Appendix D

ENGINEERING APPENDIX

CENTRAL AND SOUTHERN FLORIDA PROJECT FOR FLOOD CONTROL AND OTHER PURPOSES

TAMIAMI TRAIL
MODIFIED WATER DELIVERIES
TO EVERGLADES NATIONAL PARK

ENGINEERING APPENDIX

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1. Introduction

Modifications to the U.S. Hwy 41 (Tamiami Trail) are required between spillway structures S-333 and S-334 to permit proper conveyance of the Modified Water Deliveries to the Everglades National Park project flows and to mitigate the impact of the resulting higher water surface elevations on the roadway. See plate A14-1.

This appendix addresses only the Tentatively Selected Plan. Alternative evaluation is discussed in the main report. Engineering aspects of alternatives and other related issues are available in supporting documentation.

The portion of Tamiami Trail within the project limits is maintained by the Florida Department of Transportation (FDOT), District 6, Miami, FL. Preliminary coordination has been performed with District 6 staff as required to define the features of the selected plan. Roadway and bridge features of the selected plan include provisions (use of guardrail, use of 0.2% longitudinal bridge deck slope, etc) that require FDOT District 6 design variance approval. Further, FDOT District 6 approval is understood to be required for Preconstruction Engineering and Design (PED) phase submittals.

2. References and Prior Reports

a. U.S. Army Corps of Engineers. General Design Memorandum, Modified Water Deliveries to the Everglades National Park, Part I, Supplement 54, Central and Southern Florida Project, Jun 1992

b. U.S. Army Corps of Engineers. General Reevaluation Report, Engineering Appendix for Tamaimi Trail Modifications, Modified Water Deliveries to the Everglades National Park, Central and Southern Florida Project, Dec 2000, and Jul 2001 (Addendum to Engineering Appendix). This report did not result in a signed Record of Decision.

3. Tamiami Trail Construction History

The original Tamiami Trail was constructed in the late 1920's or early 1930's. The existing alignment was 4-5 feet of peat and muck on top of limestone bedrock. The roadway embankment was constructed by dredging the bedrock, forming what is now the canal on the north side, and placing the rock directly on top of the muck. The muck consolidated to a thickness of 2-3 feet, and the granular embankment varies from 3-6 feet thick. A rock base surface treatment was applied as the driving surface. In the mid-1940's, 20 timber bridges were added within the limits of this project, as part of a larger 38 bridge project along the Tamiami Trail in Dade County. Each bridge was approximately 45 feet long and spaced about one-half mile apart. In the early 1950's, the bridges were replaced with the current culverts. In 1968, the shoulders were widened and north side guardrail was added in 1970. Drawings from 1993 indicate previous placement of a nominal 4 inch asphalt overlay and guardrail along the south side, presumably in the 1980s. In 1993, trees along the north were removed, additional widening of the shoulders was conducted, and the roadway was resurfaced (2 inch mill and 2.5 inch asphalt overlay). The current roadway profile is variable, suggesting that the existing peat layer within the roadbed foundation consolidated unevenly. Roadway plan sets obtained from FDOT archives were reviewed. The plans pertinent to this project include:

Job Number	Date	Scope
8711-109	~ 1946	Addition of 39 45-foot long bridges, 21 within the project area
8711-109	~ 1951	Replacement of 21 bridges within project area with culverts
8711-3501	~ 1969	Widening (addition of 4 feet of pavement on the south side; two foot southern centerline shift; increase in width of travel lane from 10 feet to 12).
8711-3901	~ 1970	Addition of north guard rail.

87110-3506 ~1993 Widening of left and right shoulder pavement (5.5 inches of aggregate base, 4.2 inches of structural asphalt concrete, and 5/8 inches of friction course). Addition of asphalt concrete from the edge of structural shoulder to the outside of the guard rail on both the north and south sides of the road. Resurfacing (2 inch mill and 2.5 inch asphalt overlay) of entire roadway. Removal of trees on the north side of road.

4. Surveying and Mapping

A conceptual level topographic survey was conducted in 2000, consisting of a cross-section every mile and a centerline elevation every 500 feet. The centerline elevation varied from 10.06 to 11.92 feet (NGVD 1929 vertical datum) along the majority of the project. At the west end, the roadway rose considerably to 15.0 feet to connect to the Tamiami Trail west of S-333. The average elevation for the study corridor, excluding the data above 12 feet (which is the rise at the west end), is 10.95 feet. This figure was rounded to 11.0 feet for development of the concept alternatives.

No formal property boundary survey information was available from FDOT or the Everglades National Park (ENP), and no property boundary survey was performed as part of this analysis. Instead, Maintenance Right-of-Way lines from FDOT District 6 Maintenance Right-of-Way (R/W) maps were interpreted as permanent R/W lines, and used to determine impacts to property beyond existing R/W.

A “specific purpose elevation survey” was conducted in 2005 by the National Park Service to determine finished floor and other key structure elevations for Everglades Safari, Cooperstown, Jefferson Pilot Communications, Gator Park, and Radio One Communications. In addition to structure elevations, these surveys included only limited planimetric information. Coupled with county property records and aerial photography, these surveys were used for informal property impact determinations as a result of the bridge and roadway construction. Separately, property impacts as a result of planned higher future water elevations are discussed in the Real Estate Appendix.

A complete topographic, planimetric, and property boundary survey will be conducted in the PED phase of the project.

5. Geotechnical Investigations

5.1 Law Gibb Group, July 2000

The investigation consisted of 16 soil test borings (STB) within the project corridor, 10 in the roadway embankment and 6 in L-29, in order characterize the general nature of the subsurface conditions within the project limits. Of the 10 roadway borings, 6 were in the outside wheel path and 4 were in the shoulders. Of the 6 levee borings, 3 were in the lower maintenance road and 3 were in the top of the levee. All borings were extended until the bedrock was reached.

Results indicate a 6 inch nominal asphalt pavement thickness on an approximate 3 foot thick granular embankment on a 1-3 foot muck layer, underlain by limestone. The granular embankment gradation is classified as a coarse to fine limestone gravel with some fine sand and little, if any silt, and has a Unified Classification System designation of GP-GM. Presence of large rocks was not determined. Water elevations in the embankment varied from 5.6 to 9.4 feet NGVD 29, with most elevations at 7.4 feet. L-29 embankment water levels varied from 6.1 to 9.4 feet, with most less than 7 feet. Moisture content in the embankment material indicates a capillary rise in the embankment of about 2 feet above the water table. Muck thickness varied from zero to 3 feet thick with an approximate average 2 foot thickness. For the selected plan, muck thickness was assumed to be 3 feet thick beneath the roadway, resulting in a top of muck elevation of 5 feet.

5.2 ERES Consultants, Aug 2000

The investigation included falling weight deflectometer (FWD) testing and analysis along the project corridor. Results indicate a subgrade resilient modulus ranging from 5000 to 12,000 psi, with an average of 7,500 psi.

For background, the FWD testing provides an estimate of overall strength of the existing roadway, including the influence of the granular subbase, peat and limestone bedrock. The test applies a 9-kip load (equal to one wheel of the 18-kip axle used for design) to the pavement surface and measures the pavement deflection. Combining the deflection with the layer thickness of the asphalt and embankment, the strength of each layer is determined.

5.3 Wolf Technologies, Aug 2005

Investigations included 30 soil test borings (STB) and 290 piezocone penetration tests (CPT) intended to determine the thickness and depth of peat in the existing roadway alignment. The borings depths ranged from 7 to 13 feet below ground surface. CPT soundings ranged from a depth of 3 to 13 feet. CPT soundings were correlated to SBTs. Results indicate a peat thickness range from 0.5 to 8 feet, with an average of 2.5 feet. Under the influence of an additional 3 feet of typical road base material, expected primary consolidation of the peat layer will range from 0.5 to 9 inches, with an average of 3 inches.

6. Pavement Condition Investigations

Terracon Consulting, July 2000: This investigation included a Ground Penetrating Radar (GPR) survey and pavement distress survey of the project corridor. GPS survey results indicate an asphalt thickness range of 2 – 12 inches, with an average 6.75 inch thickness. An average asphalt thickness of 6 inches was used for the selected plan. The distress survey, which measured cracking (alligator, block, combined), raveling, and rutting, indicated an average overall rating of 6, on a 0-10 scale, with 10 being excellent.

7. Existing Conditions

7.1 Wetlands Adjacent to Project

Wetlands begin immediately south of the Tamiami Trail. Several small privately owned parcels south of the Tamiami Trail are classified as non-wetlands, and constitute fill placed in wetlands. Dominant wetland communities adjacent to the project area, as mapped by the South Florida Water Management District include sawgrass, cattail, broadleaf and floating emergents, mix of shallow open water, shrubland mix, pond apple/willow mix, and Brazilian pepper/shrubland mix.

The wetlands were evaluated in Dec 2000 using the Wetland Rapid Assessment Procedure (WRAP). The WRAP is a functional evaluation of wetland sites, which, when combined with professional judgment, provides a consistent evaluation of wetland sites by establishing a numerical score for a site based on ecological and anthropogenic variables. The acreage of each wetland habitat type is then multiplied by the WRAP score for that site to derive “functional units” for comparison purposes.

WRAP results of five areas within the project limits included scores ranging from a high of 0.70 for the sawgrass/emergent marsh and forested wetland (pond apple/willow) habitat types to a low of 0.48 for cattail dominated habitat. For perspective, a wetland habitat type with a score of 0.70 means that the wetland is functioning at 70 percent of its maximum potential of 1.0. See reference (b). Lower scores were primarily due to the proximity of the ENP wetlands to the road, and the general lack of a minimum 30-foot buffer between the highway and the wetlands. Immediately adjacent to Tamiami Trail on the south is a narrow ditch resulting from the original road construction, and adjacent to it, the quality of the wetlands is lower. Except for those wetlands fringing the highway and those wetlands dominated by nuisance and exotic vegetation, the quality of wetlands in the project area is generally good.

From a 2003 U.S. Fish and Wildlife Service Coordination Act Report, wetlands within the project area are infested to varying degrees with exotic vegetation such as Brazilian pepper (*Schinus terebinthifolius*) Australian pine (*Casuarina* spp.), *Melaleuca quinquenervia*, common reed (*Phragmites australis*), and Napier grass (*Pennisetum purpureum*). Exotic infestation is most evident along the perimeter of the U.S. Hwy 41 corridor and adjacent disturbed areas where dredge and fill activities have taken place.

7.2 Foundation Conditions

See geotechnical investigations above. Subsurface investigations describe a muck layer over medium hard limestone layers. The rock surface, which appears relatively uniform within the project limits, varies between elevation 2.0 and 6.0 NGVD 29.

7.3 Pavement Condition

Based on the FDOT's Flexible Pavement Condition Survey Handbook, the year 2000 pavement condition rating was estimated to be 6 on a 0-10 scale, with 10 being excellent. This rating represents an average for the corridor under consideration. The roadway is understood to be managed in accordance with FDOT maintenance policies and procedures.

The rating is based on both a review the FDOT's existing pavement condition database [period of record = 1976 to 1999; database rates cracking, rutting, and ride], and an independent Jul 2000 distress survey discussed above.

Existing topographic conditions are described in the Surveying and Mapping section.

7.4 Culvert Conditions

There are 55 cross drains (19 sets of single or multi-barrel corrugated metal pipe culverts) within the project corridor that convey flow from the L-29 borrow canal on the north side of the roadway to the wetlands on the south. See Table 1, Inventory of Culverts, in Annex A. Using FDOT's Culvert Service Life Estimator program, the existing reinforced concrete pipe culverts under this segment of U.S. Hwy 41 have an estimated remaining service life in excess of 300 years (design service life of 360 years less in-service period of 50 years). The service life was estimated based on parameters obtained at two boring locations along the existing alignment and at two depths within each boring. Parameters consider for the service life include the corrosion rate, potential for abrasion, and other site factors. Corrosion indicators include pH, resistivity, sulfates and chlorides.

For background, the FDOT requires that culverts be designed for a projected maintenance free time period or a design service life (DSL) appropriate for the culvert function and highway type. The projected service life of pipe material options shall provide as a minimum the DSL. The DSL for cross drains under U.S. Hwy 41 is 50 years based on the roadway classification, which in this case is a "major facility" because the traffic volume is greater than 1,600 vehicles per day Average Daily Traffic (ADT).

No formal inspections were performed to assess structural conditions of the culverts (distress in barrels or headwalls due to settlement, overloading, etc). The culverts are understood to be in adequate condition and managed in accordance with FDOT maintenance policies and procedures.

7.5 Drainage and Runoff Treatment

The roadway enjoys adequate stormwater drainage in accordance with FDOT standards for safety to the motoring public. The existing roadway does not have a stormwater runoff collection or conveyance system. Runoff from the roadway pavement flows off the road and down the embankment into the adjacent canal on the north side of the roadway or into the wetlands on the south side. No water quality or attenuation of runoff is provided.

7.6 Traffic Capacity

Existing traffic data for 2004 are 6,000 ADT, with 15.45% trucks. Using Highway Capacity Manual procedures for two-lane roads (Chapter 20), the 2004 level of service (LOS) for traffic was calculated to be LOS B. No left turn lanes, passing lanes, median buffers, or roadway lighting currently exist within the project corridor. No other formal determinations were performed regarding existing traffic capacity. The project corridor is understood to provide sufficient capacity in accordance with FDOT policies.

7.7 Assumed Existing Parameters and Values

Existing roadway asphalt thickness --------------------------------------- 6 inches
Existing roadway granular fill thickness ---------------------------------- 5.5 feet
Existing roadway top of asphalt, centerline elevation ---------------- 11.0 feet
Existing roadway top of consolidated muck elevation ----------------- 5.0 feet
Top of natural muck elevation -- 6.5 feet*
Top of bedrock elevation --- 2.0 feet**
Top of L-29 elevation ---17.4 feet
Existing L-29 borrow canal water elevation ----------------------------- 7.5 feet
Existing roadway pavement effective stiffness number -------------- 3.5
Existing roadway embankment modulus -------------------------------- 4000 psi

* Based on review of L-29 construction plans, the undisturbed top of muck elevation is 6-6.3 feet. A conservative top of muck elevation of 6.5 feet is assumed.

** Top of bedrock elevation varies from 1.7 to 6.1 feet, with most of the elevations slightly above 3 feet. For conservative estimation of embankment quantities and performance behaviors, 2 feet is assumed.

8. Design Data, Criteria, and Assumptions

8.1 Selected Plan Assumptions and Constraints

The following assumptions and constraints are incorporated into the selected plan.

a. The selected plan includes the least-cost facilities required to satisfy design requirements, while limiting encroachment into the Everglades National Park and private property to a practical minimum.

b. Modifications to Tamaimi Trail will satisfy FDOT and AASHTO prescriptive geometric and engineering criteria, but are not intended to improve traffic capacity.

c. Vehicular access to private parcels will remain during and after construction. Where adjacent to a new bridge, access ramps will replace existing driveways.

d. The Value Jet Flight 592 memorial, located near S-333, will remain undisturbed.

e. The western abutment of the central bridge must remain at least 1/2 mile east of the Osceola Indian Camp.

f. The bridges will be situated to the south side of the existing roadway alignment to reduce construction cost by avoiding impacts to L-29 and avoiding increased quantities and unit rates associated with construction in the L-29 borrow canal.

g. The existing roadway embankment is to be removed for the length of the bridges to the level of the surrounding marsh terrain, assumed to be elevation 6.0.

h. Existing triple-barrel CMP culverts unaffected by bridge or roadway transition construction will remain in place, and will be extended if necessary in conjunction with the revised typical section to remain functional. The remainder will be removed along with the existing embankment.

8.2 Hydraulic Requirements and Pertinent Water Levels

Refer to the Hydrology and Hydraulics Annex for a discussion of water levels and velocities predicted by hydrologic modeling. The following water levels are based on a central bridge net hydraulic opening of 2.0 miles, and eastern bridge net hydraulic opening of 1.0 mile.

a. Roadway Design High Water (DHW) elevation: 9.70 ft NGVD 29. Defined as the 20-year 24-hour stage, assuming a natural systems condition, based on a regional hydrologic model and a 36 year simulated period of record. This water level is only used to establish the vertical clearance requirements for the reconstructed roadway.

b. Bridge Control Water Elevation (CWE): 8.75 ft NGVD 29. Defined as the average high water elevation assuming a natural systems condition, based on regional hydrologic model and a 36 year simulated period of record. This stage, 8.75 feet, is exceeded 12.5% of the time during the period of record. This does not represent a stage that will be maintained but a stage used to determine the required low chord elevation for the proposed bridge.

c. 100-year Flood elevation: 10.1 ft NGVD 29. Assumes a natural systems condition, based on regional hydrologic model and a 36 year simulated period of record.

8.3 Traffic Parameters

West Project Limit (on proposed centerline of project) --------------- Sta. 2012+00 (near S-333)
East Project Limit (on proposed centerline of project) --------------- Sta. 2591+40.41 (near L-31N)
Project Length --- 57,940.4 feet/10.97 miles
Florida Dept. of Transportation State Route No. ---------------------- S.R. 90
Florida Dept. of Transportation Section No. ---------------------------- 870003
Florida Dept. of Transportation Functional Classification ----------- Rural Arterial
Roadway Design Speed -- 60 mph
Roadway Posted Speed Limit -- 55 mph
Number of Existing Travel Lanes -- 2
Number of Future Travel Lanes --- 2
Existing Average Daily Traffic (2004)------------------------------------- 6,000 vehicles
Projected Average Daily Traffic (2010 - Opening Year) -------------- 7,800 vehicles
Projected Average Daily Traffic (2030 - 20 Years After Opening)-- 12,700 vehicles
Percent Heavy Trucks (K30 - 2004) --------------------------------------15.45%
Peak Hour to Daily Traffic Ratio (K30 - 2004) -------------------------- 8.22%
Directional Distribution Factor (D30 - 2004) --------------------------- 67.12%
Percent Heavy Trucks (K30 - 2030) -------------------------------------- 12.0%
Peak Hour to Daily Traffic Ratio (K30 - 2030) -------------------------- 8.5%
Directional Distribution Factor (D30 - 2030) --------------------------- 60.0%

8.4 Roadway Design Criteria

The reconstruction of Tamiami Trail will be designed in accordance with the FDOT Plans Preparation Manual (PPM), AASHTO's Policy on Geometric Design of Highways and Streets, and other FDOT roadway and traffic design standards.

8.4.1 Horizontal Alignment

The selected plan satisfies the following FDOT PPM Volume 1 requirements, except as noted.

a. Maximum Horizontal Curvature. Table 2.8.3 indicates that for a rural environment (e_{max} = 0.10) and at design speed of 60 mph, the maximum curvature allowed by State Highway System (SHS) criteria is $5^0$15'00".

b. Maximum Deflections Without Horizontal Curves. For the design speed of 60 mph, Table 2.8.1a indicates a maximum deflection without horizontal curves for arterials without curb and gutter of $0^0$45'00".

c. Lane Width. Table 2.1.1 indicates a minimum through lane width of 12 feet for 2-lane rural roadways.

d. Shoulder Width. For 2-lane arterials without shoulder gutter, Table 2.3.3 indicates a minimum full shoulder width of 10 feet and a minimum paved shoulder width of 5 feet for average volume highways.

e. Border Width. For arterials with design speeds greater than 45 mph and flush shoulders, Table 2.5.1 of the PPM indicates a minimum border width of 40 feet. This criterion will not be satisfied, as the existing right-of-way is minimal. Guardrail will be used.

8.4.2 Horizontal Clearances

For roadways with flush shoulders, as outlined in Section 2.11.

Object	Clearance Requirement	Additional Notes
Light Poles	20 ft from Travel Lane	No lighting included
Utility Installations	Not within the Clear Zone	Existing utilities
Trees	Outside the Clear Zone	Behind guardrail
Bridge Piers and Abutments	Outside the Clear Zone	Will be protected
Guardrail	12 ft for Shoulders 10 ft and Wider Shoulder Width Plus 2 ft for All Other Shoulders	5 ft paved shoulders

Table 2.11.10 indicates that the required clear zone width is 36 feet adjacent to the outside travel lane, if the design speed is greater than 55 mph and there are more than 1,500 vehicles AADT. This criterion will not be satisfied. Guardrail will be used.

8.4.3 Vertical Alignment

The selected plan satisfies the following FDOT PPM Volume 1 requirements, except as noted.

a. Maximum Grade. The maximum grade permitted for a rural arterial with a 60 mph design speed is 3% according to Table 2.6.1. The maximum grade for ramps (the bridge access roads) with a design speed under 20 m.p.h. is 6%-8%.

b. Maximum Change in Grade Without Vertical Curves. The maximum change in grade permitted without a vertical curve for a 60 mph design speed is 0.4% (1.20% for 20 mph design speed) according to Table 2.6.2. Minimum K values give a design speed of 60 mph for the crest and sag conditions are 245 and 136, respectively. The minimum length curve for a crest is 400 feet and for a sag curve is 300 feet according to Tables 2.8.5 and 2.8.6. Vertical curves have been used where required.

c. Grade Datum. The required roadway base clearance above the Design High Water (DHW) elevation for rural two-lane roadways with Design Year ADT greater than 1,500 daily vehicles is 2 feet according to Table 2.6.3. Alternatively, the FDOT will allow 1 foot of clearance if asphaltic base is used.

d. Stopping Sight Distance. For a design speed of 60 mph and grades of 2% or less, Table 2.7.1 indicates a minimum stopping distance of 570 feet.

e. Cross Slope. Figure 2.1.1, Standard Pavement Cross Slopes. requires 2% pavement cross slope.

8.4.4 Pavement

The selected plan employs a typical flexible pavement design for the entire length of reconstructed roadway, in accordance with the FDOT Flexible Pavement Design Manual (2005) and the Flexible Pavement Guide (1999). See reference (b). Refinement of the pavement design will be performed during the PED phase.

8.4.5 Drainage and Runoff Treatment

Roadway drainage conditions will equal or exceed current conditions, and will not adversely impact performance of the existing cross drains (culverts). The edge of shoulder elevation will be higher than the 100-year flood elevation.

The reconstructed roadway will include less impervious area than the existing roadway by incorporating a portion of grassed shoulder within the total shoulder. While not tied to a formal numerical treatment standard, this measure is expected to provide superior filtering for sediments and oils than exists today. Detention basins are not included in the selected plan.

For background, the water quality regulatory requirements are set by the Florida Department of Environmental Protection (FDEP) in accordance with the Regulation of Stormwater Discharge or 62-25, Florida Administrative Code (FAC). Formal runoff treatment facilities could significantly increase the footprint and cost of the reconstructed roadway. Footprint increases could include wetland impacts that are counter to the ecological restoration goals of the project. See reference (b).

During construction, erosion and sediment control best management practices, designed to specific site conditions, will be used to retain sediment on-site.

8.5 Structure Design Criteria

Structures will be designed in accordance with AASHTO LRFD Bridge Design Specifications, Third Edition, 2004, and the FDOT Structures Design Guidelines (Topic No. 625-020-154-b), January 2005.

8.5.1 Horizontal and Vertical Alignment

The bridge horizontal and vertical alignments will satisfy the requirements specified for the roadway. Lane and shoulder widths will match the roadway. The bridge alignment will be positioned to minimize impact and construction cost, and to facilitate maintenance of traffic during construction, and require only a modest alignment transition at each bridge end.

8.5.2 Vertical Clearances

a. Floating debris clearance above DHW: 2.00 ft.

b. Maintenance and inspection clearance above CWE: 6.00 ft

c. Navigation clearance: not applicable

8.5.3 Exposure Conditions

The environment exposure classification for the bridges is considered slightly aggressive for the superstructure, and moderately aggressive for the substructure.

8.5.4 Design Loads

a. Dead Loads:

Unit weight of reinforced concrete	150 pcf
Traffic railing barrier	418 plf
Future wearing surface allowance	15 psf over traffic surface
S.I.P. Forms	20 psf applied between beams

b. Live Loads:
HL-93 design truck or design tandem, and design lane load
T160 permit vehicle (Strength II check only)
HS32 permit vehicle (Strength II check only)

c. Wind Load: Per the AASHTO LRFD code with an increase in pressure by 20% per the LRFD Structures Design Guidelines (as applicable for the South Florida location).

d. Other Loads: Per the AASHTO LRFD code.

8.5.5 Drainage and Runoff Treatment

Runoff from a 4-inch per hour intensity storm must not encroach on the travel lane. Given that the barrier wall type employed allows no outfall from the deck, any runoff conveyance system must accommodate the 50-year storm.

The bridge must include a runoff treatment system. The system will include a deck drainage system that will collect the first flush of runoff through a system of inlets and pipes, and convey the runoff to pollution abatement structures constructed on fill under the bridge with outfalls constructed on adjacent segments of the abandoned existing roadway embankment.

8.5.6 Material Properties

a. Concrete:

Substructure	f'c = 5,500 psi
Bridge deck and approach slabs	f'c = 4,500 psi
Prestressed beams	f'c = 8,500 psi

where f'c = 28-day concrete compressive strength

b. Reinforcing Steel: ASTM A615 - Grade 60

c. Prestressing Strands: ASTM A416 - Grade 270

d. Steel Sheet Piles: ASTM A328 - Grade 36 and A709 - Grade 50

9. Selected Plan Features

The selected plan includes modifying the existing Tamiami Trail with a raised profile and the construction of two bridges. See plates A14-3A to 10C.

<u>9.1 Roadway Features</u>

9.1.1 Typical Section

The typical section consists of two 12-foot wide travel lanes, and 10-foot wide shoulders on each side of the roadway, aligned with the existing roadway centerline. The travel lanes are on a 2% cross slope and the shoulder are on a 6% cross slope. The section employs guardrail at the outside edge of each shoulder and standard embankment side slopes. Each shoulder includes a grassed strip. See plate A14-3A.

Based on available topographic data and FDOT R/W mapping, the narrowest dimension between the north guardrail and the L-29 borrow canal top-of-embankment is 10 feet and occurs at several of the culvert crossings. On the north side of the roadway the proposed typical section increases 2 feet over the existing 8-foot shoulder. Thus, an adequate margin area exists to accommodate the wider shoulder.

No left turn lanes, passing lanes, median buffers, or roadway lighting currently exist within the project corridor. A preliminary review of the merit of these features, recent 5-year crash data, concluded the following:

a. Left turn lanes: Crash patterns and frequency do not demonstrate the need for left turn lanes.

b. Passing lanes: Future traffic service levels and the lack of supporting crash history do not substantiate the need for passing lanes.

c. Median buffer: Twelve foot travel lanes provide desirable clearances between large commercial vehicles traveling in opposite direction on two-lane, two-way rural highways. In addition, shoulders provide additional buffer for motorists to travel near the edge of the travel lane for greater separation if desired. Further, the crash history does not support use of a median buffer.

d. Lighting: Night-time crash patterns do not warrant lighting within the corridor.

9.1.2 Pavement Design

The flexible pavement design is based on future traffic loading and the existing subgrade resilient modulus.

The open-to-traffic date is assumed to be 2010, with a planning horizon year of 2030. Using a linear project based on the last 10 years of the average annual daily traffic (AADT), the 2010 AADT is estimated to be 7,800 vehicles daily, and the 2030 ADT is estimated to be 12,700 vehicles daily. 2030 traffic statistics were estimated as follows: K30 = 8.5%, D30 = 60%, T = 12%. Using Highway Capacity Manual procedures for two-lane roads, the 2030 level of service (LOS) for traffic is LOS C. This level is considered acceptable for this facility. The Equivalent 18-kip Single Axle Loads (ESAL) is 6.4 million, based on the 2030 traffic projection, 90% reliability, and a 0.96 factor for rural arterials.

The existing subgrade resilient modulus ranges from 3,300 to 7,500 psi, with a 90^{th} percentile value of 4,883 psi, which rounds to 5000 psi. See reference (b). Current research suggests a 20% subgrade modulus reduction is appropriate for roadways where the vertical separation between the base and high water is 1 foot. Although this guidance is based on granular base, not asphalt base as employed in the proposed pavement section, the design resilient modulus was conservatively reduced from 5000 psi to 4000 psi.

A pavement section Structural Number (SN) of 5.71 is required for a 20-year forecast 6.4 million ESAL, a subgrade resilient modulus of 4,000 psi, and 90% reliability. The pavement section will be constructed through placement of a series of asphalt leveling courses (overbuild), a black base, and a structural asphalt course:

Step 1: Level existing roadway (nominal elevation 10.0 feet) to 11.27 feet at centerline using Superpave Type C asphalt overbuild layers.

Step 2: Place 6-inch black base using Superpave Type C, SN = 2.64; the new centerline elevation will be 11.77 feet. Note that Step 1 provides 1.33 feet of separation between DHW and bottom of black base at lane edge (low point).

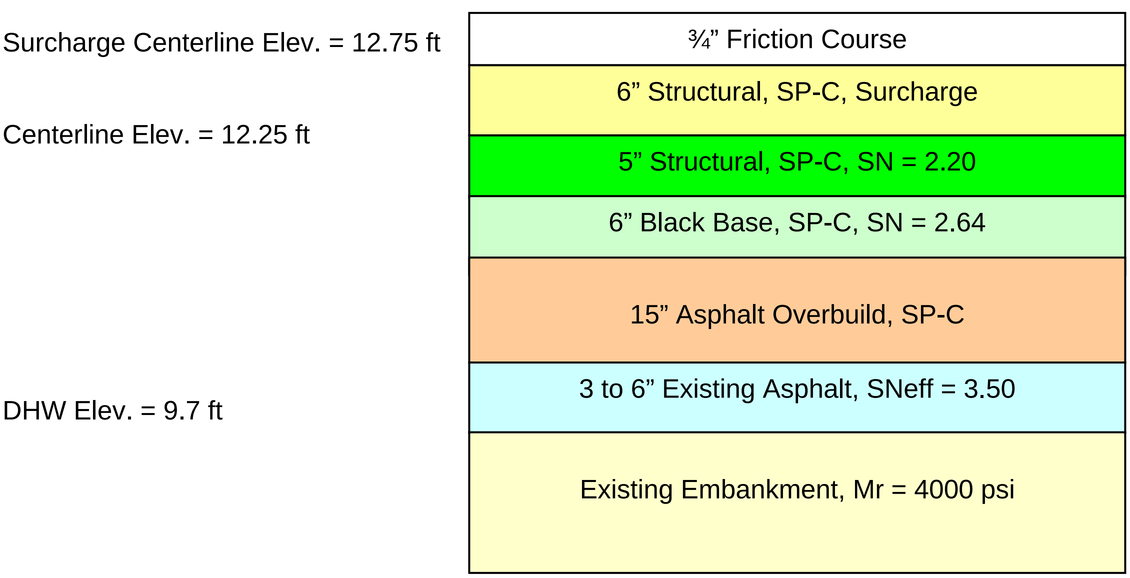
Step 3: Place 5 inch structural asphalt, Superpave Type C, SN = 2.20; the new centerline elevation will be 12.19 feet.

Step 4: Place ¾ inch friction course, FC-5; the final centerline elevation will be 12.25 feet.

The base and the structural course provide a combined SN of 4.84. For a total SN of 5.17, the SN contribution necessary from the existing roadway is 0.87. Based on Falling Weight Deflector testing, the effective structural number (SNeff) of the existing roadway under current conditions is estimated to be 3.50. See reference (b). Under the influence of a 9.7 ft DHW, the SNeff of the existing roadway is expected to decrease, but not to a value lower than 0.87, and more likely to a value greater than 2.0.

This pavement section is conservative. The Superpave Mix C leveling course (overbuild) will provide stiffness. Accounting for only half of the overbuild SN would afford an SN increase of 3.30. Further assuming a SNeff of 2.00 for the existing road under future conditions, the total pavement SN is 10.14, well above the required 5.17.

The proposed section also includes a 6 inch structural asphalt layer over the 11-inch design section, intended to surcharge the foundation. Peat consolidation settlements estimates are 3 to 7 inches, with 50% anticipated during the construction period. This asphalt surcharge, topped by a ¾-inch friction course, will set opening-day surface elevation, and will remain in place for 2 to 3 years until total peat consolidation has occurred. After settlement has occurred, the surcharge will be milled off to grade, i.e. not a uniform mill depth, and a 2-inch structural course and new friction course will be placed as a final wearing course. The proposed section for opening day is:



A drainage layer is not considered necessary, and is not included in the proposed section. A drainage layer is normally used to protect moisture sensitive granular and limerock embankments by forming a capillary water ceiling. Asphalt is not considered a moisture-sensitive material. The proposed pavement section uses the existing asphalt pavement as a construction platform for asphalt overlays, and includes no moisture sensitive materials. However, given the proposed section, use of a drainage layer could reduce the required vertical clearance between DHW and bottom of base, and therefore reduce the required pavement overbuild.

The pavement design, including separate shoulder requirements and use of a drainage layer, will be refined during the PED phase.

9.1.3 Resurfacing requirements

The recommended periodic resurfacing interval for this pavement section is 10 years, at the low end of the 10 to 15 year interval typical in Florida. This recommendation is based the Trail resurfacing history, and the roadway's continued exposure to water.

<u>9.2 Road Transition Features</u>

9.2.1 Typical Section

The roadway transition typical section includes two 12-foot wide travel lanes, and 10-foot wide shoulders on each side of the roadway. The travel lanes are on a 2% cross slope and the shoulder are on a 6% cross slope. The transitions incorporate a vertical retaining wall to limit wetland encroachment. The transition horizontal curve radii permits use of normal crown throughout the transition, which facilitates constructability and maintenance of traffic. Use of other combinations of radii and separating tangents, including superelevated sections, do not yield shorter transitions.

9.2.2 Pavement Design

Existing peat and vegetation in the transition footprint, as well as existing embankment that overlaps with the transition alignment will be removed, and a new embankment using A-1 or A-3 fill will be built. FDOT Standard Index 500 defines material removal limits using a 1:2 control line starting at the edge of shoulder and descending to the top of bedrock.

A pavement section SN of 3.93 is required for a 20-year forecast 6.4 million ESAL, a subgrade resilient modulus of 12,000 psi (for A-3 embankment material), and a 90% reliability. To limit capillary rise, a 4-inch granular drainage layer is used beneath an LBR 40 subbase. The drainage layer will include no material smaller than the No. 8 sieve, which will inhibit the capillary rise into the base layers and still have construction stability, and will be wrapped in filter fabric to prevent intrusion of the embankment soils into the layer. The proposed pavement design provides a SN of 4.52, which is exceeds 3.93, but is a reasonable minimum for a high volume roadway.

Proposed centerline elevation = Varies

¾" Friction Course
4" Structural, SP-C, SN = 1.76
10" Limerock, SN = 1.80
12" Type B, LBR 40, SN = 0.96
A-1 or A-3 Embankment, Mr=12,000 psi
4" Capillary Drainage Layer, SNeff = 3.50
A-1 or A-3 Embankment, Mr = 12,000 psi
Bedrock

9.3 Bridge Access Ramp Features

The bridge access ramp typical section includes two 12-foot travel lanes with five-foot shoulders and outside barriers. Radii of 50 feet are provided between the access road and Tamiami Trail travel lanes. These connections provide access from the bridged areas to properties south of the existing Tamiami Trail roadway. The ramps incorporate vertical retaining walls to limit wetland encroachment. The access ramps were considered as frontage road connections with the same design criteria as collector streets.

9.4 Bridges Features

9.4.1 Typical Section

The bridge typical section is 47’-1” wide and includes two 12-foot travel lanes with 10-foot shoulders and outside barriers. Both the travel lane and shoulder are on a 2% cross slope.

9.4.2 Drainage and Runoff Treatment

Deck runoff catchment will be accomplished through deck drains into a piping system suspended from the bridge deck, thence into pollution abatement structures (PAS) located at along the bridge lengths. One pollution abatement structure will be located at the beginning and end of each bridge and one structure coincident with each sag point for a total of 8 structures for two bridges. The PAS will be located on the north side of the bridge along the existing roadway embankment. Estimated fill volume is about 1800 cubic yards at each site. See plates A14-10A through A14-10C.

The proposed bridge deck drains are minimum 24 inch diameter drainage grates, placed not more than 440 feet from the crest and spaced thereafter at 80 feet on center, that discharge to 12-inch diameter drains which connect to a minimum 18-inch to maximum 24-inch diameter trunkline on both sides of the bridge. The trunklines drop from the bridge to the ground and enter a manhole and junction box arrangement that allows discharge of the lower flow rates to the PAS, and that diverts excess flows (from infrequent storm events) to surface water outfall. Pipe inverts into the PAS are set to minimize PAS embedment in rock and to limit to required vacuum hose reach when cleaning the structures from the bridge deck. Use of a diversion junction box ensures that the PAS treats the first flush of runoff and is not overloaded by the relatively clean runoff from storm events producing more than 2.8 inches of rainfall within an hour.

Deck drainage at the sag points will include a combination of drainage grates and slots in the barrier wall (24-inch by 2-inch) for overflow 0.15 foot above the deck surface, should the deck drainage system operate at less expected capacity during an infrequent storm event.

South-side bridge access ramps will allow for bridge deck drainage. The ramps include shoulder gutter inlets in the embankment that will convey runoff down the embankment to be discharged near the ramp transition to grade.

At the ends of the bridge, the deck drain collection system will tie into shoulder gutter inlets in the embankment. One of the inlets will have a diversion weir that will direct the first flush of runoff to the PAS. Excess runoff will continue down the embankment in shoulder gutter and be discharge via pipe at the low point.

Maintenance of the structures is anticipated on a yearly basis with inspection every other month to evaluate the degree of sedimentation. Maintenance of the bridge deck drainage system is anticipated on a five-year cycle with inspection every year to evaluate again the degree of sedimentation. In both cases, the degree of sedimentation could vary considerably.

9.4.3 Least Cost Structure

The most cost-effective bridge structural system employs Florida Bulb Tee (FBT) 72 beams with a composite cast-in-place concrete deck, supported on pile bents using 24-inch square precast prestressed concrete piles.

Given the runoff treatment requirement, the most cost-effective longitudinal bridge slope is 0.2%. This slope does not require a vertical curve for the design speed at the sag or crest points, and minimizes the bridge foundation cost, while allowing the minimum slope for pipe drainage. This gradient is acceptable as the bridge is not a curb and gutter section (Table 2.6.4 of the FDOT Plans Preparation Manual requires a minimum grade of 0.3% on curb and gutter sections). The barrier is not immediately adjacent to the travel lane, the bridge is not a curb and gutter section adjacent to the travel lane, and the cross slope will prevent ponding of water within the travel lane. If 0.3% minimum grade were used, vertical curves would be required and the profile would result in actual slopes less than 0.2% along the crest and sags, resulting in an inferior drainage arrangement.

Several superstructure and substructure alternatives were evaluated to determine the most cost effective bridge structure. These systems include:

Superstructure Alternatives	Substructure Alternatives
AASHTO Beams Types IV, V, & VI with Cast-in-Place Concrete Deck	18 and 24 inch square Prestressed Concrete Piles (with pre-drilling)
Florida Bulb Tees 72 and 78 with Cast-in-Place Concrete Deck	3 foot diameter Drilled Shafts

Analysis of the substructure elements conservatively assumed a top of rock elevation of 0.0, with a 10-foot minimum penetration. Quantity calculations for the prestressed pile and drilled shaft alternatives assumed an additional five feet of length for potential variability. Localized soil anomalies, e.g., sand pockets/layers will not have a significant effect on the substructure system.

A minimum 48.5 foot offset from the centerline of the bridge from the centerline of the existing roadway was established to allow a minimum area for cranes to install piles and to deliver and erect beams between the shifted roadway and the proposed bridge construction. Installation of the prestressed piles and pile bent cap construction was assumed to be performed from a temporary haul road south of the existing roadway, with temporary islands at each pile bent, or from a temporary trestle. Crane size and lifting capability may be limited based on the stability of the soils below the temporary improvements.

9.5 Borrow and Disposal Areas

No borrow sites are identified. All borrow materials are assumed to be from commercial sources. SFWMD's 183-acre Rocky Glades area, located on Richmond Drive west of Krome Avenue and west of the L-31N Canal, is the assumed material disposal site. The site is located approximately 15 miles from the east end of the project corridor. The disposal site(s) will be confirmed during the PED phase.

10. Utility Relocations

Five existing utilities are installed within the project corridor. Four will be affected by the proposed construction. Two buried telephone/fiberoptic lines run behind the guardrail on the south side of the roadway (ATT and BellSouth). A Bellsouth buried copper line runs along the north side of the roadway. A 23 kv Florida Power and Light (FPL) overhead electric line and a buried telephone/fiberoptic line (Qwest) run along the L-29 embankment. The Quest line should not be affected by the improvement. FPL lateral power lines extend south from the distribution line along L-29 to customers on the south side of Tamiami Trail. These lines will likely require temporary or permanent adjustment due to the proposed improvements.

Utilities within the proposed typical section will need to be relocated so as to remain behind the future guard rail location. Utility relocations will be coordinated with each utility owner. As the affected utilities appear to lie within the right-of-way, their relocation costs are not included in the cost estimates. The estimated cost of relocating the two affected telecommunications utilities is $3.5 to $4.0 million, assuming that they are abandoned in place. Only a cost allowance for coordinating these relocations is included in the project cost estimate.

Communication with the fiberoptic utilities indicates that the likely relocation plan for the embankment sections will be to construct new facilities, coordinated with roadway construction, and to abandon existing facilities in place. For the bridge segments, the utilities will be mounted on the bridge superstructure. Relocation plans will be finalized during the PED phase. Relocations will be integrated into the overall project construction schedule.

11. Wetland Impacts

The selected plan includes an estimated wetland loss, in acres, on the south side of the project, as follows:

	Permanent	Temporary
Roadway	12.2	8.1
Transitions	4.1	1.6
Bridges	16.0	3.6
Total	32.3	13.3

The area of the existing roadbed to be removed is 32.2 acres. Both this area and the open area immediately below the bridges (about 10 acres) are considered flow way. Any permanent wetland creation associated with this flow way is not recognized here.

For the roadway, the existing R/W to the south ranges from 24 to 40 ft from the roadway centerline, with an average of 28 ft. As a result of raising the road, the average proposed R/W will increase to 15 ft beyond the existing average (i.e. 43 ft from the roadway centerline). The raised roadway includes a proposed R/W that ranges from 0 to 19 ft beyond the existing R/W. The bridges include a proposed R/W that is approximately 44 ft beyond the existing R/W. The road-to-bridge transitions include a proposed R/W that varies from 0 to 44 beyond the existing R/W. Existing topographic and property boundary survey data are insufficient for a more accurate estimate of wetland loss. Wetland loss will be revisited in the PED phase.

Except for private parcels along the project corridor, these wetland loss estimates largely coincide with real estate impacts to ENP. Refer to the Real Estate Appendix.

12. Permit Requirements

The following permits are expected prior to construction of project features. Other permit requirements may be identified in the PED phase.

a. Florida Department of Transportation (FDOT) General Use Permit.

b. Florida Department of Environmental Protection (FDEP) Environmental Resource Permit.

c. Florida Department of Environmental Protection (FDEP) General Construction National Pollutant Discharge Elimination System (NPDES) Permit.

13. Construction and Life Cycle Costs

13.1 Construction Cost

See Construction Cost Appendix. A single construction contract is anticipated. An estimate of construction cost was developed using U.S Army Corps of Engineers software MCACES Gold. Refer to assumptions stated in the cost estimate notes. The cost estimates excludes right-of-way or other real estate acquisition costs, engineering and design, engineering during construction, and utility relocation costs.

13.2 Life Cycle Cost Analysis

See Tables 1 and 2. A 2005 average annual estimate of life cycle cost was developed, using a 50-year term, based upon anticipated periodic maintenance and operation of the improved roadway and bridges, with initial opening in 2010. The average annual cost includes a 5 3/8% federal discount rate. For comparison, a no-action case estimate was also developed. Results indicate that the proposed roadway and bridge has a lower total cost of operations and maintenance than the existing roadway.

Resurfacing costs are significant in this analysis. A conservative 7-year resurfacing interval, less than the anticipated interval of 10 years, was assumed that includes:

a. Mill 3.25 inches (0.75 inches friction course plus 2.5 inches structural)
b. Place variable depth leveling course in depressed areas, assumed to average 0.75 inches over 25% of the area)
c. Place 2.5 inches structural and 0.75 inch friction course; no change in final centerline elevation
d. Guardrail adjustment for the length of the depressed areas taken at 25% of segment length
e. Necessary incidentals such as maintenance of traffic and striping

No salvage value was presumed at the end of the analysis period. Also, although roadway transitions to the bridges will likely require a less frequent resurfacing cycle, this is ignored in the analysis.

14. Construction Schedule and Maintenance of Traffic

A single construction contract is anticipated, with a construction period estimated to be 36 months. This construction period does not address variables that could affect the construction duration, including, but not limited to, design changes, unforeseen construction means and methods, and the ability to secure / procure materials, equipment, and labor. This period does not include an allowance for design, right-of-way acquisition, and other pre-construction activities.

14.1 Staging Areas

Existing federal and state owned property within the project limits will be used for staging areas for construction equipment and materials, and construction employee parking. SFWMD property immediately north of S-333 at the west end of the corridor is approximately 5 acres. SFWMD property where L-31N intersects Tamimai Trail at the east end of the corridor is 0.5 acres. Shifting of the existing roadway travel lanes will create narrow longitudinal areas along the length of the corridor for various periods of time, which could be used for staging and other functions. Construction may be best served by having a staging area near the end of the corridor, with materials moved to the work site on an “as needed, just-in-time" basis.

14.2 Roadway Construction Maintenance of Traffic

Roadway construction will be phased as indicated in plate A14-8A and 8B. Removal of existing guardrail and some embankment placement will accompany widening the shoulders prior to paving operations. Temporary barriers will delineate the edge of travel lanes through hazard areas. Paving will be accomplished using a moving "paving train" operation, where asphalt is placed along one existing travel lane, over 1/4 mile segments during daylight, while flagmen alternate traffic in the other travel lane. The initial asphalt lift will be 1.5 inches along the existing westbound lane. A three-inch lift will then be placed along the eastbound lane, so that the maximum grade difference between the travel lanes remains at 1.5 inches. Alternating three-inch lifts will continue until reaching the desired profile grade. Temporary barriers will be adjusted as necessary for placement of embankment fill and asphalt.

14.3 Bridge Construction Maintenance of Traffic

Existing traffic will be shifted to the north on to existing shoulder and temporary pavement. Specifically, temporary barricades will be placed along the north edge of the eastbound travel lane line. Then, in ¼ mile increments, the existing guardrail will be removed, and replaced with temporary barrier wall. The existing shoulder will be removed and replaced with temporary pavement. A temporary concrete barrier will be placed at the south edge of the temporary pavement. Once completed for the entire bridge and roadway transition length, traffic will be shifted to the north. This shift will provide more than 15 feet of separation from the travel lane to proposed structure. At the transitions from the roadway to the bridge, temporary sheeting will be required along the existing southbound edge of pavement to accommodate the excavation for the transition roadway. The bridges and transitions will then be built. After completion of bridge construction, the existing adjacent roadway asphalt and earthwork will be removed.

Table 1: Life Cycle Cost Analysis: Existing Roadway

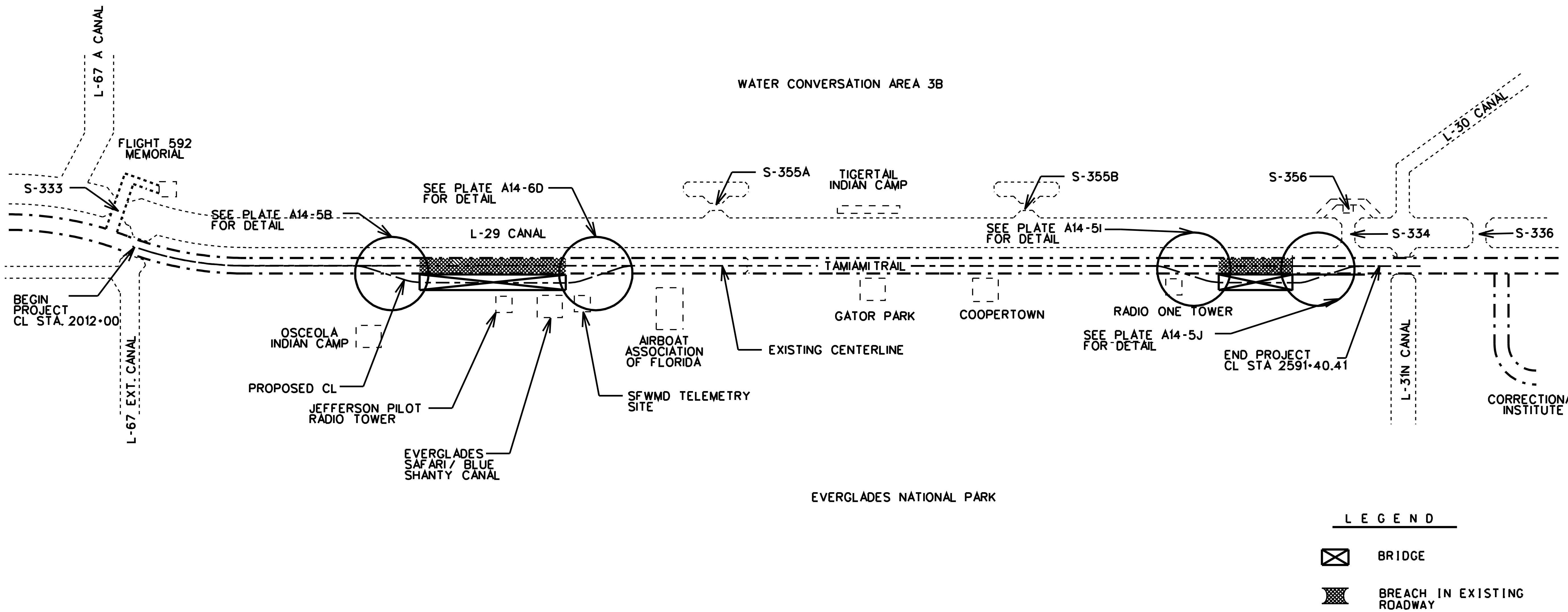
Federal Discount Rate 5.375% — Reference Year is 2005

Category	Cost Per Cycle	Basis	No. of Cycles in 50 Years	Present Worth (2005 Dollars)	Average Annual Cost (2005 Dollars)
ROADWAY MAINTENANCE					
Signing, Striping, Patching, Mowing Embankment	$417,266	Assume signing and pavement marking maintenance contract every 10 years, mowing slopes 4 times per year	50	$7,196,646.76	$417,266.00
Mowing Grassed Shoulder	$0	Paved shoulders	50	$0.00	$0.00
Culvert Cleaning	$855,000	57 pipe culverts at 50 feet length with a 7-year cleaning cycle at average cost of $300 per LF.	7	$2,638,007.29	$152,953.28
50-Year Subtotal (2005)				**$9,834,654.06**	**$570,219.28**
PERIODIC ROADWAY RESURFACING					
Periodic Roadway Resurfacing and Related Work	$12,472,333	Milling, levelling, overlay and resurfacing of 11 miles of roadway pavement to maintain level surface and design criteria. 7-year cycle presumed. Guard rail adjustment every other resurfacing.	6	$33,611,384.10	**$1,948,808.70**
50-Year Subtotal (2005)				**$33,611,384.10**	**$1,948,808.70**
BRIDGE MAINTENANCE					
Initial Inspection	$0	not applicable	1	$0.00	$0.00
Recurring Above Water Inspection at 2-Year Interval	$0	not applicable	25	$0.00	$0.00
Recurring Below Water Inspection at 2-Year Interval	$0	not applicable	25	$0.00	$0.00
Allowance for Minor Repairs and Maintenance	$0	not applicable	50	$0.00	$0.00
50-Year Subtotal (2005)				**$0.00**	**$0.00**
POLLUTION ABATEMENT SYSTEM MAINTENANCE					
Periodic Inspection of Treatment Units	$0	not applicable	50	$0.00	$0.00
Periodic Maintenance of Treatment Units	$0	not applicable	50	$0.00	$0.00
Periodic Inspection of Pipe Collection System	$0	not applicable	50	$0.00	$0.00
Periodic Maintenance of Pipe Collection System	$0	not applicable	9	$0.00	$0.00
50-Year Subtotal (2005)				**$0.00**	**$0.00**
AVERAGE ANNUAL MAINTENANCE COST					**$2,519,027.98**
PRESENT WORTH OF ANNUAL MAINTENANCE COST				**$43,446,038.15**	
INITIAL CAPITAL COST				**$0.00**	
TOTAL LIFE CYCLE COST				**$43,446,038.15**	

Table 2: Life Cycle Cost Analysis: Alternative 14

Federal Discount Rate 5.375% Reference Year is 2005

Category	Cost Per Cycle	Basis	No. of Cycles in 50 Years	Present Worth (2005 Dollars)	Average Annual Cost (2005 Dollars)
ROADWAY MAINTENANCE					
Signing, Striping, Patching, Mowing Embankment	$300,275	Assume signing and pavement marking maintenance contract every 10 years, mowing slopes 4 times per year	50	$5,178,886.15	$300,275.00
Mowing Grassed Shoulder	$3,000	Assume 4 hours per mowing pass, twice monthly, 100 mowing hours per year @ $30/hr	50	$51,741.43	$3,000.00
Cleaning Culverts	$648,000	36 pipe culverts at 60 feet length with a 7-year cleaning cycle at average cost of $300 per LF.	7	$1,999,331.84	$115,922.49
50-Year Subtotal (2005)				**$7,229,959.42**	**$419,197.49**
PERIODIC ROADWAY RESURFACING					
Periodic Roadway Resurfacing and Related Work	$8,730,633	Milling, levelling, overlay and resurfacing of 7 miles of roadway pavement to maintain level surface and design criteria. 7-year cycle presumed. Guard rail adjustment every other resurfacing. Computation documented in report.	6	$23,527,968.60	**$1,364,166.07**
50-Year Subtotal (2005)				**$23,527,968.60**	**$1,364,166.07**
BRIDGE MAINTENANCE					
Initial Inspection	$130,000	Once initially.	1	$130,000.00	$7,537.48
Recurring Above Water Inspection at 2-Year Interval	$75,000	Every 2 years at $20,000 each.	25	$704,840.92	$40,867.11
Recurring Below Water Inspection at 2-Year Interval	$75,000	Every 2 years at $20,000 each.	25	$704,840.92	$40,867.11
Allowance for Minor Repairs and Maintenance	$198,742	Estimated at $75,000 per year.	50	$3,427,731.88	$198,742.00
50-Year Subtotal (2005)				**$4,967,413.73**	**$288,013.70**
POLLUTION ABATEMENT SYSTEM MAINTENANCE					
Periodic Inspection of Treatment Units	$30,000	8 units along length of bridge, with inspection performed every other month at cost of $5,000 per inspection, or $30,000 per year.	50	$517,414.32	$30,000.00
Periodic Maintenance of Treatment Units	$40,000	8 units along length of bridge, with cleaning performed once yearly at cost of $20,000.	50	$689,885.76	$40,000.00
Periodic Inspection of Pipe Collection System	$24,000	37,000 LF of piping plus inlets and junction boxes, with cleaning performed once annually for cost of $100,000.	50	$413,931.45	$24,000.00
Periodic Maintenance of Pipe Collection System	$150,000	37,000 LF of piping plus inlets and junction boxes, with cleaning performed to 30% of system every 5 years for cost of $150,000 each time.	9	$561,916.85	$32,580.28
50-Year Subtotal (2005)				**$2,183,148.38**	**$126,580.28**
AVERAGE ANNUAL MAINTENANCE COST					**$2,197,957.54**
PRESENT WORTH OF ANNUAL MAINTENANCE COST				**$37,908,490.12**	
INITIAL CAPITAL COST				**$125,105,593.00**	
TOTAL LIFE CYCLE COST				**$163,014,083.12**	



SCHEMATIC LAYOUT
EXISTING ALIGNMENT WITH RAISED
PROFILE, WESTERN 2-MILE BRIDGE,
AND EASTERN 1-MILE BRIDGE

US Army Corps of Engineers
Jacksonville District

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JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

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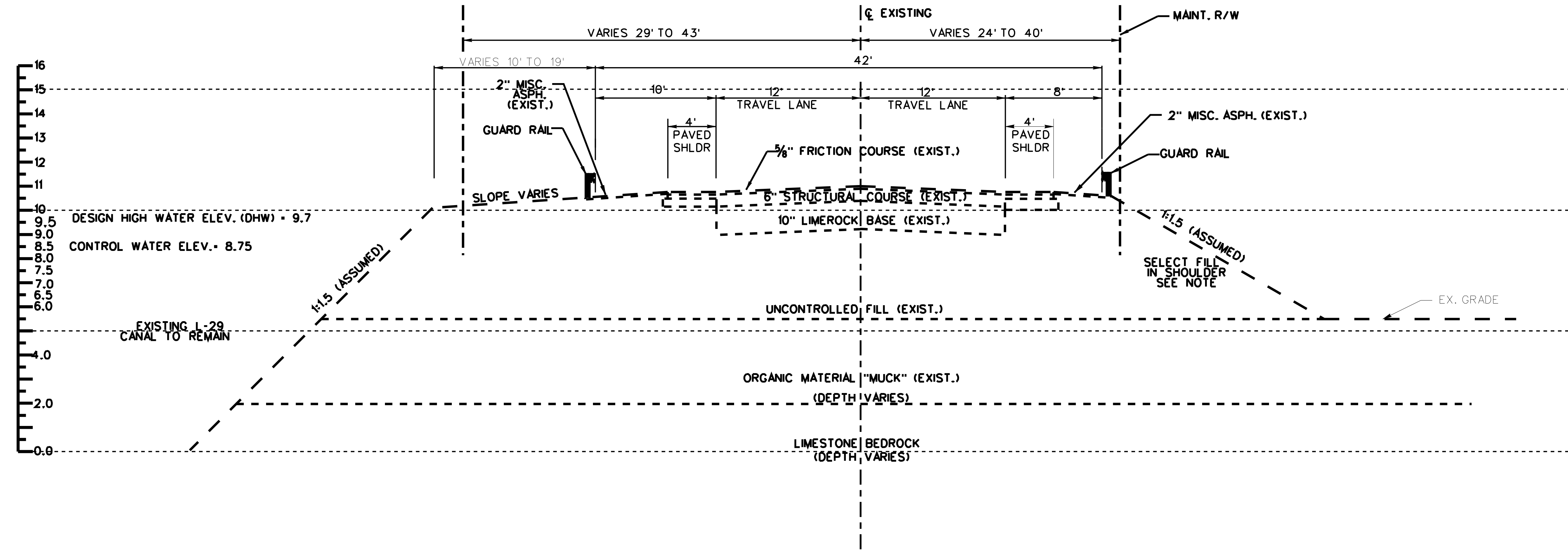
Dwn by: RA
Ckd by:
D.O.FILE NO. NNN-NN, NNN
Date: MMM YYYY

File name: C-401A10.DGN
Reference files: C-BSALT10.DGN

MODIFIED WATER DELIVERIES TO EVERGLADES NATIONAL PARK
DADE COUNTY, FLORIDA
TAMIAMI TRAIL RGRR
PROJECT LIMITS

Scale: AS SHOWN

PLATE NO.
A14-1



NOTE
WORK COMPLETED UNDER JOB NUMBER 8711-3501 IN OR AROUND 1969. WIDENING INCLUDING ADDTION OF 4 FEET OF PAVEMENT ON THE SOUTH SIDE; TWO FOOT SOUTHERN CENTERLINE SHIFT; INCREASE IN WIDTH OF TRAVEL LANES FROM 10 FT TO 12 FT

EXISTING TYPICAL SECTION

STA 2012+00 TO STA 2591+40.41

LOOKING EAST

SCALE = HORIZONTAL 1" = 10'
VERTICAL 1" = 5'

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Reference files: C-BSALT10.DGN

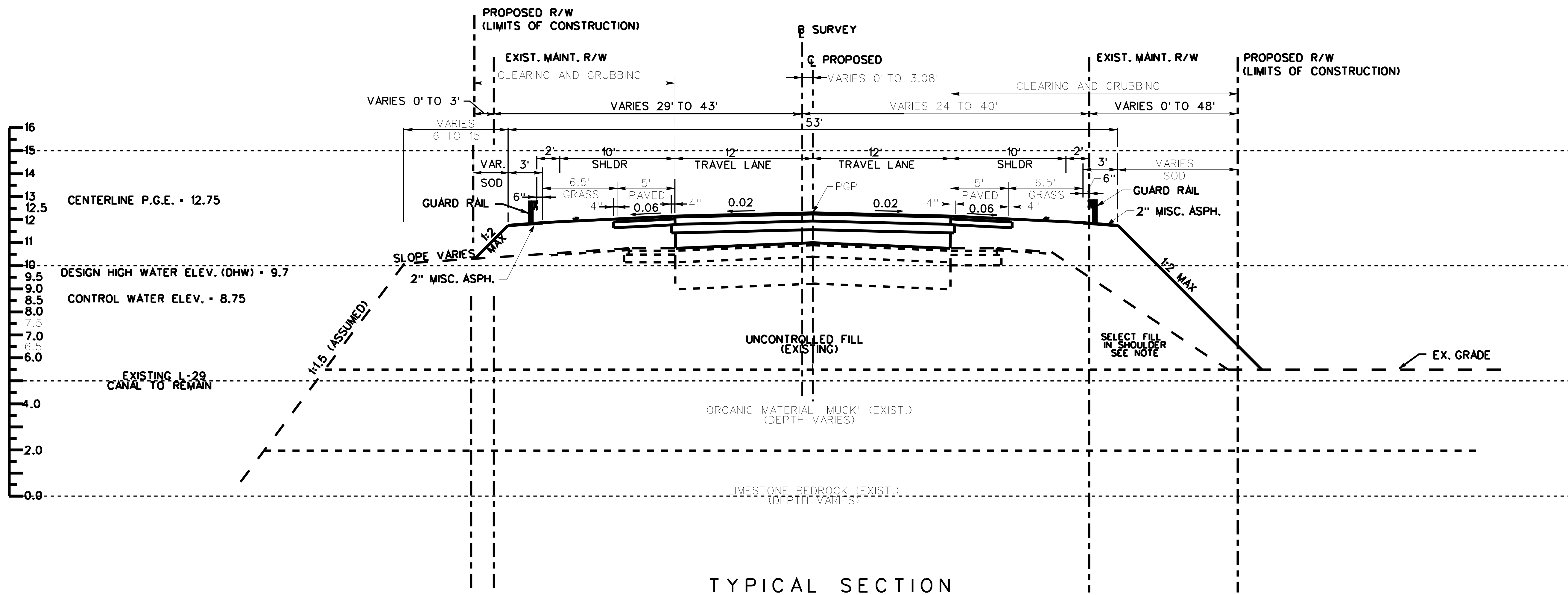
MODIFIED WATER DELIVERIES TO EVERGLADES NATIONAL PARK
DADE COUNTY, FLORIDA

TAMIAMI TRAIL RGRR

EXISTING TYPICAL SECTION

Scale: AS SHOWN

PLATE NO.
A14-2



TYPICAL SECTION
SR 90

STA 2012+00.00 TO STA 2054+13.77
STA 2193+75.85 TO STA 2455+20.69
STA 2542+02.92 TO STA 2951+40.41

NOTE
WORK COMPLETED UNDER JOB NUMBER 8711-3501 IN OR AROUND 1969. WIDENING INCLUDING ADDTION OF 4 FEET OF PAVEMENT ON THE SOUTH SIDE; TWO FOOT SOUTHERN CENTERLINE SHIFT; INCREASE IN WIDTH OF TRAVEL LANES FROM 10 FT TO 12 FT

MILLING
MILL EXISTING ASPHALT PAVEMENT (1/2" AVG. DEPTH)

OVERBUILD
TYPE SP OVERBUILD (15" AVG)

RESURFACING
BITUMINOUS BASE COURSE (TRAFFIC D) (6")
TYPE SP STRUCTURAL COURSE (5")
AND FRICTION COURSE (3/4")

LOOKING EAST

SCALE = HORIZONTAL 1" = 10'
VERTICAL 1" = 5'

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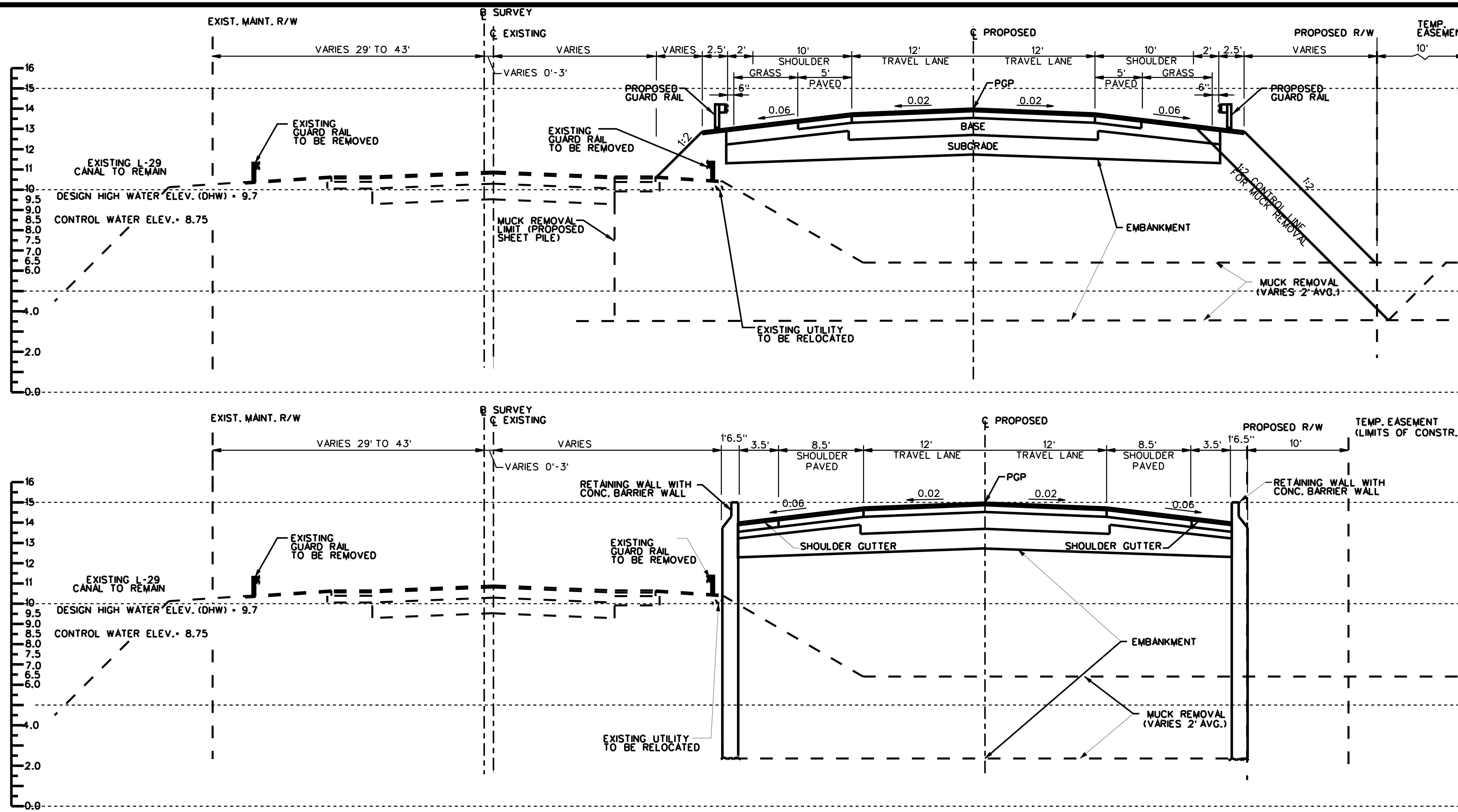
Dated: MMM YYYY

File name: C-303TSA.DGN
Reference files: C-BSALT10.DGN

MODIFIED WATER DELIVERIES TO EVERGLADES NATIONAL PARK
DADE COUNTY, FLORIDA
TAMIAMI TRAIL RGRR
PROPOSED TYPICAL SECTION

Scale: AS SHOWN

PLATE NO.
A14-3A



TYPICAL SECTION
TRANSITION FROM PROPOSED BRIDGE
TO EXISTING ROADWAY

NEW CONSTRUCTION

OPTIONAL BASE GROUP 9 WITH
TYPE SP STRUCTURAL COURSE (4")
AND FRICTION COURSE (3/4")

LOOKING EAST

SCALE = HORIZONTAL 1" = 10'
VERTICAL 1" = 5'

US Army Corps of Engineers
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File name: C-302TRN.DGN
Reference files: C-BSALT10.DGN

MODIFIED WATER DELIVERIES TO EVERGLADES NATIONAL PARK
DADE COUNTY, FLORIDA

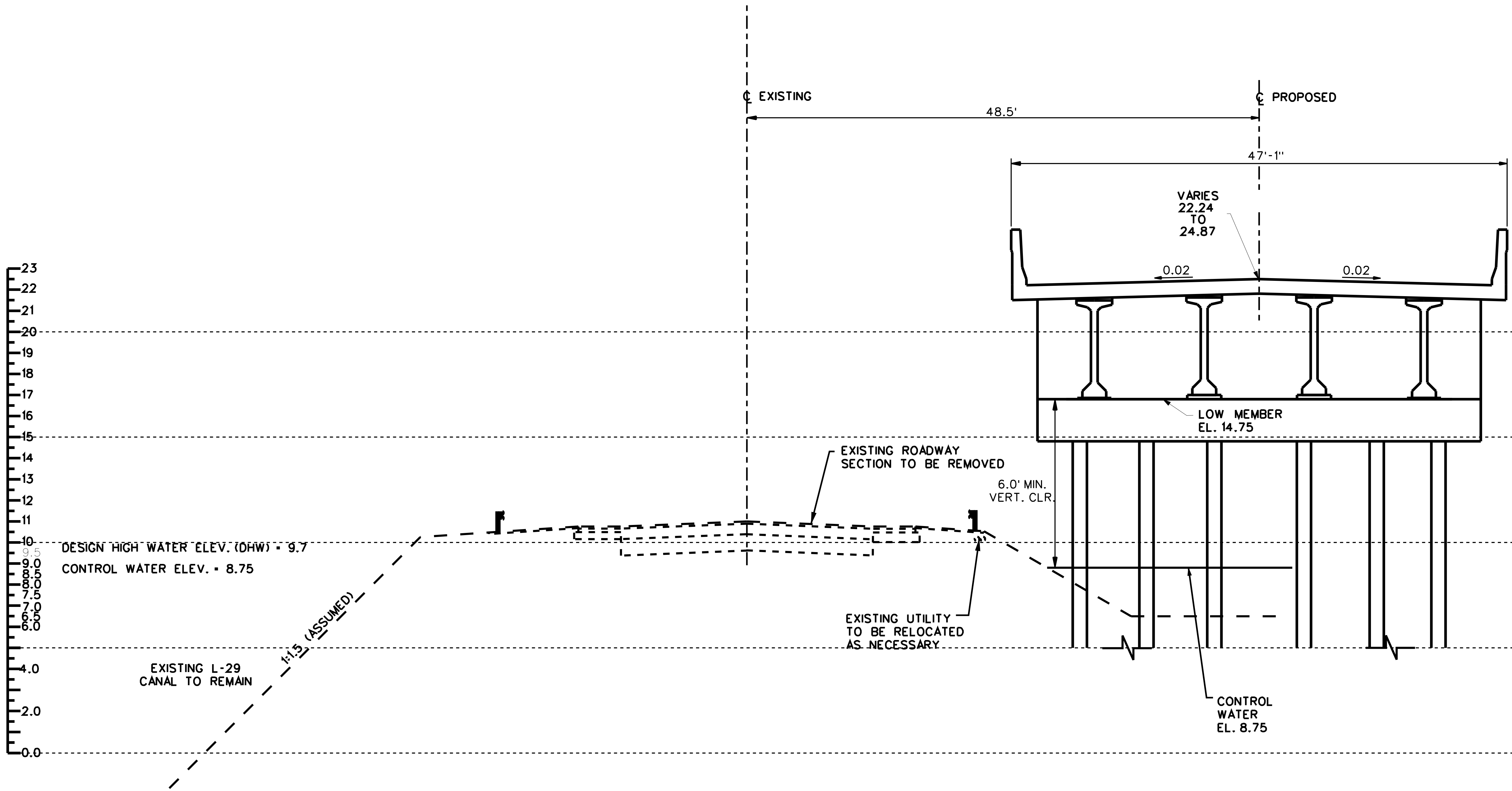
TAMIAMI TRAIL RGRR

TRANSITION TYPICAL SECTION

Scale: AS SHOWN

PLATE NO.

A14-3B



BRIDGE TYPICAL SECTION

STA 2071+14.78 TO STA 2176+74.70

STA 2472+21.69 TO STA 2525+01.63

LOOKING EAST

SCALE = HORIZONTAL 1" = 10'
VERTICAL 1" = 5'

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Dated: MMM YYYY

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File name: C-301BRG.DGN
Reference files: C-BSALT10.DGN

MODIFIED WATER DELIVERIES TO
EVERGLADES NATIONAL PARK
DADE COUNTY, FLORIDA

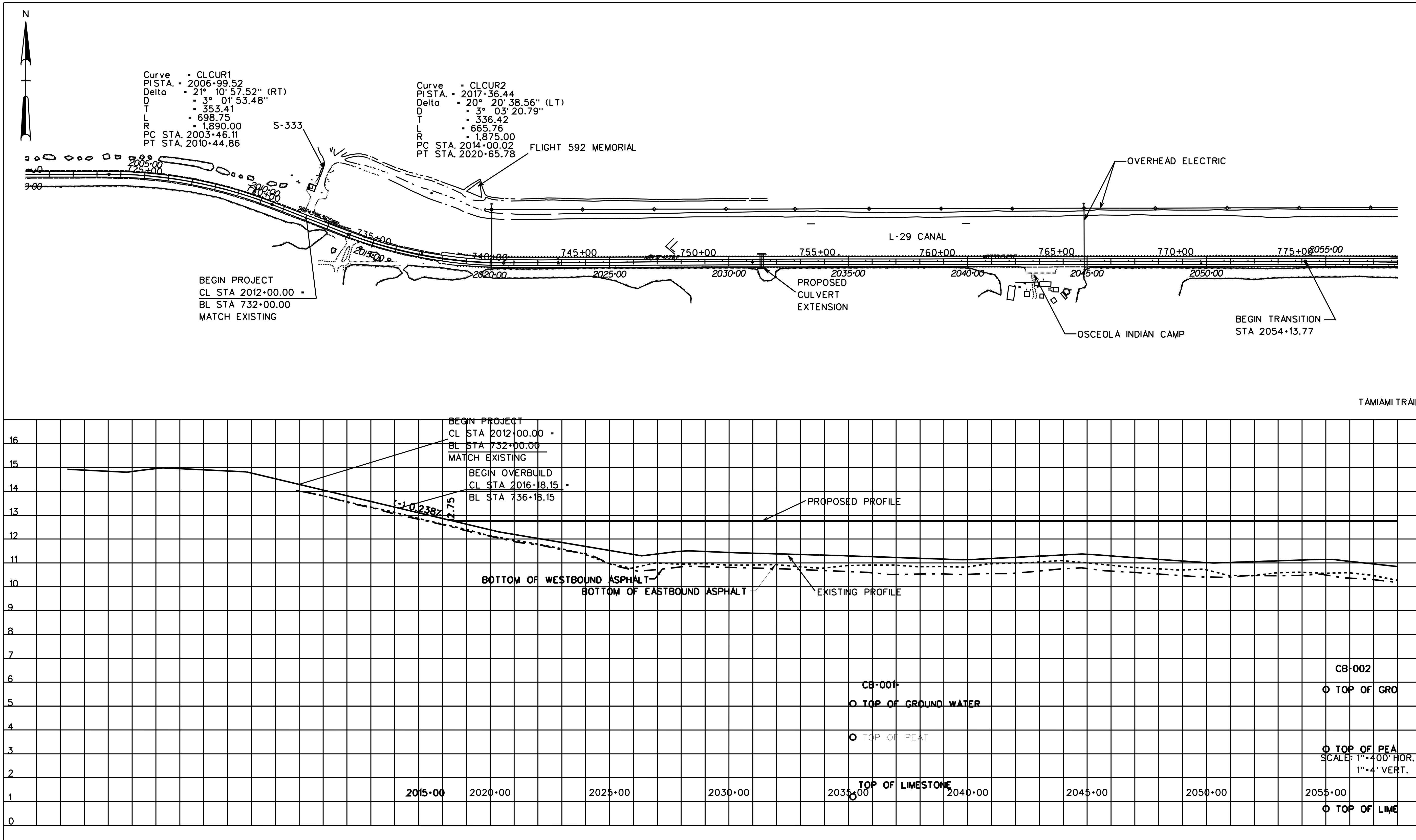
TAMIAMI TRAIL RGRR

BRIDGE TYPICAL SECTION

Scale: AS SHOWN

PLATE NO.

A14-4



* NOTE: CORE BORING LOG INFORMATION CAN BE FOUND IN THE JUNE 06, 2005 TAMIAMI TRAIL PEAT DELINIATION (MACTEC PROJECT NO. 6734-05-8959)

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Dated: MMM YYYY

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Ckd by:

File name: C-201.DGN
Reference files: C-BSALT10.DGN

MODIFIED WATER DELIVERIES TO EVERGLADES NATIONAL PARK
DADE COUNTY, FLORIDA

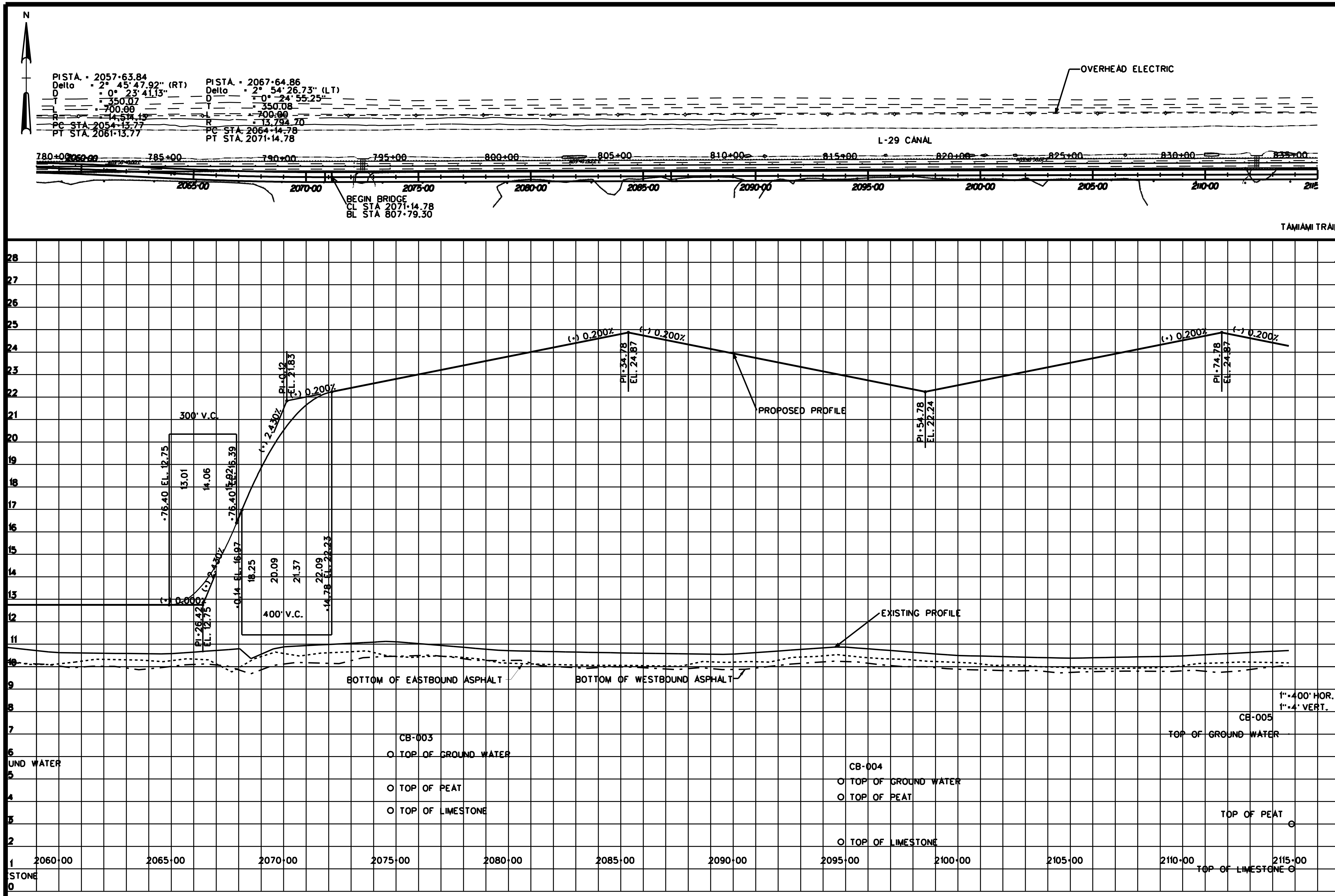
TAMIAMI TRAIL RGRR

PLAN AND PROFILE

Scale: AS SHOWN

PLATE NO.

A14-5A



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JACKSONVILLE, FLORIDA

Designed by: MP
Dwn by: RA
Ckd by:

D.O.FILE NO. NNN-NN, NNN
Dated: MMM YYYY

File name: C-202.DGN
Reference files: C-BSALT10.DGN

MODIFIED WATER DELIVERIES TO EVERGLADES NATIONAL PARK
DADE COUNTY, FLORIDA

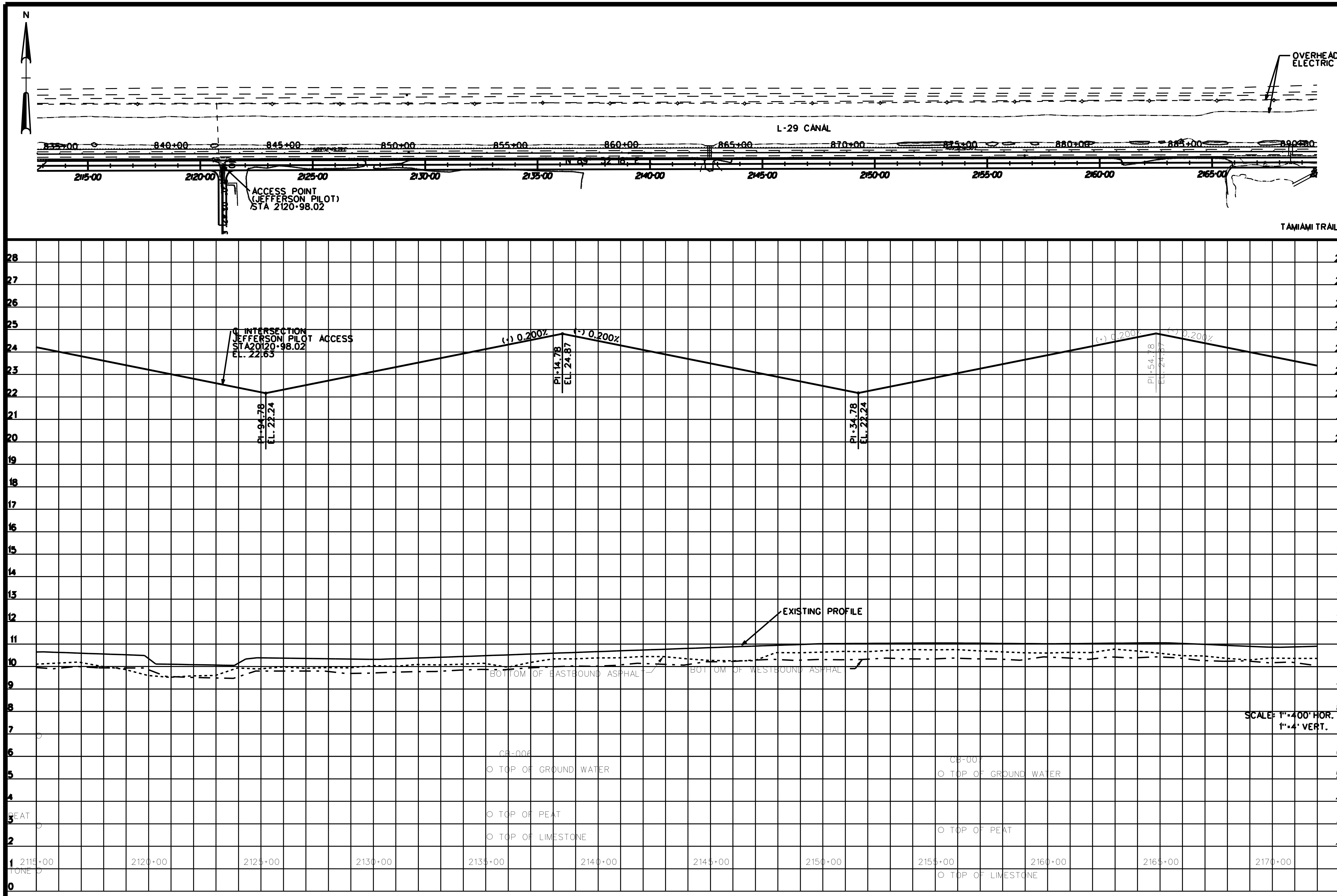
TAMIAMI TRAIL RGRR

PLAN AND PROFILE

Scale: AS SHOWN

PLATE NO.

A14-5B



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D.O.FILE NO. NNN-NN, NNN
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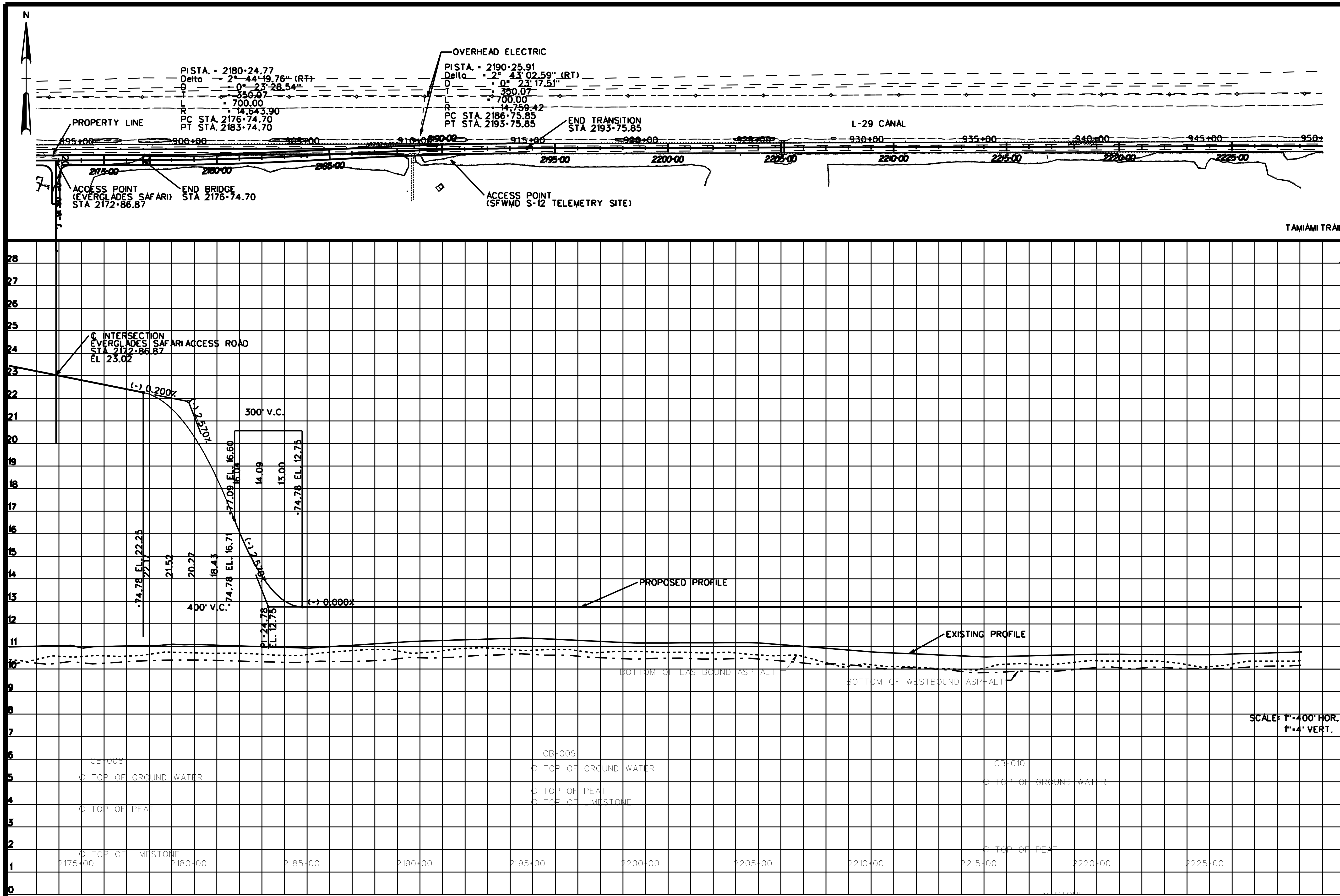
File name: C-203.DGN
Reference files: C-BSALT10.DGN

MODIFIED WATER DELIVERIES TO EVERGLADES NATIONAL PARK
DADE COUNTY, FLORIDA

TAMIAMI TRAIL RGRR
PLAN AND PROFILE

Scale: AS SHOWN

PLATE NO.
A14-5C



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D.O. FILE NO. NNN-NN, NNN
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File name: C-204.DGN
Reference files: C-BSALT10.DGN

MODIFIED WATER DELIVERIES TO
EVERGLADES NATIONAL PARK
DADE COUNTY, FLORIDA

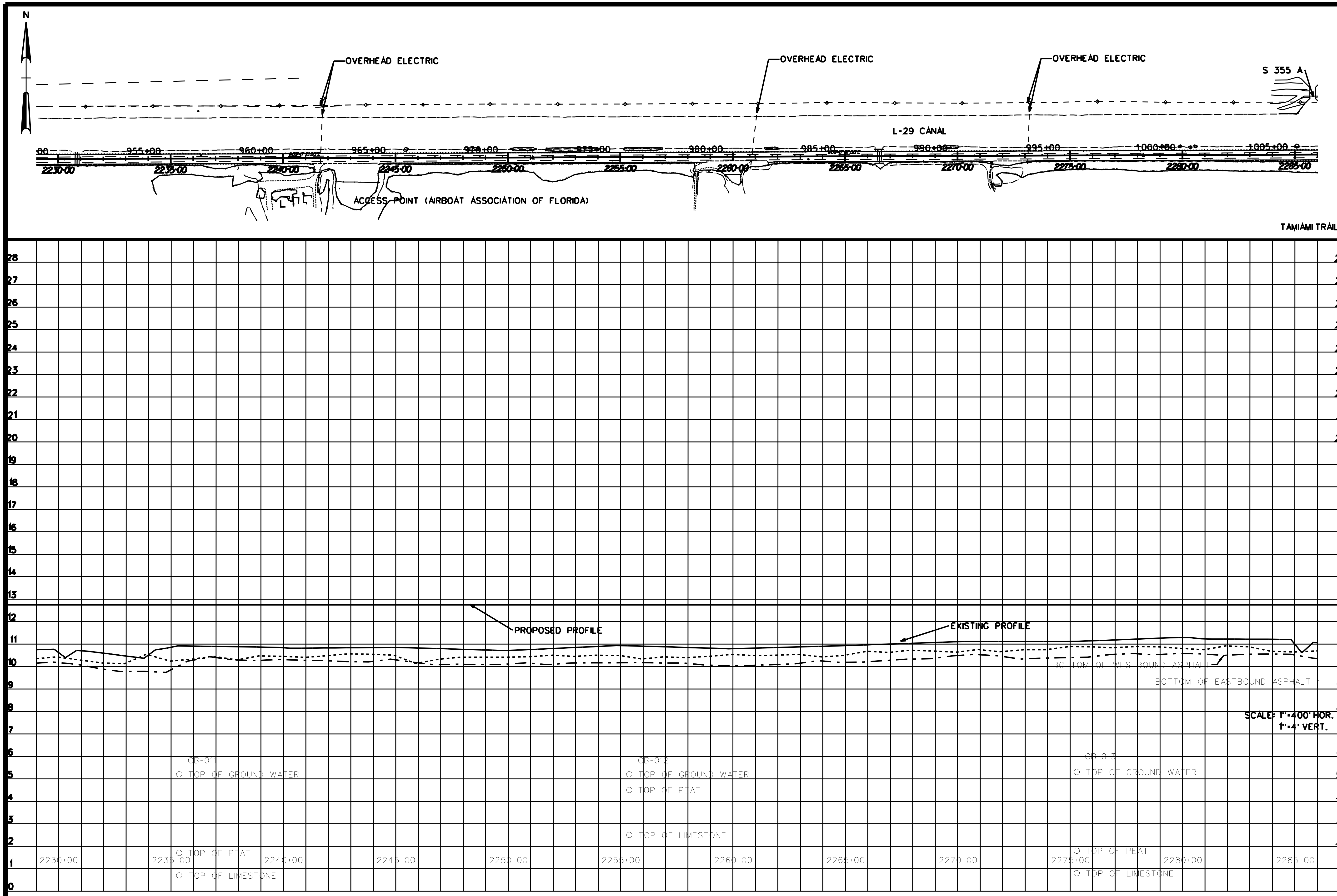
TAMIAMI TRAIL RGRR

PLAN AND PROFILE

Scale: AS SHOWN

PLATE NO.

A14-5D



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File name: C-205.DGN
Reference files: C-BSALT10.DGN

MODIFIED WATER DELIVERIES TO EVERGLADES NATIONAL PARK
DADE COUNTY, FLORIDA

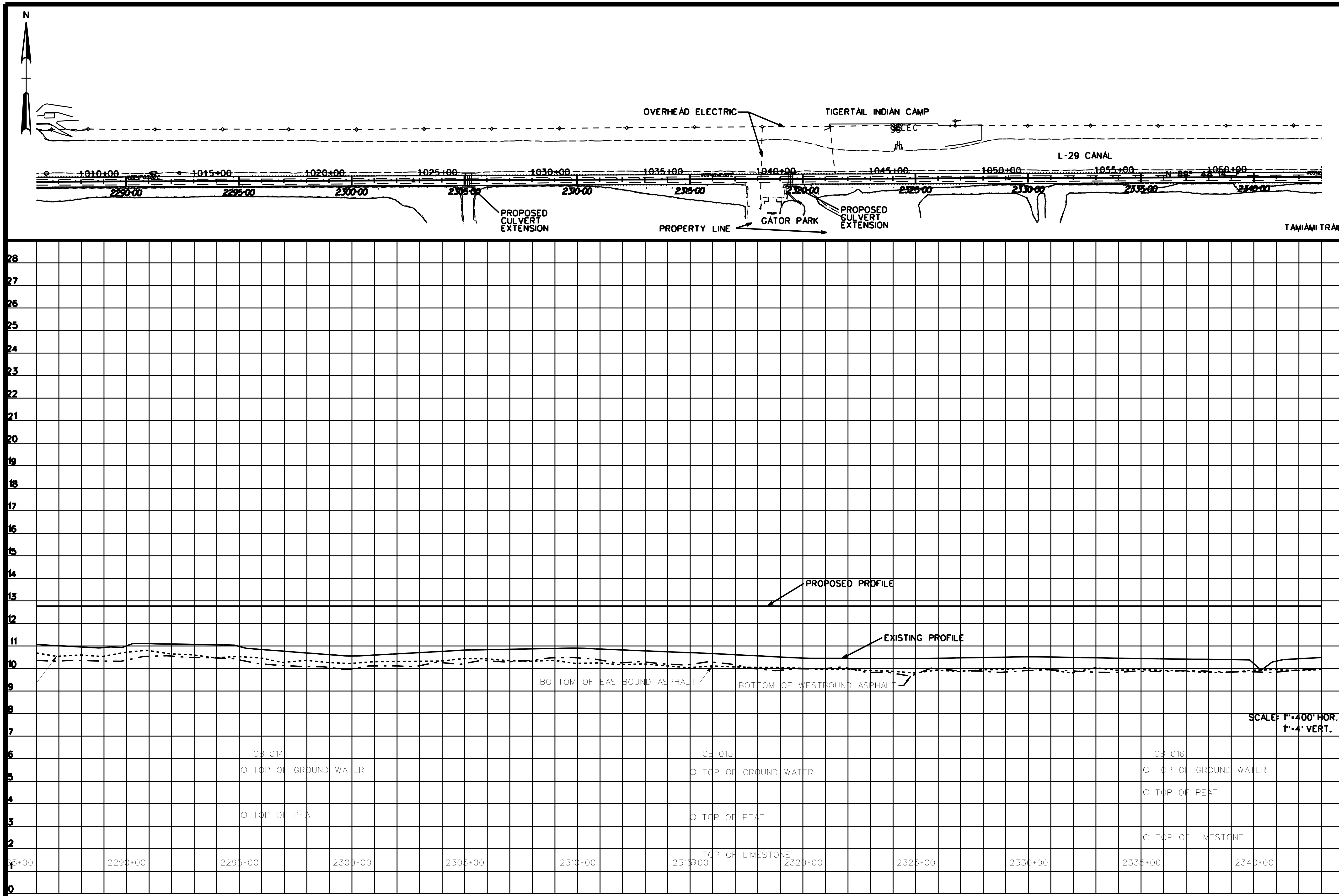
TAMIAMI TRAIL RGRR

PLAN AND PROFILE

Scale: AS SHOWN

PLATE NO.

A14-5E



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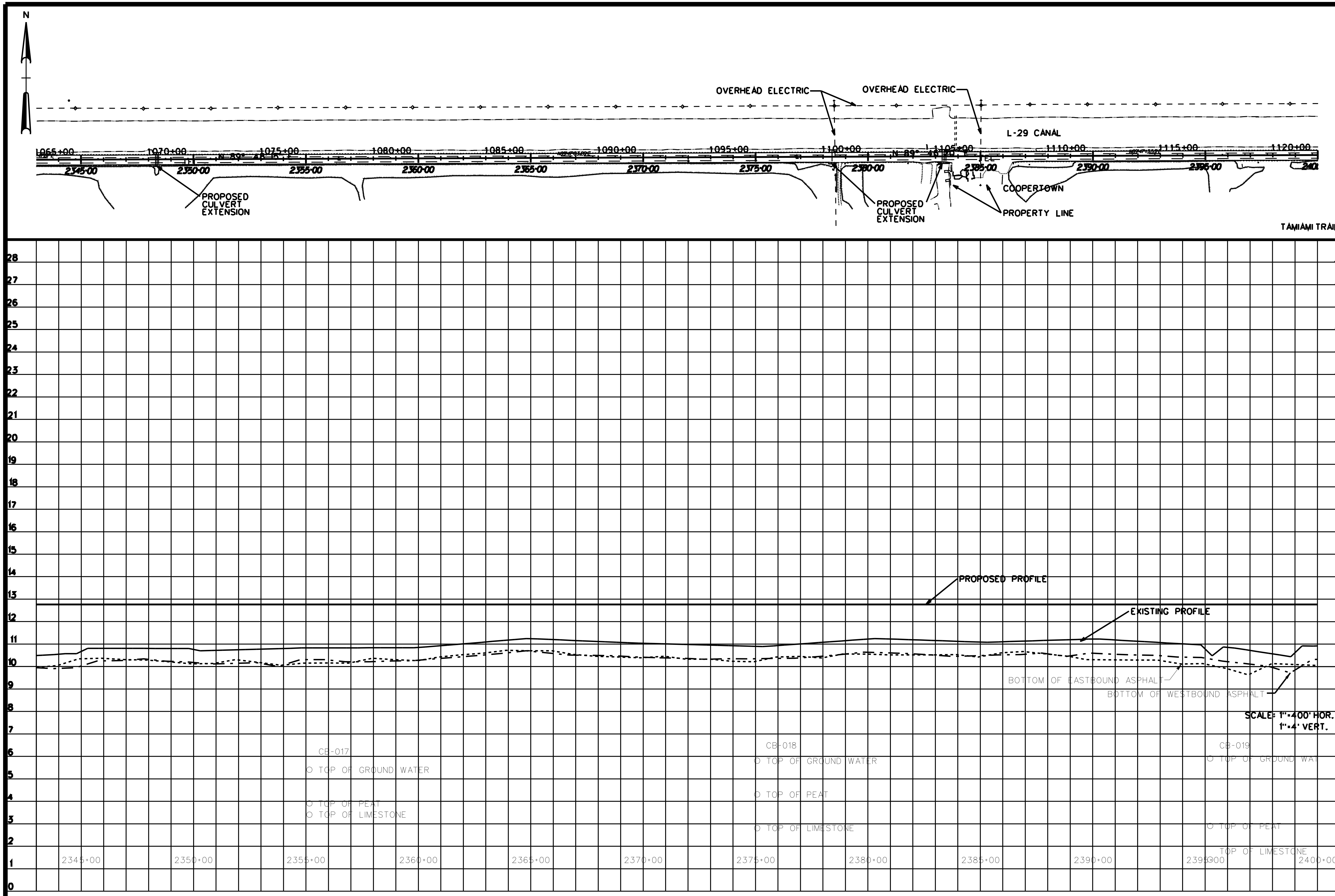
File name: C-206.DGN
Reference files: C-BSALT10.DGN

MODIFIED WATER DELIVERIES TO EVERGLADES NATIONAL PARK
DADE COUNTY, FLORIDA

TAMIAMI TRAIL RGRR
PLAN AND PROFILE

Scale: AS SHOWN

PLATE NO.
A14-5F



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Dated: MMM YYYY

File name: C-207.DGN
Reference files: C-BSALT10.DGN

MODIFIED WATER DELIVERIES TO EVERGLADES NATIONAL PARK
DADE COUNTY, FLORIDA

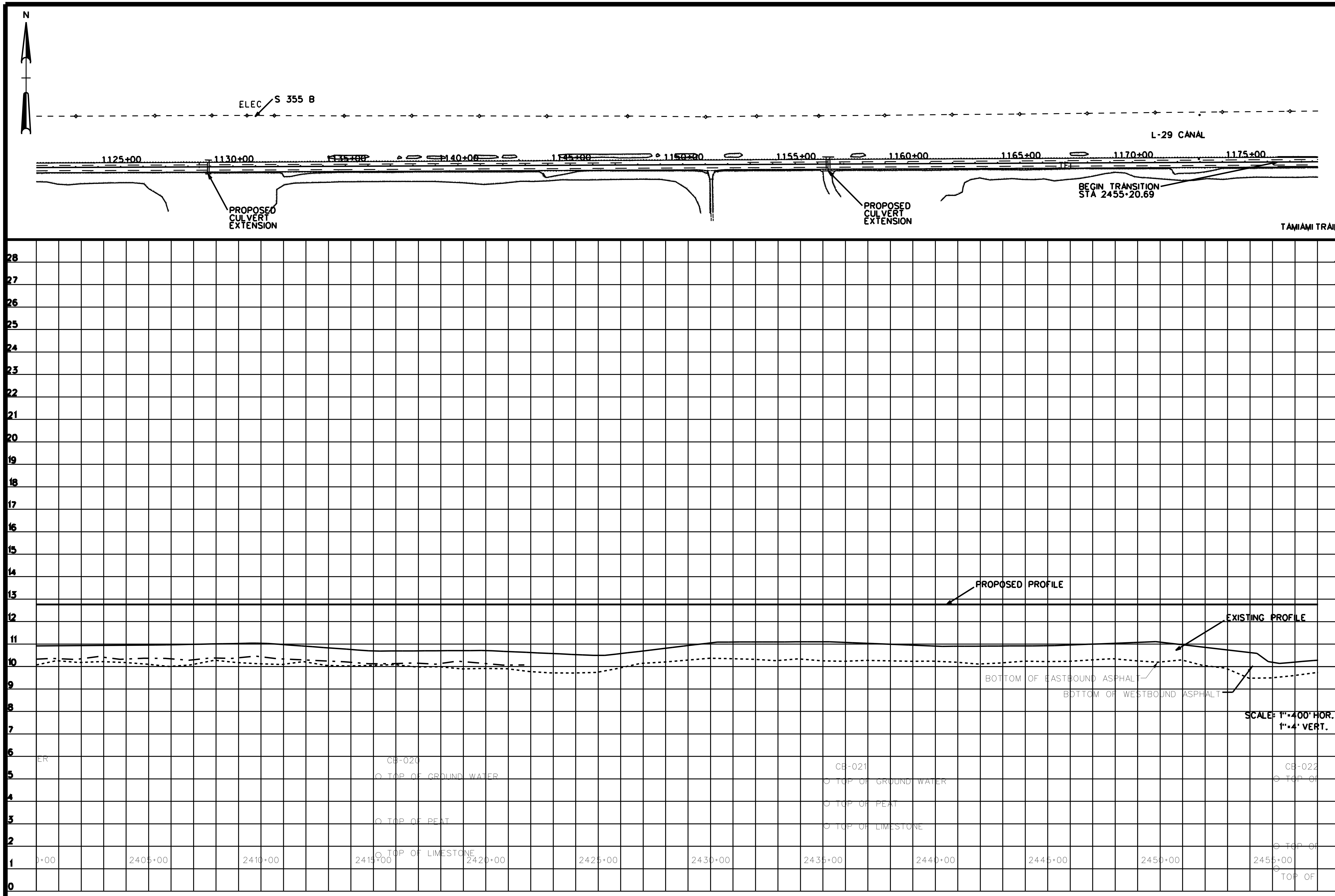
TAMIAMI TRAIL RGRR

PLAN AND PROFILE

Scale: AS SHOWN

PLATE NO.

A14-5G



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Dated: MMM YYYY

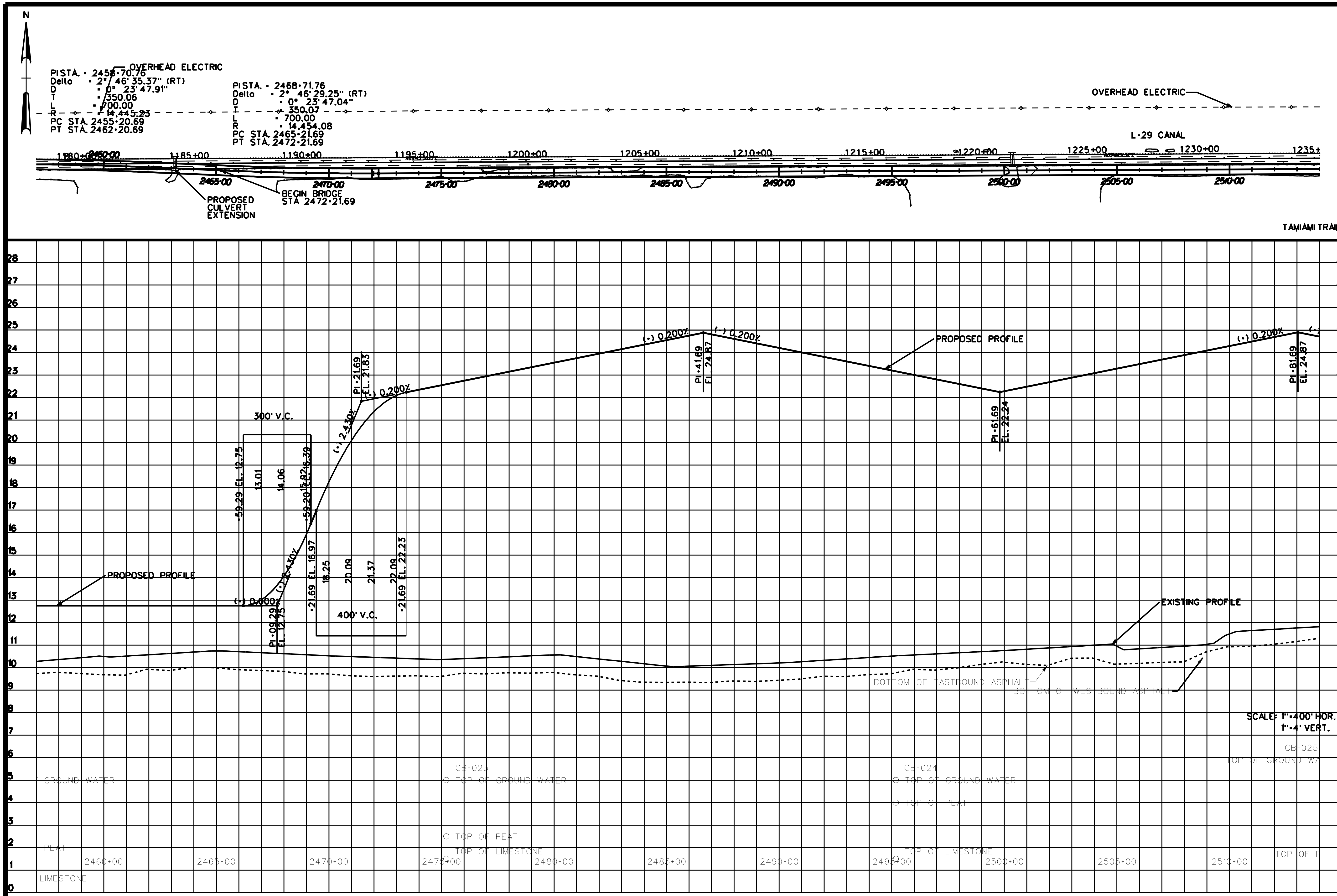
File name: C-208.DGN
Reference files: C-BSALT10.DGN

MODIFIED WATER DELIVERIES TO EVERGLADES NATIONAL PARK
DADE COUNTY, FLORIDA

TAMIAMI TRAIL RGRR
PLAN AND PROFILE

Scale: AS SHOWN

PLATE NO.
A14-5H



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Dated: MMM YYYY

File name: C-209.DGN
Reference files: C-BSALT10.DGN

MODIFIED WATER DELIVERIES TO EVERGLADES NATIONAL PARK
DADE COUNTY, FLORIDA

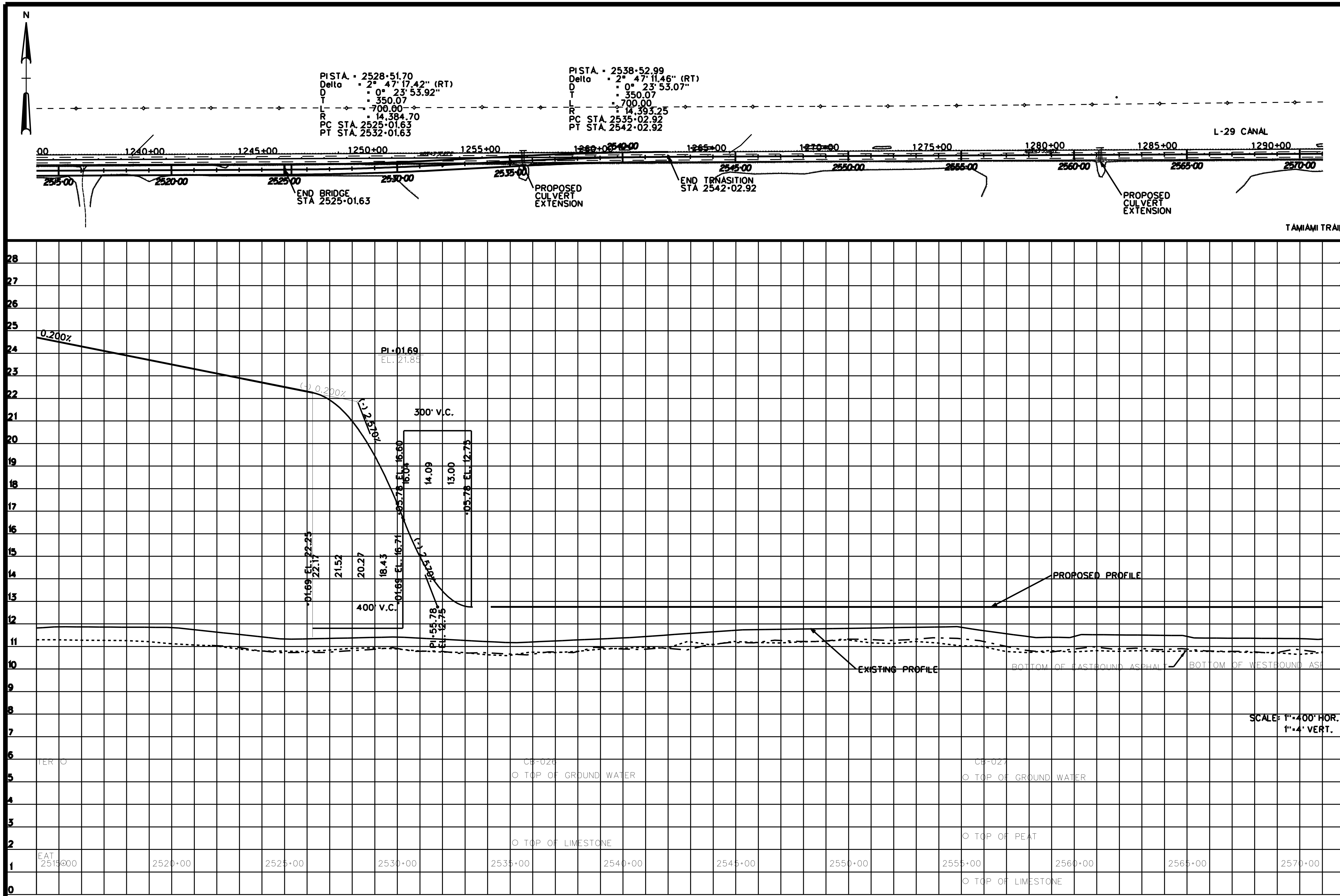
TAMIAMI TRAIL RGRR

PLAN AND PROFILE

Scale: AS SHOWN

PLATE NO.

A14-51



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Dated: MMM YYYY

Designed by: MP
Dwn by: RA
Ckd by:

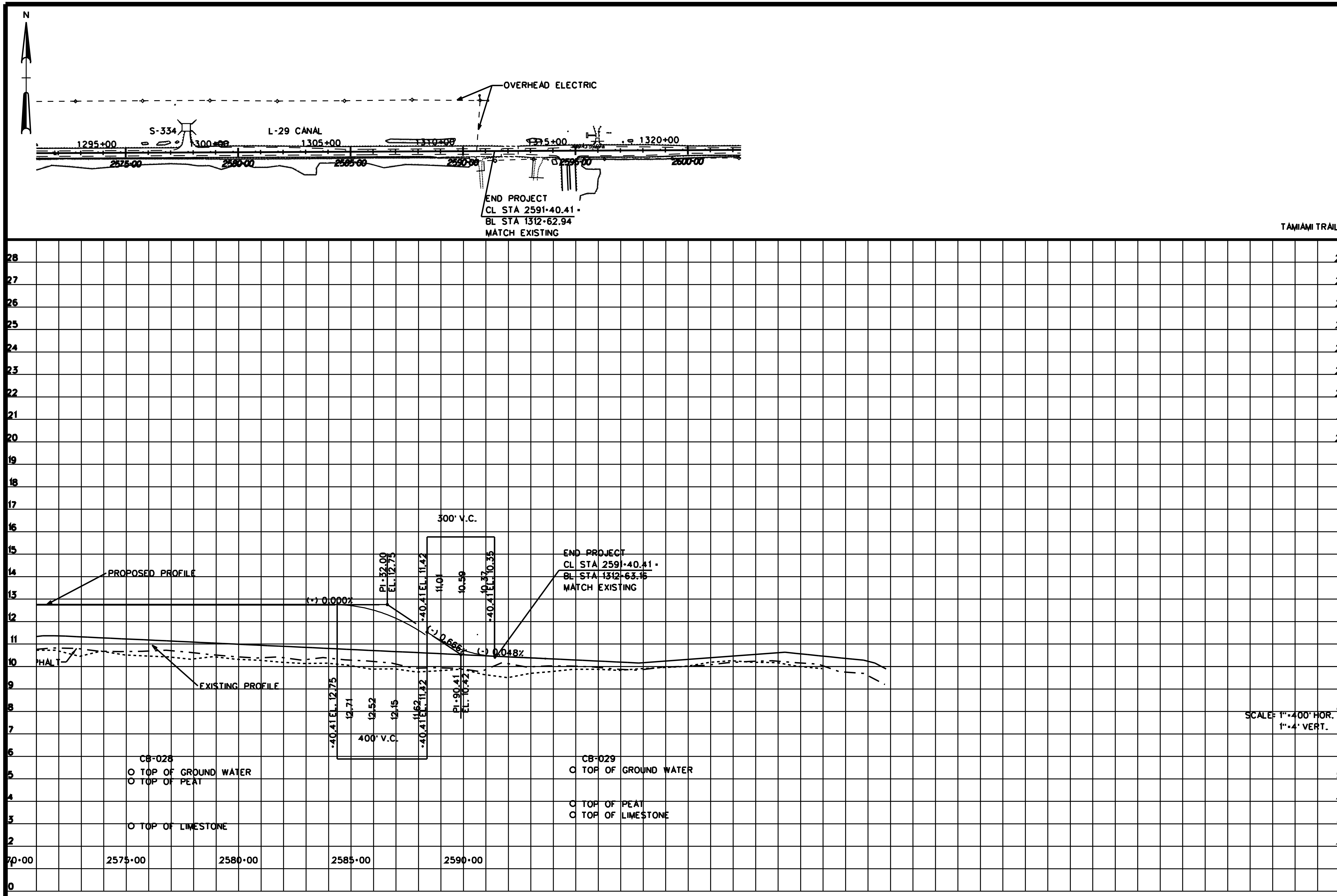
File name: C-210.DGN
Reference files: C-BSALT10.DGN

MODIFIED WATER DELIVERIES TO EVERGLADES NATIONAL PARK
DADE COUNTY, FLORIDA

TAMIAMI TRAIL RGRR
PLAN AND PROFILE

Scale: AS SHOWN

PLATE NO.
A14-5J



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File name: C-211.DGN
Reference files: C-BSALT10.DGN

MODIFIED WATER DELIVERIES TO EVERGLADES NATIONAL PARK
DADE COUNTY, FLORIDA

TAMIAMI TRAIL RGRR

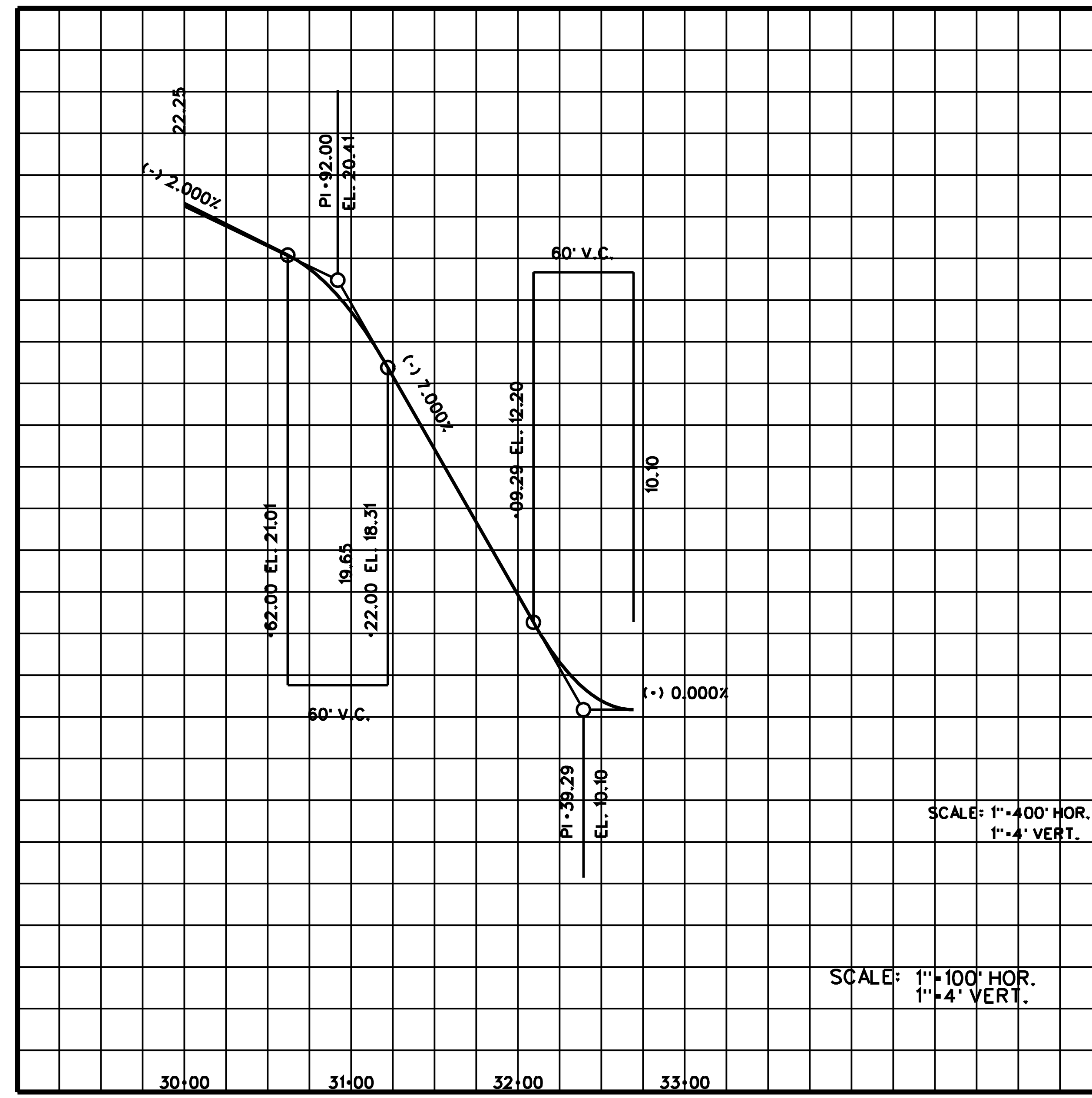
PLAN AND PROFILE

Scale: AS SHOWN

PLATE NO.

A14-5K

BRIDGE ACCESS ROAD
PLAN AND PROFILE (TYPICAL)



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Dated: MMM YYYY

File name:
Reference files: C-BSALT10.DGN

MODIFIED WATER DELIVERIES TO EVERGLADES NATIONAL PARK
DADE COUNTY, FLORIDA

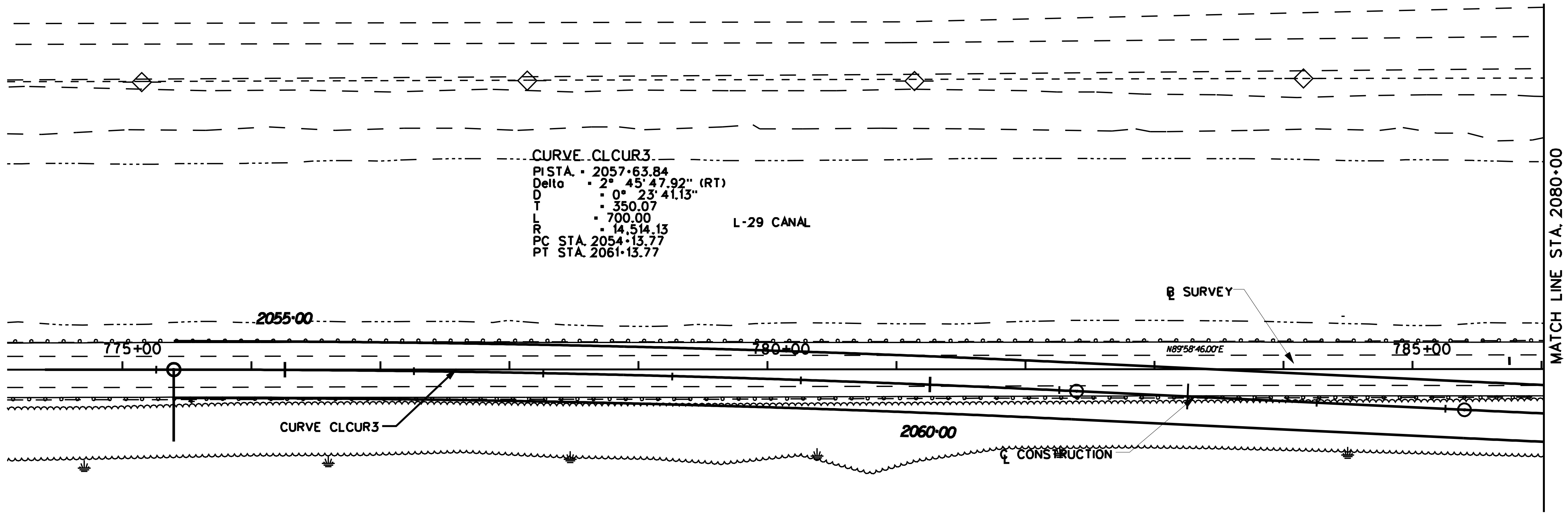
TAMIAMI TRAIL RGRR
BRIDGE ACCESS PLAN

Scale: AS SHOWN

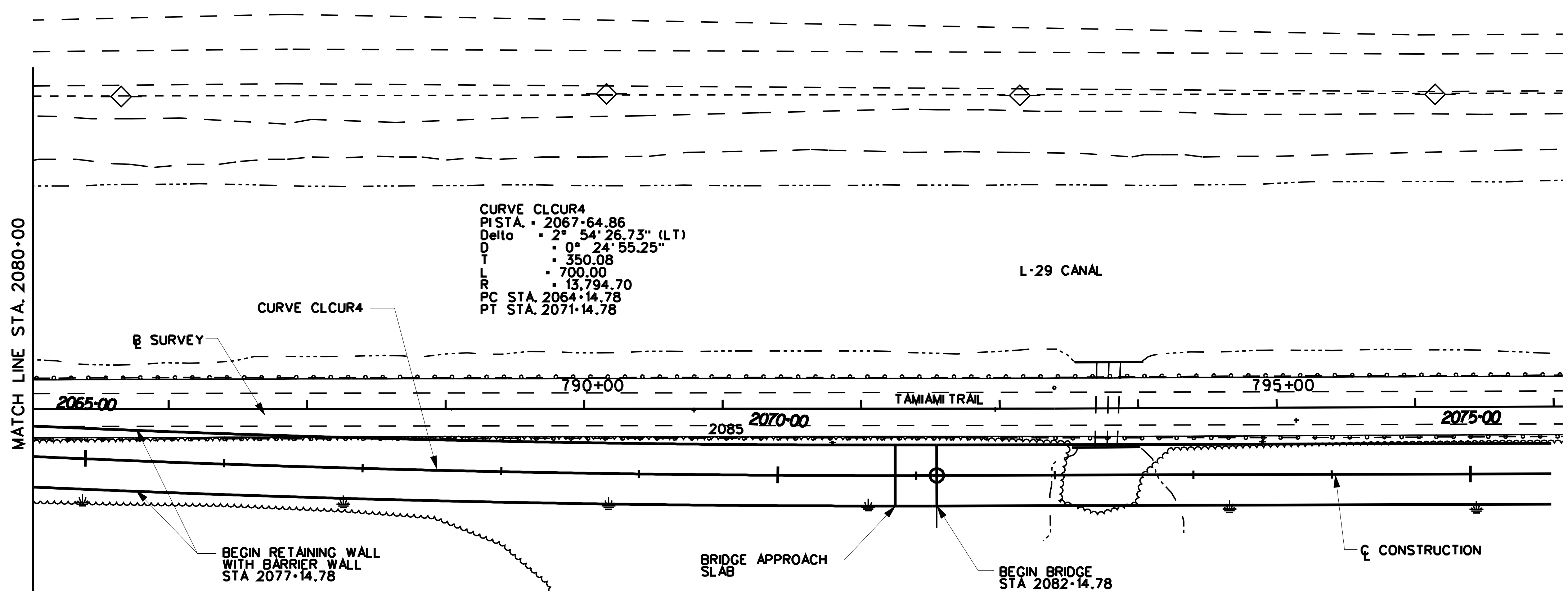
PLATE NO.
A14-6

N

1"=100'



TYPICAL ROADWAY TRANSITION



SCALE: 1"=400' HOR.
1"=4' VERT.

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File name: C-402TRN.DGN
Reference files: C-BSALT10.DGN

MODIFIED WATER DELIVERIES TO
EVERGLADES NATIONAL PARK
DADE COUNTY, FLORIDA

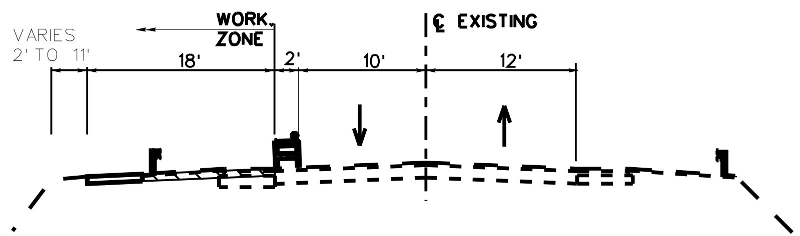
TAMIAMI TRAIL RGRR
TYPICAL TRANSITION PLAN

Scale: AS SHOWN

PLATE NO.
A14 - 7

PHASE 1-BRIDGE CONSTRUCTION

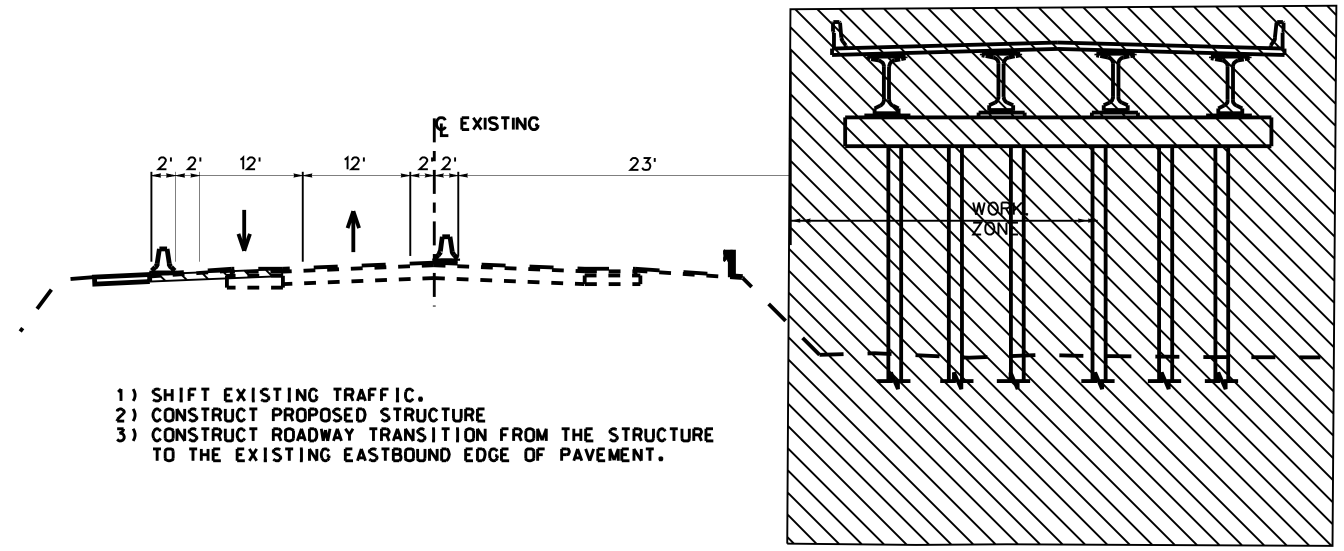
STA 2054+13.77 TO STA 2193+75.85
AND
STA 2455+20.69 TO STA 2542+02.92



1) MAINTAIN EXISTING TRAFFIC. REDUCE WESTBOUND TRAVEL LANE TO 10' TO PROTECT WORK ZONE.
2) REMOVE EXISTING GUARDRAIL
3) LEVEL EXISTING 4' PAVED SHOULDER AND PLACE TEMPORARY PAVEMENT.
4) PLACE TEMPORARY CONCRETE BARRIER.
5) WORK SHALL BE PERFORMED IN 1/4 MILE SEGMENTS

PHASE 2-BRIDGE CONSTRUCTION

STA 2054+13.77 TO STA 2193+75.85
AND
STA 2455+20.69 TO STA 2542+02.92



1) SHIFT EXISTING TRAFFIC.
2) CONSTRUCT PROPOSED STRUCTURE
3) CONSTRUCT ROADWAY TRANSITION FROM THE STRUCTURE TO THE EXISTING EASTBOUND EDGE OF PAVEMENT.

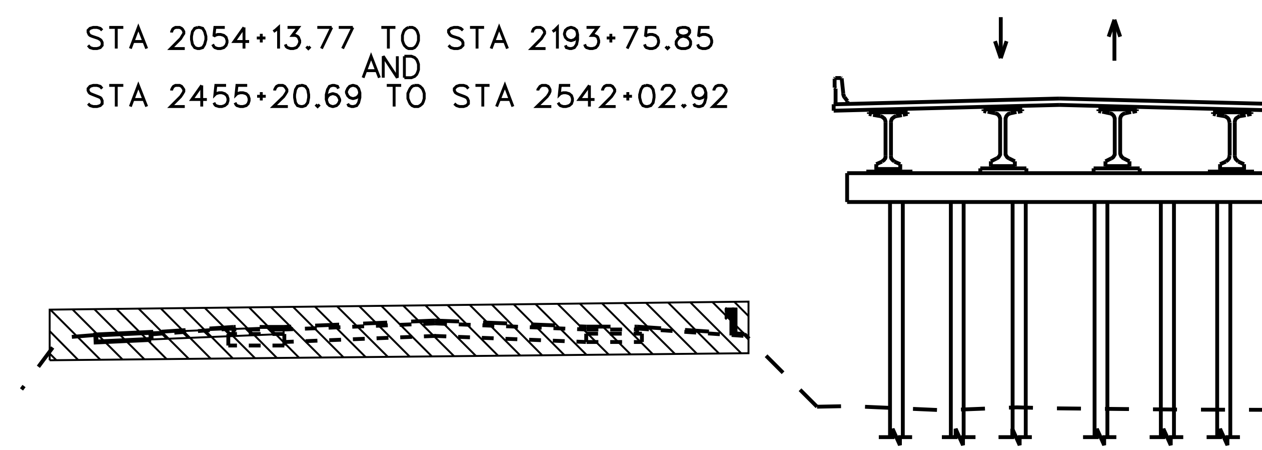
PHASE 3-ROADWAY CONSTRUCTION

STA 2016+18.15 TO STA 2054+13.77
STA 2193+75.85 TO STA 2455+20.69
AND
STA 2542+02.92 TO STA2591+40.41

1) RAISE PROFILE GRADE OF EXISTING TAMIAMI TRAIL TO REMAIN (SEE PLATE A14-8B)

PHASE 4-ROAD BED REMOVAL

STA 2054+13.77 TO STA 2193+75.85
AND
STA 2455+20.69 TO STA 2542+02.92



1) REMOVE EXISTING ROADWAY TO EL. 6.0

N.T.S.

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Designed by: MP
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File name: C-50MOT.DGN
Reference files: C-BSALT10.DGN

MODIFIED WATER DELIVERIES TO EVERGLADES NATIONAL PARK
DADE COUNTY, FLORIDA

TAMIAMI TRAIL RGRR

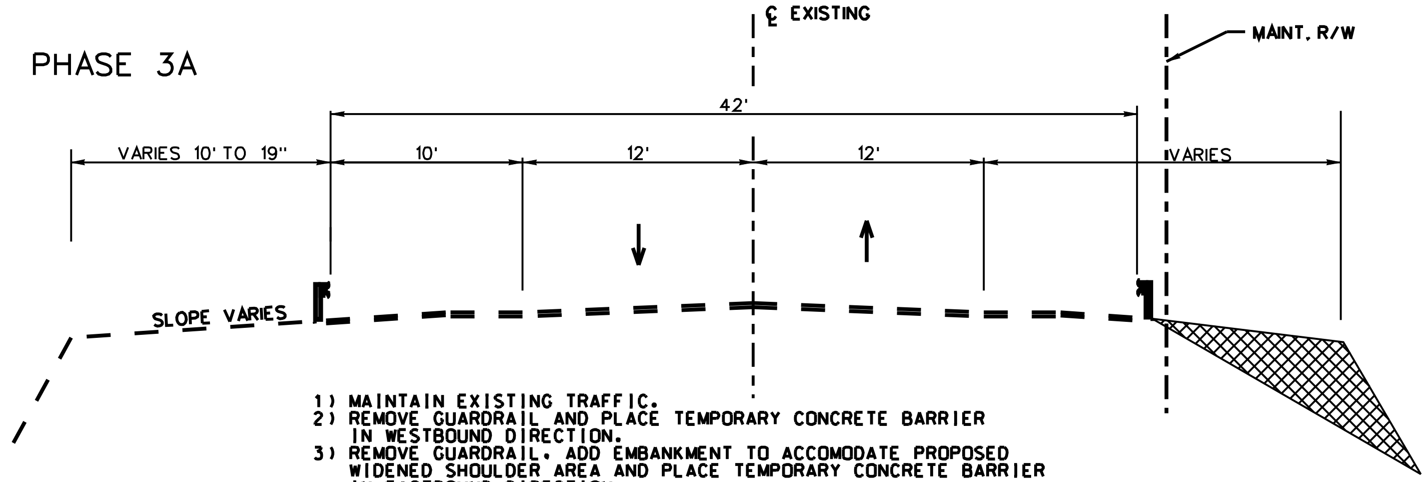
MOT PLAN

Scale: AS SHOWN

PLATE NO.

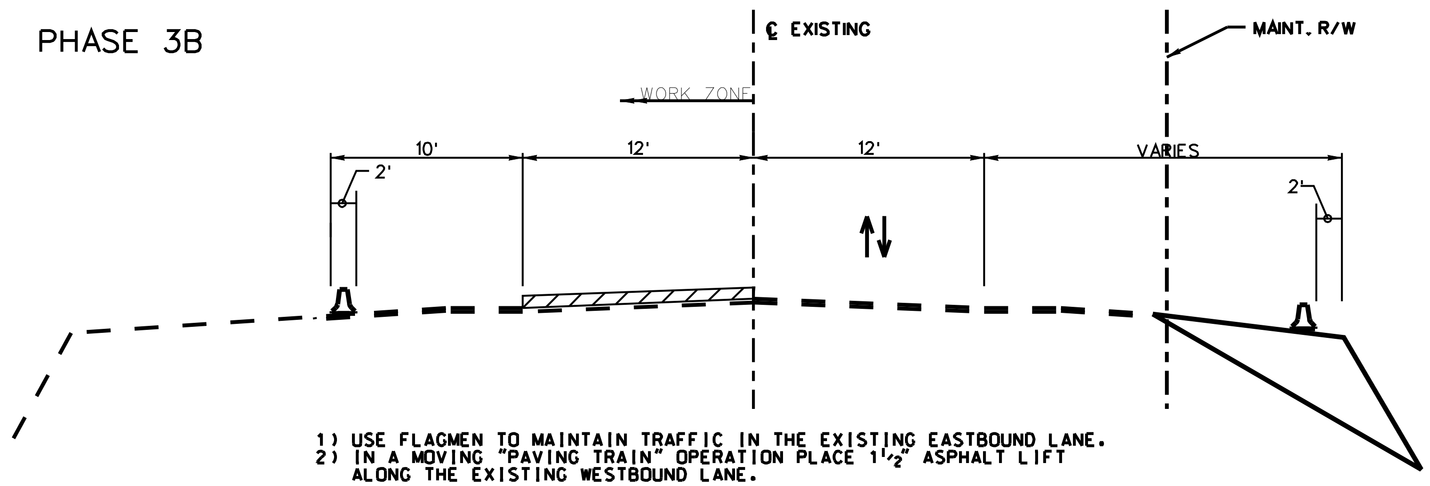
A14-8A

PHASE 3A



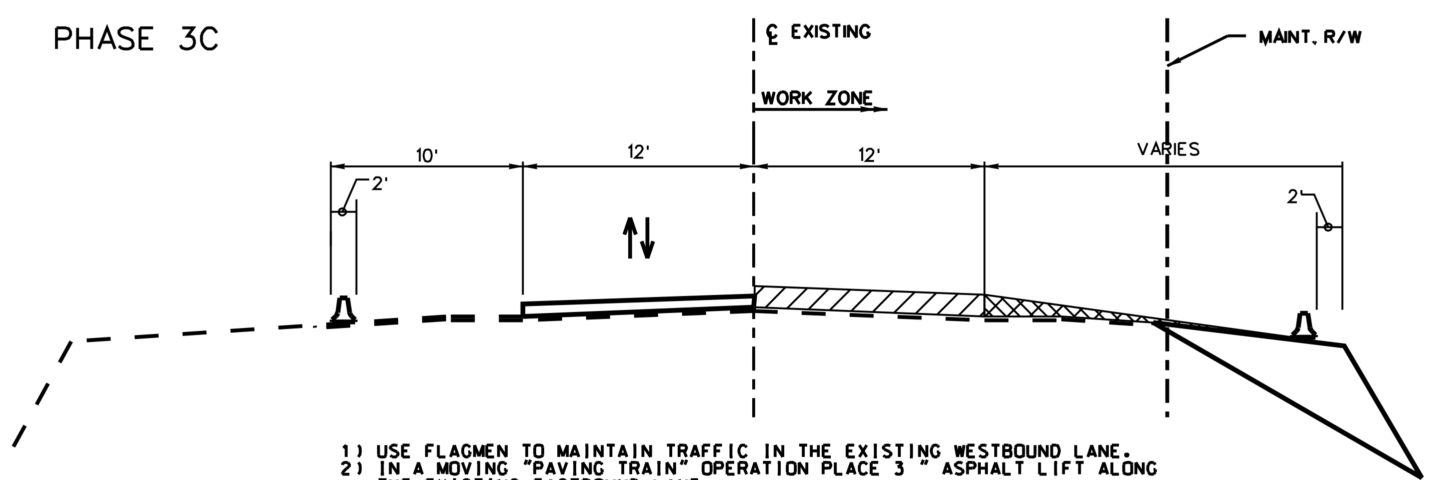
1) MAINTAIN EXISTING TRAFFIC.
2) REMOVE GUARDRAIL AND PLACE TEMPORARY CONCRETE BARRIER IN WESTBOUND DIRECTION.
3) REMOVE GUARDRAIL. ADD EMBANKMENT TO ACCOMODATE PROPOSED WIDENED SHOULDER AREA AND PLACE TEMPORARY CONCRETE BARRIER IN EASTBOUND DIRECTION.

PHASE 3B



1) USE FLAGMEN TO MAINTAIN TRAFFIC IN THE EXISTING EASTBOUND LANE.
2) IN A MOVING "PAVING TRAIN" OPERATION PLACE 1½" ASPHALT LIFT ALONG THE EXISTING WESTBOUND LANE.

PHASE 3C



1) USE FLAGMEN TO MAINTAIN TRAFFIC IN THE EXISTING WESTBOUND LANE.
2) IN A MOVING "PAVING TRAIN" OPERATION PLACE 3 " ASPHALT LIFT ALONG THE EXISTING EASTBOUND LANE.
3) PLACE EMBANKMENT
4) REPEAT IN ALTERNATING DIRECTIONS TO FINAL GRADE ADJUSTING BARRIERS AS NEEDED FOR DROP OFF PROTECTION AND ADDITION EMBANKMENT.
5) ADD SHOULDER PAVEMENT, GUARDRAIL

LOOKING EAST

SCALE = HORIZONTAL 1" = 10'
VERTICAL 1" = 5'

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File name: C-502MOT.DGN
Reference files: C-BSALT10.DGN

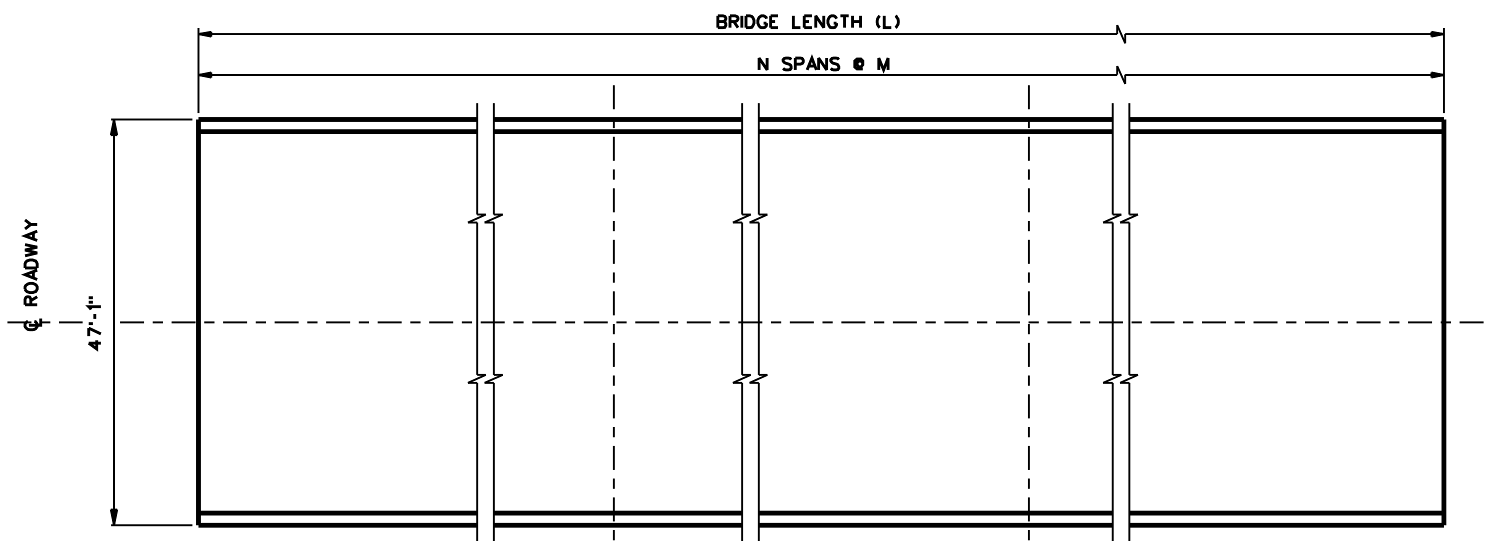
MODIFIED WATER DELIVERIES TO EVERGLADES NATIONAL PARK
DADE COUNTY, FLORIDA

TAMIAMI TRAIL RGRR

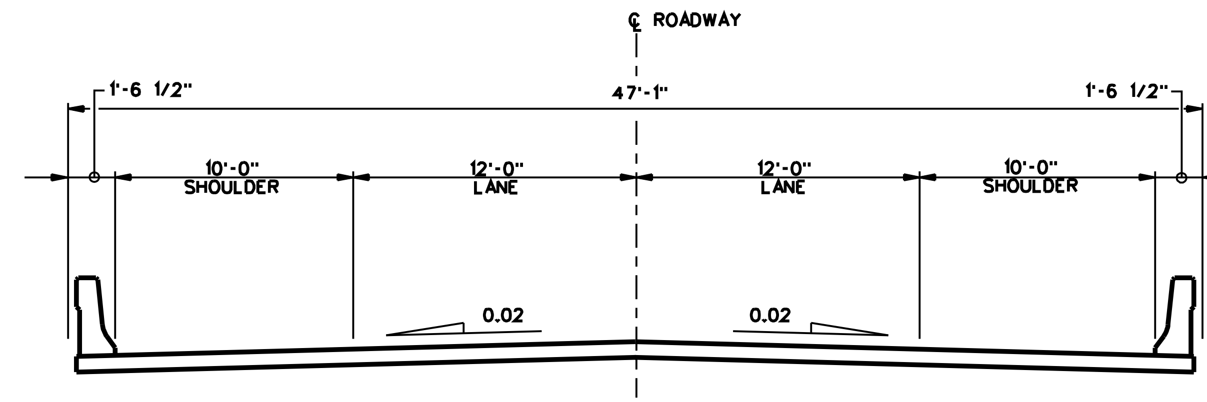
MOT PLAN

Scale: AS SHOWN

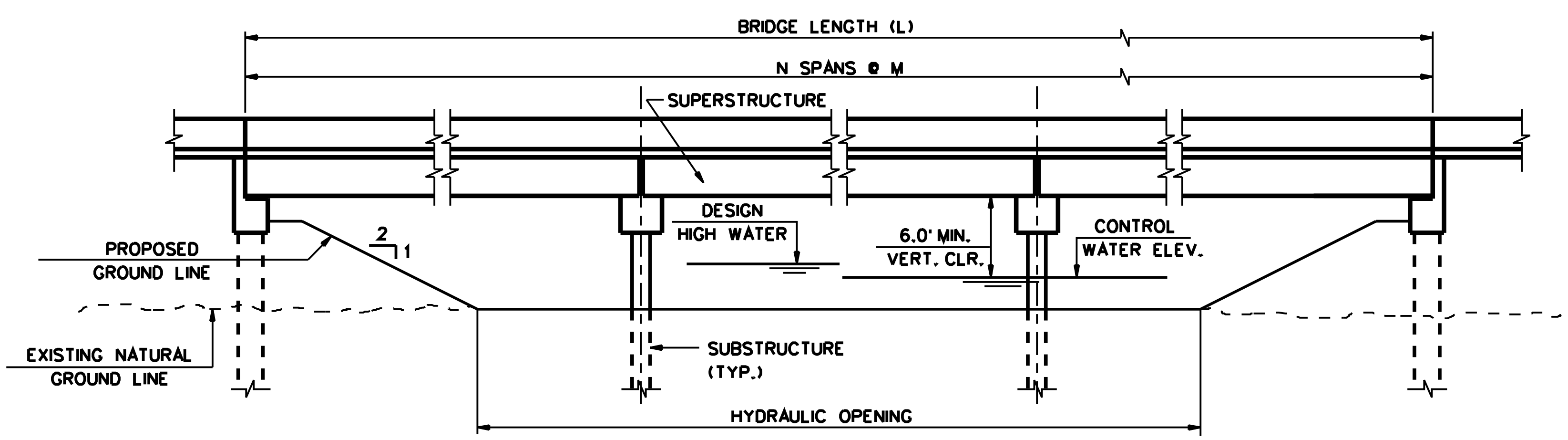
PLATE NO.
A14-8B



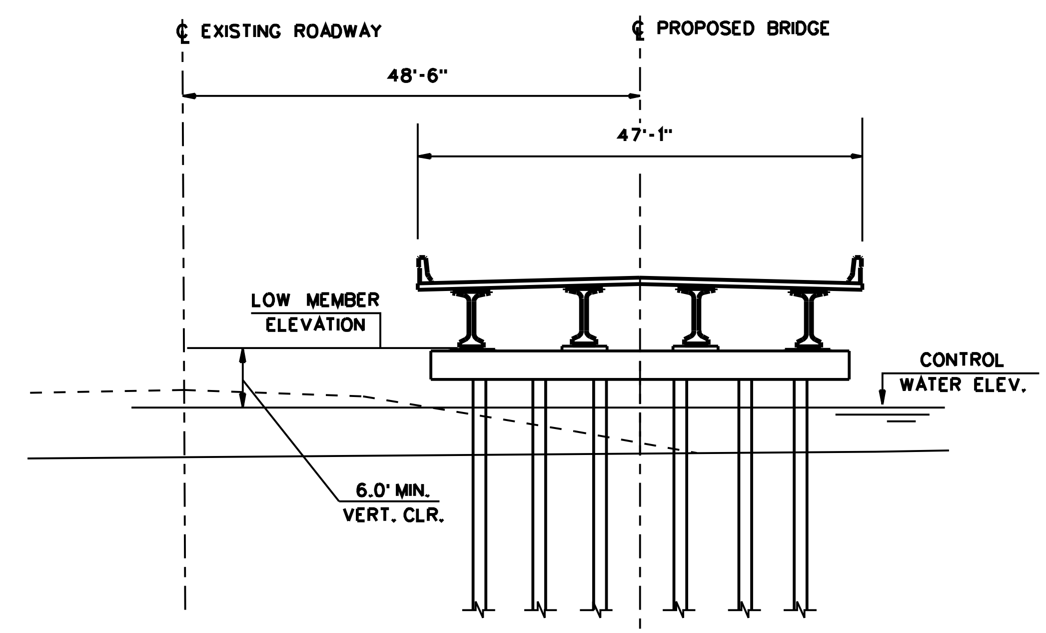
BRIDGE PLAN



BRIDGE TYPICAL SECTION



BRIDGE ELEVATION



SECTION

(LOOKING EAST)

SCALE: 1"=400' HOR.
1"=4' VERT.

BRIDGE NUMBER	BRIDGE TYPE	BRIDGE LENGTH (L)	HYDRAULIC OPENING	NUMBER OF SPANS (N)	SPAN LENGTHS (M)	SUPERSTRUCTURE TYPE	SUBSTRUCTURE TYPE	DESIGN HIGH WATER	CONTROL WATER ELEVATION	LOW MEMBER ELEVATION
1	L	10560'	10500'	106	99.15'	4 ~ FBT 72	6 ~ 24" Sq. PPC Piles	9.70'	8.75'	14.75'
2	L	5280'	5220'	53	99.15'	4 ~ FBT 72	6 ~ 24" Sq. PPC Piles	9.70'	8.75'	14.75'

BRIDGE DATA

NOTE: POLLUTION ABATEMENT SYSTEM NOT SHOWN

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File name: ALT10_PLAN&EL.dgn
Reference files: C-BSALT10.DGN

MODIFIED WATER DELIVERIES TO EVERGLADES NATIONAL PARK
DADE COUNTY, FLORIDA

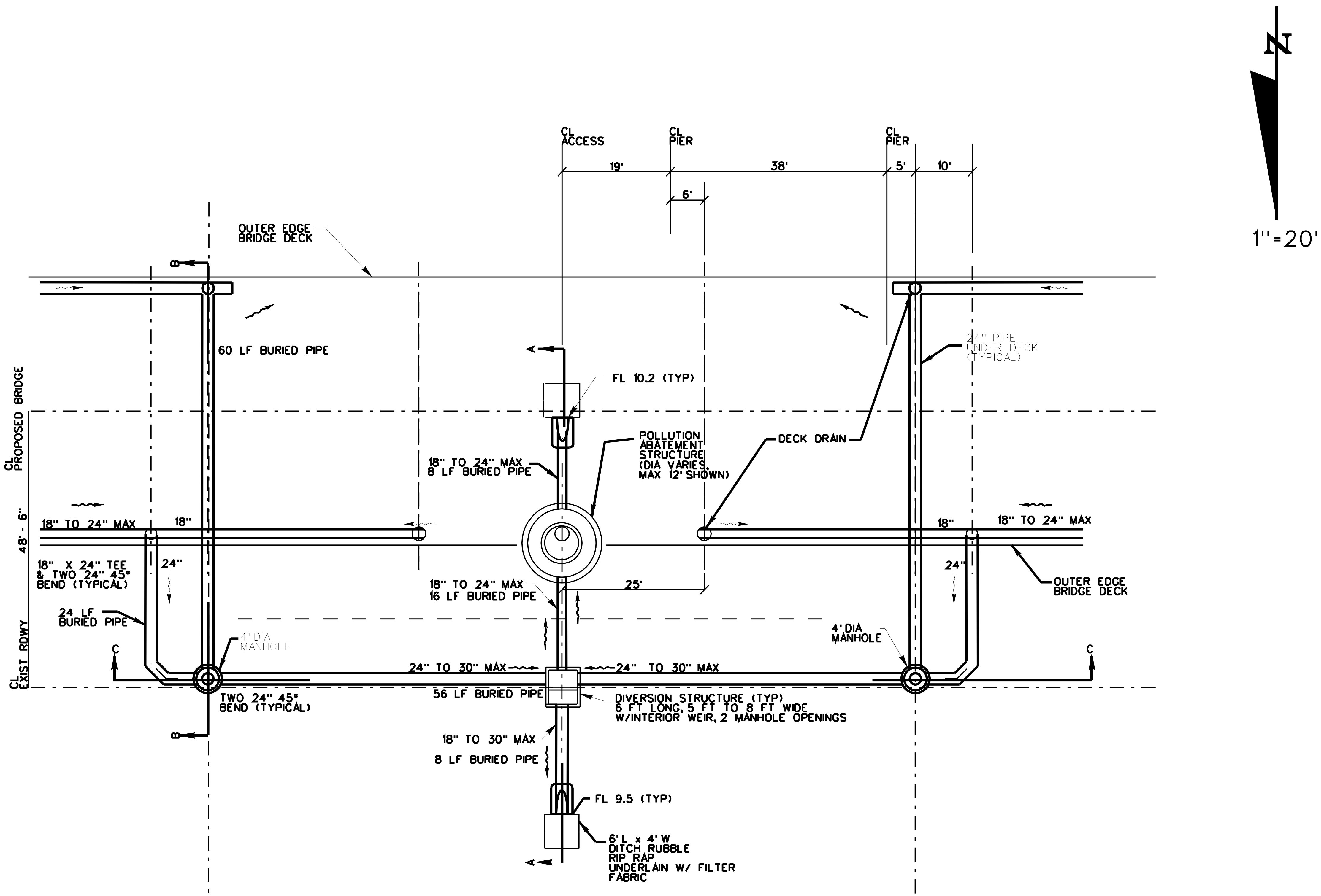
TAMIAMI TRAIL RGRR

BRIDGE PLAN

Scale: AS SHOWN

PLATE NO.

A14-9



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MODIFIED WATER DELIVERIES TO EVERGLADES NATIONAL PARK
DADE COUNTY, FLORIDA

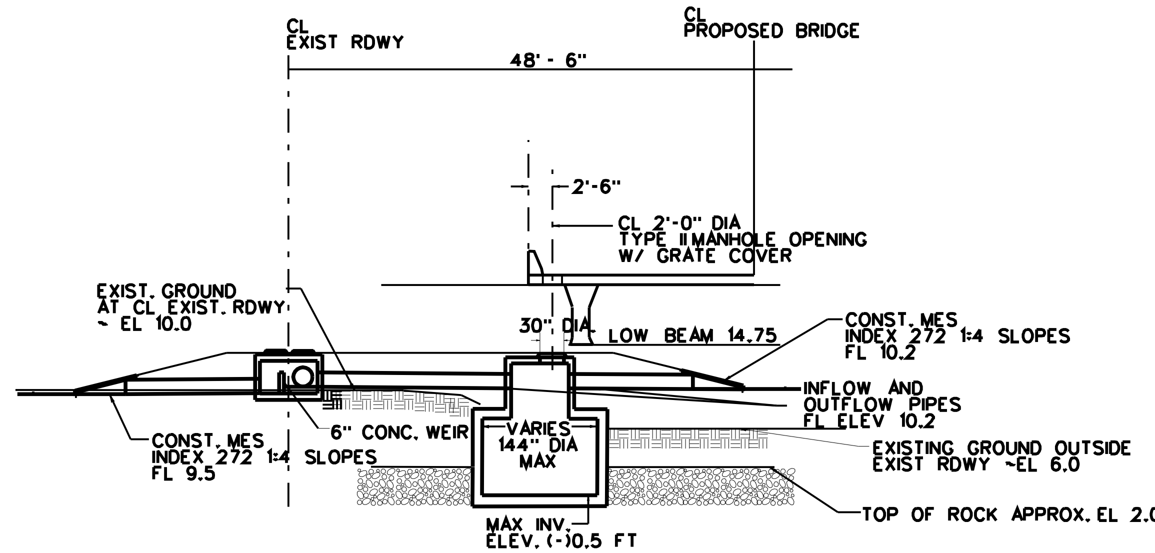
TAMIAMI TRAIL RGRR

POLLUTION ABATEMENT SYSTEM PLAN

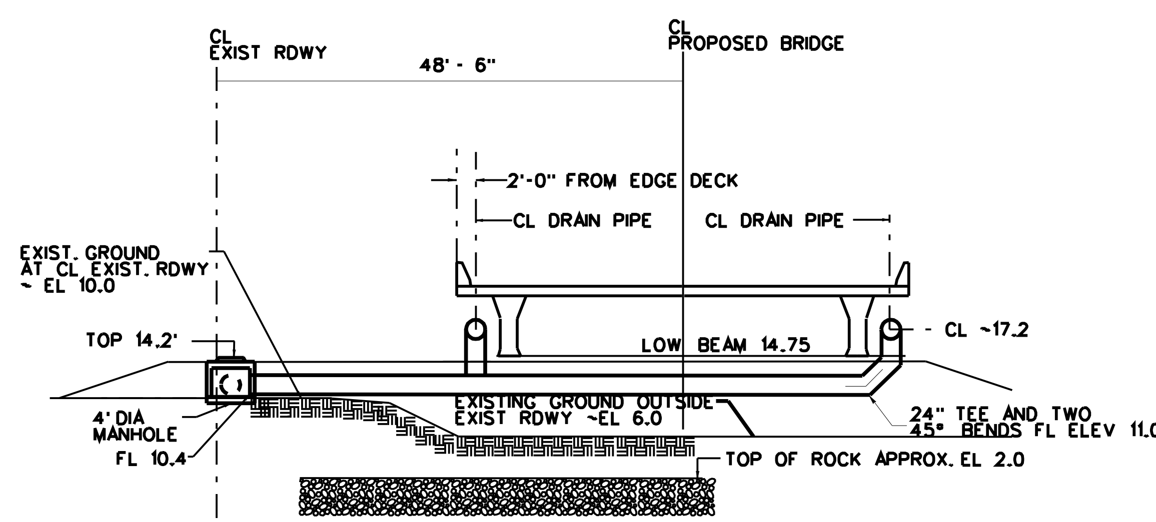
Scale: AS SHOWN

PLATE NO.

A14 - 10A



SECTION A-A



SECTION B-B

SCALE: 1"=20'

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Reference files: C-BSALT10.DGN

MODIFIED WATER DELIVERIES TO
EVERGLADES NATIONAL PARK
DADE COUNTY, FLORIDA

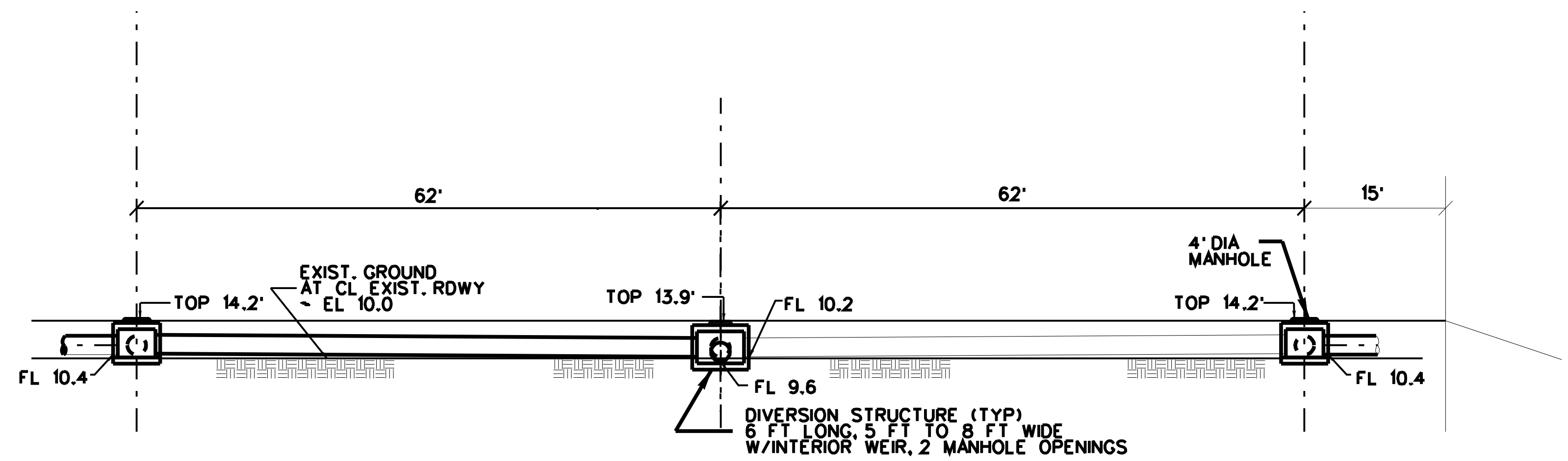
TAMIAMI TRAIL RGRR

POLLUTION ABATEMENT
SYSTEM PLAN

Scale: AS SHOWN

PLATE NO.

A14-10B



SECTION C-C

SCALE: 1"=20'

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MODIFIED WATER DELIVERIES TO
EVERGLADES NATIONAL PARK
DADE COUNTY, FLORIDA

TAMIAMI TRAIL RGRR

POLLUTION ABATEMENT
SYSTEM PLAN

Scale: AS SHOWN

PLATE NO.

A14 - 10C

Annex A: Hydrology & Hydraulics Report

Design High Water Calculation for Tamiami Trail

And

RMA-2 Modeling of North East Shark River Slough

Table of Contents

List of Tables

List of Figures

1. Introduction: As part of the Revised General Reevaluation Report/Supplemental Environmental Impact Statement (RGRR/SEIS) for the Tamiami Trail, the hydraulic modeling that was performed in the previous report was updated. This entailed re-analyzing the Design High Water (DHW) stage for Tamiami Trail and expanding the RMA-2 model to incorporate a larger portion of Everglades National Park (ENP) (Figure 1). The RMA-2 model expansion was performed in order to incorporate the interaction between the discharges from the S-12's and eastern ENP resulting from the removal of L-67 Extension (L-67Ext). The previous modeling had used both the L-67Ext and L-31 North (L-31N) levees as no flow boundaries.

2. Existing Structures: Within the boundaries of this project area exist 5 Corps of Engineers (COE) structures (S-333, S-355A, S-355B, S-334, and S-356) and 19 sets of culverts that pass water from the Levee 29 Borrow Canal (L-29BC) south through Tamiami Trail (US 41) into North East Shark River Slough (NESRS). A brief description of these features follow:

A. S-333 is a reinforced concrete, gated spillway with discharge controlled by one cable operated, vertical lift gate. The gate is operated to make releases from Water Conservation Area 3A (WCA-3A) into the Tamiami Canal (L-29BC). This structure has a maximum discharge rate of 1,350 cfs. Under the EIS for the Interim Operational Plan (IOP) it was proposed to make modifications to this structure to increase the maximum discharge capacity of the structure to 2,000 cfs. This work has not been performed to date but this discharge capacity was used in the RMA-2 analysis discussed below for CSOP Alternative 2 (West Bookend Run).

B. S-355A and S-355B are reinforced concrete, gated spillways with discharge controlled by one cable operated, vertical lift gate. Each structure is capable of a maximum discharge of 1000 cfs. These structures are a part of the Modified Water Deliveries to Everglades National Park (MWD) project and are designed to pass water from WCA-3B into NESRS. This transfer of water is via the L-29BC and the combination of culverts and a new bridge being proposed by this project along Tamiami Trail. The S-355A and S-355B structures are not currently operated due to stage constraints in the L-29BC.

C. S-334 is a reinforced concrete, gated spillway with discharge controlled by one cable operated, vertical lift gate. Operation of the gate is manually controlled, and the gate is operated to make releases from the L-29BC into the L-31N canal (South Dade conveyance system). This structure has a maximum discharge rate of 1230 cfs.

D. As part of the 2002 IOP Emergency Contract the interim pump station S-356 was constructed. S-356 is a 500 cfs diesel (4 pumps at 125 cfs each) driven pump station that pumps water from the L-31N canal into the L-29 BC for the purpose of protecting the Cape Sable Seaside Sparrow and for returning increased seepage water from NESRS into L-31N due to the implementation of the MWD Project.

E. The 19 sets of culverts are made up of a total of 55 barrels with diameters ranging in size from 48 to 60 inches (Table 1). A general hydraulic analysis was performed on the culverts to determine the total discharge capacity based on assumed upstream and downstream stages across Tamiami Trail (Table 2). The following equations were used to solve for the flowrate (Q, cubic feet per second) for partial and submerged flow, respectively (see Figure 2 for a definition sketch).

$$Q = C_d \cdot A_3 \cdot \sqrt{2 \cdot g \cdot \left(h_1 + \frac{\alpha \cdot V_1^2}{2 \cdot g} - h_3 - h_{f\_1to2} - h_{f\_2to3} \right)}$$

Equation 19.103 Type-3 Culvert Flow
Civil Engineering Reference Manual,
Michael R. Lendeburg, PE

$$Q = C_d \cdot A_o \cdot \sqrt{2 \cdot g \cdot \left(\frac{h_1 - h_4}{1 + \frac{29 \cdot C_d^2 \cdot n^2 \cdot L}{R^{\frac{4}{3}}}} \right)}$$

Equation 19.104 Type-4 Culvert Flow
Civil Engineering Reference Manual,
Michael R. Lendeburg, PE

3. Limitations of the Current Culvert System: The hydraulic conveyance capacity to move water through the Florida Department of Transportation's (FDOT) Tamiami Trail embankment is very important to the delivery of water to ENP, as well as the corresponding relationship it has on WCA-3A and WCA-3B. The culvert analysis in Table 2 shows that the current system has the hydraulic capacity to convey the required volume of water. However, this analysis only considered the ability of the culvert to move water from the immediate upstream to the immediate downstream side of the culvert and does not consider the downstream expansion losses due to the resistance of the marsh to the flow of water. The expansion losses due to the marsh will create even a higher stage than reported within Table 2 depending on the volume of water passing through the FDOT embankment. The hydraulic head required to deliver this volume of water has a detrimental impact to both Tamiami Trail and, more importantly, WCA-3A and WCA-3B. The compounded head loss from the culverts/downstream marsh creates a tailwater condition that impacts the discharge capability of S-333 (WCA-3A) and S-355A & B (WCA-3A) structures. The reduction of discharge from theses three structures will impact the stage and duration within WCA-3A and WCA-3B, potentially causing higher stages and longer durations within these areas. In addition, with only the culverts to convey water, this increased head would require that Tamiami Trail be raised higher than proposed. The culverts are further limited in that they provide only point source discharge in an area where the goal of the project is to restore historic sheet flow through the ridge and slough landscape. The ultimate goal for the restoration of the Greater Everglades Area is to make man-made features (such as roads, levees, canals, etc), to the extent practicable, transparent to the movement of water.

4. Current Operations: The discharges into the L-29BC (limited currently to S-333) are limited by stages that would cause impact to the current roadway (elevation 7.5 ft, NGVD). This elevation is based on communications with the Florida Department of Transportation (FDOT). Discharges are additionally constrained based on stages at G-3273 (elevation 6.8 ft) for the protection of the 8.5 Square Mile Area. L-29BC is used for two separate purposes:

A. Water Supply Releases: S-333 can be used in conjunction with S-334 to make water supply releases to south and east Dade County (South Dade Conveyance System). The total delivery will be the amount necessary to maintain the appropriate stages at S-331, S-25B and S-22.

B. Regulatory releases from WCA-3A to ENP are made from S-333 and the S-12's. The structures will be operated in accordance with the Interim Operation Plan (IOP, 2002). When water levels at G-3273 (a stage recorder located to the west and north of the 8.5 Square Mile Area) have been above 6.8 ft, NGVD for 24 hours, S-333 will be closed.

5. Required Water Volumes: The Everglades National Park Protection and Expansion Act (PL 101-229) Sec 104(a) (1) states:

> "Upon completion of a final report by the Chief of the Army Corps of Engineers, the Secretary of the Army, in consultation with the Secretary, is authorized and directed to construct modifications to the Central and Southern Florida Project to improve water deliveries into the park and shall, to the extent practicable, take steps to restore the natural hydrological conditions within the park."

The final report Part 1 Supplement 54 General Design Memorandum and Environmental Impact Statement Modified Water Deliveries to Everglades National Park, Florida June 1992, Section H. Recommended Project (page 52) states:

> "The goal of restoring natural hydrologic conditions will be met in terms of all three of its dimensions: location, timing and volume:
>
> * Location – The historic path of Shark River Slough will be restored by bringing WCA No.3B and NESRS back into the flowway between WCA No. 3A and Everglades National Park
>
> * Timing – Water flows through the restored Shark River Slough will reflect natural local meteorological conditions, including the extremes of natural droughts and floods, and variations in the annual seasonal and long-term cycles.
>
> * Volume – The volume of water delivered will reflect the naturally available supplies based on local meteorological conditions, except in cases where operations of the C&SF project for other authorized project purposes necessitate increased or decreased deliveries. Natural hydroperiods will be restored."

The MWD is not authorized a specific flow but rather a volume that will reflect the naturally available supplies based on local meteorological conditions. In the past confusion has revolved around the volume and timing of flows with a specific flow rate. The specific flow rate is based on the total capacity of the recommended structures of the 1992 MWD to ENP project to deliver water (Volume) into the L-29BC between structures S-333 and S-334 and then hydraulically conveyed through the Tamiami Trail (US41) embankment to ENP. This total capacity is 4,000 cfs, which is based on the discharge capacity of the following structures: 1) S-333 (1,050 cfs), S-355A (1,000 cfs), S-355B (1,000 cfs), and S-356 (950 cfs). Within the Combined Structural and Operational Plan further revisions are planned that may change the delivery of water to ENP through the use of passive weirs located in both the L-67A levee and L-29 levee.

6. Expected Flows from Combined Structural and Operational Plan (CSOP): CSOP is studying combining the MWD Project and the C-111 Canal (C-111) Project operations in a comprehensive manner to enhance water deliveries to ENP while maintaining the

other authorized purposes of both projects. Currently CSOP is evaluating several alternatives that will provide flows to North East Shark River Slough (NESRS). The average annual flows delivered across Tamiami Trail for the different CSOP alternatives evaluated are summarized in Table 3. These flows are computed at two separate transects within the South Florida Water Management Model (SFWMM or 2x2). Transect 17 represents flows west of L-67Ext and transect 18 represents flows to the east of L-67Ext. The table illustrates the wide range of average annual discharges into Shark River Slough (SRS) that different operational and structural combinations can produce (ranges from 795 kAF to 1158 kAF). Due to uncertainties of which alternative the CSOP study will select, it was decided that the Natural System Model (NSM Version 4.6.2) would be used for the roadway design high water for the FDOT roadway reconstruction. This model run was chosen because it represents our restoration stage and duration targets for the Greater Everglades System. Following are brief descriptions of the components in the CSOP alternatives to date that have a direct effect on the project area, all alternatives have the removal of the remainder of the L-67Ext (Table 4 shows a comparison for all of the alternatives):

A. Alternative 1 (East Bookend Run): The east bookend run is based on a plan similar to the 1992 MWD General Design Memorandum. Three control structures (S-345A, B, and C) are planned for the L-67A levee to pass water from WCA-3A to WCA-3B. The S-345's consist of 6 – 8-foot wide stop-log risers with 4-foot barrels at each location and associated approach and spreader canals. Three 6,000 foot gaps will be placed through the L-67C levee centered on each of the S-345's. S-355A and B will be used to discharge water out of the WCA-3B into the L-29BC. In addition to the S-355 structures, S-333 (spillway design discharge of 1350 cfs) and S-356 (500 cfs pump station) will be used to discharge water to the L-29BC from WCA-3A and L-31N, respectively.

B. Alternative 2 (West Bookend Run): This alternative replaces the S-345's with 1,000 foot passive weirs (total length equal to 3,000 feet) discharging water from WCA-3A to WCA-3B. Three 6,000 foot gaps will be placed through the L-67C levee centered on each of the S-345's. S-355A and B as well as three additional 1,000 foot passive weirs in the L-29 levee will be used to discharge water out of the WCA-3B into the L-29BC. In addition, structures S-333 (spillway design discharge increased to 2000 cfs) and S-356 (500 cfs pump station) will be used to discharge water to the L-29BC from WCA-3A and L-31N, respectively.

C. Alternative 3: This alternative uses three control structures (S-345A, B, and C) that are planned for the L-67A levee to pass water from WCA-3A to WCA-3B. The S-345's consist of 6 – 8-foot wide stop-log risers with 4 foot barrels at each location and associated approach and spreader canals. Three 6,000 foot gaps will be placed through the L-67C levee centered on each of the S-345's. S-355A and B will be used to discharge water out of the WCA-3B into the L-29BC. In addition to the S-355 structures, S-333 (spillway design discharge of 1350 cfs) and S-356 (500 cfs pump station) will be used to discharge water to the L-29BC from WCA-3A and L-31N, respectively.

D. Alternative 4: This alternative uses four 200-foot passive weir structures (S-345A, B, C, and D), total length of 800 feet, to discharge water from WCA-3A to WCA-3B. Four 6,000 foot gaps will be placed through the L-67C levee centered on each of the S-345's. S-355A and B as well as three additional 200 foot passive weirs in the L-29 levee will be used to discharge water out of the WCA-3B into the L-29BC. In addition, structures S-333 (spillway design discharge decreased to 1000 cfs) and S-356 (500 cfs pump station) will be used to discharge water to the L-29BC from WCA-3A and L-31N, respectively.

E. Alternative 5: This alternative uses three combination control/passive structures (S-345's) to discharge water from WCA-3A to WCA-3B. The S-345's will consist of 6 – 8-foot wide stop-log risers with 4 foot barrels and 60 foot passive weir at each location. S-355A and B along with three additional 200 foot passive weirs in the L-29 levee will be used to discharge water out of the WCA-3B into the L-29BC. In addition, structures S-333 (spillway design discharge decreased to 1000 cfs) and S-356 (950 cfs pump station) will be used to discharge water to the L-29BC from WCA-3A and L-31N, respectively. The exact location for the increased pumping capacity of S-356 is currently not known. For CSOP modeling purposes the location was assumed to be into the L-29BC. Subsequent discussions have revolved around linearly distributing this flow south of Tamiami Trail along the L-31N Levee.

7. Natural System Model (NSM) [http://www.sfwmd.gov/org/pld/hsm/models/nsm/index.html]: The Natural System Model (NSM) attempts to simulate the hydrologic response of the pre-drainage Everglades using recent (1965-2000) records of rainfall and other climatic inputs. The NSM does not simulate the hydrologic response of the natural system prior to influence by man but rather its hydrologic response due to the most recent climatic inputs. Although one may wish to recreate hydrologic conditions of the late 1800's or early 1900's, climatic and other data necessary to perform such a simulation do not exist. The use of recent historical records of rainfall and other inputs allow modelers to make meaningful comparisons between the responses of the current managed system to that of the natural system under conditions of identical climatic inputs. In this sense, the NSM can be a useful planning tool for restoring hydrologic conditions of the natural Everglades.

The landscape of present day south Florida has been greatly affected by land reclamation, flood control, and water management activities, which have occurred since the early 1900's. The NSM, in its current form, attempts to simulate the hydrologic system as it would function today without the existence of man's influence. The complex network of canals, structures and levees are replaced with the rivers, creeks and transverse glades that were present prior to the construction of drainage canals. Vegetation and topography used by the NSM are based on pre-drainage conditions. Landcover simulated by the NSM is static. The NSM model does not attempt to simulate vegetation succession, a primary feature in other landscape models currently under development (Everglades Landscape Model, 1994).

The NSM model boundary encompasses an area from Lake Istokpoga to Florida Bay (Figure 3). The western boundary extends southward from Lake Istokpoga to near the Gulf of Mexico, and continues along the coastal marsh fringe, turning southward to Florida Bay near Shark River Slough. The eastern boundary extends across the northern Indian Prairie Region to the Kissimmee River, and continues around the northern rim of Lake Okeechobee to the eastern most point on the lake, turning eastward to the Atlantic Ocean. The eastern boundary then follows the coastline southward to Biscayne Bay and Florida Bay.

Input data to the NSM can be classified as either static or time variant. Static data describes physical features within a cell, including vegetation, land surface elevation, aquifer properties, and river location. The NSM responds to time variant hydrologic stimuli, including rainfall, potential evapotranspiration, and inflow at the model boundary.

The NSM was developed from the South Florida Water Management Model (SFWMM) by removing the structures and canals and adding historical drainage features where applicable (i.e. transverse glades). Similar to the SFWMM, the NSM is based on a 2-mile by 2-mile grid that takes into account rainfall, evapotranspiration, topography, subsidence, as well as other hydrologic and hydraulic factors.

8. Frequency Analysis: The NSM model predicts daily average stages based on simulating observed rainfall data from the years 1965 to 2000. The water stages predicted by the NSM would account for the full range of possible seepage and conveyance feature configurations that are being considered for the Combined Structural and Operational Plan (CSOP) and subsequent Comprehensive Everglades Restoration Plan (CERP) WCA 3A/3B Decompartmentalization project. This approach is believed a more prudent design for Tamiami Trail because the design would be compatible with future restoration projects that are part of CERP. For validation of this approach, Figure 4 compares the stage duration curves at the L29BC location for CERP and alternatives considered under CSOP against the NSM simulation. This figure shows that the NSM stage levels at Tamiami Trail are higher than those expected based on current CSOP and CERP modeling, representing a conservative approach to the design high water for the pavement design.

The frequency analysis performed on the NSM utilized the Corps of Engineers (COE) computer program Flood Frequency Analysis (FFA), which computes the Log Pearson Type III distribution. The input for FFA was taken as the maximum stage (Table 5) for each year (averaged for the 5 Tamiami Trail model grid cells-Row 22, Columns 22, 23, 24, 25, & 26) from the NSM (version 4.6.2) simulated period of record (36 years). Figure 5 shows the frequency curve for the NSM model, as well as the .05 and .95 confidence limits and the Weibull plot positions of the model input data. Figure 6 compares the frequency analysis of the NSM model with the following SFWMM (2x2) model runs: CERP0, CERP1, Alt7R5, CSOP Alt 1 (East Bookend Run), CSOP Alt 2 (West Bookend Run), CSOP Alt3, CSOP Alt4, and CSOP Alt5 (Table 5 includes annual maximums for each model run).

As a visual check to the applicability of using stage data with the Log Pearson Type III distribution of the FFA program, a comparison was made to the stage hydrograph from the NSM model period of record (Figure 7). From the visual inspection of the stage hydrograph it appears that this frequency analysis appears to approximate the return frequency of the NSM model appropriately. In addition Figure 8 shows the occurrence frequency of any given stage during the modeled period of record for NSM (13,149 days). The Everglades system is predominantly a rainfall driven system, and rainfall plays a large part in determining the stage in L-29. For example, during Hurricane Irene with no structural inflows into this portion of L-29, the canal stage went up nearly 1.1 feet, from elevation 7.6 to 8.7 feet NGVD29 (See Figure 9).

9. Roadway Design High Water (DHW): Two controlling water surface elevations for the safety of the embankment are required based on the FDOT design criteria. The first

is an overtopping criterion which states that the 100-year stage should not encroach into the travel lanes. The other is for the protection of the roadbase from capillary action and requires a certain clearance from the DHW to the bottom of the base. For this design a black base is being proposed which requires 1 foot of clearance from the DHW (per FDOT letter 7 May 1999). The DHW is only used to establish the vertical clearance requirements for the reconstructed roadway. The Corps of Engineers (COE) has held two teleconferences this year (January 25 and February 15, 2005) with the FDOT, to discuss the design high water (DHW) for the 10.7 miles of roadway between S-333 and S-334. Based on recommendations from the FDOT, the COE staff has requested official acceptance by the FDOT of using the 20-year 24-hour stage for the DHW for the clearance to the bottom of the black base of the reconstructed roadway. Based on the daily time step used by the NSM model, the 20-year, 24-hour stage of 9.7 feet (see Figure 5), NGVD29 will be used for the DHW for the base clearance. The design high water for the over topping criteria will be based on the 100-year stage (10.1 feet, NGVD29, see Figure 5), this is shown for information purposes only and the DHW for the base clearance is the controlling elevation on setting the reconstructed roadway crown elevation. These stages represent the expected stages from the NSM Version 4.6.2.

10. Bridge Control Water Elevation (CWE): The Bridge CWE does not represent an operational stage that will be maintained but a stage used to determine the required low chord elevation for inspection purposes of the underside of the bridge. The CWE was computed from the average of the annual peak high water stages over a 36 year simulated period of record using the NSM. This average of the annual peak stages is 8.75 feet NGVD29.

11. L-29BC Recession Rates: Inundation of the sub-grade for extended periods of time can cause quicker degradation of the road surface. The expected recession rates for the L-29BC were computed based on the highest modeled stage from the period of record, which occurred between October and December 1999. This time period corresponds to when Hurricane Irene passed over the project area. Recession rates were computed from the simulated period of 17 October 1999 until the first significant slope change (see Table 6), ranged from approximately 0.02 ft/day (NSM Model) to 0.07 ft/day (CSOP Alternative 3). Within the period of record modeling (36 years) only three events (December 1994, October 1995, and October 1999 Figures 10, 11, and 12, respectively) produced peak stages higher than 9.7 for the L-29BC, as summarized in Table 7. The following model runs are tabulated: 1) the Natural System Model (NSM, pre-drainage), 2) CERP0, 3) CERP1, 4) Alt7R5 (Existing Conditions), 5) CSOP West Bookend, 6) CSOP East Bookend, 7) CSOP Alternative 3, 8) CSOP Alternative 4, and 9) CSOP Alternative 5. It should be noted that of the tabulated model runs, only four out of nine exhibit stages above 9.7 for any duration of the 36-year period of record (NSM, CERP0, CERP1, and CSOP West Bookend).

12. Future Operations: Once the MWD to ENP project is completed (Tamiami Trail raised, Seepage and Conveyance Features, and 8.5 Square Mile Area Constructed) the L-29BC (Tamiami Canal) between S-333 and S-334 will no longer have a stage restriction for the safety of the roadway embankment. The stage within this reach of canal will be a product of direct rainfall and operations of the Central and Southern Florida (C&SF) Project. The DHW was selected such that the road base would be below the 20-year 24-hour stage from the NSM model (9.7 feet). Table 8 compares the return frequency for the DHW stage for the 9 model runs listed above. Future projects under

CERP or other projects will have to evaluate their effect on the DHW (20-year 24-hour stage), and any change that increases this stage above the current DHW stage stated within this report would have to be mitigated for or used as a design constraint.

13. Objective of RMA-2 Modeling: The RMA-2 model is not used to determine the DHW but was used to evaluate the effects of bridge width and location when all other variables are held constant. The objective of this modeling analysis is to evaluate the velocity distribution south of the Tamiami Trail (US 41) and stage impacts that different bridge configurations will produce in North East Shark River Slough (NESRS). The goal of the Tamiami Trail Bridge is not only to pass an increased amount of flow into NESRS but also to create a more natural flow pattern (sheet flow) into NESRS. Velocities in excess of 0.1 ft/sec within ENP are assumed to be excessive and destructive to the ridge and slough processes of the Everglades. The RMA-2 model will be used to determine the stage impact in the L-29BC due to flow expansion losses based on different bridge widths.

14. RMA-2 Model Parameters: Conditions within ENP were modeled using RMA2, the depth-averaged hydrodynamic model of the Corps' TABS-MD modeling system. The model solves the depth-averaged (2D) nonlinear Navier-Stokes equations using an eddy viscosity turbulence closure. The Newton-Raphson iterative approach is used to solve the nonlinear equations. The model uses a fully implicit Galerkin finite element formulation, allowing for time steps as large as the variation in boundary forcing dictates.

A. Material Specification: Six different material types were assigned within the model based on land features (Table 9). These land features varied from the marsh to the L-29 Borrow Canal.

B. Roughness Specification: Table 9 lists the corresponding land type with the Manning's N-value used. Where the variable with depth coefficient was used, the model utilized an equation for bottom roughness as a function of water depth equation. The mathematical form of the dependence of the Manning's friction coefficient with depth is

$$n = \frac{n_0}{d^a} + n_v e^{-d/d_0} \qquad (1)$$

where d = water depth (ft)
n_0 = scaling friction factor for depth dependence
n_v = scaling factor for exponential decay dependence (vegetative effects)
α = exponent on depth dependence
d_0 = reference depth for exponential decay

Figure 13 illustrates the depth dependence curve for the four material types that use this function. All four material types with a variable n-value used the same depth dependence curve.

C. Topography: The model topography was developed from the best available data within the area. These sources included the USGS Helicopter Survey, the USGS Topometric Truck Survey, the SFMWD 5' Contour, and NHAP aerial photography (50's-60's). In addition, several Corps of Engineers surveys of L-29 Borrow Canal were used to approximate the canal invert. The accuracy of the data is approximately 0.5 feet.

D. Culvert Locations: Culvert locations were approximated as gaps through Tamiami Trail. These locations were set to the same elevation as the marsh downstream of the culvert. To account for the increased area and ease of flow, the Manning's n-value was set higher than what would be typically used for a culvert structure. Based on limitations of the model to not exceed a 50 percent change in area between elements (the base grid along the south side of Tamiami Trail is 200 feet by 200 feet), the culverts were approximated as 12.5 feet wide. All culvert structures were approximated to the same width. Figure 14 shows the model mesh in the vicinity of one of the culverts through Tamiami Trail.

E. Boundary Conditions: The model uses two types of boundary conditions, 1) boundary discharge lines and 2) boundary headlines. Boundary discharge lines were defined for all inflow points along the northern boundary of the model representing all structures. A boundary headline was used along the southern boundary to specify the starting water surface elevations from gage P-36. To determine the flows and stage for the model runs, a frequency analysis using the Log Pearson Type III Distribution was performed on the West Bookend Run (CSOP Alternative 2 dated 010405 v5.5.4). The West Bookend Run was chosen because it was the most environmentally aggressive plan that put the largest volume of water into North East Shark River Slough. Table 10 lists the results of this analysis and Table 11 lists the distribution of flow from west to east into ENP based on the frequency analysis. Steady state simulations were performed for the following return period discharges: 1, 2, 5, 10, 20, 25, 50, and 100 year events.

F. Structure Locations: All structures and culverts were located in the general proximity of the real world coordinates plus or minus 100 feet based on the mesh configuration of the model. The new weirs on the L-29 levee are based on the centerline locations of the CSOP model runs for Water Conservation Area 3B.

15. Alternatives: 12 Different Bridge alternatives were modeled. Figure 15 shows the alternative bridge location transposed over elevations along a cross section taken approximately 1000 feet south of the trail.

A. Existing Conditions (No Action): This model run represents the distribution of flow south of Tamiami Trail as if no bridge was added to this portion of road. This is a planning condition run that is not feasible due to impacts to Tamiami Trail and Water Conservation Area 3B.

B. 3000-foot Bridge (Alternative 9): The 3,000 foot bridge is located between the Blue Shanty Canal and the Airboat Association (Same as previous report). This will not affect any of the culverts through Tamiami Trail.

C. 4-mile Bridge Central (Alternative 10): The 4 mile bridge is located in the center between structures S-333 and S-334 starting on the east side of the Blue Shanty Canal and extending east 4 miles (Same as previous report). This alternative will remove 9 of the 19 culverts beneath Tamiami Trail.

D. 4-mile Bridge East (Alternative 11): The 4 mile bridge is located on the east side starting approximately 200-300 feet west of structure S-334 and proceeds west approximately 4 miles, ending between Coopertown and the Tigertail Camp. This alternative will remove 8 of the 19 culverts beneath Tamiami Trail.

E. Three-mile Bridge West (Alternative 12): The 3 mile bridge would begin approximately 1,500 feet west of the Airboat Association of Florida and proceed west approximately three miles, ending approximately one-half mile east of (before) the Osceola Camp.

F. Two-mile Bridge West (Alternative 13): The 2 mile bridge would begin 1,300 feet west of the S-12 Telemetry Tower and proceed west approximately two miles, ending approximately one-half mile east of (before) the Osceola Camp.

G. Two-mile West Bridge and One-mile East Bridge (Alternative 14): The 2 mile bridge on the west side starts approximately 1,200 feet west of the S-12 Telemetry Tower and proceeds west approximately two miles, ending approximately 2,640 feet east of (before) the Osceola Camp. The 1 mile bridge on the east side would start approximately on mile west of S-334 and proceed west approximately one mile, ending approximately 3,000 feet east of (before) Radio One.

H. 1.3-mile West Bridge and 0.7-mile East Bridge (Alternative 15): The 1.3 mile west bridge would begin approximately 1,300 feet west of Everglades Safari and proceed west approximately 1.3 miles, ending approximately 4,500 feet east of (before) the Osceola Camp.

I. Three – 3000 foot Bridges (Alternative 16): The opening for the eastern bridge would start approximately one mile west of S-334 and proceed west approximately 3,000 feet, ending approximately 6,000 feet east of (before) Radio One. The opening for the central bridge would start approximately 1,300 feet west of S-355A and proceed west approximately 3,000 feet, ending immediately east of (before) the Airboat Association of Florida. The western bridge would start approximately 2,000 feet west of the Jefferson Pilot Communication Site and proceed west 3,000 feet, ending approximately 4,500 feet east of (before) the Osceola Camp.

J. Ten-mile Bridge (Alternative 17): This Bridge spans the length of Tamiami Trail from S-333 to S-334 (Approximately 10.7 miles). The bridge abutments will begin approximately 200 feet east and west of S-333 and S-334, respectively, too allow flows to become less turbulent before reaching the beginning of the bridge. This alternative will remove all 19 culverts beneath Tamiami Trail.

K. 1-mile West Bridge and 1-mile East Bridge:

L. 2-mile Bridge West and 2-mile Bridge East:

16. RMA-2 Results: Several different results were analyzed from the RMA-2 Model output as part of the benefits analysis. A brief description follows for each set of information.

A. For each alternative, the velocity at the center of the bridge for the 1-year and 100-year computed flows was compared to the marsh velocity at a distance of approximately 10,000 feet downstream of the road from the 10.7-mile bridge option. Velocities for these return periods are depicted in Figures 16 and 17, respectively. The target is to minimize the difference in velocity between the bridge and the marsh. The higher velocities produced by the shorter bridge are extremely destructive to the ridge and slough environment of the Everglades immediately south of the Tamiami Trail.

B. For each alternative the area with velocities above 0.1 feet per second was computed. This allowed for a comparison of which alternatives would produce the least amount of impacted area (Table 12). The calculations for the area are based on the area immediately south of Tamiami Trail and east of S-333.

C. The backwater effect that the marsh produces is the main controlling factor in the stage in the L-29BC. Each bridge alternative analyzed as part of the Tamiami Trail RGRR/SEIS would produce a minimum amount of head loss across the embankment. For example in the Draft RGRR/SEIS in 2003, the recommended alternative had a 3,000 foot bridge to convey water south. The differences are the net opening of the bridge and the expansion losses created by the marsh as the water moves south and away from the bridge opening. To show the impact of embankment capacity (size of openings for culverts or bridge) vs. marsh resistance, a plot was generated from the RMA-2 model runs comparing the stage difference between the L-29BC and 10,000 feet downstream (ΔH) in the marsh for the various bridge lengths considered (Figure 18; note existing culverts are indicated as zero bridge length in this graph). This clearly shows that bridge length affects the getaway capacity of the downstream marsh, and the longer the bridge the more efficient the marsh is at moving water south into North East Shark River Slough (NESRS). The L-29BC acts as a stage equalizer upstream of the roadway embankment and this increased stage is then propagated into WCA-3B as water is discharged through the S-355's and potentially other passive structures (ΔS) in L-29 (resulting in a stage increase for WCA-3B of $\Delta H + \Delta S$)

17. Enhancement of Flow from L-29 Canal into the Deeper Sloughs of NESS: While the existing culverts provide a hydraulic connection to the deeper sloughs existing within Northeastern Shark Slough (NESS), the capacity is not commensurate with amount of flow expected in these deeper sloughs during both high and low flow conditions. Preferential flow through these deeper sloughs is even more pronounced during drier times.

As can be seen in Figure 19, the eastern portion of Shark Slough (from the L-67A extension to the L-31N levee) varies in elevation from about 5.6 feet NGVD to 7.2 feet NGVD. Without the obstruction of Tamiami Trail the preferential flow path resulting from this varying elevation would be in the deeper sloughs. Figure 19 also shows the relative marsh capacity for a stage of 7.5 feet NGVD, which represents a typical transitional condition when the highest areas are only slightly inundated. The distribution of flow within northeast Shark Slough will become more uniformly distributed (from West to East) as depth increases and the relative depth differences reduce. The 7.5 feet NGVD stage is within two tenth of the median value for the No Action and Alternatives 1 through 4 of the Combined Structural and Operational Plan (CSOP) for the Modified Water Deliveries to Everglades National Park (MWD ENP) and the C-111 Canal projects.

A. Average and High Flow Conditions: The stages in northeast Shark Slough range from about 4 feet NGVD (about 2 feet below ground surface) to 9 feet NGVD with a median stage of about 7.5 feet NGVD. As can be seen in Figure 19, the stage of 7.5 feet NGVD results in an average depth of about 1.1 feet with a maximum depth of about 1.9 feet and a minimum depth of about 0.3 feet

The increased connection provided by the bridge aligned with deeper portions of northeast Shark Slough facilitates increased flow where it should occur preferentially. As can be seen in Figure 19, with the water level less than 0.5 above the ridges most of the flow occurs in the deeper sloughs. It is important for water to be rapidly delivered to these deeper sloughs, commensurate with this capacity, during wet periods to produce higher velocities desirable for the redevelopment and maintenance of open water vegetation in these sloughs. This assessment assumes that sheet flow is based on the following equations

Manning Equation; $Q = (u/n)\ A\ Rh^{(2/3)}\ (hf / L)^{(1/2)}$
A depth dependent Manning n ($n = \sim d\ -0.77$)

Where:

A = Cross Section Flow Area = $W * d$
W = Flow Width
d = Flow Depth
P = Wetted Perimeter
R = Hydraulic Radium = $A/P = (W * d) / W \sim d$

B. Dry Conditions: During dry periods these deeper sloughs will have meaningfully deeper levels. The importance of these connections during drier periods is increased by the fact that both the existing condition and the expected range of the “with project” conditions (Tamiami Trail Bridge in conjunction with CSOP Operations) are drier than the desired conditions as represented by the Natural System Model (NSM). Specifically, NSM Version 4.6 predicts that the water levels would be at or below ground surface for approximately 2% of the time whereas as the existing conditions (ALT7R5) and alternatives (1 through 4) range from 8% to 11% percent of the time. The CERP reduces these dry conditions to 4% of the time. The increased connection that a bridge provides over culverts in terms of capacity and connectivity (sheet flow with low velocity versus flow through culverts) is expected, for the same water availability, to have the following benefits:

- Better distribution of the water; high water levels with more natural recession rates and less abnormal dry out as the limited water available can reach these sloughs.
- Facilitates the movement of fish into the L-29 canal through the deepest portions of Northeastern Shark Slough during dry outs which allows for rapid repopulation of these sloughs.
- Reduces unnatural predation around the culverts due to their limited area.

C. Evaluation Procedure: The benefits of different bridge lengths and locations were assessed considering each bridge location. A representative “marsh capacity” was estimated on 200 feet wide intervals using the USGS helicopter ground elevations and Manning’s “n” based flow equation used in the South Florid Water Management Model (SFWMM). The location of each bridge is then used to calculate the marsh capacity directly connected by a bridge opening. This marsh capacity for the bridge is then divided by the marsh capacity of the approximately 11 mile wide northeast Shark Slough from the L-67 Extension to the L-31N levee (NAD83 horizontal coordinates from 763,500 to 821,250) and expressed as percentage.

Table 1
INVENTORY OF CULVERTS ALONG U.S. 41(TAMIAMI TRAIL)
INFORMATION PROVIDED BY FDOT (RICARDO SALAZAR-DRAINAGE SECTION)

FDOT HEADWALL STRUCTURE NAME U/S	D/S	STATION OF CL	DIST. FROM U/S TO D/S STRUCTURE (ft)	ROAD EL.(ft)	PIPE LENGTH (ft)	PIPE DIA. (inches)	INLET INVERT EL.(ft)	AVE. INLET INVERT EL.(ft)	OUTLET INVERT EL.(ft)	AVE. OUTLET INVERT EL.(ft)	TOP OF CULV. EL. (ft)
COE S-333		732+10.0	1027.5	-	-	-	-	-	-	-	-
S-1	S-2	752+57.0			61.6	54	4.68		5.02		
S-1	S-2	752+65.0	3083.5	10.90	61.6	54	4.76	4.7	5.04	5.0	9.2
S-1	S-2	752+72.0			61.6	54	4.68		4.90		
S-3	S-4	793+69.0			61.0	60	4.35		4.59		
S-3	S-4	793+77.0	4045.0	10.95	61.0	60	4.09	4.4	4.55	4.5	9.4
S-3	S-4	793+86.0			61.0	60	4.69		4.38		
S-5	S-6	833+46.5			61.0	60	3.76		4.06		
S-5	S-6	833+55.0	3507.0	10.76	61.0	60	3.80	3.8	4.20	4.2	8.8
S-5	S-6	833+64.0			61.0	60	3.89		4.34		
S-7	S-8	863+83.0			62.0	54	3.82		3.89		
S-7	S-8	863+91.0	2809.5	10.77	62.0	54	3.86	3.8	3.99	4.0	8.3
S-7	S-8	863+98.5			62.0	54	3.85		4.06		
S-9	-	889+65.5			85.0	60	4.25		-		
S-9	-	889+74.0	3121.5	10.86	85.0	60	4.16	4.2	-		9.2
S-9	-	889+82.5			85.0	60	4.28		-		
S-10	S-11	926+27.0			60.5	48	3.79		4.06		
S-10	S-11	926+34.0	3116.5	10.79	60.5	48	3.23	3.6	3.99	4.1	7.6
S-10	S-11	926+40.5			60.5	48	3.73		4.13		
S-12	S-13	951+99.0			61.5	60	4.14		4.05		
S-12	S-13	952+07.0	3071.0	10.94	61.5	60	4.09	4.1	4.02	4.0	9.1
S-12	S-13	952+16.0			61.5	60	4.08		4.03		
S-14	S-15	987+67.5			61.0	54	4.90		4.95		
S-14	S-15	987+76.0	3715.5	10.87	61.0	54	5.02	4.9	4.90	4.9	9.4
S-14	S-15	987+84.5			61.0	54	4.91		4.73		
S-16	S-17	1026+30.0			62.7	60	1.93		2.36		
S-16	S-17	1026+38.0	2648.0	10.66	62.7	60	2.42	2.2	2.35	2.4	7.2
S-16	S-17	1026+46.0			62.7	60	2.20		2.42		
S-16	S-17	1026+55.5			62.7	60	2.18		2.34		
S-18	S-19	1040+63.5			62.0	60	3.02		3.11		
S-18	S-19	1040+72.0	2157.9	10.58	62.0	60	2.85	3.0	3.08	3.1	8.0
S-18	S-19	1040+80.5			62.0	60	3.08		3.22		
S-20	S-21	1069+54.8			61.0	48	4.08		4.08		
S-20	S-21	1069+61.7	2946.5	10.65	61.0	48	4.11	4.1	4.06	4.1	8.1
S-20	S-21	1069+68.0			61.0	48	4.16		4.03		
S-22	S-23	1099+65.0	1750.4	11.20	61.5	60	2.90	2.9	3.05	3.1	8.6
S-24	S-25	1104+53.5			60.5	60	3.84		3.71		
S-24	S-25	1104+62.5	1461.2	11.13	60.5	60	3.72	3.8	3.55	3.6	8.8
S-24	S-25	1104+71.0			60.5	60	3.76		3.65		
S-26	S-27	1128+87.3	2592.8	11.10	60.2	54	3.60	3.5	3.80	3.8	8.0
S-26	S-27	1128+95.0			60.2	54	3.48		3.81		
S-28	S-29	1156+40.0			62.8	60	4.14		4.25		
S-28	S-29	1156+48.0	2774.3	11.22	62.8	60	4.02	4.1	4.08	4.2	9.1
S-28	S-29	1156+57.0			62.8	60	4.14		4.22		
S-30	S-31	1184+37.5			61.0	48	3.48		3.35		
S-30	S-31	1184+43.5	3256.4	10.78	61.0	48	3.65	3.6	3.32	3.6	7.6
S-30	S-31	1184+50.0			61.0	48	3.70		4.02		
S-32	S-33	1221+54.0			60.7	48	3.35		3.32		
S-32	S-33	1221+60.7	3620.0	10.92	60.7	48	3.34	3.4	3.31	3.3	7.4
S-32	S-33	1221+67.9			60.7	48	3.43		3.34		
S-34	S-35	1256+76.0			61.5	42	4.07		4.09		
S-34	S-35	1256+83.5	3040.4	11.32	61.5	42	4.15	4.1	4.08	4.1	7.6
S-34	S-35	1256+89.0			61.5	42	4.13		4.05		
S-36	S-37	1282+34.8			62.0	48	3.82		3.92		
S-36	S-37	1282+41.4	2060.8	11.58	62.0	48	3.84	3.8	3.95	3.9	7.8
S-36	S-37	1282+48.4			62.0	48	3.76		3.95		
COE S-334		1298+05.0	781.8	-	-	-	-	-	-	-	-

Table 2
MODIFIED WATER DELIVERIES

U.S. 41 CULVERTS
CULVERT DISCHARGE RATING(CFS)

TW EL (FT-NGVD)	ALL CULVERTS BETWEEN S-333 AND S-334 HW EL (FT-NGVD)																
	7.0	7.1	7.2	7.3	7.4	7.5	7.6	7.7	7.8	7.9	8.0	8.1	8.2	8.3	8.4	8.5	8.6
7.0	0	1,172	1,705	2,145	2,537	2,901	3,239	3,563	3,870	4,164	4,444	4,715	4,980	5,234	5,483	5,724	5,957
7.1		0	1,205	1,751	2,197	2,594	2,956	3,298	3,620	3,926	4,216	4,496	4,768	5,029	5,283	5,530	5,768
7.2			0	1,238	1,794	2,247	2,644	3,011	3,352	3,672	3,975	4,265	4,546	4,815	5,076	5,329	5,572
7.3				0	1,269	1,462	1,819	2,132	2,415	2,674	2,915	3,143	3,363	3,573	3,776	3,971	4,159
7.4					0	1,297	1,870	2,332	2,737	3,104	3,442	3,762	4,066	4,355	4,634	4,902	5,159
7.5						0	1,322	1,904	2,370	2,776	3,142	3,483	3,803	4,106	4,396	4,673	4,939
7.6							0	1,347	1,935	2,404	2,810	3,179	3,521	3,841	4,144	4,434	4,709
7.7								0	1,368	1,963	2,434	2,843	3,215	3,556	3,877	4,180	4,467
7.8									0	1,388	1,987	2,463	2,875	3,246	3,589	3,910	4,212
7.9										0	1,405	2,011	2,490	2,903	3,277	3,620	3,940
8.0											0	1,422	2,033	2,514	2,931	3,305	3,648
8.1												0	1,438	2,053	2,538	2,956	3,330
8.2													0	1,452	2,072	2,560	2,978
8.3														0	1,465	2,090	2,579
8.4															0	1,478	2,106
8.5																0	1,489
8.6																	0
8.7																	
8.8																	
8.9																	
9.0																	
9.1																	
9.2																	

TW EL (FT-NGVD)	ALL CULVERTS BETWEEN S-333 AND S-334 HW EL (FT-NGVD)																
	8.7	8.8	8.9	9.0	9.1	9.2	9.3	9.4	9.5	9.6	9.7	9.8	9.9	10.0	10.1	10.2	10.3
7.0	6,180	6,387	6,591	6,784	6,960	7,125	7,766	7,933	8,097	8,257	8,414	8,569	8,720	8,869	9,016	9,160	9,302
7.1	5,995	6,207	6,415	6,612	6,792	6,961	7,595	7,766	7,933	8,097	8,257	8,414	8,569	8,720	8,869	9,016	9,160
7.2	5,805	6,022	6,234	6,436	6,620	6,793	7,421	7,595	7,766	7,933	8,097	8,257	8,414	8,569	8,720	8,869	9,016
7.3	4,339	4,508	4,672	4,827	4,968	5,104	7,242	7,421	7,595	7,766	7,933	8,097	8,257	8,414	8,569	8,720	8,869
7.4	5,404	5,633	5,856	6,068	6,262	6,444	7,058	7,242	7,421	7,595	7,766	7,933	8,097	8,257	8,414	8,569	8,720
7.5	5,192	5,428	5,657	5,875	6,075	6,263	6,870	7,058	7,242	7,421	7,595	7,766	7,933	8,097	8,257	8,414	8,569
7.6	4,971	5,215	5,452	5,676	5,882	6,076	6,677	6,870	7,058	7,242	7,421	7,595	7,766	7,933	8,097	8,257	8,414
7.7	4,740	4,993	5,238	5,470	5,683	5,883	6,477	6,677	6,870	7,058	7,242	7,421	7,595	7,766	7,933	8,097	8,257
7.8	4,497	4,761	5,015	5,255	5,476	5,683	6,272	6,477	6,677	6,870	7,058	7,242	7,421	7,595	7,766	7,933	8,097
7.9	4,239	4,516	4,781	5,031	5,261	5,477	6,059	6,272	6,477	6,677	6,870	7,058	7,242	7,421	7,595	7,766	7,933
8.0	3,966	4,258	4,536	4,797	5,037	5,262	5,839	6,059	6,272	6,477	6,677	6,870	7,058	7,242	7,421	7,595	7,766
8.1	3,671	3,983	4,277	4,551	4,803	5,038	5,610	5,839	6,059	6,272	6,477	6,677	6,870	7,058	7,242	7,421	7,595
8.2	3,352	3,688	4,000	4,291	4,556	4,803	5,371	5,610	5,839	6,059	6,272	6,477	6,677	6,870	7,058	7,242	7,421
8.3	2,998	3,366	3,704	4,014	4,296	4,557	5,121	5,371	5,610	5,839	6,059	6,272	6,477	6,677	6,870	7,058	7,242
8.4	2,596	3,011	3,381	3,716	4,018	4,296	4,858	5,121	5,371	5,610	5,839	6,059	6,272	6,477	6,677	6,870	7,058
8.5	2,120	2,608	3,024	3,392	3,720	4,019	4,580	4,858	5,121	5,371	5,610	5,839	6,059	6,272	6,477	6,677	6,870
8.6	1,499	2,129	2,619	3,034	3,396	3,721	4,284	4,580	4,858	5,121	5,371	5,610	5,839	6,059	6,272	6,477	6,677
8.7	0	1,505	2,138	2,628	3,037	3,397	3,967	4,284	4,580	4,858	5,121	5,371	5,610	5,839	6,059	6,272	6,477
8.8		0	1,512	2,145	2,631	3,038	3,621	3,967	4,284	4,580	4,858	5,121	5,371	5,610	5,839	6,059	6,272
8.9			0	1,517	2,148	2,631	3,239	3,621	3,967	4,284	4,580	4,858	5,121	5,371	5,610	5,839	6,059
9.0				0	1,519	2,148	2,805	3,239	3,621	3,967	4,284	4,580	4,858	5,121	5,371	5,610	5,839
9.1					0	1,519	2,290	2,805	3,239	3,621	3,967	4,284	4,580	4,858	5,121	5,371	5,610
9.2						0	1,683	2,381	2,916	3,367	3,764	4,123	4,454	4,761	5,050	5,323	5,583

Table 3
Average Annual Overland Flow Across Tamiami Trail
(Transect 17 = WSS and Tansect 18 = ESS)

SFWMM Simulation	Transect 17 1000 acre-ft	Transect 18 1000 acre-ft	SRS Total 1000 acre-ft	% Distribution West / East
NSM 4.6.2	477	895	1372	35% / 65%
D13R	434	487	921	47% / 53%
CERP0 *	398	509	907	44% / 56%
Alt7R5	623	172	795	78% / 22%
No Action	376	493	869	43% / 57%
East Bookend (CSOP)	452	516	968	47% / 53%
**West Bookend (CSOP) ** **	447	597	1044	43% / 57%
West Bookend (b) (CSOP)	451	683	1134	40% / 60%
Alternative 3 (CSOP)	527	631	1158	46% / 54%
Alternative 4 (CSOP)	434	540	974	45% / 55%
Alternative 5 (CSOP)	437	538	975	45% 55%

*CERP0 flows at T18 do not include S-356 flows, which discharges south of T18 into NESRS
** Used in RMA-2 Analysis

Table 4
CSOP Seepage and Conveyance Features
Table for Information Only data will be Finilzed as part of the CSOP Documentation

		Alt 1 East Bookend	Alt 2 West Bookend	Alt 3	Alt 4	Alt 5	
1) L-67A Conveyance Features							
Passive Control Structure	Number of Weirs =	---	3	---	4	3	
	Length of Weirs (each) =	---	1000 ft	---	100 ft	60	Length at
		Crest Elevation (North to South)				Each Site	elevation
	L-67AWA	---	8.7 ft	---	9.0 ft	9.5	30 ft
	L-67AWB	---	8.0 ft	---	9.0 ft	9.0	20 ft
	L-67AWC	---	8.2 ft	---	8.5 ft	8.5	10 ft
	L-67AWD	---	---	---	8.2 ft	Total L =	60 ft
Control Structure	Number of Stop Log Riser Structures =	3	---	3	---	3	
	Number of Culverts per Location =	6	---	6	---	6	
	Riser Width =	8.0 ft	---	8.0 ft	---	8.0 ft	
	Barrel Diameter =	4.0 ft	---	4.0 ft	---	4.0 ft	
	Invert Elevation =	4.0 ft	---	4.0 ft	---	4.0 ft	
		Riser Crest Elevation					
	S-345A =	3 @ 8.5ft, 3 @ 9.5ft	---	9.0 ft	---	9.0 ft	Closure
	S-345B =	6 @ 9.5 ft	---	8.5 ft	---	8.5 ft	Criteria
	S-345C =	3 @ 8.5ft, 3 @ 9.5ft	---	8.0 ft	---	8.0 ft	(Else Removed)
	Plugs in L-67A Canal	No	Yes	No	Yes	Yes	
2) L-67C Levee Degrade (Gaps are centered on structures listed in 1 above.)							
	Number of Gaps =	3	3	3	4	3	
	Length of Gap =	6000 ft	6000 ft	6000 ft	6000 ft	6000 ft	
	Total Length of Gap =	18,000 ft	18,000 ft	18,000 ft	24,000 ft	18,000 ft	
3) L-29 Conveyance Features							
	a) S-355 A and B	**Structures have been constructed (1996).**					
	b) Passive Weirs in L-29						
	Number of Weirs =	---	3	---	3	3	
	Length of Weirs (each) =	---	1000 ft	---	200 ft	200	
		Crest Elevation (West to East)					
	L-29WA	---	6.6 ft	---	6.5 ft	6.5 ft	
	L-29WB	---	6.6 ft	---	6.3 ft	6.3 ft	
	L-29WC	---	6.6 ft	---	6.3 ft	6.3 ft	
4) S-333							
	Discharge (cfs) =	2,000	2,000	2,000	1,000	1,000	
	Anchoring System	Yes	Yes	Yes	Yes	Yes	
		(Part 1 Supplement 55, FDM 1, p 48 section H-3, paragraph e)					
	Apron Lengthing	Yes	Yes	Yes	No	No	
		(IOP Requirement due to increasing maximum discharge.)					
5) Removal of the Remainder of L-67 Ext							
	Length =	28,700 ft	28,700 ft	28,700 ft	28,700 ft	28,700 ft	
	Completed Length (2002 IOP Emergency) =	20,000 ft	20,000 ft	20,000 ft	20,000 ft	20,000 ft	
6) S-356 Pump Station		Completed during the 2002 IOP Emergency (500 cfs)					
	Constructed Capacity =	500	500	500	500	500	cfs
	Additional Capacity =	---	---	---	---	450	cfs
	Total Capacity =	500	500	500	500	950	cfs

Table 5
Yearly Peak Stages
From Evaluated Model Runs

Year	NSM	CERP0	CERP1	ALT7R5	West Book	East Book	Alt 3	Alt 4	Alt 5
1965	8.46	8.31	8.31	7.66	8.33	8.37	8.27	8.11	8.04
1966	9.38	8.95	8.94	7.93	8.85	8.91	8.60	8.60	8.59
1967	8.66	8.52	8.48	7.80	8.30	8.43	8.46	8.11	8.14
1968	9.37	9.08	9.08	8.03	9.10	9.05	8.76	8.78	8.75
1969	9.54	9.22	9.21	8.17	9.32	9.12	8.95	9.02	9.07
1970	9.14	8.96	8.94	7.98	8.97	8.98	8.65	8.74	8.74
1971	7.87	7.87	7.83	7.35	8.03	7.18	7.51	7.67	7.66
1972	8.49	8.45	8.40	7.97	8.26	8.65	8.49	8.20	8.11
1973	8.06	7.77	7.74	7.56	7.41	7.76	7.99	7.43	7.51
1974	8.13	8.18	8.17	7.76	8.01	7.85	8.10	7.74	7.66
1975	8.51	8.41	8.36	8.05	8.26	8.50	8.45	8.14	8.02
1976	8.53	8.42	8.39	7.81	8.27	8.47	8.48	8.16	8.11
1977	8.26	7.81	7.80	7.62	7.75	7.75	8.10	7.64	7.72
1978	8.67	8.51	8.47	7.86	8.35	8.55	8.46	8.27	8.16
1979	8.89	8.46	8.46	7.92	8.50	8.69	8.51	8.41	8.40
1980	8.82	8.42	8.42	7.98	8.34	8.65	8.45	8.36	8.27
1981	8.83	8.46	8.46	7.74	8.38	8.53	8.50	8.27	8.27
1982	8.92	8.78	8.76	8.01	8.67	8.73	8.51	8.50	8.46
1983	8.95	8.72	8.68	8.04	8.89	8.94	8.50	8.62	8.67
1984	8.68	8.33	8.30	7.96	8.17	8.28	8.42	8.06	8.04
1985	8.51	8.16	8.14	7.85	8.16	8.08	8.32	7.95	7.83
1986	8.33	8.34	8.31	7.88	8.20	8.54	8.39	8.13	8.03
1987	8.40	8.02	7.99	7.85	8.02	8.28	8.40	8.01	8.06
1988	8.57	8.23	8.18	7.74	7.98	8.34	8.40	8.00	8.09
1989	7.29	7.42	7.43	6.48	6.53	6.57	6.64	6.69	6.34
1990	7.43	7.08	6.99	7.18	6.70	7.32	7.23	6.78	6.80
1991	9.08	8.63	8.64	7.54	8.45	8.42	8.47	8.28	8.18
1992	8.78	8.35	8.33	7.86	8.22	8.70	8.43	8.34	8.38
1993	9.06	8.48	8.47	7.77	8.32	8.55	8.46	8.32	8.31
1994	9.78	9.40	9.40	8.11	9.71	9.18	9.25	9.67	9.36
1995	9.75	9.51	9.50	8.23	9.70	9.05	8.96	9.21	9.26
1996	9.17	8.77	8.75	7.87	8.79	8.90	8.51	8.49	8.53
1997	8.83	8.66	8.64	7.77	8.42	8.65	8.47	8.30	8.32
1998	9.28	9.00	8.99	7.97	9.04	9.05	8.55	8.75	8.75
1999	9.84	9.84	9.82	8.59	9.75	9.51	9.29	9.51	9.49
2000	8.78	8.60	8.60	7.86	8.45	8.47	8.53	8.54	8.39
Maximum Stage	**9.84**	**9.84**	**9.82**	**8.59**	**9.75**	**9.51**	**9.29**	**9.67**	**9.49**
	NSM	**CERP0**	**CERP1**	**ALT7R5**	**West Book**	**East Book**	**Alt 3**	**Alt 4**	**Alt 5**

Table 6
Recession Rates
Various Model Runs (October 1999)

Model Run	First Day	Stage (ft)	Last Day	Stage (ft)	Number of Days	Stage Difference (ft)	Recession Rate (ft/day)
NSM Model	17-Oct-99	9.84	24-Nov-99	9.21	38	0.63	0.017
CERP0	16-Oct-99	9.82	24-Nov-99	9.07	39	0.75	0.019
Alt7R5	17-Oct-99	8.59	24-Nov-99	7.71	38	0.88	0.023
CSOP Alt 1 (East Bookend)							
	17-Oct-99	9.51	28-Oct-99	9.02	11	0.49	0.045
	17-Oct-99	9.51	22-Oct-99	9.1	5	0.41	0.082
CSOP Alt 2 (West Bookend)							
	18-Oct-99	9.75	24-Nov-99	9.25	37	0.50	0.014
	18-Oct-99	9.75	25-Oct-99	9.5	7	0.25	0.036
CSOP Alt 3							
	17-Oct-99	9.29	24-Nov-99	8.98	38	0.31	0.008
	17-Oct-99	9.29	22-Oct-99	8.92	5	0.37	0.074
CSOP Alt 4	17-Oct-99	9.51	24-Nov-99	9.15	38	0.36	0.009
	17-Oct-99	9.51	24-Oct-99	9.3	7.00	0.21	0.030
CSOP Alt 5	17-Oct-99	9.49	24-Nov-99	8.89	38	0.60	0.016
	17-Oct-99	9.49	30-Oct-99	9.15	13.00	0.34	0.026
Historical Data							
	17-Oct-99	8.64	24-Nov-99	7.72	38	0.92	0.024

Note: See Figure 9 for a plot of the stage hydrographs.

Table 7
Number of Days above 9.7 ft in the Period of Record Modeling

Model Run	December 1994		No Name Storm October 1995		Hurrican Irene October 1999		Total Number of days above 9.7
	# of Days	Peak Stage	# of Days	Peak Stage	# of Days	Peak Stage	
NSM	18	9.78	6	9.75	7	9.84	31
CERP0	0	9.40	0	9.51	3	9.84	3
CERP1	0	9.40	0	9.50	3	9.82	3
ALT7R5	0	8.11	0	8.11	0	8.59	0
West Bookend	1	9.71	0	9.49	4	9.75	5
East Bookend	0	9.12	0	9.05	0	9.51	0
Alt 3	0	9.25	0	8.96	0	9.29	0
Alt 4	0	9.67	0	9.25	0	9.51	0
Alt 5	0	9.36	0	9.26	0	9.49	0

Total number of days in model simulation = 13,149

Table 8
Computed Frequency Occurrence of the DHW (9.7 ft)
For Model Runs

	Return Frequency (yrs)	
NSM	20	
CERP0	45	
CERP1	45	
ALT7R5	>500	Operationally Constrained
East Bookend	>500	Operationally Constrained
West Bookend	55	
Alt 3	>500	Operationally Constrained
Alt 4	150	
Alt 5	200	

Table 9
RMA-2 Model Material Types

Material Number	Land Type	Manning's N-Value
1	Marsh	Variable with Depth
2	L-29BC	0.035
3	Culverts thru Tamiami Trial	0.045
4	Just downstream of Culvert	Variable with Depth
5	Just downstream of S-12's	Variable with Depth
6	marsh along L-31N	Variable with Depth

Table 10
West Bookend Flow Frequency Analysis Results for RMA-2 Modeling

Frequency		Tail Water	Western Flows to ENP				Eastern Flows to ENP					
Event	%	NP-36	S-12A	S-12B	S-12C	S-12D	S-333	L-29WA	L-29WB	S-355 A&B	L-29WC	S-356
1.01	99	4.25	19	38	52	126	65	234	197	229	171	125
2	50	5.05	186	378	404	514	356	392	380	554	406	450
5	20	5.35	350	687	704	812	1167	465	434	632	448	500
10	10	5.50	470	897	909	1019	2000	506	457	657	459	500
20	5	5.63	587	1095	1104	1223	2000	542	473	672	464	500
25	4	5.67	625	1157	1164	1288	2000	553	478	675	465	500
50	2	5.77	740	1340	1348	1492	2000	584	488	682	467	500
100	1	5.87	854	1514	1525	1698	2000	614	497	686	467	500

Note: * Frequency curve was not performed for this structure. The data did not support this type of analysis. Instead the flows were assumed based on the operating manner of the SFWMM 2 by 2 output.

Table 11
Flow Distribution West to East West Bookend Run

Frequency		**Total Flow**		**Percentage Split**		**Total**
Event (year)	**%**	**West (cfs)**	**East (cfs)**	**West**	**East**	**Flow (cfs)**
1.01	99	235	1,021	18.7%	81.3%	1,257
2	50	1,482	2,538	36.9%	63.1%	4,020
5	20	2,553	3,646	41.2%	58.8%	6,199
10	10	3,295	4,580	41.8%	58.2%	7,875
20	5	4,009	4,651	46.3%	53.7%	8,660
25	4	4,234	4,670	47.6%	52.4%	8,904
50	2	4,921	4,721	51.0%	49.0%	9,642
100	1	5,592	4,764	54.0%	46.0%	10,356

Table 12
RMA-2 Analysis of Area of Impact of
Velocity Greater than 0.1 ft/sec

		Acres Above
	No Action	187
Alt 9	3000 Foot	411
Alt 10	4 Mi Central	98
Alt 11	4 Mi East	105
Alt 12	3 Mi West	181
Alt 13	2 Mi West	220
Alt 14	2 Mi West & 1 Mi East	295
Alt 15	1.3 Mi West & 0.7 Mi East	300
Alt 16	Three - 3,000 foot	330
Alt 17	10.7 Mi	8

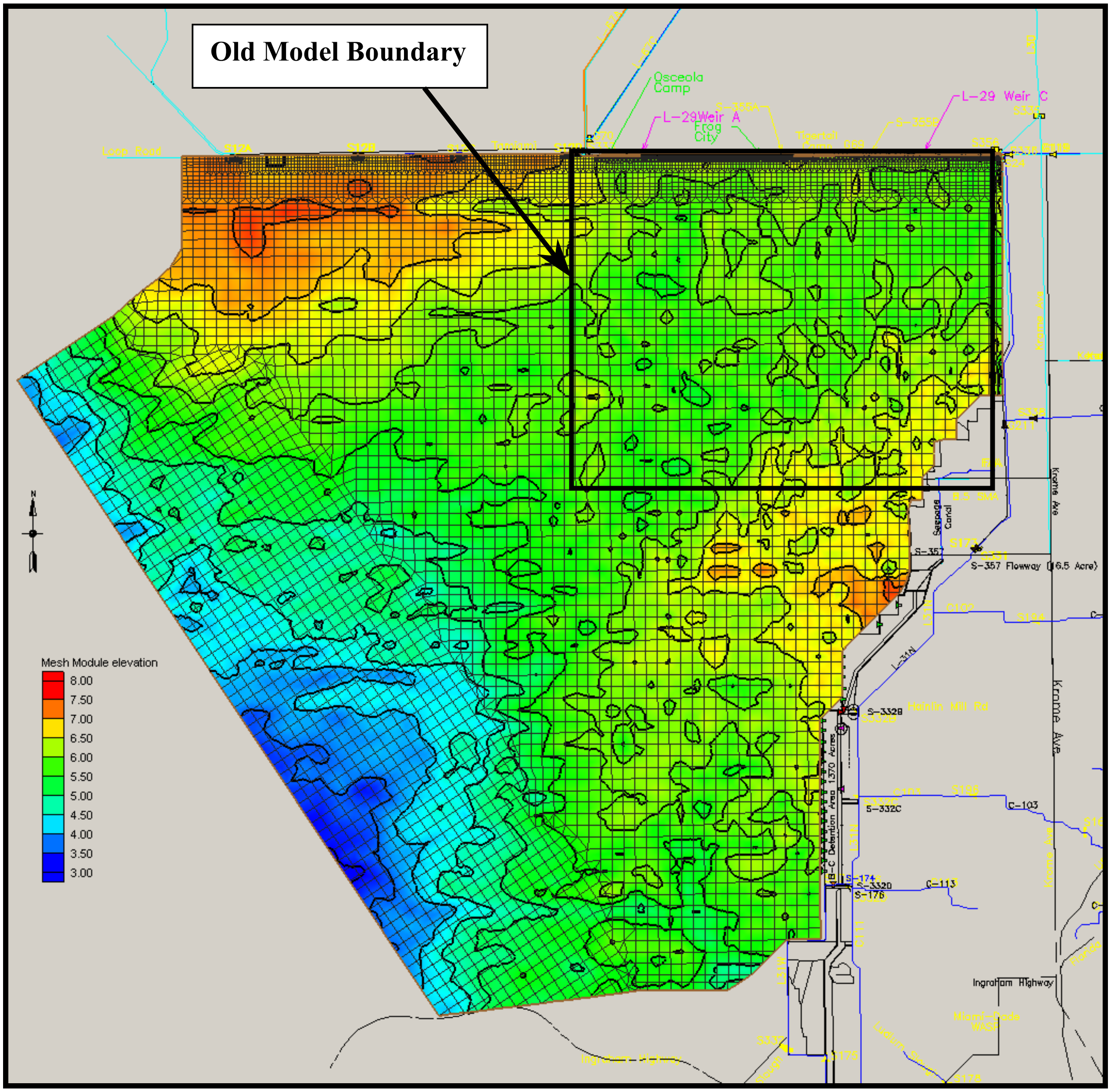

Figure 1 RMA-2 Model Mesh Boundaries

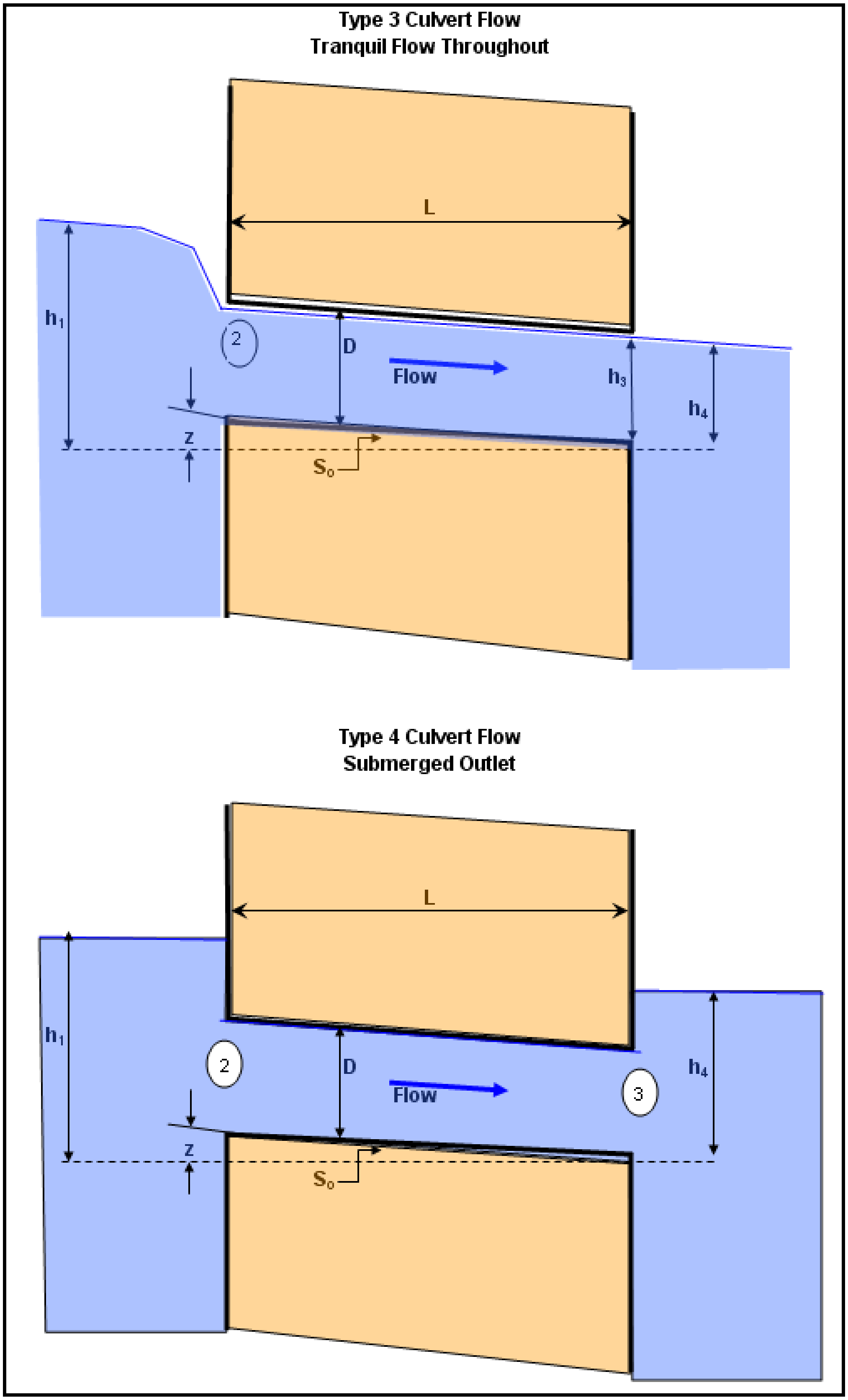

Figure 2 Culvert Discharge Definition Sketch

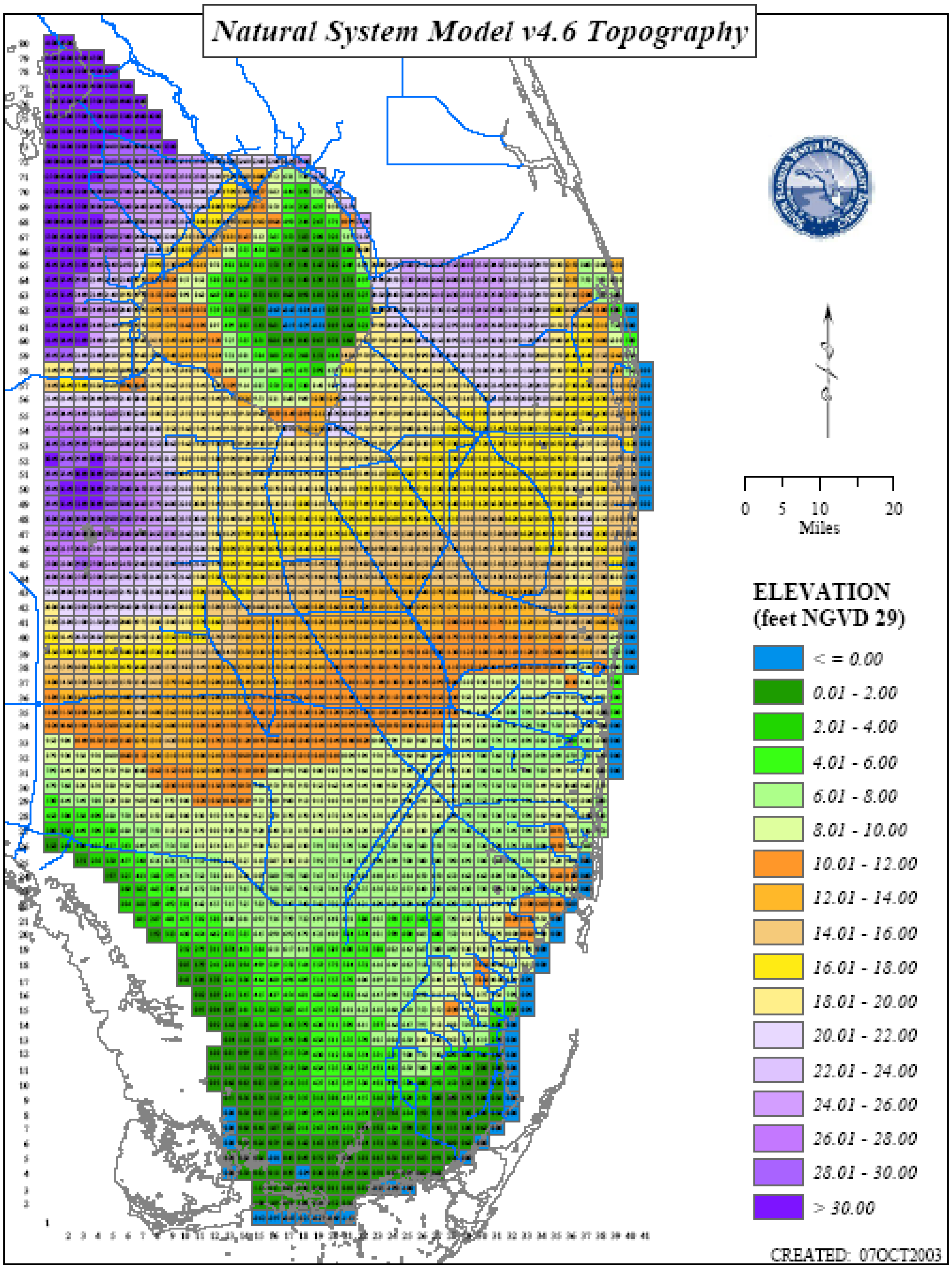

Figure 3 NSM Model Grid (http://www.sfwmd.gov/org/pld/hsm/models/nsm/index.html)

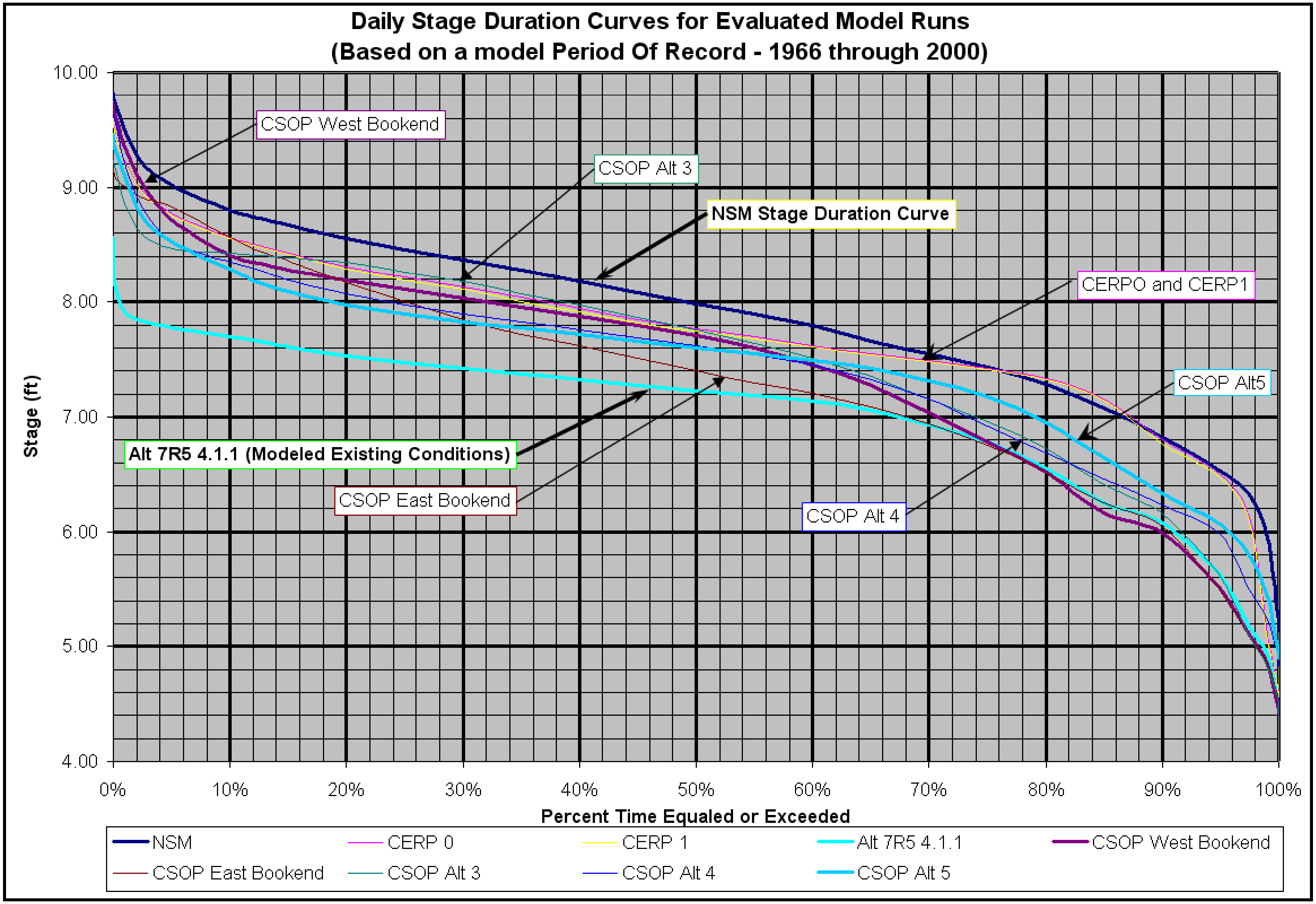

Figure 4 Daily Stage Duration Curves for Evaluated Model Runs

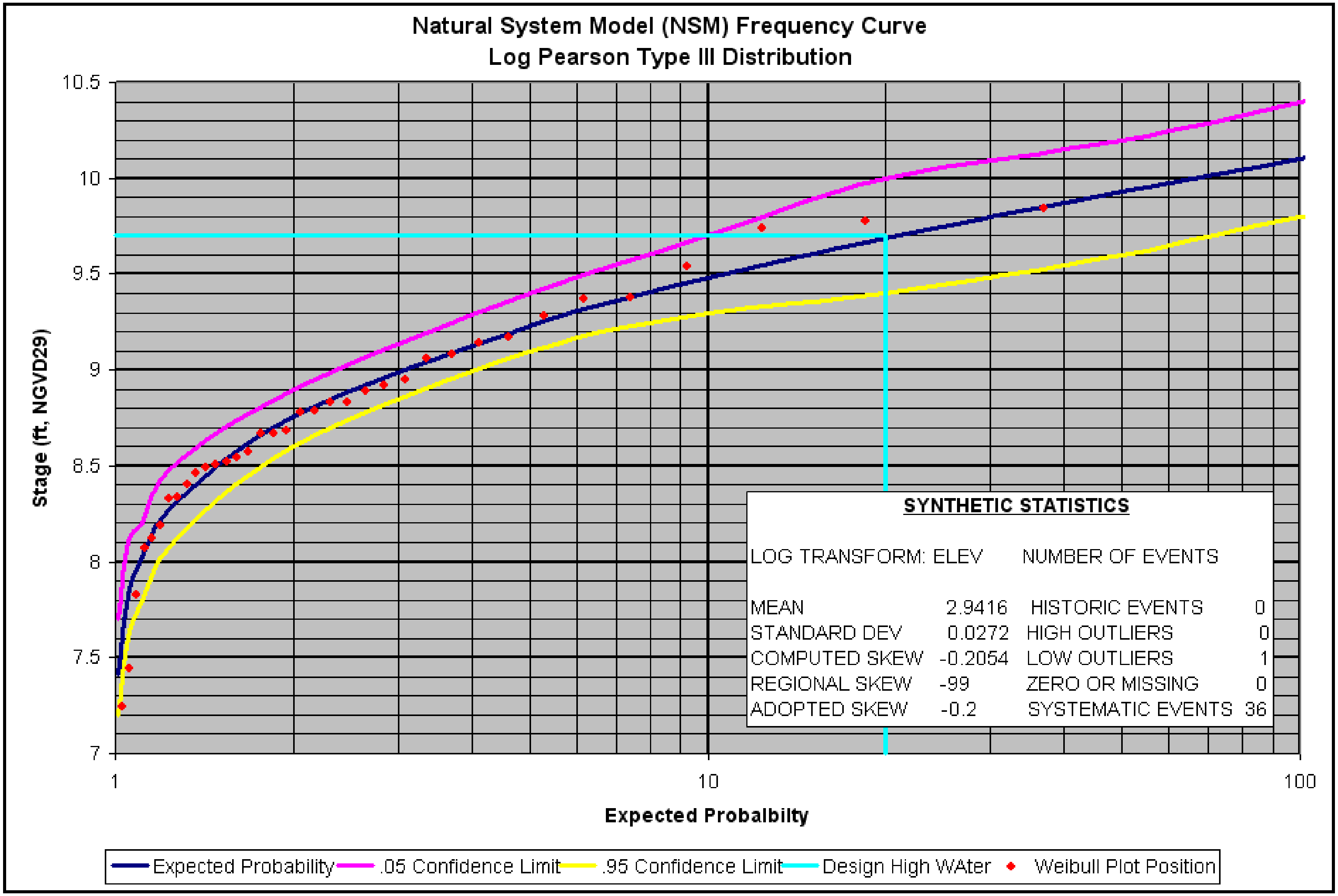

Figure 5 Natural System Model (NSM) Frequency Curve

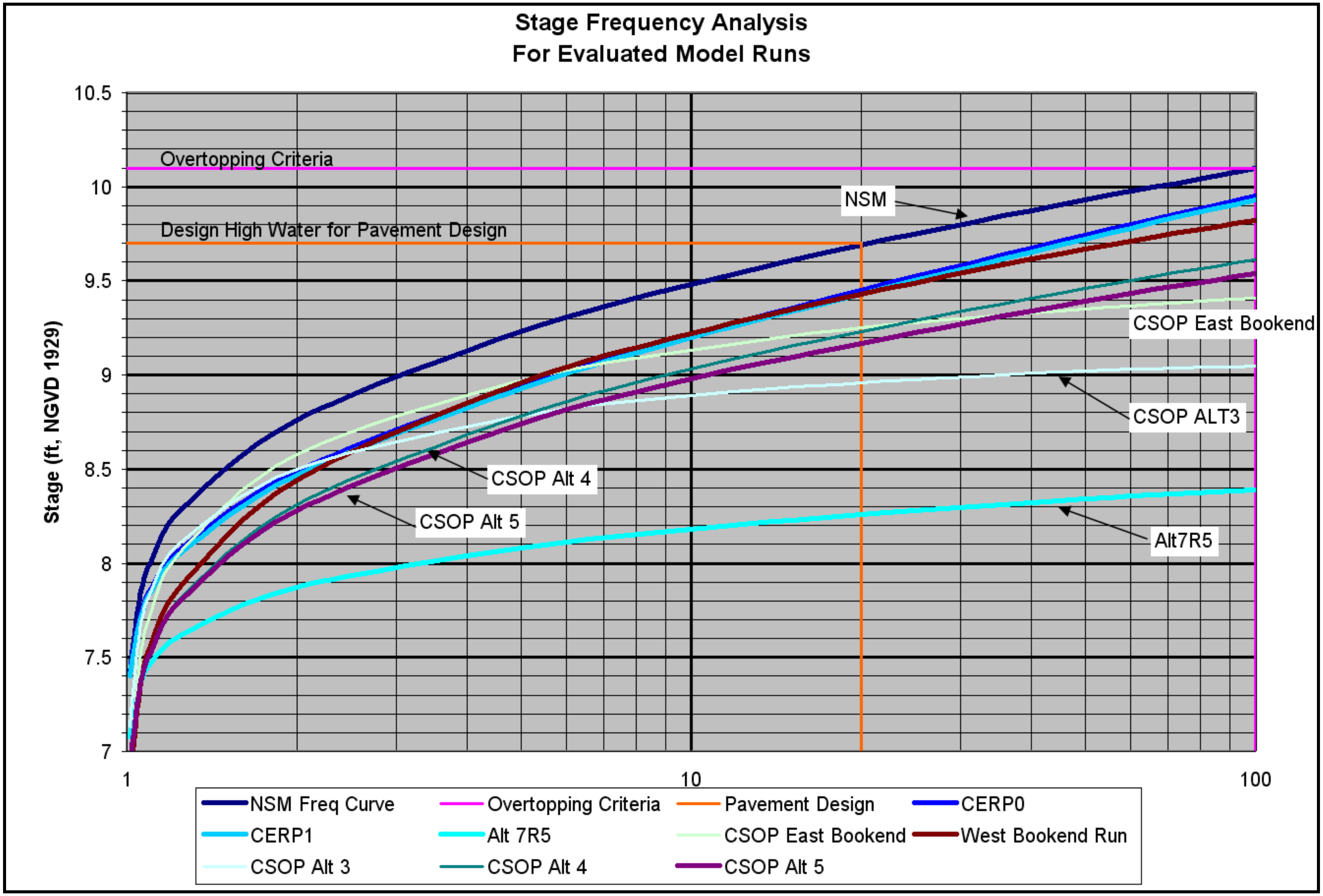

Figure 6 Stage Frequency Analysis Comparisons between Evaluated Model Runs

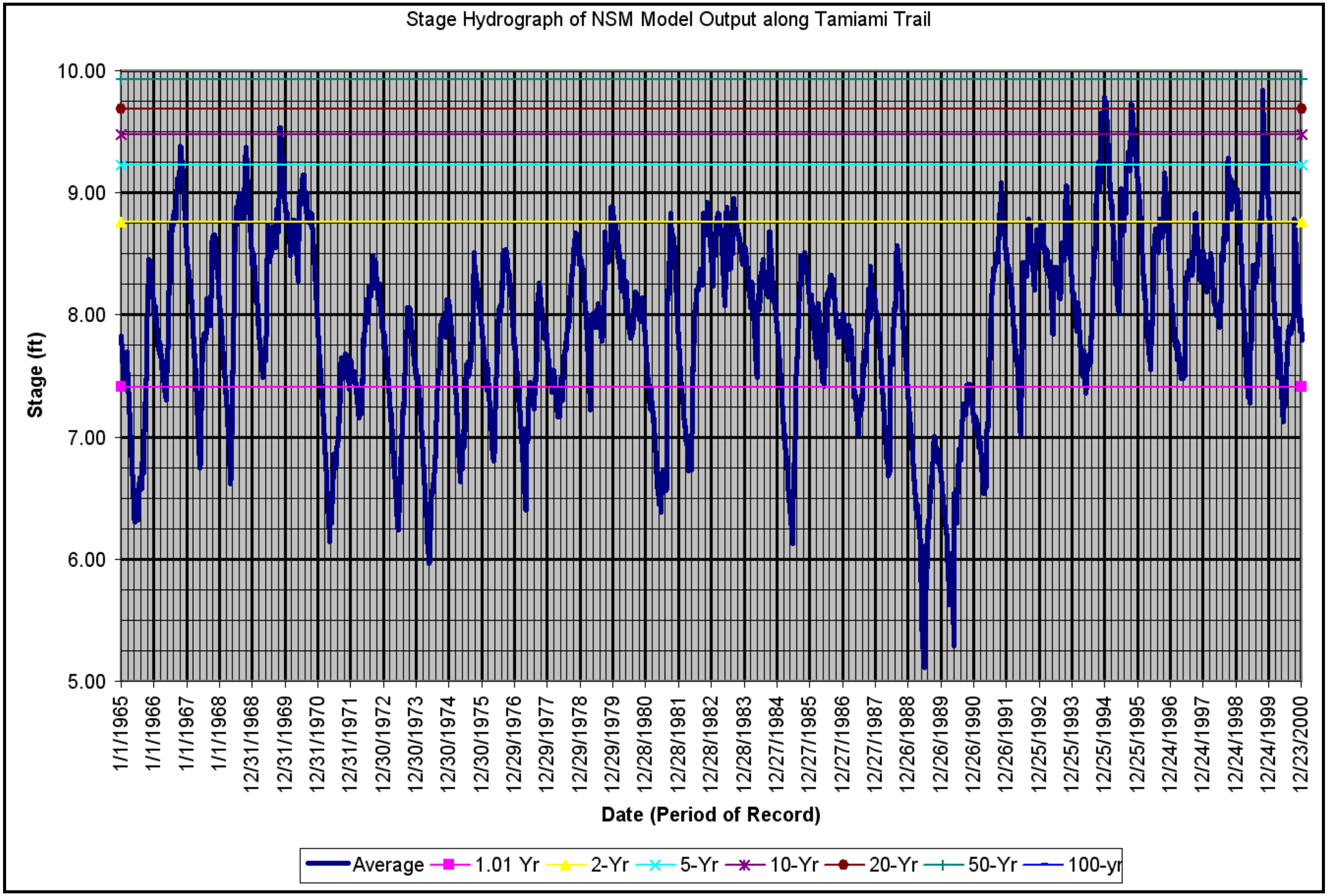

Figure 7 Comparison of NSM Frequency Analysis with NSM Stage Hydrograph

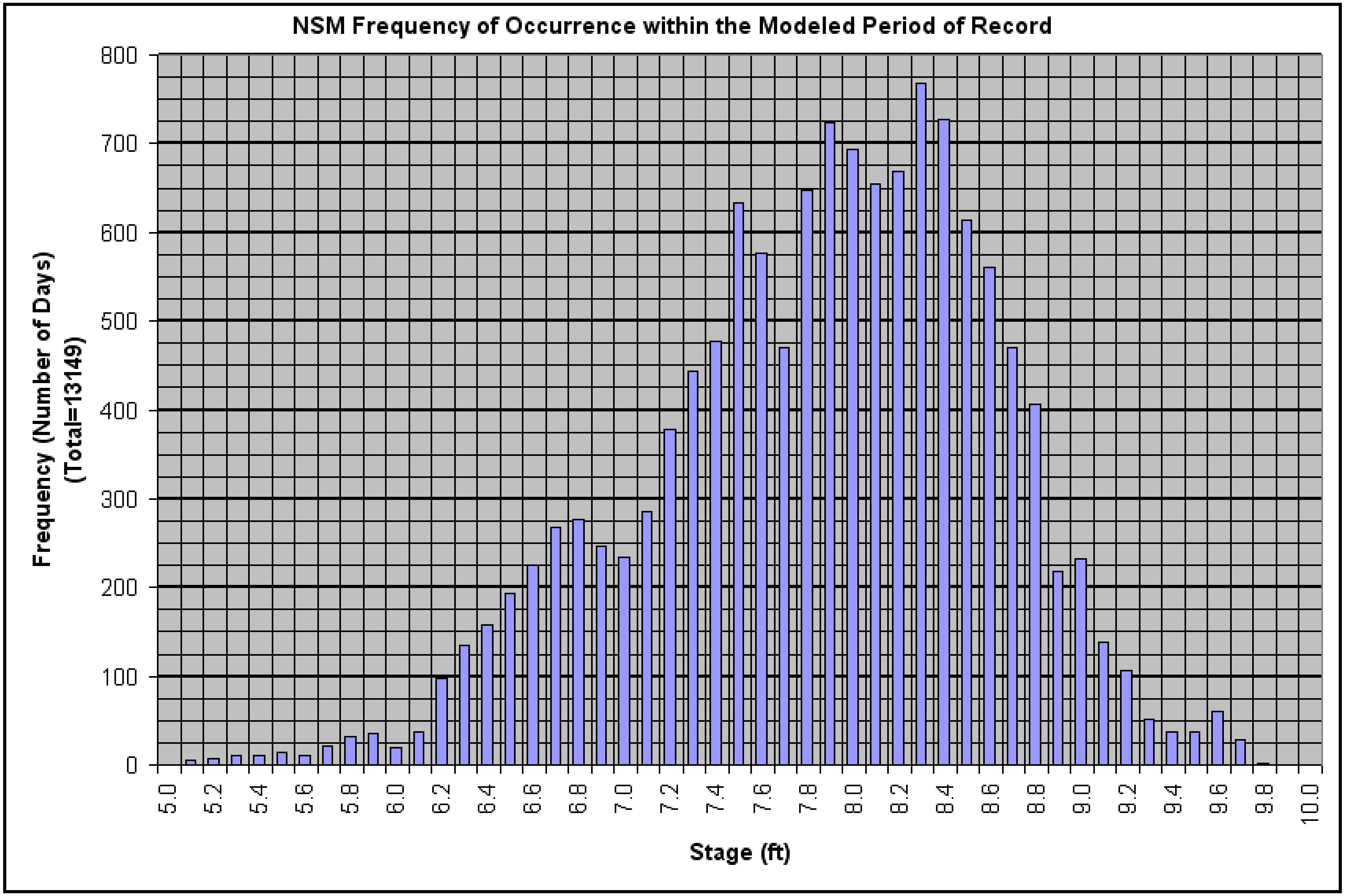

Figure 8 NSM Frequency of Occurrence within the Modeled Period of Record

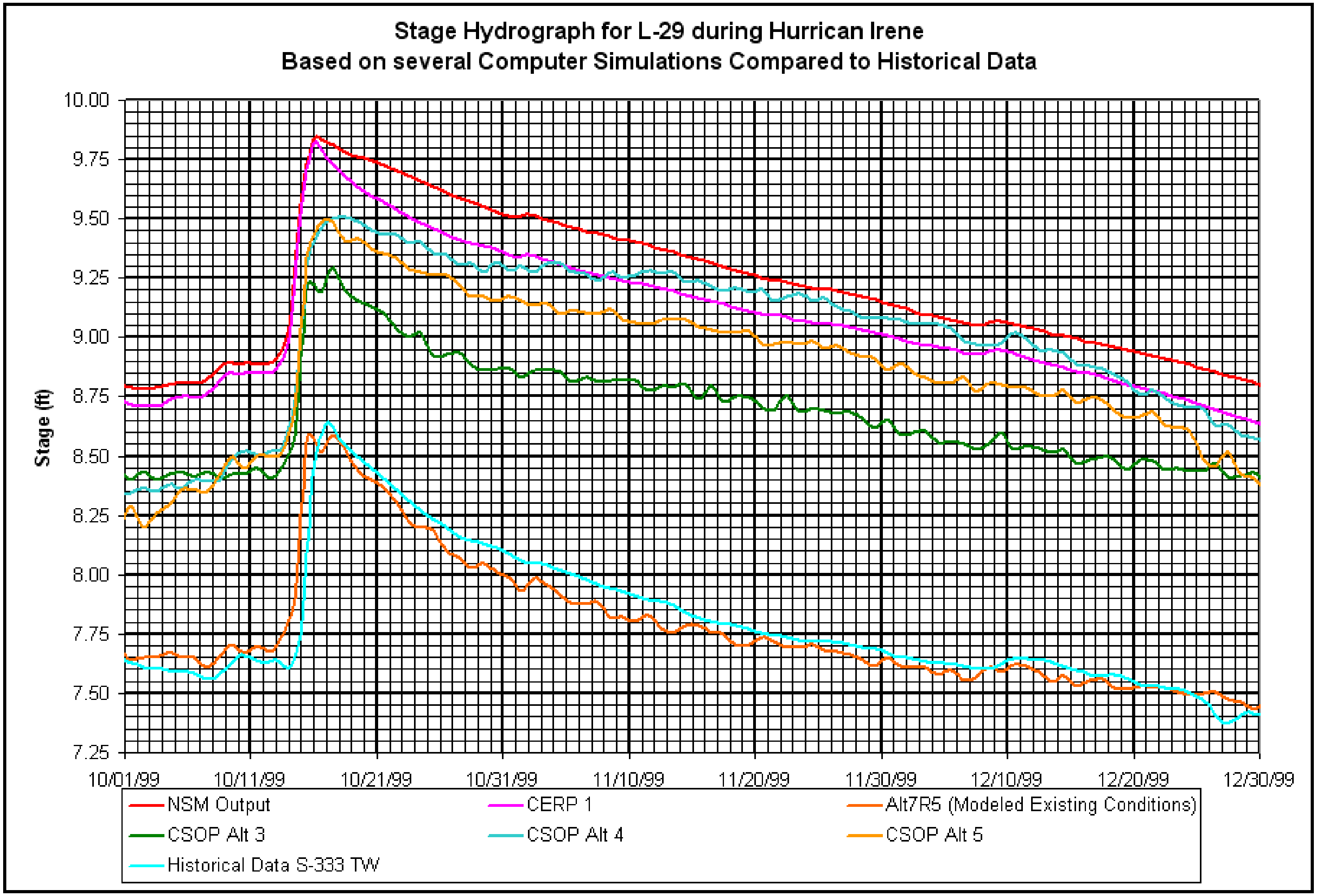

Figure 9 Stage Hydrograph Showing Recession Rates During Hurricane Irene

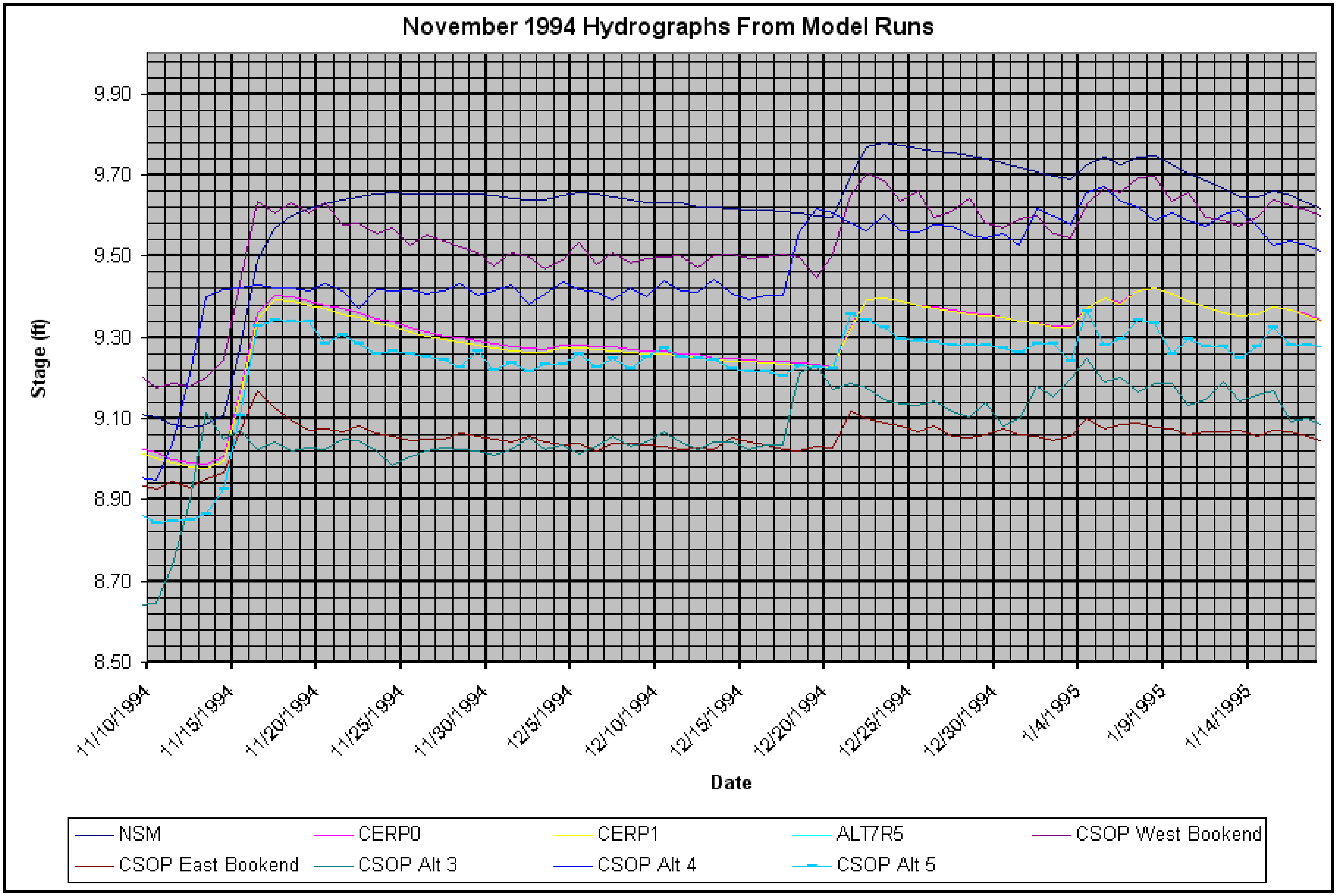

Figure 10 November 1994 Hydrographs from Model Runs

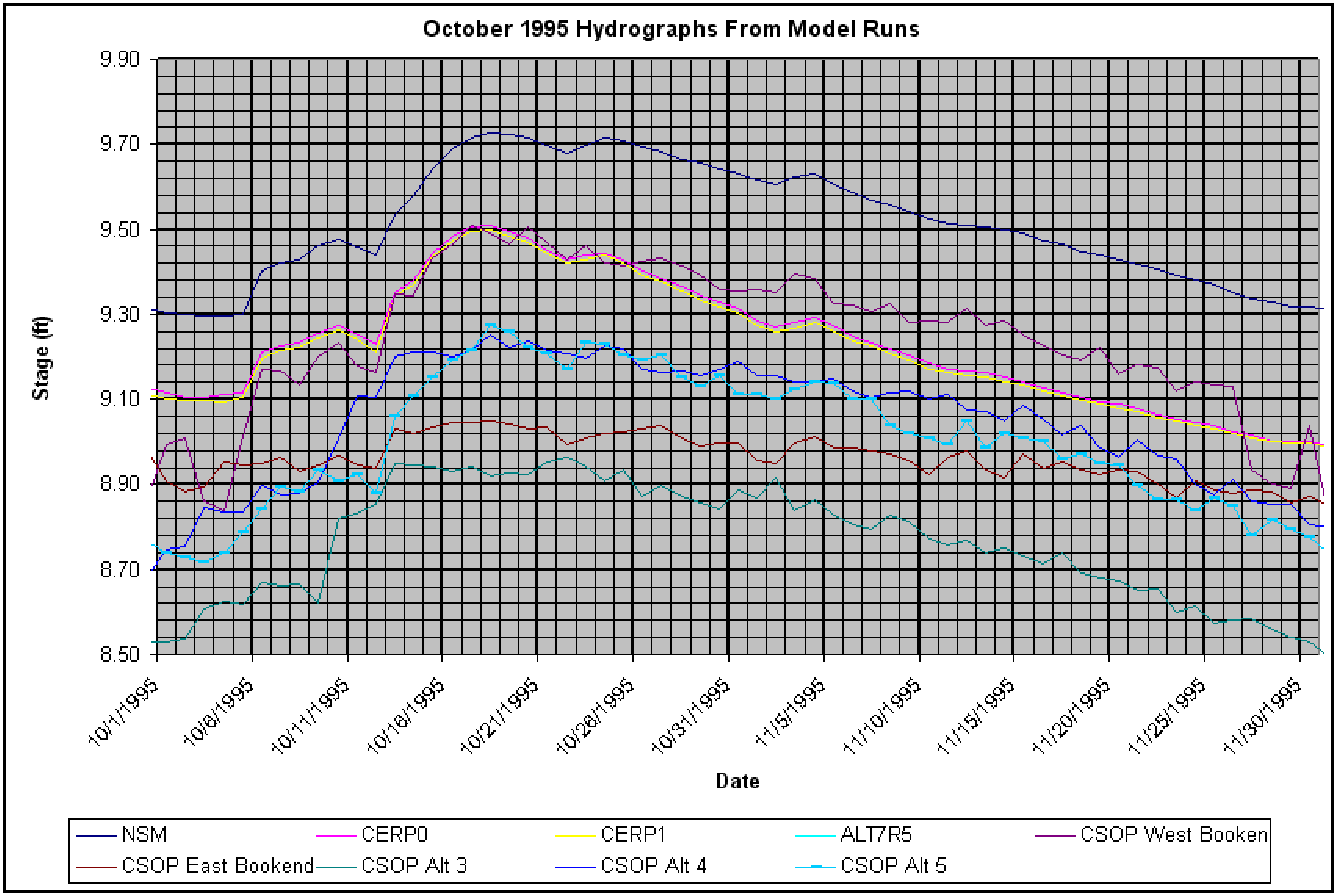

Figure 11 October 1995 Hydrographs from Model Runs

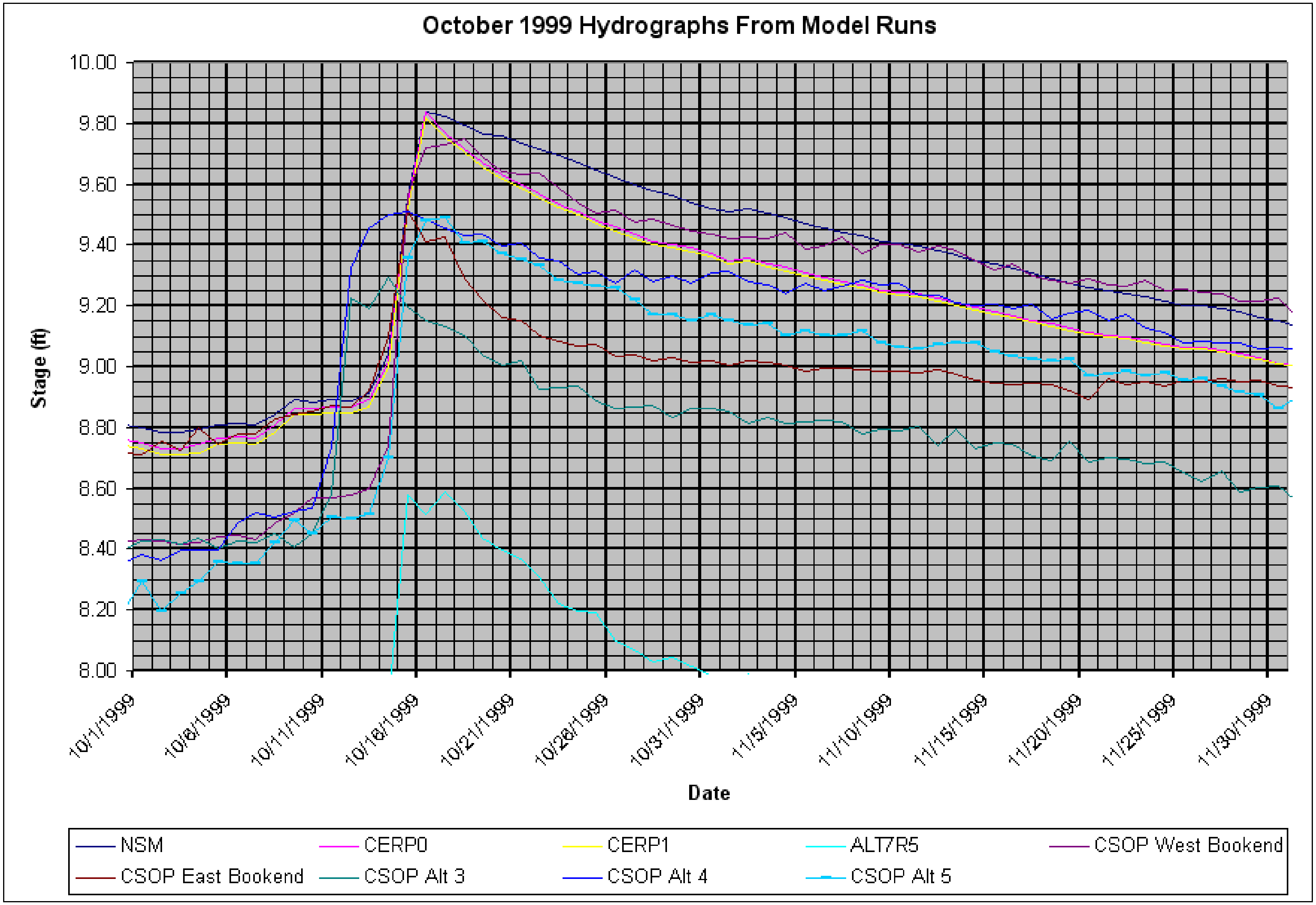

Figure 12 October 1999 Hydrographs from Model Runs

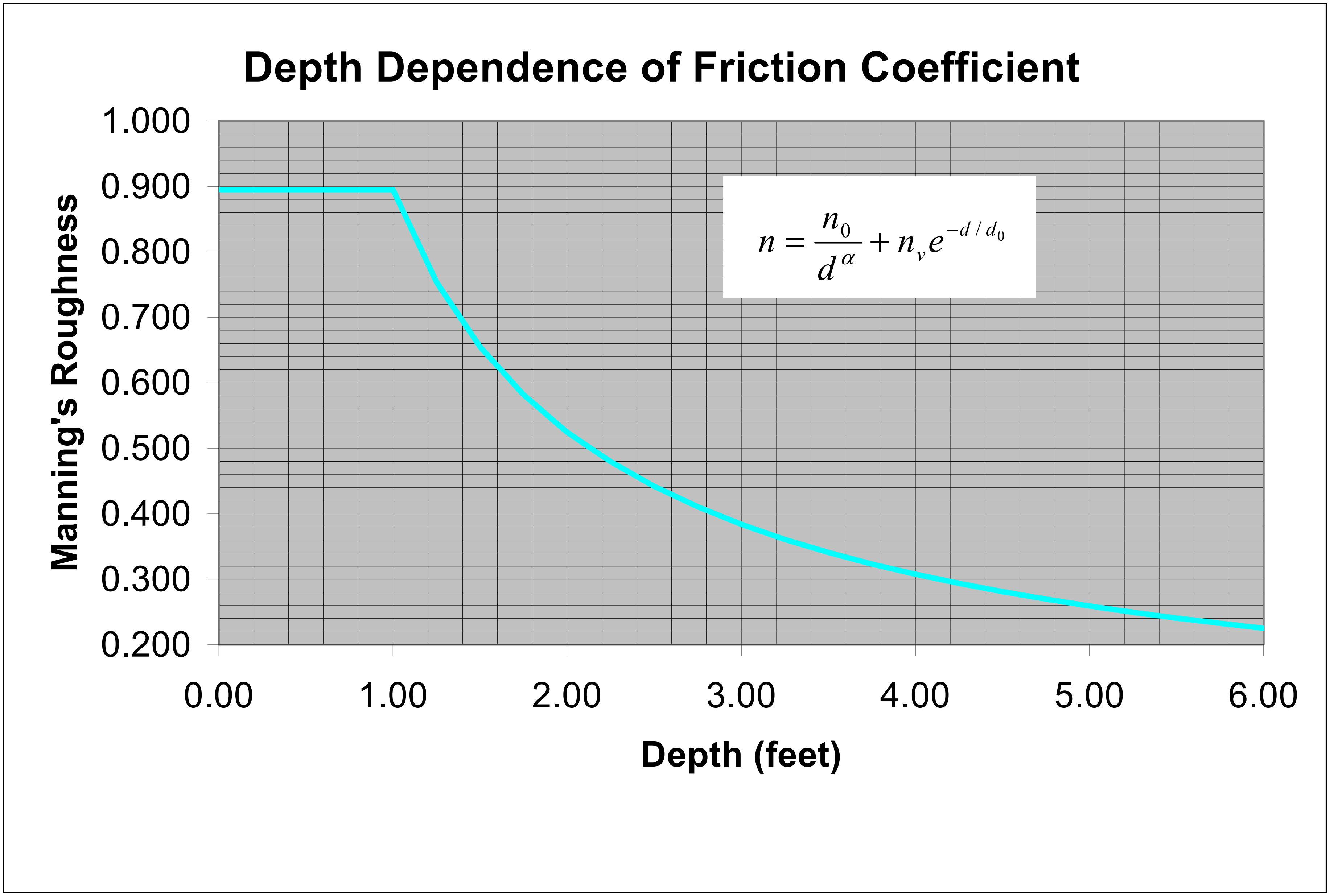

Figure 13 Depth Dependence Friction Coefficient for RMA-2 Model

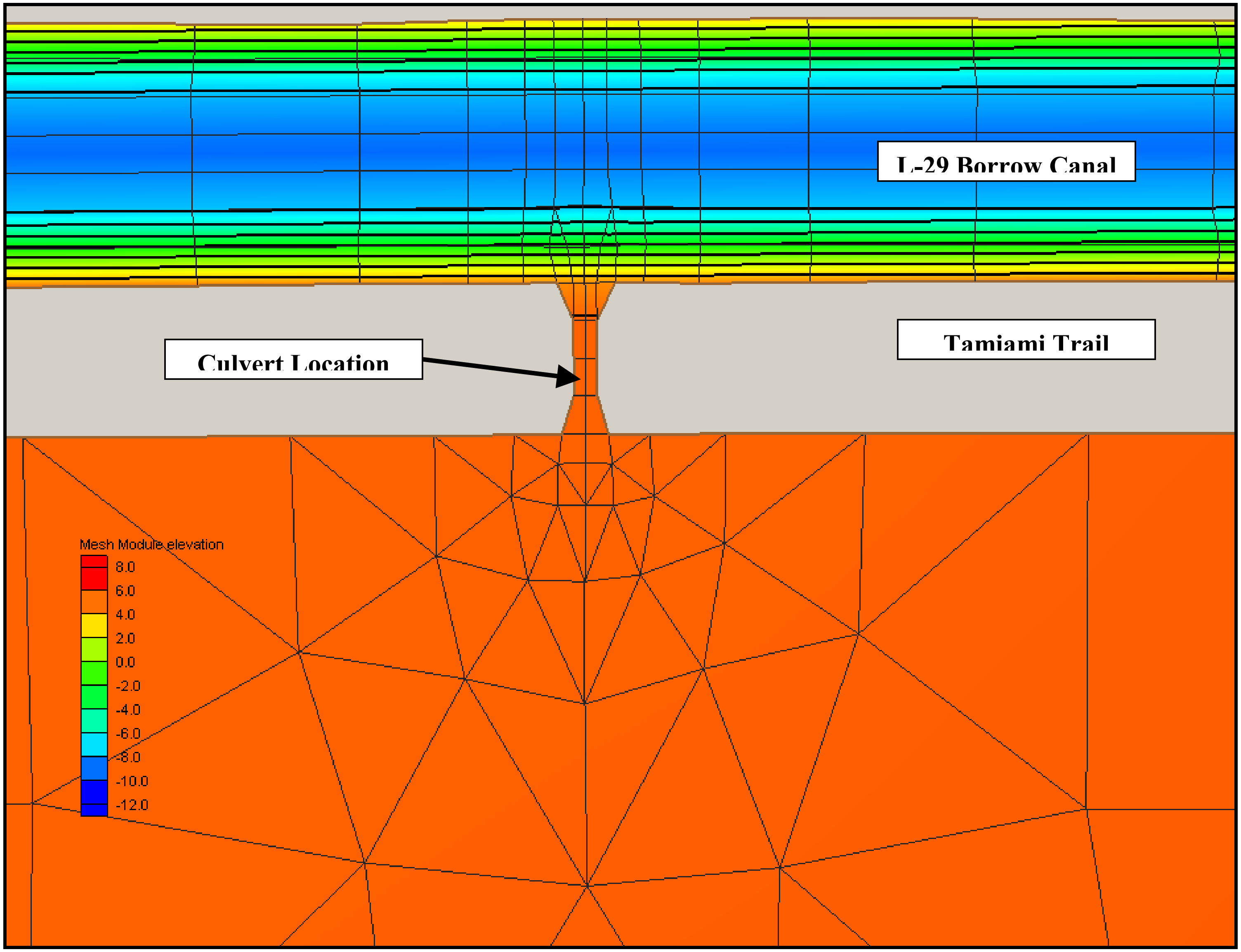

Figure 14 RMA-2 Mesh Geometry at Culvert Location

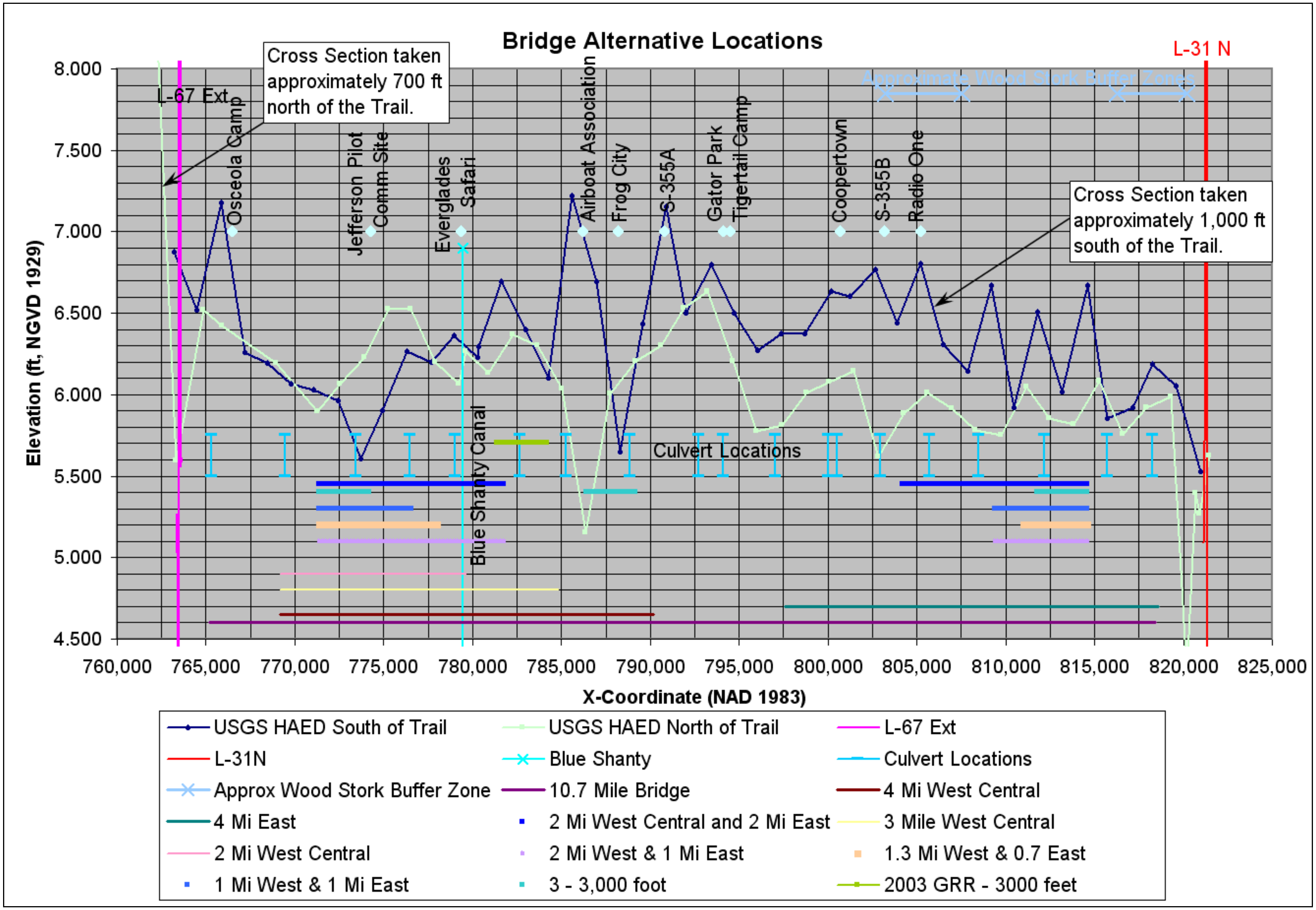

Figure 15 Bridge Alternative Locations

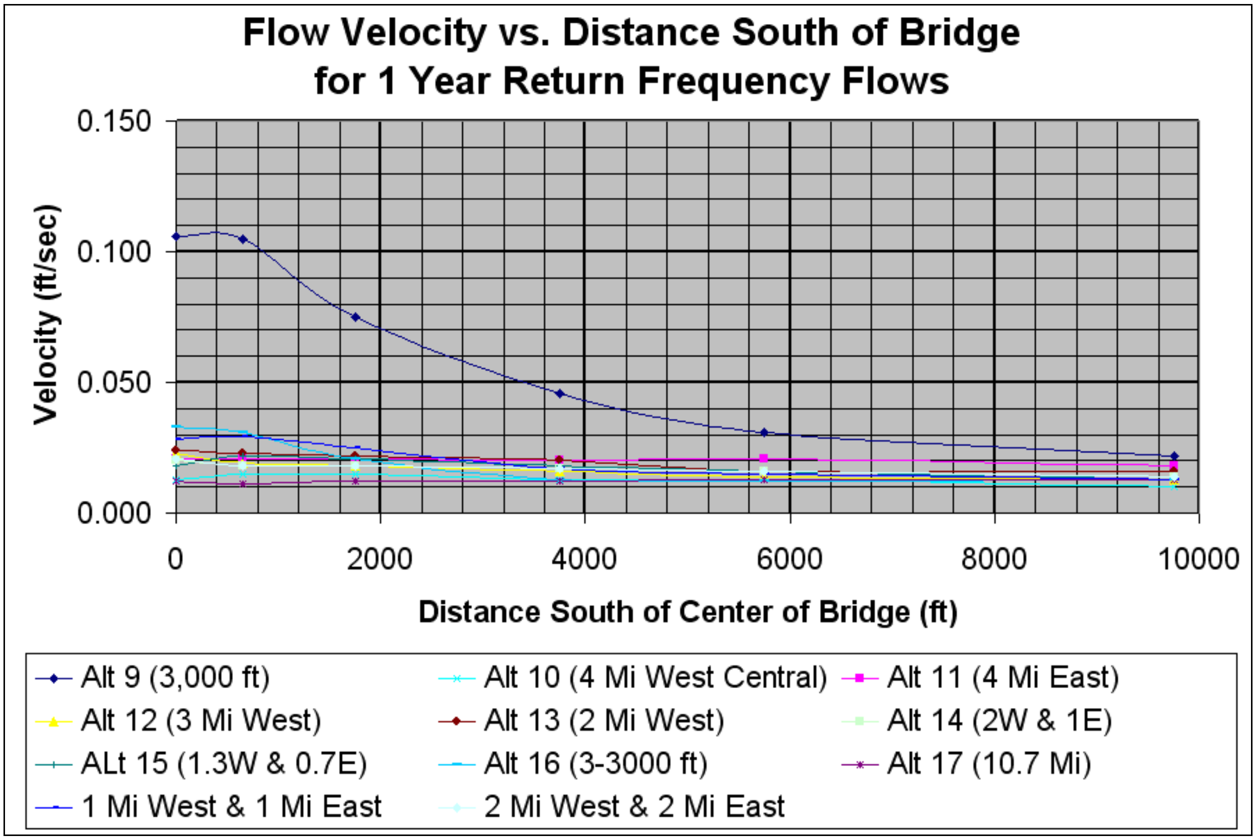

Figure 16 Flow Velocity vs. Downstream Distance 1 Year Return Frequency

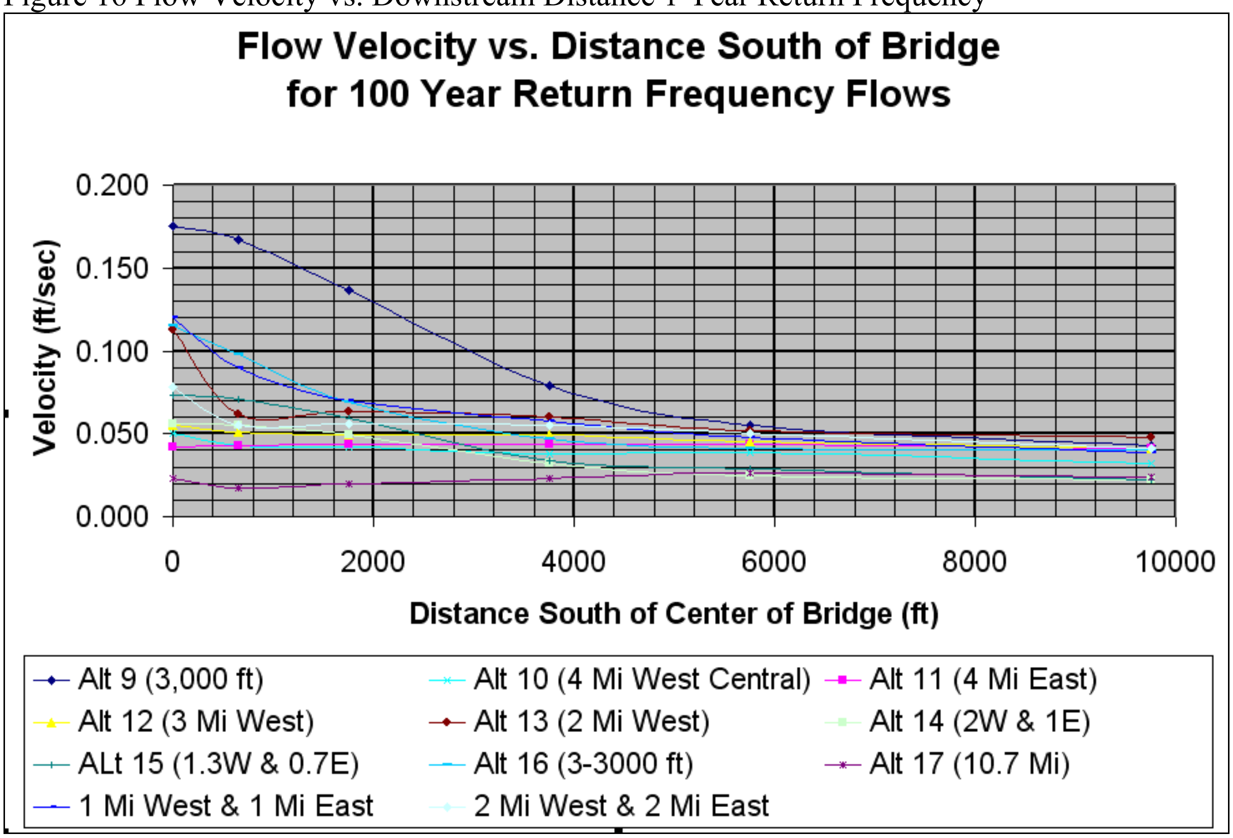

Figure 17 Flow Velocity vs. Downstream Distance 100 Year Return Frequency

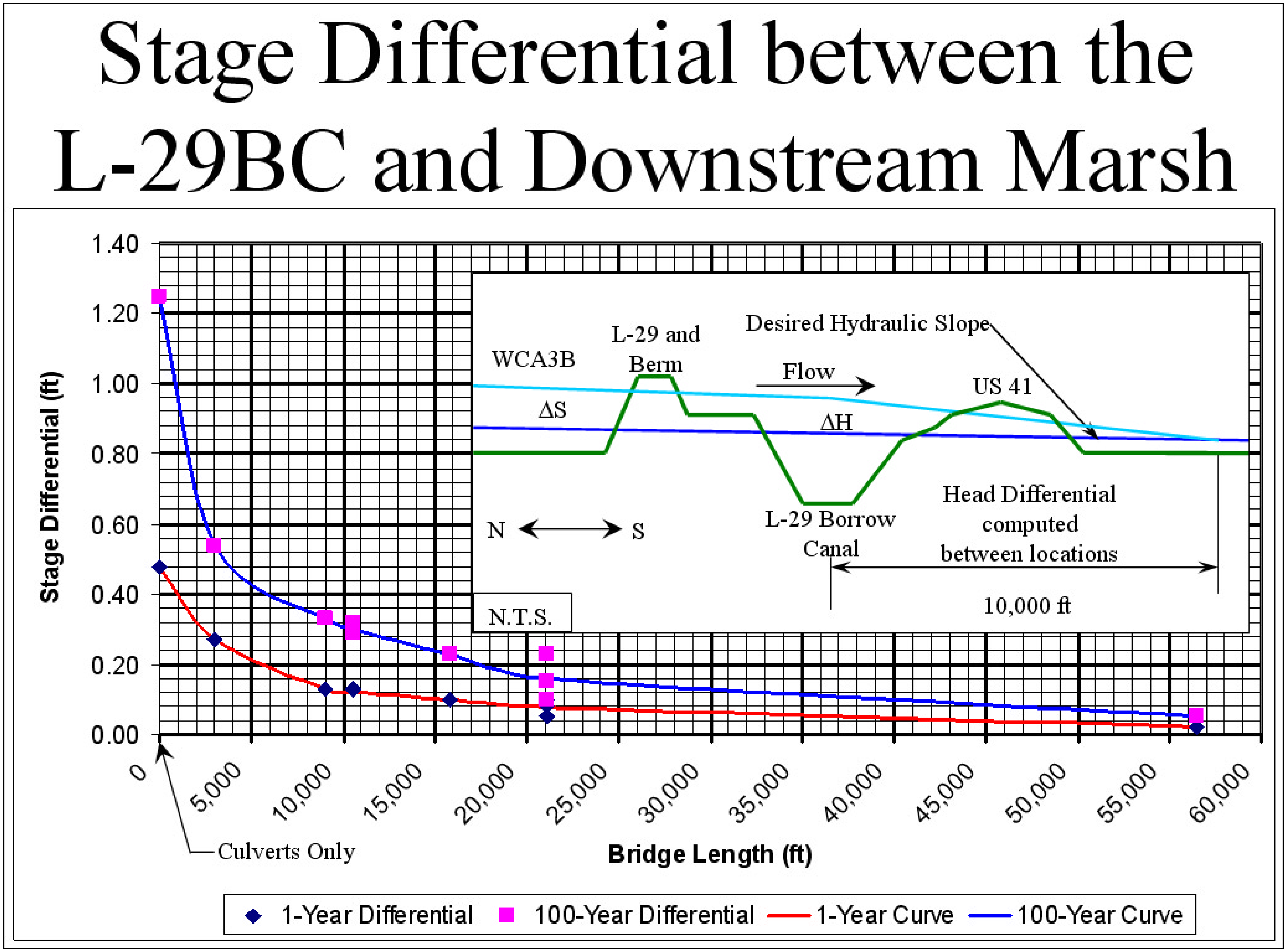

Figure 18 Stage Differential between the L-29BC and Downstream Marsh

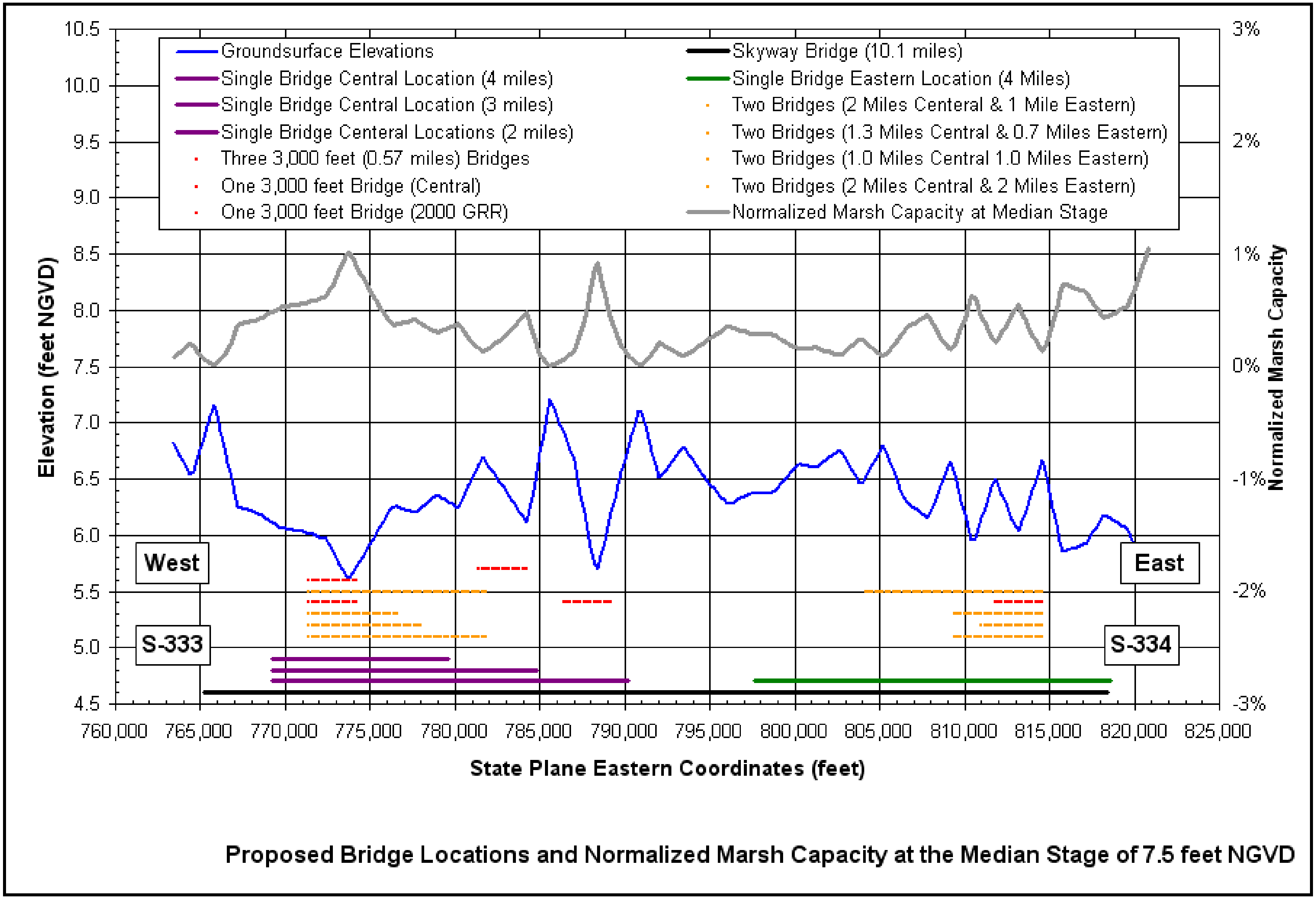

Figure 19 Normalized Marsh Capacity at the Median Stage of 7.5 feet NGVD

Annex B: Correspondence and Communications

PBS&J

An employee-owned company

Meeting Minutes - Final

To: Attendees
From: Jack Schnettler - PBS&J
Copies: File
Date: October 5, 2005
Subject: Tamiami Trail Alternatives
Meeting with Florida DOT District 6

Meeting Date: Thursday, September 22, 2005
Meeting Time: 9:00 am - 12:30 pm
Meeting Place: Florida DOT District 6 - Conference Room B
Purpose: Coordination with Florida DOT
Prepared By: Jack Schnettler - PBS&J
Attendees:

Name	*Agency/Firm*	*Telephone*	*E-mail Address*
Barbara Culhane	FDOT	305-470-5231	barbara.culhane@dot.state.fl.us
Mikhail Dubrovsky	FDOT	305-499-2354	mikhail.dubrovsky@dot.state.fl.us
Ricardo Salazar	FDOT	305-470-5264	ricardo.salazar@dot.state.fl.us
Kim Saing	FDOT	305-479-5254	kim.saing@dot.state.fl.us
Mike Wolz	USACOE	904-232-1435	michael.w.wolz@usace.army.mil
James McRae	USACOE	904-232-3294	james.mcrae@usace.army.mil
Alex Barreras	Corradino	305-218-6679	abarreras@corradino.com
Mike Ciscar	Corradino	305-594-0735	mciscar@corradino.com
Ariel Millan	Gannett Fleming	786-845-9540	amillan@gfnet.com
Mike Priory	PBS&J	954-733-7233	mpriory@pbsj.com
Jack Schnettler	PBS&J	305-514-3369	jsschnettler@pbsj.com
Glenn Myers	PBS&J	954-733-7233	gfmyers@pbsj.com
Cynthia Skogsberg	PBS&J	407-806-4219	cjskogsberg@pbsj.com
Jack Schnettler	PBS&J	305-514-3369	jsschnettler@pbsj.com
By Teleconference:			
David Horhota	FDOT Materials Office		david.horhota@dot.state.fl.us
David Chiu	FDOT		david.chiu@dot.state.fl.us
Bob Diffenderfer	Lewis, Longman & Walker, PA		rdiffenderfer@llw-law.com
Bob Crim	FDOT Central Office		bob.crim@dot.state.fl.us
John Atkinson	Ayres Associates		atkinsonj@AyresAssociates.com

The purpose of the meeting was to discuss the review comments by FDOT and its consultants on the prior engineering appendix submittal and responses in progress by PBS&J as the USACOE engineering consultant for the Tamiami Trail Alternatives. The first part of the discussion focused on geotechnical investigation requirements and procedures for the bridge section of the corridor. This was followed by a discussion of various review comments, as listed in a summary table to facilitate the discussion. This table is attached with an update in the rightmost column as to the disposition of the comment per the meeting discussions.

The following points summarize the key items discussed:

Bridge Geotechnical Discussion

- Mr. Wolz noted that the COE is interested in starting its engineering phase in October, and needs to secure topographic and aerial information as well as subsurface investigations. The geotechnical work could take 9-12 months to accomplish and is complicated by access to pier locations. Nominal requirements are for 80-foot borings at every pier line, staggered, for 3 miles of bridges. He noted that it took 2 months to finalize the traffic control plan for the recent muck delineation work. For the future work, encroachment into Everglades National Park will involve demonstrating minimal impact to wetlands, despite the future construction to occur in the same area.
- Mr. Wolz went on to inquire as to what latitude is possible in the positioning of the borings and the number of borings, considering that the available subsurface information suggests a relative uniform top of rock elevation and reasonably consistent composition of the rock layers. This matter was discussed by the meeting participants, and the circumstances of the Tampa Crosstown Expressway elevated roadway foundations were touched upon. It was concluded with concurrence of FDOT staff that a 20-30 foot offset would likely be acceptable indicate that the offset of borings would be acceptable only if drilled shafts were not the recommended alternative, but that the number of boring locations would need to be retained. COE will provide some recent geotechnical information it collected to FDOT soon, once it is finalized. Mr. Myers discussed his analysis of drilled shafts versus prestressed piles, and that the basis for the tentative recommendation for the pile foundations according to the limited available information, driven piling is the recommended alternative. This recommendation will be verified through the soil boring program.
- Mr. Wolz requested FDOT to provide input to the most advantageous ways to accomplish the boring program. Mr. Horhota replied that he would make some contacts to persons with relevant experience and provide some feedback. Mr. Wolz requested that a cooperative effort between FDOT and COE be pursued to converge on a preferred Traffic Control Plan as directly as possible.
- Mr. Wolz noted that COE is anxious to facilitate construction and queried whether bridge work could start with 30% design based on best available information, with the design to allow for adjustments based on the results from the additional subsurface investigations. Mr. Saing replied that kind of fasttracking has been done before. Mr. Salazar noted that the scour analysis in the Bridge Hydraulic Report (BHR) needed approval first before review of bridge plans would be allowed. There was a brief discussion led by Ms. Skogsberg as to the documentation in the BHR in the engineering appendix, basically that the velocities were so low, and the underlying rock sufficiently hard, that scour was not really a concern.
- Mr. Wolz noted that he had located borings from the 1960s taken for Levee 29 on the north side of the road, down to minus 20 feet below mean sea level. He asked if these would be sufficient for the westbound boring requirements. There were about 16 borings along the 11-mile project length.

Review of FDOT Comments on the Engineering Appendix

- Mr. Wolz provided introductory comments regarding the review status of the environmental document which includes several appendices. He explained that the present Tentatively Selected Plan (TSP) consists of a 2-mile bridge in the west half of the corridor and a 1-mile bridge in the east half of the corridor. He referred to these features on a plan and profile plot on the table, while the Engineering Appendix being finalized by PBS&J was for a prior 4-mile bridge option in the west half of the corridor. Thus the comments by FDOT are in relation to the latter single bridge option, but will be applied as applicable to the TSP.

- Mr. Wolz noted the lead time for concept approval in order to seek congressional funding, and that the intent is to begin the design process in October 2005. To expedite that process, it is desirable to resolve as many issue areas as possible, and to avoid roadway features for which approval could be problematic.
- Mr. Wolz requested FDOT representatives to speak with one voice. FDOT representatives clarified that concensus on issues within the group at this meeting does not supercede the decision making of those at FDOT involved with reviewing and approving design variances, traffic control plans, and typical section packages, and other elements, but that they would attempt to render the most straightforward and pragmatic feedback possible.
- The balance of the discussion focused on the discussion and resolution of the items in the attached file summarizing the comments discussed. The highlights of each are summarized below:

  - <u>Bridge Drainage System</u>: A lengthy discussion on this matter provided for an informative exchange of information and views, leading to a better mutual understanding of the basis for the system, its key features, and its applications elsewhere, and its maintenance. After this discussion, it was concurred that they would be acceptable to the District, presuming that FDEP approves. PBS&J will complete the Engineering Appendix on this basis. Mr. Wolz further explained that discussions with FDEP about the cost of the bridge collection system have led to a conclusion to invest $3 million in the most prudent and beneficial manner for water quality, which most likely will mean collecting and treating only the ends of the bridges, with pollution abatement containers at the bridge abutments. [Note: Mr. Wolz clarified subsequent to the meeting that FDEP remains interested in bridge drainage collection system, but desirably a simplied, less costly configuration; PBS&J will be communicating further information on this matter to meeting attendees and Mr. Bob Perez of FDOT District 6 very soon.]
  - <u>Bridge Longitudinal Grade</u>: There was considerable discussion of the trade-offs between the 0.2% and 0.3% gradients between meeting participants. The exchange of viewpoints was helpful and constructive. Based on discussion, for a condition where the bridge will retain the drainage collection system, it was concluded that the COE will pursue the 0.2% gradient. Should the eventual situation be that the bridge can be drained acceptably by scuppers, then a 0% grade could be acceptable, provided COE gets approval from Mr. Harold Desdunes at District 6 who oversees review of design variances.
  - <u>Profile at Access Ramps</u>: After some discussion of the issues, it was recognized that the access ramps could be moved slightly to avoid some minor drainage concerns. With the TSP, only one ramp appears needed.
  - <u>Median Buffer</u>: This feature was suggested, but is not required. Mr. Schnettler indicated that a preliminary review of crash history did not show any significant head-on accident experience, and that the minimal side friction along this road (few drives) provided ample separation between opposing vehicles considering the 12 foot travel lanes and future 10 foot shoulders. It was acknowledged that existing and projected traffic was considerably less than on Krome Avenue or on the US 1 20-mile stretch corridor. Mr. Schnettler will be providing a review of traffic and crash data in this regard.
  - <u>Roadway Lighting, Left Turn Bays and Passing Lanes</u>: These features were suggested based on possible need. Mr. Schnettler indicated that a preliminary review of crash history did not show any significant accident experience that would support such features, and that the straight, flat alignment and minimal side friction along this road (few drives) provided a relative simple driving environment. It was acknowledged that a review showing the features are not needed should be sufficient. It was noted by Mr. Millan that the primary obligation of the COE is to maintain the facilities design features per current standards, not substantial betterment. Mr. Schnettler will be providing a review of traffic and crash data in this regard. Discussion of these elements will be added to the Engineering Appendix.
  - <u>Shoulder Pavement Design</u>: It was acknowledged by Mr. Priory that the shoulder design will be appropriate for that portion of the roadway, and not "overbuilt" unless some other condition requires this.
  - <u>Sodding on Slopes Behind Guard Rails</u>: This comment has been addressed.
  - <u>Paved Shoulder Width</u>: There was a brief discussion including some background information by Mr. Wolz about the COE discussions with FDEP regarding the water quality. Their present understanding

is that grass strip in the shoulder is highly preferred. PBS&J will retain this feature in the Engineering Appendix.

- Water Quality Along Road Embankment: There was discussion including some background information by Mr. Wolz about the COE discussions with FDEP regarding the water quality. Their present understanding is that grass strip in the shoulder would be acceptable to FDEP in lieu of a berm system which would cause other impacts and costs. PBS&J will retain this feature in the Engineering Appendix. Mr. Wolz was asked to provide some documentation of the dialogue with FDEP regarding water quality. He indicated that some appropriate documentation can be included in correspondence appendix.
- Design Variance for Border Width: The need for this action is acknowledged by COE and will be pursued in the design phase, as soon as it is possible.
- Design Variance for Horizontal Clearance and Recoverable Terrain: The need for this action is acknowledged by COE and will be pursued in the design phase, as soon as it is possible.
- Alternative Paving Section: Receipt and review of the alternative pavement section provided by Mr. Bob Perez of FDOT District 6 was acknowledged. The intent is to examine this option more closely in the engineering design phase; it will be documented in the final Engineering Appendix.
- Address Several Typical Section Features: These items as noted in the summary table have been corrected in the typical section schematic, and there was no discussion of these.
- Approval of Typical Section Package and Traffic Control Package: It was recognized by COE that there are various FDOT reviews and approvals to be secured, and that these will be formally undertaken in the COE design phase, noting that the sooner these can be presented to FDOT the better.

The meeting was concluded at 12:30 pm. The following action items were noted:

1. Mr. Wolz will see that additional geotechnical information is forwarded to FDOT when available in final form.
2. Mr. Schnettler will coordinate with Ms. Culhane on documentation and review of traffic and safety-related elements in the near future.
3. Mr. Horhota will provide feedback on strategies to accomplish the bridge soil borings with minimum impact to wetlands and to maintenance of traffic.
4. Mr. Wolz will provide some appropriate documentation of FDEP guidance on water quality.

Comments received were incorporated into these final minutes. I can be contacted as follows should there be any other required followup: Jack Schnettler - PBS&J (Phone: 305-514-3369; email: jsschnettler@pbsj.com).

Jack S. Schnettler, PE
Project Manager

Tamiami Trail Alternatives
SUMMARY TABLE OF FDOT COMMENTS
[This table summarizes responses from FDOT in last round where concurrence had not been reached. Updated: 09/29/05

Category	*Source Docu-ment*	*Item No.*	*FDOT Comment*	*Response*	*Further Discussion Needed?*	*Suggested Approach to Resolution*	*Concensus Resolution per Meeting of 9/22/05*
BRIDGE	C	3	Pollution abatement structures subject to clogging….	Use of system was dictated, and effort made in design concept to minimize performance issues for the system.	YES	Discuss details further.	Drainage collection and treatment system will be retained for Eng. App. Per COE discussion with FDEP, a less costly collection system is being considered.
	C	4	Longitudinal bridge gradient	Will provide for 0.3% slope.	YES	Confirm design criteria.	The 0.2% gradient will be retained, with the notation that COE will need to request a variance, which should be doable.
	C	5	Longitudinal profile at intersections	With 0.3% slope, there will still be some relatively flat slope areas due to vertical curves.	YES	Confirm design criteria.	The ramps can be moved slightly to eliminate intersection grading issues. The Tentatively Selected Plan (TSP) has only one such ramp.
ROADWAY FEATURES	A	A.1	Median buffer needed.	No specific standards for requiring this feature.	YES	Discuss details further.	COE consultant (PBS&J) to review traffic and crash data and substantiate that the feature is not needed. Discussion will be included in final Eng. App.
	A	B.2	Consider lighting, turn bays, passing zones.	These features are being considered further.	YES	Discuss details further.	Ditto.
	A	B.5	Consider passing zones where warranted and feasible.	These features are being considered further.	YES	Discuss details further.	Ditto.
	B	24	Consider need for lighting, turn bays, passing zones, based on crash history.	These features are being considered further.	YES	Discuss details further.	Ditto.

Category	*Source Docu-ment*	*Item No.*	*FDOT Comment*	*Response*	*Further Discussion Needed?*	*Suggested Approach to Resolution*	*Concensus Resolution per Meeting of 9/22/05*
ROADWAY TYPICAL SECTION	A	A.2	Design of shoulder pavement should be reevaluated.	This point is recognized and will be addressed in final design.	YES	Discuss.	This will be addressed by the COE in the engineering design phase.
	A	A.6	Sodding on slopes behind guard rails.	Comment has been addressed.	No	N/A	Resolved.
	A	A.7	Recommend 8-ft. paved shoulder. (See Comment B/12 below.)	The 5-ft. paved shoulder conforms to PPM, and affords a grass strip for water quality, per USACOE discussions with FDEP.	YES	Discuss details further.	COE discussion with FDEP indicates need for grass strip. This is acceptable to FDOT with documentation.
	A	A.8	Water quality along road embankment section.	USACOE discussions with FDEP led to guidance for water quality treatment system on the bridge and grassed strip on the shoulder.	YES	Discuss details further.	COE discussion with FDEP indicates need for grass strip. This is acceptable to FDOT with documentation.
	A	B.6	Design variation for border width needed; possibly others. (See Comment B/28 below.)	Need for specific variations and exceptions is noted. Intent is to resolve in final design phase.	YES	Discuss resolution in final design phase.	This will be addressed by the COE in the engineering design phase.
	B	3	Consider alternate paving section using Geodrain product.	This concept was given a preliminary review, and the Intent is to further analyze and resolve in final design phase.	YES	Discuss intent to examine further in final design phase.	This will be addressed by the COE in the engineering design phase.
	B	12	The grass strip in the shoulder is a maintenance issue. (See Comment A/A.7 above.)	The 5-ft. paved shoulder conforms to PPM, and affords a grass strip for water quality, per USACOE discussions with FDEP.	YES	Discuss details further.	COE discussion with FDEP indicates need for grass strip. This is acceptable to FDOT with documentation.
	B	13	Show and label BL survey in relation to proposed CL.	Comment has been addressed.	No	N/A	Resolved.
	B	14	Label paved shoulder and correct graphic details.	Comment has been addressed.	No	N/A	Resolved.
	B	22	Correct limits of grassing and sodding.	Comment has been addressed.	No	N/A	Resolved.
	B	23	Show limits of clearing/grubbing, construction, and sodding.	Comment has been addressed.	No	N/A	Resolved.
	B	26	Clearance of 5 feet needed between top face of canal front slope and guard rail.	Comment has been addressed.	No	N/A	Resolved.

Category	*Source Docu-ment*	*Item No.*	*FDOT Comment*	*Response*	*Further Discussion Needed?*	*Suggested Approach to Resolution*	*Concensus Resolution per Meeting of 9/22/05*
ROADWAY TYPICAL SECTION (continued)	B	27	Design variation for "horizontal clearance" and "recoverable terrain" is needed.	Need for specific variations and exceptions is noted. Intent is to resolve in final design phase.	YES	Discuss resolution in final design phase.	This will be addressed by the COE in the engineering design phase.
	B	28	Design variation for border width needed. (See Comment A/B.6 above.)	Need for specific variations and exceptions is noted. Intent is to resolve in final design phase.	YES	Discuss resolution in final design phase.	This will be addressed by the COE in the engineering design phase.
	B	31	Approval of typical section package will be required.	Need for specific design approvals is noted. Intent is to resolve in final design phase.	YES	Discuss resolution in final design phase.	This will be addressed by the COE in the engineering design phase.
	B	32	Approval of traffic control plan package will be required.	Need for specific design approvals is noted. Intent is to resolve in final design phase.	YES	Discuss resolution in final design phase.	This will be addressed by the COE in the engineering design phase.

LEWIS, LONGMAN & WALKER, P.A.
ATTORNEYS AT LAW

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JACKSONVILLE

June 20, 2005

Dennis Duke
U. S. Army Corps of Engineers
701 San Marco Blvd.
Jacksonville, FL 32207-8175

RE: Tamiami Trail – Modified Water Deliveries Plan

Dear Dennis:

Thank you for traveling to meet with the Florida Department of Transportation in Miami on May 31 to discuss the Tamiami Trail and the Modified Water Deliveries Plan. The meeting was very helpful and clarified several issues including the following:

1. The Corps will design, permit and build the roadway modifications and bridges to accommodate the Modified Water Deliveries Plan.

2 As part of its endeavors, the Corps will arrange for all necessary property acquisitions, utility movements, etc.

3. The Corps will handle all necessary environmental assessment work, mitigation issues, tribal issues and all tasks related to design and project management.

4. The FDOT will not be responsible for any task related to this work. Its function is to review all necessary documents to determine the acceptability of the project as a substitute facility.

5. It is anticipated that the Corps and FDOT will enter into an agreement which will allow the maximum design elevation flow to pass under the Tamiami Trail. The terms of that agreement have not been discussed.

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1001 3rd Avenue West
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Fax: (850) 224-9242

West Palm Beach
1700 Palm Beach Lakes Blvd.
Suite 1000
West Palm Beach, FL 33401
(561) 640-0820
Fax: (561) 640-8202

The FDOT will cooperate fully regarding the Tamiami Trail. I await the requested project timeline so that we can follow the Corps' progress on a task basis.

Sincerely,

Daniel D. Richardson

DDR:lt

c: Lloyd Pike, ACOE Jacksonville
John Pax, ACOE Jacksonville
Tambour Eller, ACOE Jacksonville
Dan Kimball, Everglades National Park
Ysela Llort, FDOT Tallahassee
Robert Downie, FDOT Tallahassee
John Martinez, FDOT Miami
Javier Rodriguez, FDOT Miami
Michael Wolz, ACOE, Jacksonville ✓
Bradley Foster, ACOE, Jacksonville

1000 N.W. 111 Avenue
Miami, Florida 33172

June 20, 2005

Mr. Robert M. Carpenter
Colonel, U.S. Army
District Engineer
Jacksonville District Corps of Engineers
P.O. Box 4970
Jacksonville, Florida 32232-0019

Dear Col. Carpenter:

The Florida Department of Transportation (FDOT) is in receipt of your letters dated April 5, 2005 and May 5, 2005 which respectively inform the FDOT of the Design High Water Elevation (DHW) and proposed roadway design typical cross-section for the Revised General Reevaluation Report/Supplemental Environmental Impact Statement (RGRR/SEIS), on the Tamiami Trail (US 41) for the Modified Water Deliveries to Everglades National Park Project (MWD).

As you are aware, the FDOT has continued to stress the importance of establishing the predicted DHW for this project as it relates directly to the design requirements for the reconstruction of the road to be designed, permitted and constructed by the Army Corps of Engineers (ACOE). Given that The Everglades National Park Protection and Expansion Act of 1989 (Public Law 101-229) authorized the ACOE to "to the extent practicable, take steps to restore the natural hydrological conditions within the Park", it is imperative that the proposed design of the Tamiami Trail be based upon consideration of the maximum authorized surface/groundwater elevations, flow, peak elevation durations and potential hydrologic fluctuations.

Based upon results of Natural System Model (NSM) runs conducted by the ACOE, as presented to the FDOT in summarized format in your April 5, 2005 letter to the FDOT, the ACOE is proposing to use 20-year, 24 hour stage (9.7 feet, NGVD 1929) as the DHW for the pavement design and notes the DHW for the over-topping criteria will be based on the 100-year stage (10.1 feet, NGVD 1929). These elevations are acceptable for use in developing the design criteria as long as they will not be exceeded by water elevations resulting from future projects developed under the Comprehensive Everglades Restoration Plan (CERP), including the Water Conservation Area (WCA) 3 Decompartmentalization ("Decomp") Projects. Based on the elevations that the NSM yields, the 20-year, 24 hour stage of 9.7 feet would govern and should be used as the control elevation.

Subsequent to receipt of your April 5, 2005 letter, the FDOT reiterated its previous requests for additional information regarding hydrologic modeling conducted for the project (please refer to our letter of March 22, 2004 and earlier correspondence, attached). These DHW elevations are proposed for purposes of establishing design criteria for construction of the Tamiami Trail bridge and roadway portions, necessary as mitigation for impacts to this facility to be caused by the implementation of the MWD and associated projects. As per our meeting held May 31, 2005 at the FDOT, the FDOT District VI Drainage Engineer, Ricardo Salazar, or his appropriate representative, will travel to the ACOE's Jacksonville Office to review the NSM and the assumptions used for the model. Our acceptance of the above cited storm frequencies and canal stages is conditional pending Mr. Salazar's review of the NSM, the hydrology/hydraulics report that is being developed in conjunction with the RGRR/SEIS and other hydrologic data requested by the FDOT. It is also re-emphasized that a Bridge Hydraulic Report, which includes deck drainage and scour analysis, is necessary prior to 30% submittal of the bridge structural plans.

The ACOE letter to the FDOT dated May 5, 2005, provides a cross-section diagram used for "screening level design and cost estimating", and represents the roadway design elements associated with elevating the existing Tamiami Trail to mitigate the impact of the increased surface water elevation in the L-29 borrow canal. Following are the comments related to the proposed typical section:

1. The center-line of the proposed cross- section is aligned in such a way that it would cause encroachment outside of FDOT right-of-way to the south, into Everglades National Park (ENP), at varying widths of 3.5 to 22 feet. The FDOT cannot accept responsibility for this potential right-of-way encroachment, acquisition or any associated wetland and/or wildlife impacts or mitigation.

2. The diagram provided should also indicate the DHW elevation in the L-29 Borrow Canal, indicate the proposed use of black-base or asphalt-base pavement design, and address Water Quality Treatment features to meet Miami-Dade County standards.

3. The pavement design and all pertinent information (reports, etc.) must be submitted to the FDOT's District Pavement Design Engineer for review.

4. Please provide the proposed centerline elevation. Backup calculations must be provided to FDOT to include determination of DHW elevation as outlined in the FDOT Drainage Manual. In addition, proper clearances must be maintained between the bottom of the base course and the DHW as outlined by the FDOT Plans Preparation Manual (PPM) Volume I, Table 2.6.3. The pavement section should be re-evaluated following further geotechnical testing; in addition, it

should be reevaluated once other pertinent information is received such as the calculations of 18 kip Equivalent Single Axle Loads, Resilient Modulus recommendations, and traffic data including percentage of truck traffic. Until this information is finalized, FDOT cannot approve any particular Profile Grade Line (PGL) elevation for the proposed project.

5. The "Assumed Pavement Design" does not comply with the FDOT Pavement Design Manual (PDM) and Index 514 with regard to thickness of base material. Please address this issue.

6. The decision to restrict the base course to asphalt must be documented and approved by the FDOT District Design Engineer, and a copy of documentation furnished to the FDOT State Pavement Design Engineer (see PDM - January 2005, Section 5.5.2, page 5.34.0).

7. If the required 2-foot minimum base clearance from DHW cannot be achieved, then asphalt base will be necessary. Stabilization (Type B, Load Bearing Ratio [LBR] 40) should be provided. Show the stabilization layer (12" below travel lane base) extended to the shoulder points.

8. Design Year should be set 20 years after the anticipated opening year for the proposed project.

9. Draw the stabilized subgrade to the extended shoulder points and label.

10. The thickness of the structural course should be increased. As per the FDOT PDM, the recommended minimum thickness for new construction is 2" for $ESAL_D$ from 300,000 to 3.5 million and 3" if greater than 3.5 million. However, for future milling it is recommended that the minimum should be 3" even if $ESAL_D$ does not exceed 3.5 million. The structural course must be Type SP (superpave) and the friction course should be FC-5 (3/4") (indicate in lieu of "surface course"). Note that although the PDM does not require open graded friction course (FC-5) on two lanes for all design speeds, FDOT District VI will require the use FC-5 for this project.

11. The type of soil stabilization to be used should be indicated (for example geo-textile, geo-grid material, surcharging, or muck removal).

12. Use miscellaneous asphalt (2" thick) in lieu of the grassed strip (from outside edge of paved shoulder to the extended shoulder point); add label for "misc. asphalt" and remove the 3 ft. width.

13. Show and label the "BL survey" (baseline survey); show dimensional relation (offset range) of the proposed "CL const." (centerline construction) to the BL

survey.

14. Label the "paved shoulder"; show the mainline base and paved shoulder base extended 4" beyond the edge of travel lane pavement and shoulder pavement, respectively.

15. Change the label at the crown to "PGP" (Profile Grade Point)"instead of "PGL" (Profile Grade Line).

16. Show the station limits of the roadway typical section.

17. Show the range in the offset (clearance) from the outside edge of travel lane to the canal bank.

18. Show pavement cross slopes as decimals (0.02, 0.06, etc.); show sideslopes in vertical:horizontal format (1:2, etc.); show 0.06 on the full shoulder.

19. Show the range in the R/W width (proposed) from the proposed "CL const."

20. Show the border width (range) on both sides of the roadway.

21. Please further explain Note no. 1: "Existing cross section is paved full width between guardrails".

22. Grassing should be extended to the face of guardrail/limit of miscellaneous asphalt under guardrail. Also, erosion protection must be provided behind the guardrail (2:1 slopes require grassing/sodding). Please note that seed and mulch are not allowed on 2:1 (or steeper) slopes.

23. Show the limits of "clearing and grubbing"; show "limits of construction"; indicate "sod" on the sideslopes and as needed within the limits of construction.

24. Please review existing crash data for this segment of the corridor. Evaluation should be made of the need for provision of passing zones, roadway lighting, and the addition of left-turn bays, as existing crash data warrants.

25. In high fill/embankment areas, vertical retaining wall sections (instead of guardrail with 2:1 slopes) should be considered to further reduce impacts.

26. Per PPM 4.2.1, five (5) feet of clearance must be provided between the top of the canal front slope and the guardrail. This dimension may be decreased if deep-posts, or closely spaced posts, are used for the guardrail.

27. A design variation will be necessary for "horizontal clearance (canal hazard)"

and for "recoverable terrain" even with the provision of guardrail. Note that guardrail is a mitigating measure and does not substitute horizontal clearance and slope criteria).

28. We note the Border Width as inconsistent with the PPM. Please address this issue.

29. FDOT review of a preliminary plan and profile view of the proposed section is required.

30. SFWMD's criteria should be used for establishing the low member elevation of any proposed bridges or culverts.

31. Approval of a typical section package by the FDOT's District Design Engineer, including both roadway and bridge typical sections, will be required.

32. Approval of this typical section will not be finalized until Traffic Control Plan (previously referred to as Maintenance of Traffic) phasing is reviewed by the FDOT to insure that the proposed typical section addresses constructability issues.

The FDOT appreciates the opportunity to provide comment on the DHW stages for the MWD Project and on the proposed screening level cross-section design for Tamiami Trail. Our comments above are, of course, subject to our full agreement on the total project design, project funding and our settlement of substitute facility issues. The FDOT requests that the ACOE ensures that water levels do not exceed 7.5 ft NGVD until reconstruction has taken place to maintain the safe usage and structural integrity of the existing roadway.

Thank you for your continued coordination with the FDOT with respect to this important effort. Should you have any questions or comments in this regard, please contact Ms. Alice Bravo, P.E, FDOT District Six Environmental Management Engineer, or Ms. Marjorie Bixby, FDOT District Six Environmental Administrator, in our Environmental Management Office at (305) 470-5220.

Sincerely,

John Martinez, P.E
FDOT District Six Secretary

cc: Jose Abreu, P.E., FDOT
Ysela Llort, FDOT
Javier Rodriguez, FDOT
Gus Pego, FDOT

Carolyn Ismart, FDOT
Alice Bravo, P.E., FDOT
Marjorie Bixby, FDOT
Barbara Culhane, FDOT
Robert Downie, FDOT
Bob Crim, FDOT
Colleen Castille, FDEP
Dan Kimball, ENP
Brad Foster, ACOE
Michael Wolz, ACOE
Chip Mirriam SFWMD
Paul Linton, SFWMD
Eugene Duncan, Miccosukee Tribe of Indians
Greg May, Executive Director South Florida Ecosystem Restoration Task Force
Dan Richardson, Lewis, Longman & Walker
Erin Deady, Lewis, Longman & Walker

W0/2

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT CORPS OF ENGINEERS
P.O. BOX 4970
JACKSONVILLE, FLORIDA 32232-0019

REPLY TO ATTENTION OF

MAY 5 2005

Engineering Division
Design Branch

Mr. Jose Abreu
Secretary, Florida Department of Transportation
605 Suwannee Street
Tallahassee, Florida 32399-0450

Dear ~~Mr.~~ Jose Abreu:

The purpose of this letter is to initiate communication that will insure the roadway cross section and other improvements proposed for Tamiami Trail (U.S. Hwy 41) will be satisfactory to the Florida Department of Transportation (the Department). These modifications will be performed under the Revised General Reevaluation Report/Supplemental Environmental Impact Statement (RGRR/SEIS) for Modified Water Deliveries to Everglades National Park (ENP).

The proposed design high water was communicated to you in a letter dated April 5, 2005 (copy enclosed). The design high water elevation for the project dictates that the existing roadway be raised to mitigate the impact of the increased water surface elevation in the L-29 borrow canal to deliver additional water to ENP. Please find enclosed a drawing of the cross section that was used for screening level design and cost estimating. We believe that all of the features proposed in the cross section comply with the requirements outlined in the Department's Plan Preparation Manual. Your comments on our screening level concept are welcomed and encouraged.

In order to complete the RGRR, this office intends to obtain the services of an A/E firm that is experienced with the Department's processes and procedures to further develop our screening level concepts into planning level designs that will be acceptable to the Department. We expect that our consultant will coordinate with FDOT District 6 personnel directly to produce a least cost, environmentally acceptable plan that falls within the Department's design guidance and provides acceptable levels of safety and minimal disruption to the motoring public.

We look forward to working closely with the Department during the course of this project. If you have any additional questions or need additional information, please call me or have your staff contact Mr. Stephen C. Duba, Chief, Engineering Division, at 904-232-2251.

Sincerely,

Robert M. Carpenter
Colonel, U.S. Army
District Engineer

Enclosures

Copies Furnished (with enclosure):

Mr. Truman Eugene Duncan, Water Resources Director, Miccosukee Tribe of Indians of Florida, Post Office Box 440021, Tamiami Station, Miami, Florida 33144
Mr. Terry Rice, Suite 303, 7700 North Kendall Drive, Miami, Florida 33156
Mr. Dan Kimball, Acting Superintendent, Everglades National Park, 950 North Krome Avenue, Homestead, Florida 33035
Mr. Bruce Boler, Everglades National Park, 950 North Krome Avenue, Homestead, Florida 33035
Mr. Chip Merriam, Deputy Executive Director, Water Resources Management, South Florida Water Management District, 3301 Gun Club Road, West Palm Beach, Florida 33406
Mr. Paul Linton, Lead Engineer, Coastal Ecosystems, South Florida Water Management District, 3301 Gun Club Road, West Palm Beach, Florida 33406
Mrs. Marjorie Bixby, District 6 Environmental Administrator, Florida Department of Transportation, 1000 NW. 111th Avenue, Miami, Florida 33172

NOTE:
1. EXISTING CROSS SECTION IS PAVED FULL WIDTH BETWEEN THE GUARDRAILS
2. PROPOSED CENTER LINE ELEVATION IS 12.74 NGVD.
3. CENTERLINE WILL SHIFT APPROXIMATELY 12 FT SOUTH
4. DESIGN DATA WAS TAKEN FROM PREVIOUS GRR.
5. ROADWAY DESIGN SPEED 60 MPH
6. ROADWAY POSTED SPEED 55 MPH
7. EXISTING ADT (1999) 5,200 VEHICLE
8. PROPOSED ADT (2022) 9,200 VEHICLES
9. PAVEMENT SECTION ASSUMED TO BE AS FOLLOWS:
   3/4" SURFACE COURSE
   2 1/4" STRUCTURAL COURSE
   15" BASE CURSE
   PAVEMENT SECTION WILL BE REEVALUATE FOLLOWING ON GOING GEOTECHNICAL TESTING

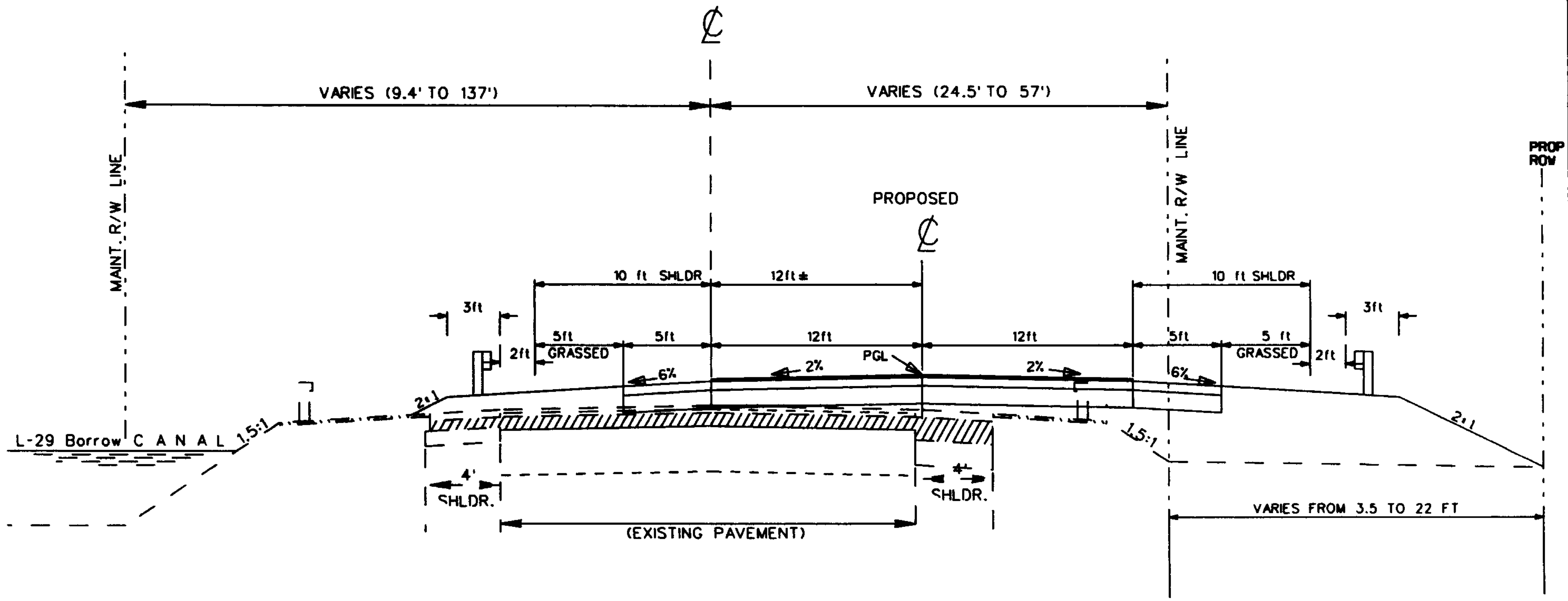

PLATE 1	CENTRAL AND SOUTHERN FLORIDA PROJECT FOR FLOOD CONTROL AND OTHER PURPOSES **MODIFIED WATER DELIVERIES TO ENP** PROPOSED ROADWAY CROSS SECTION	File name: X-SEC.DGN Reference files: dm8.5x11.DGN	Designed by: JWM Dwn by: JWM / Ckd by: Dated: 25 APRIL 2005 D.O.FILE NO.	Scale: AS SHOWN Plot date: APRIL 25 200 Plot scale: NTS	DEPARTMENT OF THE ARMY JACKSONVILLE DISTRICT, CORPS OF ENGINEERS JACKSONVILLE, FLORIDA — US Army Corps of Engineers Jacksonville District.

Florida Department of Transportation

JEB BUSH
GOVERNOR

1000 NW 111th Avenue, Room 6103
Miami, Florida 33172

JOSÉ ABREU
SECRETARY

March 22, 2004

James C. Duck, Chief of Planning
U.S. Army Corps of Engineers
701 San Marco Boulevard
Jacksonville, Florida 32207

RE: General Reevaluation Report/Supplemental Environmental Impact Statement for the Tamiami Trail: Modified Water Deliveries to Everglades National Park ("GRR/SEIS")

Dear Mr. Duck:

I would like to clarify that the Florida Department of Transportation ("FDOT") strongly supports the goals of the Modified Water Deliveries to Everglades National Park Project as long as the U.S. Army Corps of Engineers (ACE) fully implements the measures necessary to avoid the degradation of the Tamiami Trail roadway facility and does not create safety hazards on Tamiami Trail by weakening the pavement structure and creating road overtopping conditions. It is our understanding that the purpose of the Tamiami Trail GRR/SEIS was to address these issues as stated on Page 8 of the document - "This study includes evaluating alternatives that will allow the passage of the MWD design flow to North East Shark River Slough (NESRS) such that the sub-grade of the existing Tamimai Trail would not be impacted by elevated water levels in the Tamiami Canal along the north shoulder of the highway". The importance of the study and the need to protect Tamiami Trail is expanded on Page 60 of the GRR/SEIS - "The damage caused by the saturation [of the roadway base] weakens the support for the asphalt pavement. Because of this, the asphalt pavement will deflect more than normal under traffic, at which point structural fatigue cracking will occur, and shortly thereafter, potholes develop. This would be a road hazard potentially contributing to traffic accidents. This extensive fatigue marks the end of the pavement life, at which point the asphalt is rendered to be nothing more than a granular base." "In addition, with the anticipated water elevation, overtopping could occur, thereby providing adverse implications to emergency vehicles and hurricane evacuation." (P.195). There is also the potential serious danger of the roadway embankment being undermined and an embankment failure or washout occurring while a car is breaking, maneuvering or suddenly stopping on the damaged pavement.

The need for an overlay or reconstruction to take place prior to the implementation of MWD Design water flows to maintain roadway safety is clearly articulated in the GRR/SEIS P. 8, P. 60 and P. 159). It is for these reasons that the conclusion is reached in the GRR/SEIS that the "no-action alternative" (provide MWD design flow but take no-action on the Tamiami Trail roadway) was never considered to be a realistic alternative for implementation (p.140).

We remain concerned about the fundamental issue that we have previously raised. The Modified Water Deliveries to Everglades National Park (MWD) project associated increase in water level in the Tamiami Canal (L-29) adjacent to Tamiami Trail (U.S. 41/S.R. 90) can not be implemented until the roadway is either reconstructed or overlayed to an appropriate elevation that meets FDOT design criteria for several significant safety related reasons. Secondly, there seems to be a discrepancy between the recommended Alternative 7a and what the GRR/SEIS actually authorizes based on the terminology used in the document and particularly in the Executive Summary. Because of this discrepancy, it remains ambiguous as to who the proposed responsible party is for constructing and implementing the remaining portions of the recommended alternative.

Comment #1 - MWD increased water elevations can not be implemented until the Tamiami Trail is raised to an appropriate elevation that meets FDOT design criteria, either by reconstruction or pavement overlay, by the U.S. Army Corps of Engineers (ACE) to avoid significant safety problems on the roadway.

Comment #2 - Since the existing roadway did not experience any significant deterioration while water levels in the Tamiami Canal were maintained at the historical level of 7.5', any overlay/reconstruction (and associated resulting responsibilities, including design, permitting, ROW acquisition, contamination remediation, and construction) and additional maintenance funds required for the roadway to maintain it in a safe condition are the responsibility of the ACE.

Comment #3 – The concept proposed in the GRR/SEIS that FDOT will be compensated for flowage easements and will use the funds to overlay the roadway at FDOT's option should be removed from the GRR/SEIS document since it contradicts the underlying purpose of the entire GRR/SEIS and will not be accepted by FDOT. The ACE is responsible for all construction and maintenance expenses required to maintain Tamiami Trail in a safe condition with the increased water elevations proposed under MWD.

The FDOT has requested on numerous occasions information regarding the hydrologic/hydraulic modeling assumptions and input data used by the ACE to support the modeling results provided in the GRR/SEIS. These requests date back as far as our September 29, 2000 comment letter (**Attachment A**) and were once again restated in an e-mail to Ms. Eller dated March 5, 2004 (**Attachment B**). That e-mail included a request for a 30 day extension on the comment period beginning from the date that FDOT receives the requested information. We have not received the requested information and the ACE has denied our request for a time extension. In light of this, we are providing these comments on the GRR/SEIS but reserve the right to modify these comments and provide additional comments once we have confirmed and are in receipt of the requested information, responses to the comments in this letter, the updated Appendix C ("Engineering Appendices") and once our consultants have completed their review of the hydrologic/hydraulic modeling analyses. It is the responsibility of the ACE, and the purpose of the GRR/SEIS, to assess potential impacts of the implementation of the MWD project to the Tamiami Trail. The FDOT must be able to accurately review and independently assess all information related to the ACE's assessment, conclusions and proposed action in this regard. To date, the FDOT is still asking for basic hydrologic/hydraulic modeling information that will enable us to accomplish this.

Comment #4 – Please provide the hydrologic/hydraulic modeling assumptions and input data used by the ACE to support the modeling results provided in the GRR/SEIS. This information was originally requested in September 2000 (Attachment A) and most recently requested by e-mail on March 5, 2004 (Attachment B).

On page ES-2, the Executive Summary states that the recommended alternative consists of a raised 3,000 foot bridge over the deepest portion of Northeast Shark River Slough. Additionally, there are five (5) recommended plan actions listed which include:

✓ (1) Construction of the 3,000 foot bridge
✓ (2) Removal of the existing highway fill adjacent to the bridge
(3) In accordance with the real estate agreement to be signed with FDOT, pay compensation for a flowage easement along the unbridged portion of Tamiami Trail
✓ (4) Maintain the existing 57 culverts along the Tamiami Trail
(5) Maintain water flow throughout the remaining segment of the Tamiami Trail between the S-333 and S-334

Further, the Executive Summary states that the 3,000-foot conveyance channel easement, use of the conveyance structures and a flowage easement are the "project features which are needed for the project to function" and are to be operated and maintained by the Non-Federal sponsor. The substitute facilities consist of the 3,000 foot bridge and pavement upgrades to the unbridged portion of the Tamiami Trail road between S-333 and S-334. Finally on page ES-3 the document states, "Authorization under this GRR is sought for only the 'project features [i.e., easements] needed to complete this MWD project.' The description, evaluation, and recommendation of the substitute facilities [i.e., bridge structure and pavement overlay] are provided to establish that substitute facilities can be implemented to pass the anticipated MWD flows." Does this document authorize the substitute facilities including the 3,000 foot bridge and the pavement upgrades? Per the GRR/SEIS, the only "project features which are needed for the project to function" that are not substitute facilities are the use of the conveyance structures and a flowage easement. The Executive Summary would seem to caveat the entire document such that the recommended Alternative 7A is not authorized by the GRR/SEIS and that it only authorizes flowage easements. Are these the only project features authorized by this Final GRR/SEIS document? It remains unclear what the GRR/SEIS is actually authorizing and what alternative components must be constructed, operated and maintained by other entities, who those entities are and when those facilities must be constructed. It would appear that further NEPA analysis will be necessary to authorize the construction of the transportation facilities listed above, including the 3,000 foot bridge and pavement upgrades to the unbridged portion of the Tamiami Trail road between S-333 and S-334.

Comment #5 – The substitute facilities discussions in the GRR/SEIS effectively transfers responsibility for the Tamiami Trail portion of MWD (bridge structure and pavement overlay) to the FDOT. FDOT can not accept this responsibility. Any statements referencing FDOT as responsible for design, permitting, ROW acquisition, MOT plans, funding or construction of the

roadway reconstruction, the pavement overlay, the 3000' bridge, or the removal of old Tamiami Trail adjacent to the new bridge must be deleted from the document, and replaced with language which clearly states that the ACE will take on all responsibilities associated with the construction of the 3000' bridge and the pavement overlay of the unbridged portion of Tamiami Trail including acquisition of a permit from FDOT to authorize this construction.

The GRR/SEIS Abstract states: "Where appropriate, an option was included for raising the elevation of the pavement and subgrade on either side of the bridges or culverts to prevent damage under the rare event when the full design flow could occur". FDOT maintains that this event will not be rare and the modeling in the GRR/SEIS shows that this condition will be more common than reflected by this statement. To illustrate, in Section 6.0, on page 60, the document states, "when the water elevation is 7.5 feet or lower, conditions will be no worse than what currently exists because the water is presently at elevation 7.5 feet. Between elevation 7.6 and 8.0 feet, there is a 50 percent chance of failure occurring."

Comment #6 - Implementation of the MWD project will raise water elevations in the L-29 above their current levels. This contradicts the assertion in the GRR/SEIS that under rare events the full design flow could occur. It is anticipated to occur as an operation of the project. This contradiction must be clarified in the document.

In Section 3.4, on page 59, the document states that the limestone base is approximately 85 percent saturated due to capillary action and is significantly deteriorated. This value is stated in an ambiguous manner and is not substantiated anywhere in the document. To the contrary, FDOT has previously stated that the road is in good condition and not in need of reconstruction. The statement made on P. 59 also contradicts the geotechnical data provided in the "Report of a Geotechnical Exploration" dated December 1, 2000 performed by LawGibb Group which is part of Appendix C (Engineering Appendices of the GRR/SEIS).

Comment #7 – Clarify the base saturation comment made on P. 59 and provide the supporting test results since it contradicts the "Report of a Geotechnical Exploration" performed as part of the study and the discussion on Page 12 of the Engineering Appendix that the roadway embankment is at the optimum moisture content of 7 to 9%. If the comment on P. 59 is incorrect and/or can not be substantiated, strike it from the document.

In Section 6.0, on page 60, there is a significant error in the information offered in the GRR/SEIS. The document states, "According to FDOT, the water elevation must be at a minimum of two inches below the base of the road for the limestone base to maintain its integrity."

Comment #8 – The 2" reference on P. 60 is incorrect, per FDOT standards the water level can not encroach within two feet of the limerock base of a road for more than 24 hours. Please see our letter dated May 1999 (Attachment C) stating this requirement. Please revise the document.

The GRR/SEIS states that Alternative 7(a) includes the overlay of the existing pavement with asphaltic "black" base to an elevation of 11 on Page 87 which is incorrect. As previously stated in FDOT's letter dated March 30, 2000 (**Attachment D**), the crown elevation of the roadway must be set such that there is one foot of clearance between the Design High Water (DHW) elevation and the lowest point of the asphaltic "black" base pavement footprint and so that the travel lanes on the roadway are not overtopped during a 50 Year Frequency storm event. The example that is provided in the March 2000 letter states that for a DHW of 9.5', the necessary crown elevation to provide the base clearance would be 12.54' after accounting for the necessary pavement cross slopes (6% for shoulders and 2% for travel lanes). One foot of base clearance is required for an asphaltic base and two feet of base clearance would be required for a pavement design that uses a limerock base. The exact required crown elevation will not be known until the ACE performs refined hydrologic/hydraulic modeling during final design, in particular the Critical Storm Duration Analysis, and a final pavement design both of which must be reviewed and approved by FDOT. The Critical Storm Duration Analysis should include all storms up to a 100 year frequency storm. The MWD water levels will have to be operated below the DHW elevation and could only be exceeded for a duration of less than 24 hours during a heavy rainfall event.

Comment #9 – All alternatives that involve roadway reconstruction or pavement overlay must raise the road to an "appropriate elevation" that provides the required base clearance to the Design High Water (DHW) and meets overtopping criteria per FDOT requirements. The DHW is the water elevation maintained in the Tamiami Canal between S-333 and S-334 for more than 24 hours determined from a Critical Storm Duration Analysis for all storms up to a 100 Year Frequency Storm. Overtopping Criteria requires that the travel lanes are not overtopped by the water elevations produced by a 50 Year Storm event. One foot of clearance must be provided between the DHW and the low point of the pavement asphaltic base footprint. Calculate the correct crown elevation (with necessary pavement cross slopes) for the proposed DHW elevation and revise all document text and calculations accordingly.

In the Addendum to the GRR/SEIS in the beginning of the document, the 2003 cost lists $17,593,102 for the roadway. There is no figure associated with the maintenance that will be necessary from the implementation of the pavement overlay proposed in the recommended Alternative 7A. This maintenance money is inextricably tied to the overlay because of the damage the higher water elevations will cause to the roadway. This is not routine highway maintenance due to wear and tear from vehicles traveling the roadway but is directly related to the need for continued maintenance from the higher water elevations. With the MWD water elevations the projected culvert flow will not be as rapid as exists today leading to increased operation and maintenance costs for the culverts as well. But for the project, this maintenance need would not occur. This need is not addressed in the document anywhere.

Comment #10 – When the FDOT originally proposed (September, 2000) that the Tamiami Trail could be raised to an appropriate elevation by means of a pavement overlay rather than reconstruction of the pavement and roadway embankment, discussions with the U.S. Army Corps of Engineers included provision of a maintenance fund reserve (or Escrow Account) by the ACE that FDOT could use to cover increased maintenance expenses resulting from the increased water elevations. Please include this as one of the elements of any alternative proposing a pavement overlay rather than reconstruction. Individual components related to "operations" and

"maintenance" must be clearly defined and responsibility clearly assigned.

In Section 6.14.1 (P. 220) it is stated that "The footprint of Alternative 7a falls within the maintenance right-of-way (ROW) of the existing roadway and ownership is claimed by FDOT." However, P. 180 states that Alternative 7A requires 13.327 acres of ROW acquisition on the north and 21.759 acres of ROW acquisition on the south. The existing guardrail on the south side of the roadway is located very close to the southern ROW boundary, therefore it is likely that the statement on P. 220 is incorrect and ROW acquisition is required for Alternative 7A.

Appendix H, on page 7, includes ambiguous text implying that lands owned by Everglades National Park (ENP) will be required for the proposed Alternative 7A bridge structure and that if required, "necessary easements will be obtained from the National Park Service for FDOT". A similar situation seems to exist with the L-29 Canal.

Comment #11 – Please clarify all discrepancies with regard to the ROW required to implement Alternative 7A and further clarify that any necessary ROW acquisition will be performed by the ACE as part of their design/permitting efforts for their construction project to reconstruct/overlay Tamiami Trail to an appropriate elevation meeting the base clearance and overtopping criteria required by FDOT.

In the Executive Summary, page ES-4, the document describes different portions of the Recommended Plan. The document states, "Alternative 7a would involve modifying the Tamiami Trail, which has been identified as a historic cultural resource; mitigation has been discussed with the State Historic Preservation Officer ("SHPO") and would likely consist of documentation." The SHPO has concurred that this modification would constitute an adverse affect. FDOT is concerned that ACE has not finalized Section 106 Consultation in conjunction with completion of this GRR/SEIS.

Comment # 12 - The ACE must complete its Section 106 consultation effort with the SHPO and the Advisory Council of Historic Place (ACHP), mitigate for any adverse impacts that the project could have on Tamiami Trail and provide assurances that these responsibilities will not fall on FDOT.

Section 6.10 includes the responsibilities of the Non-Federal Sponsor. Item i states "That as between the Government [ACE] and the Non-Federal Sponsor that the Non-Federal Sponsor shall be the operator of the Project for purposes of CERCLA liability.

Comment #13 – Section 6.10 must explicitly state that FDOT shall not be the operator of the Project for purposes of CERCLA liability as a part of the implementation of the Recommended Plan, bridge construction, pavement reconstruction/overlay, or associated project feature. The FDOT shall also not be liable for issues associated with water quality as related to the movement of water or sediment from L-29 or WCA-3A to WCA-3B or other receiving waters south of the Tamiami Trail, or any other modifications associated with the Project.

Additional Comments
Comment 14 - PP. 202, 203 and 204 – Graphics should be presented with better legends or labeling, as currently presented it is unclear what they represent. Each graphic indicates "3700 CFS". Present modeling results for MWD stated design flow of 4000 CFS.

Comment #15 - P. 200 – Please provide calculations for Environmental Performance Scores. Please provide detailed breakdown of Cost Estimates.

Comment #16 - Discrepancies exist within the GRR/SEIS and the appendices as to the location of the 3000' bridge proposed as part of Alternative 7A. What is the proposed bridge location? P. 206 states that "Appropriate NEPA documentation would be prepared to address any re-siting [of the bridge]". What would that documentation consist of and when would it be prepared?

Comment #17 - The last paragraph in P. 206 (continued on P. 207) seems to imply that FDOT would design and construct modifications to Tamiami Trail with "funds [that] are provided as compensation for giving the Corps water conveyance rights, not specifically for elevating the pavement or other measures." As previously stated herein, water elevations in the Tamiami Canal can not be raised above 7.5' without damaging the roadway unless the Tamiami Trail is rebuilt or overlayed to an appropriate elevation. This is the only way to address FDOT's safety concerns for Tamiami Trail. It is also the only way to comply with the Florida Coastal Zone Management Program Federal Consistency Evaluation Procedures – Item #9 – of Appendix L. This responsibility falls completely on the ACE and should not have to be borne by FDOT.

Comment #18 - Appendix I – the Department of Interior Final Fish and Wildlife Coordination Act Report – on P. 47 states that the 10 year frequency storm should really be estimated at a 9.55' water level based on their modeling results and that their modeling results are generally significantly lower than the flow distribution based on historic data. Given this information, what is the true anticipated Design High Water (as defined in this letter) for the Tamiami Canal between S-333 and S-334?

Comment #19 - Page ES-5 - The removal of aquatic vegetation will be an annual expense and will be required for the system to properly function. In the past the airboats prevented the weed buildup but that will not be the situation in the future. Therefore, there will be increased weed removal operating and maintenance costs. The U.S. Army Corps of Engineers must make provisions to fund these additional maintenance costs that FDOT will bear as a result of this project.

Comment #20 - Page 6 Section 1 - Will the L-29 levee be removed or altered to promote sheet flow? It presently provides wave protection for the existing road. The same comment applies to the discussion of removal of current unimproved roadways. There is an impact in removing these as they may serve as breakers for wind action and wave run up on the current embankment. Their removal will lead to increased maintenance costs. Please address this issue in the GRR/SEIS.

Comment #21 - Page 57 - CERP design flows are projected to be higher – up to 5200 cfs – higher than in the 1992 report. Culverts can pass the MWD design flows but the water levels to the South will result in higher backwater requiring higher water levels in L-29 to deal with the culverts invert elevations, size, location and the head loss that will need to be overcome. The discussion clearly represents an altered flow regime resulting in higher levels, higher durations and greater frequencies all of which contribute to higher maintenance costs induced by the modifications. Please address this issue in the GRR/SEIS.

Comment #22 - Page 58 - Water levels to the South of Tamiami Trail are not managed but water levels could become much higher – What is meant by much higher? A detailed model review is needed to determine the height, duration and frequency and the resulting impact on the embankment. Please address this issue in the GRR/SEIS.

Comment #23 - Page 59 - Reference is made to Corps flow test results on erosion and washouts. Did the test conditions approximate the conditions that will exist after Alternative 7A is constructed and MWD water levels are implemented? Provide documentation of the test that was performed, including methodology, procedures and provisions taken, and test results.

Comment #24 - Page 61 - A detailed breakdown of the projected operating and maintenance costs for current conditions and for conditions under the projected flow regime needs to be presented to make an appropriate decision on whether the future costs are properly addressed. Please provide.

Comment #25 - Page 61 - The foundation will be impacted with rapid canal drawdown in anticipation of a severe tropical storm and then rapidly filling the canal during the heavy rainfall events. This pumping of the foundation will cause increased maintenance costs to maintain the pavement in a safe condition. Please address this issue in the GRR/SEIS.

Comment #26 - The FDOT culvert letter and the consultant report included in the Engineering Appendices needs to be carefully considered. The 7a conditions will be different from the conditions that presently exist with the culverts. There will be higher water levels, slower flow rates flowing through the culverts and longer periods of time where the water will be at higher elevations in the culverts and this will happen more frequently. This can lead to increased sedimentation in the culverts or in blocking the culverts by the building of nests. These conditions may lead to increased aquatic weed growth. Please address this issue in the GRR/SEIS.

PAVEMENT

Comment #27 - It is noted that current pavement design analysis is based upon an existing pavement thickness of 6 inches however much of the existing roadway pavement thickness is less than 6 inches. The analysis should be revised to be based on the minimum pavement thickness unless a detailed survey and multiple pavement designs will be developed during final design by the ACE.

1. Actual traffic growth rate is 4.66%. Traffic growth rate used in pavement analysis is 2.2%. Revise pavement analysis for correct traffic growth rate.
2. Increased water surface elevation was accounted for by reducing Mr from 5000psi to 4000psi – provide justification for this.
3. Life cycle cost based on assumption that existing roadway consists of 6 inch asphalt over 12 inch LBR 40 limerock base. Is this an accurate assumption considering that much of the alignment has less than 6 inch asphalt and base may be not well compacted / contaminated with fines from

underlying muck migrating into the open graded base. Revise analysis and base on minimum existing asphalt layer.

4. Further discussion related to the clearance between design high water and pavement base is needed. The December 22, 2000 Final Design (100%) Submittal includes a May 7, 1999 letter from Richard Bonner indicating criteria for the base clearance.
    a. May be reduced from 2-feet to 1-foot for the purpose of conceptual alternative development
    b. Clearance based on use of black base
    c. Clearance to be measured from design high water to bottom of base at the outside edge of shoulder or travel lane (whichever is lower)
    d. Base flooding not expected to exceed Department's 24 hour criteria
    e. Base clearance to be reevaluated for recommended alternative prior to final approval
    f. If clearance can be reasonably increased with minimal economic and / or environmental impacts, may be asked to review design and provide increased clearance

STRUCTURES (Bridge and Culverts)
Comment #28 - What is the velocity of flow through the bridge opening? Has consideration been given to costs associated with scour protection / maintenance and / or maintenance associated with deposition (i.e. dredging to maintain flow)?

Comment #29 - What is the velocity of flow through the culverts? Has consideration been given to costs associated with scour protection / maintenance and / or maintenance associated with deposition (i.e. flushing culverts to maintain flow)?

ROADWAY EMBANKMENT
Comment #30 - What is the maximum differential head from upstream to downstream side of embankment and what is the anticipated duration? Has any head differential been considered in evaluation of embankment stability?

Comment #31 - What is the potential for increased erosion of the embankment due to wave action and have costs associated with protection and maintenance been included?

Comment #32 - What is conceptual design of new roadway embankment approaches to the proposed bridge? What measures are anticipated to address stability and long term settlement of new approach embankments? Muck must be removed or treated in these areas.

Comment #33 - What is the potential for fluctuation of the water surface elevation? It should be noted that long term settlement will occur due to raising roadway profile grade. Settlement will be somewhat dependent upon the water surface elevation and fluctuation. Has this been considered and what range of potential long term settlements are anticipated? Have costs associated with these long term settlements been accounted for? Will these settlements impact the structural integrity or flow characteristics of the existing culverts?

relates to #30

Comment #34 - Analyze embankment stability with respect to fluctuating water surface elevation.

Page 206 of the documents states "It is the intention of the Federal government not to expend any more funds than necessary to construct alternate facilities for the Tamiami Trail that a future project under CERP may impact." Be assured that the expenditure of funds by the ACE for the construction of any alternatives that include a pavement overlay in order to raise the roadway elevations and prevent pavement failure and roadway overtopping are necessary as part of the MWD Project. If water levels are increased without appropriate modifications to the pavement, the pavement will be severely deteriorated to the point that it loses all structural value and the opportunity to overlay the pavement rather than to reconstruct it will have been lost. This severe pavement deterioration can occur within a timeframe of approximately a year and a half.

Our comments contained in this letter constitute substantive issues that have not been addressed in the Final SEIS and therefore should be included either in a revised Final SEIS, or as errata sheets attached to the Record of Decision. Letters and e-mails referenced in this Final GRR/SEIS comment letter are hereby incorporated by reference and are attached.

Please contact me or Ms. Marjorie Bixby the District Six Environmental Administrator at 305-470-5200 should you have any questions or require additional information.

Sincerely,

Alice Bravo

Alice N. Bravo, P.E
District Environmental Management Engineer

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Kim Taplin, ACOE West Palm Beach
Henry Dean, SFWMD
Dewey Worth, SFWMD

Dan Kimball, Everglades National Park
Dave Sikkema, Everglades National Park

Attachments:

Attachment A – Letter dated September 29, 2000
Attachment B – E-mail dated March 5, 2004
Attachment C – Letter dated May 7, 1999
Attachment D – Letter dated March 30, 2000