APPENDIX G1. CIVIL/STRUCTURAL

Engineering Appendix – Civil Engineering

Surveys & Mapping:

Surveys and mapping were provided by Fairfax County. Most of the data was provided in GIS format, with the exception of field run-cross-sections and storm drain surveys which were provided in autocad format. For use in the feasibility drawings, all GIS data was imported to Autocad.

One-foot contours were provided for the study area. Information about the survey method, datums, target scale, targeted contour interval, accuracy, etc. was requested, but only partial information was provided (July 29, 2004 letter from Baker Engineering). The contours appear to have been targeted for a map scale of 1"=100' or so, and a contour interval greater than one-foot (for example, the contours do not indicate curbs along the roads). A text file was provided stating "one-foot contours, interpolated from 5-ft contour data". Discrepancies were noted between the contours shown along the North streambank and the spot elevations shown on the field-run cross-sections S-2 and S-3. The aerial imagery and the pavement outlines do not reflect the ramp that was built along the north side of the stream.

Fairfax County provided detailed field surveys & mapping for the storm drain channels and storm drain pipes. The USACE created contours for these areas as a separate drawing file (456v-sp01a). The old contours within these areas were deleted from the main contour drawing (456v-sp01).

Utility surveys (quality level "B") for the immediate area around the levee was provided by the County through a contract with So-Deep, Inc. They located utilities using surface geophysical methods and review of record mapping. They did not provide surveys for the gravity sanitary sewers. Additional utility mapping was provided in GIS format for sanitary sewer pipes and water mains. As-built record plans were requested for all storm drains and sanitary sewer pipes that cross through the line of protection. As-built plans were received for the sanitary sewer siphon and 48" pipe, the Jones Point sewage pumping station, and the sewer pipes outfalling to the pumping station. No other as-built plans were received.

Cross-section data was provided for four cross-sections across Cameron Run. The cross-sections were field-run after the June 2006 storm.

Wetland locations were delineated by USACE Planning Division.

Horizontal control: NAD 83, State Plane Virginia

Vertical control: Appears to be NGVD29

The original mapping data is filed under R:/civil/ Huntington LFP/data/surveys and mapping/GIS_CADD. For use as autocad plan base sheet, the GIS data was imported into Autocad files, and are filed under the main project folder as xreferences.

Based on the accuracy of the mapping data, multiple sources of the data, and the above mentioned discrepancies, new topographic mapping should be done during the preconstruction engineering and design phase.

CADD:

A digital terrain model of the area was not provided. The USACE prepared digital terrain models of the existing ditches based on the County's field-run survey. The USACE also prepared an approximate digital terrain model "existing surface from GIS" using the 1-foot contour data and points. This was revised by pasting the existing ditch surfaces onto it, and it is called "**Final existing surface**".

The stream cross-section data was too widely spaced to create a terrain model of Cameron Run. Instead, a model "existing cross sections" was created in the immediate vicinity of the cross-sections.

Levee Alignments

Three levee alignments were investigated schematically.

Alignment 1 was located close to the stream bank (offset approximately 200' from the stream centerline). This alignment has the benefit of minimizing impacts to the park and providing room for interior ponding (if needed); however, it impacts wetlands and increases the floodplain elevation more than the other 2 alignments.

Alignment 2 was located further away from the stream (offset approximately 350' from the stream centerline). This alignment should cause the least increase to the floodplain elevation; however, it bisects the park and provides less room for interior ponding (if needed).

Alignment 3 was located as close to the streambank without impacting the wetlands. The alignment will impact the baseball field, bike path, and playground. Portions of the playground and bike path can be relocated; however, the baseball outfield will be shortened as shown.

Alignment 3 was advanced to the feasibility stage with minor revisions.

Levee Profile

The Water Resources Section provided the top of protection profile for the 100-year event with risk & uncertainty. To provide additional protection, the top of levee profile shown is approximately 0.5-feet higher. The eastern tie-out elevation should be verified in the next phase with a more accurate topographic survey. The top of levee profile was simplified as a straight line with a uniform slope.

Levee Cross-Section

The Geotechnical Branch provided the typical sections shown on the drawings. According to the Water Resources Section, riprap is not needed on the levee banks.

Levee Drainage Structures

Currently, the Huntington community is drained to Cameron Run by six drainage channels/pipes. It is advantageous to provide a few large gravity outlets than numerous smaller ones (EM 1110-2-1413 para. 5-2b). Two gravity drainage structures through the levee are proposed, one at each end of the levee. The drainage structures will have flap gates and sluice gates in accordance with EM 1110-2-1913. The flap gates are designed to close automatically when floodwaters rise. The sluice gates provide a secondary way to prevent backflow if the flap gates fail. An additional drainage structure was investigated near the middle of the levee, but since it would require excavating and maintaining an outfall channel through wetlands, it was not pursued further. A storm drain system adjacent to the levee is proposed to direct normal flows to the drainage structures. This system will be susceptible to siltation due to the mild slope, so frequent maintenance is expected.

The existing storm drain outfalls are set very low, within the tidal range. The new drainage structures will likewise be set low. Based on the Cameron Run cross-sections, it appears that the stream has silted in above the existing storm drain outfall elevations. Therefore, Cameron Run and the storm drain outfall channels should be dredged. Since this stream rises rapidly, the system is heavily dependent on the automatic flap gates. As a result, maintenance dredging of the outfall channels down to el. -2.5 will be required to maintain operation of the gates. This may require some maintenance dredging of Cameron Run as well.

To minimize excavation and stream impacts, the westernmost drainage structure is aligned with the existing drainage channel. For the inlet and outlet structure, non-flared walls were chosen for the same reason. The backwall of the structures are parallel to the levee contour to avoid warping the levee slope, and the box culvert will extend beyond the outlet structure to facilitate the flap gate. This design is based on similar structures used at nearby Fourmile Run.

Box culverts were chosen by the hydraulic engineer for the drainage structures through the levee. EM 1110-2-2902 Chapter 3 only discusses using circular concrete pipe for levees. The EM also specifies using joints that are pressure rated. Since precast box culverts typically do not have pressure-tight joints, cast-in-place box culverts are assumed for the box culverts beneath the levee. Further investigation of precast box culvert joints, or alternative circular pipes, should be done during the next phase. Drainage fill is provided around the landside ends of the pipes in accordance with EM 1110-2-1913. For pipes *beneath the levee foundation*, the EM requires outletting the drainage fill to the surface by encapsulating the next manhole in drainage fill. This is the case for the sanitary drainage structure. The box culverts beneath the levee are assumed to be cast-in-place; will be 12 inches thick along the floor, walls, and the top; and reinforced with #4 bars in the longitudinal direction at each face and #5 bars in the transverse direction at each face.

Headwalls and aprons that extend from the box culverts are assumed to be cast-in-place and 12 inches thick. The headwalls are to be reinforced with #4 bars in the vertical direction at each face and #5 bars in the horizontal direction at each face. The aprons are to be reinforced with #4 bars in the longitudinal direction at each face and #5 bars in the transverse direction at each face.

High Flow Diversion and Pumping Station

During a high-water event, the drainage structure gates will be closed, and flows will be diverted to a centrally located pump station via a separate drainage system. Both ditches and pipes were considered for the diversion system, and conceptual plans were developed. A ditch would be a significant feature in this park, and it would remain wet due to the mild slope. Therefore, a piped system was chosen. Precast box culverts are acceptable for the diversion system. The diversion culverts were offset from the levee toe so that the trench excavation line would not affect the levee toe. However, the culvert was located near the toe at the westernmost end to avoid private property impacts (at the request of Fairfax County).

The diversion system was designed to begin diverting flows to the pumping station when water in the main outfall channels reaches elevation 3.5. Mean higher high water in Cameron Run is approximately el. 2.7 (Cameron Run Sediment Study, 2007), so the system is very dependent on the operation of the automatic flap gates on the drainage structures. If the flap gates were to not close, a moderate storm occurring during a high tide could cause the pump station to operate. As a result, maintenance dredging of the outfall channels down to el. -2.5 will be required to maintain operation of the gates. This may require some maintenance dredging of Cameron Run as well.

The pumping station was not detail-designed for this study, and an alternatives analysis was not done. According to EM 1110-2-3105 (chapter 7), pumping stations can discharge over the levee or through the levee. For the purpose of developing a conceptual cost estimate, it is assumed that the pumping station will be similar to the Edmonston or Colmar pumping station on the Anacostia River project. Those pumping stations receive drainage from multiple pipes and channels, and they discharges through the line of protection by way of a discharge chamber and gravity pipe. To avoid excavating and maintaining a discharge channel through the wetland, the discharge pipe will be elevated a few feet above the wetland.

For the pump station concept plan, the foundation is assumed to be a three foot thick mat foundation reinforced at the top and bottom in each direction with #7 bars. Two 12 inch thick floor slabs will be poured for the pump station. One slab includes the sump area while the other includes the discharge chamber. The two slabs cover approximately 1200 square feet and are reinforced along the bottom in each direction with #8 bars and at the top in each direction with #4 bars.

The walls in and around the pump station vary in thickness from 12 inches to 18 inches to 24 inches. The upper level exterior walls of the pump station are 12 inches thick and are reinforced with #8 bars at each face in the vertical direction and #6 bars at each face in the horizontal direction. The lower level exterior walls are 24 inches thick and are reinforced with #10 bars at each face in the vertical direction and #6 bars at each face in the horizontal direction. The lower level 18 inches interior walls are reinforced with #8 bars at each face in the vertical direction and #6 bars at each face in the horizontal direction.

The roof of the pump station is assumed to be constructed with steel framing members that support a light gage metal deck.

Ponding Area for Pumping Station

In addition to the storage provided by the channels and pipes, the area adjacent to the levee can be used as a ponding area. To provide additional storage, excavated ponding areas were investigated. The area was limited to the park adjacent to the levee, but not extending into the wooded areas. Geotechnical limitations required keeping the bottom at el. 6.0 or greater. Due to this, the only way to provide significant storage is to grade the entire area down to el. 6.0. As a result, the area will drain poorly, and will not be suitable for park activities. At the request of the County, the design includes this ponding area.

Access Routes

The levee can be accessed from three locations as shown on the drawings. Two of the routes are to be elevated above the anticipated interior ponding elevation (8.0). The Fenwick Drive access point is below the anticipated interior ponding elevation (el. 8.0). The end of Fenwick Drive is shown to be raised to accommodate the diversion culverts; however, it will still be up to 1-foot below the ponding elevation.

Ramps are provided to the top of the levee and down to the riverside toe. To allow for recreational access, two handicap accessible ramps are provided. A maintenance route is shown along the riverside toe to allow for maintenance of the drainage structure outfalls.

Beltway Info

VDOT provided survey drawings (contours-rte1.dgn and main-survey-align.dgn) showing spot elevations along the roadway and shoulder. These were done in 1996 using the NGVD29 datum. For use in the RAS model, the drawings were imported into Autocad and roughly translated, rotated, and scaled to closely match the horizontal datum. These drawings were provided to the Water Resources Section for use in the RAS model. Reconstruction of this area of the beltway is on-going, and more is planned in the near future.

Sanitary Sewer Impacts

The line of protection will cross an existing 48” sanitary sewer pipe and an existing 16” sewer pipe near the east end of the levee. EM 1110-2-1913 discourages pipes beneath levees, and allows them only if they meet certain criteria. The criteria typically requires upgrading the pipe and adding provisions for emergency closure to prevent floodwaters from backing up through the pipe.

Since the 48” pipe crosses the line of protection, a drainage structure with a sluice gate would be required to prevent backflow of floodwater, assuming that the pipe would be flooded by Cameron Run. This sluice gate control manhole would need to be monitored during a flood event, and the sluice gate would only be closed if backflow was observed. Construction of a sluice gate on an existing 48” sanitary sewer pipe raises the following concerns:

1. Sewage flow would need to be maintained during construction.
2. It would require personnel on the ready to close the gate during a storm.
3. Since this stream rises rapidly, it would be difficult to close the gate in time.
4. Closing the gate would cause sewage flows to overflow into the protected area.
5. Closing the gate would impact the Jones Point Pumping Station.
6. The sewage flows may have to be considered in the stormwater pumping station design.

Due to these concerns, the assumption that the sewer would be flooded was investigated. The as-built drawings for the 48” sewer were reviewed for possible flood entry points:

The manhole located just on the riverside of the levee is susceptible to flooding. However, it may be possible to waterproof and anchor it to avoid flooding.

The 48” sewer transitions into an inverted siphon in order to pass beneath Cameron Run. The influent chamber to the siphon is underground, but it has an above-ground access structure with a low opening around el. 15.0. This is above the 100-year water surface profile, but below the top of protection.

The siphon consists of ductile iron pipes encased in concrete and supported on piles as it crosses below Cameron Run. Risk of flooding appears minimal.

The outlet chamber for the siphon is underground, but it has a 10” air vent pipe with an opening around el. 15.0. This is above the 100-year water surface profile, but below the top of protection.

The next manhole north of the beltway is elevated above the levee, and flooding is not expected.

The risk of sewer flooding was discussed with the District’s engineering technical leaders, and the conclusion was that the feasibility design should include a sluice gate drainage structure on the 48” sanitary sewer.

The 48” pipe beneath the levee was reviewed for conformance with the strength and watertightness requirements in EM 1110-2-2902 and EM 1110-2-1913. As-built plans for the 48” pipe are dated 1980. The pipe is noted as ASTM C-76, Class IV RCP on a concrete cradle. It is buried 10-feet deep, and an additional 5-feet of levee will be constructed on top of it. This type of pipe meets the minimum requirements, but there is no indication of the type of joints used. Therefore, since a portion of the pipe will have to be removed anyway to construct the sluice gate structure, all of the pipe beneath the levee will be replaced. Drainage fill is provided around the landside end of the pipe in accordance with EM 1110-2-1913. For pipes *beneath the levee foundation*, the EM requires outletting the drainage fill to the surface by encapsulating the next manhole in drainage fill.

The 16” pipe could be relocated to avoid crossing the levee, or it could be modified to meet the criteria. Relocation has the advantage of less risk, but may be more costly. This was discussed with the District’s engineering technical leaders, and the conclusion was that the feasibility design should include relocating the 15” pipe.

The 16” sewer pipe outfalls to a pumping station (Jones Point Pumping Station) located near the east end of the levee. Based on the as-built plans, the wet well won’t flood until flood waters rise above el. 18.0; therefore, direct flooding of the well is not expected. As a precaution, backflow preventers are recommended on all sanitary house connections to prevent sewage backflow in the event that the pumping station fails.

The stormwater pumping system will also impact the sanitary sewer system. If interior ponding behind the levee extends over the sanitary manholes, stormwater could flood the manholes. Stormwater and sewage could then backup into basements through the sanitary house connections. It is assumed that the manholes within the ponding area are not watertight. Therefore, they should be waterproofed and modified with watertight manhole lids. They may also need to be modified to prevent flotation. Stormwater and sewage could also backup into the basements through any house cleanouts that may exist within the ponding areas. Therefore, backflow preventers may be needed on all sanitary house connections.

Other Utility Impacts

As shown on the drawings, light poles and a television line will need to be reconstructed. The roadway work will also require raising some manholes, meter covers, valve covers, and a hydrant.

Regulatory/Compliance Considerations:

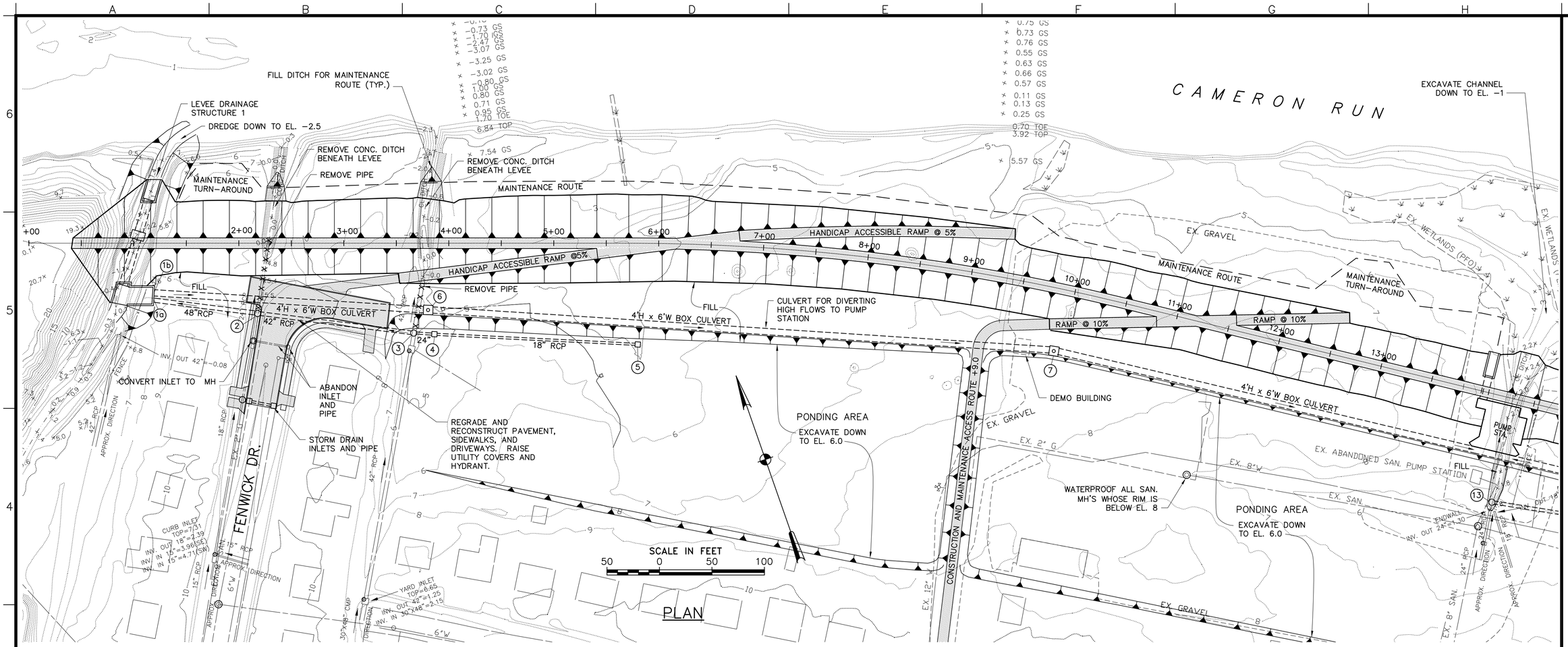
Construction will affect existing wetlands, streams, tidal waters, and trees.

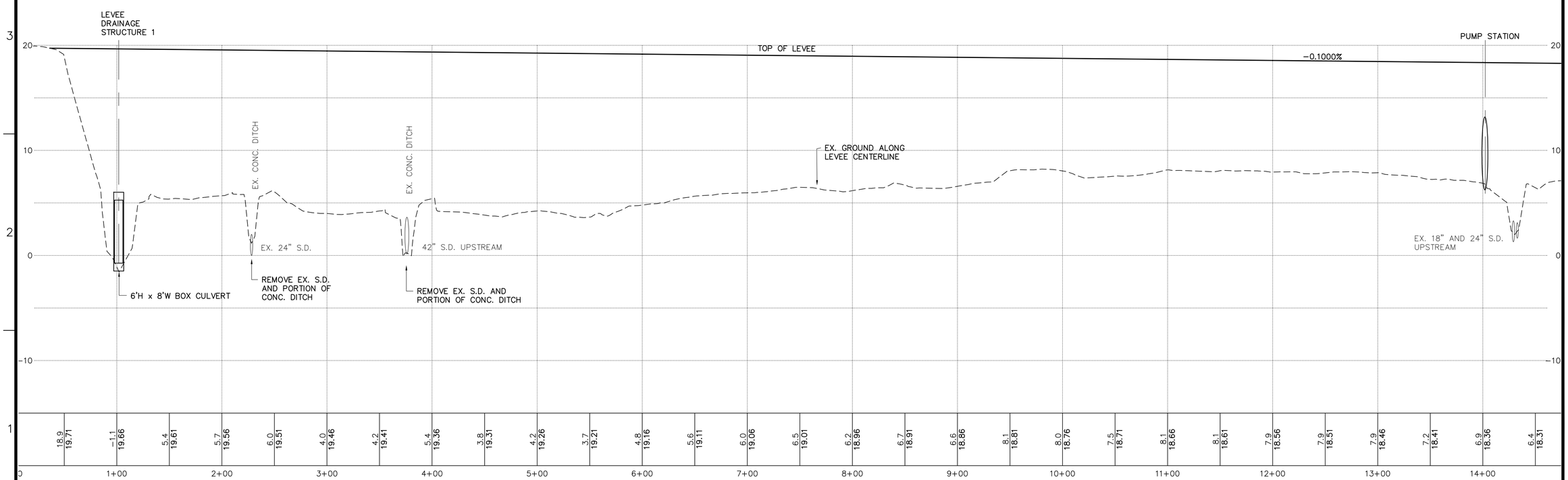
Required permits/approvals may include: erosion and sediment control, NPDES, possible forest conservation (if applicable), and authorization to work in streams and wetlands.

Remaining Effort:

Several civil engineering-related tasks are deferred to the next phase:

1. Topographic surveys & mapping suitable for final design/preparation of construction drawings.
2. At the east end of the levee, verify the tie-out elevation based on the survey.
3. Surveys & mapping of sanitary sewers.
4. Further investigation of the potential use of pre-cast box culverts or circular culverts in lieu of cast-in-place culverts for the drainage structures through the levee (due to concerns about pressure-tight joints).
5. Alternatives analysis of the interior drainage system (pumping station, culverts, ponding area).
6. If a ponding area is included as part of the interior drainage system, design modifications to the sanitary sewer system within the ponding area to prevent flooding of the sewers.
7. Assess impacts caused by ponding area (loss of recreational areas, mosquitoes, etc.).
8. Assess need for backflow preventers at each house connection.
9. Design toe drain outfall.
10. Approval of truck route to site for construction. Consider impacts/damage to roadways due to numerous truck loads of materials.
11. Approval of the sanitary sewer modifications.
12. Approval of impacts to the park, especially if a ponding area is part of the final design.
13. Final detailed design of levee, drainage structures, storm drain system, roadway modifications, utility modifications, pumping station, grading, erosion & sediment control, stormwater management (if applicable), landscaping, recreational features, traffic control, and access routes.
14. Preparation of construction drawings.
15. Specifications
16. Permits.
17. Preparation of operations & maintenance manual.





LEVEE PROFILE

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HUNTINGTON
FAIRFAX COUNTY, VIRGINIA
FLOOD DAMAGE REDUCTION STUDY

PLAN & PROFILE

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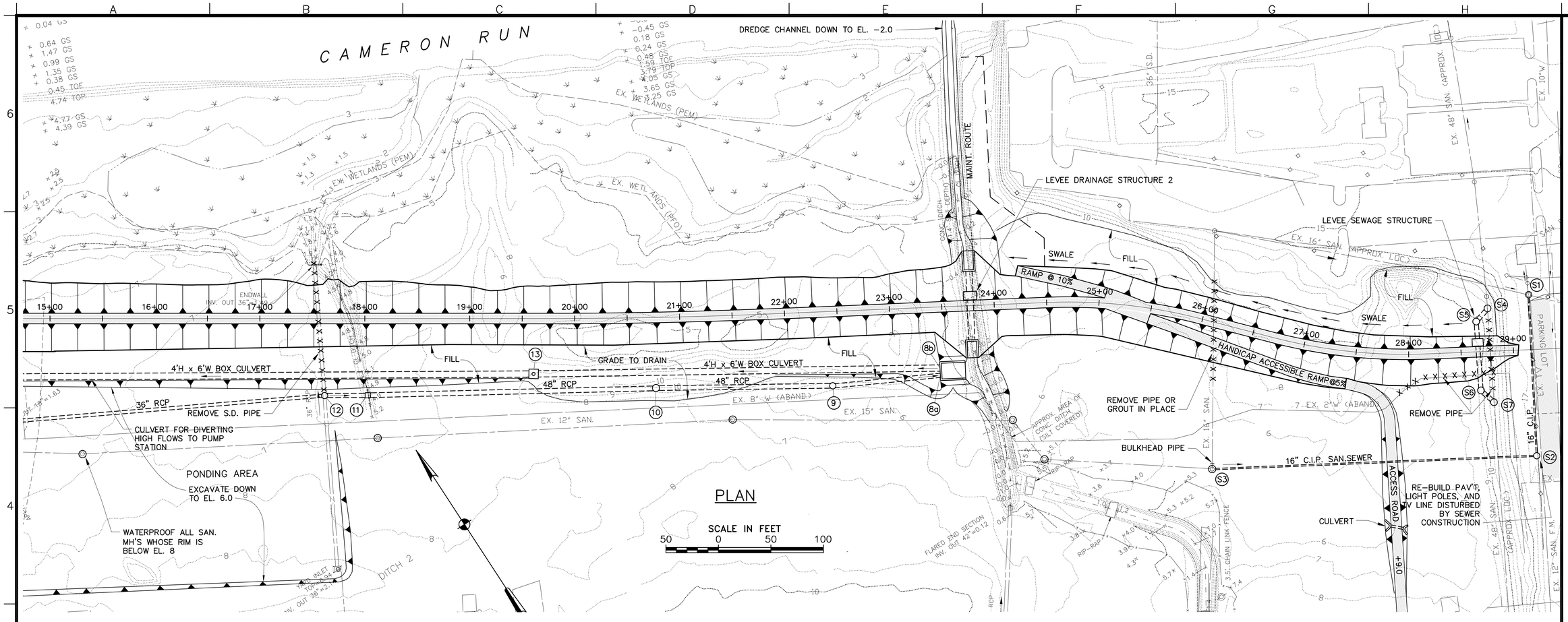

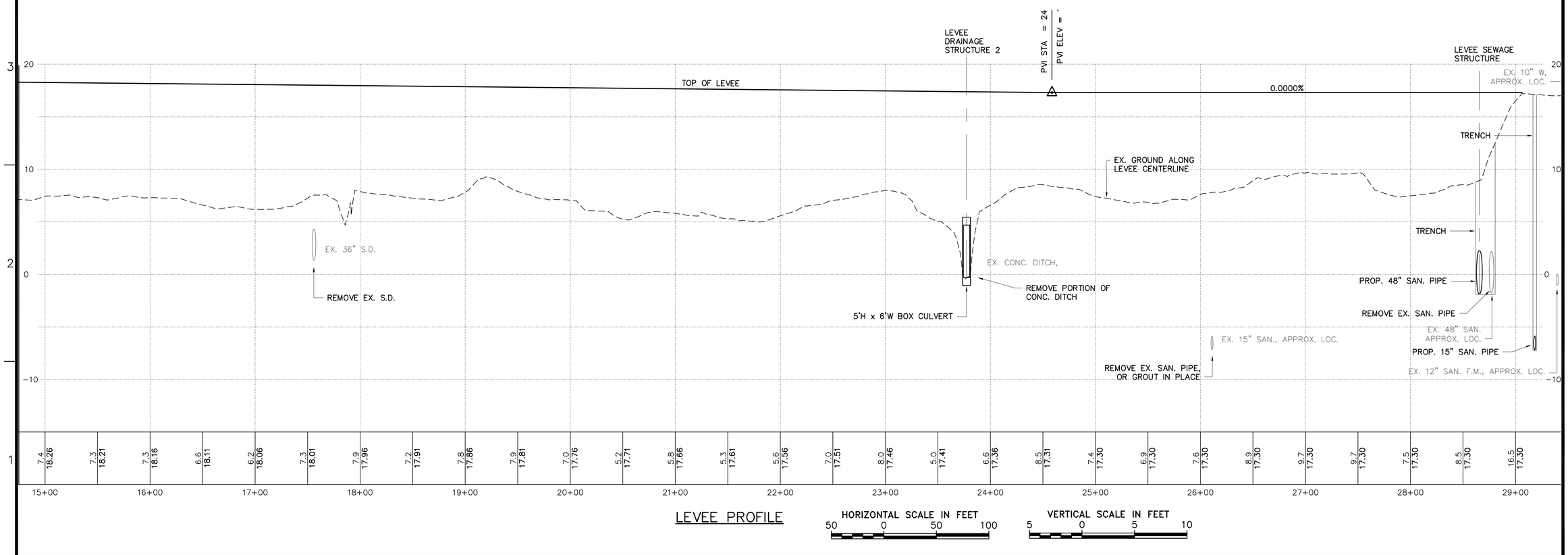

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PLAN & PROFILE

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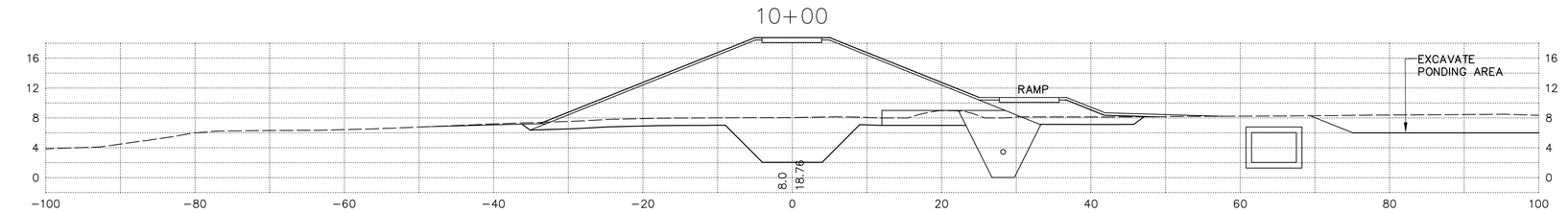

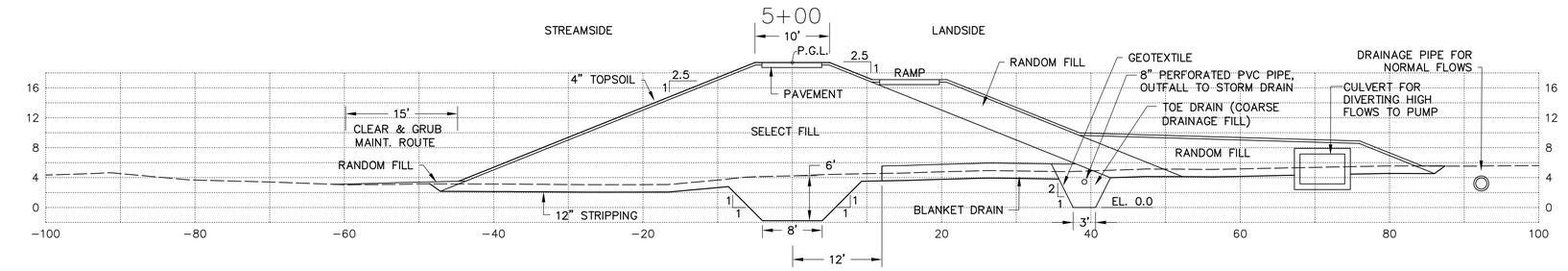

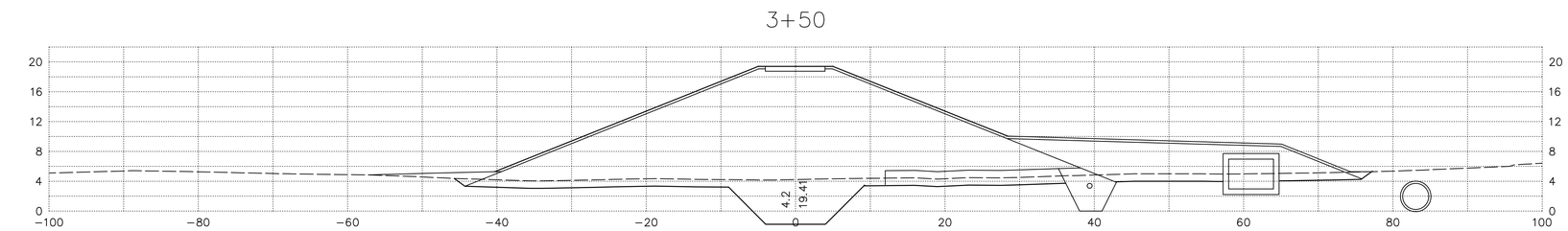

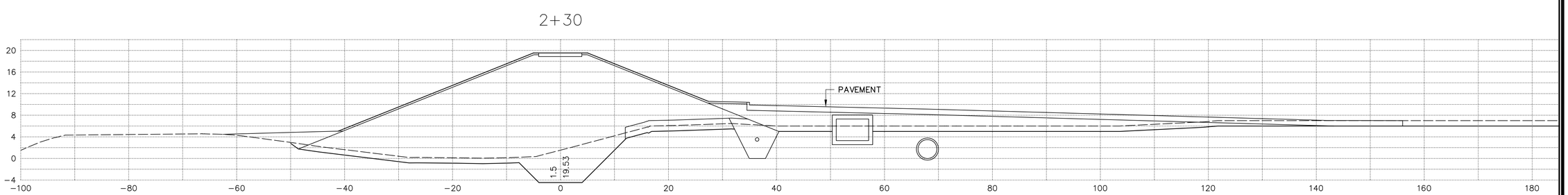

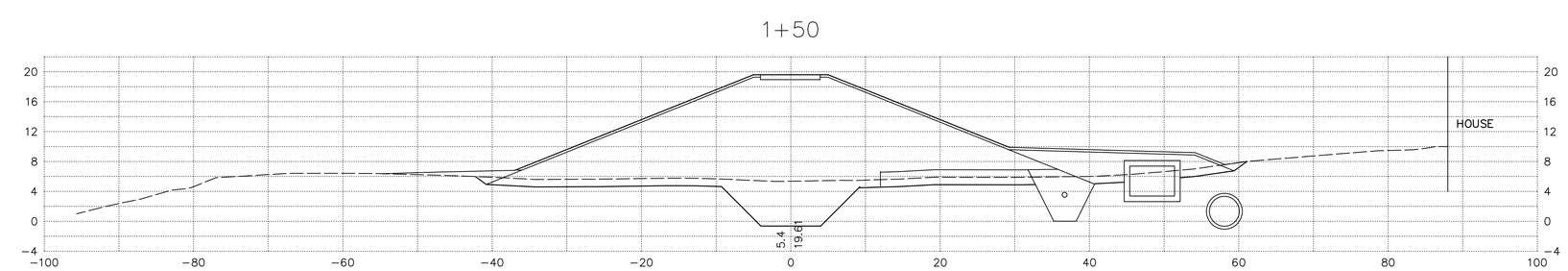

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LEVEE CROSS SECTIONS

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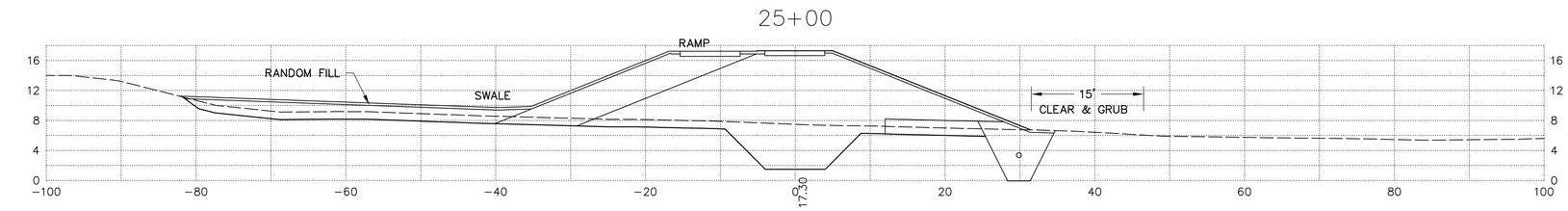

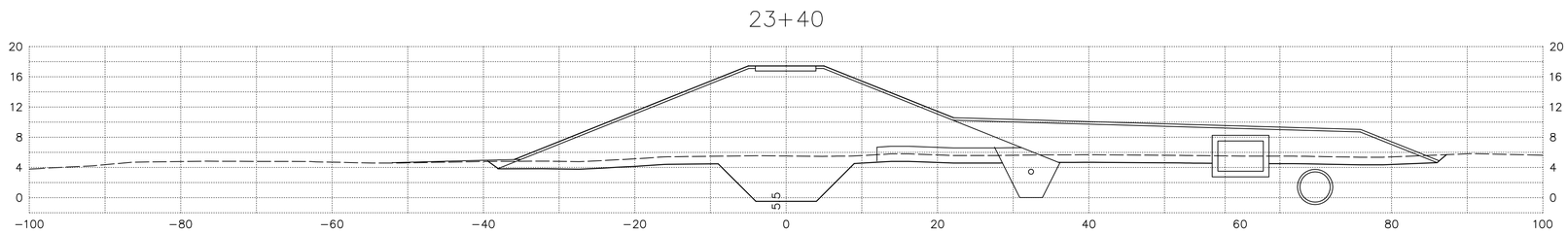

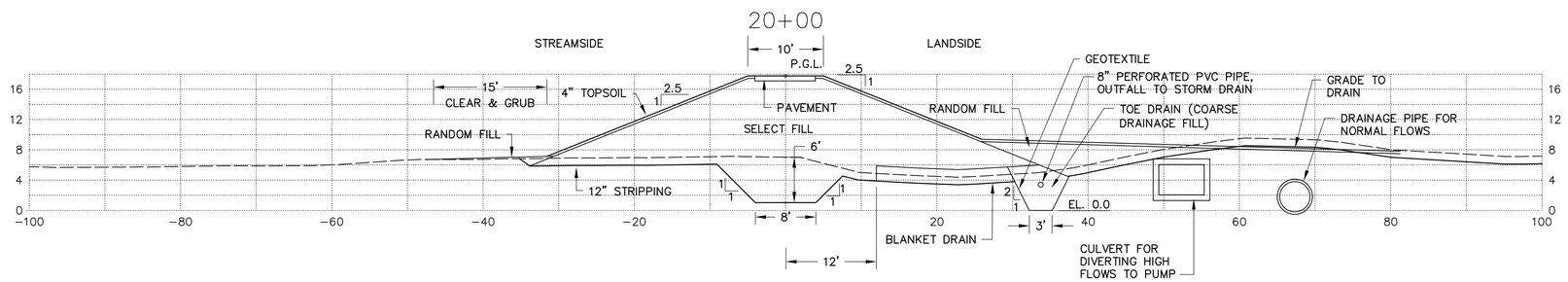

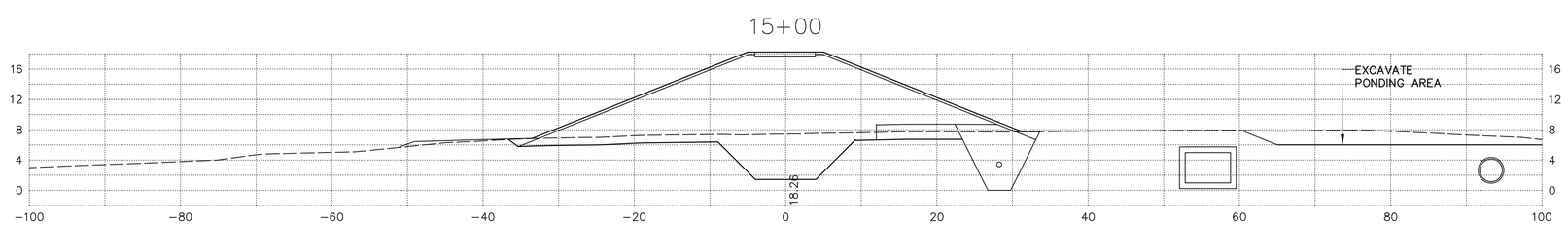

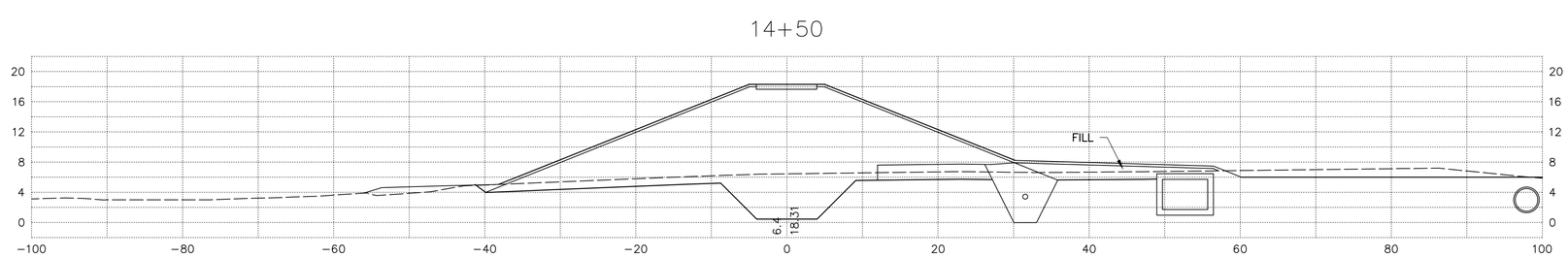

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FLOOD DAMAGE REDUCTION STUDY

LEVEE CROSS SECTIONS

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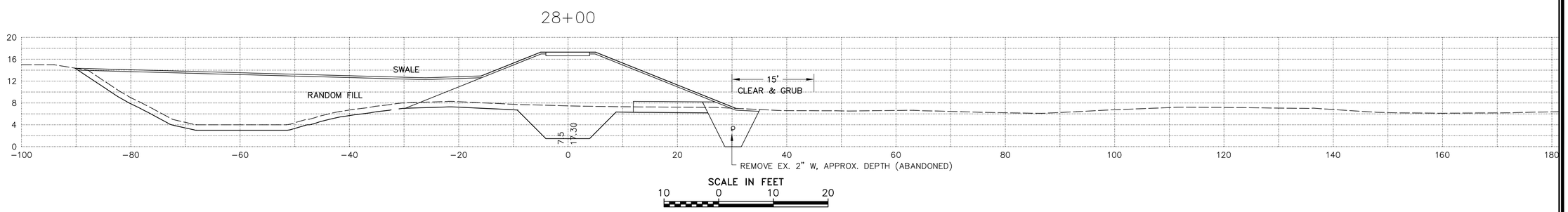

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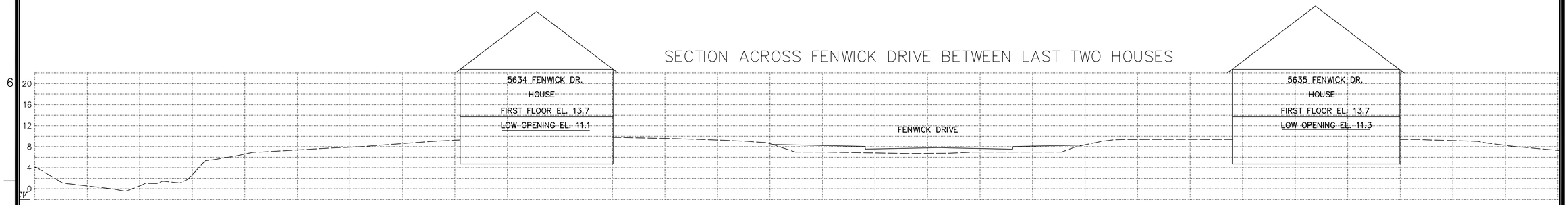

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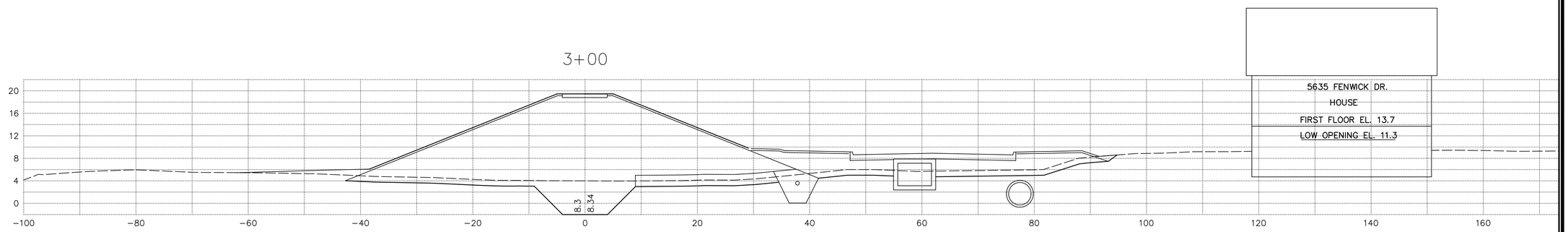

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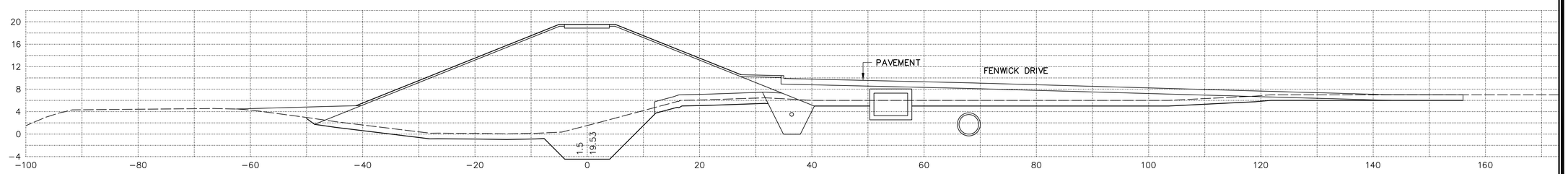

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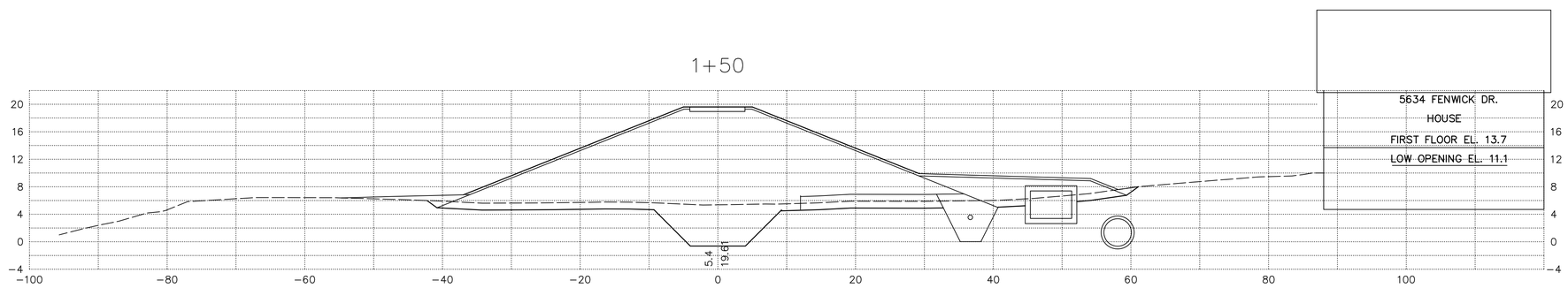

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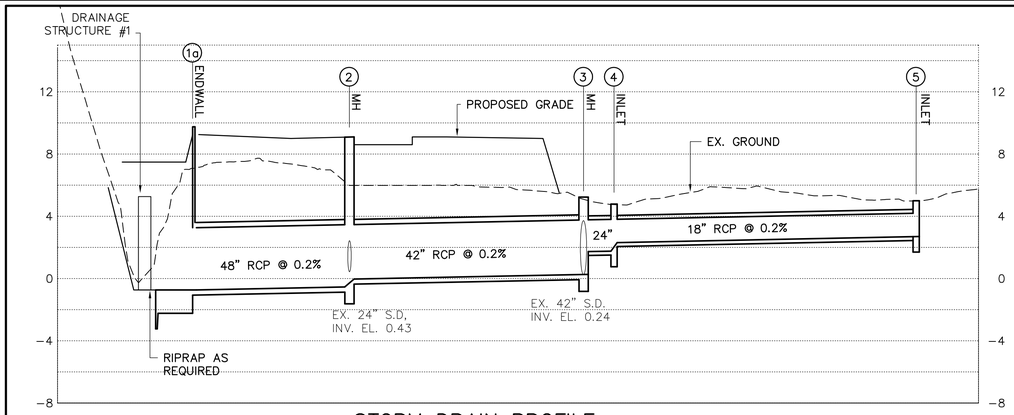
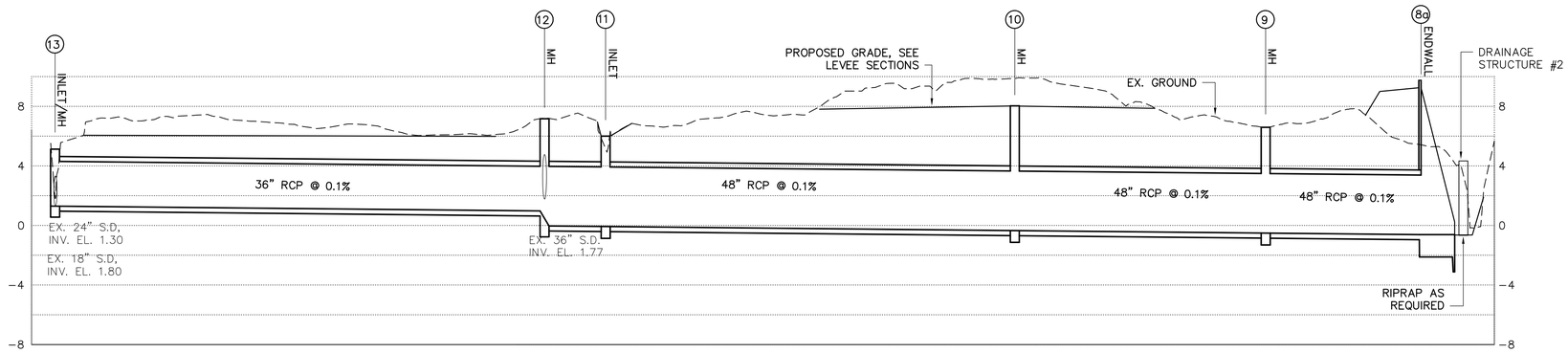
FENWICK DRIVE SECTIONS

Sheet Number:

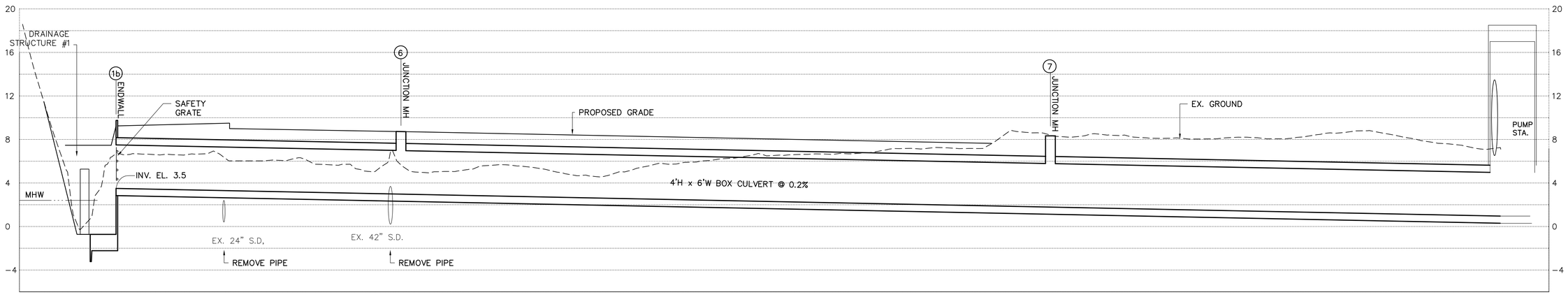
W304



STORM DRAIN PROFILE



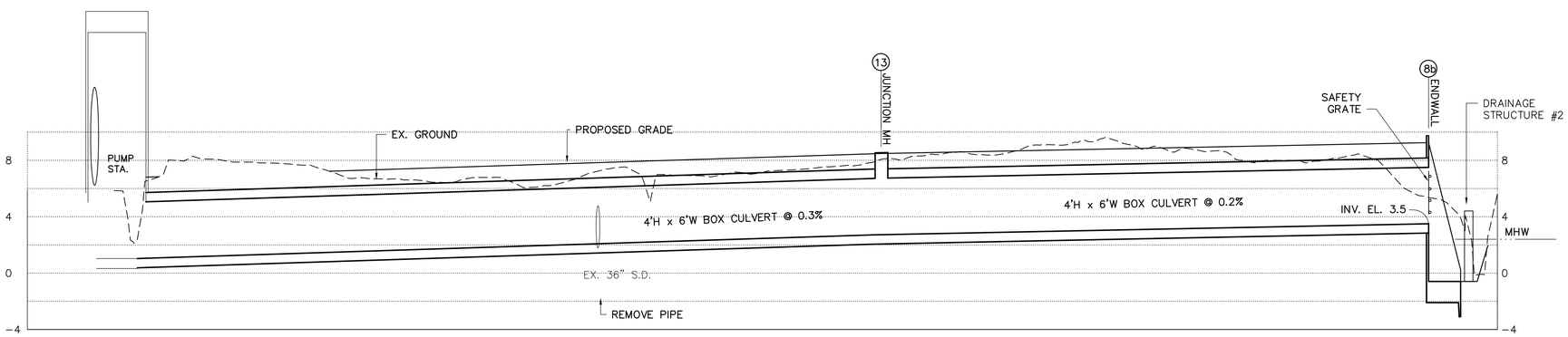
STORM DRAIN PROFILE



HIGH FLOW DIVERSION PROFILE

HORIZONTAL SCALE IN FEET
50 0 50 100

VERTICAL SCALE IN FEET
5 0 5 10



HIGH FLOW DIVERSION PROFILE

US Army Corps of Engineers
Baltimore District

SYMBOL	REV.	DATE	DESCRIPTION	BY

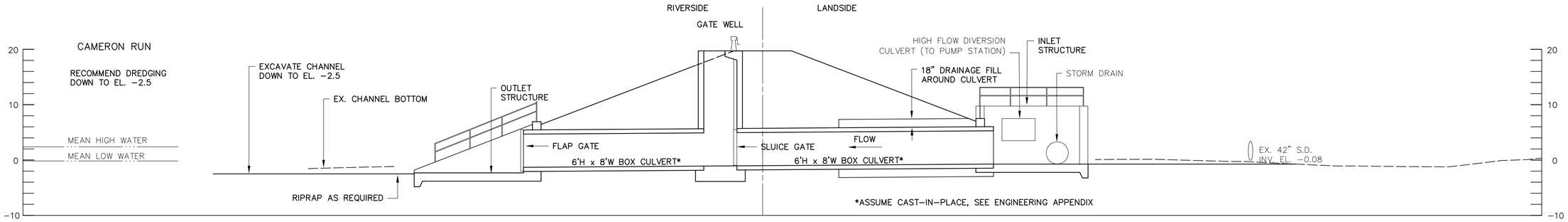
U.S. ARMY ENGINEER DISTRICT, BALTIMORE
CORPS OF ENGINEERS
BALTIMORE, MARYLAND

PLATE | DRAWING NUMBER XXXXX | FILE NAME 456W501
SCALE: AS SHOWN | DATE: OCT 2008 | PLT SCALE: XXX

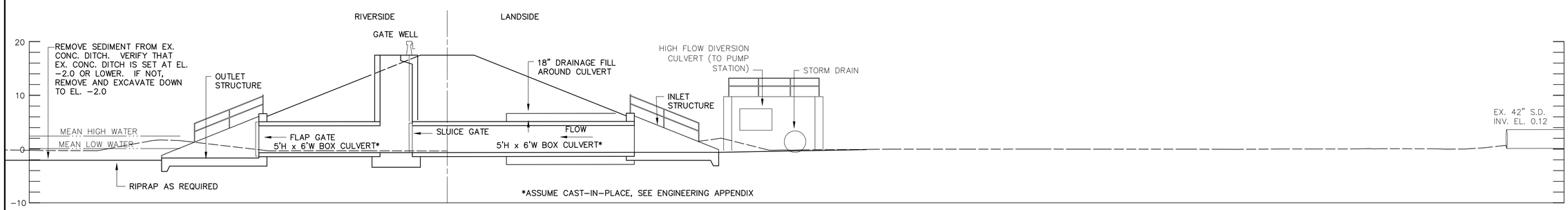
HUNTINGTON
FAIRFAX COUNTY, VIRGINIA
FLOOD DAMAGE REDUCTION STUDY

STORM DRAIN AND
HIGH FLOW DIVERSION PROFILES

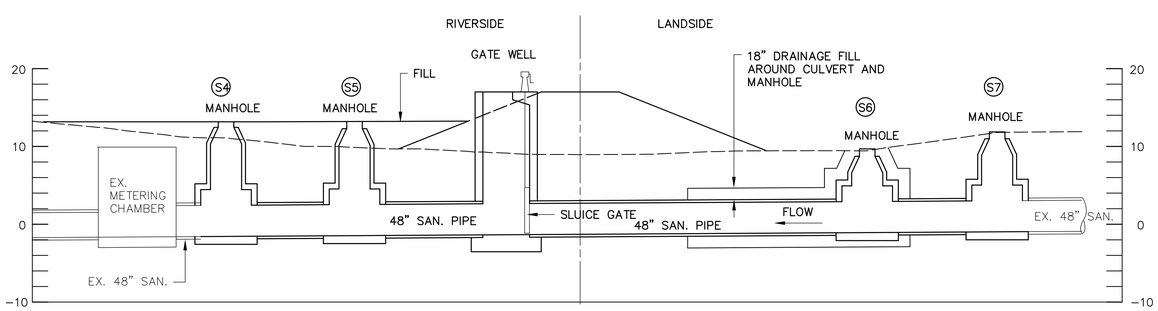
Sheet Number:
W501



LEVEE DRAINAGE STRUCTURE #1 PROFILE



LEVEE DRAINAGE STRUCTURE #2 PROFILE



LEVEE SEWAGE STRUCTURE PROFILE

SCALE IN FEET

10 0 10 20

US Army Corps of Engineers
Baltimore District

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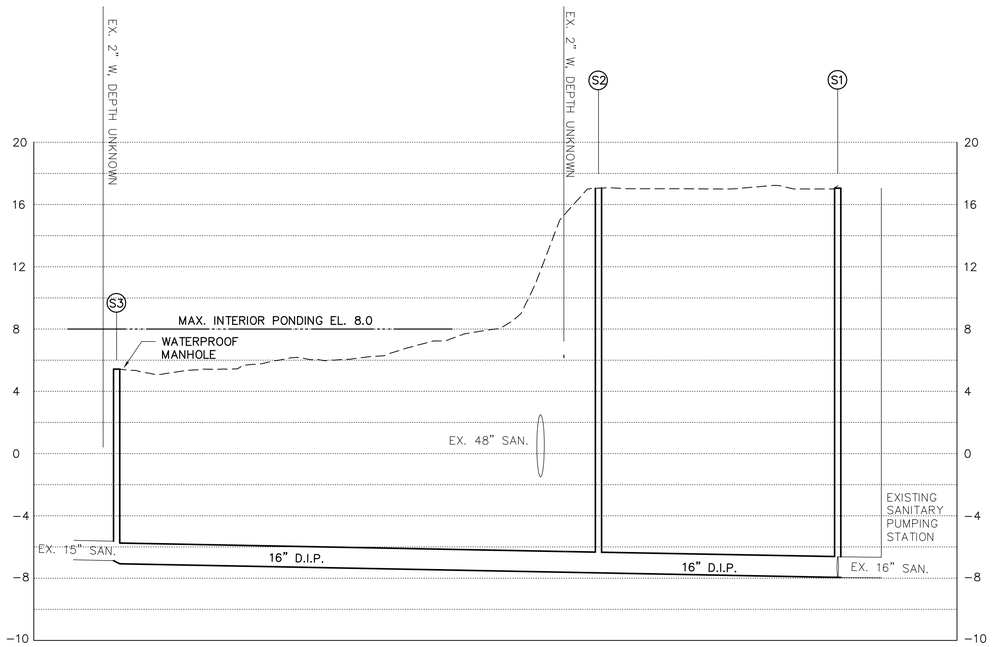
FLOOD DAMAGE REDUCTION STUDY

LEVEE STRUCTURE PROFILES

Sheet Number:

W502



16" SANITARY SEWER PROFILE

HORIZONTAL SCALE IN FEET
50 0 50 100

VERTICAL SCALE IN FEET
5 0 5 10

US Army Corps of Engineers
Baltimore District

SYMBOL	REV.	DATE	DESCRIPTION	BY

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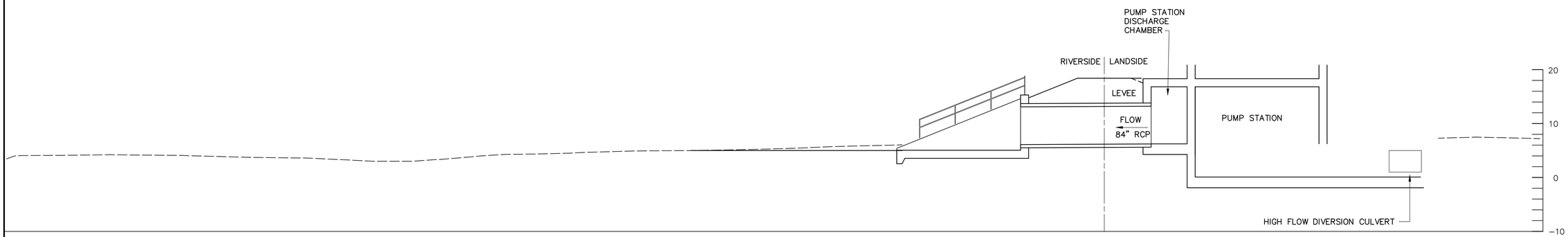
HUNTINGTON
FAIRFAX COUNTY, VIRGINIA
FLOOD DAMAGE REDUCTION STUDY

SANITARY SEWER PROFILES

Sheet Number:
W503



CONCEPTUAL PUMP STATION PROFILE

US Army Corps of Engineers
Baltimore District

SYMBOL	REV.	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DISTRICT, BALTIMORE
CORPS OF ENGINEERS
BALTIMORE, MARYLAND

PLATE | DRAWING NUMBER XXXXX | FILE NAME 456W504
SCALE: AS SHOWN | DATE: OCT 2008 | PLT SCALE: XXX

HUNTINGTON
FAIRFAX COUNTY, VIRGINIA
FLOOD DAMAGE REDUCTION STUDY

CONCEPTUAL PUMP STATION PROFILE

Sheet Number:
W504