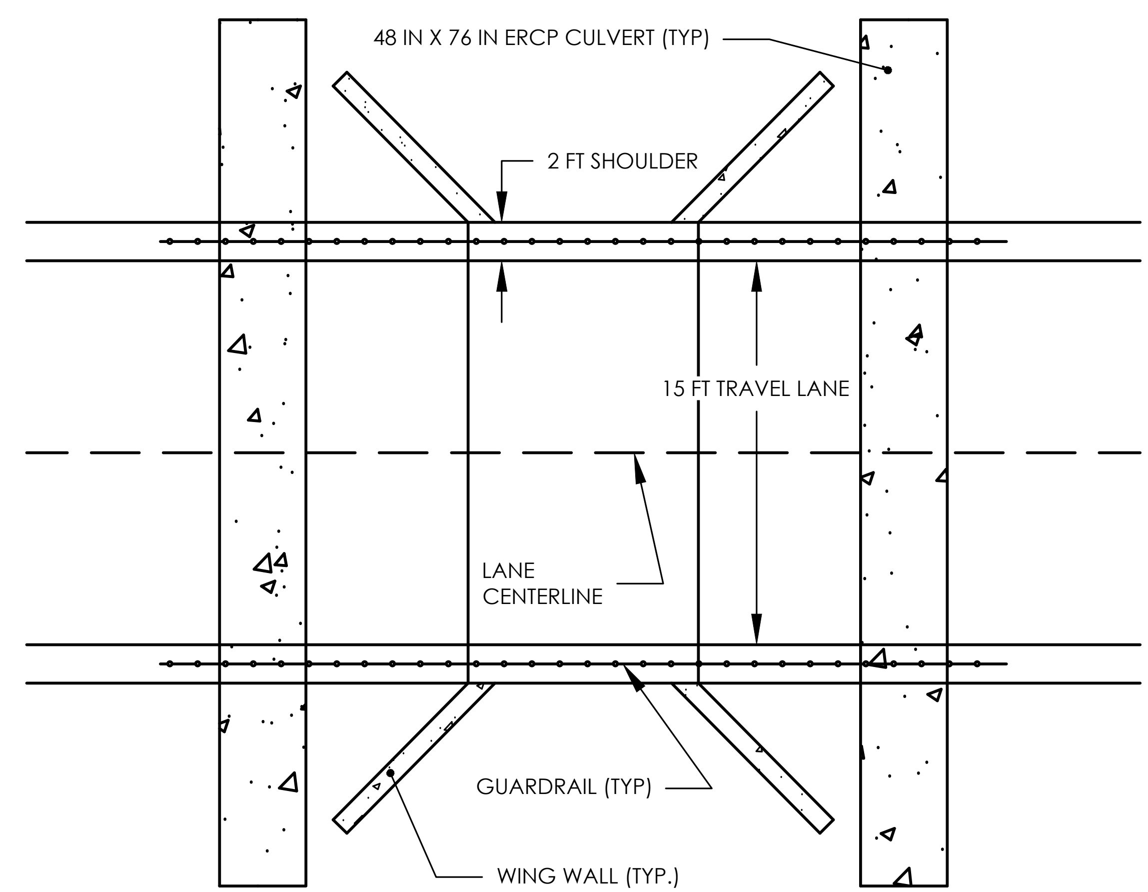
OCT.2018



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®

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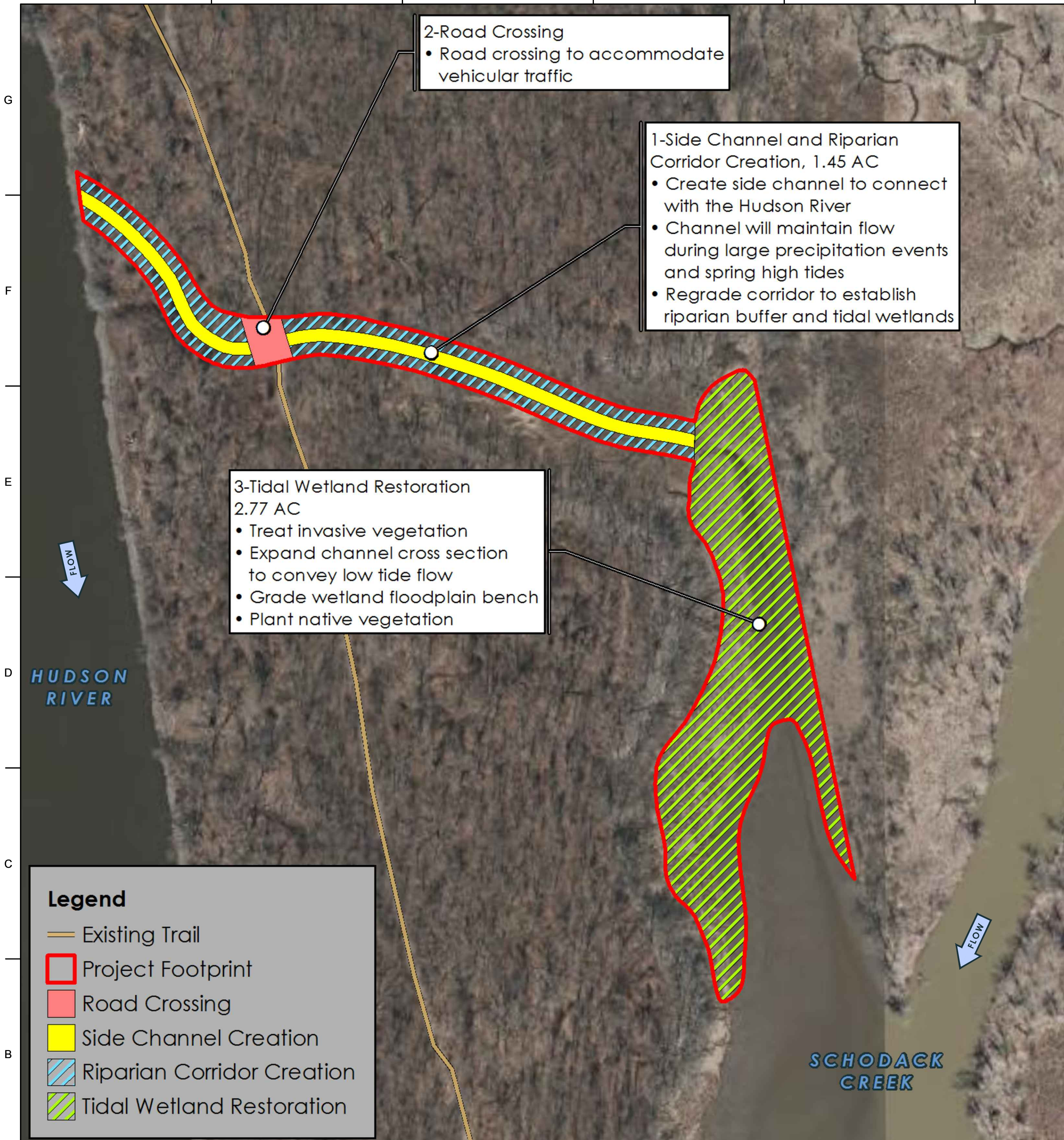
HUDSON RIVER HABITAT RESTORATION
SCHODACK ISLAND STATE PARK
COLUMBIA, GREENE, AND RENSSELAER COUNTIES, NY

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'

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 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

US Army Corps of Engineers®

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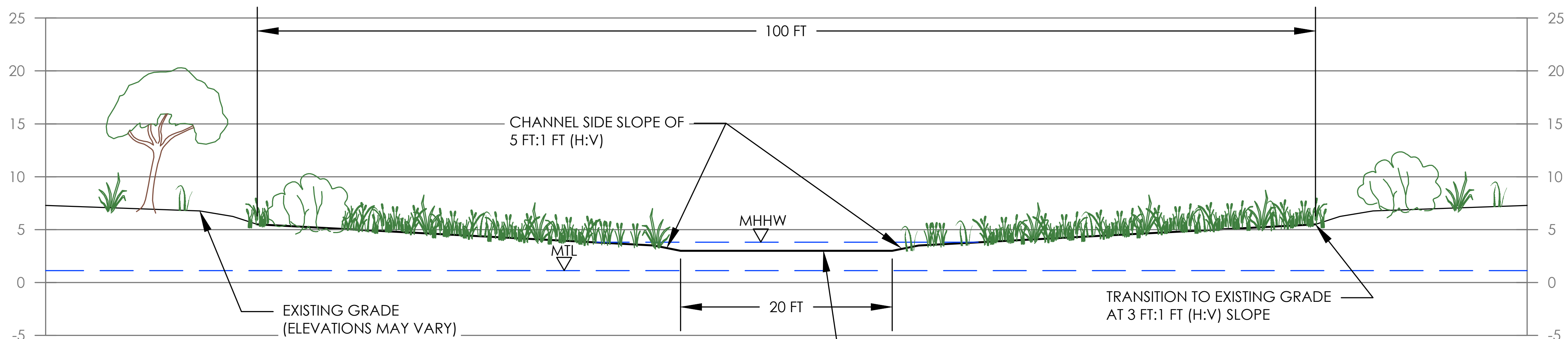
HUDSON RIVER HABITAT RESTORATION
SCHODACK ISLAND STATE PARK
COLUMBIA, GREENE, AND RENSSELAER COUNTIES, NY

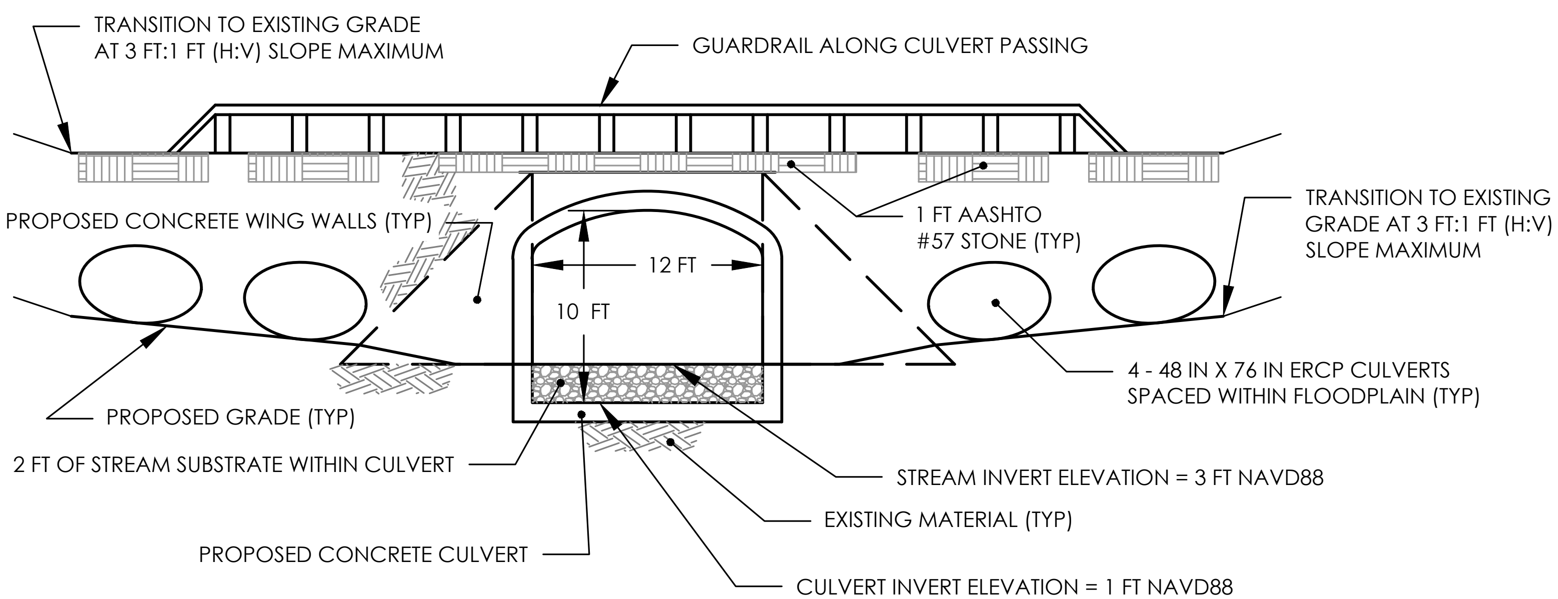
SCHODACK ISLAND SOUTH ALTERNATIVE 1
SITE LOCATION

SHEET ID
1

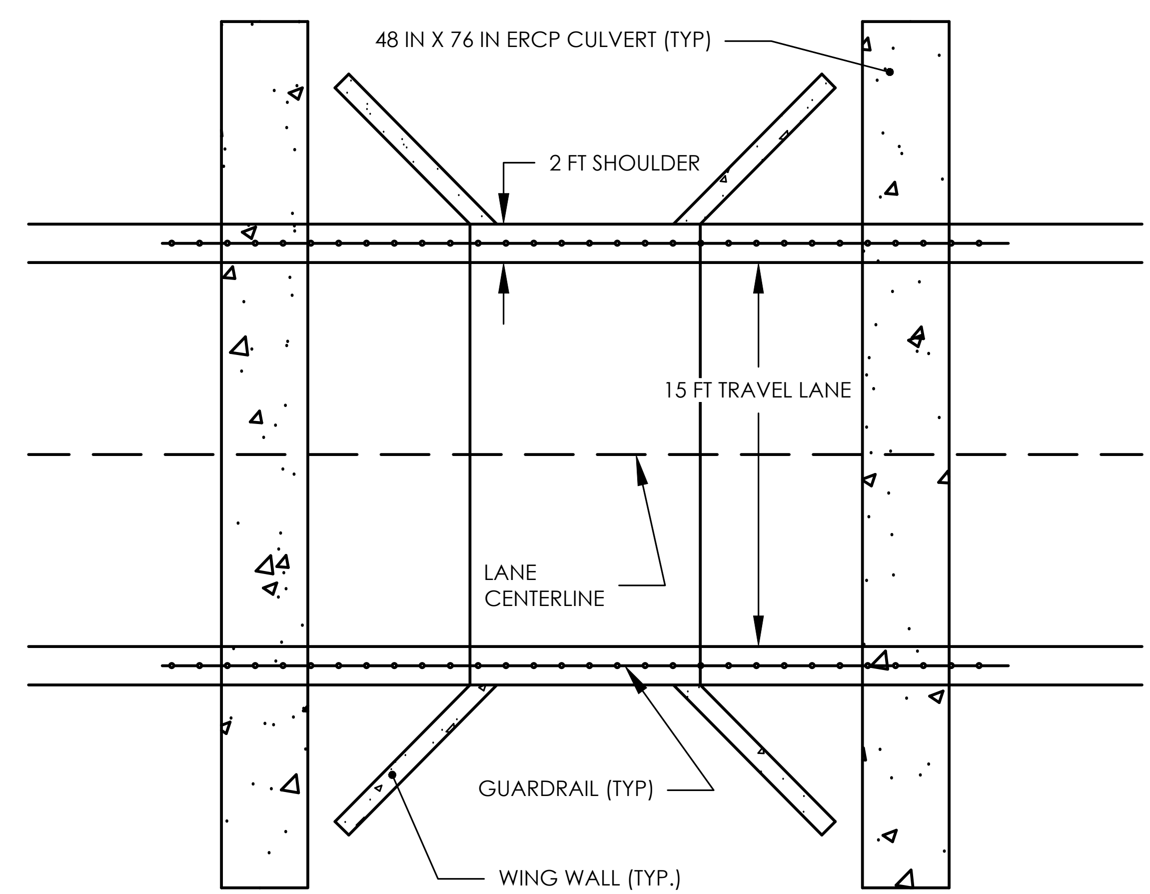
OCT.2018



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

US Army Corps of Engineers®

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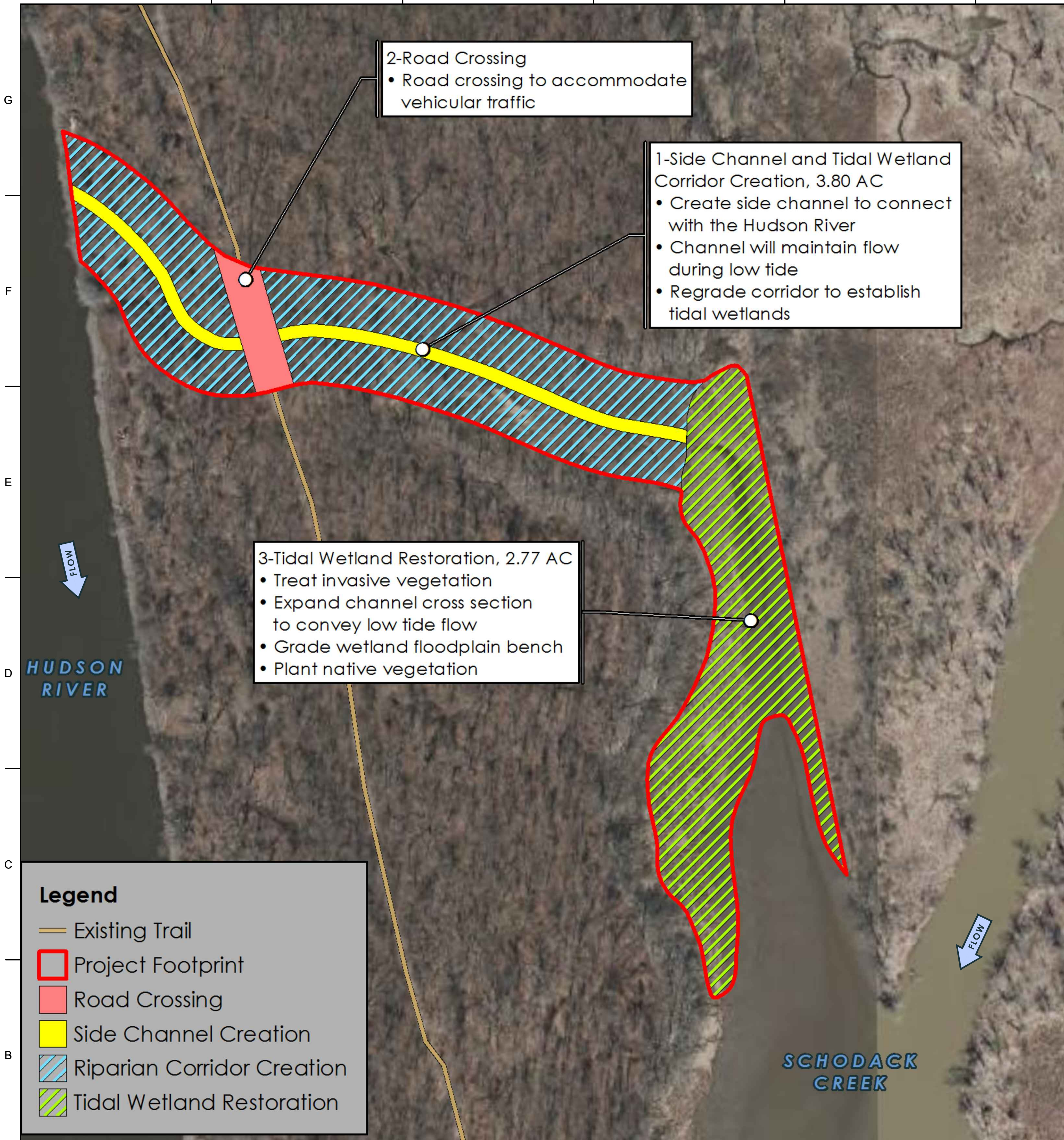
COLUMBIA, GREENE, AND RENSSELAER COUNTIES, NY

SCHODACK ISLAND SOUTH ALTERNATIVE 1
DETAILS

SHEET ID
2

OCT.2018



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South - Alternative 2
1" = 200'

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

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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

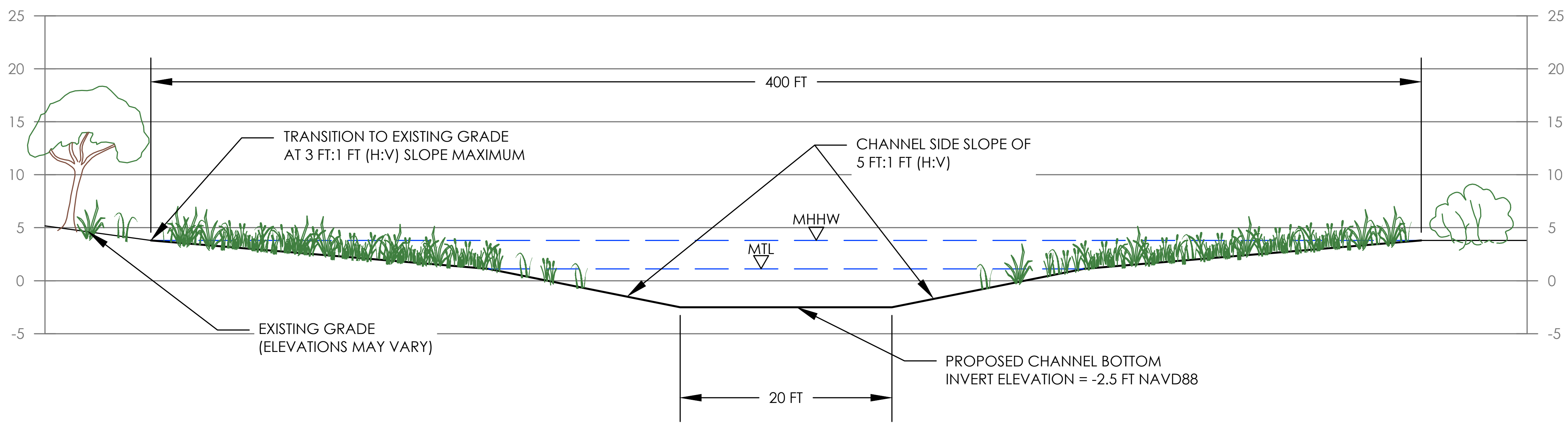
PRINCETON HYDRO, LLC
1108 OLD YORK ROAD
RINGOES, NEW JERSEY, 08551

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

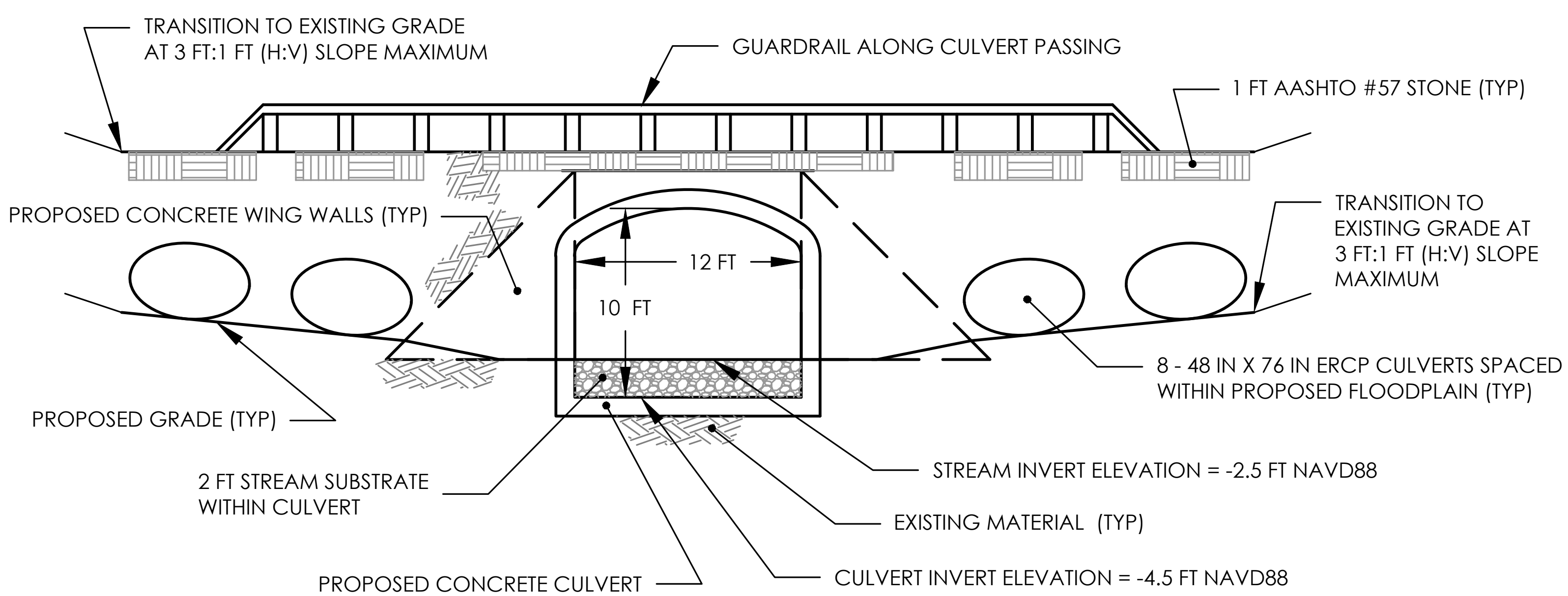
SCHODACK ISLAND SOUTH ALTERNATIVE 2
SITE LOCATION

SHEET ID
1

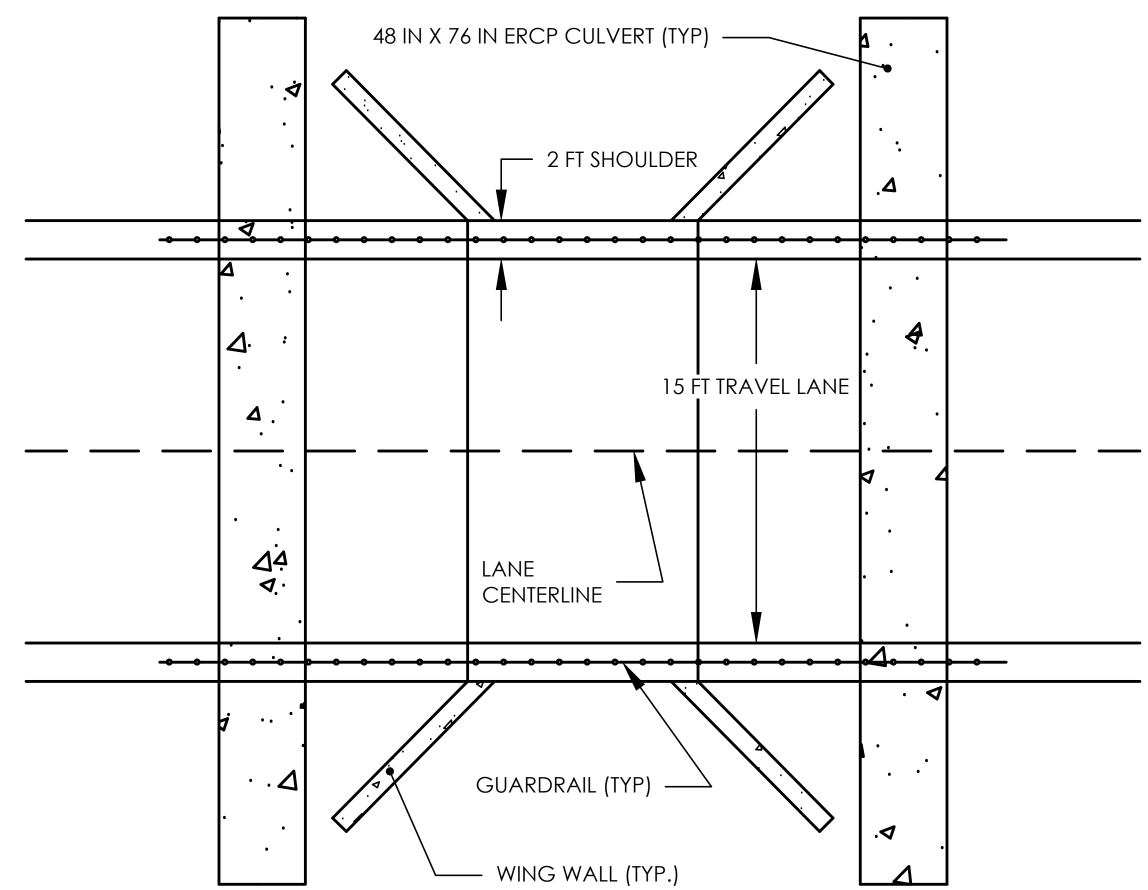
OCT.2018



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®

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NEW YORK DISTRICT
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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 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'

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

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

A SCHEDULE OF QUANTITIES
Pocket Wetland - Alternative 1

US Army Corps of Engineers®

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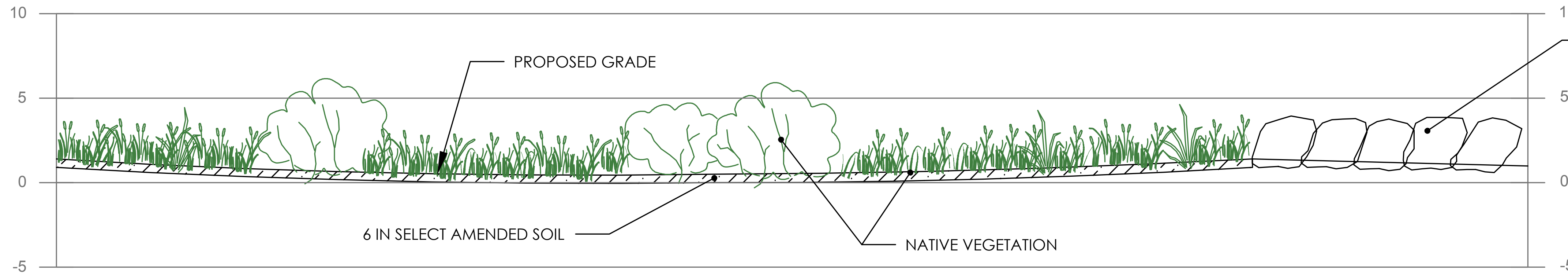
HUDSON RIVER HABITAT RESTORATION
SCHODACK ISLAND STATE PARK
COLUMBIA, GREENE, AND RENSSELAER COUNTIES, NY

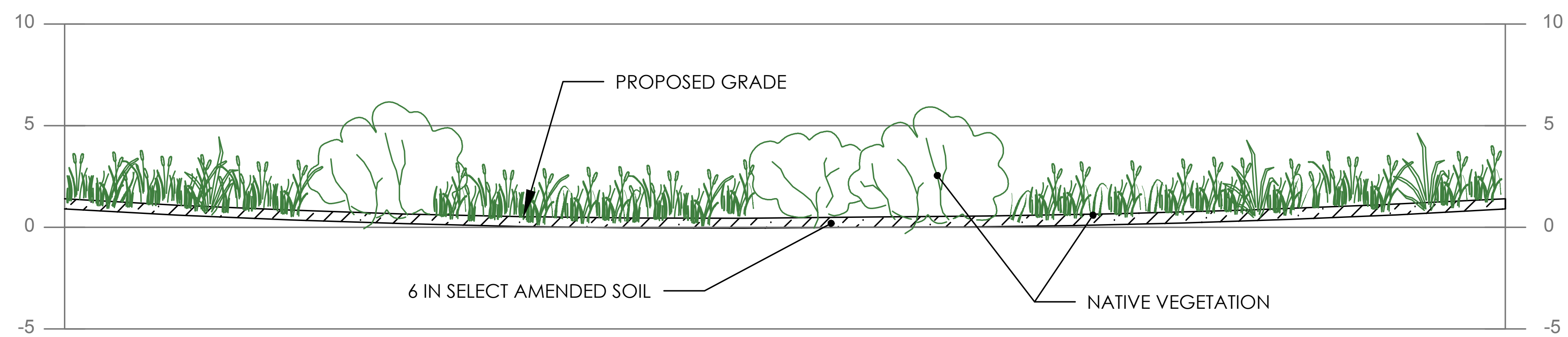
SCHODACK ISLAND POCKET WETLANS
SITE LOCATION

SHEET ID
1

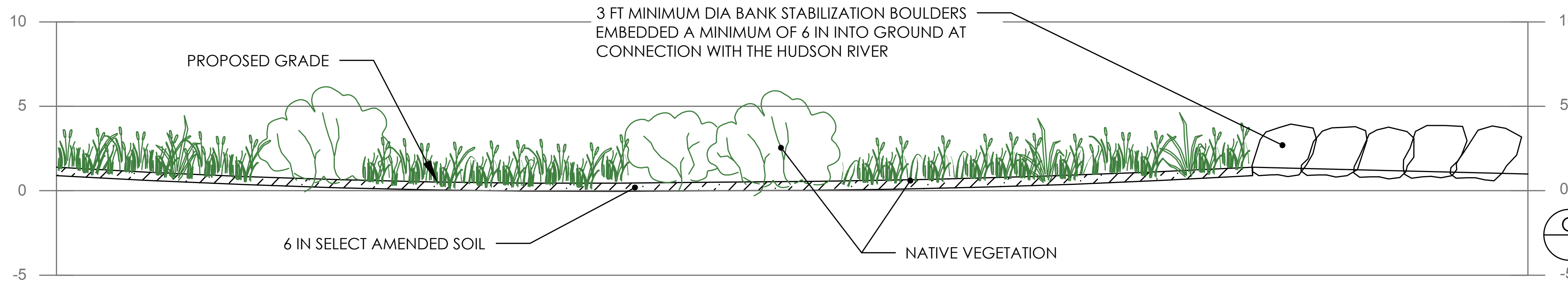
OCT.2018



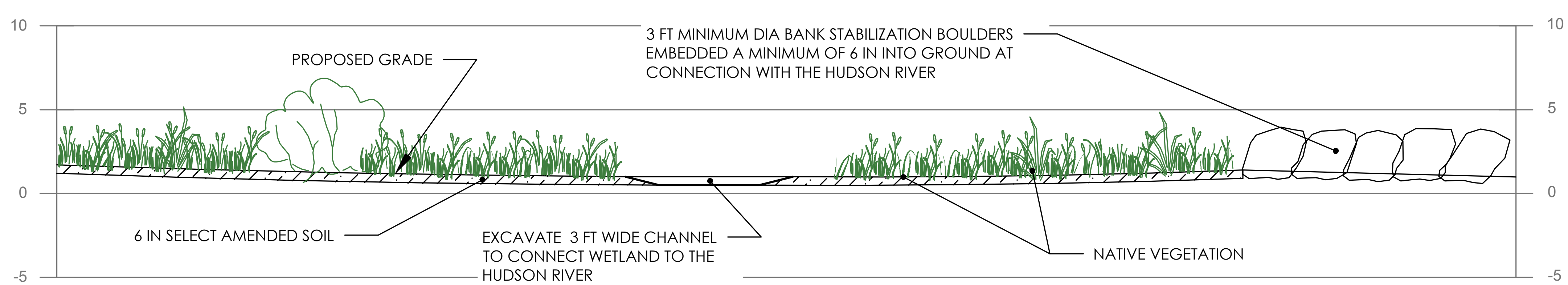
A TIDAL WETLAND RESTORATION - A
POCKET WETLANDS
SCHODACK ISLAND



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



C TIDAL WETLAND RESTORATION - C
POCKET WETLANDS
SCHODACK ISLAND



D TIDAL WETLAND CREATION - D
POCKET WETLANDS
SCHODACK ISLAND

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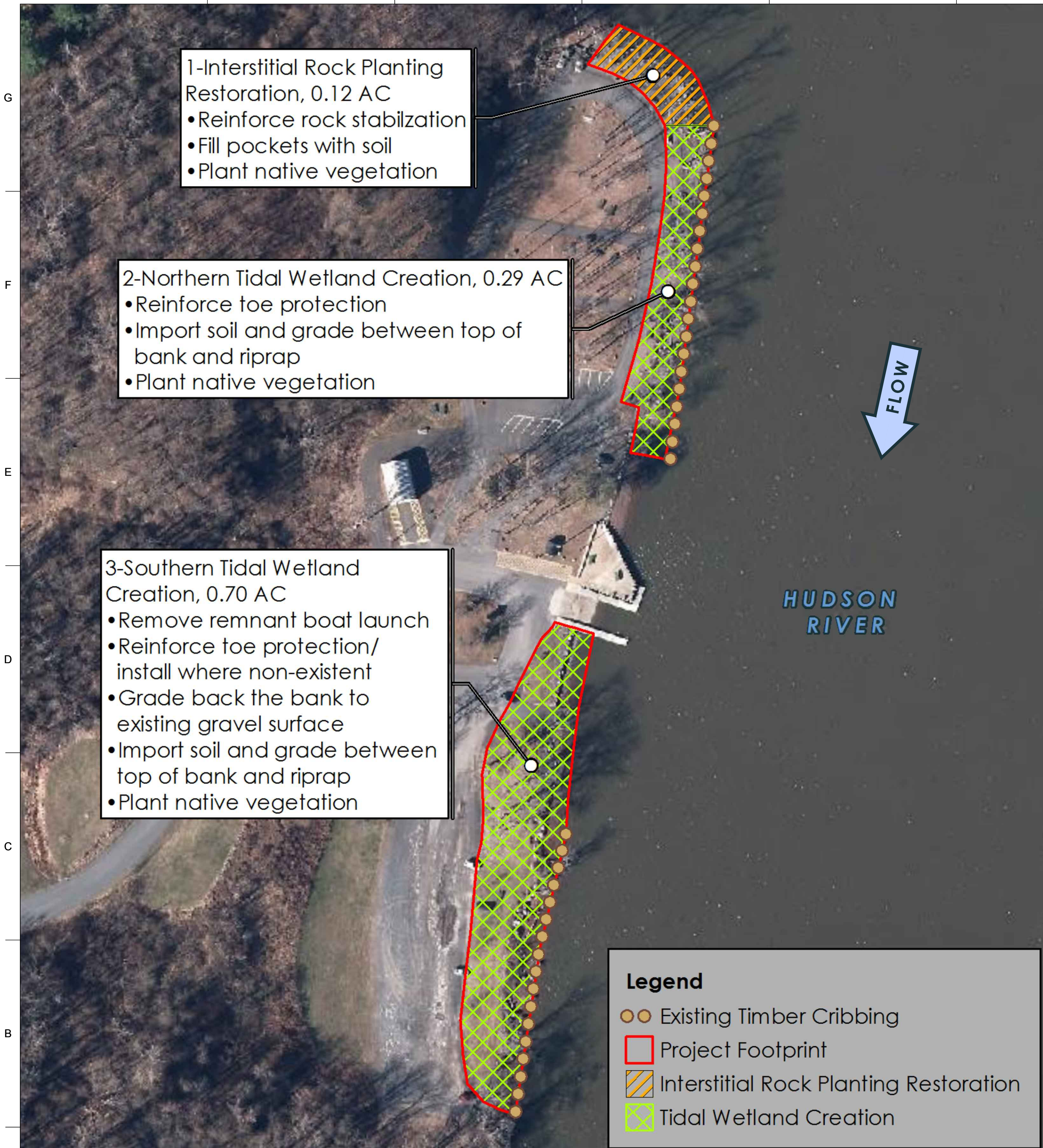
HUDSON RIVER HABITAT RESTORATION
SCHODACK ISLAND STATE PARK
COLUMBIA, GREENE, AND RENSSELAER COUNTIES, NY

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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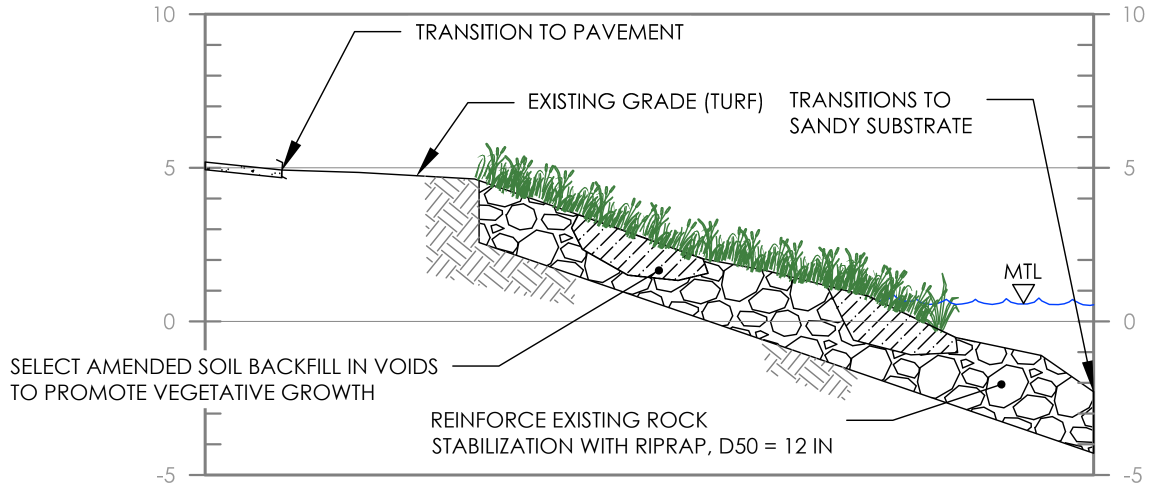
HUDSON RIVER HABITAT RESTORATION
CHARLES RIDER PARK
ULSTER COUNTY, NY

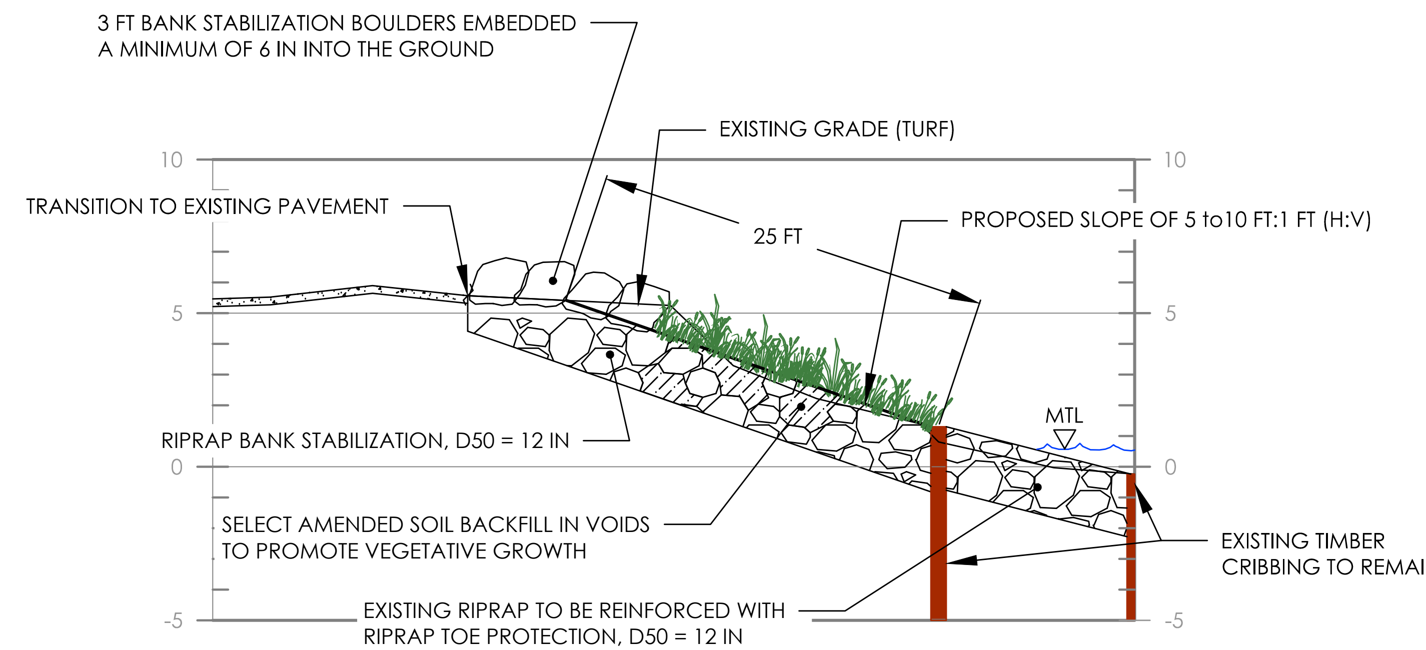
CHARLES RIDER PARK ALTERNATIVE 1
SITE LOCATION

SHEET ID
1

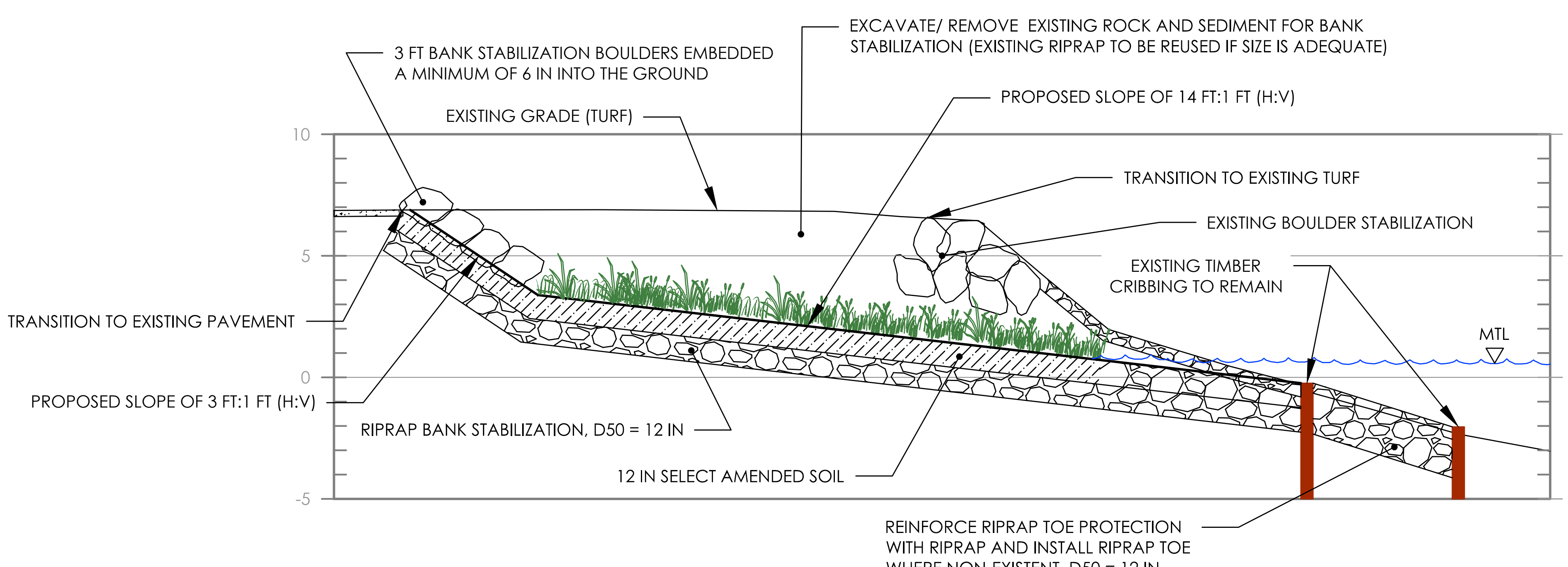
SEP.2018



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

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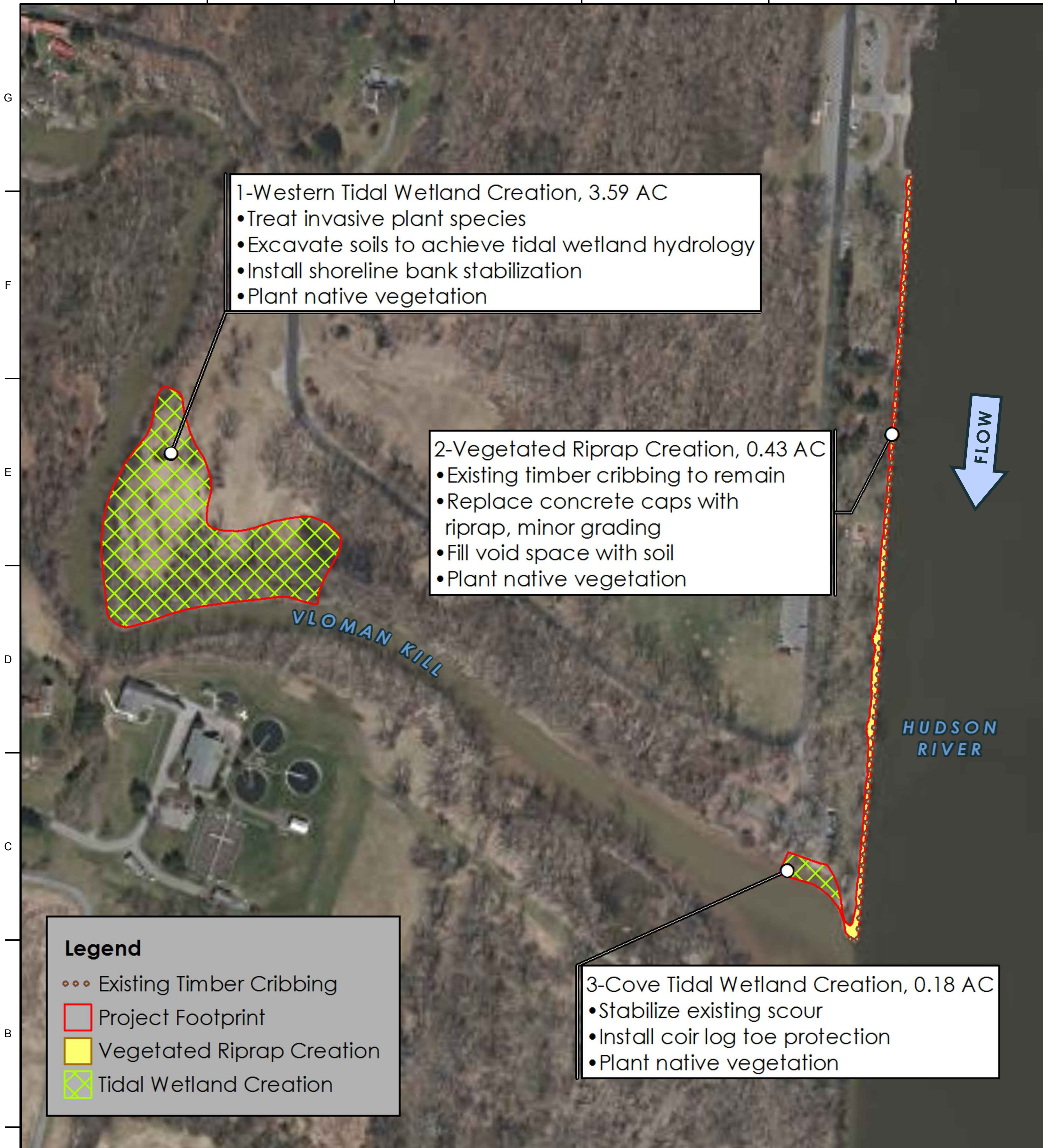
HUDSON RIVER HABITAT RESTORATION
CHARLES RIDER PARK
ULSTER COUNTY, NY

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
SY	Square Yards

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

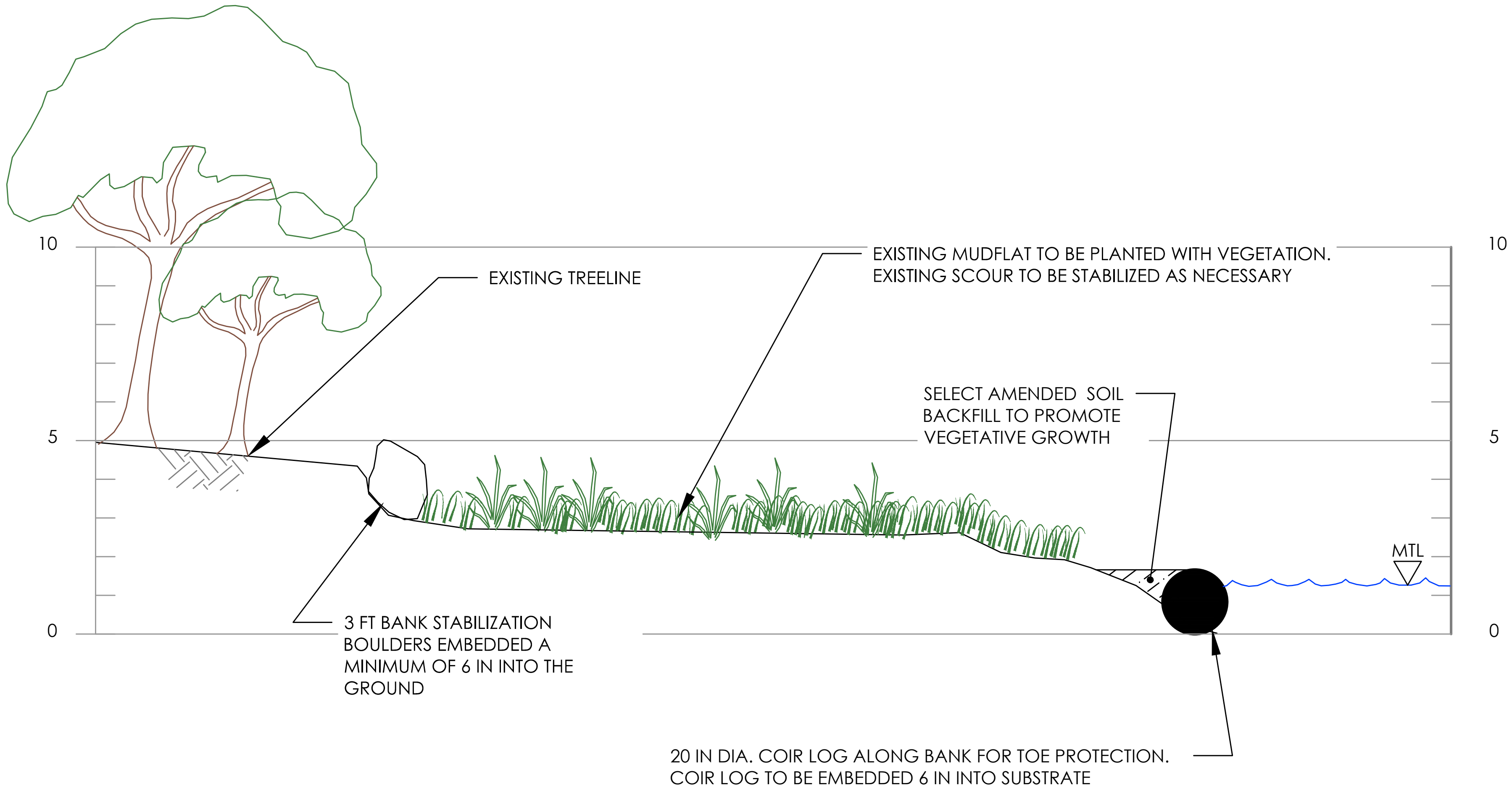
PRINCETON HYDRO, LLC
1108 OLD YORK ROAD
RINGOES, NEW JERSEY, 08551

HUDSON RIVER HABITAT RESTORATION
HENRY HUDSON PARK
ALBANY COUNTY, NY

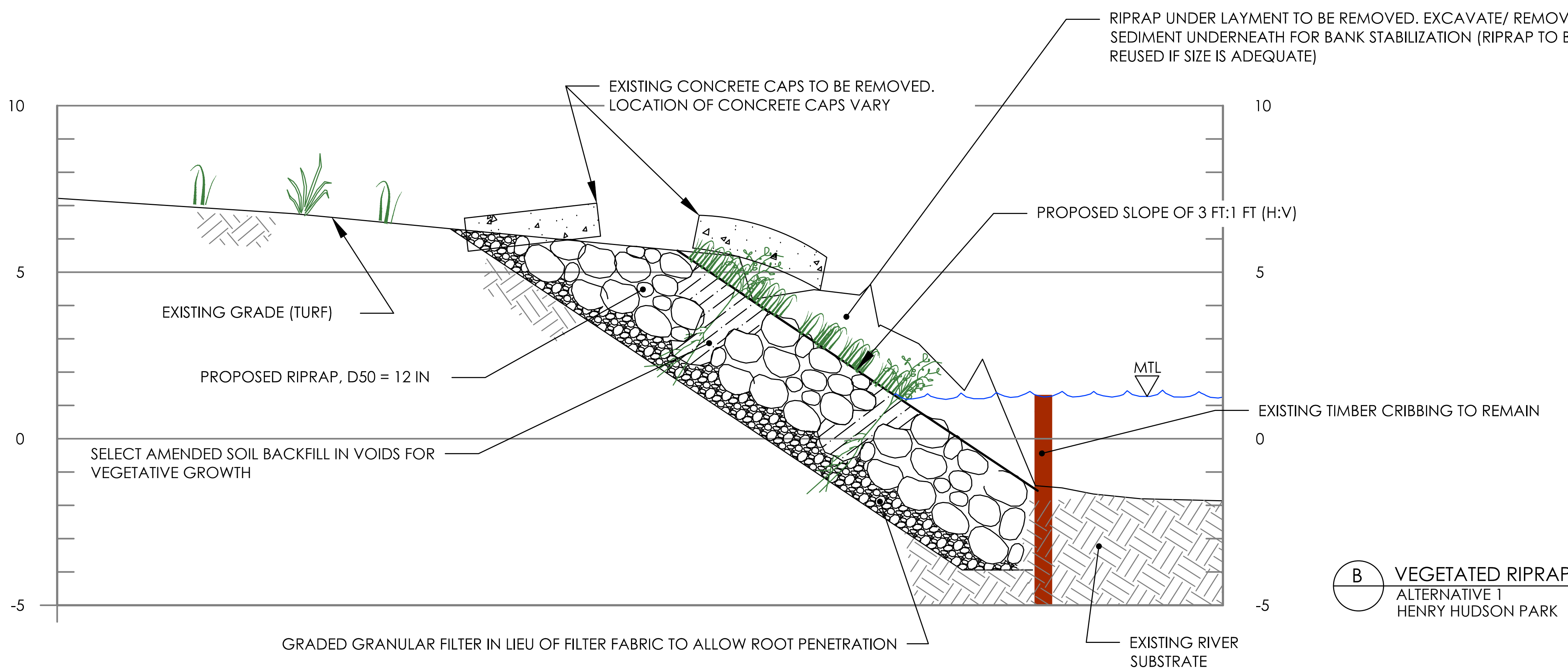
HENRY HUDSON PARK ALTERNATIVE 1
SITE LOCATION

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®

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HUDSON RIVER HABITAT RESTORATION
HENRY HUDSON PARK
ALBANY COUNTY, NY

HENRY HUDSON PARK ALTERNATIVE 1
DETAILS

SHEET ID
2

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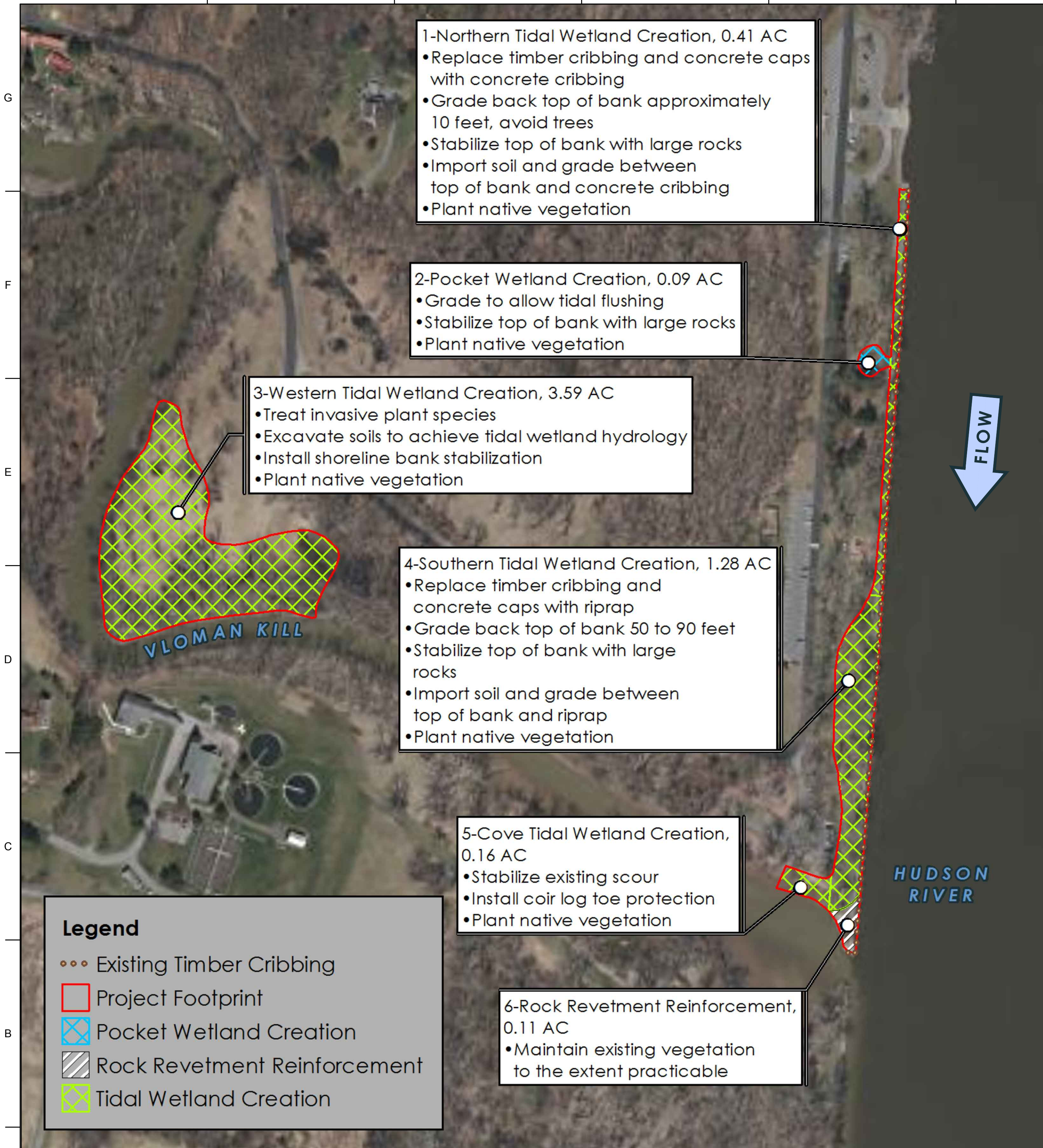

1 PLAN VIEW
Alternative 2
1" = 300'

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

US Army Corps of Engineers®

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HUDSON RIVER HABITAT RESTORATION
HENRY HUDSON PARK
ALBANY COUNTY, NY

HENRY HUDSON PARK ALTERNATIVE 2
SITE LOCATION

SHEET ID
1

OCT.2018

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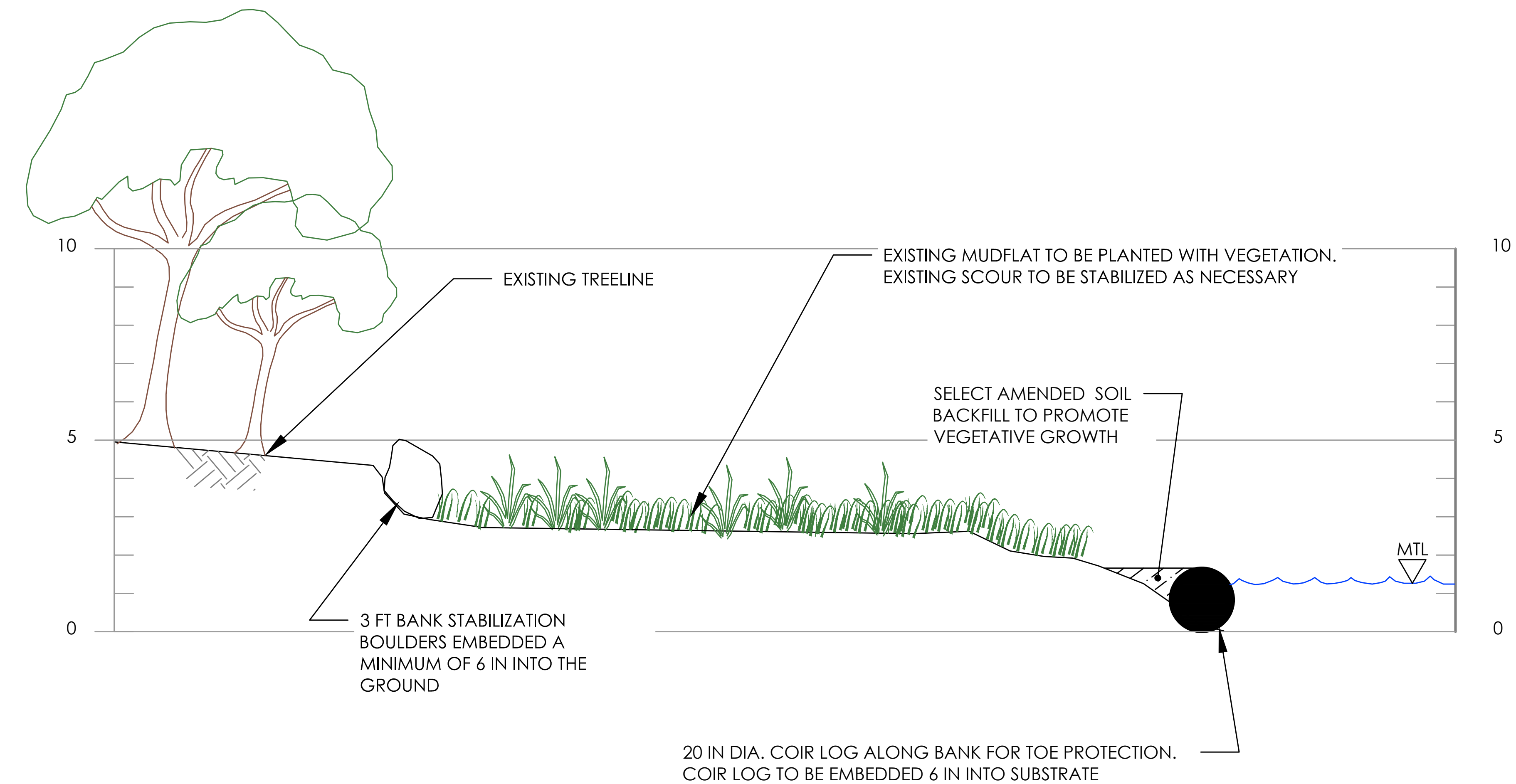
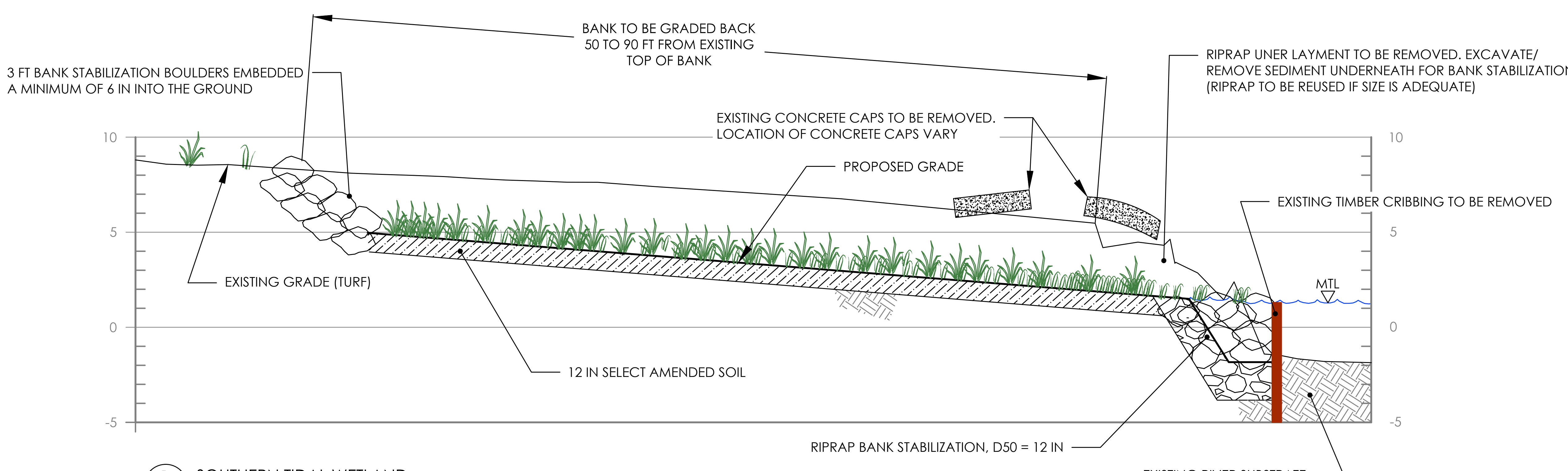


A COVE TIDAL WETLAND
ALTERNATIVE 2
HENRY HUDSON PARK



B SOUTHERN TIDAL WETLAND
ALTERNATIVE 2
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ALBANY COUNTY, NY

HENRY HUDSON PARK ALTERNATIVE 2
DETAILS

SHEET ID
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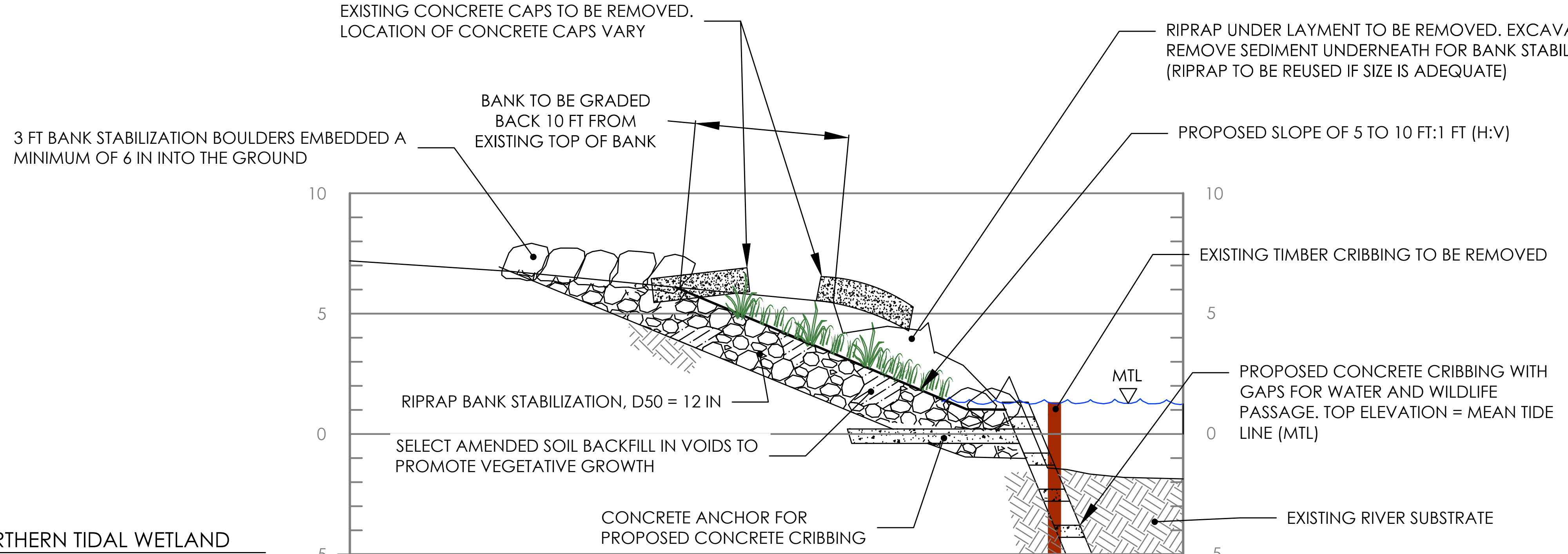
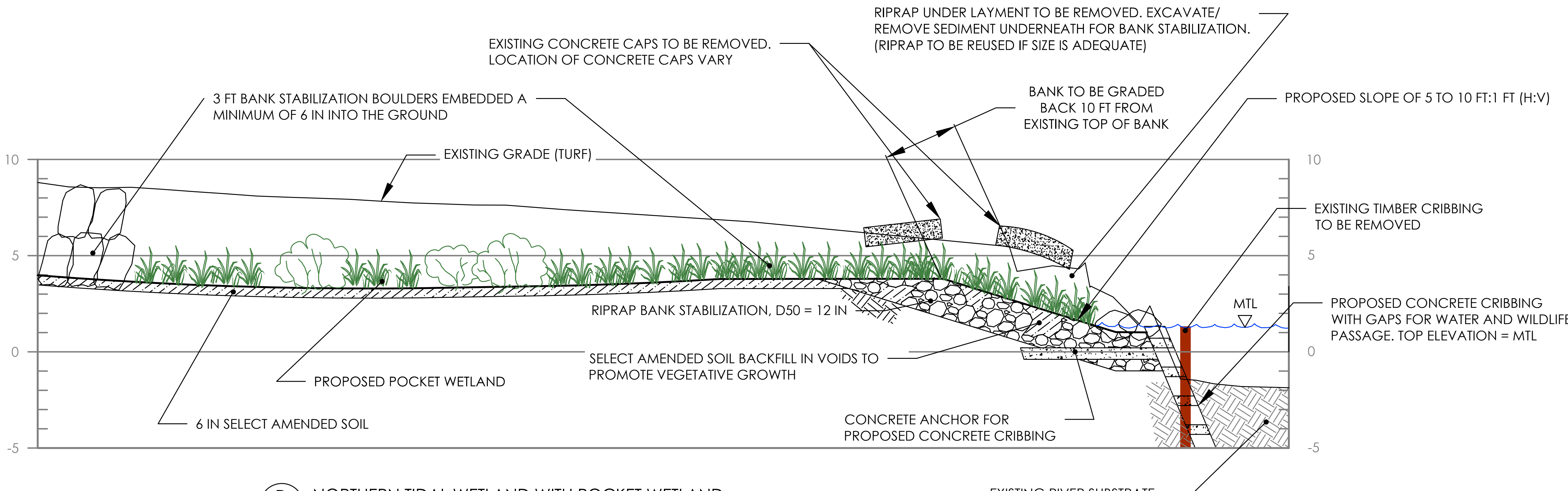


C NORTHERN TIDAL WETLAND
ALTERNATIVE 2
HENRY HUDSON PARK



D NORTHERN TIDAL WETLAND WITH POCKET WETLAND
ALTERNATIVE 2
HENRY HUDSON PARK

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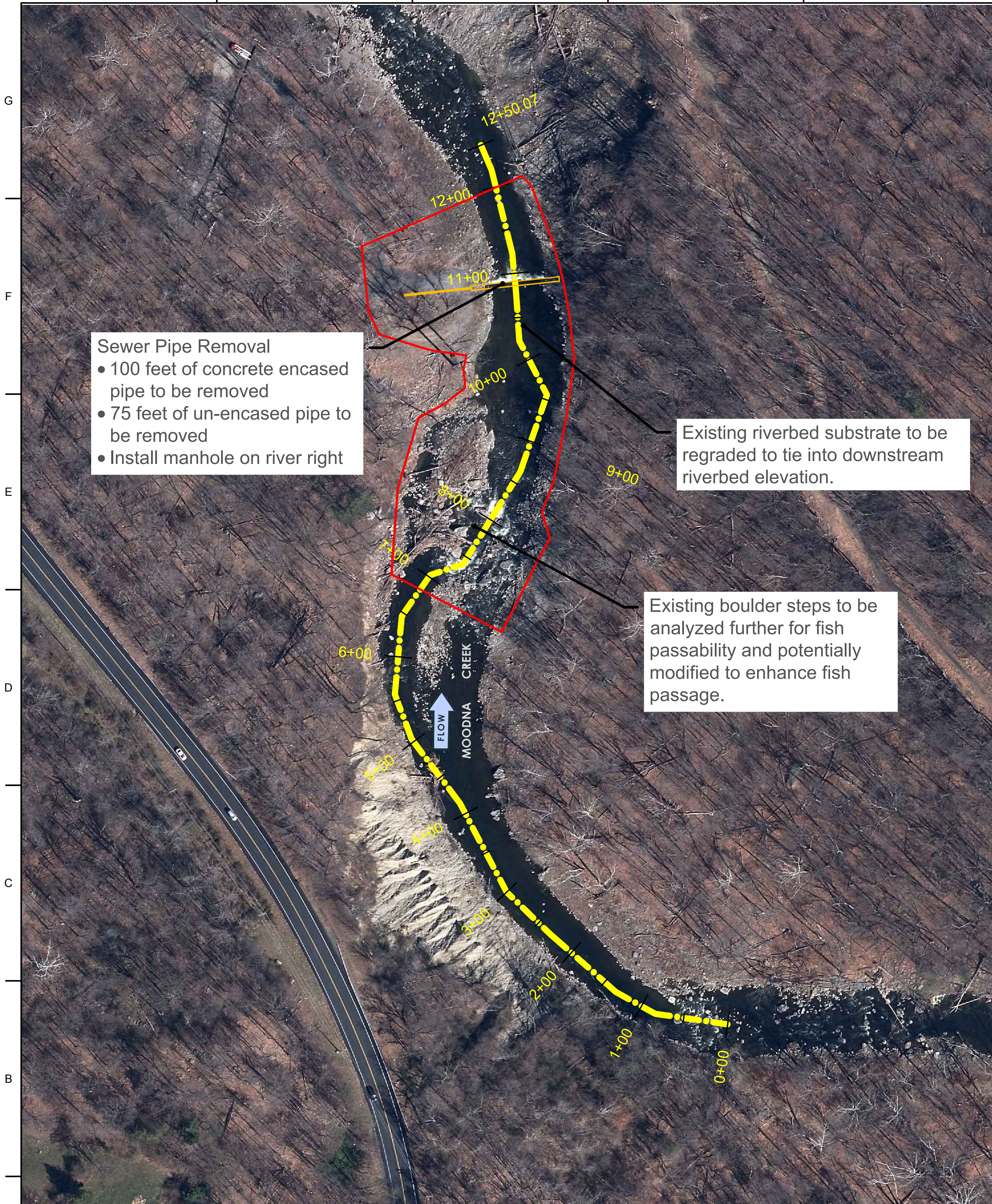
HUDSON RIVER HABITAT RESTORATION
HENRY HUDSON PARK
ALBANY COUNTY, NY

HENRY HUDSON PARK ALTERNATIVE 2
DETAILS

SHEET ID
3

OCT.2018

MOODNA CREEK
AOP 1 - UTILITY CROSSING
ALTERNATIVE 1:
BARRIER REMOVAL



Legend
- River Profile
- Project Footprint
- Proposed Sewer Pipe Removal

1 PLAN VIEW
1" = 150'

0 30 60 90 120 150 300 450 600 FEET

SCALE: 1" = 150'

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

MARK	DESCRIPTION	DATE

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

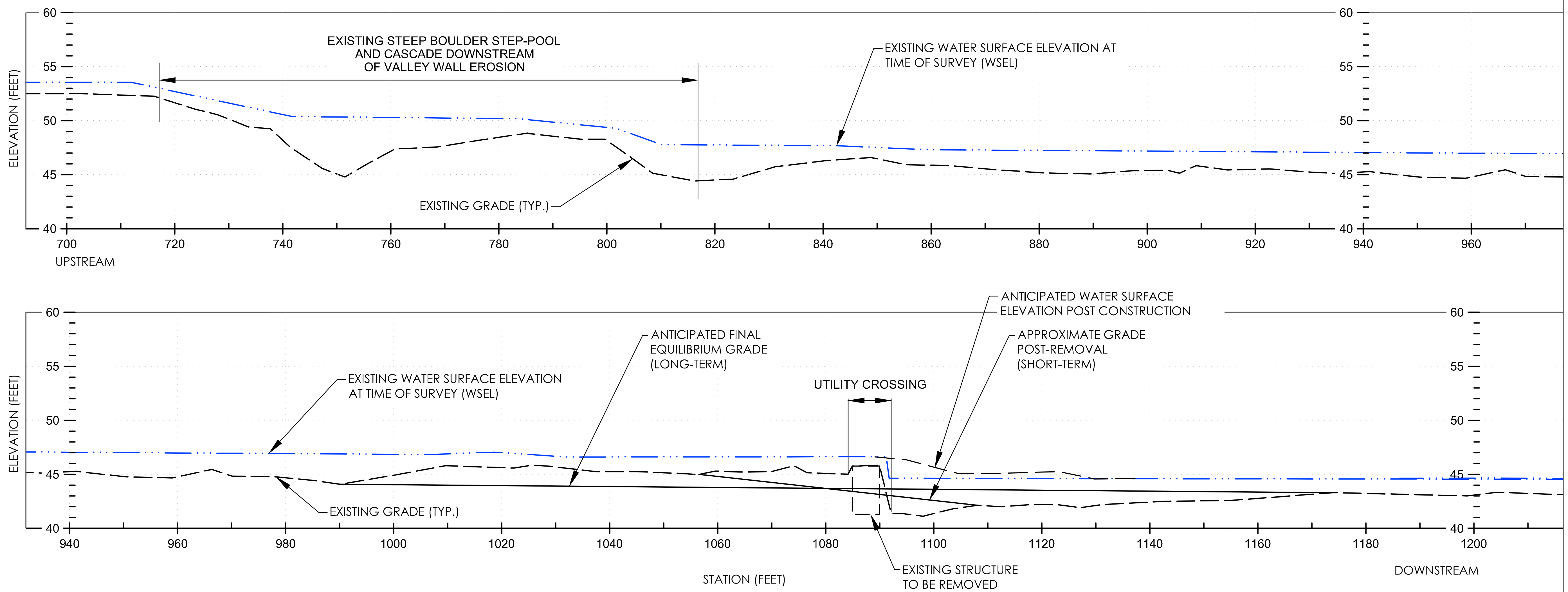
U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT
26 FEDERAL PLAZA
NEW YORK, NEW YORK, 10278

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

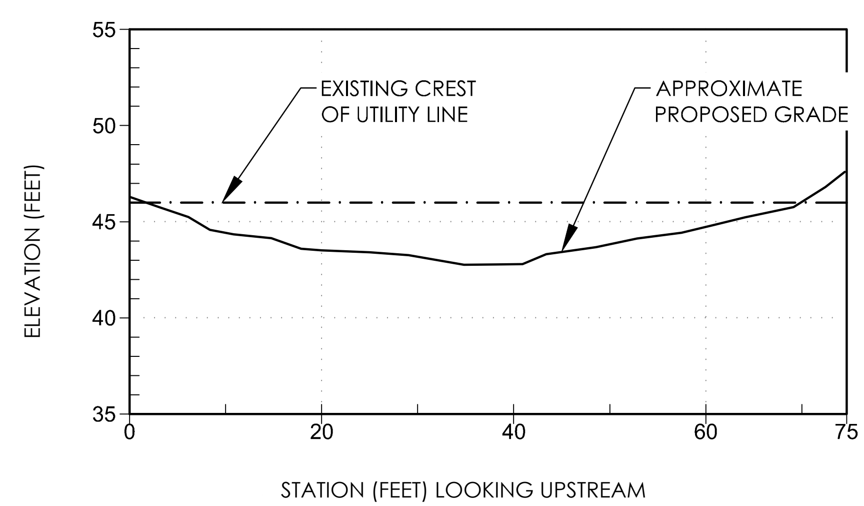
SHEET ID
1

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®

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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

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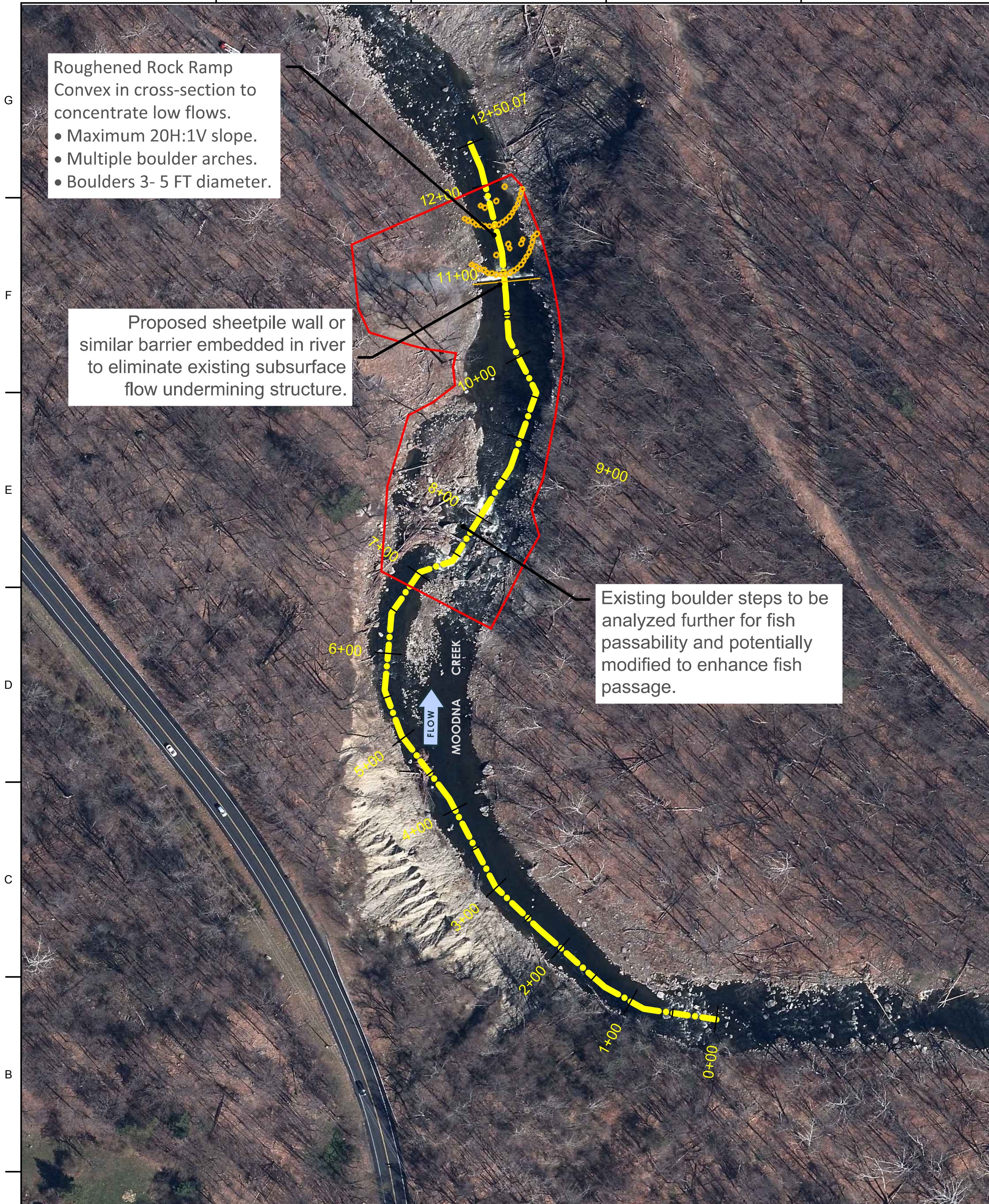
MOODNA CREEK
AOP 1 - UTILITY CROSSING
ALTERNATIVE 2: FISHWAY



Legend
- River Profile
- Project Footprint
- Proposed Fishway

1 PLAN VIEW
1" = 150'

0 30 60 90 120 150 300 450 600 FEET

SCALE: 1" = 150'

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

MARK | DESCRIPTION | DATE

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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

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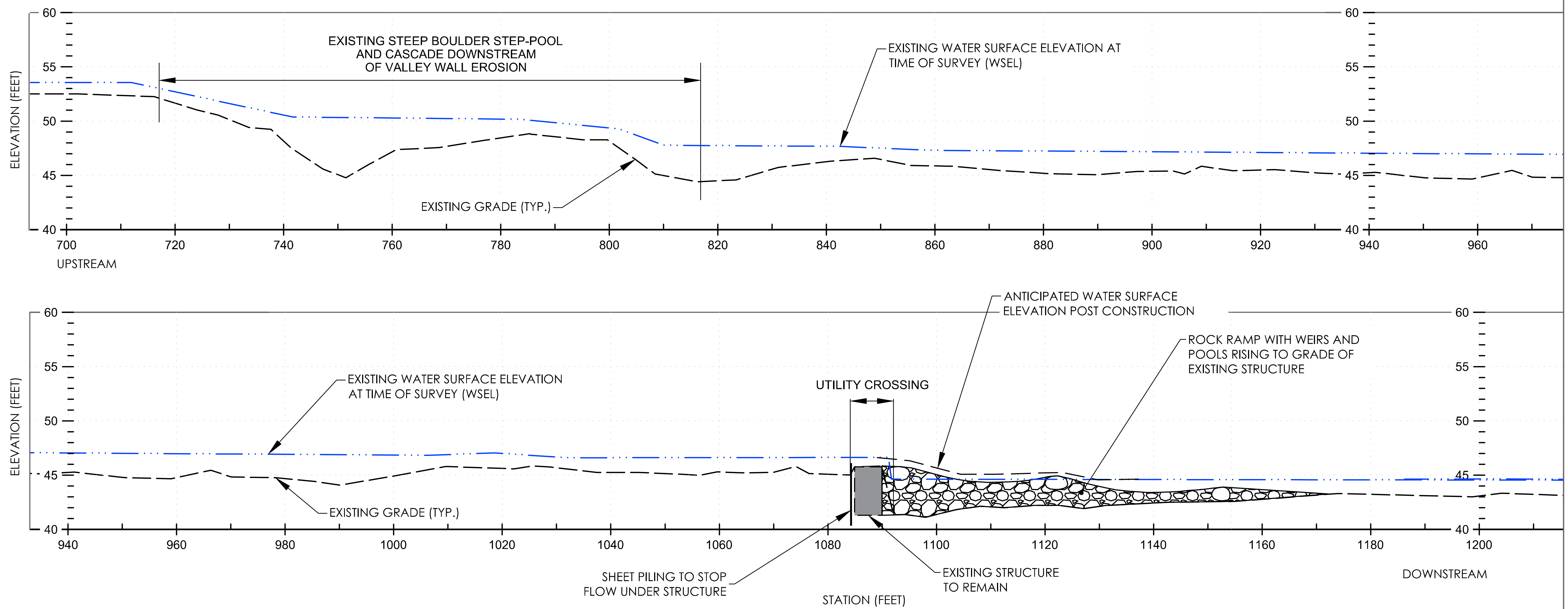
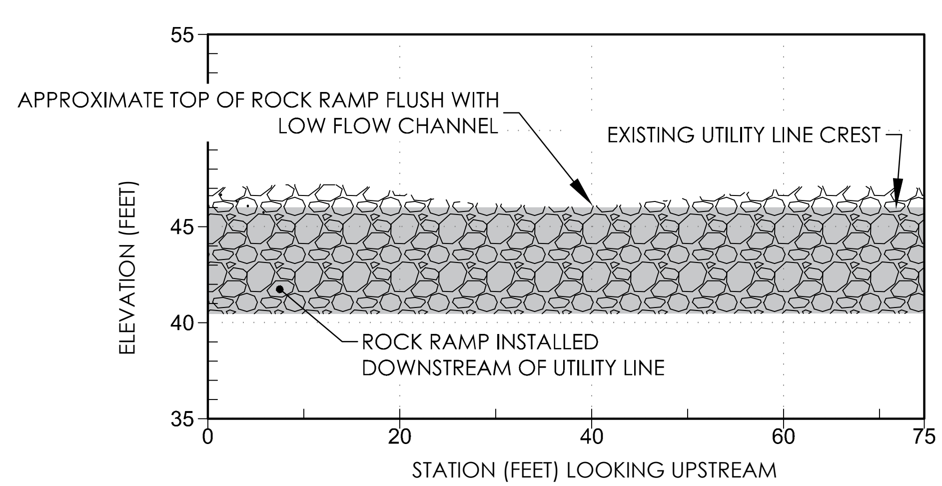


A AOP 1 - UTILITY CROSSING PROFILE
ALTERNATIVE 2: FISHWAY
MOODNA CREEK

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

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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

US Army Corps of Engineers

(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

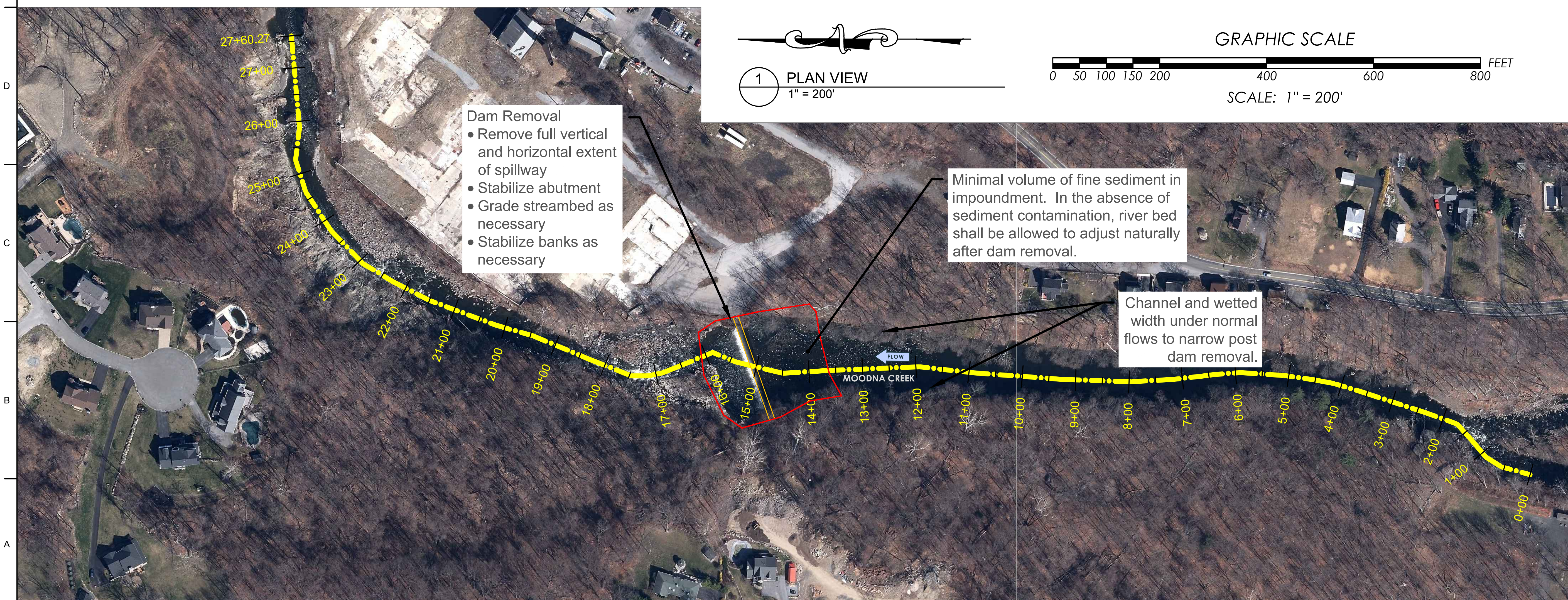
Item	Unit	Quantity
Traffic Control	LS	1
Turbidity Barrier	LF	200
Silt Fence	LF	80
Stabilized Construction Entrance	TON	50
Construction Access Reinforcement	TON	90
Construction Access Ramp	TON	160
Construction Access Pad	TON	230
Clearing and Grubbing	AC	0.1

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

MARK | DESCRIPTION | DATE

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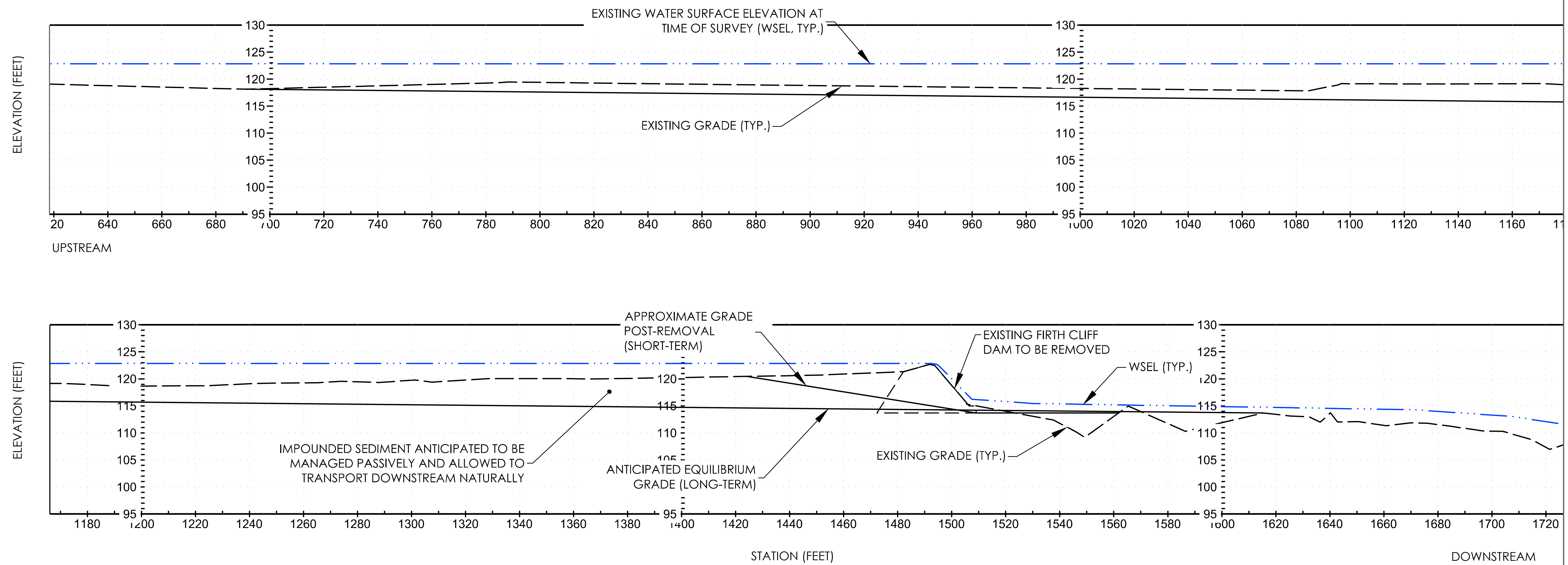
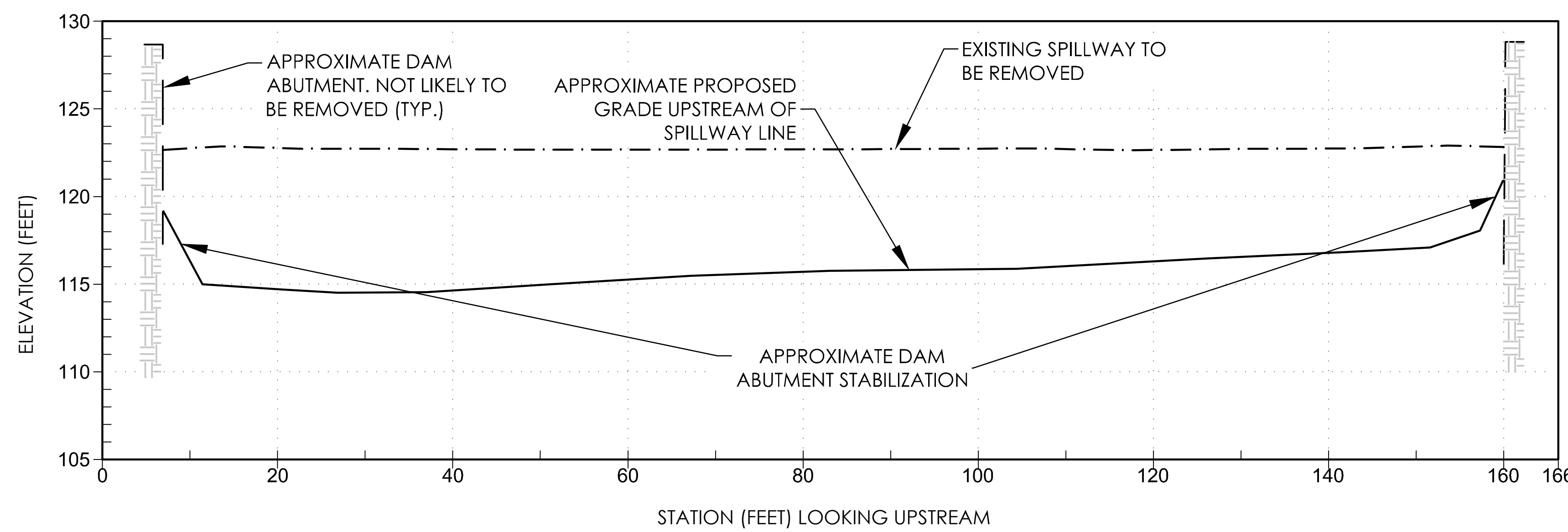


A AOP 2 - FIRTH CLIFF DAM PROFILE
ALTERNATIVE 1: DAM REMOVAL
MOODNA CREEK



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

US Army Corps of Engineers

MARK | DESCRIPTION | DATE

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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

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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'

US Army Corps of Engineers

MARK | DESCRIPTION | DATE

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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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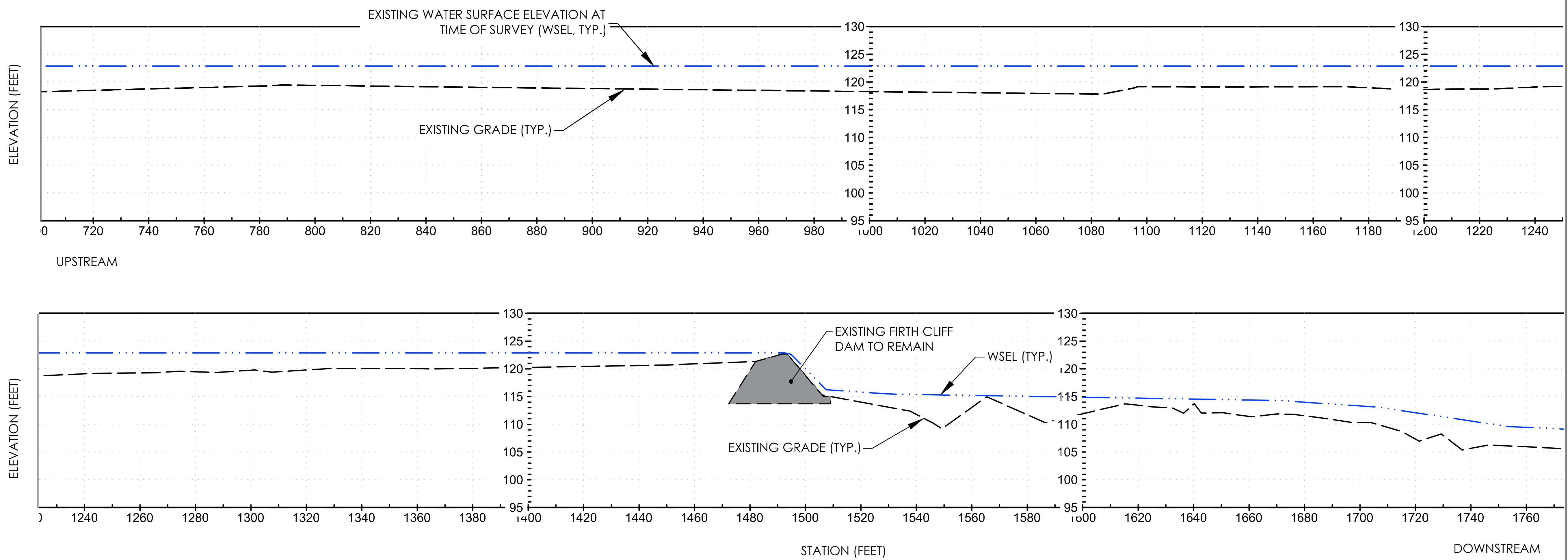
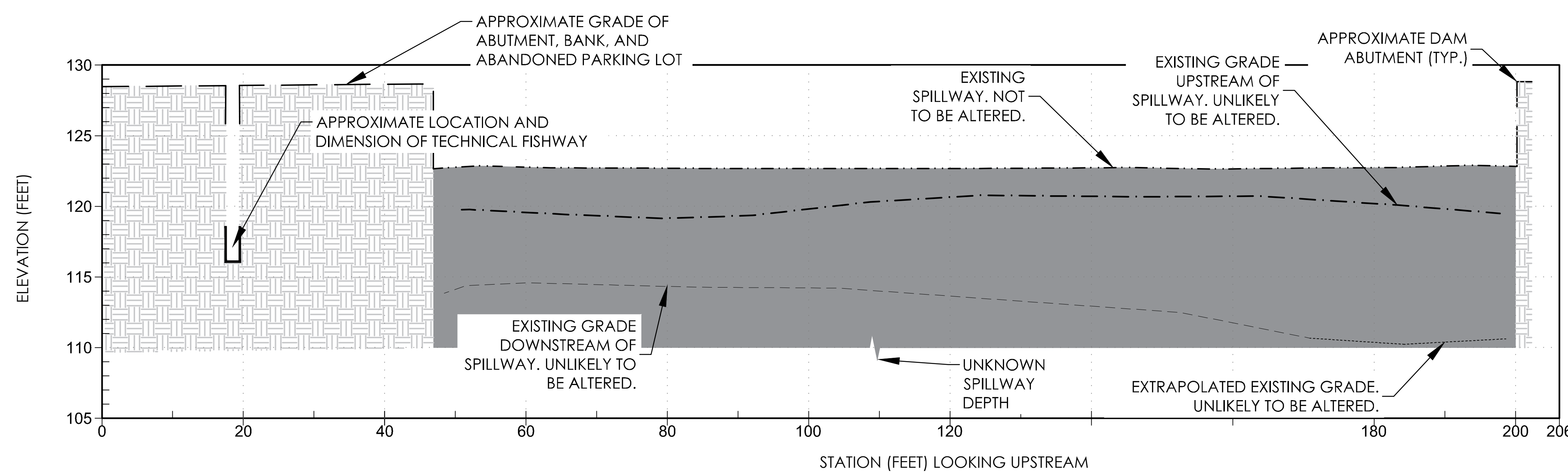


A AOP 2 - FIRTH CLIFF DAM PROFILE
ALTERNATIVE 2: FISHWAY
MOODNA CREEK

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

US Army Corps of Engineers

MARK | DESCRIPTION | DATE

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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

MOODNA CREEK
AOP 3 - ORRS MILL DAM
ALTERNATIVE 1:
DAM REMOVAL

1 PLAN VIEW
1" = 150'

0 30 60 90 120 150 300 450 600 FEET

SCALE: 1" = 150'

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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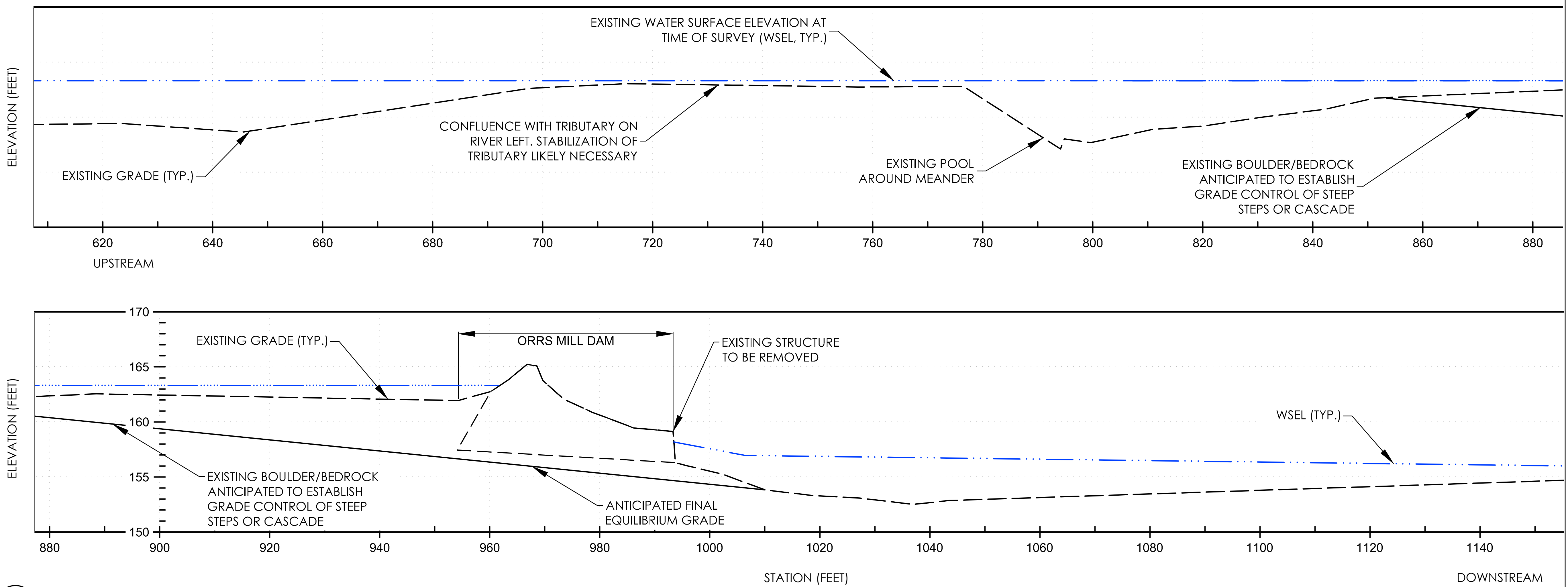
HUDSON RIVER HABITAT RESTORATION
MOODNA CREEK
ORANGE COUNTY, NY
MOODNA CREEK
AOP 3 - ORRS MILL DAM
ALTERNATIVE 1 - DAM REMOVAL

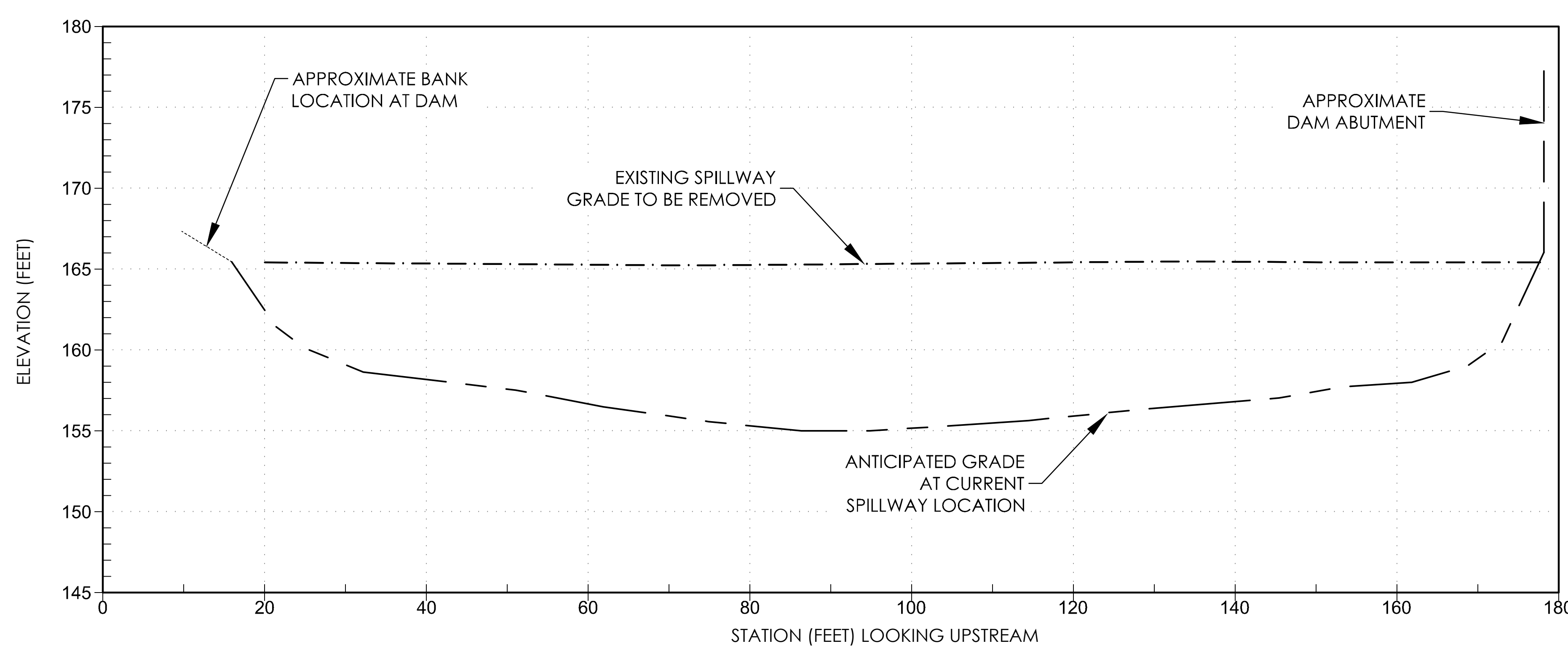
SHEET ID
1

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

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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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MOODNA CREEK
AOP 3 - ORRS MILL DAM
ALTERNATIVE 2: DAM BREACH

Legend
- River Profile
- Project Footprint
- Dam Breach
- Proposed Boulder

1 PLAN VIEW
1" = 150'

0 30 60 90 120 150 300 450 600 FEET

SCALE: 1" = 150'

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

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
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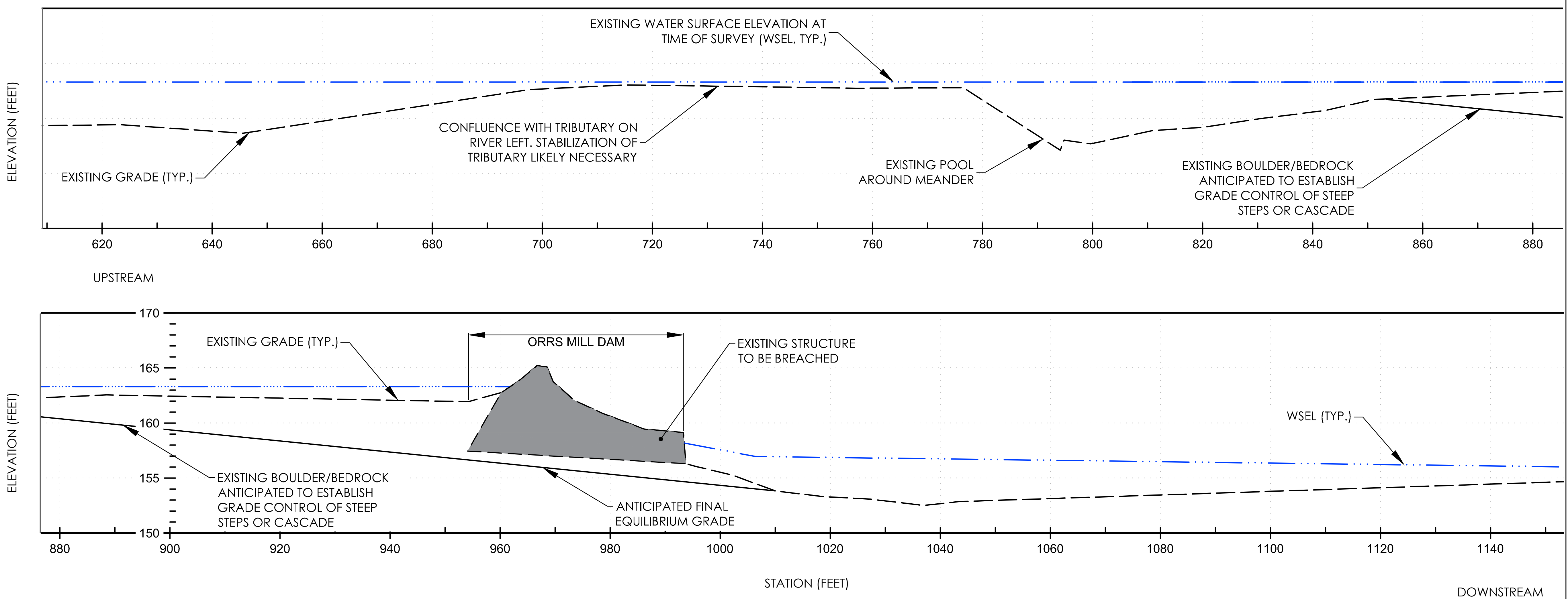
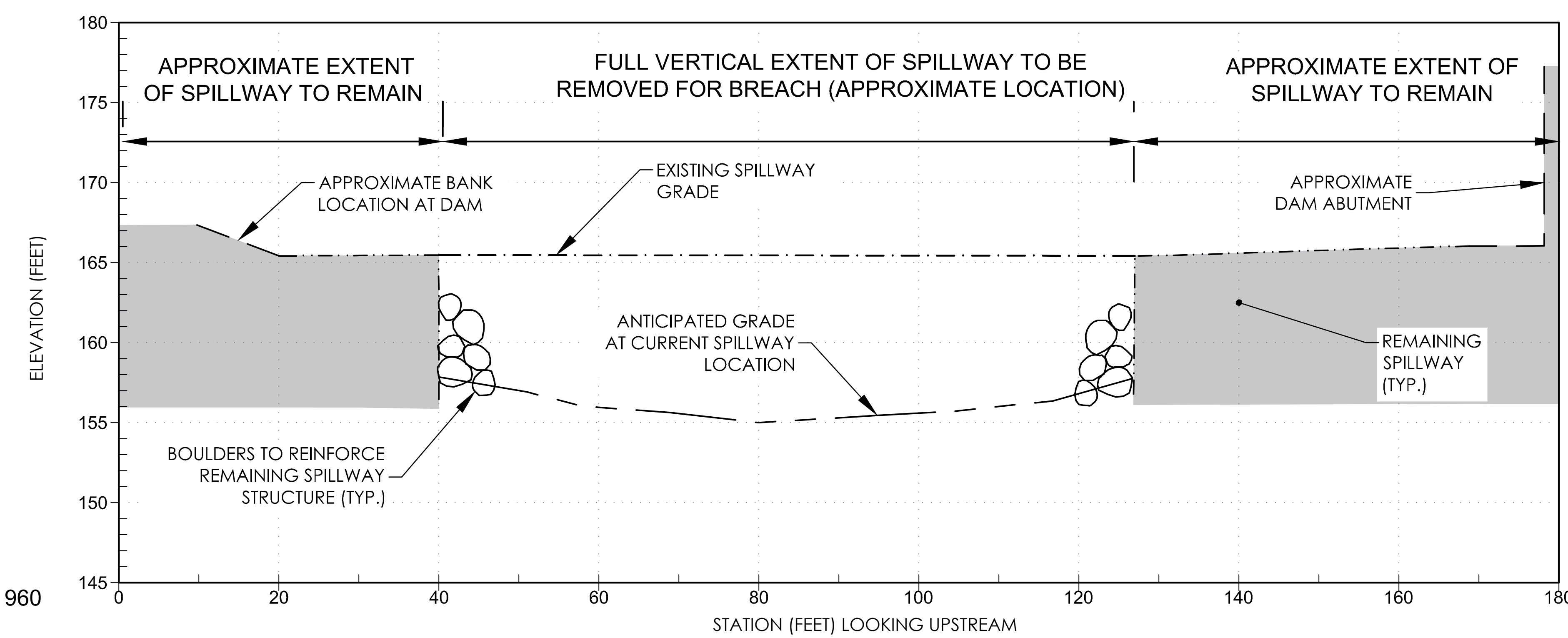


A AOP 3 - ORRS MILL DAM PROFILE
ALTERNATIVE 2: DAM BREACH
MOODNA CREEK

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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	SIZE: 11x17

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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

RONDOUT CREEK
EDDYVILLE DAM
ALTERNATIVE 1: FISHWAY

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

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

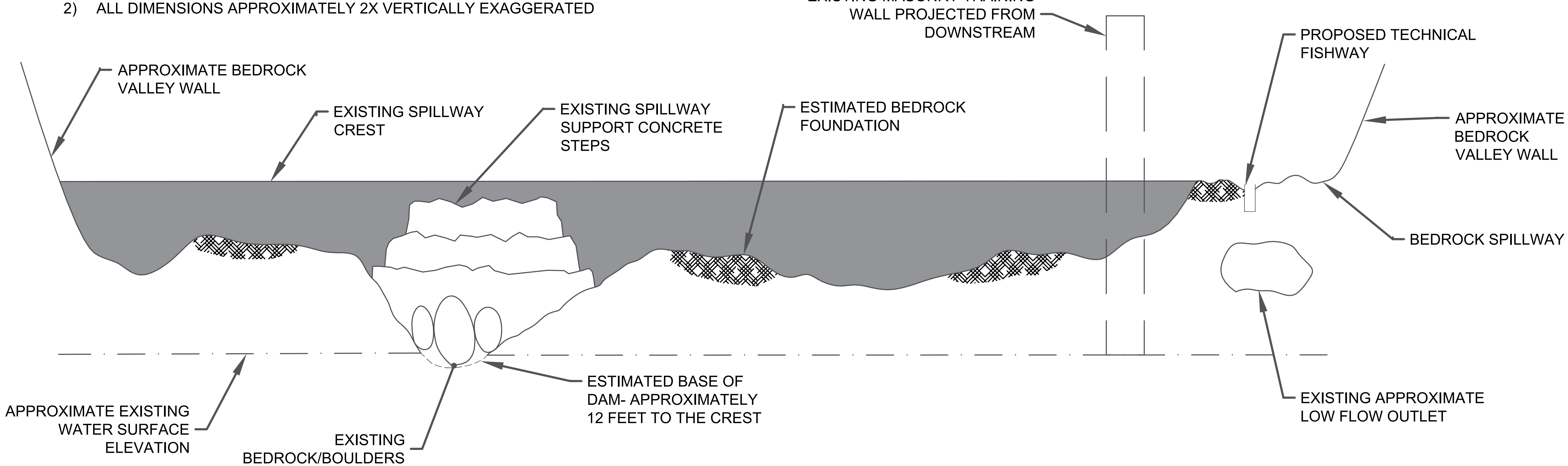
RONDOUT CREEK
EDDYVILLE DAM
ALTERNATIVE 1 - FISHWAY

SHEET ID
1

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

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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
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

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

U.S. ARMY CORPS OF ENGINEERS
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RONDOUT CREEK
ULSTER COUNTY, NY

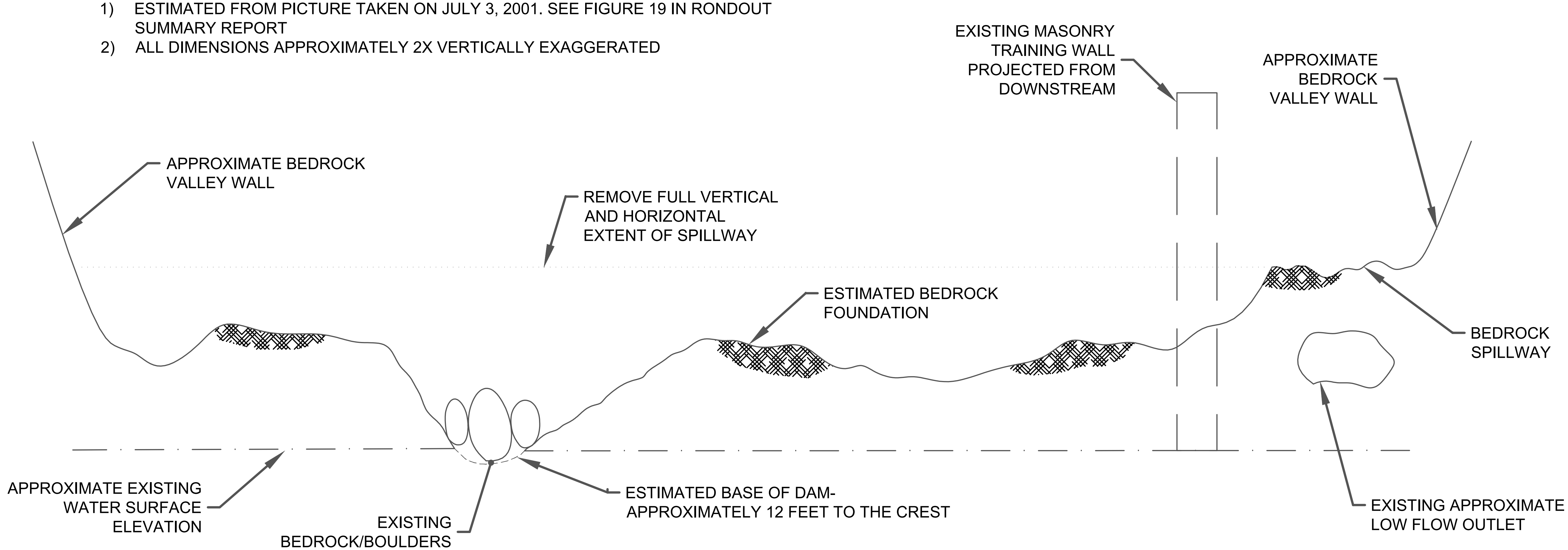
RONDOUT CREEK
EDDYVILLE DAM
ALTERNATIVE 2 - DAM REMOVAL

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 REMOVAL - CROSS SECTION
ALTERNATIVE 2
RONDOUT CREEK

US Army Corps of Engineers®

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EDDYVILLE DAM
ALTERNATIVE 2 - DAM REMOVAL

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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 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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ULSTER COUNTY, NY

RONDOUT CREEK
EDDYVILLE DAM
ALTERNATIVE 3 - DAM NOTCHING

SHEET ID
1

OCT.2018

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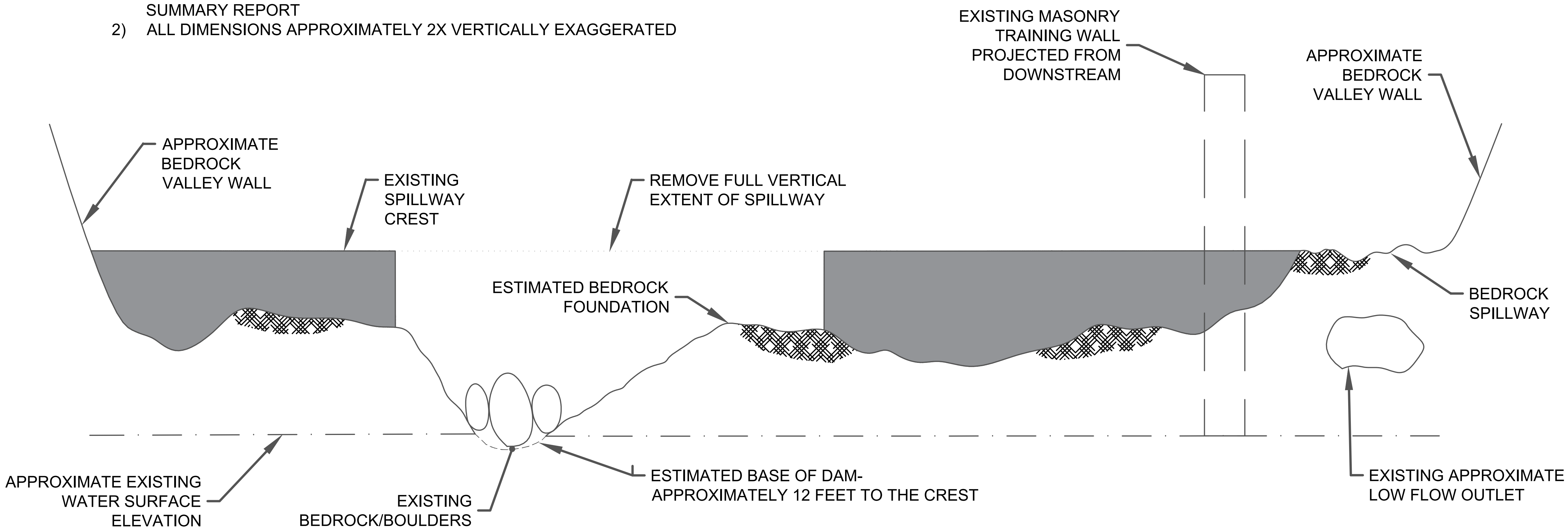

A DAM NOTCHING - CROSS SECTION
ALTERNATIVE 3
RONDOUT CREEK

US Army Corps of Engineers®

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