Deliverable 3.2 – Final Alternative Schematic Design Technical Memorandum

Dated September 2, 2005

TO: Jonathan P. Madden, P.E. / South Florida Water Management District

BY: Alex Vazquez, P.E. / A.D.A. Engineering, Inc.
Luis Silva / A.D.A. Engineering, Inc.

SUBJECT: General Engineering Services Work Order No. CN040912-WO05
Evaluation of Alternatives for Elimination of Stormwater Discharges from the North Springs Improvement District (NSID) to the Everglades Protection Area (EPA)

TASK: Task 3 – Schematic Design of Alternatives

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1. Background

Florida's Everglades Forever Act (EFA), Florida Statute (F.S.) 373.4592, establishes long-term water quality goals designed to restore and protect the Everglades Protection Area (EPA). Figure 1.1 shows an overview of the EPA. As defined in the EFA, the EPA includes Water Conservation Areas (WCAs) 1, 2A, 2B, 3A, 3B, the Arthur R. Marshall Loxahatchee National Wildlife Refuge and the Everglades National Park. The 1994 EFA required the South Florida Water Management District (SFWMD) to apply for a permit from the Florida Department of Environmental Protection (FDEP) to operate and maintain water control structures (pumps, gates, culverts) which discharge into, within or from the EPA, and which are not included in the Everglades Construction Project (ECP).

The SFWMD's permit application was submitted to FDEP in September 1994, and FDEP formally issued Permit #06, 502590709 to the SFWMD on April 20, 1998. This permit, designated as the Non-ECP Permit, provides schedules, strategies and a monitoring program to ensure compliance with state water quality standards to the maximum extent practicable for discharges from the structures. Upon issuance of the Non-ECP permit, the SFWMD initiated the implementation of the permit conditions through the creation of the Everglades Stormwater Program (ESP). Some of the stormwater discharges from the North Springs Improvement District (NSID) basin flow west into WCA-2A, via the NSID Pump Station 1. Therefore, the NSID basin is one of the eight ESP basins. Figure 1.2 shows the limits of the NSID basin and the location of the pump stations.

The long-term goal of the Everglades restoration effort is to combine point source controls, basin-level solutions and regional solutions in a system-wide approach to ensure that all waters in the EPA meet the numeric phosphorus criterion and other applicable state water quality standards. In order to achieve this goal, the SFWMD has developed the Everglades Protection Area Tributary Basins Long-Term Plan for Achieving Water Quality Goals (Long-Term Plan).

During the 2003 legislative session, the 1994 EFA was amended to include reference to the March 17, 2003 Long-Term Plan (with modifications) as the appropriate strategy for achieving the long-term water quality goals of the EPA. The amended EFA was subsequently revised during the same legislative session to address concerns about portions of the amended version. The Long-Term Plan was revised in October 2003 to incorporate direction received from the legislature, as well as to address comments received from various stakeholders and the public.

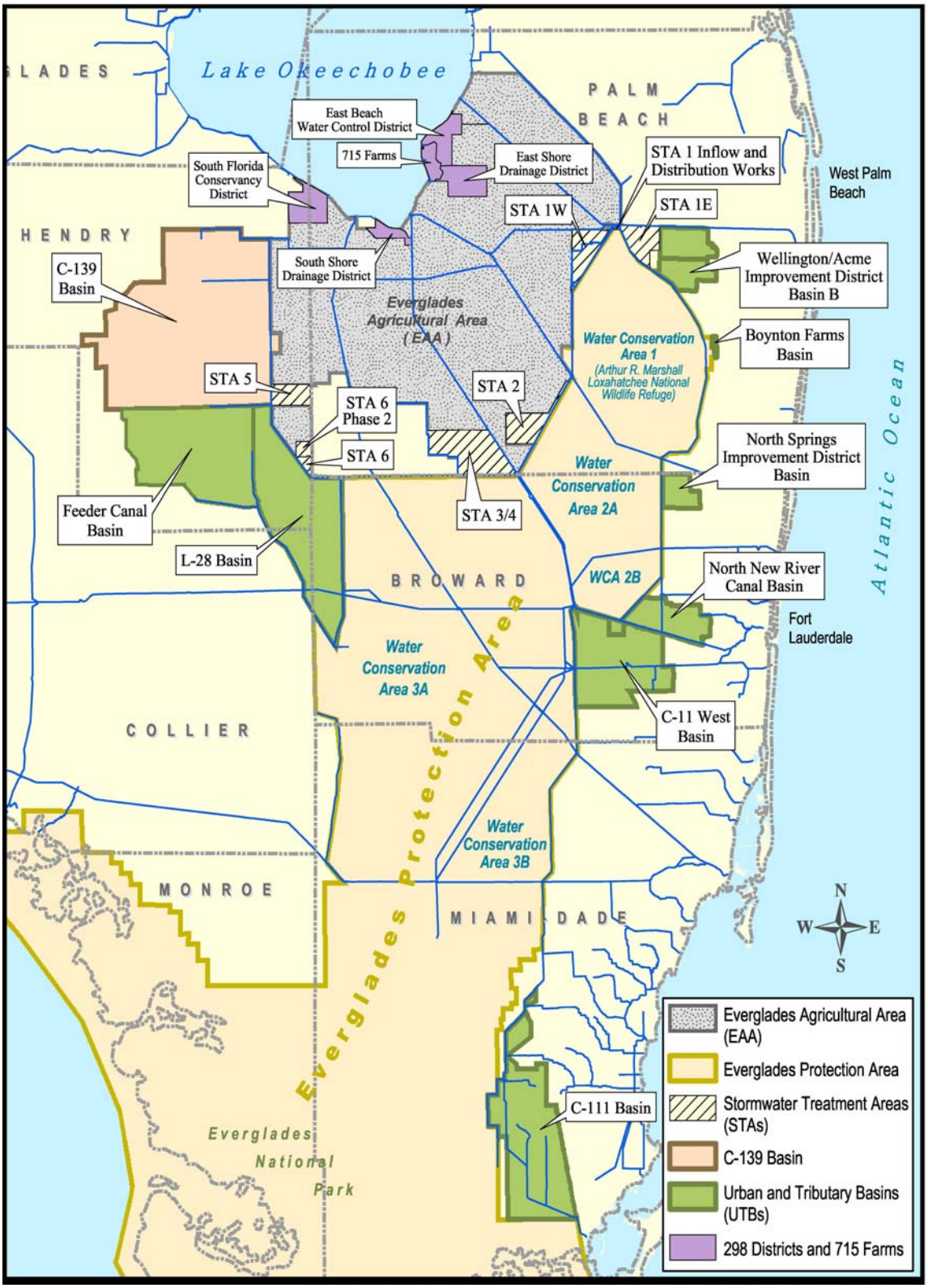


Figure 1.1 – Overview of the Everglades Protection Area

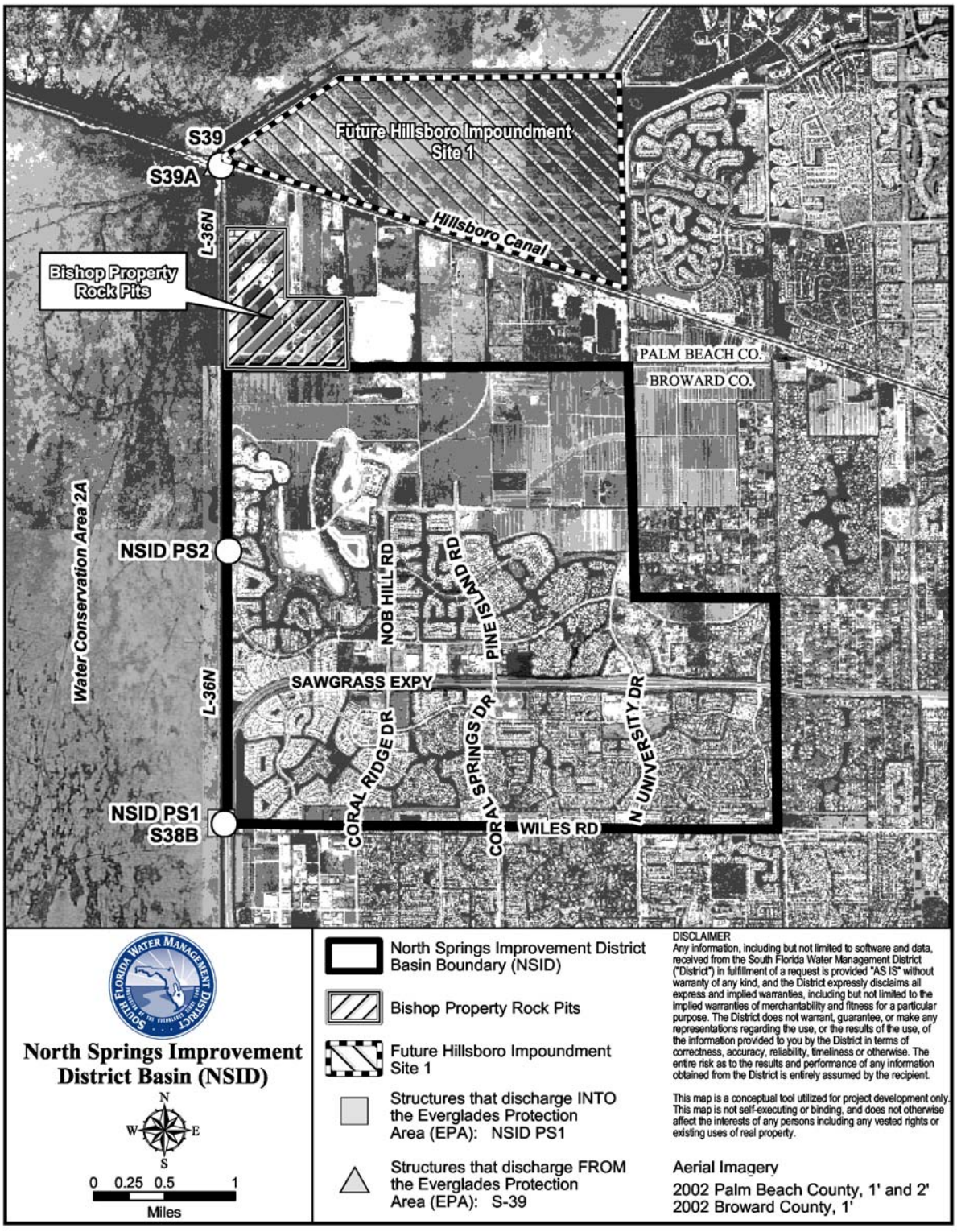


Figure 1.2 – North Springs Improvement District Basin Limits

The October 27, 2003 Long-Term Plan was submitted to the FDEP in December 2003. As recommended by the Long Term Plan, the 2004 Hydrologic & Hydraulic (H&H) Analysis for NSID and Hillsboro basins was performed to determine if there would be any negative impacts from redirecting water currently discharged to WCA-2A instead to the Hillsboro Canal east through the S-39A Structure.

The Long-Term Plan for the NSID basin assumed that the conveyance of NSID basin flows to the Hillsboro Canal and the Hillsboro Site 1 Impoundment would be made by the Comprehensive Everglades Restoration Plan (CERP). Under this assumption, there were no additional project elements included in the Long-Term Plan to implement the alternative that redirected all NSID basin flows to the Site 1 Impoundment. The CERP Site 1 Impoundment Draft Implementation Report (PIR) dated February 2005 includes replacement of the S-39A structure and canal improvements from the proposed pump station east to the Lake Worth Drainage District (LWDD) E-1 Canal. The locations of the Site 1 Impoundment and S-39A Structure are also shown on Figure 1.2.

The Hillsboro Site 1 Impoundment was not included in the analysis for storage or impoundment of flood event discharges. Under typical operation conditions, the Site 1 Impoundment will pump from the Hillsboro Canal when the canal is above its control elevation and the Impoundment is below its design high water level. The South Florida Water Management Model, Version 3.5, (a continuous 31-year simulation) was used to estimate the stage duration curves of water levels within the Site 1 Impoundment. Based on the results of the 31-year simulation model, it was assumed that for this analysis the Impoundment would be filled to capacity prior to a major storm event and it could not be depended on for flood protection. Therefore, in the 2004 H&H Analysis for NSID basin and Hillsboro Canal, all flows from the NSID basin were routed to the Hillsboro Canal and discharged through the G-56 Structure to tide. The analysis, completed in July 2004, concluded that the excess flows from the NSID basin would adversely impact stages within the Hillsboro Canal. The evaluation included an assessment of the potential to connect adjacent Bishop Property sand mines to the NSID water management system for additional surface water storage by gravity conveyance. The Bishop Property was not modeled as an above grade impoundment with pumped inflow. This analysis also showed that providing gravity connection to the Bishop Property would not mitigate the impacts to the Hillsboro Canal. The location of the Bishop Property in relation the Hillsboro Canal is depicted on Figure 1.2.

The SFWMD contracted A.D.A. Engineering, Inc. (ADA) through the General Engineering Services Work Order CN040912-WO05 to evaluate alternatives for potential improvements related to the Hillsboro basin to meet long-term water quality goals for discharges from the NSID basin to the EPA and minimize impacts to the Hillsboro and L-36 canals. Pertinent data from the 2004 H&H Analysis for the NSID and Hillsboro basins will be utilized to define general parameters of the alternatives. Environmental impacts will not be analyzed and no recommendations will be made as a result of the conduct of this evaluation. The results of this evaluation are intended to

assist decision-makers. Planning-level cost estimates of the alternatives including land acquisition, construction, and operation and maintenance (O&M) will be the primary result of this evaluation of alternatives.

The alternatives being evaluated as part of this project are as follows:

- Alternative 1, Improvements to Hillsboro Canal and Associated Improvements – Dredging of portions of the Hillsboro and L-36 canals in combination with modifications to the G-56 Structure required to mitigate for excess discharge from the NSID basin.

- Alternative 2, Bishop Property Impoundment – Construction of an above ground pumped reservoir based on the area and configuration of the Bishop Property to accept the required excess discharge volume from the NSID basin.

2. Scope and Objective

Work Order CN040912-WO05 includes planning-level evaluation and cost estimating of two alternatives to meet long-term water quality goals for discharges from the NSID basin to the EPA and minimize impacts to the Hillsboro and L-36 canals. The Statement of Work of this work order includes the following tasks, subtasks and deliverables:

- Task 1 – Kick-off Meeting
  Deliverables:
  1.1 – Kick-off meeting summary

- Task 2 – Data Review and Alternative Assessment
  Task 2.1 – Data Review and Summary
  Task 2.2 – Extract Pertinent Data from Previous Model and Calculate Excess Volume
  Deliverables:
  2.1 – Data Assessment and Methodology Technical Memorandum
  2.2 – Draft Alternative Assessment Technical Memorandum
  2.3 – Final Alternative Assessment Technical Memorandum

- Task 3 – Schematic Design of Alternatives
  Task 3.1 – Alternative 1, Hillsboro & L-36 Canal Improvements Schematic Design
  Task 3.2 – Alternative 2, Impoundment Schematic Design
  Deliverables:
  3.1 – Draft Alternative Schematic Design Technical Memorandum
  3.2 – Final Alternative Schematic Design Technical Memorandum

- Task 4 – Cost Estimating for Alternatives
  Deliverables:
  4.1 – Draft Alternative Cost Estimate Technical Memorandum
  4.2 – Final Alternative Cost Estimate Technical Memorandum

- Task 5 – Technical Review Meetings for Tasks 2, 3 and 4
  Task 5.1 – Technical Review Meeting for Task 2
  Task 5.2 – Technical Review Meeting for Task 3
  Task 5.3 – Technical Review Meeting for Task 4
  Deliverables:
  5.1 – Task 2 Technical Review Meeting Summary
  5.2 – Task 3 Technical Review Meeting Summary
  5.3 – Task 4 Technical Review Meeting Summary

This Technical Memorandum – Final Alternative Schematic Design (Deliverable 3.2) – summarizes the work items associated with Task 3 of the Statement of Work. As part of Task 3, schematic designs were developed for Alternatives 1 and 2 in accordance with the methodology and assumptions outlined in the Final Alternative Assessment Technical Memorandum (Deliverable 2.3). The two alternative schematic designs are as follows and are described Sections 3 and 4:

- Alternative 1 – Hillsboro and L-36 Canal Improvements Schematic Design
- Alternative 2 – Bishop Property Impoundment Schematic Design

Applicable review comments associated with Deliverable 3.1 were incorporated as part of Deliverable 3.2 (Final Alternative Schematic Design Technical Memorandum). The results documented in the Final Alternative Schematic Design Technical Memorandum will support the development of a 50-year present worth cost for each alternative (Task 4 – Cost Estimating for Alternatives). These costs will be used to assist decision makers in determining the most cost-effective solution to meet the long-term water quality goals outlined in the Long-Term Plan.

3. Alternative 1 – Hillsboro and L-36 Canal Improvements Schematic Design

3.1 Alternative 1 Improvements and Assumptions

As outlined in Deliverable 2.3 (Final Alternative Assessment Technical Memorandum), Alternative 1 will be comprised of the improvements required to the Hillsboro Canal, L-36 Canal and G-56 Structure to accommodate the maximum permitted flows discharged under current conditions to WCA-2A from the NSID basin, after the peak stage in the L-36 Canal reaches the 10-year, 24-hour design storm peak stage. Alternative 1 will include the following specific improvements:

1. Increasing Hillsboro Canal cross-sectional area from the G-56 Structure to the LWDD E-1 Canal and from the proposed Site 1 Impoundment inflow pump station to the S-39 Structure,
2. Increasing L-36 Canal cross-sectional area from the NSID Pump Station # 2 to the S-39A Structure, and
3. Increase capacity of the G-56 Structure to accommodate the flow from the NSID Basin.

Figure 3.1 shows the preliminary location of the Alternative 1 improvements.

The following are key assumptions associated with Alternative 1:

1. CERP Hillsboro Site 1 Impoundment project is implemented, including the following improvements:
    a. Hillsboro Canal improvements from the LWDD E-1 Canal to the Site 1 Impoundment inflow pump station
    b. Existing S-39A Structure replaced with a 600 cubic feet per second (approximately 270,000 gallons per minute) gated structure (twin gated 8 foot by 8 foot box culverts)
2. No Hillsboro Canal improvements will be required between the LWDD E-1 Canal to the Site 1 Impoundment inflow pump station. It is assumed that the Hillsboro Canal improvements associated with the Site 1 Impoundment project will be able to accommodate the additional 200,000 gpm flow that will be discharged from the NSID basin.
3. No Hillsboro Canal improvements will be required east of the G-56 Structure and there will not be any downstream adverse impacts.
4. No L-36 Canal improvements will be required south of the NSID Pump Station #2.
5. Canal cross-sectional area increase will be achieved by deepening the canal instead of widening the canal. If canal widening is required it will assumed that there is adequate right-of-way available.

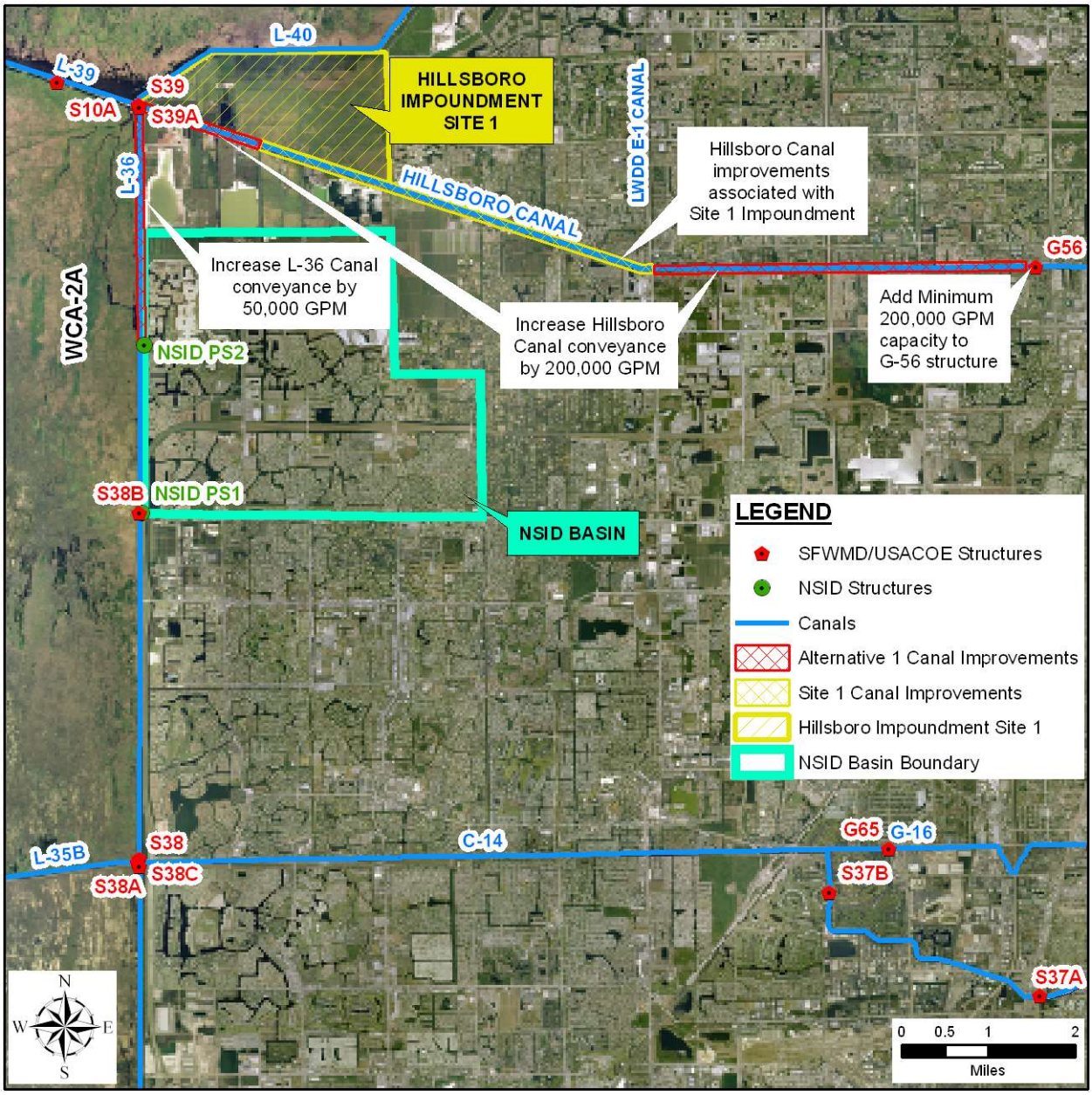


Figure 3.1 – Alternative 1 Improvements

3.2 Alternative 1 Schematic Design Summary

Alternative 1 was assessed in accordance with the methodology outlined in the Final Alternative Assessment Technical Memorandum (Deliverable 2.3). As part of that assessment, the Hillsboro Canal was subdivided into two branches:

- West Branch - from the S-39 Structure to the Hillsboro Site 1 Impoundment inflow pump station
- East Branch - from the LWDD E-1 Canal to the G-56 Structure

The alternative assessment indicated that to accommodate the additional flow from the NSID Basin, the Hillsboro West Branch, Hillsboro East Branch and L-36 Canal cross sectional area would have to be increased. Table 3.1 summarizes the additional required canal cross sectional area at each available XP-SWMM model cross sections. This table also summarizes the excavation or dredging volumes required to achieve these areas. To obtain the required additional cross sectional area for each canal section, the canal bottom was deepened where possible. The deepening of each cross-section along the Hillsboro and L-36 Canals followed the same procedure used in the CERP Site 1 Impoundment Draft PIR. The CERP Site 1 Impoundment Draft PIR called for 2H:1V side-slopes.

The Hillsboro Canal West Branch will require a bottom depth cut between approximately four to nine feet to elevation -9.0 feet relative to the National Geodetic Vertical Datum of 1929 (ft-NGVD29), to meet the required flow area. This elevation will match the bottom elevation of the CERP Site 1 Impoundment Draft PIR. As outlined in the Final Alternative Assessment Technical Memorandum, in order to arrive at a realistic cross-sectional area for the Hillsboro Canal West Branch, a 1.0 foot per second (ft/s) minimum velocity was assumed. This change in velocity reduced the required additional area, but the required area could not be achieved by deepening the canal alone in some areas. The canal was widened between approximately 16 and 32 feet in order to achieve the required cross-sectional area. The widening was included because it is assumed that there is available right-of-way on the north side of the Hillsboro Canal West Branch, since this land will be available for the CERP Site 1 Impoundment site.

The Hillsboro Canal East Branch will require a bottom depth cut between approximately one to four feet to meet the additional area required. The canal bottom elevation varies from -10 to -4 ft-NGVD29, with 10H:1V slopes between elevation variations. The bottom widths shall be maintained at a minimum of 11 feet with a side-slope ratio of 2H:1V. As for the west branch, the required area could not be achieved by deepening the canal alone in some areas. The canal was widened between approximately 3 and 19 feet in order to achieve the required cross-sectional area. For cost estimating purposes, it was assumed that there is adequate right-of-way to accommodate this widening.

The entire Hillsboro Canal improvements, West and East Branches, for Alternative 1 are included in Attachment A. Attachment A includes schematic canal profiles and required cross section modifications.

The L-36 Canal improvements were calculated from the NSID Pump Station #2 to the S-39A Structure, as documented in the Final Alternative Assessment Technical Memorandum. Similarly to the Hillsboro Canal West Branch, a minimum velocity of 1.0 ft/s was used to calculate realistic required cross-sections. The deepening of the canal cross-sections will be approximately between one to three feet in depth to elevation -3.0 ft-NGVD29. The existing canal bottom elevation is at -1.0 ft-NGVD29. Therefore, a 10H:1V slope will be maintained to match the existing grade. Canal bottom width varies from 28 to 57 feet. The L-36 Canal improvements for Alternative 1 are included in Attachment B.

As documented in the Final Alternative Assessment Technical Memorandum, the canal improvement assessment was performed using the available cross sections included in the XP-SWMM hydrologic/hydraulic model. In addition, no hydrologic/hydraulic modeling was performed. Results from prior modeling efforts were used to determine the required addition flow area to pass the flow from the NSID Basin without increasing calculated peak stages. Therefore, to better assess the required additional canal cross sectional areas, a detailed hydrologic/hydraulic modeling analysis should be performed and better topography information should be used.

To accommodate the additional flow that will be conveyed by the improved Hillsboro West Branch, Hillsboro East Branch and L-36 Canal, the capacity of the G-56 Structure must be increased by 445 cubic feet per second (200,000 gallons per minute). The capacity of the G-56 Structure could be increased by adding one gate or a gated culvert. The addition of one gate to the existing structure would provide an additional 1,640 cubic feet per second (approximately 736,000 gallons per minute) flow capacity under controlled discharge with 1.15 feet of operating head, in accordance with the G-56 Deerfield Structure on the Hillsboro Canal General Design Memorandum dated January 1989. Based on coordination with SFWMD staff, it was concluded that the capacity of the structure should be increased by adding a gated culvert, because adding a gate to the existing structure will yield an extensive incremental cost that will not be totally associated with the cost of conveying the additional flow from the NSID Basin. To convey 445 cfs with 1.15 of effective head, two 96-inch corrugate metal pipe culverts with sluice gates will be required adjacent to the G-56 Structure. These culverts could be located at the north end of the structure, where there is adequate right-of-way available.

Table 3.1
Alternative 1 Required Canal Improvements Summary

XP-SWMM Link	Link Length (FT)	Q_{exs} Existing Peak Flow (CFS)	V_{exs} Existing Peak Velocity[1] (FT/S)	Stage[2] (FT-NGVD29)	Flow Area at Stage[3] (SF)	Q_{add} Additional Flow Required (CFS)	Flow A_{req} Area Required[4] (SF)	Additional Flow Area Required[5] (SF)	Additional Flow Area Provided[6] (SF)	Additional Canal Cut Area Above Peak Stage[7] (SF)	Incremental Additional Volume[8] (CY)	Cumulative Volume (CY)
L-36 CANAL												
XS11.1	3,729	349.64	1.00	10.18	349.6	111	460.6	111.0	157.3	-	21,725	21,725
XS20	7,895	280.60	1.00	9.31	280.6	111	391.6	111.0	123.5	-	36,113	57,838
XS32	2,838	266.04	1.00	9.27	266.0	111	377.0	111.0	111.3	-	11,700	69,538
HILLSBORO CANAL - WEST BRANCH												
NXS1	1,738	258.96	1.00	9.05	259.0	445	704.0	445.0	450.9	-	29,029	29,029
NXS2	1,959	252.40	1.00	9.02	252.4	445	697.4	445.0	561.7	94.0	47,581	76,611
NXS3	1,966	246.44	1.00	9.01	246.4	445	691.4	445.0	629.9	150.0	56,775	133,385
NXS4	2,127	240.29	1.00	9.01	240.3	445	685.3	445.0	445.0	31.0	37,493	170,878
HILLSBORO CANAL - EAST BRANCH												
NXS18	1,073	2,512.30	2.76	11.51	911.9	445	1,073.4	161.5	196.0	13.0	8,306	8,306
NXS18.1	1,074	2,513.16	2.75	11.43	915.2	445	1,077.3	162.1	196.0	13.0	8,314	16,619
NXS19	2,006	2,802.47	3.09	11.23	906.4	445	1,050.3	143.9	187.6	56.0	18,099	34,719
NXS20	774	2,803.44	3.34	11.06	839.1	445	972.3	133.2	209.6	5.0	6,152	40,871
NXS21	1,446	2,916.59	1.93	11.00	1,512.0	445	1,742.7	230.7	244.3	51.0	15,817	56,688
NXS22	2,147	2,975.05	2.09	10.86	1,421.4	445	1,634.0	212.6	234.9	-	18,680	75,368
NXS23	1,195	4,729.29	3.72	12.20	1,271.0	445	1,390.6	119.6	126.1	-	5,579	80,947
NXS24	1,196	4,729.98	3.94	11.93	1,200.2	445	1,313.1	112.9	124.6	-	5,517	86,464
NXS25	497	4,729.20	3.35	11.87	1,410.0	445	1,542.7	132.7	140.7	-	2,590	89,054
NXS25.2	497	5,790.32	4.13	11.77	1,402.0	445	1,509.8	107.7	177.2	-	3,262	92,316
NXS25.1	994	6,046.45	4.39	11.53	1,378.9	445	1,480.4	101.5	177.2	-	6,524	98,840
NXS26	1,056	6,065.00	4.71	11.21	1,288.0	445	1,382.5	94.5	101.1	-	3,954	102,794
NXS26.1	1,056	6,066.28	4.84	10.85	1,254.7	445	1,346.7	92.0	101.1	-	3,954	106,748
NXS27	986	6,065.15	3.89	10.67	1,558.0	445	1,672.3	114.3	140.7	-	5,138	111,886
NXS27.1	985	6,082.55	3.98	10.46	1,526.7	445	1,638.4	111.7	140.7	-	5,133	117,020
NXS28	1,003	6,081.90	3.62	10.28	1,681.9	445	1,805.0	123.1	178.4	-	6,627	123,647
NXS28.1	1,004	6,081.53	3.61	10.17	1,683.7	445	1,806.9	123.2	178.4	-	6,634	130,281
NXS29	1,847	6,086.15	4.38	9.64	1,391.1	445	1,492.8	101.7	124.0	-	8,484	138,765
NXS30	1,848	6,087.10	4.02	9.26	1,514.6	445	1,625.3	110.7	149.1	-	10,205	148,970
G56US	412	6,086.35	2.75	9.22	2,210.0	445	2,371.6	161.6	172.0	-	2,625	151,595

1 V_{exs} for the L-36 and West Branch of the Hillsboro Canal are less than 0.5 ft/s. A 1.0 ft/s min. velocity was assumed as acceptable velocity for SFWMD Canals. V_{exs} is the peak velocity associated with the peak flow per the XP-SWMM model.

2 Stage at Peak Flow according to link downstream node.

3 Flow areas in accordance with stage corresponding to time of peak flow.

4 Total flow area required below peak stage to accommodate an additional 50,000 gpm (111 cfs) [L-36] and 200,000 gpm (445 cfs) [Hillsboro] flow at V_{exs}.

5 Required flow area below peak stage, computed as the difference between flow area at peak stage and area required.

6 Flow area provided below peak stage.

7 Canal excavation area above peak stage.

8 Total canal excavation volume for additional flow area required.

Acronyms

FT = feet; CFS = cubic feet per second; FT/S = feet per second; SF = square feet; CY = cubic yards; NGVD29 = National Geodetic Vertical Datum of 1929

4. Alternative 2 – Bishop Property Impoundment Schematic Design

4.1 Alternative 2 Improvements and Assumptions

As outlined in Deliverable 2.3, Alternative 2 is comprised of constructing an above-ground impoundment with the location and characteristics of the Bishop Property to accommodate the volume discharged to WCA-2A from the NSID Basin under current conditions. This volume is calculated using the maximum permitted discharge rate from the time period the peak stage upstream of NSID Pump Station #1 reaches the 10-year, 24-hour design storm peak stage until the Hillsboro Canal again has capacity to discharge the water to tide. Alternative 2 will include the following specific components:

1. An above ground impoundment with the location and characteristics of the Bishop Property to store the excess runoff volume that would be discharged to WCA-2A during a 100-year, 3-day storm event as outlined under the current permit conditions;
2. A 200,000 gpm pump station to redirect L-36 Canal flows and discharge the runoff volume into the impoundment;
3. Seepage pump station to collect seepage collected from the required seepage collection canal;
4. Discharge structure to discharge water from the impoundment to the L-36 Canal, once stages in the Hillsboro Canal reach acceptable levels;
5. Emergency overflow structure to allow discharge from the reservoir, when reservoir is full and there is a storm larger than a 25-year, 3-day design storm event; and
6. Cross-sectional area improvements of the portion of the L-36 Canal from the NSID Pump Station #2 to the Bishop Property impoundment pump station and from the Bishop Property impoundment discharge structure to the S-39A Structure.

Figure 4.1 shows the preliminary location of the Alternative 2 components.

The following are key assumptions associated with Alternative 2:

1. Required impoundment size will be based on the runoff volume that would be discharged from the NSID Basin to WCA-2A through Pump Station #1 during a 100-year, 3-day storm event.
2. CERP Hillsboro Site 1 Impoundment project is implemented, including the following improvements:
    a. Hillsboro Canal improvements from the LWDD E-1 Canal to the Site 1 Impoundment inflow pump station
    b. Existing S-39A Structure replaced with a 600 cubic feet per second (approximately 270,000 gallons per minute) gated structure (twin gated 8 foot by 8 foot box culverts)

3. No L-36 Canal improvements will be required along the Bishop Property impoundment westerly boundary and south of NSID Pump Station #2.
4. Approach for determining the additional canal cross-sectional area required in the L-36 Canal will be as for Alternative 1.

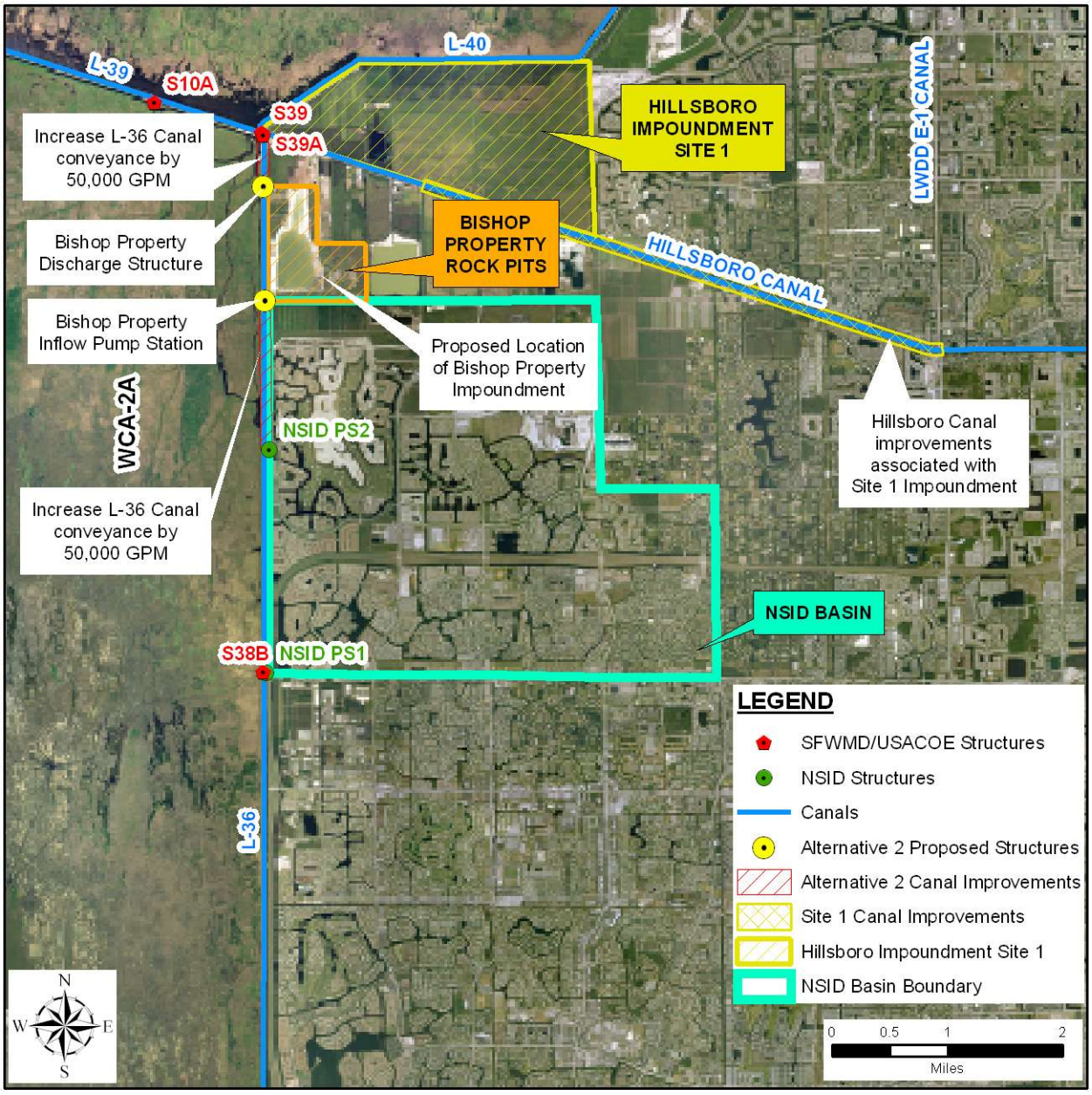


Figure 4.1 – Alternative 2 Improvements

4.2 Alternative 2 Schematic Design Summary

Alternative 2 was assessed in accordance with the methodology outlined in the Final Alternative Assessment Technical Memorandum. As part of that assessment, a total of 3,100 acre-feet (ac-ft) of runoff must be detained within the Bishop Impoundment to accommodate the volume discharged to WCA-2A from the NSID Basin under current conditions. This is the runoff volume that would be discharged from the NSID Basin to WCA-2A through Pump Station # 1 during a 100-year, 3-day storm event between the time the stage upstream of Pump Station #1 reaches the 10-year, 24-hour design storm stage (10.22 ft-NGVD29), until the time the tailwater stage at the S-39A Structure falls below elevation 9.0 ft-NGVD29.

The alternative assessment also indicated that to accommodate the additional flow from NSID, a portion of the L-36 Canal bottom will have to be deepened to provide the additional canal areas summarized in Table 4.1. This table also summarizes the required excavation or dredging volumes required to obtain these areas.

Table 4.1
Alternative 2 Required Canal Improvements Summary

XP-SWMM Link	Link Length (FT)	Q_{exs} Existing Peak Flow (CFS)	V_{exs} Existing Peak Velocity[1] (FT/S)	Stage[2] (FT-NGVD29)	Flow Area at Stage[3] (SF)	Q_{add} Additional Flow Required (CFS)	Flow A_{req} Area Required[4] (SF)	Additional Flow Area Required[5] (SF)	Additional Flow Area Provided[6] (SF)	Incremental Additional Volume[7] (CY)	Cumulative Volume (CY)
L-36 CANAL											
XS11.1	3,729	349.64	1.00	10.18	349.6	111	460.6	111.0	157.3	21,725	21,725
XS20	3,171	280.60	1.00	9.31	280.6	111	391.6	111.0	123.5	14,504	36,229
XS32	2,330	266.04	1.00	9.27	266.0	111	377.0	111.0	111.3	9,605	45,834

1 V_{exs} for the L-36 and West Branch of the Hillsboro Canal are less than 0.5 ft/s. A 1.0 ft/s min. velocity was assumed as acceptable velocity for SFWMD Canals. V_{exs} is the peak velocity associated with the peak flow per the XP-SWMM model.

2 Stage at Peak Flow according to link downstream node.

3 Flow areas in accordance with stage corresponding to time of peak flow.

4 Total flow area required below peak stage to accommodate an additional 50,000 gpm (111 cfs) [L-36] and 200,000 gpm (445 cfs) [Hillsboro] flow at V_{exs}.

5 Required flow area below peak stage, computed as the difference between flow area at peak stage and area required.

6 Flow area provided below peak stage.

7 Total canal excavation volume for additional flow area required.

Acronyms

FT = feet; CFS = cubic feet per second; FT/S = feet per second; SF = square feet; CY = cubic yards; NGVD29 = National Geodetic Vertical Datum of 1929

The L-36 Canal improvements shall take place from the NSID Pump Station #2 to the Bishop Impoundment inflow pump station located at the southern end of the Bishop Impoundment and from the Bishop Impoundment discharge structure located on the north end of the Bishop Impoundment to the S-39A Structure, as mentioned in the Final Alternative Assessment Technical Memorandum. No improvements will be made to the L-36 Canal between the Bishop Impoundment inflow pump station and discharge structures.

Similarly to Alternative 1, a velocity of 1.0 ft/s was used to create realistic cross-sections. The deepening of the canal cross-sections will be approximately between one to three feet in depth to elevation -3.0 ft-NGVD29. The existing canal bottom elevation is at -1.0 ft-NGVD29. Therefore, a 10H:1V slope will be maintained to match the existing grade. Canal bottom width varies from 28 to 57 feet. The L-36 Canal improvements for Alternative 2 are included in Attachment C.

As for Alternative 1, the canal improvement assessment was performed using the available cross sections included in the XP-SWMM hydrologic/hydraulic model. In addition, no hydrologic/hydraulic modeling was performed. Results from prior modeling efforts were used to determine the required addition flow area to pass the flow from the NSID Basin without increasing calculated peak stages. Therefore, to better assess the required additional canal cross sectional areas, a detailed hydrologic/hydraulic modeling analysis should be performed and better topography information should be used.

The proposed design assumptions outlined in the CERP Site 1 Impoundment Draft PIR were used to determine the Bishop Property Impoundment normal pool depth, containment levees, and seepage canals. The CERP Site 1 Impoundment Draft PIR includes a water storage depth of eight feet above average ground elevation (normal pool depth). Average ground elevation at the Bishop Property is approximately at elevation 9.0 ft-NGVD29, which was determined from available LIDAR topographic data. The normal pool depth for the Bishop Property Impoundment will be 17.0 ft-NGVD29. The storage volume available within the mined lake area of the Bishop property is 107 ac-ft, assuming that the control groundwater elevation for the site is 8.0 ft-NGVD29. Therefore, a total of approximately 375 acres of reservoir wetted area will be required at the normal pool depth. However, a total of 380 acres is being provided as part of the improvements, which will provide a total of 3,150 ac-ft of storage at an eight-foot normal pool depth.

As part of the improvements to the Bishop Impoundment, approximately 18,160 feet of containment levee and 13,900 feet of seepage canal will be required. To accommodate these canals and levees, at total of 457 acres will be required. The total area within the Bishop property is approximately 408 acres. Therefore, a total of approximately 49 acres will be required in addition to the area within the Bishop Property. This area was assumed to be available at the northeast end of the Bishop Property. However, areas to the north and southeast of the property could also be available depending on land

costs and willing sellers. If further mining occurs within the Bishop Property at the northeast and southeast ends of the property, the additional required area could be reduced but will not be completely eliminated.

The required top of embankment levee elevation is 25.0 ft-NGVD29 to accommodate an eight-foot normal pool depth and an additional eight-foot of wind set up/wave run up from full reservoir depth, as documented in the CERP Site 1 Impoundment Draft PIR . The required seepage canal will include a bottom at elevation -5.0 ft-NGVD29 and with a width of five feet. This seepage canal will be located along the limits of the Bishop Impoundment, except the length adjacent to the L-36 Canal. The storage volume in the seepage canal is approximately 13.4 ac-ft. The schematic design for the Bishop Property typical sections and site layout are included in Attachment D.

Operation of the Bishop Impoundment will require four structures as follows:

1. Inflow Pump Station
2. Seepage Pump Station
3. Discharge Structure
4. Emergency Overflow Spillway

The inflow pump station was sized to accommodate the capacity of the discharges from the NSID Basin to WCA-2A during a 100-year, 3-day design storm event, which is 445 cfs (200,000 gpm). The seepage pump station size was derived based on the prorated length of seepage canal used for the Site 1 Impoundment design. The Site 1 Impoundment includes approximately 22,617 feet of seepage canal with two 75 cfs (67,325 gpm) pumps used specifically for seepage control. Interpolating between the required 13,900 feet of seepage canal for the Bishop Impoundment, one 92 cfs (41,300 gpm) pump will be required for the Bishop Property Impoundment.

The discharge structure for the Bishop Impoundment was sized based on the capacity of the expanded L-36 Canal, which is 445 cfs (200,000gpm), at 2.2 feet of hydraulic head. Therefore, using a culvert nomograph, two 84-inch corrugated metal pipe culverts with sluice gates will be required to discharge the 445 cfs.

As illustrated on Figure 4.2, the design for the emergency overflow spillway was designed to retain the 25-year, 3-day storm event. The normal pool depth of eight feet was used above the average ground elevation. With a maximum head over the normal pool between 1.0 to 1.5 feet, the weir crest is to be at the Full Pool depth. Since the Site 1 Impoundment used a 305 cfs spillway, interpolating between impoundment storage areas at normal pool depths, the required spillway for the Bishop Impoundment will need to convey approximately 70 cfs (31,420 gpm) flow, which will require a 15-feet weir length for a design head of 1.5 feet.

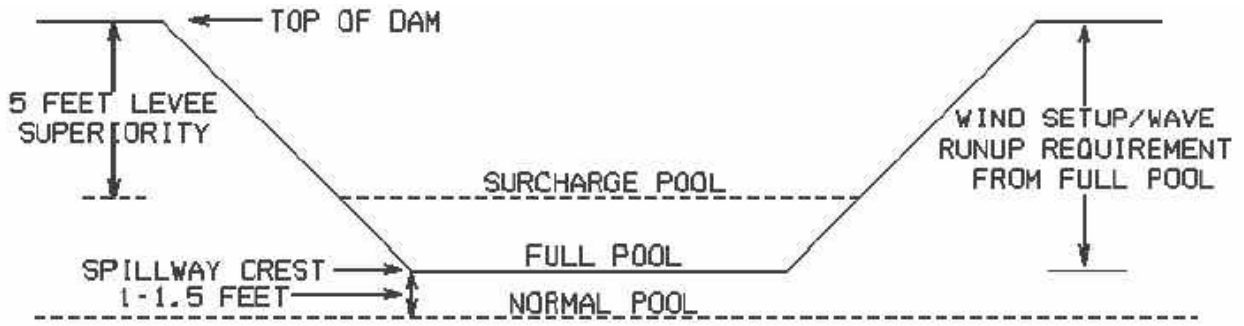
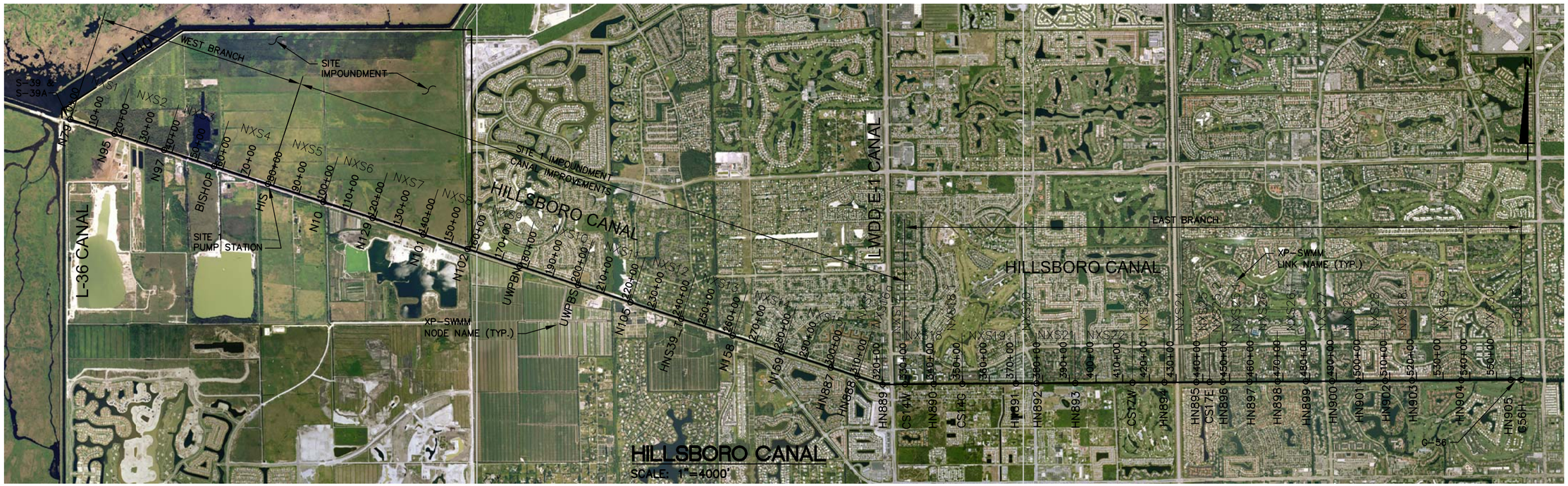
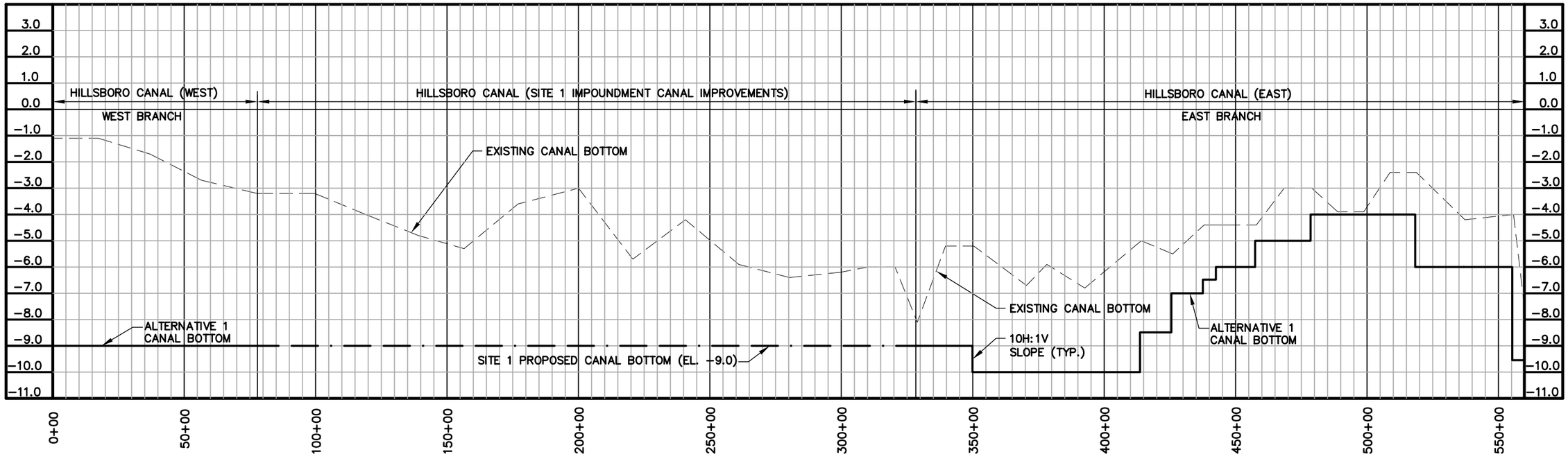


Figure 4.2 – Bishop Property Design Elevations for Impoundment Embankments

Attachment A
NSID Alternative 1 Hillsboro Canal Improvements Profile and Cross-sections





NOTES:

1. ELEVATIONS ARE IN FEET RELATIVE TO THE NATIONAL GEODETIC VERTICAL DATUM OF 1929
2. CANAL STATION IS BASED ON THE XP-SWMM MODEL CHAINAGE

HILLSBORO CANAL

HORIZONTAL SCALE: 1"=4000'
VERTICAL SCALE: 1"=4'

ATTACHMENT A-1

NSID ALTERNATIVE 1

HILLSBORO CANAL PROFILE IMPROVEMENTS

DATE: 08/08/05 | SCALE: AS SHOWN | DRAWN BY: A.M. | APPROVED BY: A.V. | PROJECT #C110-05-001

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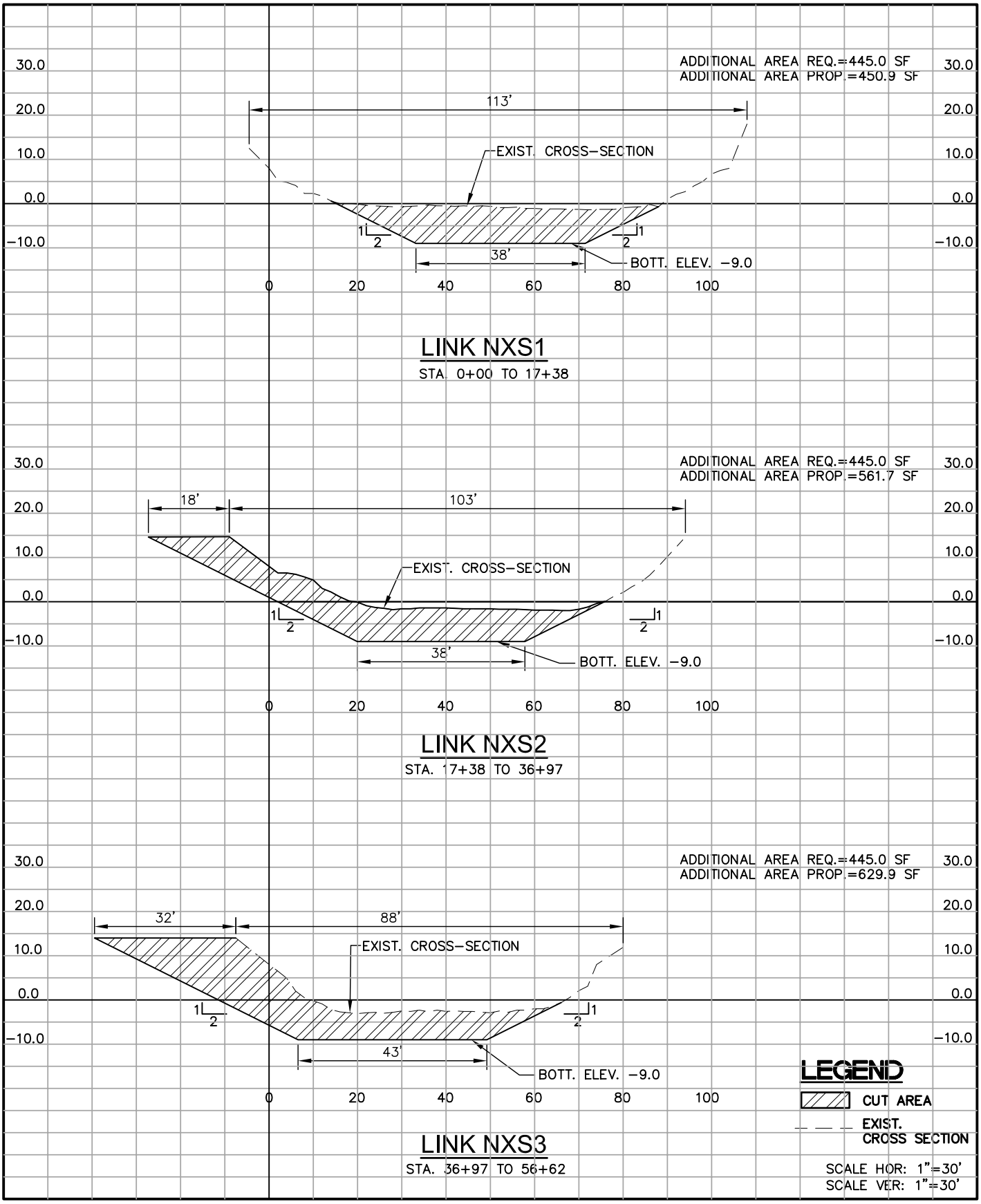

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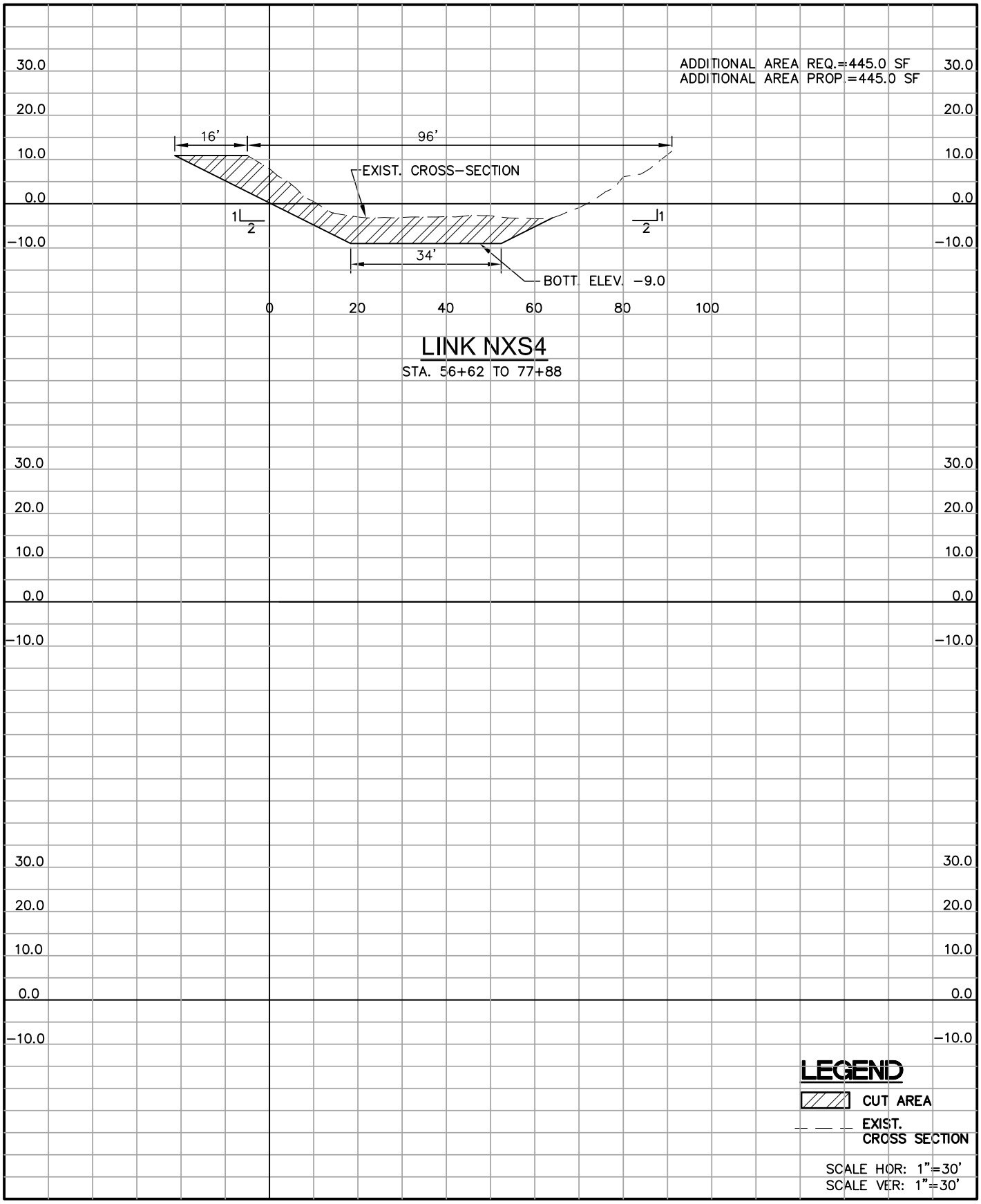
NSID ALTERNATIVE 1
HILLSBORO CANAL (WEST)
IMPROVEMENTS-CROSS-SECTION

DATE: 08-09-05	SCALE: AS SHOWN	DRAWN BY: L.S.	APPROVED BY: A.V.

PROJECT #C110-05-001

ATTACHMENT:

A-2



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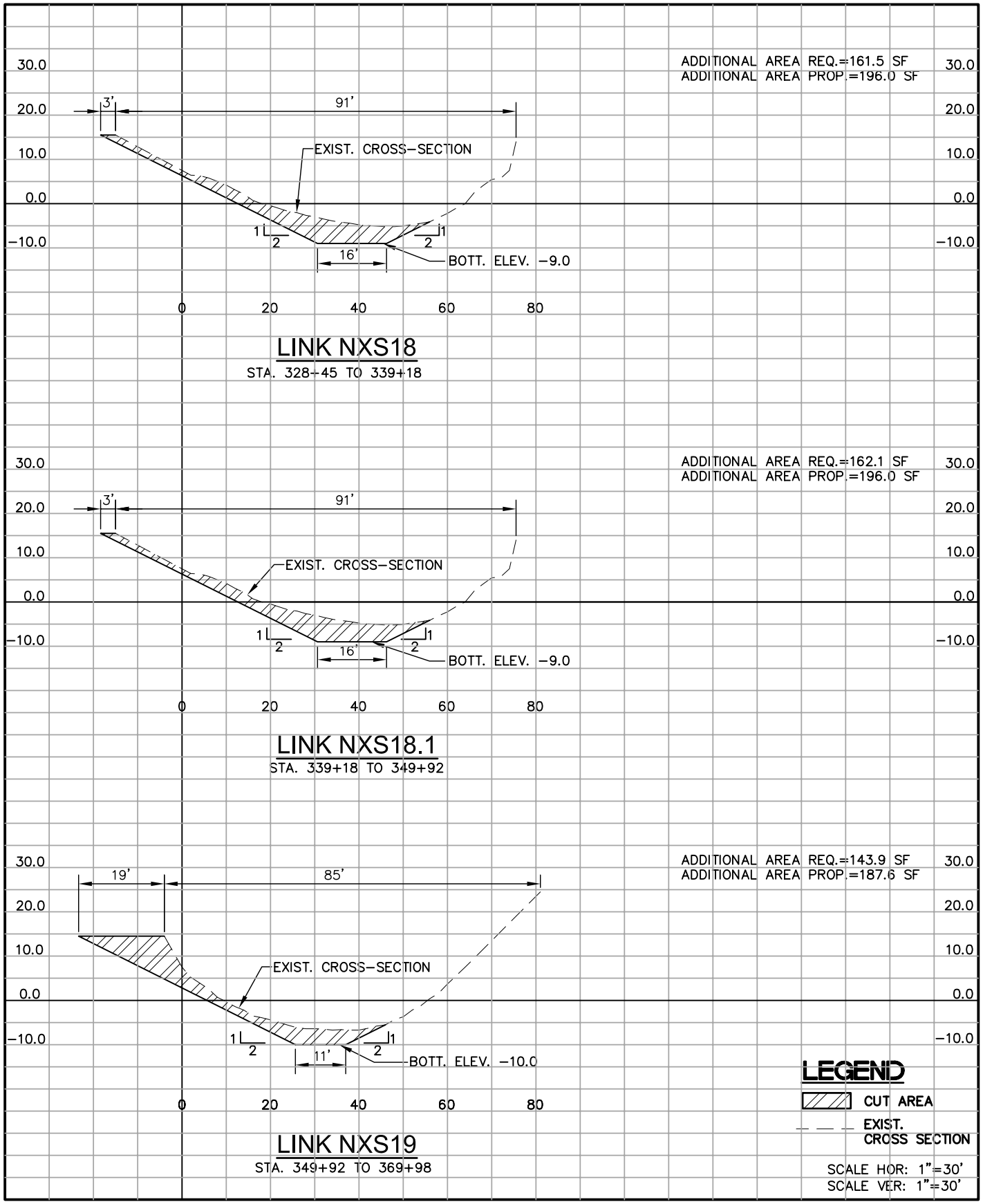
NSID ALTERNATIVE 1
HILLSBORO CANAL (WEST)
IMPROVEMENTS-CROSS SECTION

DATE: 08-09-05	SCALE: AS SHOWN	DRAWN BY: L.S.	APPROVED BY: A.V.

PROJECT #C110-05-001

ATTACHMENT:

A-3



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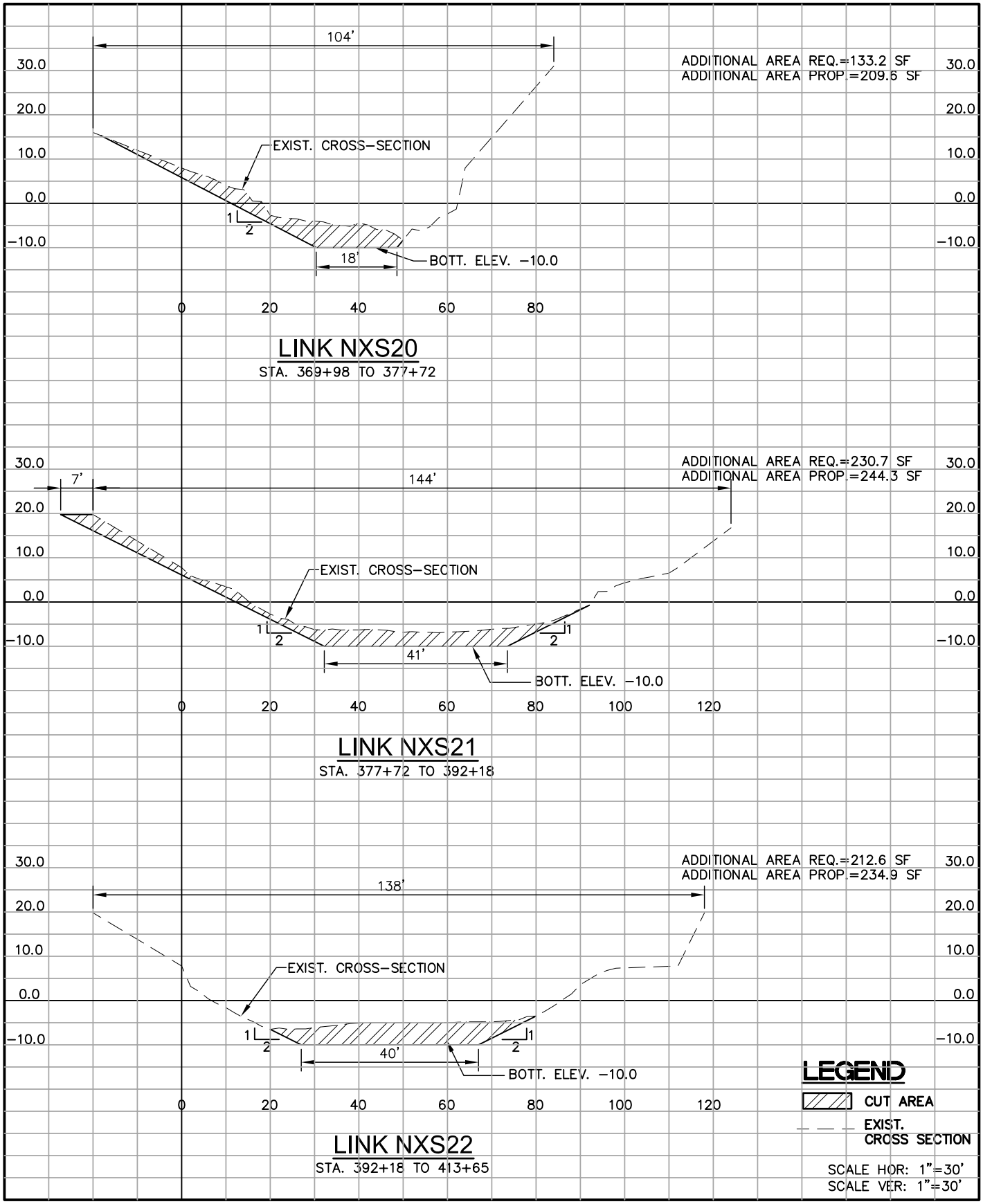
NSID ALTERNATIVE 1
HILLSBORO CANAL (EAST)
IMPROVEMENTS-CROSS SECTION

DATE: 08-09-05	SCALE: AS SHOWN	DRAWN BY: L.S.	APPROVED BY: A.V.

PROJECT #C110-05-001

ATTACHMENT:

A-4



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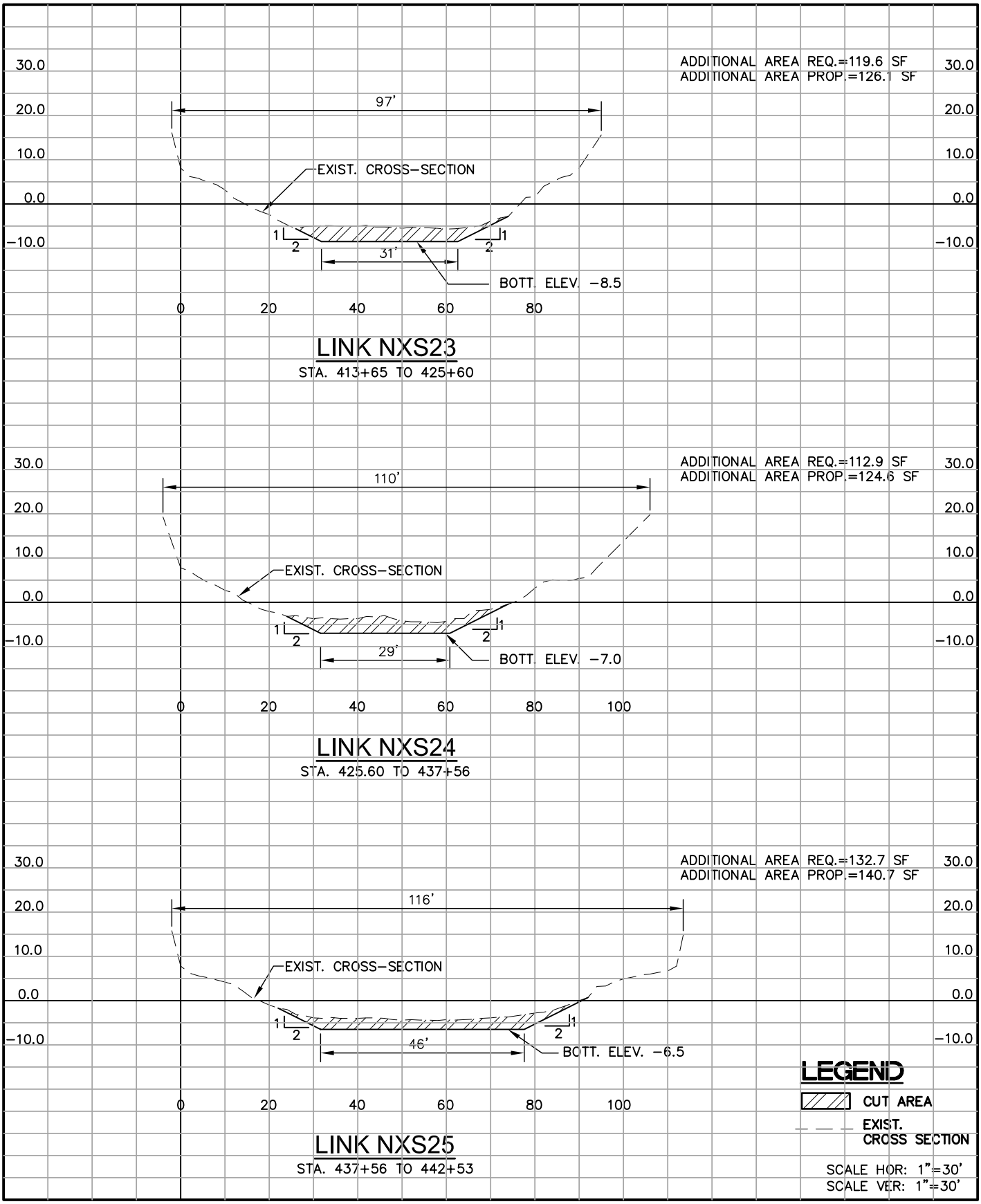
NSID ALTERNATIVE 1
HILLSBORO CANAL (EAST)
IMPROVEMENTS-CROSS SECTION

DATE: 08-09-05	SCALE: AS SHOWN	DRAWN BY: L.S.	APPROVED BY: A.V.

PROJECT #C110-05-001

ATTACHMENT:

A-5



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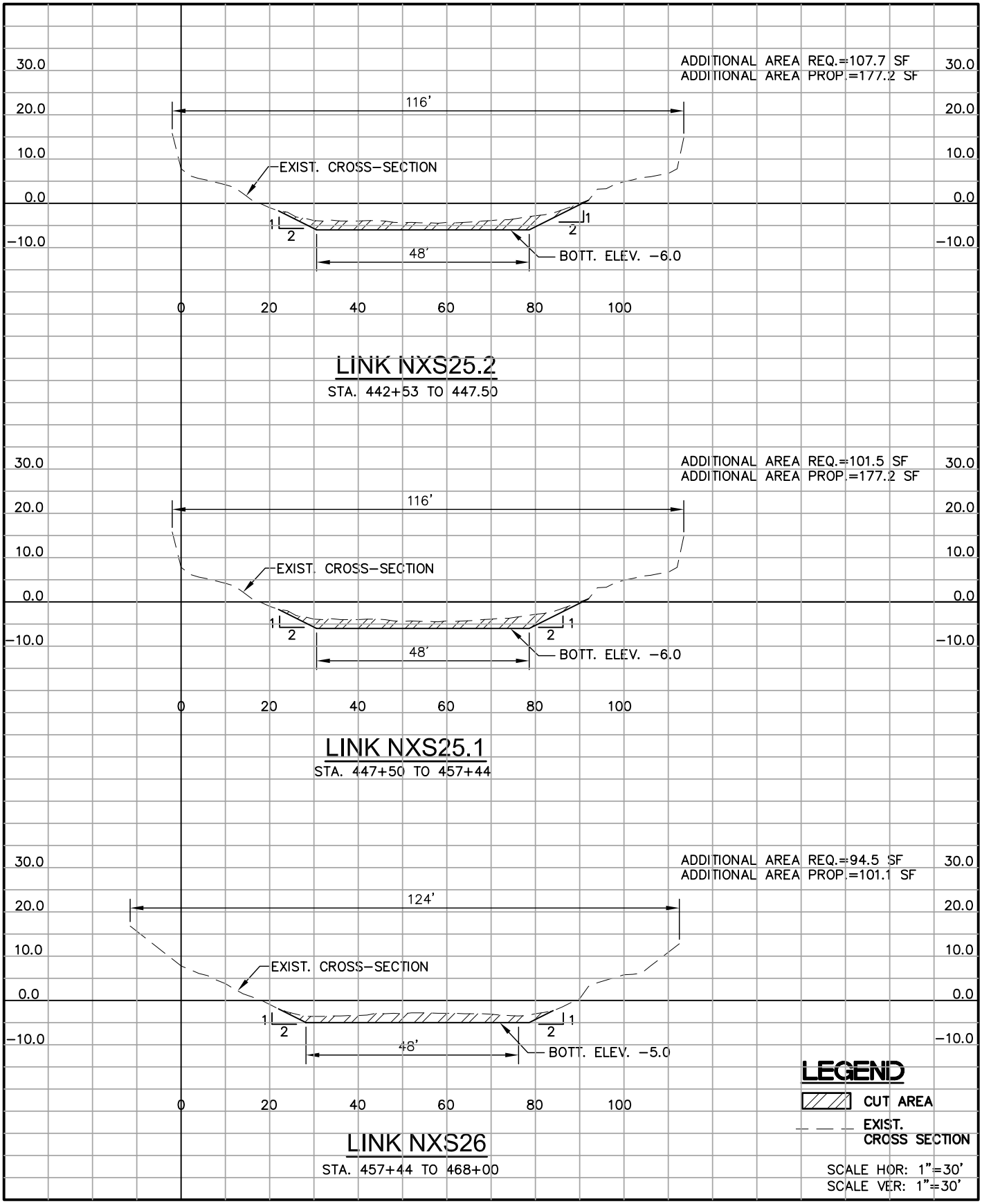
NSID ALTERNATIVE 1
HILLSBORO CANAL (EAST)
IMPROVEMENTS-CROSS SECTION

DATE: 08-09-05	SCALE: AS SHOWN	DRAWN BY: L.S.	APPROVED BY: A.V.

PROJECT #C110-05-001

ATTACHMENT:

A-6



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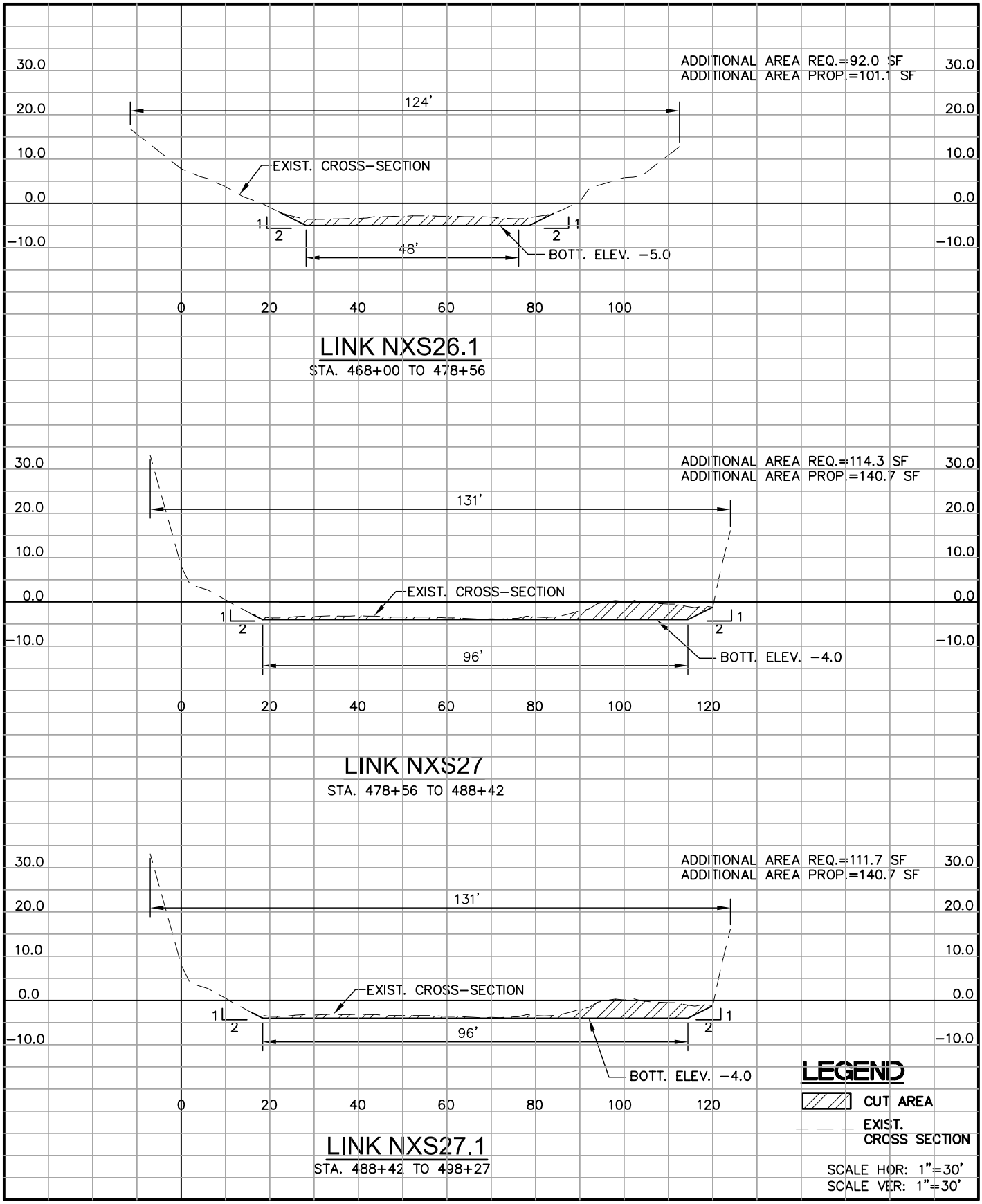
NSID ALTERNATIVE 1
HILLSBORO CANAL (EAST)
IMPROVEMENTS-CROSS SECTION

DATE: 08-09-05	SCALE: AS SHOWN	DRAWN BY: L.S.	APPROVED BY: A.V.

PROJECT #C110-05-001

ATTACHMENT:

A-7



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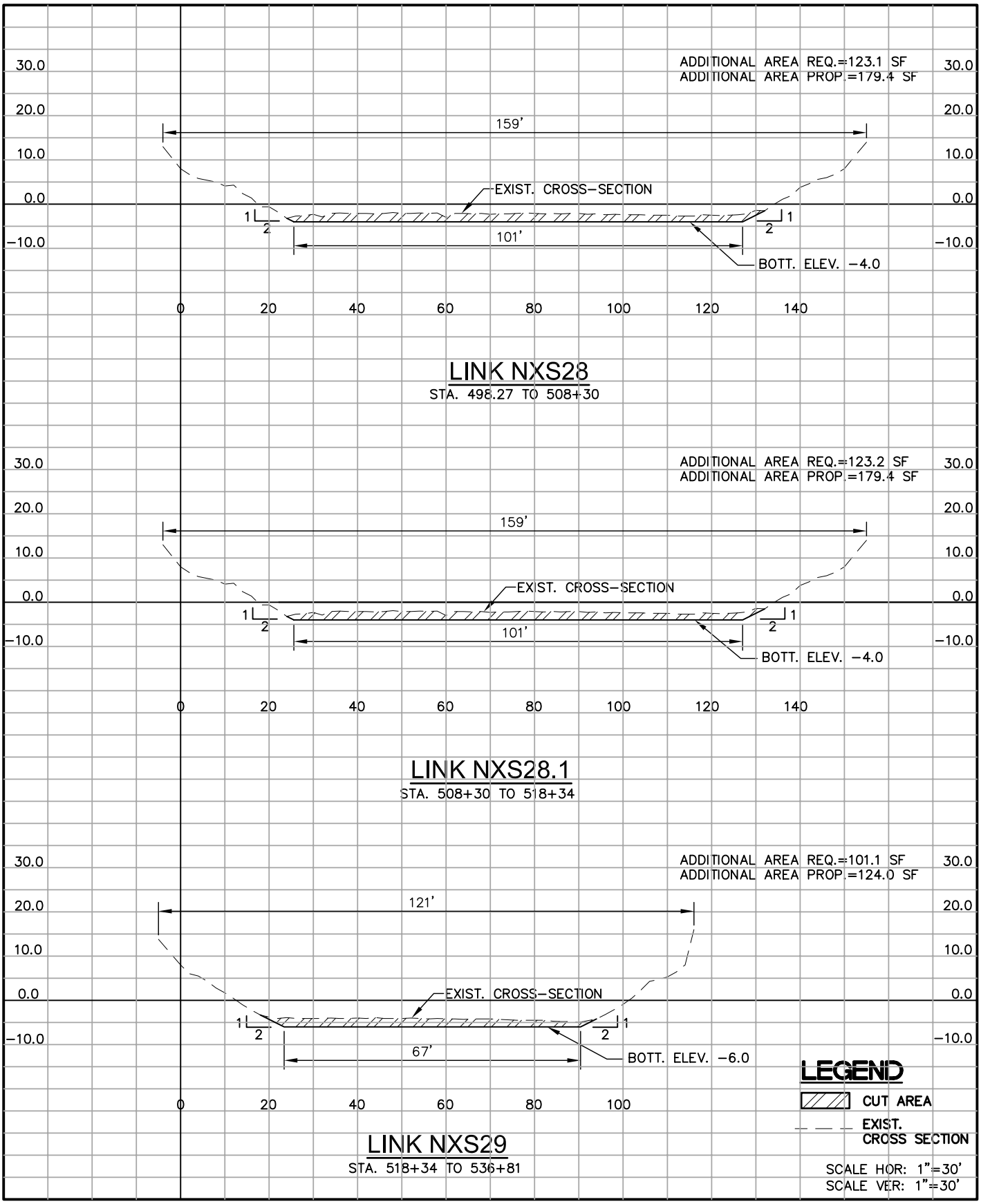
NSID ALTERNATIVE 1
HILLSBORO CANAL (EAST)
IMPROVEMENTS-CROSS SECTION

DATE: 08-09-05	SCALE: AS SHOWN	DRAWN BY: L.S.	APPROVED BY: A.V.

PROJECT #C110-05-001

ATTACHMENT:

A-8



LINK NXS28

STA. 498.27 TO 508+30

LINK NXS28.1

STA. 508+30 TO 518+34

LINK NXS29

STA. 518+34 TO 536+81

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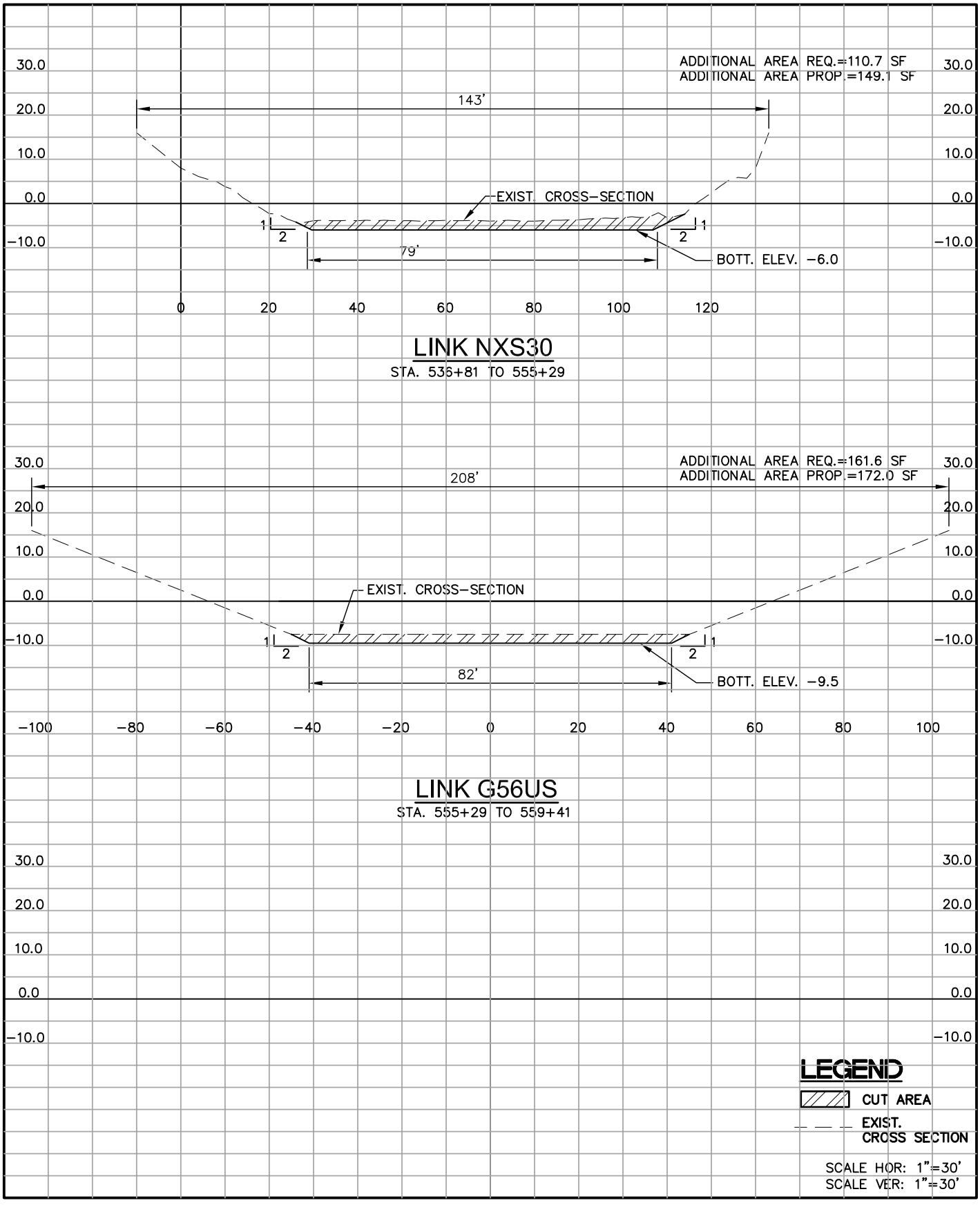
HILLSBORO CANAL (EAST)
IMPROVEMENTS-CROSS SECTION

DATE: 08-09-05	SCALE: AS SHOWN	DRAWN BY: L.S.	APPROVED BY: A.V.

PROJECT #C110-05-001

ATTACHMENT:

A-9



LINK NXS30

STA. 536+81 TO 555+29

LINK G56US

STA. 555+29 TO 559+41

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NSID ALTERNATIVE 1
HILLSBORO CANAL (EAST)
IMPROVEMENTS-CROSS SECTION

DATE: 08-09-05	SCALE: AS SHOWN	DRAWN BY: L.S.	APPROVED BY: A.V.

PROJECT #C110-05-001

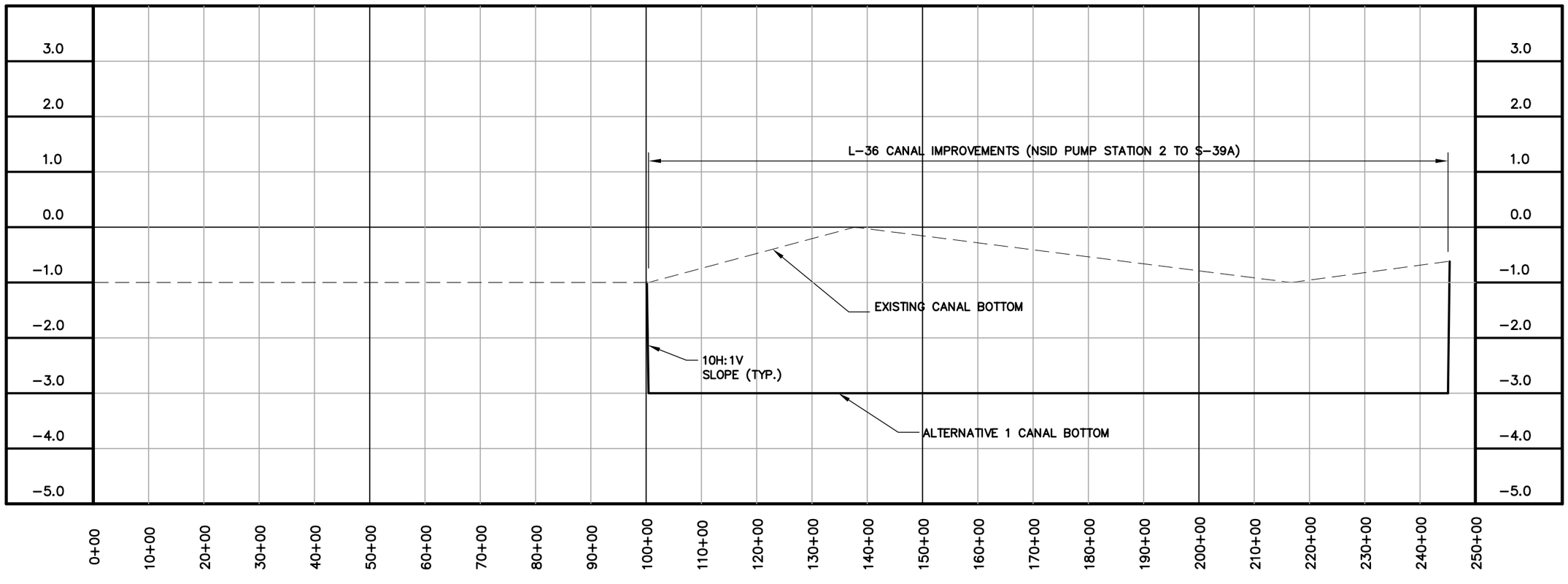
ATTACHMENT:

A-10

Attachment B
NSID Alternative 1 L-36 Canal Improvements Profile and Cross-sections

L-36 CANAL

SCALE: 1"=2000'



NOTES:

1. ELEVATIONS ARE IN FEET RELATIVE TO THE NATIONAL GEODETIC VERTICAL DATUM OF 1929
2. CANAL STATION IS BASED ON THE XP-SWMM MODEL CHAINAGE

L-36 CANAL

HORIZONTAL SCALE: 1"=2000'
VERTICAL SCALE: 1"=2'

ATTACHMENT B-1

NSID ALTERNATIVE 1

L-36 CANAL PROFILE IMPROVEMENTS

PROJECT #:C110-05-001
APPROVED BY: A.V.
DRAWN BY: A.M.
SCALE: AS SHOWN
DATE: 08/08/05

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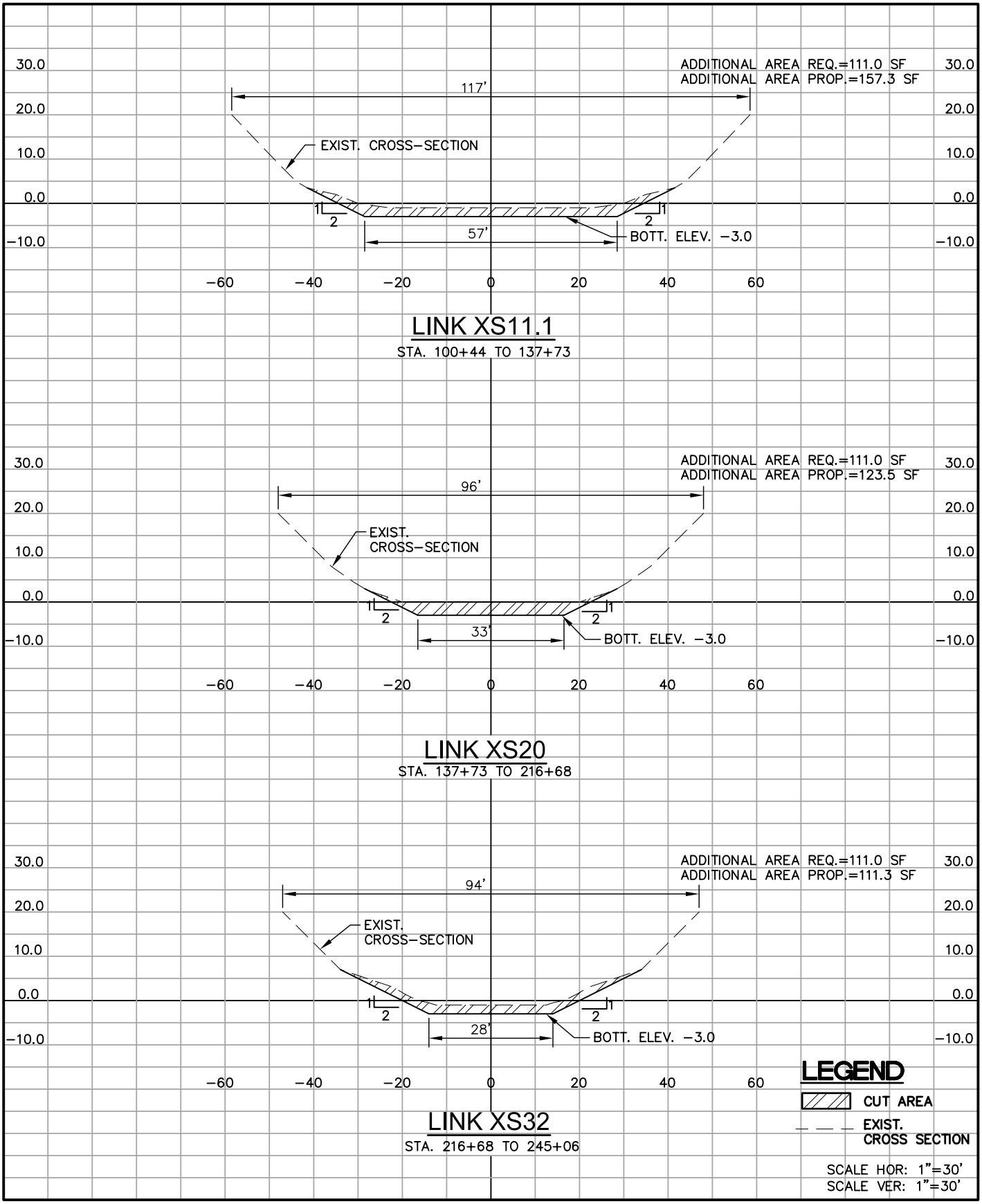

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NSID ALTERNATIVE 1
L-36 CANAL IMPROVEMENTS
CROSS-SECTION

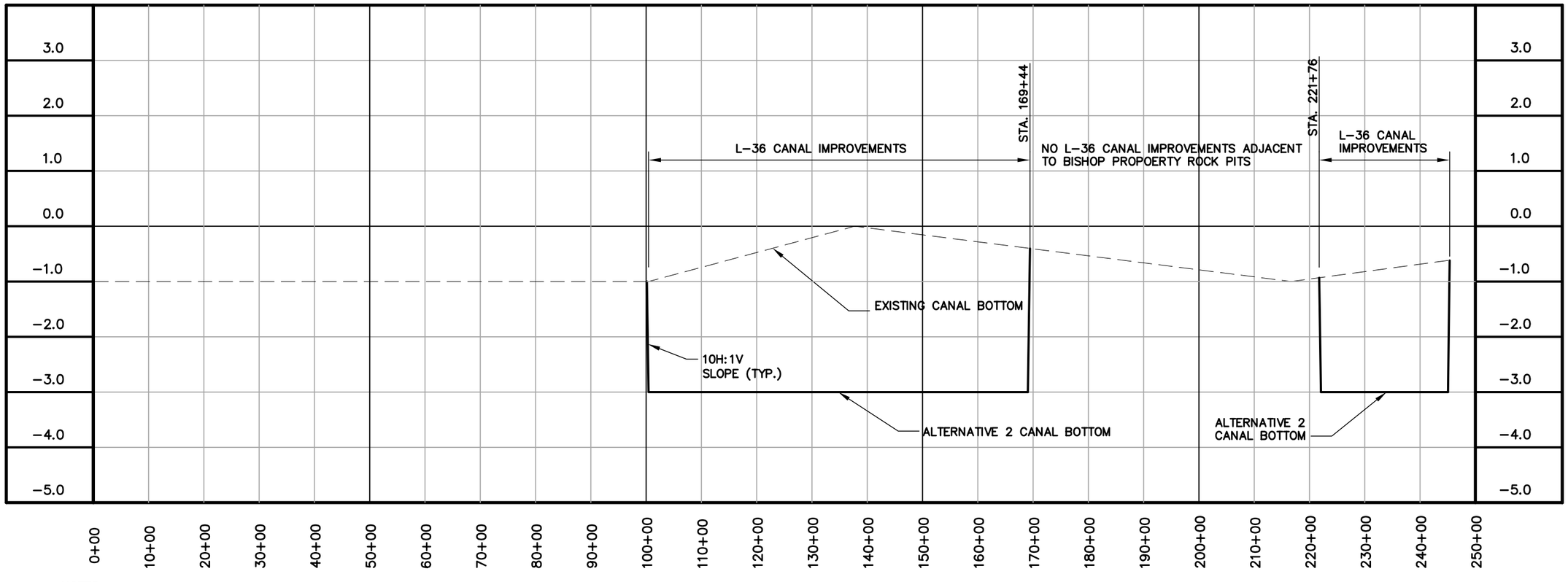
PROJECT #C110-05-001
ATTACHMENT:
B-2

DATE: 08-09-05	SCALE: AS SHOWN	DRAWN BY: L.S.	APPROVED BY: A.V.

Attachment C
NSID Alternative 2 L-36 Canal Improvements Profile and Cross-sections

L-36 CANAL

SCALE: 1"=2000'



NOTES:

1. ELEVATIONS ARE IN FEET RELATIVE TO THE NATIONAL GEODETIC VERTICAL DATUM OF 1929
2. CANAL STATION IS BASED ON THE XP-SWMM MODEL CHAINAGE

L-36 CANAL

HORIZONTAL SCALE: 1"=2000'
VERTICAL SCALE: 1"=2'

ATTACHMENT C-1

NSID ALTERNATIVE 2

L-36 CANAL PROFILE IMPROVEMENTS

PROJECT #:C110-05-001
APPROVED BY: A.V.
DRAWN BY: A.M.
SCALE: AS SHOWN
DATE: 08/08/05

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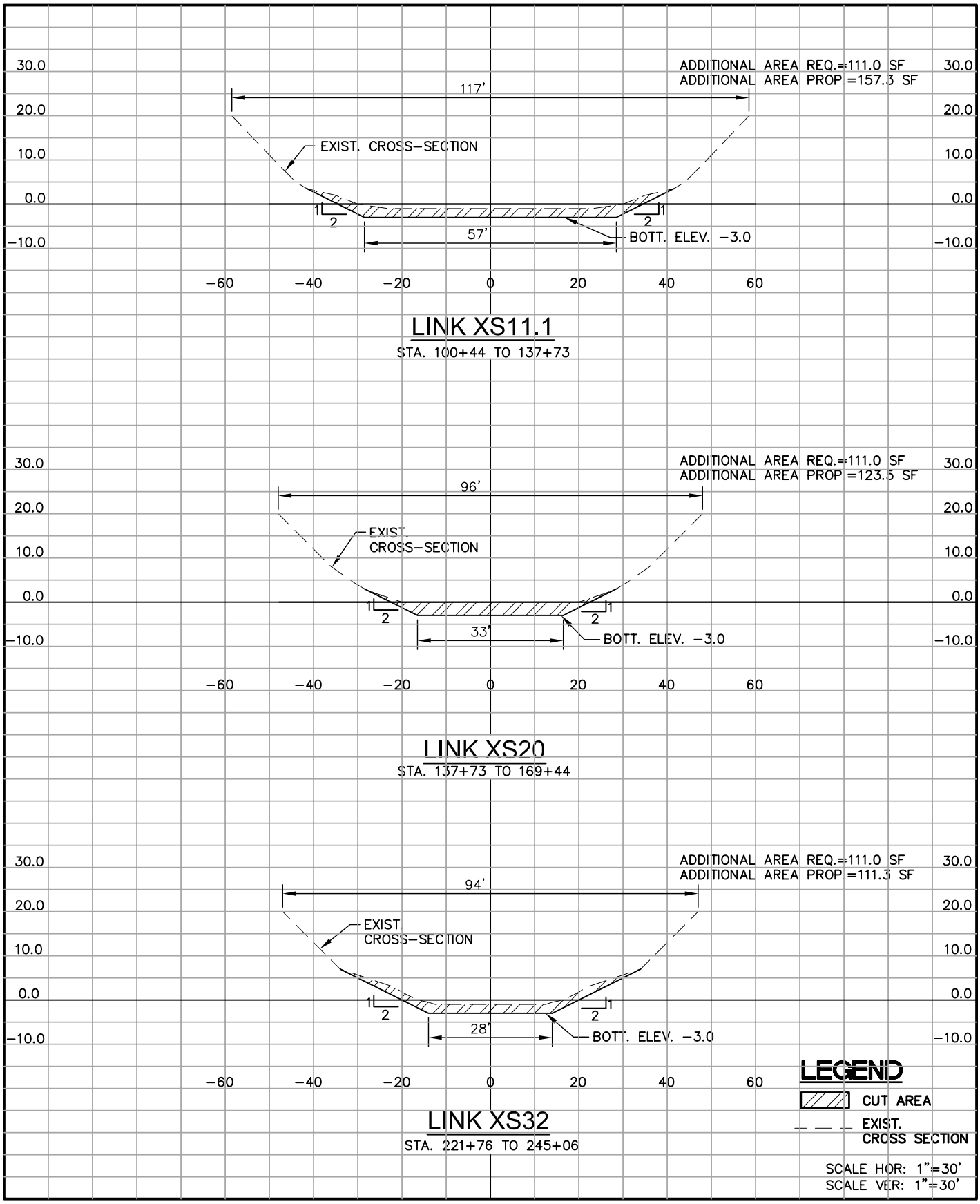

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NSID ALTERNATIVE 2
L-36 CANAL IMPROVEMENTS
CROSS-SECTION

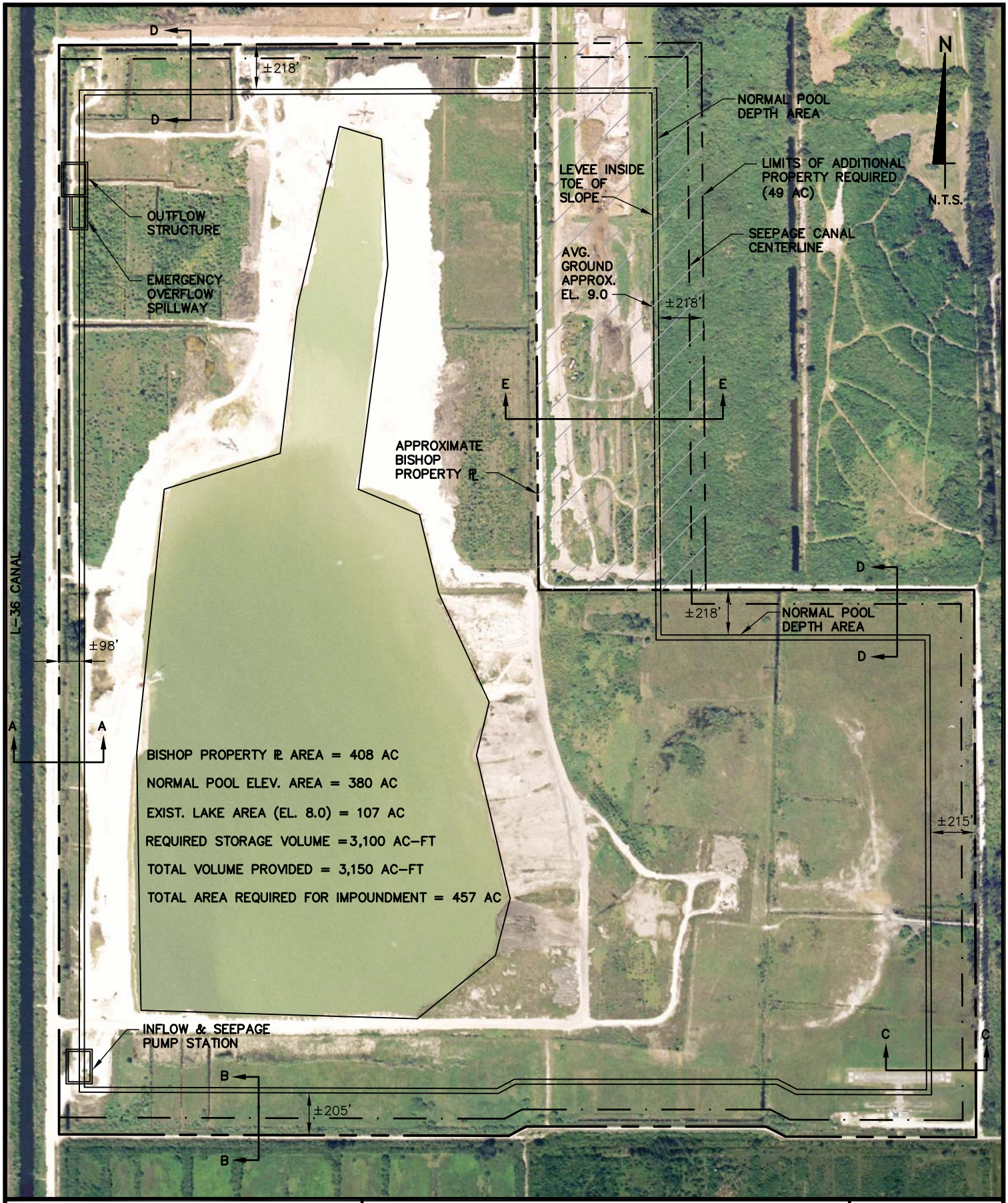
DATE: 08-09-05	SCALE: AS SHOWN	DRAWN BY: L.S.	APPROVED BY: A.V.

PROJECT #C110-05-001

ATTACHMENT:

C-2

Attachment D
NSID Alternative 2 Bishop Property Improvements Plan and Typical Sections



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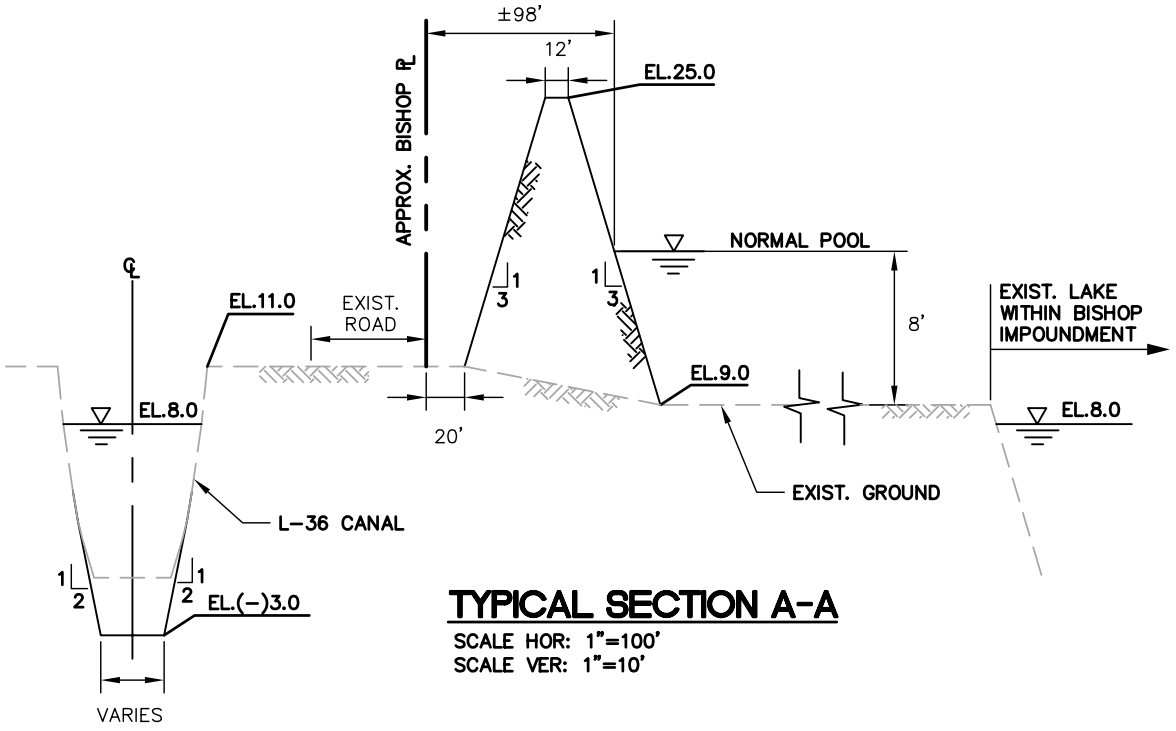
NSID ALTERNATIVE 2
BISHOP PROPERTY IMPROVEMENTS PLAN

DATE: 08-09-05	SCALE: N.T.S.	DRAWN BY: L.S.	APPROVED BY: A.V.

PROJECT #C110-05-001

ATTACHMENT:

D-1



TYPICAL SECTION A-A

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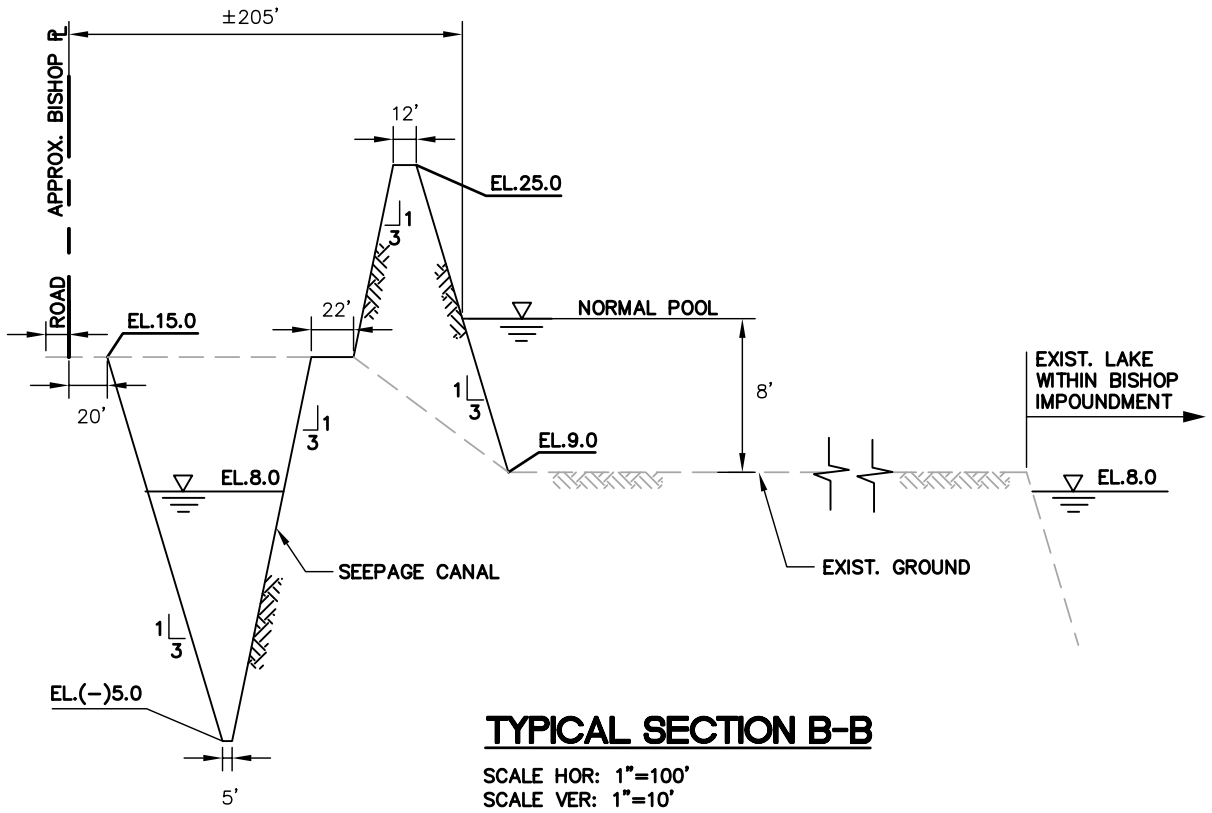

TYPICAL SECTION B-B

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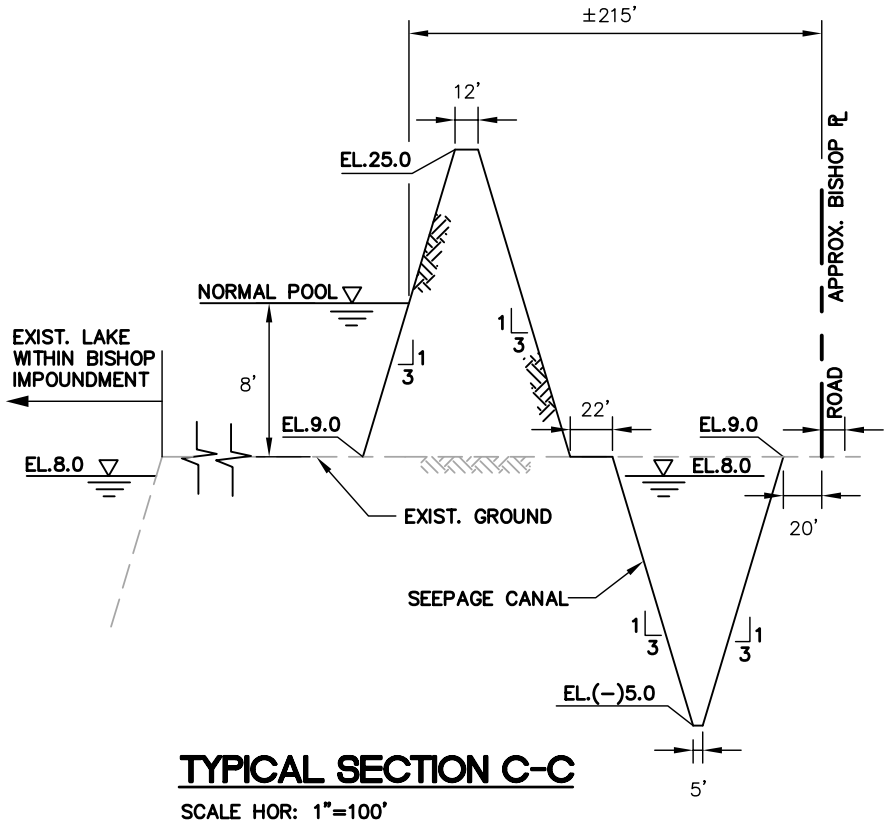
NSID ALTERNATIVE 2
BISHOP PROPERTY IMPROVEMENTS
TYPICAL SECTIONS

PROJECT #C110-05-001
ATTACHMENT:
D-2

DATE:08-09-05 | SCALE:AS SHOWN | DRAWN BY: L.S. | APPROVED BY: A.V.



TYPICAL SECTION C-C

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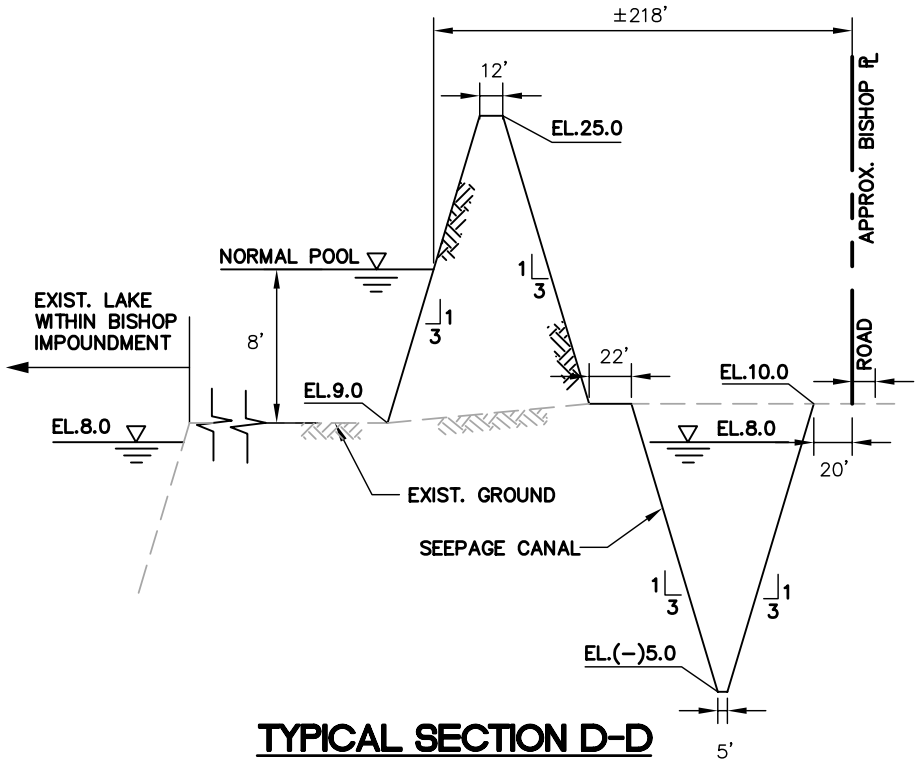

TYPICAL SECTION D-D

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SCALE VER: 1"=10'

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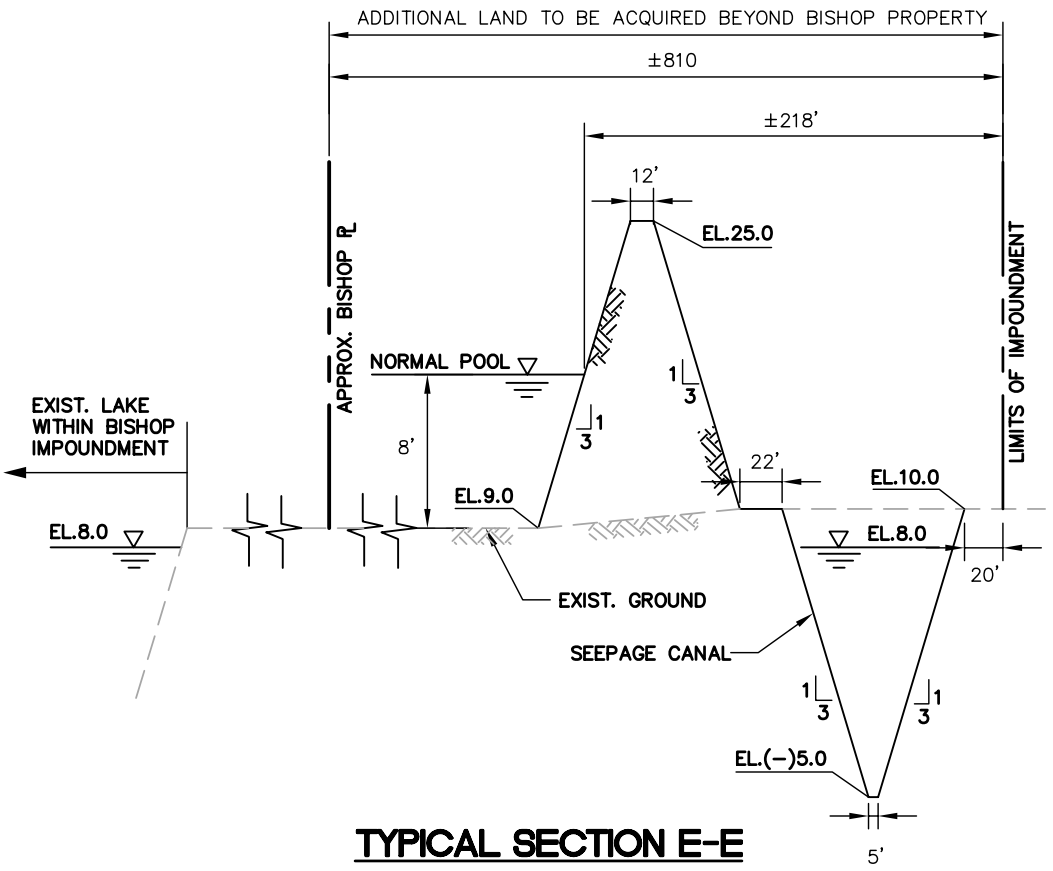
NSID ALTERNATIVE 2
BISHOP PROPERTY IMPROVEMENTS
TYPICAL SECTIONS

DATE: 08-09-05	SCALE: AS SHOWN	DRAWN BY: L.S.	APPROVED BY: A.V.

PROJECT #C110-05-001
ATTACHMENT:
D-3



TYPICAL SECTION E-E

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SCALE VER: 1"=10'

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NSID ALTERNATIVE 2
BISHOP PROPERTY IMPROVEMENTS
TYPICAL SECTIONS

DATE: 08-09-05	SCALE: AS SHOWN	DRAWN BY: L.S.	APPROVED BY: A.V.

PROJECT #C110-05-001

ATTACHMENT:

D-4