FPN: 441942-1-22-01
SR 31 FROM SR 80 (PALM BEACH BLVD) TO SR 78 (BAYSHORE RD)
OVER CALOOSAHATCHEE RIVER
PROJECT DEVELOPMENT AND ENVIRONMENT STUDY
LEE COUNTY, FLORIDA

BRIDGE HYDRAULICS REPORT

PREPARED FOR
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The official record of this report is the electronic file digitally signed and sealed under 61G15-23.004, F.A.C.

I, Mark Gosselin, PhD, PE, hereby state that this report, as listed in the following Table of Contents, is, to the best of my knowledge and belief, true and correct and represents the described work in accordance with current established engineering practices. I hereby certify that I am a Licensed Professional Engineer in the State of Florida practicing with INTERA Incorporated, and that I have supervised the preparation of and approve the evaluations, findings, opinions, and conclusions hereby reported.

This document has been digitally signed and sealed by Mark Gosselin, PhD, PE with a Digital Signature.

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1.0 Introduction

Complex flow patterns under extreme flood conditions at bridges located within coastal systems make such bridges susceptible to scour-related damage. To guard against scour-related damage, the Federal Highway Administration (FHWA) and the Florida Department of Transportation (FDOT) require a detailed analysis to determine design hydraulic parameters at the bridge and assess the vulnerability of bridges to flow-induced scour. For this reason, DRMP subcontracted INTERA Incorporated (INTERA) to develop a bridge hydraulics report (BHR) for the Project Development and Environment (PD&E) Study to address capacity, operational, and structural deficiencies of SR 31 from SR 80 (Palm Beach Boulevard) to SR 78 (Bayshore Road) in northeastern Lee County. The project will evaluate the potential widening of the roadway up to six lanes, which may include paved shoulders, sidewalks, bike lanes, and/or a multi-use pathway, to meet future travel demand. The project will additionally evaluate repair/rehabilitation and replacement options regarding the Wilson Pigott Bridge as design elements of the bridge are substandard.

This BHR combines the latest FHWA and FDOT technical guidelines with hydraulic modeling and coastal engineering methodologies. Hydrodynamic and wave modeling provided predictions of hydraulic parameters needed to estimate various design conditions.

The following standards apply to the bridge's designs.

- The design storm frequency equals 50 years (yrs) given the bridge's Average Daily Traffic exceeds 1,500 (FDOT, 2022b).
- The scour design flood frequency equals 100 yrs and the scour design check flood frequency equals 500 yrs (FDOT, 2022b).
- For concrete superstructures in aggressive environments (high chloride content), the FDOT (2022c) states that the minimum vertical clearance equals 12 ft between mean high water (MHW) and the low member of bridge.
- For drainage, the FDOT (2022c) states that the minimum debris vertical clearance equals two feet between the design flood (50-yr event) and the low member of bridge.
- For navigation, FDOT (2022c) specifies a six-foot minimum clearance above MHW within the navigation channel of tidal waterbodies. However, given this bridge crosses the Okeechobee Waterway, the U.S. Coast Guard (USCG) specifies a minimum vertical clearance of 55 ft above MHW and a minimum horizontal clearance of 150 ft within the navigational channel (https://www.dco.uscg.mil).
- For coastal bridges, the FDOT (2022c) requires that the vertical clearance between the superstructure and the 100-yr wave crest elevation (including storm surge and wind setup) must equal at least one foot. If not, the FDOT (2022b) requires a qualified coastal engineer address the requirements found in AASHTO (2008) — essentially, requiring the bridge withstand forces due to waves.
- FDOT (2022b) states abutment protection should protect against the effects of scour conditions and wind- and boat-generated waves.
- FDOT (2022b) indicates the bridge design must incorporate a sea level rise analysis to assess the vulnerability of flooding over its design life.

- Finally, FDOT (2022b) stipulates that the bridge designer must limit the spread resulting from a rainfall intensity of four inches per hour.

Following this introduction and a brief description of the study area (Chapter 2), this report describes the methods to determine the hydraulic parameters needed to calculate scour for the design conditions. Chapter 3 describes the hydrodynamic model, including the expected offshore surge conditions applied at the model boundary to drive the model, and wave model, and documents the results of model simulations. Chapter 4 describes the results of the scour analysis based on the hydrodynamic parameters presented in Chapter 3. Finally, Chapter 5 highlights other design considerations including vertical clearances, abutment and other shoreline protection, and deck drainage.

2.0 Site Description

2.1 General Site Characteristics

The existing SR 31 Wilson Pigott Bridge (#120064) spans the Caloosahatchee River (Figure 2.1) approximately 21 miles upstream from the river's confluence with the Gulf of Mexico and approximately 4 miles downstream of the W.P. Franklin Lock and Dam. The W.P. Franklin Lock and Dam were constructed in 1965 for flood control, water control, prevention of salt-water intrusion, and navigation purposes. The structure has a discharge capacity of 28,900 cfs. Figure 2.2 shows a close up view of the bridge over the river. The two-lane bascule bridge was constructed in 1960 and has a 25 ft clearance at the navigation span. The bridge is 778 ft long and contains 13 approach spans. The bridge's proximity to the Gulf of Mexico (connected via the Caloosahatchee River and San Carlos Bay) subjects the site to hurricane storm surge. Hurricane storm surge produces the conditions utilized to evaluate scour at the bridge.

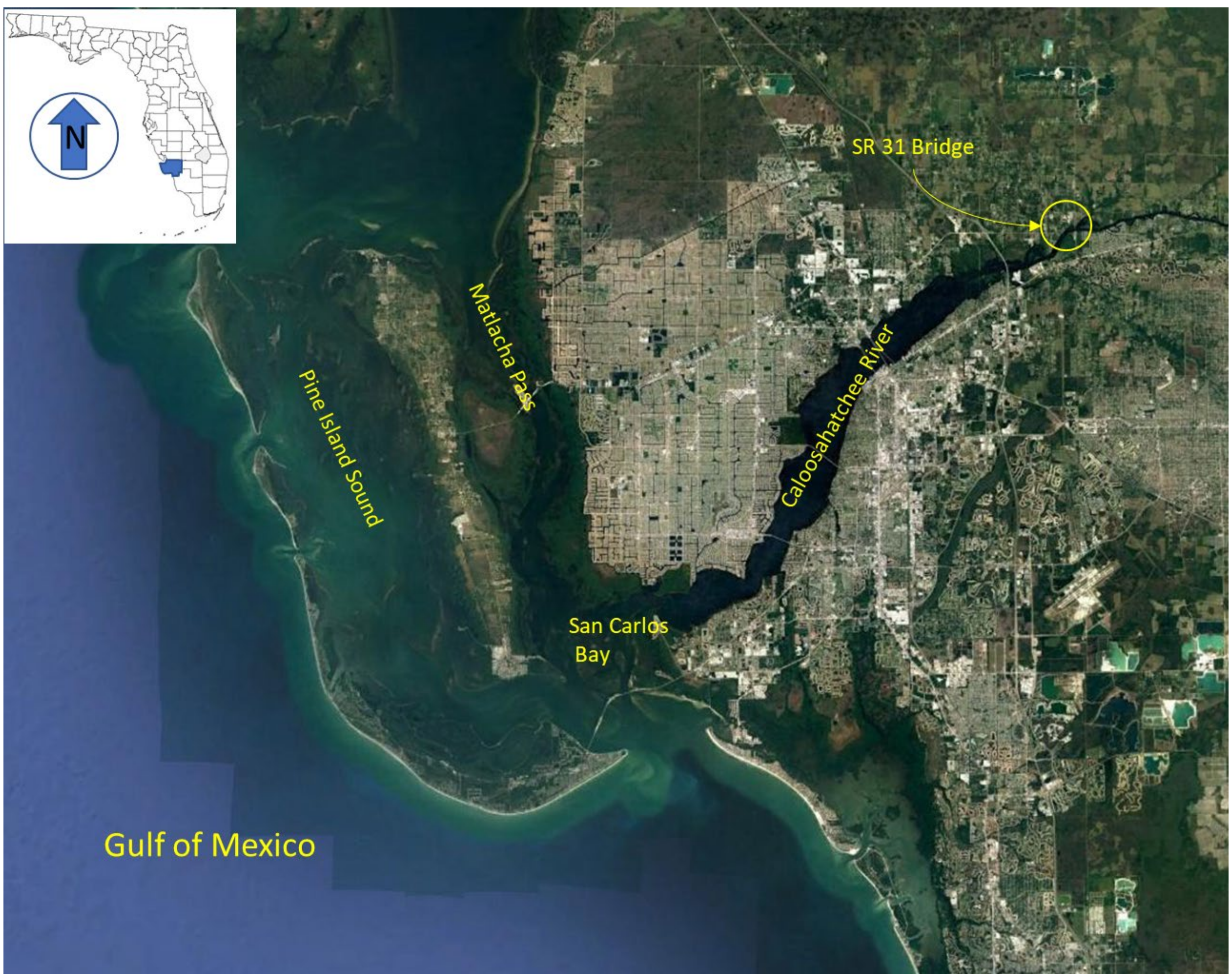

Figure 2.1 Location Map

Figure 2.2 Zoomed View of Existing Bridge

2.2 Tidal Datums

The closest National Oceanic and Atmospheric Administration (NOAA) Station is the Fort Myers, FL [8725520] station located near the US-41 bridge. Table 2.1 presents the tidal datums from this station. As Figure 2.2 illustrates the NOAA station is located in the Caloosahatchee River adjacent to the bridge. The tide gage is an active primary station. Values presented in Table 2.1 represent the tidal datums for the 1983 – 2001 tidal epoch.

Table 2.1 Tidal Benchmark Information, Fort Myers, FL (NOAA 8725520)

Tidal Datum Type	Elevation (ft-NAVD)
Mean Higher High Water (MHHW)	0.28
Mean High Water (MHW)	0.06
Mean Sea Level (MSL)	-0.41
Mean Low Water (MLW)	-0.89
Mean Lower Low Water (MLLW)	-1.04

The station location is approximately 8.5 river miles downstream of the project location. Given this distance, an alternative source of tidal datum information is provided by the Florida Department of Environmental Protection (FDEP) on its labins.org website. The website provides tidal interpolation points in most tidally influenced waterways between known NOAA benchmarks. From the website, tide interpolation point 1214 located just upstream of the bridge provides the closest source of information. The website lists the MHW as +0.23 ft-NAVD and the MLW as -0.78 ft-NAVD. Given the proximity of the point compared with the NOAA station, the FDEP values are recommended for use at this bridge.

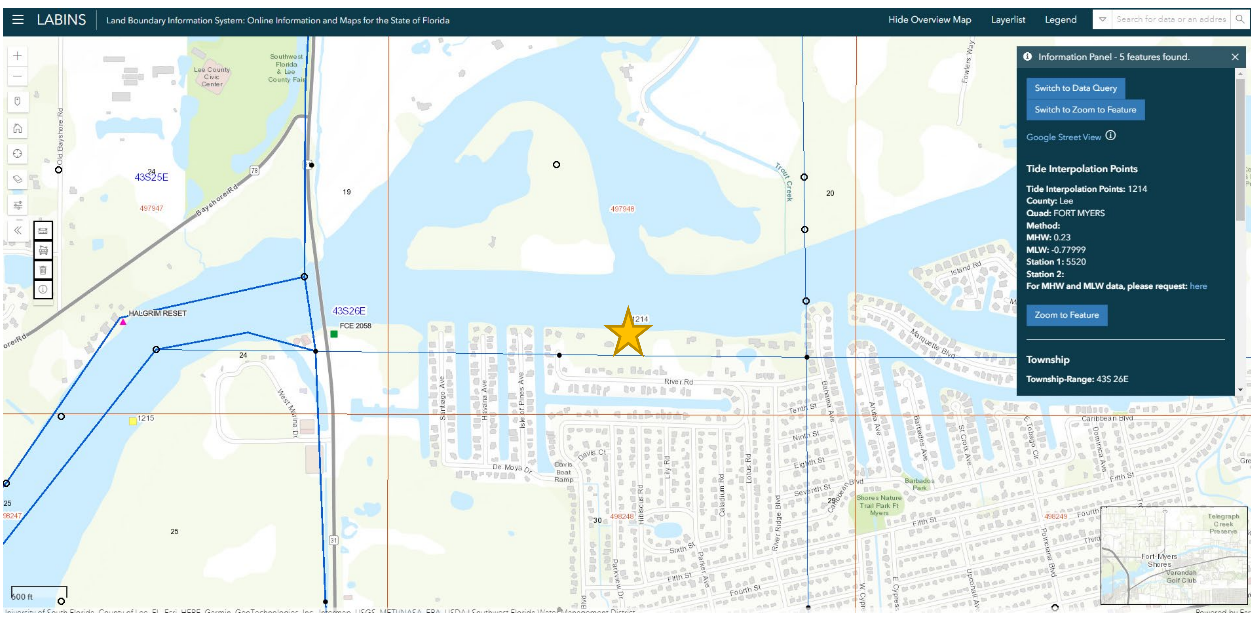

Figure 2.3 Labins.org Tide Interpolation Point Location

2.3 Winds

Notably, AASHTO (2008) recommends American Society of Civil Engineers (ASCE) 7-05 for determining design wind speeds. Given an updated ASCE document exists, namely ASCE 7-22, this study applied more recent values from the ASCE 7 Hazard Tool (https://asce7hazardtool.online/), which includes ASCE 7-22 values. The tool provides 3-second (sec) gusts for various return periods (Table 2.2) at the location of the bridge. Applying methods outlined in the U.S. Army Corps of Engineers' (USACE) *Coastal Engineering Manual* (USACE, 2006), this study converted these 3-sec gusts to sustained (also known as one-minute average wind speeds), 10-minute (min), and one-hour (hr) average wind speeds. The sustained wind speed corresponds to wind speeds on the Saffir-Simpson hurricane scale and, the 10-min wind speed corresponds to speeds utilized in Federal Emergency Management Agency (FEMA) storm surge modeling applications.

Table 2.2 Wind Speeds near the Bridge Site for Various Return Periods

Return Period (yr)	3-sec Gust (mph)	1-min Wind Speed (mph)	10-min Wind Speed (mph)	1-hr Wind Speed (mph)	Saffir-Simpson Category (Based on 1-min Wind Speed)
10	78	64	54	52	Category 1
25	100	82	69	67	Category 2
50	113	93	78	76	Category 3
100	124	102	86	83	Category 3
500	158*	129	109	106	Category 5

*Interpolated

2.4 Hurricane History

Hurricanes have significantly affected the project location. Investigation of NOAA's HURDAT database reveals that from 1850 to 2021, 106 tropical storms and hurricanes have passed within 60 nautical miles (nmi) of the bridge. Figure 2.3 shows the paths of these hurricanes and tropical storms. As the figure shows, some of the hurricanes and tropical storms made landfall very near the site or moved parallel to the coast.

Hurricane Ian most recently affected the area in 2022 weeks before the submittal of this report. It made landfall on Sept. 28, 2022 near Cayo Costa in southwestern Florida as a dangerous, high-end Category 4 storm. While high water marks are continuing to be collected, initial findings are that the hurricane induced a storm surge that reached in excess of 13 ft-NAVD on the coast at Fort Myers Beach and over 7 ft in the upper reaches of the Caloosahatchee River. The nearest NOAA tidal station to the bridge in the Caloosahatchee River at Fort Myers (Station No. 8725520; 26.6483° N, 81.8717° W) recorded a peak water surface elevation of +7.44 ft NAVD88.

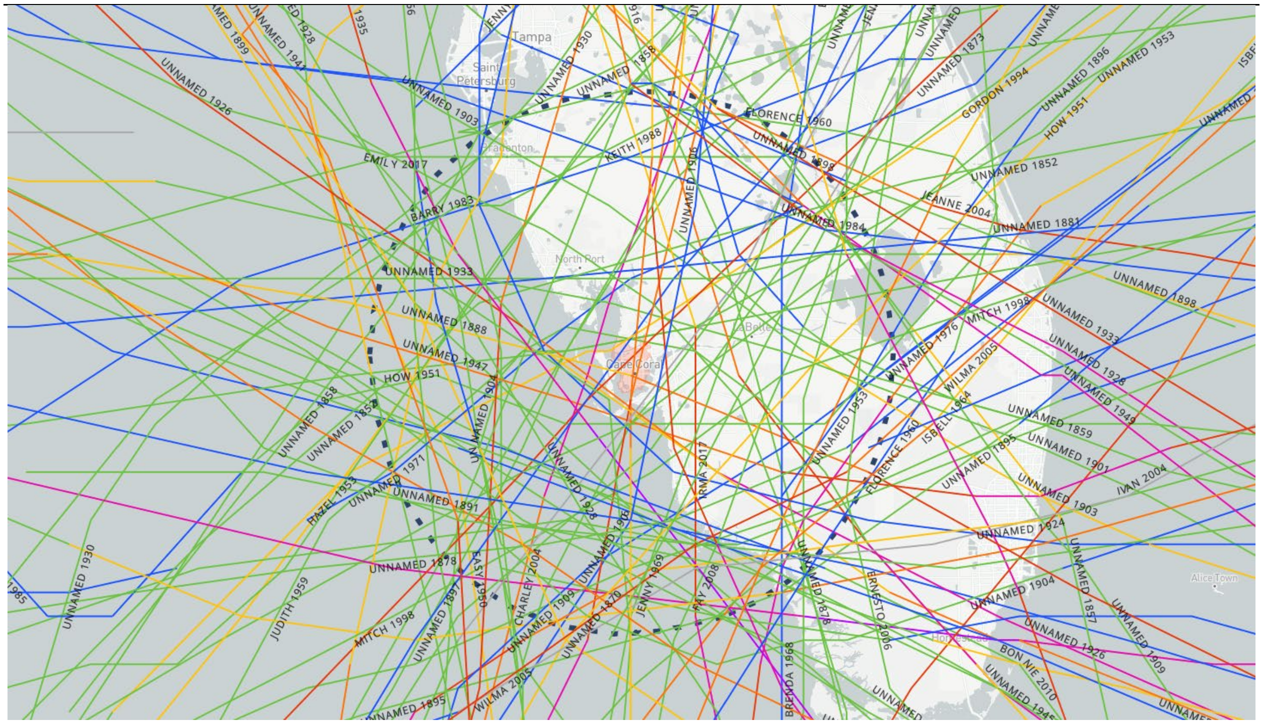

Figure 2.4 Tropical Storms and Hurricanes Passing within 60 nmi of the Bridge (1852-2021) (coast.noaa.gov/hurricanes)

For the hydrodynamic and wave modeling effort (discussed in Chapter 3), a wind and pressure field hindcast of Hurricane Charley drove the simulations for the calibration and the 50-, 100-, and 500-yr events. Simulating the 50-, 100-, and 500-yr events required scaling the hurricane Charley wind and pressure fields. Wind speed is scaled based on the wind data presented in Section 2.3. To scale pressure, a relationship between the central pressure and the wind speeds at landfall provides the method to scale these fields. Figure 2.4 presents a plot of the wind speed versus the central pressure for the maximum wind speed for all the hurricanes from the NOAA's HUDAT database that passed within one degree of the bridge. In the plot the black dots represent the value of the wind speed and central pressure for each hurricane and the dashed line represents the curve defined by the equation in the figure.

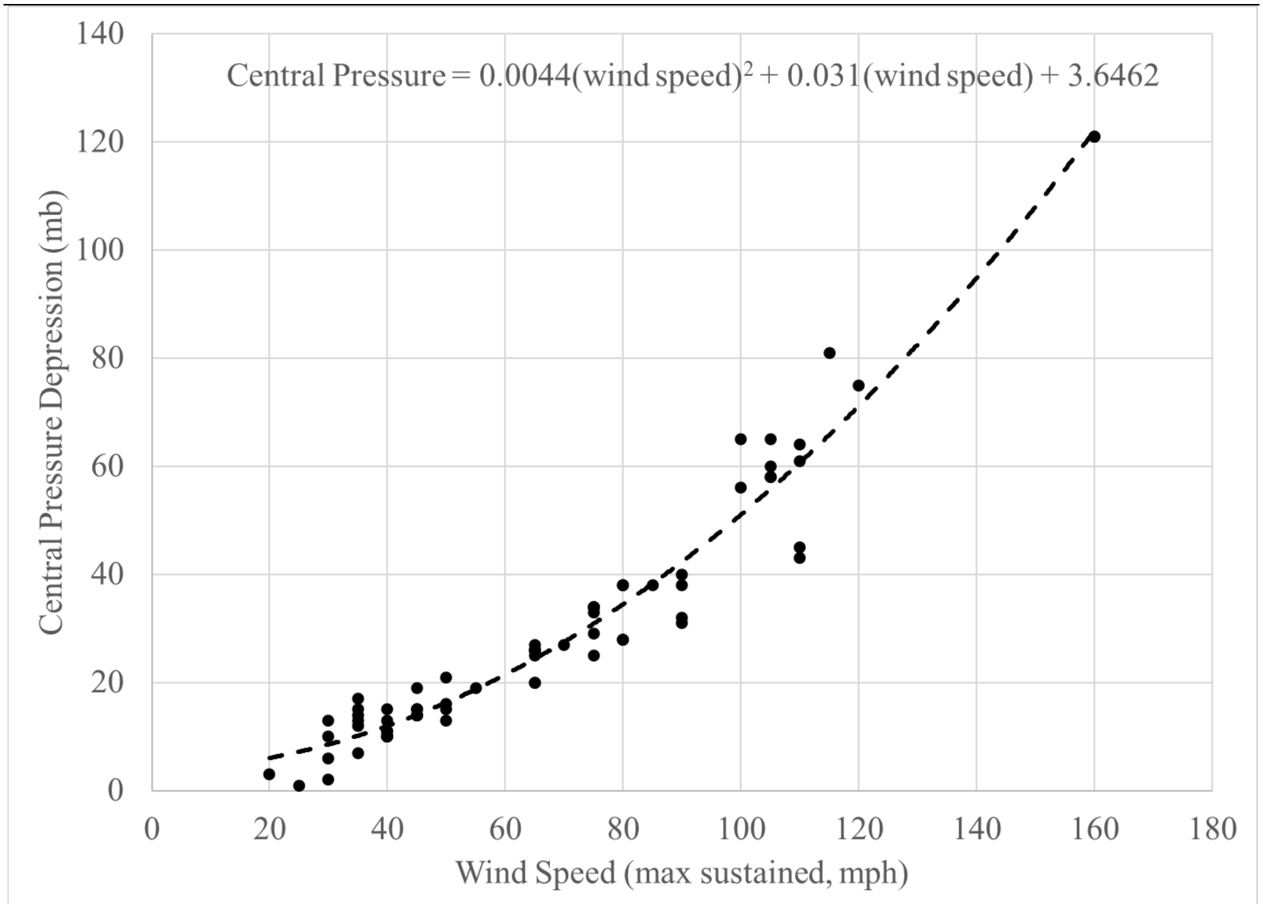

Figure 2.5 Central Pressure and Maximum Sustained Wind Speed Relationship

2.5 FEMA Flood Map and Studies

FEMA performs return period analyses for flood susceptibility nationwide. The results of these analyses culminate in the production of FEMA Flood Insurance Rate Maps (FIRMs) detailing the flood elevations for a specified return interval for a specific region. The effective FEMA study is dated August 28, 2008, with a revision dated December 7, 2018. A preliminary FEMA study dated November 17, 2022, is also available.

For the effective FEMA study, the bridge is depicted in FEMA Flood Map No. 12071C284F (Figure 2.6). The map locates the bridge within Zone AE (elevation +7 ft-NAVD88) with the north approach located within a Zone AE (elevation +7 ft-NAVD88) and the south approach emergent. The Flood Insurance study does not list still water levels (SWLs) for other return periods at the bridge, but the flood profiles at Kickapoo Creek just downstream of the bridge on the north bank show Caloosahatchee River backwater elevations for 25-, 100-, and 500-yr return period events equal to approximately +5.5, 7.0, and 8.0 ft-NAVD88.

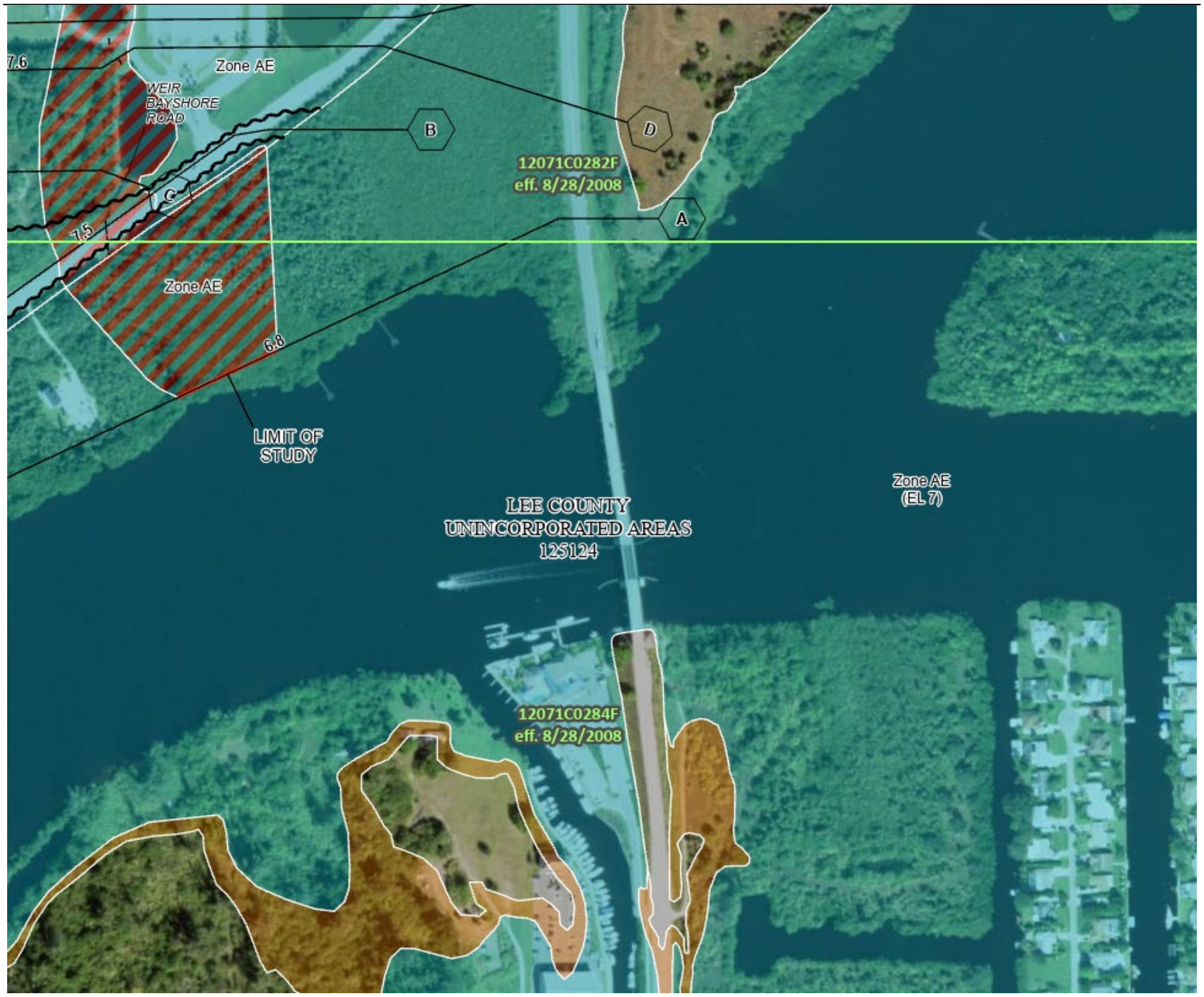

Figure 2.6 Excerpt of Effective FEMA Flood Map Number 12071C0284F (www.msc.fema.gov)

For the preliminary study, the bridge is depicted in FEMA Flood Map No. 12071C0284G (Figure 2.6). The map locates the bridge within Zone VE (elevation +12 ft-NAVD88) with both approaches emergent. FEMA's preliminary still water levels (SWLs) (i.e., water surface elevations) for 50-, 100-, and 500-yr return period events, equal 8.0, 9.3, and 12.7 ft-NAVD88.

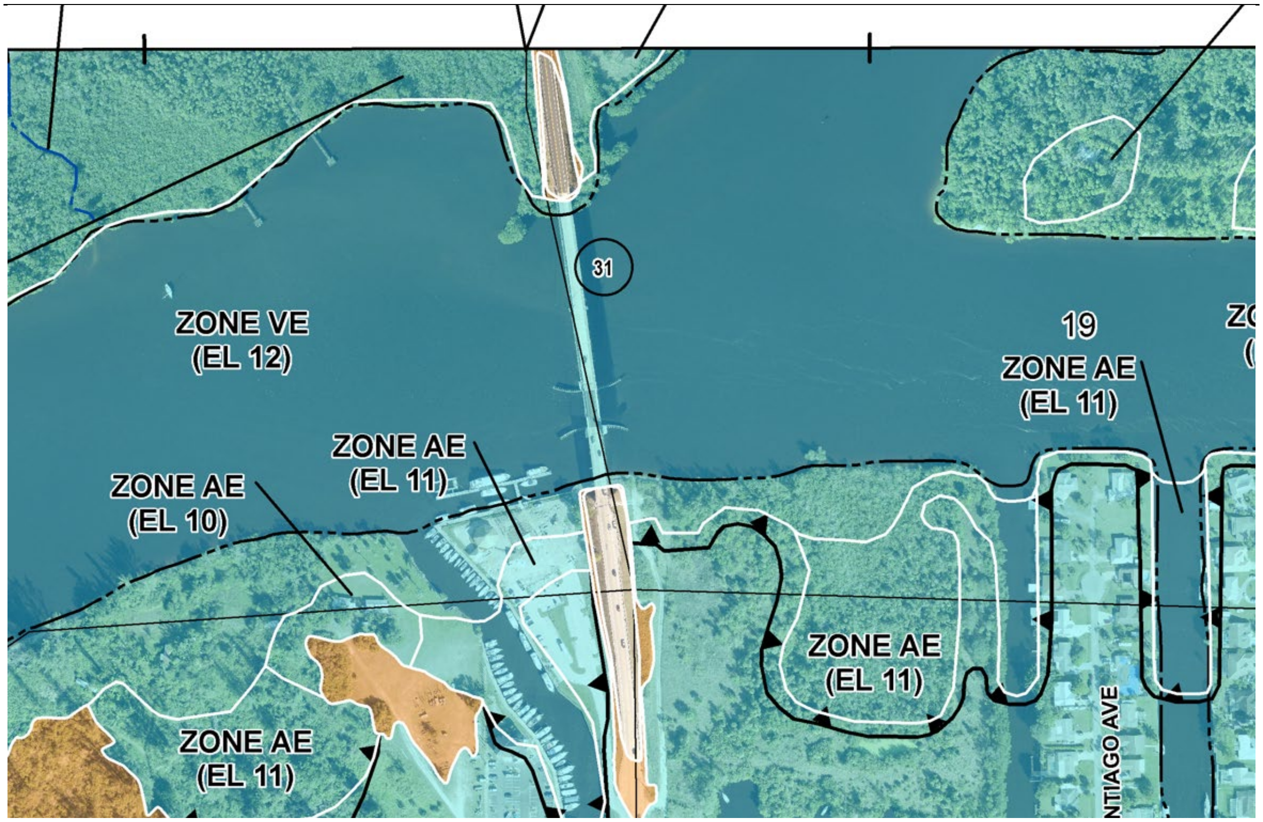

Figure 2.7 Excerpt of Preliminary FEMA Flood Map Number 12071C0284G (www.msc.fema.gov)

All bridge crossings must comply with the National Flood Insurance Program. As shown on the effective and preliminary FIRMs, the bridge does not lie in a FEMA floodway. Therefore, a FEMA no-rise study associated with the new bridge is not required.

2.6 Sea Level Rise

INTERA calculated SLR for this bridge in two ways, first employing the techniques described in the FDOT Drainage Manual (2022b) and second using probabilistic methods similar to the study they performed for Little Ringling Bridge. Notably, these two methodologies provide different estimates which are employed in different ways. The FDOT methodology is an estimate of the SLR at the end of life at the bridge. The method is the least conservative treatment of SLR. The probabilistic methodology is the expected value SLR to be combined with hurricane surge for the different return period events which can occur at any point during the lifetime of the bridge. It is not an end of life estimate. Additionally, given the nonlinear relationship between hurricane surge and water depth, it is possible to get different expected values of SLR for different return periods.

FDOT (2022b) indicates designers should apply straight-line extrapolation of the relative sea level rise trend at the nearest NOAA station to determine the sea level rise magnitude over the design life of the facility, in this case, the bridge. From the NOAA website, the historic sea level rise (3.37 +/- 0.44 mm/yr) measured at Fort Myers, FL (the closest, long-term NOAA gage to the site). Given the assumption the replacement bridge will begin service in 2030 and have a design service life of 75 years, bridge designers must consider for up to approximately 1.25 ft of sea level rise by 2105 using this methodology.

NOAA (2022) and the associated Interagency Sea Level Rise (SLR) Tool (Interagency Sea Level Rise Scenario Tool – NASA Sea Level Change Portal) provided the SLR localized for Fort Myers tidal gage. The methodology considers the whole life of a structure probabilistically and quantifies the risk associated with SLR exceeding design SLR. The storm surge and SLR are represented as probability distribution functions (PDF) based on storm surge return values and NOAA (2022) probabilities respectively. An idealized cost function is employed decreasing linearly from a value of two at the start of the structure life to a value of one at the end representing decreasing replacement costs and constant failure costs. Storm surge and SLR cannot be linearly superposed due to non-linear interactions. A correction factor for these non-linear effects can be developed using storm surge simulations with and without SLR. USACE Coastal Hazard System (CHS (dren.mil)) provided the simulation results to develop the necessary correction factors. Equipped with PDFs describing SLR and storm surge, and the equations to combine them, many realizations of the lifetime of the structure using Monte Carlo (MC) simulations are performed. Design elevations and design SLR are calculated such that the risk is equivalent to the accepted levels without SLR.

NOAA (2022) provides SLR probabilities conditional on global warming. The largest global warming case of 5°C is applied to give the most conservative SLR. Table 2.3 provides the calculated SLR for different return periods as compared with employing the straight line extrapolation methodology contained in the FDOT Drainage Manual. From the table, employing the probabilistic methodology with the 5°C warming case results in higher expected sea level rise than the FDOT methodology. It is important to note that the probabilistic values reflect the most probable SLR at the time of each event rather than the SLR at the end of life of the bridge (which is the case for the FDOT methodology).

Table 2.3 Sea Level Rise Calculations

	Sea Level Rise (ft)		
Method	**50-yr**	**100-yr**	**500-yr**
FDOT Drainage Manual	1.25	1.25	1.25
Probabilistic 5°C	1.5	1.5	1.4

Notably, Section 161.551, Florida Statutes (FS), requires state agencies, among others, which "commission or manage a construction project within the coastal building zone using funds appropriated from the state", conduct a sea level impact projection (SLIP) study. Section 161.54, FS defines the coastal building zone as "the land area from the seasonal high-water line landward to a line 1,500 feet landward from the coastal construction control line as established pursuant to s. 161.053, and, for those coastal areas fronting on the Gulf of Mexico, Atlantic Ocean, Florida Bay, or Straits of Florida and not included under s. 161.053, the land area seaward of the most landward velocity zone (V-zone) line as established by the Federal Emergency Management Agency and shown on flood insurance rate maps." Neither condition applies because the bridge does not lie in an area with a coastal construction control line and does not front the Gulf of Mexico, Atlantic Ocean, Florida Bay, or Straits of Florida. Therefore, the FDOT does not need to conduct a SLIP study for this project.

2.7 Sediment Characteristics

Tierra, Inc. (Tierra) performed a preliminary geotechnical study for the proposed bridge (2022). They collected four SPT borings near the existing bridge abutments and two water borings in April 2022. These borings generally show sand/silty sand overlaying layers of clay. Given that cohesive sediments generally resist scour, the scour calculation will assume that the bed is comprised of cohesionless sediment for the entirety of the bed.

Tierra reports median sediment sizes (*D50*) for the different soil types encountered for each boring. The data suggest a *D50* range of 0.28 to 0.33 mm (with a single outlier measurement of 0.09 mm) for soils within in the upper 6 ft of the soils. Scour calculations will test the sensitivity of this range on predicted scour depths.

Appendix A presents the reviewed soil boring logs and laboratory classification test results.

2.8 Bridge Geometry

Given the FDOT will construct the replacement bridge as part of a design-build contract, DRMP has only developed preliminary design parameters suitable for developing a request for proposal (RFP). The following paragraph presents some of the preliminary RFP details.

The high-level replacement bridge will locate to the east of the existing bridge alignment. The bridge consists of 11 intermediate piers with two end bents. The 12 spans are lengths vary from 165 to 166.5 ft. Piers 2, 3, 4, and 12 have dual hammer head configurations each founded on buried 20.5’ x 35.5’ x 8.0’ pile caps (thickness includes the seal). The top of the pile caps are buried 3 ft below grade. Beneath the pile caps are 3 x 5 pile groups comprised of 30” square prestressed concrete piles. The water piers (5-11) are also dual hammer head configurations each founded on 22.5’ x 59’ x 8.0’ water line pile caps (thickness includes the seal). The elevation of the top of the pile caps are +5.23 ft. Beneath the pile caps are 5 rows of 2 or 3 piles of 30” square prestressed concrete piles. Each dual hammer head pier is spaced 65’-4” apart. The bridge low chord occurs on the north side of the bridge and equals +13.82 ft-NAVD.

Appendix B presents some of the geometry details for the bridge.

3.0 Hydrodynamic and Wave Modeling

Scour computations require specific hydraulic parameters. Determining these parameters requires a detailed hydraulic analysis of the study area. The complexity of flow conditions at the bridge site dictated the method employed in this analysis. These conditions result from the propagation of a hurricane surge from the Gulf of Mexico through the San Carlos Bay and into the Caloosahatchee River.

To develop hydraulic parameters, INTERA employed a coupled model to simulate hurricane storm surge propagation. The coupled models are Advanced Circulation Model for Coastal Ocean Hydrodynamics (ADCIRC) code to provide a time-dependent, two-dimensional model to simulate the complex flow regime and the Simulating Waves Nearshore (SWAN) model provides a time-dependent, two-dimensional model to include wave-induced influences on still water levels and develop wave heights and periods. This chapter outlines the hydrodynamic and wave modeling efforts that developed the hydraulic parameters associated with the 50-, 100-, and 500-yr storm events.

ADCIRC, a numerical model developed specifically for generating long duration hydrodynamic circulation along shelves, coasts, and within estuaries, intends to produce numerical simulations for very large computational domains in a unified and systematic manner (https://adcirc.org/). ADCIRC solves the equations of motion for a moving fluid on a rotating earth. The equation formulation includes applying the traditional hydrostatic pressure and Boussinesq approximations and discretizing the equations in space via the finite element method and in time via the finite difference method. The ADCIRC program includes both a two-dimensional depth integrated (2DDI) mode and a three-dimensional (3D) mode. For both, the model solves for elevation via the depth-integrated continuity equation in Generalized Wave-Continuity Equation form. The model solves for velocity via either the 2DDI or 3D momentum equations. These equations retain all the nonlinear terms. ADCIRC includes solution capabilities in either a Cartesian or a spherical coordinate system.

The program simulated hurricane storm surges in the project area. Possible boundary conditions for the model include

- Specified elevation (harmonic tidal constituents or time series);
- Specified boundary normal flow (harmonic tidal constituents or time series);
- Zero boundary normal flow;
- Slip or no slip conditions for velocity;
- External barrier overflow out of the domain;
- Internal barrier overflow between sections of the domain;
- Surface stress (wind and/or wave radiation stress);
- Atmospheric pressure; and
- Outward radiation of waves (Sommerfield condition).

This study applied ADCIRC to simulate hydraulic parameters associated with the 50-, 100-, and 500-yr storm surge events.

For hurricane storm surge simulations, the inputs to the ADCIRC model include a bathymetric/topographic unstructured mesh, hindcasted wind and pressure fields, tidal constituents, and wave radiation stresses from SWAN.

In addition to providing wave radiation stresses, SWAN simulated wave heights and periods. Developed at the Delft University of Technology in the Netherlands, SWAN is a one- and two-dimensional numerical model for estimating wave parameters in coastal areas, lakes, and estuaries from given wind, bathymetric, and current conditions. The wave action balance equation with sources and sinks (Holthuijsen et al., 2003) forms the basis of the model. Wave propagation processes represented include propagation through geographic space, refraction due to spatial variations in bottom and current, shoaling due to spatial variations in bottom and current, blocking and reflections by opposing currents, and transmission through, blockage by, or reflection against obstacles. Wave generation and dissipation processes represented include generation by wind; dissipation by white-capping, depth-induced wave breaking, and bottom friction; and wave-wave interactions. The model contains both stationary and non-stationary operational modes formulated for Cartesian, curvilinear, or spherical coordinate systems. The inputs to the SWAN model include a bathymetric/topographic unstructured mesh, hindcasted wind field, water surface elevation, and currents from ADCIRC.

The following sections describe the setup and execution of ADCIRC (including wave model, SWAN; known as SWAN+ADCIRC).

3.1 Model Development

This study utilized a model mesh developed by INTERA for various bridge projects located within the Pine Island Sound area. The present study refined a portion of that model mesh lying within San Carlos Bay and the Caloosahatchee River to develop the hydraulics at the proposed bridge crossing. The refined mesh covers the western North Atlantic Ocean, the Gulf of Mexico, and the Caribbean Sea (Figures 3.1, 3.2, and 3.3). The mesh includes over 136,000 triangular elements with over 72,000 nodes located at the corners of the elements.

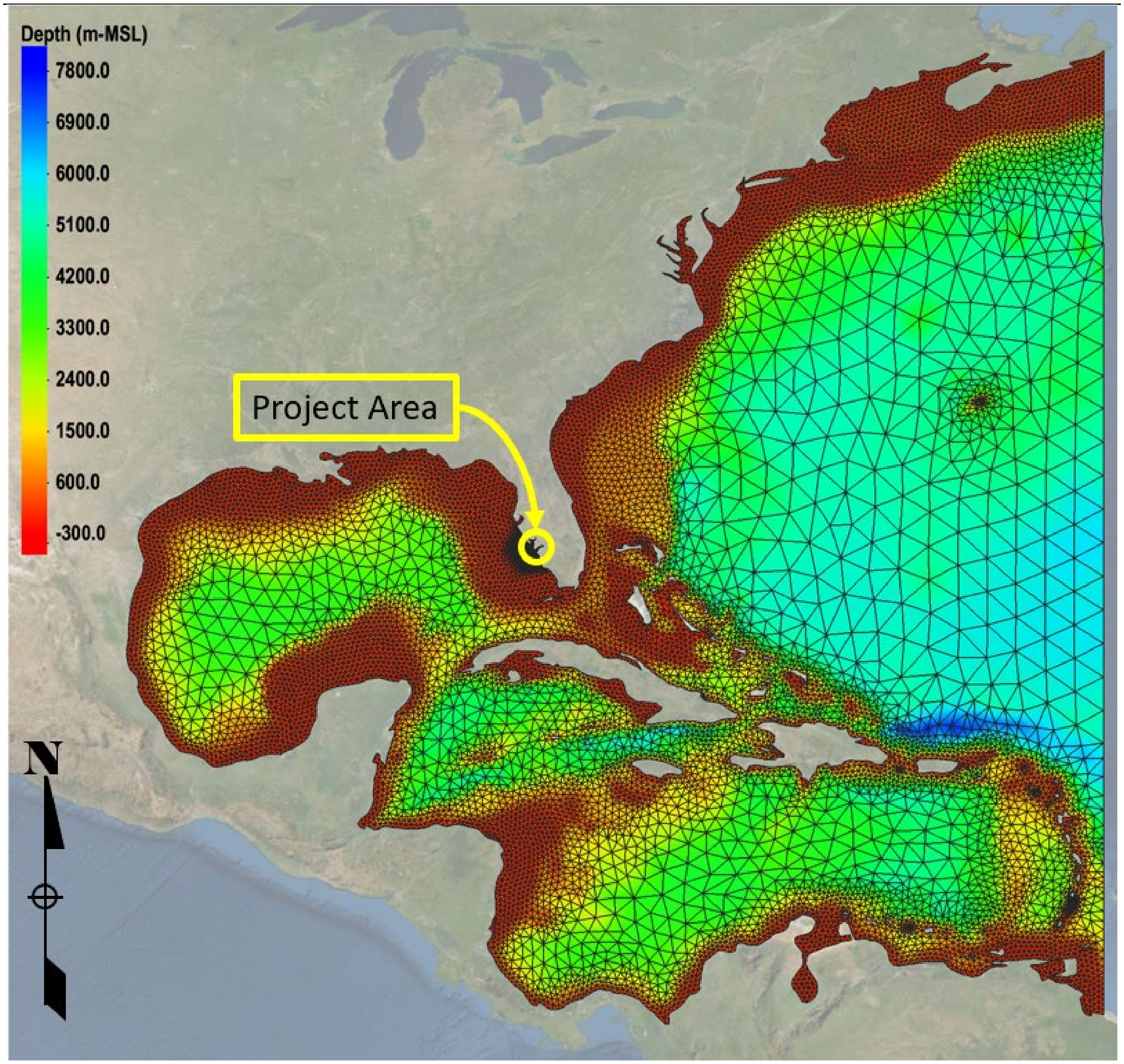

Figure 3.1 SWAN+ADCIRC Model Mesh Extent and Bathymetric Contours

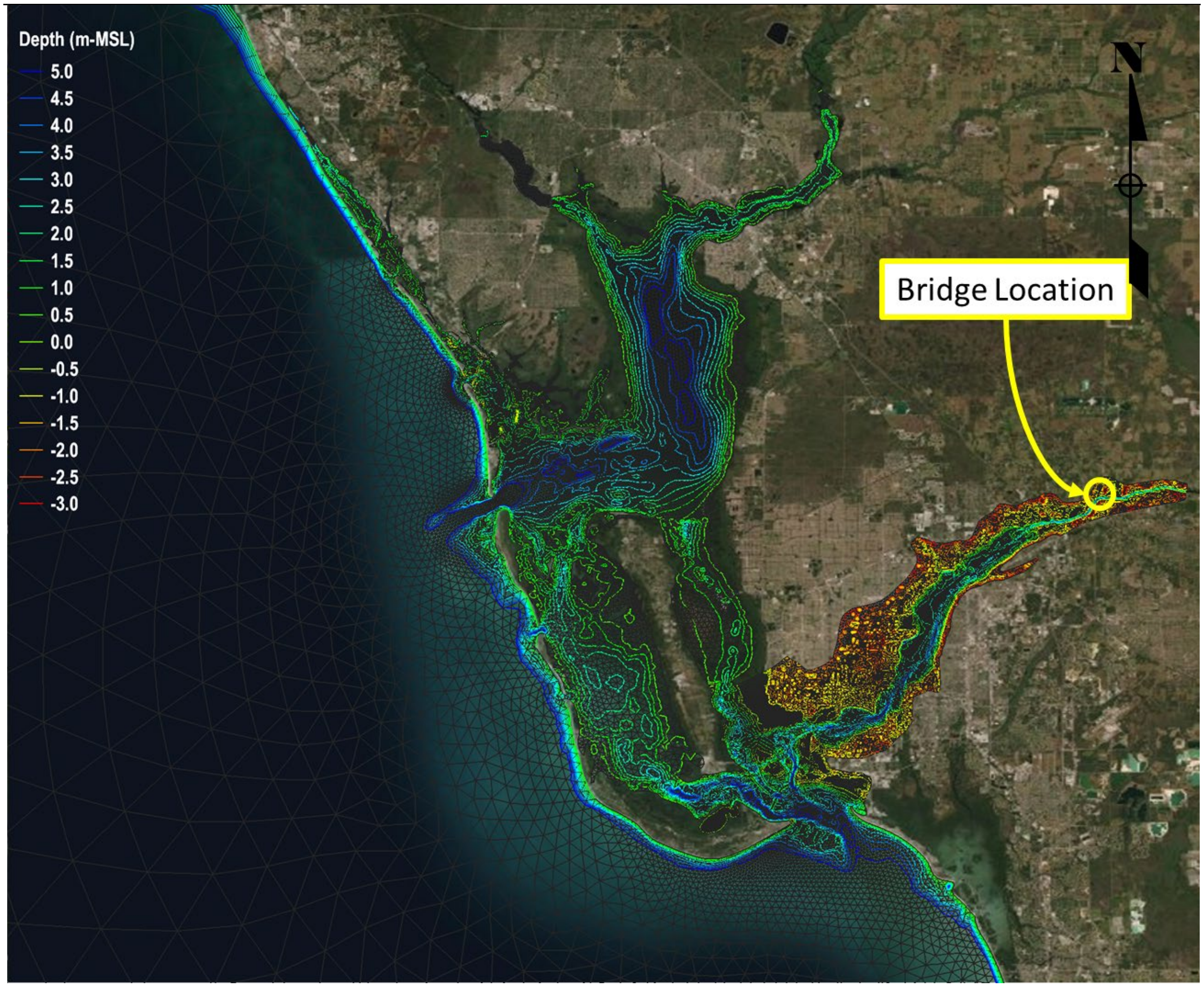

Figure 3.2 Regional View of SWAN+ADCIRC Model Mesh and Bathymetric Contours

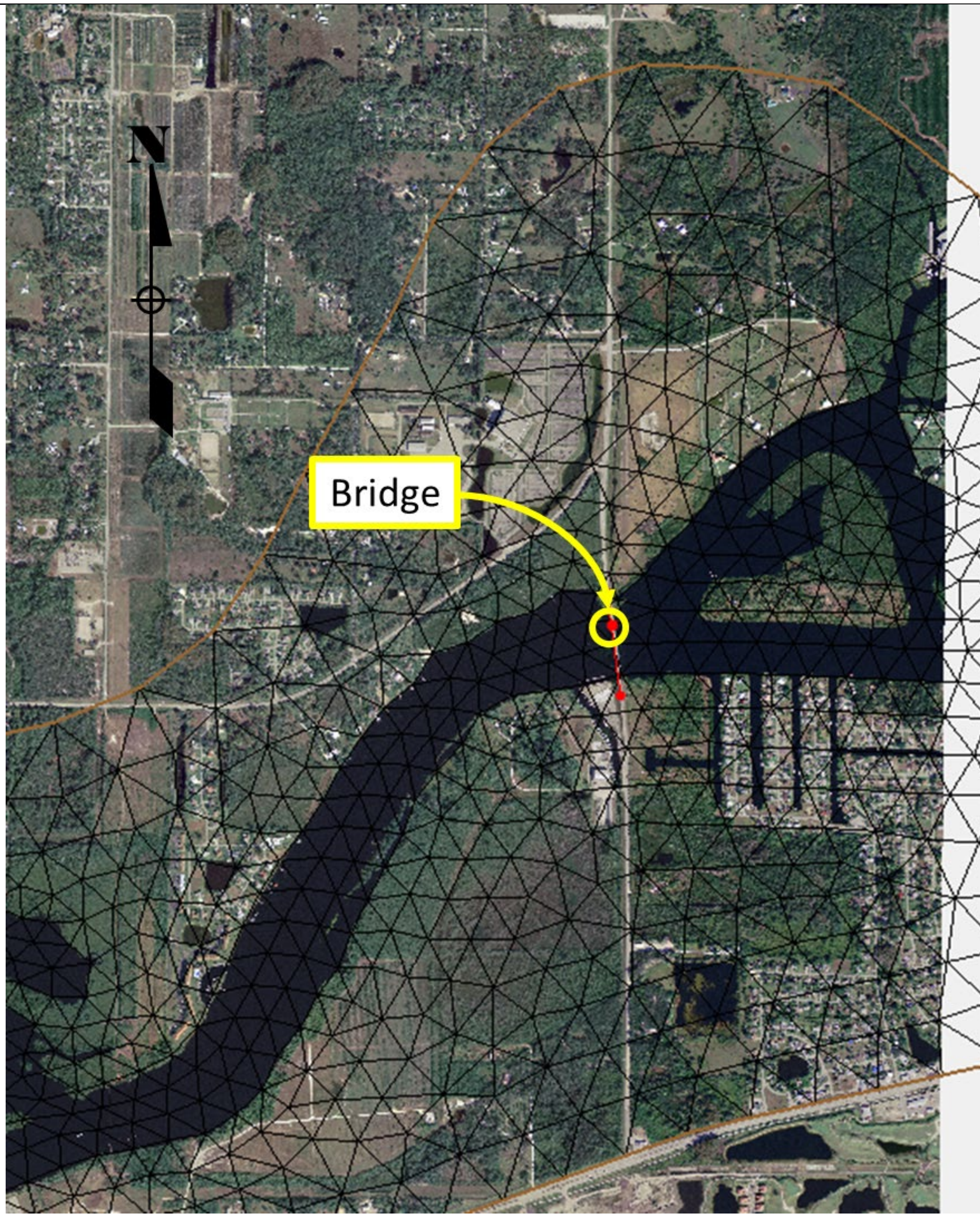

Figure 3.3 Local View of SWAN+ADCIRC Model Mesh and Bathymetric Contours

A wind and pressure field hindcast of Hurricane Charley drove the SWAN+ADCIRC simulations. First, model calibration simulations adjusted model parameters to closely match measured water levels at NOAA's Fort Myers station. Once calibrated, this study adjusted the hurricane's wind fields to match ASCE 7-05 50-, 100-, and 500-year wind speeds for winds oriented along the river at the bridge location. Scaling of the pressure fields occurred by subtracting atmospheric pressure (1,013.25 millibars) first, adjusting the central pressure depressions using the relationship shown in Figure 2.4, and adding back atmospheric pressure.

Table 3.1 Wind and Pressure Field Scaling Factors

Return Period (yrs)	Wind Speed Factor	Central Pressure Depression Factor
Hurricane Charley	1.00	1.00
50	1.85	1.37
100	2.04	1.57
500	2.60	2.24

In addition to wind and pressure fields, model setup also included specifying a tidal condition on the open ocean boundary along the eastern edge of the mesh. This study employed the 13 non-zero tidal potentials at each boundary node. These include the 2N2, K1, K2, L2, M2, MU2, N2, NU2, O1, P1, Q1, S2, and T2 constituents. All the simulations included specifying bottom friction via Manning's *n* (*n* = 0.11 for land, n = 0.04 for marsh, and n = 0.0195 for water, determined through calibration) and lateral eddy viscosity (ESL = 2.0 m2/s, also determined through calibration), both specified in ADCIRC, and a globally specified friction factor of 0.038 in SWAN. The time step for the simulations equaled 0.5 seconds.

3.2 Model Calibration

INTERA calibrated the model by simulating Hurricane Charley and matching measured water levels at NOAA's Fort Myers tide gage (station no. 8725520). Model calibration involves an iterative process of adjusting model parameters until the model results at a set location closely match NOAA's measured data at that location.

Model calibration applies the following error estimations as a quantitative method to judge their ability to reproduce measured events. The first equation provides an estimate of the mean error (*E*), the average of the deviation of the calculated from the measured values defined as

$$E = \frac{\sum_{i=1}^{N} (\chi_c - \chi_m)_i}{N} \tag{3.1}$$

where χ_c is the calculated value, χ_m is the measured value, and *N* is the total number of data points. A positive value for the mean error would indicate that the model overestimates the event, while a negative value would indicate the model underestimates the event.

The root-mean square error (E_{rms}) indicates the absolute error of the comparison. Equation 3.2 defines this error as

$$E_{rms} = \sqrt{\frac{\sum_{i=1}^{N} (\chi_c - \chi_m)_i^2}{N}} \tag{3.2}$$

The final error estimator (E_{pct}) represents the percent error. This variable gives an indication of the degree to which the calculated values misrepresent the measured values. Percent error is given as

$$E_{pct} = \frac{E_{rms}}{R} \tag{3.3}$$

where R is a representative range of the variable χ. For the hurricane simulation, the R-value equaled the storm surge height.

Calibration involved the adjustment of model friction and lateral eddy viscosity until modeled water surface elevations matched measured values fall within acceptable error range. FEMA (2007) defines this range as 10% or less for tidal calibrations. For storm surge calibrations, FEMA acknowledges the complexity associated with measurements during storms. Based on that complexity, FEMA notes that the acceptable error range will exceed values expected under normal tidal calibrations.

The hurricane hindcast simulation employed the coupled SWAN+ADCIRC model. As discussed above, input to this model includes wind and pressure fields and tidal constituents. Figure 3.5 compares the model predicted (hindcasted) water surface elevations with the measured values. Table 3.2 presents error calculations for the Hurricane Charley simulation. From Table 3.2, the percent error (9.7%) is well within FEMA's acceptable limits for calibration for tide-only simulations let alone for storm surge simulations.

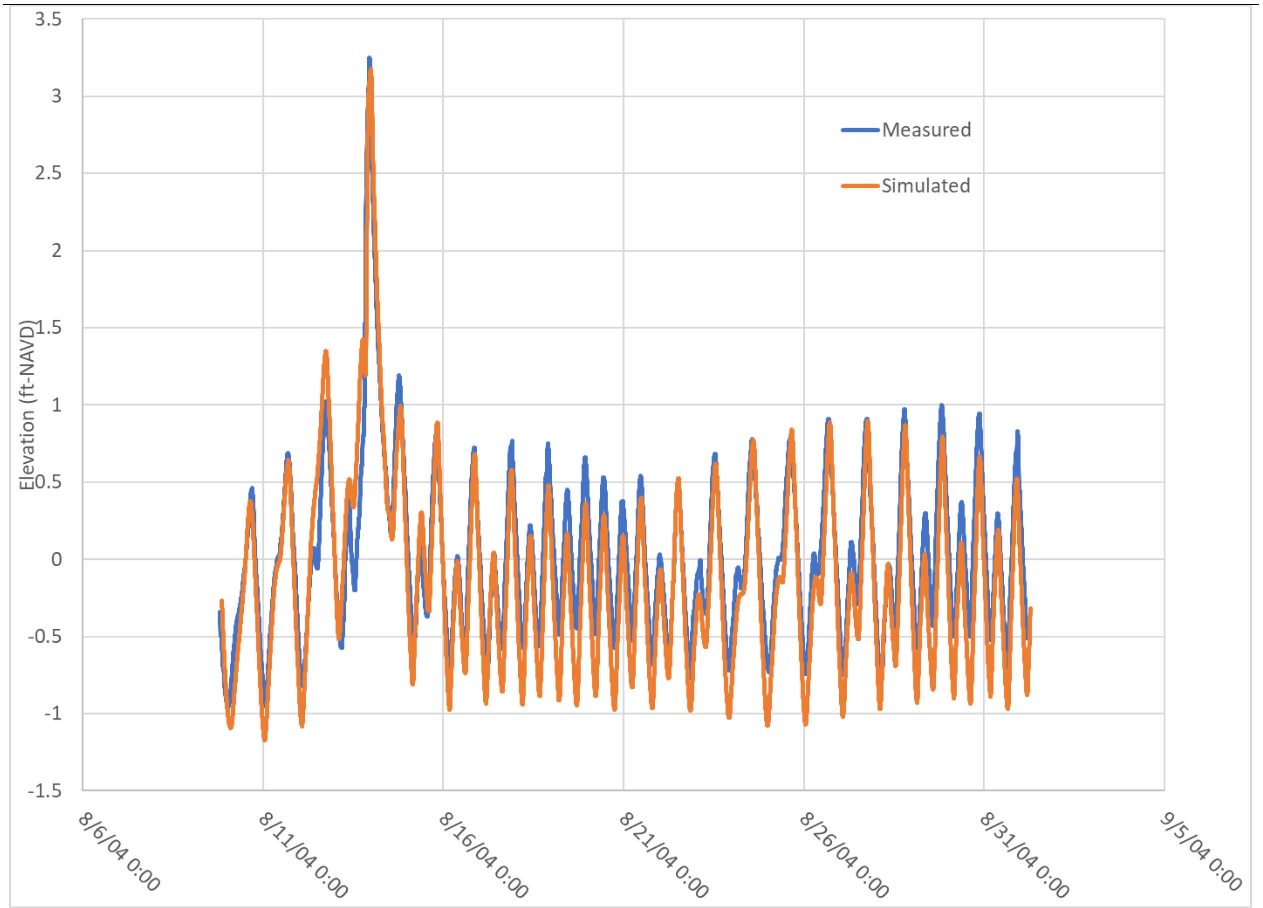

Figure 3.4 Measured and Predicted Water Surface Elevations at Fort Myers during Hurricane Charley

Table 3.2 Water Level Error Summary for Hurricane Charley (2004) at Fort Myers

Parameter	Value
Mean Error (ft)	0.16
RMS Error (ft)	0.43
Percent Error	9.7%

Given the percent error values are within FEMA's acceptable limits, the SWAN+ADCIRC model proves suitable for simulating hydraulic parameters associated with the 50-, 100-, and 500-yr hurricane storm surge events.

3.3 Model Simulation Results

This section presents the results of the storm surge modeling. Boundary conditions included tidal potentials at the ocean boundary and meteorological boundary conditions (wind and pressure) from Hurricane Charley scaled and translated to impact the bridge location. Notably, simulations were performed employing boundary conditions with runoff at the upstream boundary set at the capacity of the W.P. Franklin Lock and Dam with differing downstream elevations (MHW, MLW, with and without SLR). These simulations did not produce flows, velocities, or elevations that exceeded the storm surge simulations. As such, only the surge simulations are presented. Figures 3.6 – 3.8 present contours of the 50-, 100-, and 500-yr flow velocity magnitude and vectors representing the flow direction at the time of maximum velocity at the bridge. Figures 3.9 – 3.11 contain time series plots of water surface elevation, velocity magnitude, and flow rate for the 50-, 100-, and 500-yr storm surge events at the bridge's location. Table 3.3 tabulates the model results for the 50-, 100- and 500-yr storm surge events at the bridge.

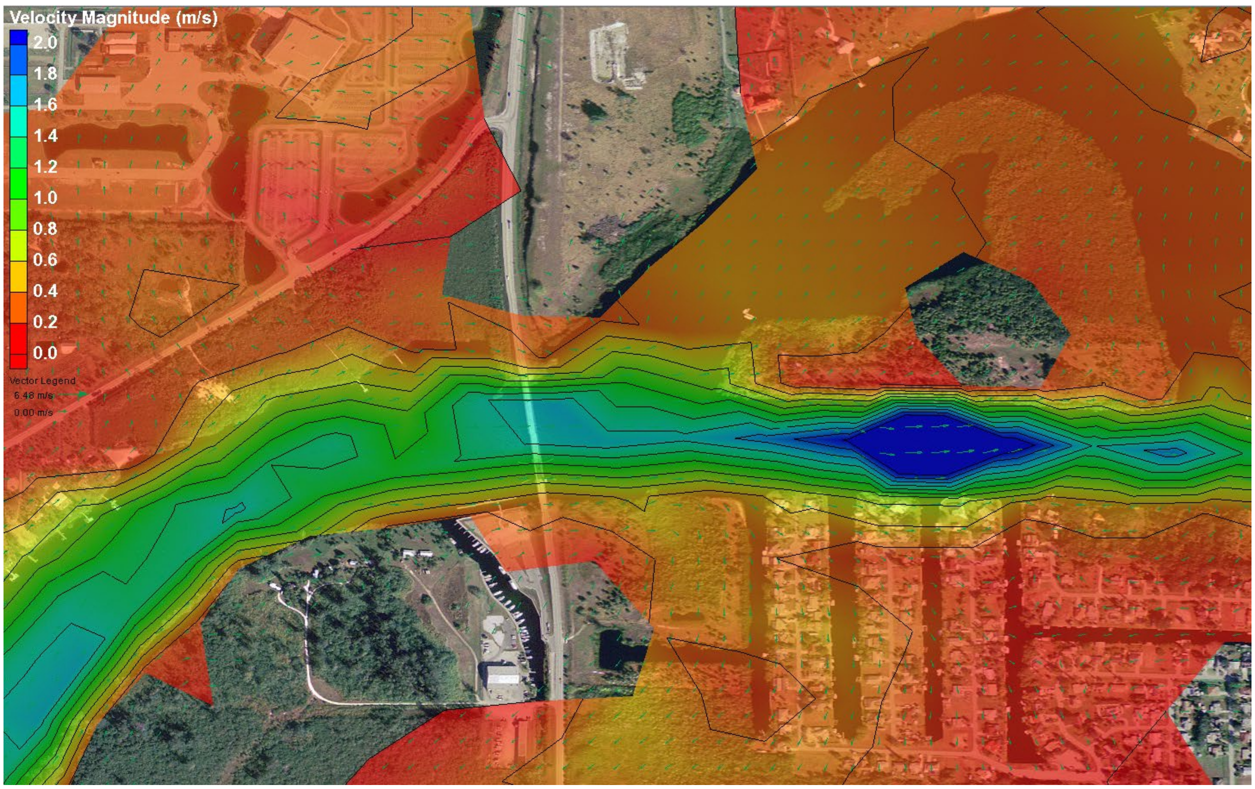

Figure 3.5 Velocities near Bridge during 50-yr Storm Surge Simulation

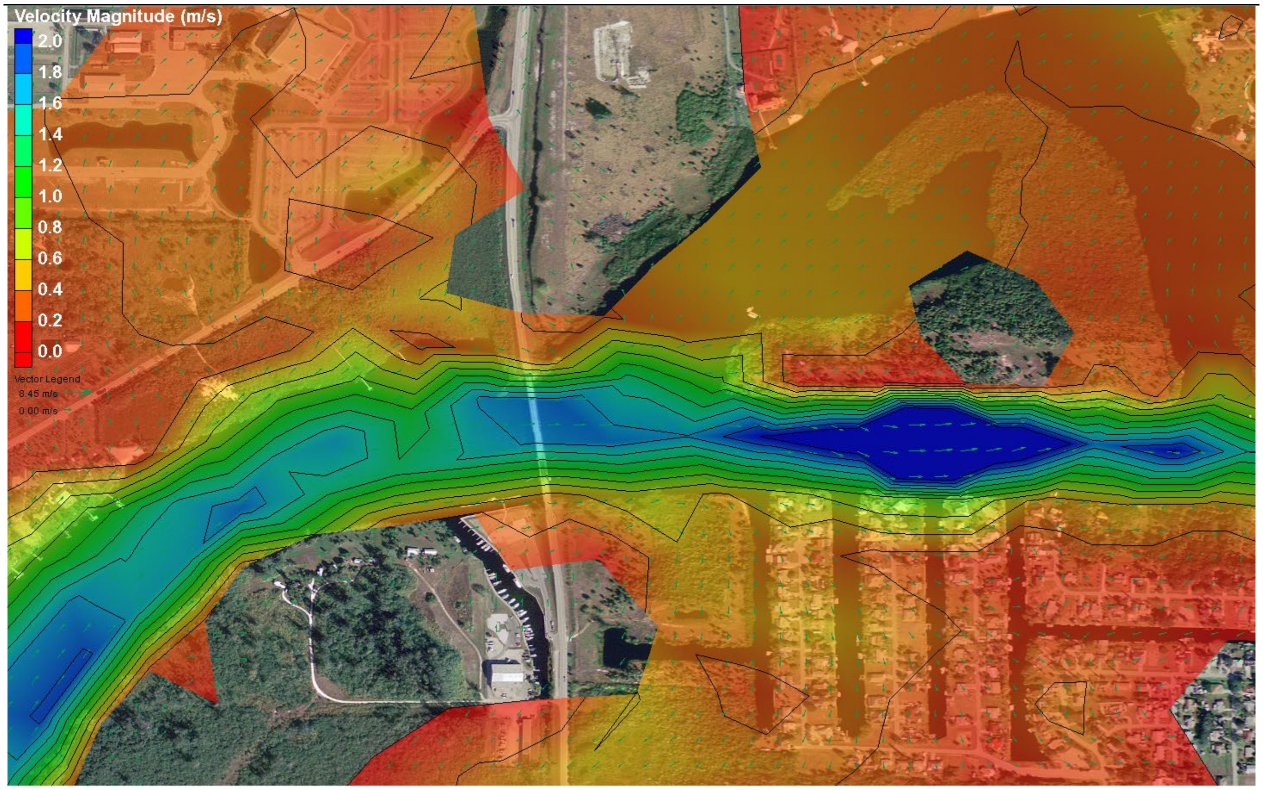

Figure 3.6 Velocities near Bridge during 100-yr Storm Surge Simulation

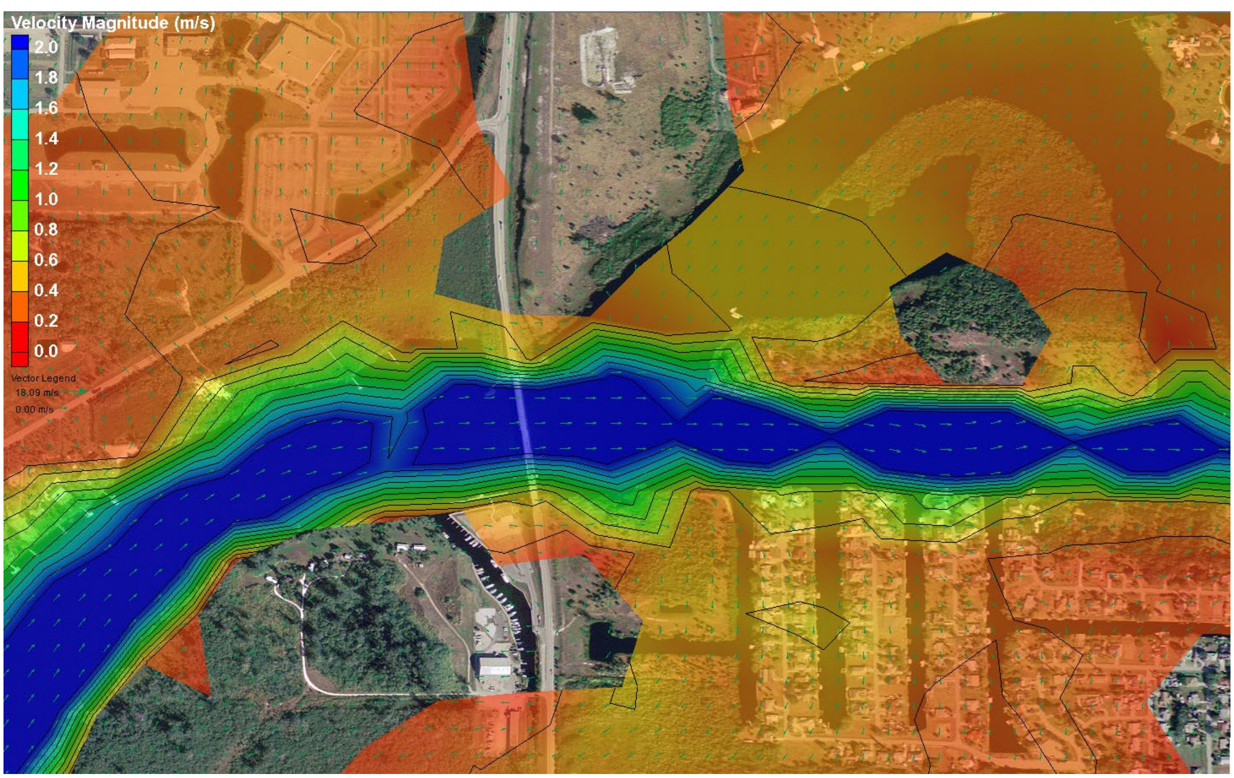

Figure 3.7 Velocities near Bridge during 500-yr Storm Surge Simulation

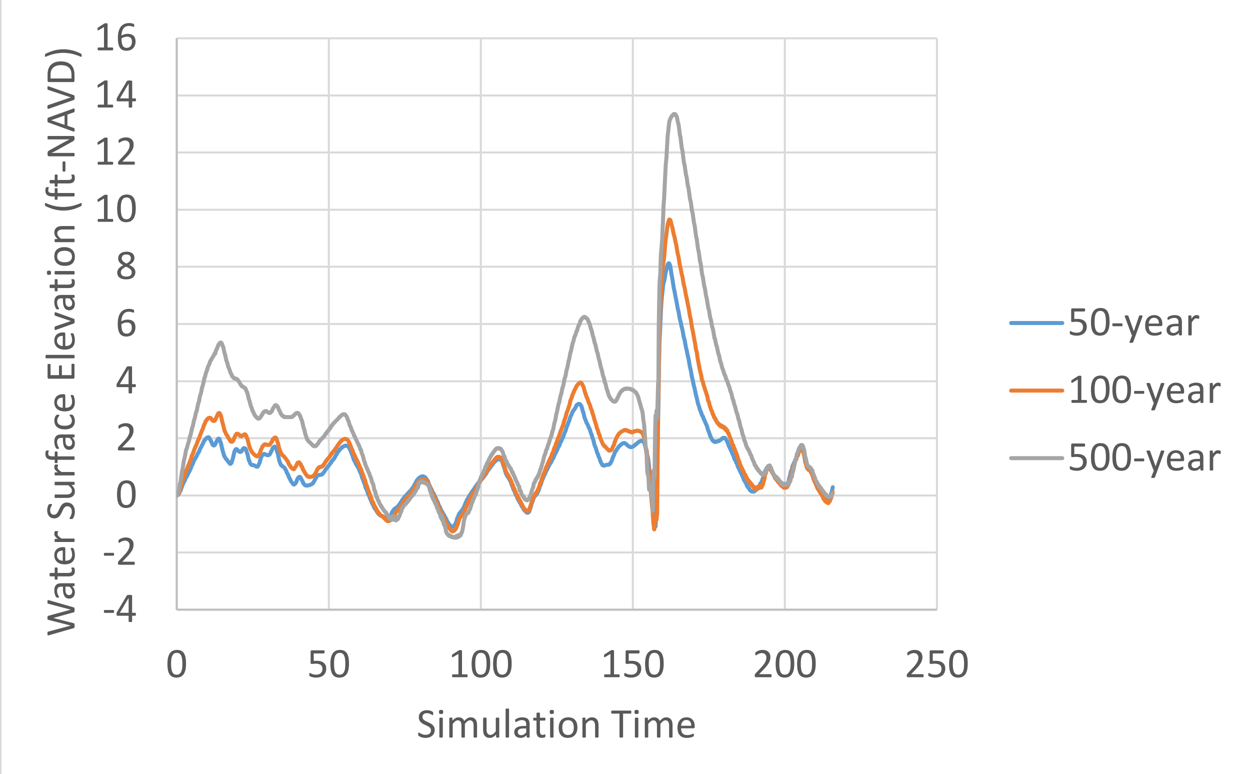

Figure 3.8 Water Surface Elevation Time Series for 50-, 100-, and 500-yr Storm Surge Simulation at the Middle of the Bridge

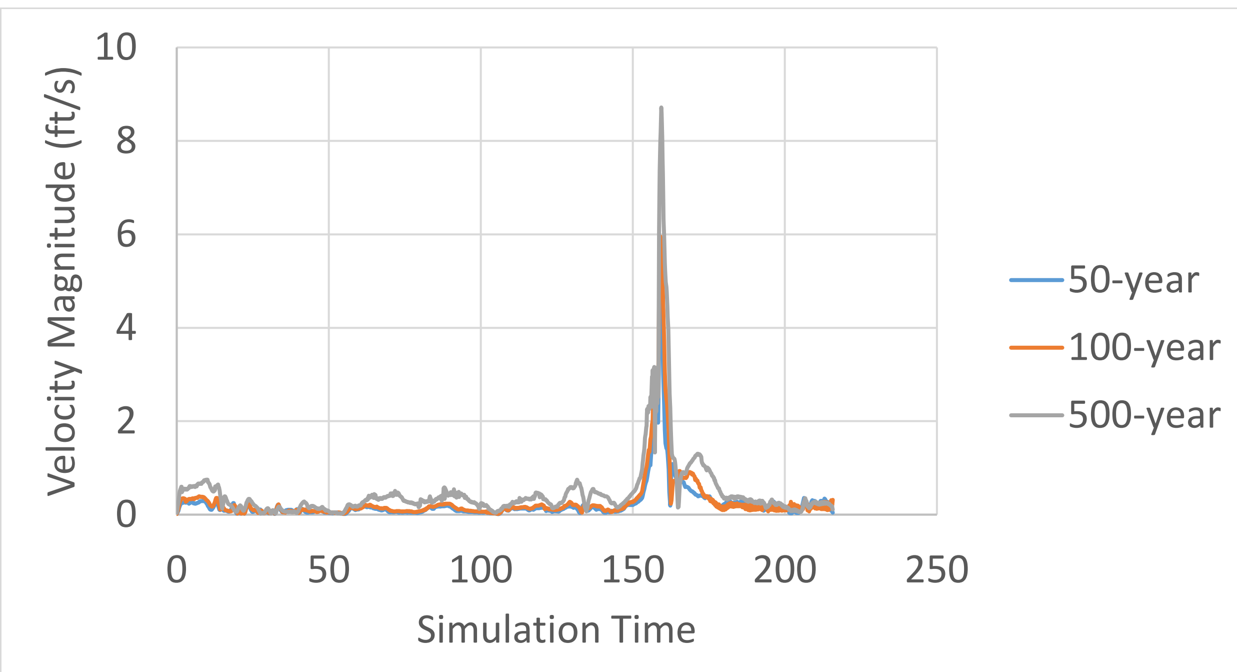

Figure 3.9 Velocity Magnitude Time Series for 50-, 100-, and 500-yr Storm Surge Simulation at the Middle of the Bridge

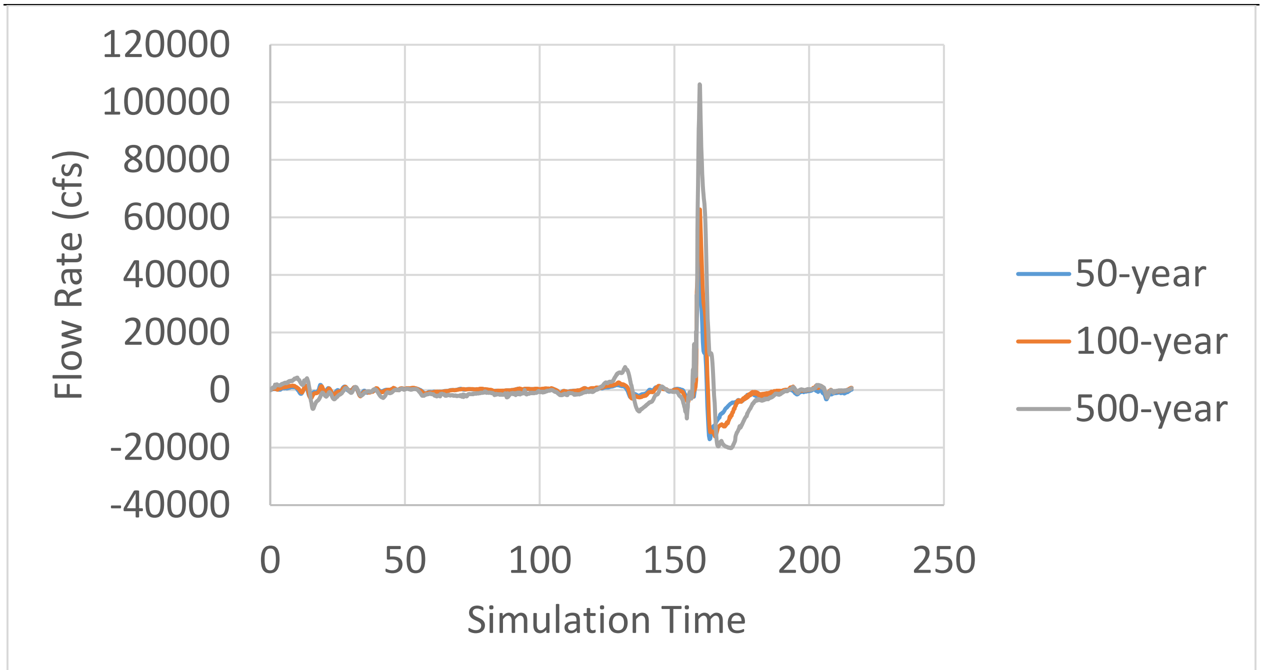

Figure 3.10 Flow Time Series for 50-, 100-, and 500-yr Storm Surge Simulation along the Bridge

Table 3.3 Hurricane Storm Surge Model Results at the Bridge without Sea Level Rise

Flood Data	**Design (50-yr) Flood**	**Base (100-yr) Flood**	**Greatest (500-yr) Flood**
Water Surface Elevation (ft-NAVD88)*	+8.1 (+9.6)	+9.7 (+11.2)	+13.4 (+14.8)
Maximum Discharge (cfs)	50,231	62,754	106,257
Maximum Velocity (ft/s)	4.9	6.0	8.7
Maximum Significant Wave Height (ft)		1.8	
Maximum Wave Crest Elevation (ft-NAVD)*		+10.6 (+12.1)	
Exceedance Probability (%)	2	1	0.2
Frequency (yr)	50	100	500

* Values in parentheses incorporate probabilistic sea level rise.

The water surface elevations match FEMA's preliminary values well. Results in parentheses represent elevations with sea level rise from section 2.6 added linearly. Additional output from the modeling included wave heights and peak period during the 100-year event. The highest significant wave height during the passage of the storm was 1.8 ft with a peak period of 2.6 seconds. These low wave heights are not surprising given the relatively short fetch lengths and the fact that the winds blow across the river during the height of the storm surge. The maximum wave crest elevation was developed from the surge and wave time series and equaled +10.6 ft-NAVD during the 100-year event. Notably, the wave crest elevations will not reach the low chord of the bridge even with sea level rise added.

4.0 Scour Calculations

Total scour consists of three components: (1) general scour (aggradation/degradation and meandering), (2) contraction scour, and (3) local scour. Unlike general scour, the contributions of local and contraction scour derive from the results of the hydraulic analysis presented in Chapter 3. Local scour computations apply empirical equations developed by FDOT in conjunction with the University of Florida. The formulation of the complex pier scour calculation methodology follows techniques described in the Florida Bridge Scour Manual (FDOT, 2021). Determination of general and contraction scour follow the methodologies discussed in HEC-18 (Arneson et al., 2012). These equations require inputs such as main channel flow, local velocities (magnitude and direction), and depth of flow. The model simulations presented in Chapter 3 provide the values for these parameters. This chapter presents discussions of the scour components and the results of these scour calculations for the bridge.

4.1 General Scour

Most of the bridges in the National Bridge Inventory (NBI) that cross water bodies continually adjust their beds and banks (Lagasse et al., 2012). Channel stability at the bridge crossing depends on the stream or tidal system. Changes upstream and downstream affect stability at the bridge crossing. Natural and manmade disturbances may result in changes in sediment load and flow dynamics resulting in adverse changes in the stream channel at the bridge crossing. These changes may include channel bank migration, aggradation, or degradation of the channel bed. During channel migration, one bank tends to erode laterally while the opposite bank tends to accrete. During aggradation or degradation of a channel, the channel bed and thalweg tend to accrete or erode.

Channel stability, as characterized by channel migration and aggradation/degradation of the channel bed, is an important consideration in evaluating the potential scour at a bridge for two reasons. First, because aggradation and degradation influence the channel’s hydraulic properties, any hydraulic modeling must consider their effects when determining design scour conditions. Second, bank migration, thalweg shifting, and degradation may cause foundation undermining regardless of whether the bridge experiences the design storm event. This section presents an analysis of channel migration and aggradation/degradation of the channel bed at the bridge. This analysis forecasts channel stability based on historic observations near the bridge. The analysis incorporates a review of available historic aerials near the bridge. These help to evaluate channel migration and thalweg position within the channel banks and aggradation or degradation of the bed.

4.1.1 Historical Conditions — Long-term Aggradation/Degradation

Long-term aggradation (deposition) or degradation (erosion) considers historical observations at the bridge site to analyze changes to the channel cross section projected over an extended period. This analysis allows the designer to predict the channel bathymetry at some future time and use this prediction to determine the hydraulic parameters needed to compute contraction and local scour depths. Thus, the evaluation of the potential exposure of the bridge foundations to the cumulative effects of scour requires an understanding of the long-term changes of channel bathymetry.

The most recent bridge inspection report (Marlin Engineering 2021) contains historical cross sections appropriate for long-term aggradation/degradation analysis at the bridge. Available data spanned the period 1998 to 2021. Typically, a bridge inspector obtains these profiles from the measurement of lead lines deployed over the railing or from the water line at each bent. Small errors in bottom data are common in lead line measurements; factors such as current velocity, marine growth, continuity in measurement location, and operator error frequently induce such errors. Nevertheless, analysis of the channel profile history documented by these surveys indicates the degree of long-term aggradation/degradation and channel stability. Additionally, since no historical information is available along the new alignment, this analysis assumes that long-term trends at the existing bridge will be the same as along the proposed alignment.

Figures 4.1 – 4.2 present the historical cross sections for the existing bridge crossings. The cross sections indicate some minor fluctuations over the period examined. Historical changes to the watershed area, such as new dam installation and sediment mining (dredging), could affect long-term bay hydrology and sediment loads. Dams can alter stream morphology by trapping sediment, modify the stream hydrograph, and change the sediment size distribution. Given the presence of the lock upstream, it is prudent to include some form of degradation into the scour analysis. Averaging the elevation change from both profiles yields a degradation of 0.06 ft over the 23 years between the first and last inspection. Scaling this to a 75 year life yields 0.2 ft of degradation. For the purposes of scour calculation this value is rounded up to 1.0 ft.

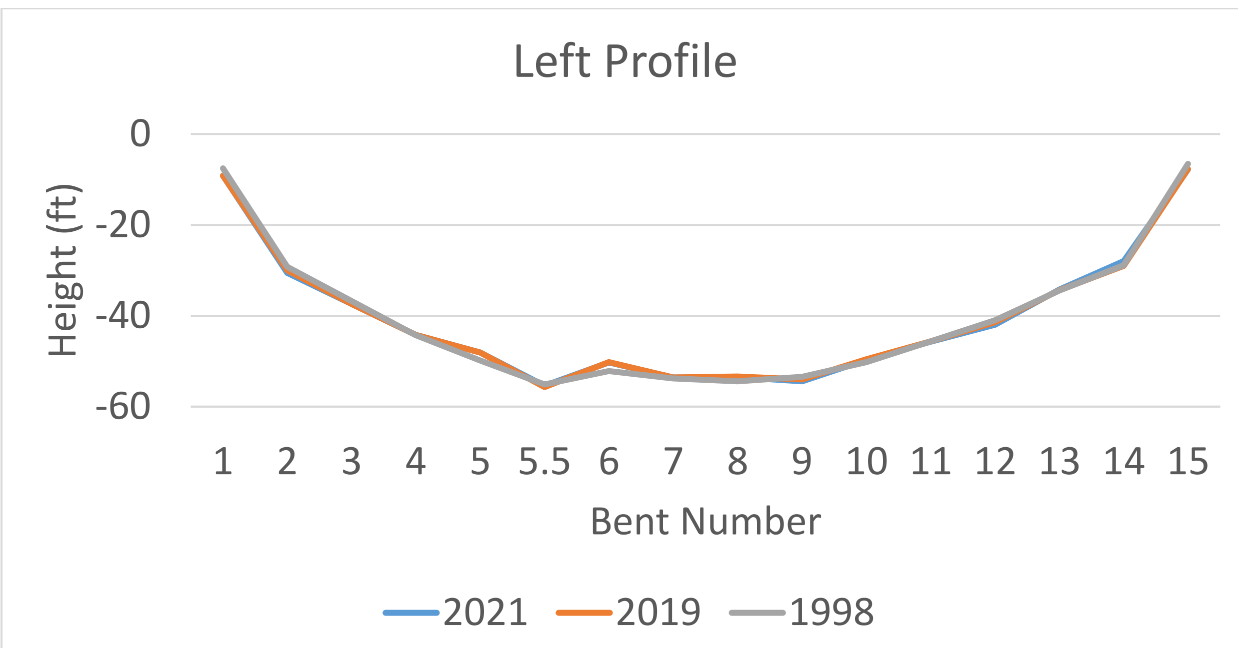

Figure 4.1 Left Profile Bed Cross Section of Existing Bridge

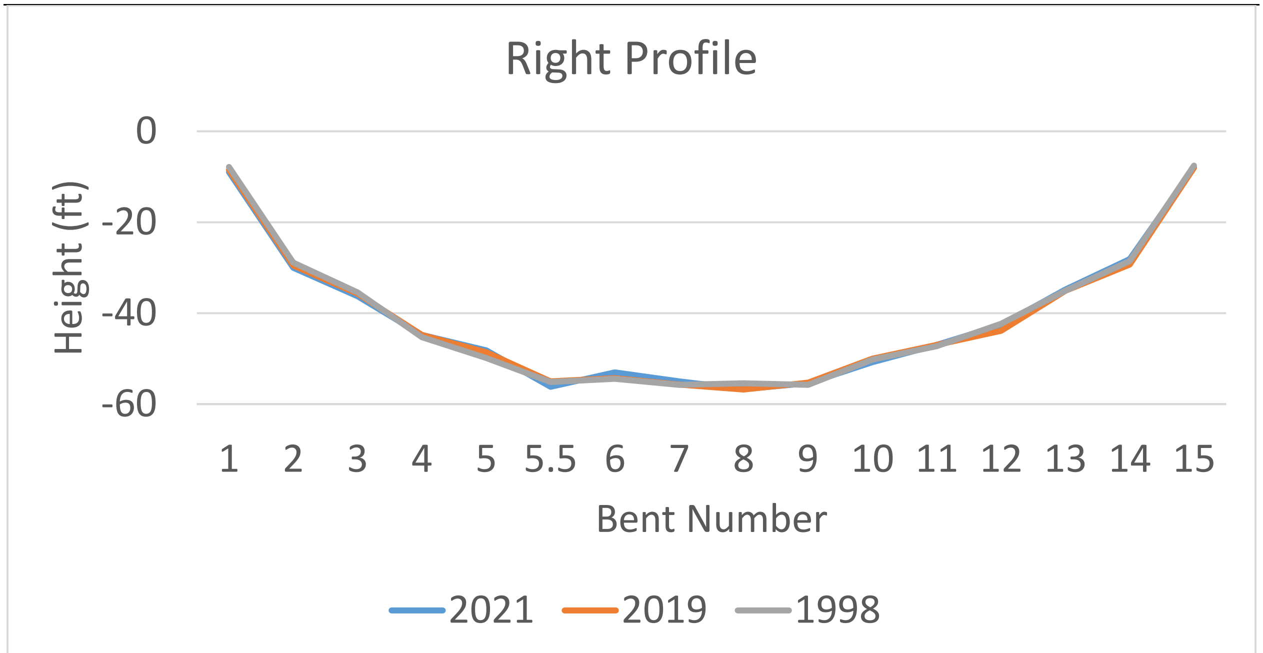

Figure 4.2 Right Profile Bed Cross Section of Existing Bridge

4.1.2 Channel Migration

Lateral channel migration is an important factor to consider when deciding on a bridge's location. Rivers and streams, dynamic entities, can continually shift banklines and move both laterally and downstream. Bridges, on the other hand, are static entities that fix the river/stream at a specific location. This juxtaposition of a bridge's immobility and a river's instability can lead to erosion of the approach embankment, changes in the contraction or local scour due to changes in flow direction, or increases in abutment scour. Factors affecting lateral channel migration include stream geomorphology, bridge crossing location, flood characteristics, characteristics of the bed and bank material, and wash load (Arneson et al., 2012).

The shorelines near the bridges could potentially accrete and erode based on seasonal and long-term variations of currents and wave climate. Additionally, the channel could experience sedimentation and lateral shifting of the thalweg. Aerial imagery and historic channel surveys provide the best means to determine long-term erosive or accretive trends of the shorelines and channel near the bridge crossings. Based on aerial imagery from 1994 – 2022 (see figures below) and the above channel cross-sectional surveys, the shorelines appear stable. The shorelines of the river and Havens Island have changed little as the surrounding area has developed over time.

Figure 4.3 Historical Aerial 1994 from Google Earth

Figure 4.4 Historical Aerial 2022 from Google Earth

4.1.3 Conclusion

From the available survey data and watershed information, degradation scour at the bridge is calculated as 1 ft over the lifetime of the bridge. Lateral shifting of the channel is considered negligible.

4.2 Contraction Scour

An abrupt decrease in cross-sectional area at a bridge induces an increase in velocity, which causes contraction scour (a lowering of the channel bottom over the entire width of the cross section). Changes in cross-sectional area can result from natural channel constriction and encroachment of a bridge structure by both the abutments and the piles. HEC-18 presents equations and procedures for computing contraction scour under various encroachment conditions (cases). Case 1C (Figure 4.5) — abutments set back from edge of channel — best approximates the conditions at the bridge.

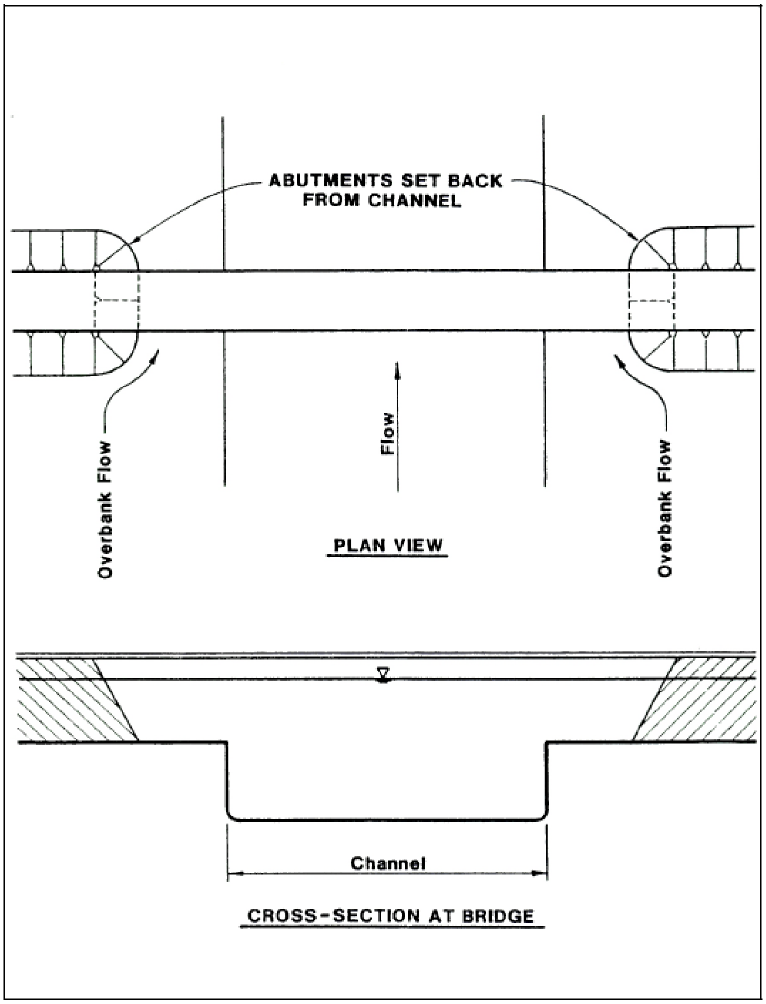

Figure 4.5 Diagram of Case 1C – Abutments Set Back from Edge of Channel (Arneson et al., 2012)

Computing contraction scour for the bridges requires determining whether the scour occurs as live-bed or clear-water. That is, scour depth computations require values for the depth-averaged critical velocity in the channel necessary to begin sediment motion on the bed. Calculating these values requires representative sediment sizes (generally the median grain size, *D50*). This analysis examined three median grain sizes: 0.1, 0.28, and 0.33 mm (Section 2.7).

Live bed contraction scour computation follows the Modified Laursen Live Bed Contraction Scour Equation found in HEC-18 (Section 6.3):

$$\frac{y_2}{y_1} = \left(\frac{Q_2}{Q_1}\right)^{6/7} \left(\frac{W_1}{W_2}\right)^{k_1} \tag{4.1}$$

$$y_s = y_2 - y_0 \tag{4.2}$$

where *y* is the average depth of the cross section, *Q* is the flow rate through the cross section, and *W* is the width of the cross section. The subscripts 1 and 2 refer to the locations upstream of the bridge and at the bridge and y_0 is the average existing depth in the contracted section. For live bed conditions, sediment transport primarily occurs as suspended load. As such, k_1 ranges from 0.64 to 0.69. If primarily bed load sediment transport, then k_1 equals 0.59. One then applies Equation 4.2 to determine scour depth.

Given the location of the new alignment and the direction of flow during the design event (upstream), the flow through the new bridge is expanding from the previous alignment rather than contracting. Based on their average flows, water depths, and velocities produced by SWAN+ADCIRC simulations (Chapter 3) and the bridge geometry, both the 100- and 500-yr events produce no contraction scour (Table 4.1) as expected. Therefore, contraction scour does not contribute to total scour.

Table 4.1 Contraction Scour Inputs and Results

Variable	Units	Definition	100-yr	500-yr
y_1	ft	Average depth in the upstream main channel	14.3	14.6
V_1	ft/s	Average velocity in the upstream main channel	6.2	10.3
D_{50}	mm	Median diameter of bed material	0.38	0.38
K_u		Vc Coefficient	6.2	6.2
V_c	ft/s	Critical velocity	1.88	1.89
$V_1>V_c$?		Scour Mode	Live bed	Live bed
y_1	ft	Average depth in the upstream main channel	14.3	14.6
y_2	ft	Average depth in the contracted section	7.1	7.1
y_0	ft	Existing depth in the contracted section before scour	9.0	9.2
Q1	ft^3/s	Flow in the upstream channel transporting sediment	62,754	106,262
Q2	ft^3/s	Flow in the contracted channel	62,754	106,262
W_1	ft	Bottom width of the upstream main channel that is transporting bed material	705	705
W_2	ft	Bottom width of main channel in contracted section less pier width(s)	1,026	1,026
K_1		Exponent	0.64	0.69
y_s	ft	Contraction scour	0.0	0.0

4.3 Local Scour

Local scour refers to bed erosion around obstacles in the path of flow. Obstacles may include piers and abutments. Local scour results from fluid acceleration and vortex creation around the obstacle and near the bed. The amount of scour depends on obstacle geometry, current velocity and angle of attack or skew angle (the angle between the flow direction and the major axis of the pier/pile group), flow depth, and soil characteristics. HEC-18 separates local scour into two categories — pier scour and abutment scour — based on the type of obstacles the flow encounters.

4.3.1 Pier Scour

Flow parameters vary with time and location within the bridge cross section. To determine the most conservative (maximum) scour depth, this study applied the FDOT local scour formulas (FDOT, 2021) to calculate the local pier scour for the maximum velocity at multiple points across the bridge cross section. Additionally, this study included a sensitivity study of multiple sediment sizes (0.1 to 0.33 mm) to identify which sediment yielded the highest scour estimations. The FDOT equations predict the scour depth based on sediment characteristics (*D50*), flow parameters, and complex pier geometry. The flow parameters include depth, velocity, and angle of attack. The pier geometry includes the dimensions of the pile cap and pile group.

Table 4.2 presents the maximum local scour (and design scour elevations) computed at the bridge for the 100- and 500-yr storm events. Analyses focused on estimating local scour with the maximum velocity and associated water surface elevation and maximum water surface elevation and associated velocity. For each of these two conditions, study calculations employed the maximum conditions across all the water piers and across all the land piers. Assumed initial bed elevations originated from survey data provided by DRMP and rounded down to the nearest foot. Reported scour depths reflect the maximum scour depth calculated under the design storm surge conditions. Appendix C presents local scour calculation input and output tables. Because of scour theory limitations, scour calculations conservatively assume that the water based dual hammer head piers 5 – 11 function as one continuous unit given their close proximity. Notably, this leads to very high predictions of scour at piers 10 and 11 where the pile cap exerts significant influence on the bed given how shallow the water is near these piers.

Table 4.2 Bridge Scour Elevations for Design Events

Pier Number	Initial Bed Elevation (ft-NAVD)	Degradation (ft)	100-year Event			500-year Event		
			Contraction Scour (ft)	Local Pier Scour (ft)	Total Scour Elevation (ft-NAVD)	Contraction Scour (ft)	Local Pier Scour (ft)	Total Scour Elevation (ft-NAVD)
2	7.0	0.0	0.0	5.9	1.1	0.0	6.0	1.0
3	5.0	0.0	0.0	5.9	-0.9	0.0	6.0	-1.0
4	2.0	0.0	0.0	5.9	-3.9	0.0	6.0	-4.0
5	-13.0	1.0	0.0	16.1	-30.1	0.0	19.4	-33.4
6	-21.0	1.0	0.0	15.4	-37.4	0.0	18.1	-40.1
7	-23.0	1.0	0.0	15.3	-39.3	0.0	17.9	-41.9
8	-8.0	1.0	0.0	17.3	-26.3	0.0	21.5	-30.5
9	-8.0	1.0	0.0	17.3	-26.3	0.0	21.5	-30.5
10	-2.0	1.0	0.0	24.4	-27.4	0.0	30.2	-33.2
11	-2.0	1.0	0.0	24.4	-27.4	0.0	30.2	-33.2
12	2.0	0.0	0.0	5.9	-3.9	0.0	6.0	-4.0

4.3.2 Abutment Scour

Local scour takes place at abutments that obstruct flow and modify the flow field. The FDOT Drainage Manual (FDOT, 2022b) states “abutment scour estimates are not required when the minimum abutment protection is provided.” The proposed bridge replacement will include abutment protection. As such, abutment scour calculations prove unnecessary.

4.4 Long Term Scour for Vessel Impact

Bridge foundations designed to resist ship impact include in their load combinations estimates of long- and short-term scour. Per AASHTO (2009), long-term scour includes anticipated future channel degradation and scour across the entire water body in the absence of the bridge. This definition differs from the general channel processes definition. In practical terms, long-term scour for vessel impact corresponds to everyday scour for live-bed conditions and the 100-yr total scour for clear-water conditions.

Figure 3.9 shows the velocities at the bridge crossing during the surge events. From the figure, the days before the storm show tidal velocities well below the 1.8 fps required to be considered in the live bed range. Because this velocity is larger than the magnitudes shown in the figure, clear-water scour would occur at the structure during normal tidal flows. For structures subject to clear-water scour, the long-term scour equals the 100-yr (Design) scour at the piers. Table 4.2 presents the scour values.

5.0 Other Design Considerations

In addition to calculating the bridge hydraulics and associated scour, this BHR also addresses vertical clearance, abutment and other shoreline protection, and deck drainage. This chapter discusses these other design considerations.

5.1 Vertical Clearance

5.1.1 Environment

Section 260.8.1 of FDOT (2022c) specifies a 12-ft minimum clearance above MHW for concrete superstructures in aggressive waters (i.e., high chloride content). The FDOT set this criterion to protect the bridge superstructure from corrosion by placing it above the splash zone. Given a MHW elevation of +0.23 ft-NAVD and 1.25 ft of sea level rise (FDOT method for end of life), the low member of the bridge should lie above +13.48 ft NAVD. The proposed low chord of +13.82 ft exceeds this value.

5.1.2 Debris Clearance

Section 260.8.1 of FDOT (2022c) specifies a two-foot minimum clearance above the design flood stage (i.e., the 50-yr design storm water surface elevation). The FDOT set this criterion to prevent debris carried downstream during a flood event from either accumulating on the bridge or damaging the bridge during design storm events. The maximum elevation associated with the 50-year event is +8.1 ft-NAVD. Given this elevation, low member should lie above +9.1 ft NAVD88 to meet this criterion. Including 1.5 ft of sea level rise (probabilistic method), the low member should lie above +10.6 ft-NAVD. The proposed low chord of +13.82 ft exceeds this value.

5.1.3 Navigation

Section 260.8.1 of FDOT (2022c) specifies a six-foot minimum clearance above MHW within the navigation channel of tidal waterbodies. Given a MHW elevation of +0.23 ft-NAVD, the low member of the bridge at the navigation span should lie above +6.23 ft-NAVD to meet this requirement. For this bridge, the USCG specifies a minimum vertical clearance of 55 ft above MHW within the navigational channel. Therefore, the low member of the bridge at the navigation span should lie above +55.23 ft for navigational purposes. Including sea level rise, the low member at the navigation span would exceed the downstream constraint at I-75 and thus including sea level rise not recommended.

5.1.4 Coastal Bridges

Given the bridges' location, wind-generated (hurricane-generated) waves could reach the bridge during a design hurricane landfall event. For coastal bridges, Section 260.8.1 of FDOT (2022c) stipulates that the vertical clearance of the superstructure must lie at least one foot above the 100-yr wave crest elevation. From Chapter 3, the worst-case 100-yr wave crest elevation including sea level rise is +12.1 ft-NAVD. Therefore, the superstructure must lie at or above +13.1 ft-NAVD at that worst-case location. The proposed low chord of +13.82 ft exceeds this value.

5.2 Abutment Protection

FDOT (2022b) designates that the engineer should design abutment protection to protect against the effects of scour conditions and wind- and boat-generated waves. For vertical wall abutments, FDOT (2022b) indicates minimum protection should consist of either rubble riprap or cabled and anchored articulated concrete block (ACB). Under 100-year condition with sea level rise, only very small waves would affect the abutments based on the assumed ground elevations. As such, any of the minimum abutment protection types appear suitable at this site.

Given the determined velocities, the designer should employ FDOT Rubble (Bank and Shore Protection) riprap as described in section 530 of the FDOT Standard Specifications for Road and Bridge Construction (FDOT, 2022d). A layer of FDOT-approved geotextile filter fabric topped with a 1-ft thick layer of bedding stone should lie beneath the riprap. The riprap mattress width extend 10 ft from the base of the MSE walls and extend along the approach walls at least 15 ft (or the approach slab length) from the begin and end bridge locations. The riprap must have a thickness of at least twice the median stone diameter (2.5 ft) and should rest on top of a one-foot-thick layer of bedding stone.

5.3 Deck Drainage

The FDOT (2022b) stipulates that the bridge designer must limit the spread to one half of the lane resulting from a rainfall intensity of four inches per hour on a road with a design speed of 45 mph. As per DRMP, the bridge profile does not exceed this threshold. Thus, runoff will be collected at the begin and end bridge stations. Appendix D contains the supporting calculations provided by DRMP.

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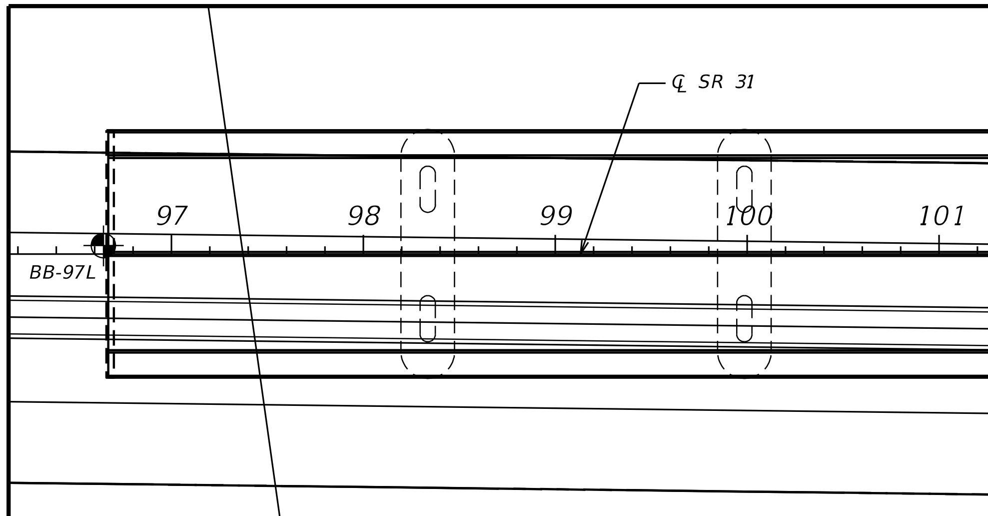
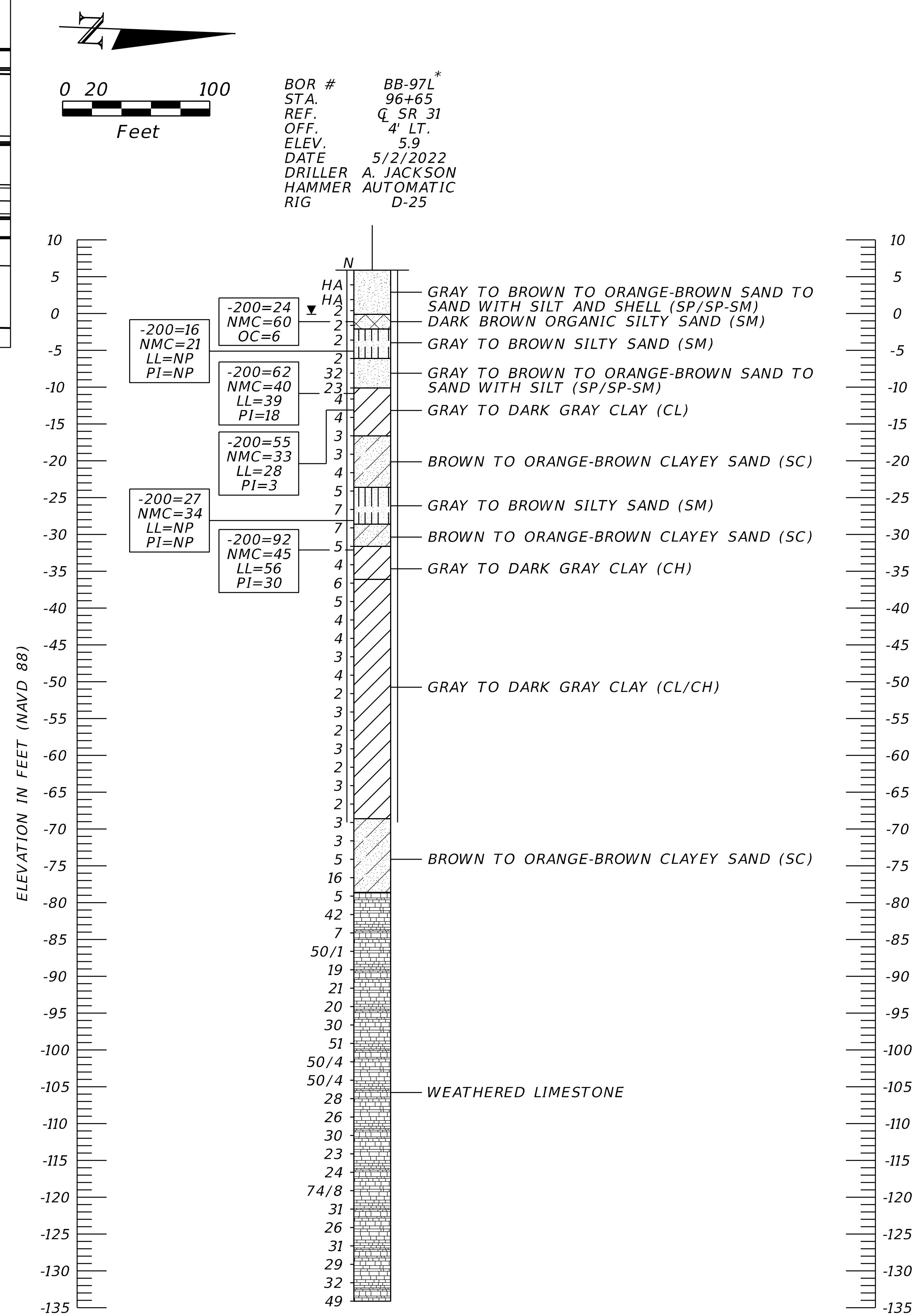
Appendix A Geotechnical Information



BORING LOCATION PLAN



BORING TERMINATED AT ELEVATION -134.1 FT (NAVD 88)

LATITUDE: N 27.71431
LONGITUDE: W 81.75967

LEGEND

SAND (SP/SP-SM)
CLAY (CL/CH)
SILTY SAND (SM)
WEATHERED LIMESTONE
CLAYEY SAND (SC)
ORGANIC SILTY SAND (SM)
SILT (ML)

SP	UNIFIED SOIL CLASSIFICATION SYSTEM (ASTM D 2487) GROUP SYMBOL AS DETERMINED BY VISUAL REVIEW AND LABORATORY TESTING ON SELECTED SAMPLES FOR CONFIRMATION OF VISUAL REVIEW.
N	NUMBERS TO THE LEFT OF BORINGS INDICATE SPT VALUE FOR 12 INCHES OF PENETRATION (UNLESS OTHERWISE NOTED).
50/4	NUMBER OF BLOWS FOR 4 INCHES OF PENETRATION
HA	HAND AUGERED TO VERIFY UTILITY CLEARANCE
-200	PERCENT PASSING #200 SIEVE
NMC	NATURAL MOISTURE CONTENT (%)
LL	LIQUID LIMIT (%)
PI	PLASTICITY INDEX (%)
OC	ORGANIC CONTENT (%)
NP	NON-PLASTIC
D_{50}	PARTICLE DIAMETER SUCH THAT 50% OF THE SOIL BY WEIGHT IS OF SMALLER SIZE (mm)
NAVD 88	NORTH AMERICAN VERTICAL DATUM OF 1988
	APPROXIMATE SPT BORING LOCATION
	GROUNDWATER LEVEL ENCOUNTERED DURING FIELD EXPLORATIONS
100	LOSS OF CIRCULATION OF DRILLING FLUID (%)
	CASING
℄ SR 31	CENTERLINE OF CONSTRUCTION OF SR 31

ENVIRONMENTAL CLASSIFICATION:

SUBSTRUCTURE	CONCRETE: EXTREMELY AGGRESIVE(1) (CHLORIDES=10,295 PPM)
SUBSTRUCTURE	STEEL: EXTREMELY AGGRESIVE (CHLORIDES=10,295 PPM)
SUPERSTRUCTURE	EXTREMELY AGGRESIVE (CHLORIDES=10,295 PPM)

SOIL TEST RESULTS:

RESISTIVITY	5,600 TO 14,000 OHM-CM
CHLORIDES	<15 TO 30 PPM
SULFATES	<5 TO 15 PPM
pH	7.9 TO 8.3

WATER TEST RESULTS:

RESISTIVITY	1,300 TO 1,400 OHM-CM
CHLORIDES	27 TO 33 PPM
SULFATES	51 PPM
pH	8.5 TO 9.2

NOTE:

(1) THE ENVIRONMENTAL CLASSIFICATION IS BASED ON DATA RESULTS OF 10,295 PPM AS PRESENTED IN THE FLORIDA DEPARTMENT OF TRANSPORTATION BRIDGE ENVIRONMENT DATA SUMMARY TABLE.

(2) BASED ON A REVIEW OF THE "UPPER FLORIDAN AQUIFER POTENTIOMETRIC SURFACE" MAPS PUBLISHED BY THE USGS, THE POTENTIOMETRIC SURFACE ELEVATION OF THE UPPER FLORIDAN IN THE BRIDGE VICINTY RANGES FROM APPROXIMATELY +40 TO +50 FEET, NGVD 29. ARTESIAN FLOW CONDITIONS WERE NOT ENCOUNTERED DURING OUR FIELD EXPLORATION; HOWEVER, ARTESIAN FLOW CONDITIONS WERE REPORTED IN THE BORING DATA SHOWN IN THE ORIGINAL 1958 BRIDGE PLANS OF THE EXISTING SR 31 BRIDGE. THE CONTRACTORS TOOLS AND CONSTRUCTION METHODS SHOULD BE CAPABLE OF HANDLING ARTESIAN LEVELS UP TO A HEAD OF +50 FEET, NGVD 29 AT NO ADDITIONAL COST TO THE DEPARTMENT.

(3) THE LOCATIONS AND ELEVATIONS OF THE BORINGS DENOTED WITH AN ASTERISK (*) WERE PROVIDED BY THE PROJECT SURVEYOR. THE REMAINING BORINGS WERE LOCATED IN THE FIELD BY A REPRESENTATIVE OF TIERRA USING GARMIN EXTREX® HAND-HELD, NON-SURVEY GRADE GLOBAL POSITIONING SYSTEM (GPS) EQUIPMENT WITH A MANUFACTUREDER'S REPORTED ACCURACY OF ±10 FEET. STATION, OFFSET AND ELEVATION OF THE BORING LOCATIONS WERE DETERMINED USING THE GPS COORDINATES OBTAINED IN THE FIELD IN CONJUNCTION WITH PROJECT DESIGN FILES. THEREFORE, THESE BORING LOCATIONS AND ELEVATIONS SHOULD BE CONSIDERED APPROXIMATE.

	SAFETY HAMMER	AUTOMATIC HAMMER
GRANULAR MATERIALS-RELATIVE DENSITY	SPT N-VALUE (BLOWS/FT.)	SPT N-VALUE (BLOWS/FT.)
VERY LOOSE	LESS THAN 4	LESS THAN 3
LOOSE	4 to 10	3 to 8
MEDIUM DENSE	10 to 30	8 to 24
DENSE	30 to 50	24 to 40
VERY DENSE	GREATER THAN 50	GREATER THAN 40
SILTS AND CLAYS CONSISTENCY	SPT N-VALUE (BLOWS/FT.)	SPT N-VALUE (BLOWS/FT.)
VERY SOFT	LESS THAN 2	LESS THAN 1
SOFT	2 to 4	1 to 3
FIRM	4 to 8	3 to 6
STIFF	8 to 15	6 to 12
VERY STIFF	15 to 30	12 to 24
HARD	GREATER THAN 30	GREATER THAN 24

BRIDGE NO. 12XXXX

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REVISIONS

DATE	BY	DESCRIPTION	DATE	BY	DESCRIPTION

THOMAS E. MUSGRAVE, JR., P.E.
License Number: 81669
TIERRA, INC.
7351 TEMPLE TERRACE HIGHWAY
TAMPA, FLORIDA 33637

DRAWN BY:	BMG 08-22
CHECKED BY:	AH 08-22
DESIGNED BY:	BMG 08-22
CHECKED BY:	TEM 08-22

STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION

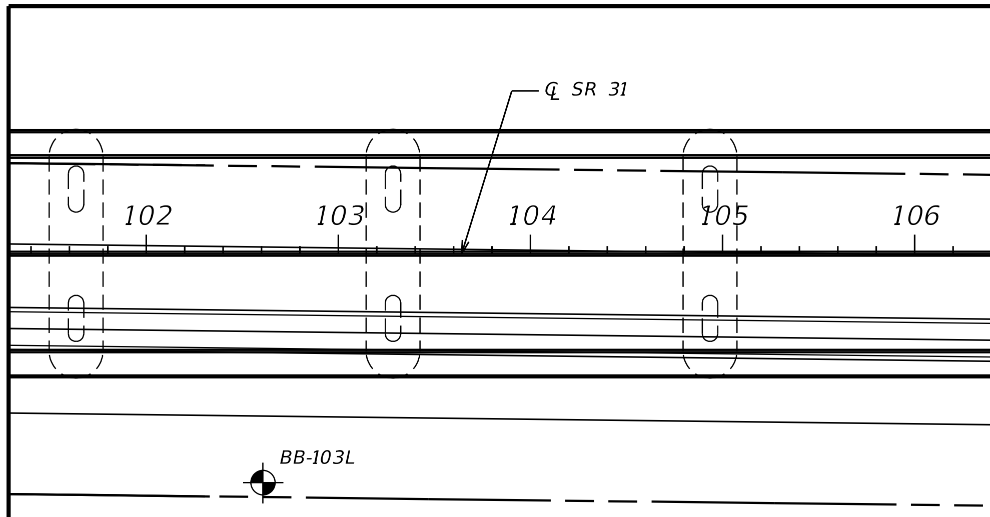
ROAD NO.	COUNTY	FINANCIAL PROJECT ID
SR 31	LEE	441942-1-22-01

SHEET TITLE: REPORT OF CORE BORINGS (1 OF 4)

PROJECT NAME: SR 31 FROM SR 80 (PALM BEACH BOULEVARD) TO SR 78 (BAYSHORE ROAD)

REF. DWG. NO.

SHEET NO.



BORING LOCATION PLAN

ENVIRONMENTAL CLASSIFICATION:

SUBSTRUCTURE CONCRETE: EXTREMELY AGGRESIVE (1)
(CHLORIDES=10,295 PPM)

SUBSTRUCTURE STEEL: EXTREMELY AGGRESIVE
(CHLORIDES=10,295 PPM)

SUPERSTRUCTURE EXTREMELY AGGRESIVE
(CHLORIDES=10,295 PPM)

SOIL TEST RESULTS:
RESISTIVITY 5,600 TO 14,000 OHM-CM
CHLORIDES <15 TO 30 PPM
SULFATES <5 TO 15 PPM
pH 7.9 TO 8.3

WATER TEST RESULTS:
RESISTIVITY 1,300 TO 1,400 OHM-CM
CHLORIDES 27 TO 33 PPM
SULFATES 51 PPM
pH 8.5 TO 9.2

NOTE:

(1) THE ENVIRONMENTAL CLASSIFICATION IS BASED ON DATA RESULTS OF 10,295 PPM AS PRESENTED IN THE FLORIDA DEPARTMENT OF TRANSPORTATION BRIDGE ENVIRONMENT DATA SUMMARY TABLE.

(2) BASED ON A REVIEW OF THE "UPPER FLORIDAN AQUIFER POTENTIOMETRIC SURFACE" MAPS PUBLISHED BY THE USGS, THE POTENTIOMETRIC SURFACE ELEVATION OF THE UPPER FLORIDAN IN THE BRIDGE VICINTY RANGES FROM APPROXIMATELY +40 TO +50 FEET, NGVD 29. ARTESIAN FLOW CONDITIONS WERE NOT ENCOUNTERED DURING OUR FIELD EXPLORATION; HOWEVER, ARTESIAN FLOW CONDITIONS WERE REPORTED IN THE BORING DATA SHOWN IN THE ORIGINAL 1958 BRIDGE PLANS OF THE EXISTING SR 31 BRIDGE. THE CONTRACTORS TOOLS AND CONSTRUCTION METHODS SHOULD BE CAPABLE OF HANDLING ARTESIAN LEVELS UP TO A HEAD OF +50 FEET, NGVD 29 AT NO ADDITIONAL COST TO THE DEPARTMENT.

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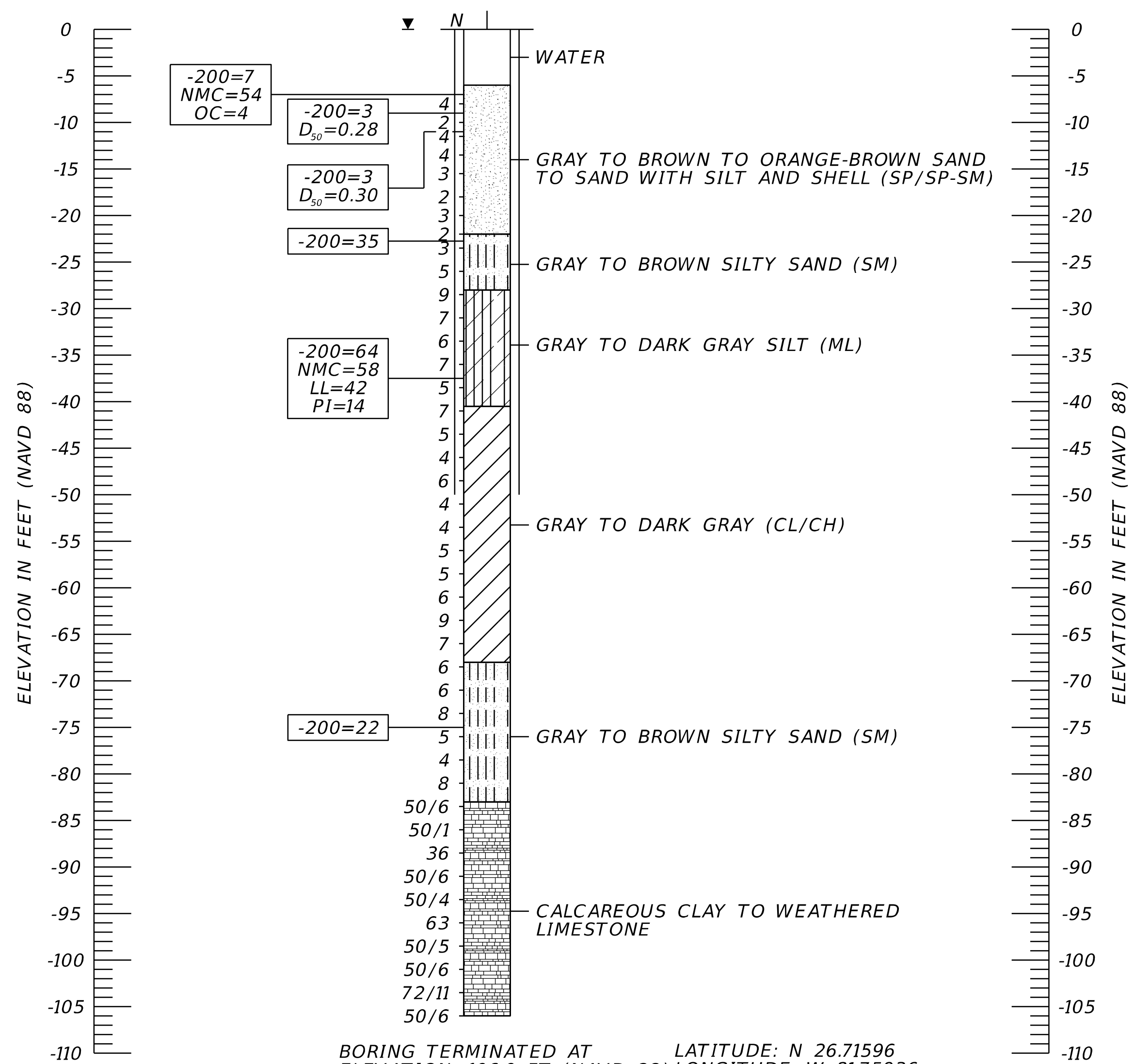
BOR # BB-103L
STA. 102+61
REF. ℄ SR 31
OFF. 119' RT.
ELEV. -6.0 (MUDLINE)
DATE 8/24/2022
DRILLER D.STAKELIN
HAMMER SAFETY
RIG D-25



BORING TERMINATED AT ELEVATION -106.0 FT (NAVD 88)

LATITUDE: N 26.71596
LONGITUDE: W 81.75936

LEGEND

SAND (SP/SP-SM)
CLAY (CL/CH)
SILTY SAND (SM)
WEATHERED LIMESTONE
CLAYEY SAND (SC)
ORGANIC SILTY SAND (SM)
SILT (ML)

SP	UNIFIED SOIL CLASSIFICATION SYSTEM (ASTM D 2487) GROUP SYMBOL AS DETERMINED BY VISUAL REVIEW AND LABORATORY TESTING ON SELECTED SAMPLES FOR CONFIRMATION OF VISUAL REVIEW.
N	NUMBERS TO THE LEFT OF BORINGS INDICATE SPT VALUE FOR 12 INCHES OF PENETRATION (UNLESS OTHERWISE NOTED).
50/4	NUMBER OF BLOWS FOR 4 INCHES OF PENETRATION
HA	HAND AUGERED TO VERIFY UTILITY CLEARANCE
-200	PERCENT PASSING #200 SIEVE
NMC	NATURAL MOISTURE CONTENT (%)
LL	LIQUID LIMIT (%)
PI	PLASTICITY INDEX (%)
OC	ORGANIC CONTENT (%)
NP	NON-PLASTIC
D_{50}	PARTICLE DIAMETER SUCH THAT 50% OF THE SOIL BY WEIGHT IS OF SMALLER SIZE (mm)
NAVD 88	NORTH AMERICAN VERTICAL DATUM OF 1988
	APPROXIMATE SPT BORING LOCATION
	GROUNDWATER LEVEL ENCOUNTERED DURING FIELD EXPLORATIONS
100	LOSS OF CIRCULATION OF DRILLING FLUID (%)
	CASING
℄ SR 31	CENTERLINE OF CONSTRUCTION OF SR 31

	SAFETY HAMMER	AUTOMATIC HAMMER
GRANULAR MATERIALS- RELATIVE DENSITY	SPT N-VALUE (BLOWS/FT.)	SPT N-VALUE (BLOWS/FT.)
VERY LOOSE LOOSE MEDIUM DENSE DENSE VERY DENSE	LESS THAN 4 4 to 10 10 to 30 30 to 50 GREATER THAN 50	LESS THAN 3 3 to 8 8 to 24 24 to 40 GREATER THAN 40
SILTS AND CLAYS CONSISTENCY	SPT N-VALUE (BLOWS/FT.)	SPT N-VALUE (BLOWS/FT.)
VERY SOFT SOFT FIRM STIFF VERY STIFF HARD	LESS THAN 2 2 to 4 4 to 8 8 to 15 15 to 30 GREATER THAN 30	LESS THAN 1 1 to 3 3 to 6 6 to 12 12 to 24 GREATER THAN 24

BRIDGE NO. 12XXXX

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REVISIONS

DATE	BY	DESCRIPTION	DATE	BY	DESCRIPTION

THOMAS E. MUSGRAVE, JR., P.E.
License Number: 81669
TIERRA, INC.
7351 TEMPLE TERRACE HIGHWAY
TAMPA, FLORIDA 33637

DRAWN BY: BMG 08-22
CHECKED BY: AH 08-22
DESIGNED BY: BMG 08-22
CHECKED BY: TEM 08-22

STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION

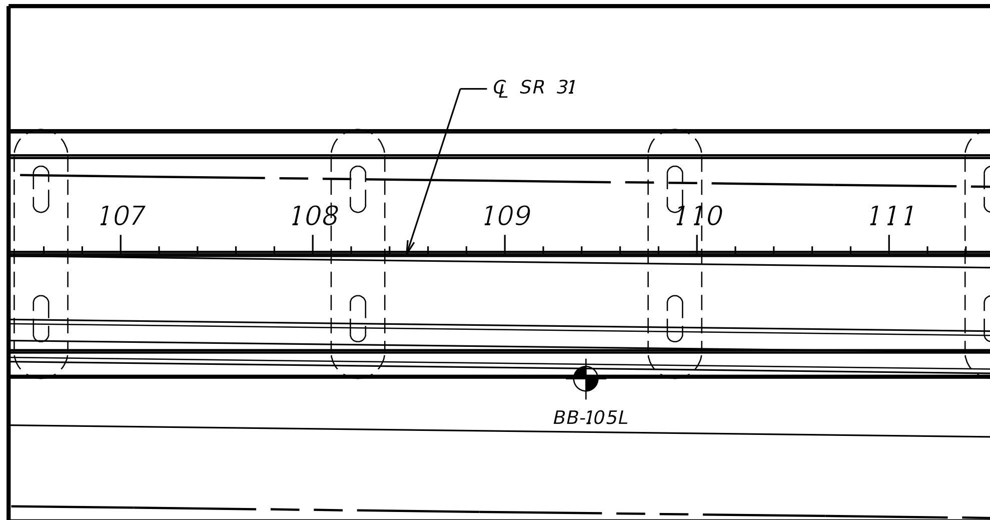
ROAD NO.	COUNTY	FINANCIAL PROJECT ID
SR 31	LEE	441942-1-22-01

SHEET TITLE: REPORT OF CORE BORINGS (2 OF 4)

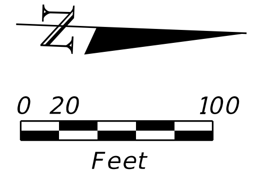
PROJECT NAME: SR 31 FROM SR 80 (PALM BEACH BOULEVARD) TO SR 78 (BAYSHORE ROAD)

REF. DWG. NO.

SHEET NO.



BORING LOCATION PLAN



ENVIRONMENTAL CLASSIFICATION:

SUBSTRUCTURE	CONCRETE: EXTREMELY AGGRESIVE(1) (CHLORIDES=10,295 PPM)
SUBSTRUCTURE	STEEL: EXTREMELY AGGRESIVE (CHLORIDES=10,295 PPM)
SUPERSTRUCTURE	EXTREMELY AGGRESIVE (CHLORIDES=10,295 PPM)

SOIL TEST RESULTS:

RESISTIVITY	5,600 TO 14,000 OHM-CM
CHLORIDES	<15 TO 30 PPM
SULFATES	<5 TO 15 PPM
pH	7.9 TO 8.3

WATER TEST RESULTS:

RESISTIVITY	1,300 TO 1,400 OHM-CM
CHLORIDES	27 TO 33 PPM
SULFATES	51 PPM
pH	8.5 TO 9.2

NOTE:

(1) THE ENVIRONMENTAL CLASSIFICATION IS BASED ON DATA RESULTS OF 10,295 PPM AS PRESENTED IN THE FLORIDA DEPARTMENT OF TRANSPORTATION BRIDGE ENVIRONMENT DATA SUMMARY TABLE.

(2) BASED ON A REVIEW OF THE "UPPER FLORIDAN AQUIFER POTENTIOMETRIC SURFACE" MAPS PUBLISHED BY THE USGS, THE POTENTIOMETRIC SURFACE ELEVATION OF THE UPPER FLORIDAN IN THE BRIDGE VICINITY RANGES FROM APPROXIMATELY +40 TO +50 FEET, NGVD 29. ARTESIAN FLOW CONDITIONS WERE NOT ENCOUNTERED DURING OUR FIELD EXPLORATION; HOWEVER, ARTESIAN FLOW CONDITIONS WERE REPORTED IN THE BORING DATA SHOWN IN THE ORIGINAL 1958 BRIDGE PLANS OF THE EXISTING SR 31 BRIDGE. THE CONTRACTORS TOOLS AND CONSTRUCTION METHODS SHOULD BE CAPABLE OF HANDLING ARTESIAN LEVELS UP TO A HEAD OF +50 FEET, NGVD 29 AT NO ADDITIONAL COST TO THE DEPARTMENT.

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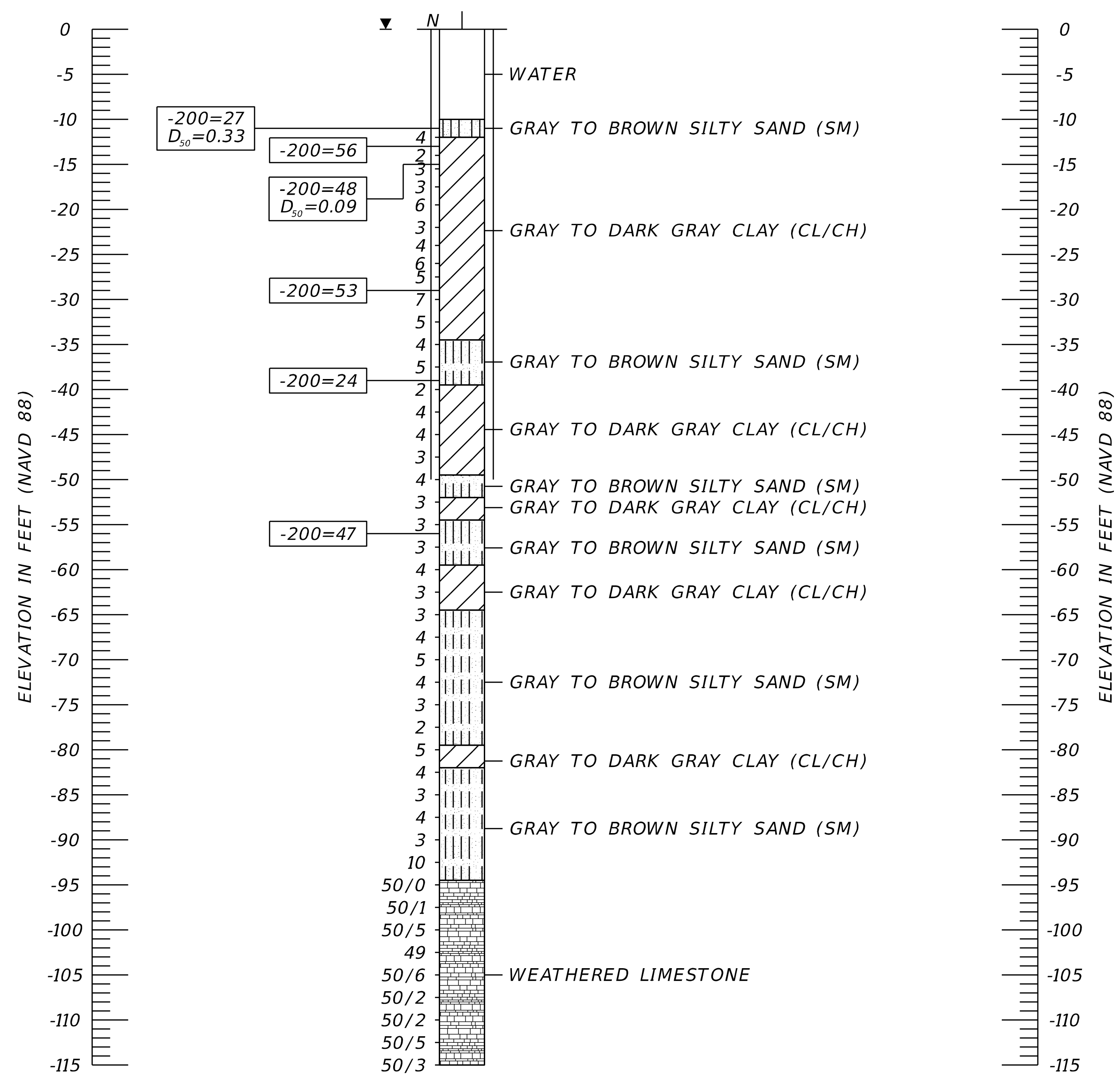
BOR #	BB-105L
STA.	109+42
REF.	℄ SR 31
OFF.	65' RT.
ELEV.	-10.0 (MUDLINE)
DATE	8/25/2022
DRILLER	D.STAKELIN
HAMMER	SAFETY
RIG	D-25



BORING TERMINATED AT ELEVATION -115.0 FT (NAVD 88)

LATITUDE: N 26.71783
LONGITUDE: W 81.75961

LEGEND

SAND (SP/SP-SM)	CLAY (CL/CH)
SILTY SAND (SM)	WEATHERED LIMESTONE
CLAYEY SAND (SC)	ORGANIC SILTY SAND (SM)
SILT (ML)	

SP	UNIFIED SOIL CLASSIFICATION SYSTEM (ASTM D 2487) GROUP SYMBOL AS DETERMINED BY VISUAL REVIEW AND LABORATORY TESTING ON SELECTED SAMPLES FOR CONFIRMATION OF VISUAL REVIEW.
N	NUMBERS TO THE LEFT OF BORINGS INDICATE SPT VALUE FOR 12 INCHES OF PENETRATION (UNLESS OTHERWISE NOTED).
50/4	NUMBER OF BLOWS FOR 4 INCHES OF PENETRATION
HA	HAND AUGERED TO VERIFY UTILITY CLEARANCE
-200	PERCENT PASSING #200 SIEVE
NMC	NATURAL MOISTURE CONTENT (%)
LL	LIQUID LIMIT (%)
PI	PLASTICITY INDEX (%)
OC	ORGANIC CONTENT (%)
NP	NON-PLASTIC
D_{50}	PARTICLE DIAMETER SUCH THAT 50% OF THE SOIL BY WEIGHT IS OF SMALLER SIZE (mm)
NAVD 88	NORTH AMERICAN VERTICAL DATUM OF 1988
	APPROXIMATE SPT BORING LOCATION
	GROUNDWATER LEVEL ENCOUNTERED DURING FIELD EXPLORATIONS
100	LOSS OF CIRCULATION OF DRILLING FLUID (%)
	CASING
℄ SR 31	CENTERLINE OF CONSTRUCTION OF SR 31

	SAFETY HAMMER	AUTOMATIC HAMMER
GRANULAR MATERIALS-RELATIVE DENSITY	SPT N-VALUE (BLOWS/FT.)	SPT N-VALUE (BLOWS/FT.)
VERY LOOSE	LESS THAN 4	LESS THAN 3
LOOSE	4 to 10	3 to 8
MEDIUM DENSE	10 to 30	8 to 24
DENSE	30 to 50	24 to 40
VERY DENSE	GREATER THAN 50	GREATER THAN 40
SILTS AND CLAYS CONSISTENCY	SPT N-VALUE (BLOWS/FT.)	SPT N-VALUE (BLOWS/FT.)
VERY SOFT	LESS THAN 2	LESS THAN 1
SOFT	2 to 4	1 to 3
FIRM	4 to 8	3 to 6
STIFF	8 to 15	6 to 12
VERY STIFF	15 to 30	12 to 24
HARD	GREATER THAN 30	GREATER THAN 24

BRIDGE NO. 12XXXX

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REVISIONS

DATE	BY	DESCRIPTION	DATE	BY	DESCRIPTION

THOMAS E. MUSGRAVE, JR., P.E.
License Number: 81669
TIERRA, INC.
7351 TEMPLE TERRACE HIGHWAY
TAMPA, FLORIDA 33637

DRAWN BY:	BMG 08-22
CHECKED BY:	AH 08-22
DESIGNED BY:	BMG 08-22
CHECKED BY:	TEM 08-22

STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION

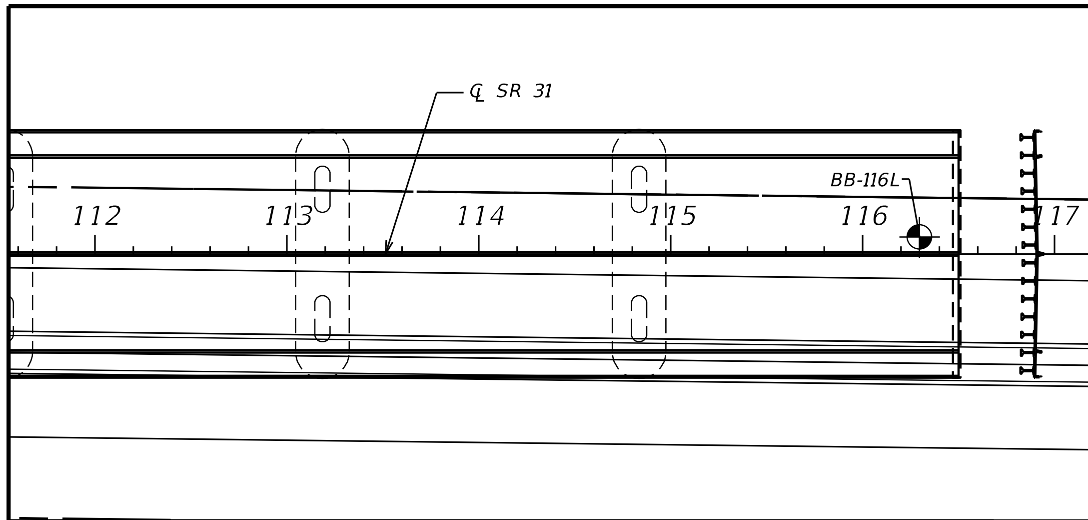
ROAD NO.	COUNTY	FINANCIAL PROJECT ID
SR 31	LEE	441942-1-22-01

SHEET TITLE: REPORT OF CORE BORINGS (3 OF 4)

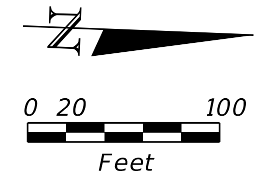
PROJECT NAME: SR 31 FROM SR 80 (PALM BEACH BOULEVARD) TO SR 78 (BAYSHORE ROAD)

REF. DWG. NO.

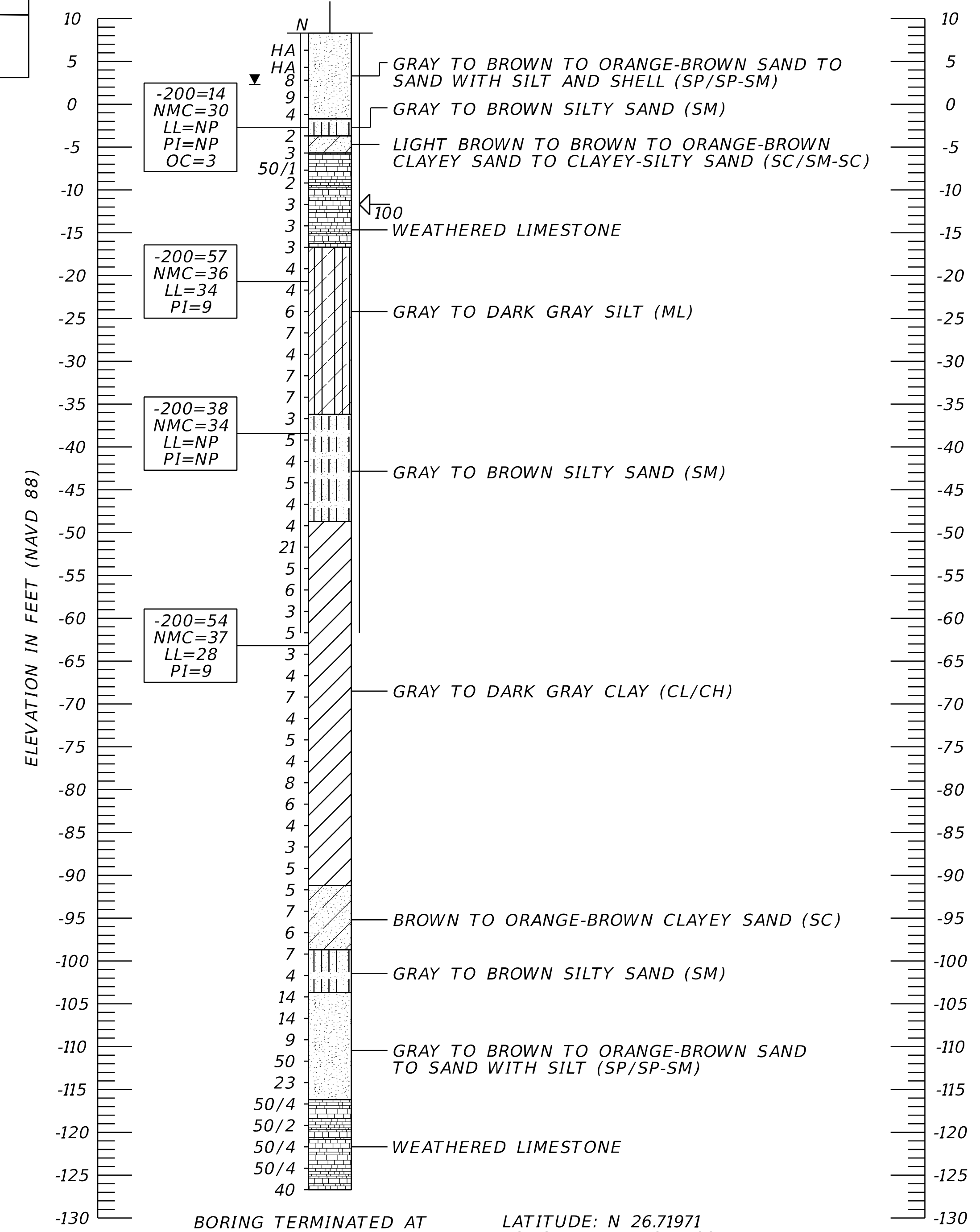
SHEET NO.



BORING LOCATION PLAN



BOR # BB-116L*
STA. 116+30
REF. ℄ SR 31
OFF. 9' LT.
ELEV. 8.3
DATE 4/28/2022
DRILLER A. JACKSON
HAMMER AUTOMATIC
RIG D-25



BORING TERMINATED AT ELEVATION -126.7 FT (NAVD 88)

LATITUDE: N 26.71971
LONGITUDE: W 81.75991

ENVIRONMENTAL CLASSIFICATION:

SUBSTRUCTURE	CONCRETE: EXTREMELY AGGRESIVE (1) (CHLORIDES=10,295 PPM)
SUBSTRUCTURE	STEEL: EXTREMELY AGGRESIVE (CHLORIDES=10,295 PPM)
SUPERSTRUCTURE	EXTREMELY AGGRESIVE (CHLORIDES=10,295 PPM)

SOIL TEST RESULTS:

RESISTIVITY	5,600 TO 14,000 OHM-CM
CHLORIDES	<15 TO 30 PPM
SULFATES	<5 TO 15 PPM
pH	7.9 TO 8.3

WATER TEST RESULTS:

RESISTIVITY	1,300 TO 1,400 OHM-CM
CHLORIDES	27 TO 33 PPM
SULFATES	51 PPM
pH	8.5 TO 9.2

NOTE:

(1) THE ENVIRONMENTAL CLASSIFICATION IS BASED ON DATA RESULTS OF 10,295 PPM AS PRESENTED IN THE FLORIDA DEPARTMENT OF TRANSPORTATION BRIDGE ENVIRONMENT DATA SUMMARY TABLE.

(2) BASED ON A REVIEW OF THE "UPPER FLORIDAN AQUIFER POTENTIOMETRIC SURFACE" MAPS PUBLISHED BY THE USGS, THE POTENTIOMETRIC SURFACE ELEVATION OF THE UPPER FLORIDAN IN THE BRIDGE VICINTY RANGES FROM APPROXIMATELY +40 TO +50 FEET, NGVD 29. ARTESIAN FLOW CONDITIONS WERE NOT ENCOUNTERED DURING OUR FIELD EXPLORATION; HOWEVER, ARTESIAN FLOW CONDITIONS WERE REPORTED IN THE BORING DATA SHOWN IN THE ORIGINAL 1958 BRIDGE PLANS OF THE EXISTING SR 31 BRIDGE. THE CONTRACTORS TOOLS AND CONSTRUCTION METHODS SHOULD BE CAPABLE OF HANDLING ARTESIAN LEVELS UP TO A HEAD OF +50 FEET, NGVD 29 AT NO ADDITIONAL COST TO THE DEPARTMENT.

(3) THE LOCATIONS AND ELEVATIONS OF THE BORINGS DENOTED WITH AN ASTERISK (*) WERE PROVIDED BY THE PROJECT SURVEYOR. THE REMAINING BORINGS WERE LOCATED IN THE FIELD BY A REPRESENTATIVE OF TIERRA USING GARMIN EXTREX® HAND-HELD, NON-SURVEY GRADE GLOBAL POSITIONING SYSTEM (GPS) EQUIPMENT WITH A MANUFACTUREDER'S REPORTED ACCURACY OF ±10 FEET. STATION, OFFSET AND ELEVATION OF THE BORING LOCATIONS WERE DETERMINED USING THE GPS COORDINATES OBTAINED IN THE FIELD IN CONJUNCTION WITH PROJECT DESIGN FILES. THEREFORE, THESE BORING LOCATIONS AND ELEVATIONS SHOULD BE CONSIDERED APPROXIMATE.

LEGEND

SAND (SP/SP-SM)
CLAY (CL/CH)
SILTY SAND (SM)
WEATHERED LIMESTONE
CLAYEY SAND (SC)
ORGANIC SILTY SAND (SM)
SILT (ML)

SP	UNIFIED SOIL CLASSIFICATION SYSTEM (ASTM D 2487) GROUP SYMBOL AS DETERMINED BY VISUAL REVIEW AND LABORATORY TESTING ON SELECTED SAMPLES FOR CONFIRMATION OF VISUAL REVIEW.
N	NUMBERS TO THE LEFT OF BORINGS INDICATE SPT VALUE FOR 12 INCHES OF PENETRATION (UNLESS OTHERWISE NOTED).
50/4	NUMBER OF BLOWS FOR 4 INCHES OF PENETRATION
HA	HAND AUGERED TO VERIFY UTILITY CLEARANCE
-200	PERCENT PASSING #200 SIEVE
NMC	NATURAL MOISTURE CONTENT (%)
LL	LIQUID LIMIT (%)
PI	PLASTICITY INDEX (%)
OC	ORGANIC CONTENT (%)
NP	NON-PLASTIC
D_{50}	PARTICLE DIAMETER SUCH THAT 50% OF THE SOIL BY WEIGHT IS OF SMALLER SIZE (mm)
NAVD 88	NORTH AMERICAN VERTICAL DATUM OF 1988
	APPROXIMATE SPT BORING LOCATION
	GROUNDWATER LEVEL ENCOUNTERED DURING FIELD EXPLORATIONS
100	LOSS OF CIRCULATION OF DRILLING FLUID (%)
	CASING
℄ SR 31	CENTERLINE OF CONSTRUCTION OF SR 31

	SAFETY HAMMER	AUTOMATIC HAMMER
GRANULAR MATERIALS-RELATIVE DENSITY	SPT N-VALUE (BLOWS/FT.)	SPT N-VALUE (BLOWS/FT.)
VERY LOOSE	LESS THAN 4	LESS THAN 3
LOOSE	4 to 10	3 to 8
MEDIUM DENSE	10 to 30	8 to 24
DENSE	30 to 50	24 to 40
VERY DENSE	GREATER THAN 50	GREATER THAN 40
SILTS AND CLAYS CONSISTENCY	SPT N-VALUE (BLOWS/FT.)	SPT N-VALUE (BLOWS/FT.)
VERY SOFT	LESS THAN 2	LESS THAN 1
SOFT	2 to 4	1 to 3
FIRM	4 to 8	3 to 6
STIFF	8 to 15	6 to 12
VERY STIFF	15 to 30	12 to 24
HARD	GREATER THAN 30	GREATER THAN 24

BRIDGE NO. 12XXXX

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REVISIONS

DATE	BY	DESCRIPTION	DATE	BY	DESCRIPTION

THOMAS E. MUSGRAVE, JR., P.E.
License Number: 81669
TIERRA, INC.
7351 TEMPLE TERRACE HIGHWAY
TAMPA, FLORIDA 33637

DRAWN BY: BMG 08-22
CHECKED BY: AH 08-22
DESIGNED BY: BMG 08-22
CHECKED BY: TEM 08-22

STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION

ROAD NO.	COUNTY	FINANCIAL PROJECT ID
SR 31	LEE	441942-1-22-01

SHEET TITLE: REPORT OF CORE BORINGS (4 OF 4)

PROJECT NAME: SR 31 FROM SR 80 (PALM BEACH BOULEVARD) TO SR 78 (BAYSHORE ROAD)

REF. DWG. NO.

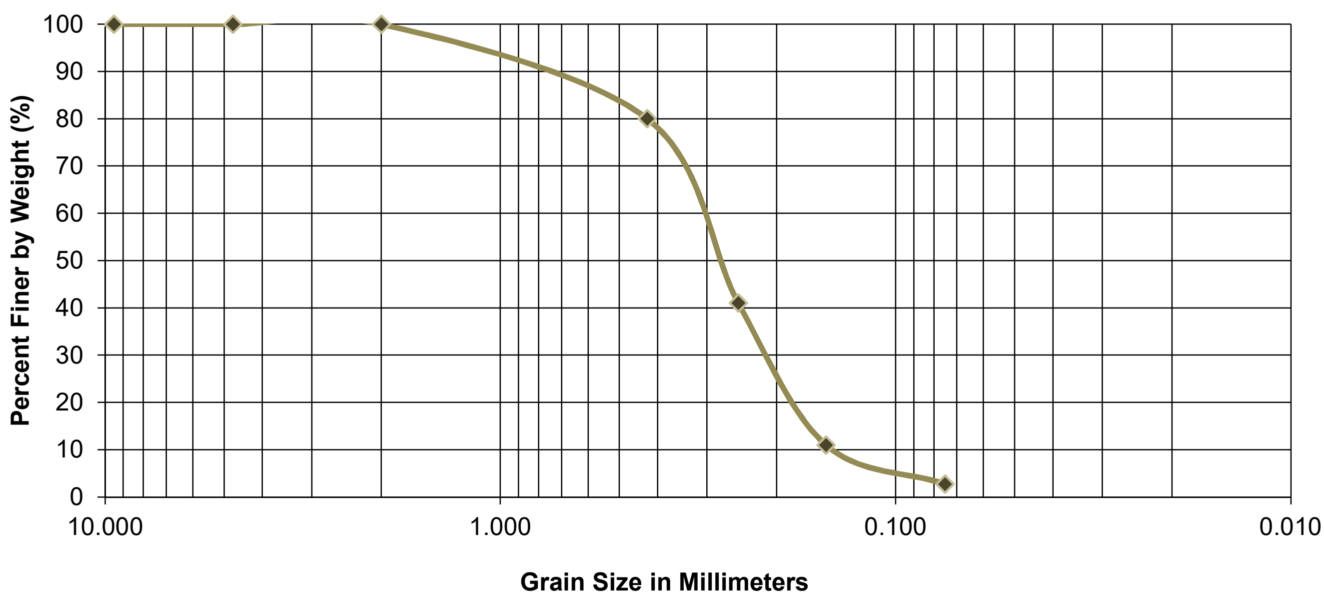
SHEET NO.

Grain Size Distribution Report

SR 31 Project Development and Environment (PD&E) Studies
From SR 80 (Palm Beach Blvd) to SR 78 (Bayshore Blvd)
Lee County, Florida
FPN: 441942-1-22-01
Tierra Project No. 6511-18-173

Sample Location	Sample No.	Depth (feet)
Station 102+61, 119' RT.	BB-103L	2.0 - 0.0

Grain Size Distribution Curve



Material Description	Classification	
	USCS	AASHTO
Gray to Brown Fine Sand to Sand with Silt	SP	A-3

Sieve Number	Diameter (mm)	Percent Finer by Weight (%)
3/4"	19.000	100
3/8"	9.500	100
4	4.750	100
10	2.000	100
40	0.425	80
60	0.250	41
100	0.150	11
200	0.075	3

Coefficients

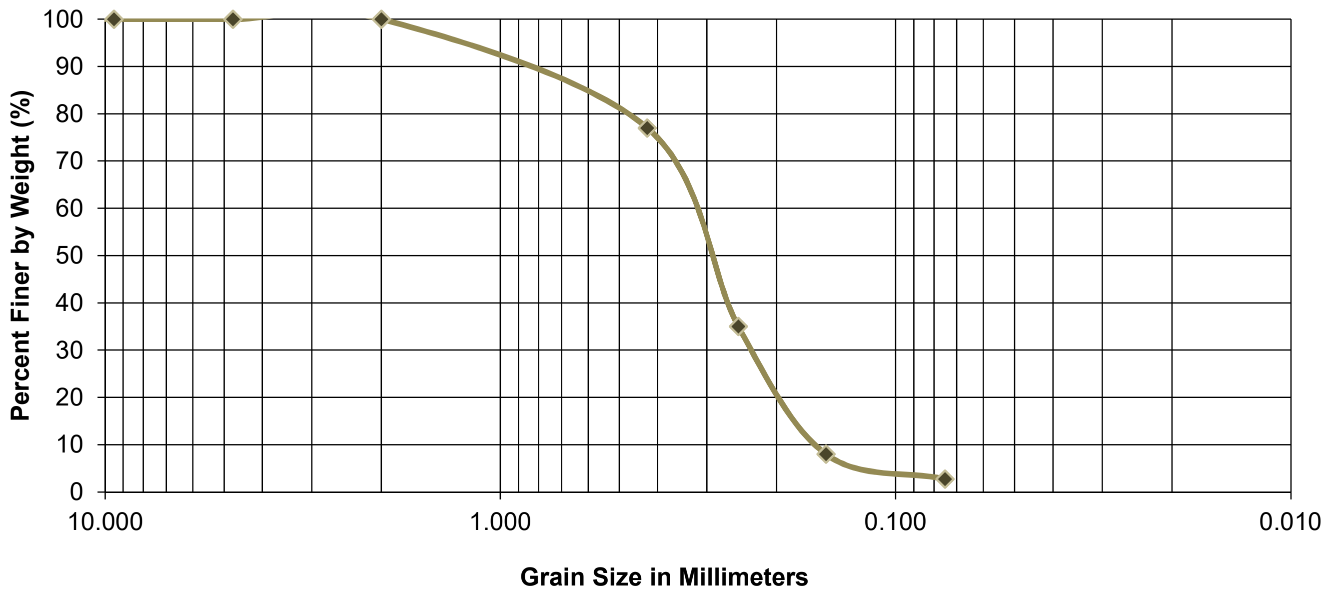
D_{10}	0.14	D_{30}	0.21
D_{50}	***0.28***	D_{60}	0.32
D_{85}	0.63	D_{90}	2.00
C_U	2.35	C_C	0.96

Grain Size Distribution Report

SR 31 Project Development and Environment (PD&E) Studies
From SR 80 (Palm Beach Blvd) to SR 78 (Bayshore Blvd)
Lee County, Florida
FPN: 441942-1-22-01
Tierra Project No. 6511-18-173

Sample Location	Sample No.	Depth (feet)
Station 102+61, 119' RT.	BB-103L	4.0 - 6.0

Grain Size Distribution Curve



Material Description	Classification	
	USCS	AASHTO
Gray to Brown Fine Sand to Sand with Silt	SP	A-3

Sieve Number	Diameter (mm)	Percent Finer by Weight (%)
3/4"	19.000	100
3/8"	9.500	100
4	4.750	100
10	2.000	100
40	0.425	77
60	0.250	35
100	0.150	8
200	0.075	3

Coefficients

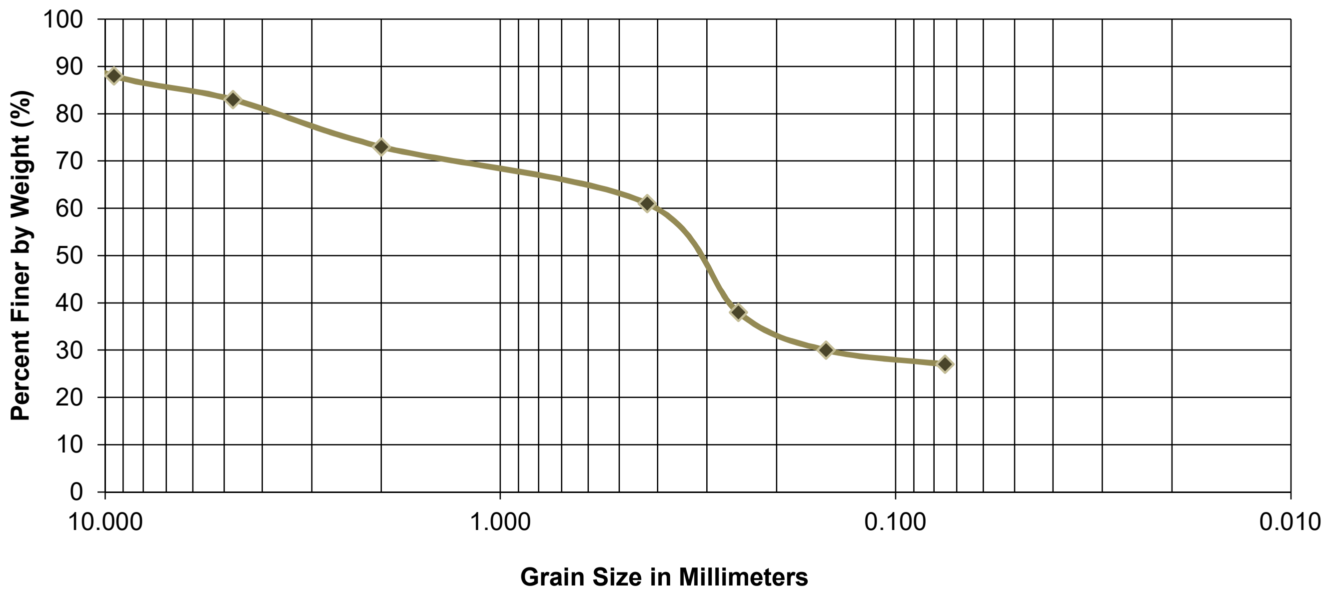
D_{10}	0.16	D_{30}	0.23
D_{50}	***0.30***	D_{60}	0.34
D_{85}	0.73	D_{90}	2.00
C_U	2.20	C_C	0.97

Grain Size Distribution Report

SR 31 Project Development and Environment (PD&E) Studies
From SR 80 (Palm Beach Blvd) to SR 78 (Bayshore Blvd)
Lee County, Florida
FPN: 441942-1-22-01
Tierra Project No. 6511-18-173

Sample Location	Sample No.	Depth (feet)
Station 109+42, 65' RT.	BB-105L	0.0 - 2.0

Grain Size Distribution Curve



Material Description	Classification USCS	Classification AASHTO
Gray to Brown Fine Sand to Sand with Silt	SM	A-2-4

Sieve Number	Diameter (mm)	Percent Finer by Weight (%)
3/4"	19.000	98
3/8"	9.500	88
4	4.750	83
10	2.000	73
40	0.425	61
60	0.250	38
100	0.150	30
200	0.075	27

Coefficients

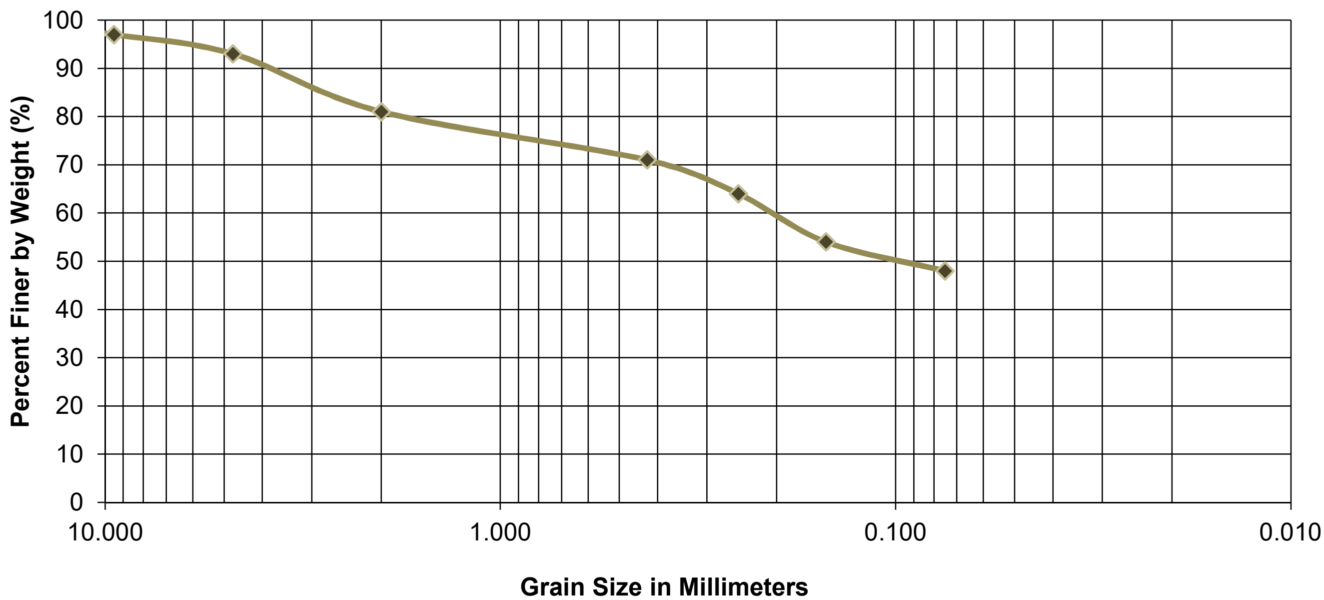
D_{10}	---	D_{30}	0.15
D_{50}	*0.33*	D_{60}	0.42
D_{85}	6.27	D_{90}	19.00
C_U	---	C_C	---

Grain Size Distribution Report

SR 31 Project Development and Environment (PD&E) Studies
From SR 80 (Palm Beach Blvd) to SR 78 (Bayshore Blvd)
Lee County, Florida
FPN: 441942-1-22-01
Tierra Project No. 6511-18-173

Sample Location	Sample No.	Depth (feet)
Station 109+42, 65' RT.	BB-105L	4.0 - 6.0

Grain Size Distribution Curve



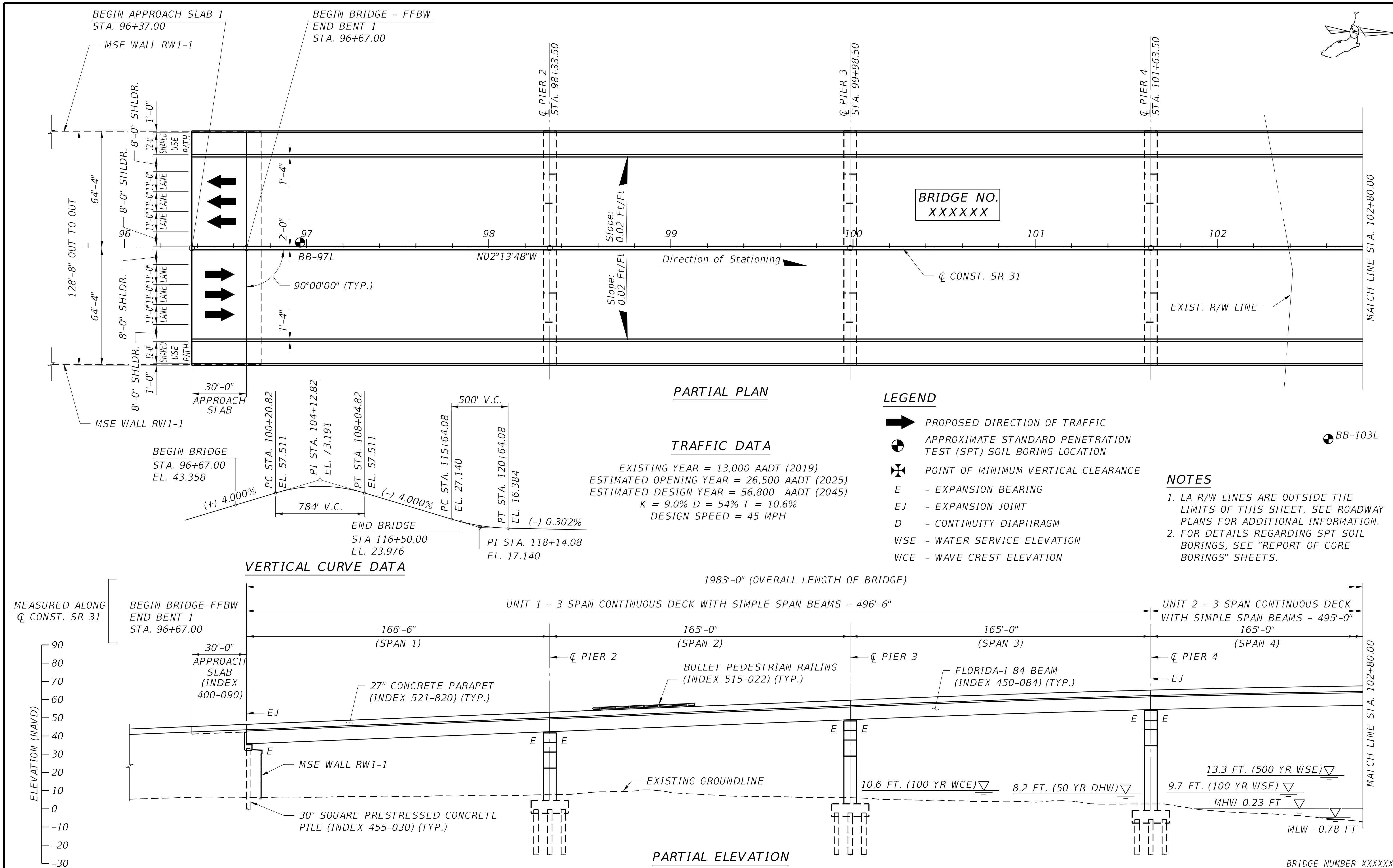
Material Description	Classification	
	USCS	AASHTO
Gray to Brown Fine Sand to Sand with Silt	SM	A-4

Sieve Number	Diameter (mm)	Percent Finer by Weight (%)
3/4"	19.000	100
3/8"	9.500	97
4	4.750	93
10	2.000	81
40	0.425	71
60	0.250	64
100	0.150	54
200	0.075	48

Coefficients

D_{10}	---	D_{30}	---
D_{50}	*0.09*	D_{60}	0.20
D_{85}	2.67	D_{90}	9.50
C_U	---	C_C	---

Appendix B Replacement Bridge Geometry



REVISIONS					
DATE	BY	DESCRIPTION	DATE	BY	DESCRIPTION
					30% PLANS NOT FOR CONSTRUCTION

LEO E. RODRIGUEZ, P.E.
License Number: P.E. 78493
DRMP, INC.
15310 AMBERLY DRIVE, SUITE 200
TAMPA, FL 33647

DRAWN BY: JMA 09-22
CHECKED BY: EG 09-22
DESIGNED BY: LCY 09-22
CHECKED BY: EG 09-22

STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION

ROAD NO.	COUNTY	FINANCIAL PROJECT ID
SR 31	LEE	441942-1-22-1

SHEET TITLE: PLAN AND ELEVATION (1 OF 3)

PROJECT NAME: SR 31 FROM SR 80 (PALM BEACH BOULEVARD) TO SR 78 (BAYSHORE ROAD)

REF. DWG. NO.

SHEET NO. B1-01

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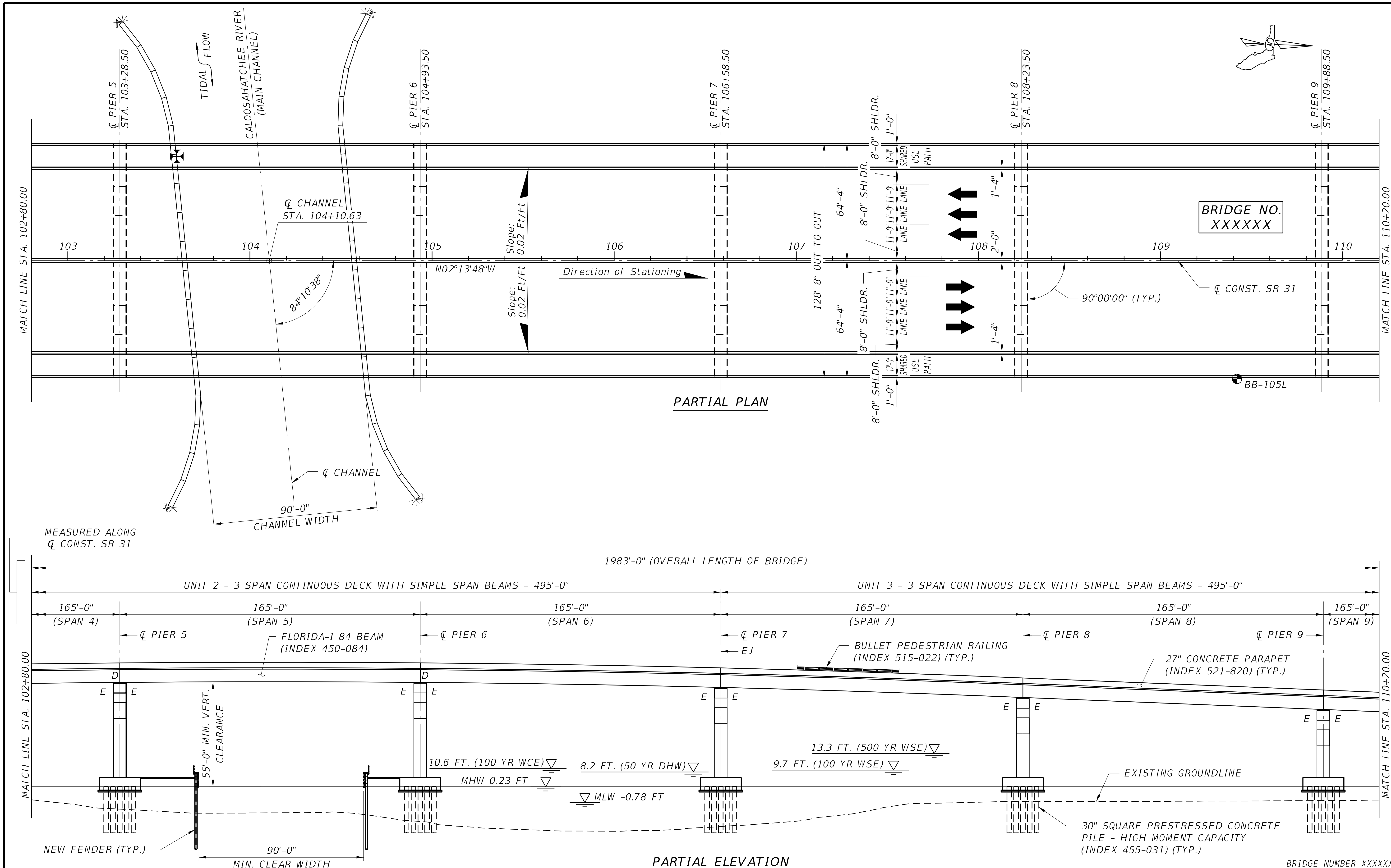
DRAFT BDR SUBMITTAL



REVISIONS					
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DRMP, INC.
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TAMPA, FL 33647

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DESIGNED BY: LCY 09-22
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STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION

ROAD NO.	COUNTY	FINANCIAL PROJECT ID
SR 31	LEE	441942-1-22-1

SHEET TITLE: PLAN AND ELEVATION (2 OF 3)

PROJECT NAME: SR 31 FROM SR 80 (PALM BEACH BOULEVARD) TO SR 78 (BAYSHORE ROAD)

REF. DWG. NO.

SHEET NO. B1-02

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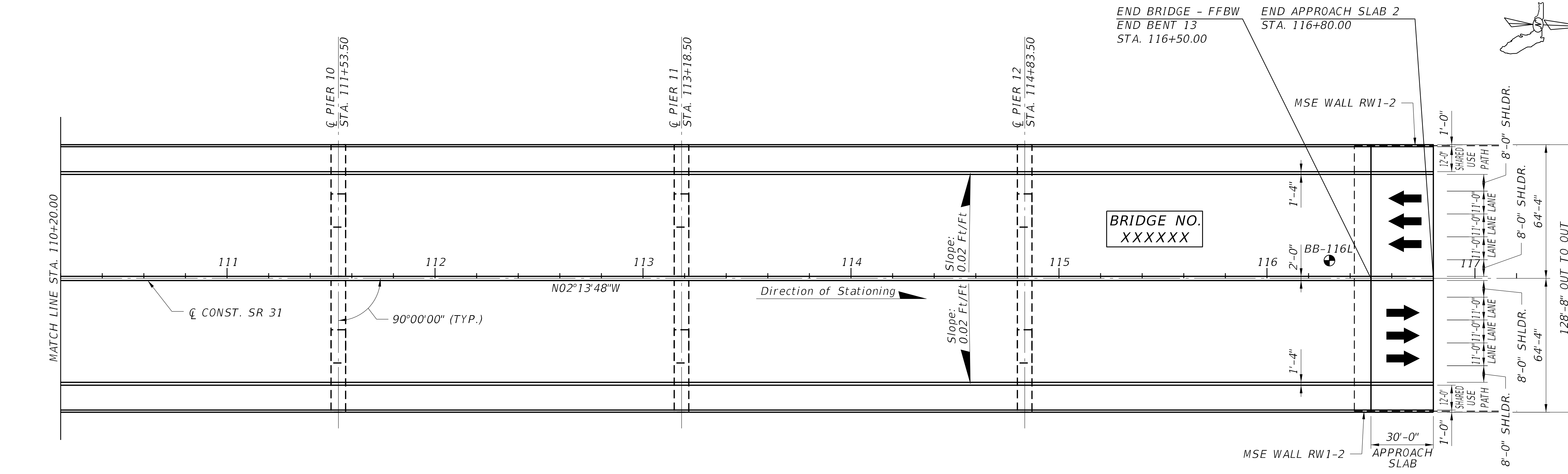
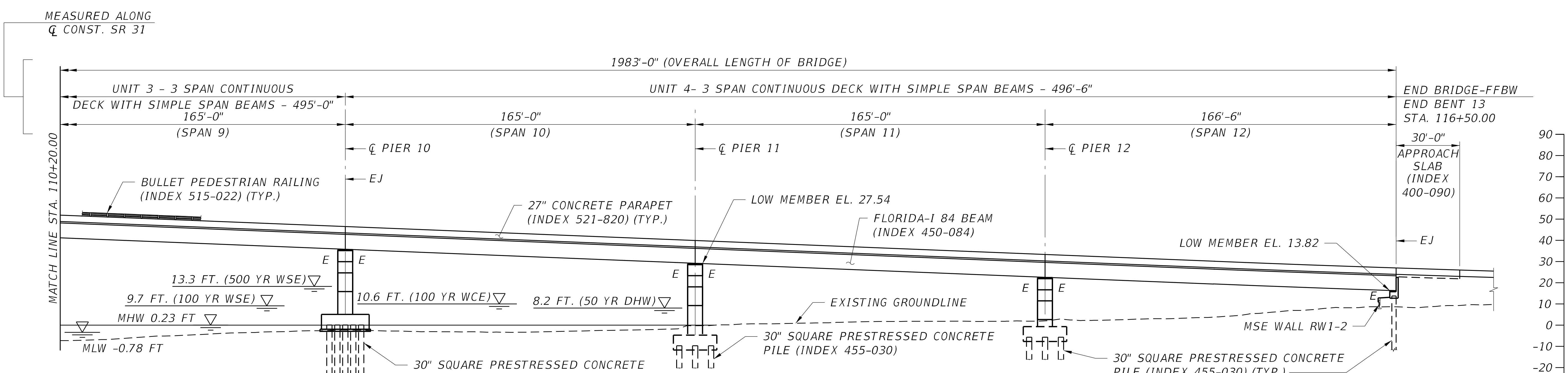


PARTIAL PLAN



PARTIAL ELEVATION

BRIDGE NUMBER XXXXXX

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DRMP, INC.
15310 AMBERLY DRIVE, SUITE 200
TAMPA, FL 33647

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DESIGNED BY:	LCY 09-22
CHECKED BY:	EG 09-22

STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION

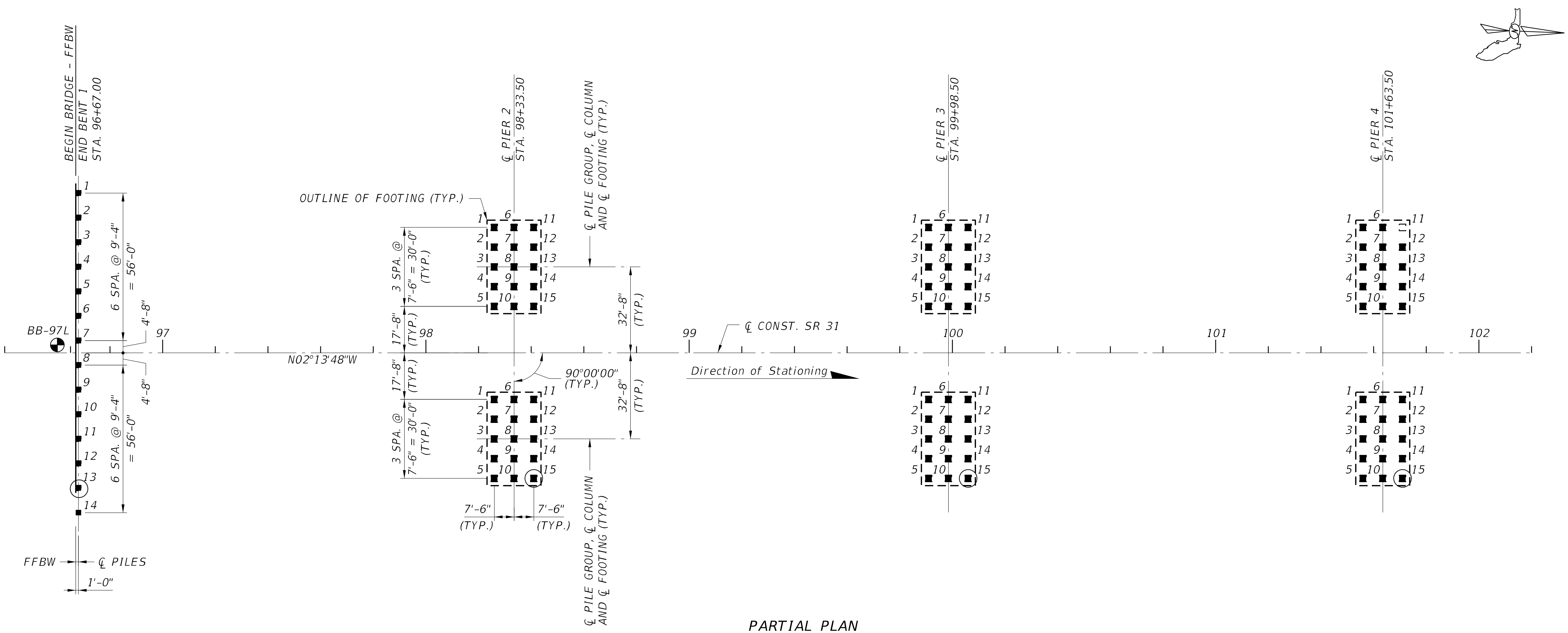
ROAD NO.	COUNTY	FINANCIAL PROJECT ID
SR 31	LEE	441942-1-22-1

SHEET TITLE: PLAN AND ELEVATION (3 OF 3)

PROJECT NAME: SR 31 FROM SR 80 (PALM BEACH BOULEVARD) TO SR 78 (BAYSHORE ROAD)

REF. DWG. NO.

SHEET NO. B1-03



PARTIAL PLAN

LEGEND

APPROXIMATE STANDARD PENETRATION TEST (SPT) SOIL BORING LOCATION

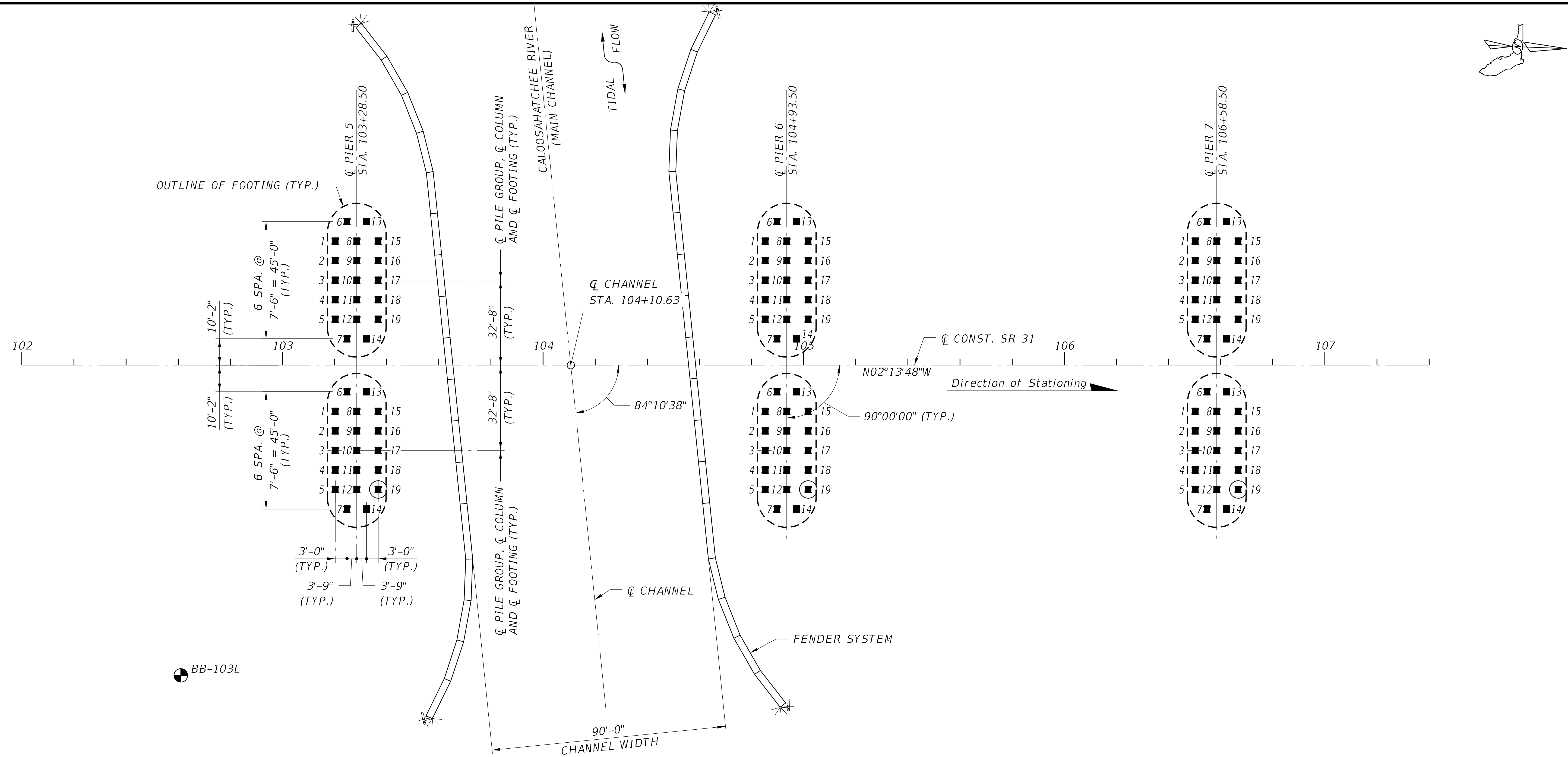
30" SQ. PRESTRESSED CONCRETE PILE - HIGH MOMENT CAPACITY, DRIVEN PLUMB

30" SQ. PRESTRESSED CONCRETE - HIGH MOMENT CAPACITY TEST PILE, DRIVEN PLUMB

NOTES

1. WORK "FOUNDATION LAYOUT" SHEET WITH "PILE DATA TABLE AND NOTES" SHEET.

BRIDGE NUMBER XXXXXX



PARTIAL PLAN

BRIDGE NUMBER XXXXXX

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1531 AMBERLY DRIVE, SUITE 200
TAMPA, FL 33647

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JLA 09-22	EG 09-22	LCY 09-22	EG 09-22

STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION

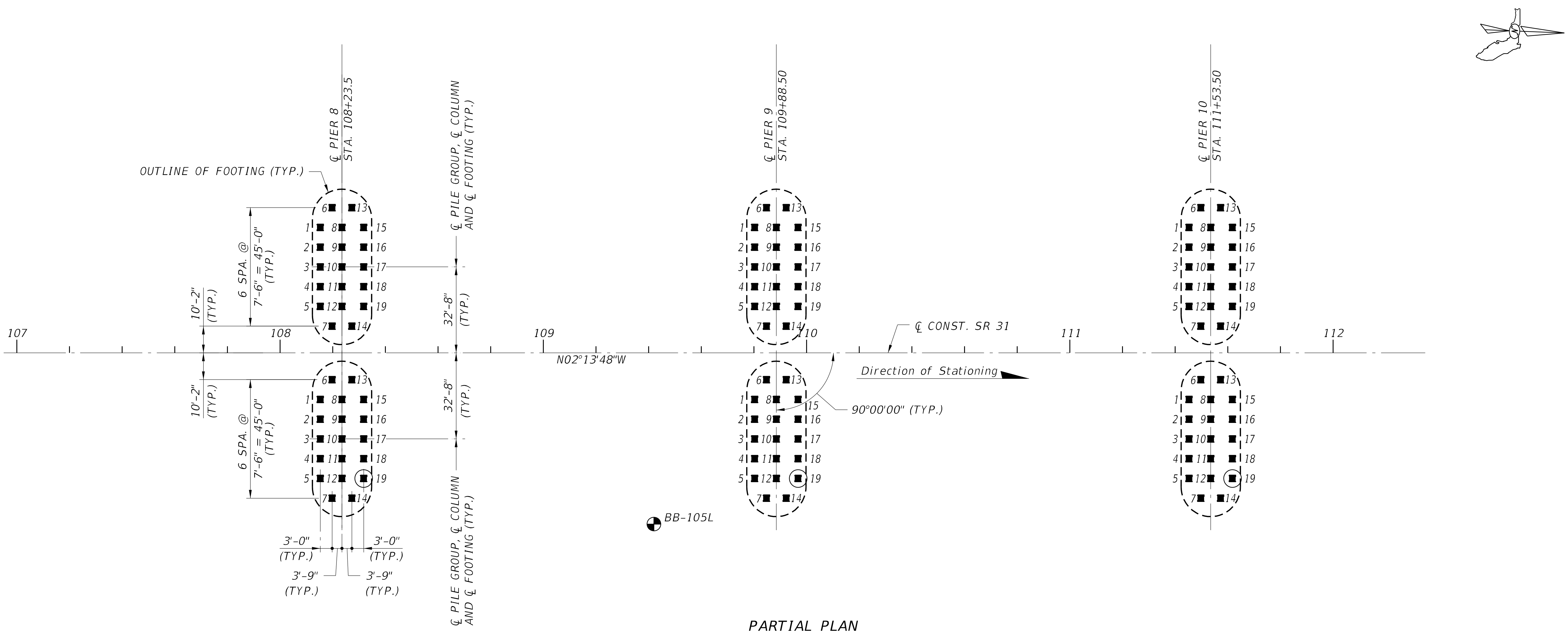
ROAD NO.	COUNTY	FINANCIAL PROJECT ID
SR 31	LEE	44194-22-01

SHEET TITLE: FOUNDATION LAYOUT (2 OF 4)

PROJECT NAME: SR 31 FROM SR 80 (PALM BEACH BOULEVARD) TO SR 78 (BAYSHORE ROAD)

REF. DWG. NO.

SHEET NO. B1-11



PARTIAL PLAN

BRIDGE NUMBER XXXXXX

REVISIONS					
DATE	BY	DESCRIPTION	DATE	BY	DESCRIPTION
					30% PLANS NOT FOR CONSTRUCTION

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1531 AMBERLY DRIVE, SUITE 200
TAMPA, FL 33647

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DESIGNED BY: LCY 09-22
CHECKED BY: EG 09-22

STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION

ROAD NO.	COUNTY	FINANCIAL PROJECT ID
SR 31	LEE	44194-22-01

SHEET TITLE: FOUNDATION LAYOUT (3 OF 4)

PROJECT NAME: SR 31 FROM SR 80 (PALM BEACH BOULEVARD) TO SR 78 (BAYSHORE ROAD)

REF. DWG. NO.

SHEET NO. B1-12

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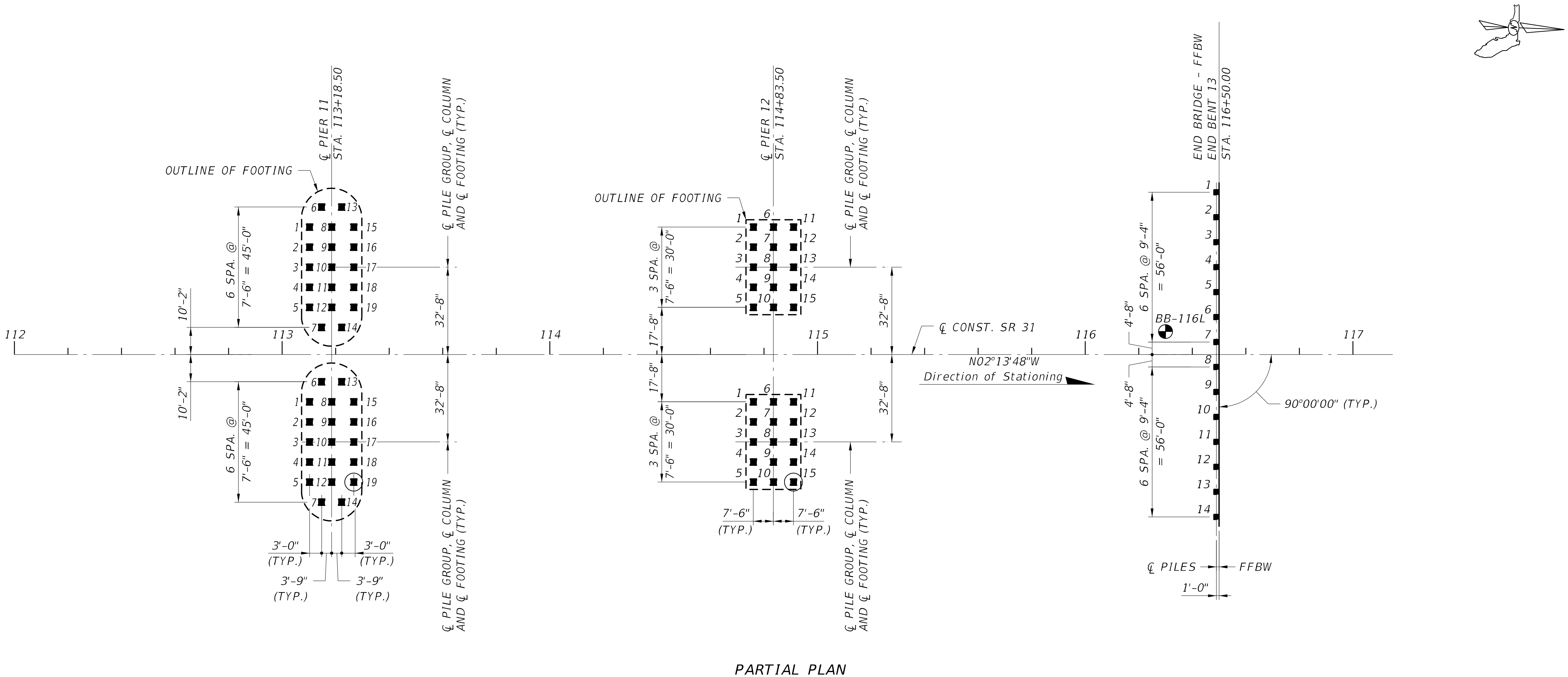

PARTIAL PLAN

BRIDGE NUMBER XXXXXX

REVISIONS					
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					30% PLANS NOT FOR CONSTRUCTION

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1531 AMBERLY DRIVE, SUITE 200
TAMPA, FL 33647

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DESIGNED BY: LCY 09-22
CHECKED BY: EG 09-22

STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION

ROAD NO.	COUNTY	FINANCIAL PROJECT ID
SR 31	LEE	44194-22-01

SHEET TITLE: FOUNDATION LAYOUT (4 OF 4)

PROJECT NAME: SR 31 FROM SR 80 (PALM BEACH BOULEVARD) TO SR 78 (BAYSHORE ROAD)

REF. DWG. NO.

SHEET NO. B1-13

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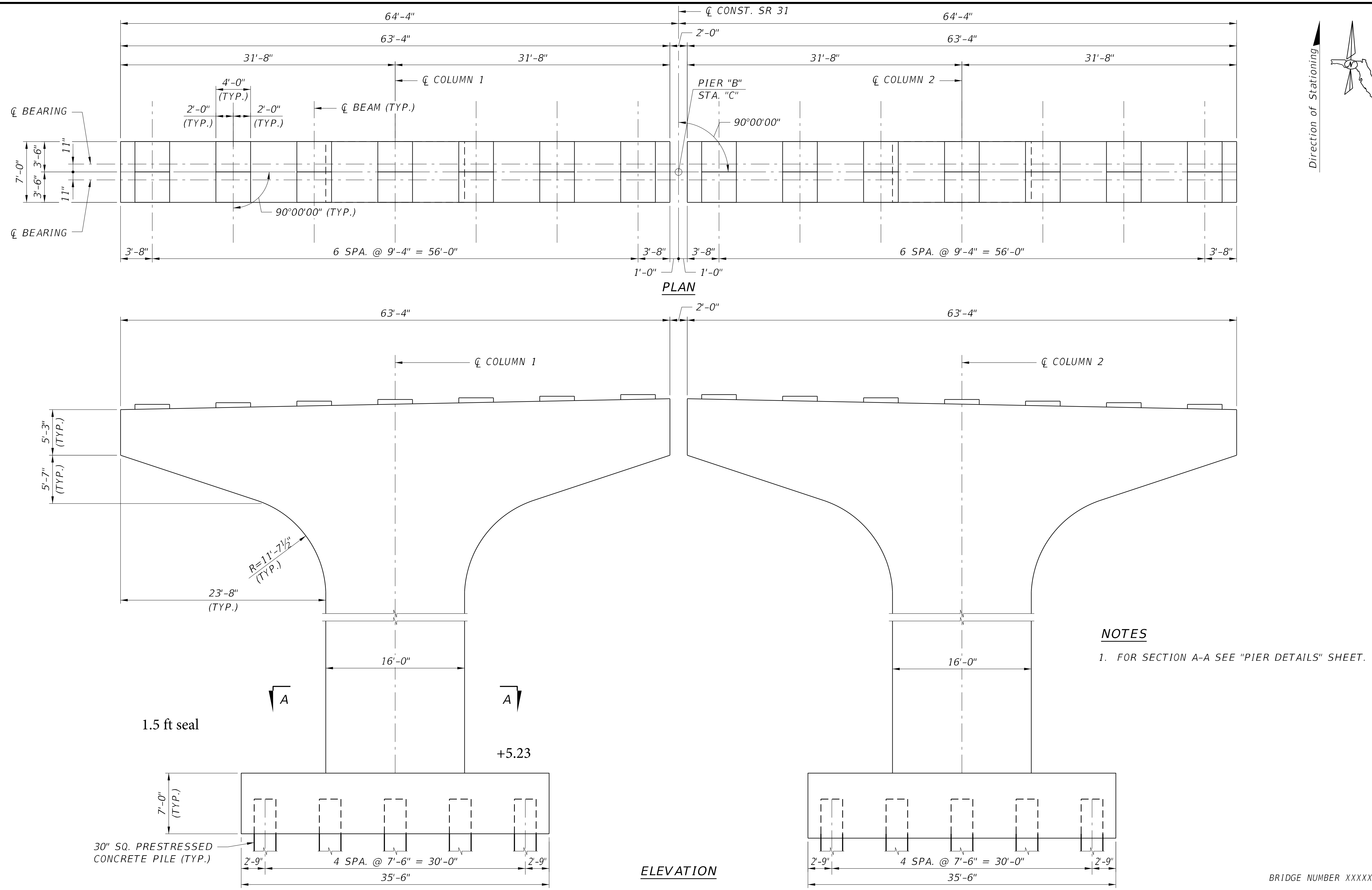

NOTES

1. FOR SECTION A-A SEE "PIER DETAILS" SHEET.

BRIDGE NUMBER XXXXXX

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REVISIONS					
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1531 AMBERLY DRIVE, SUITE 200
TAMPA, FL 33647

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STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION

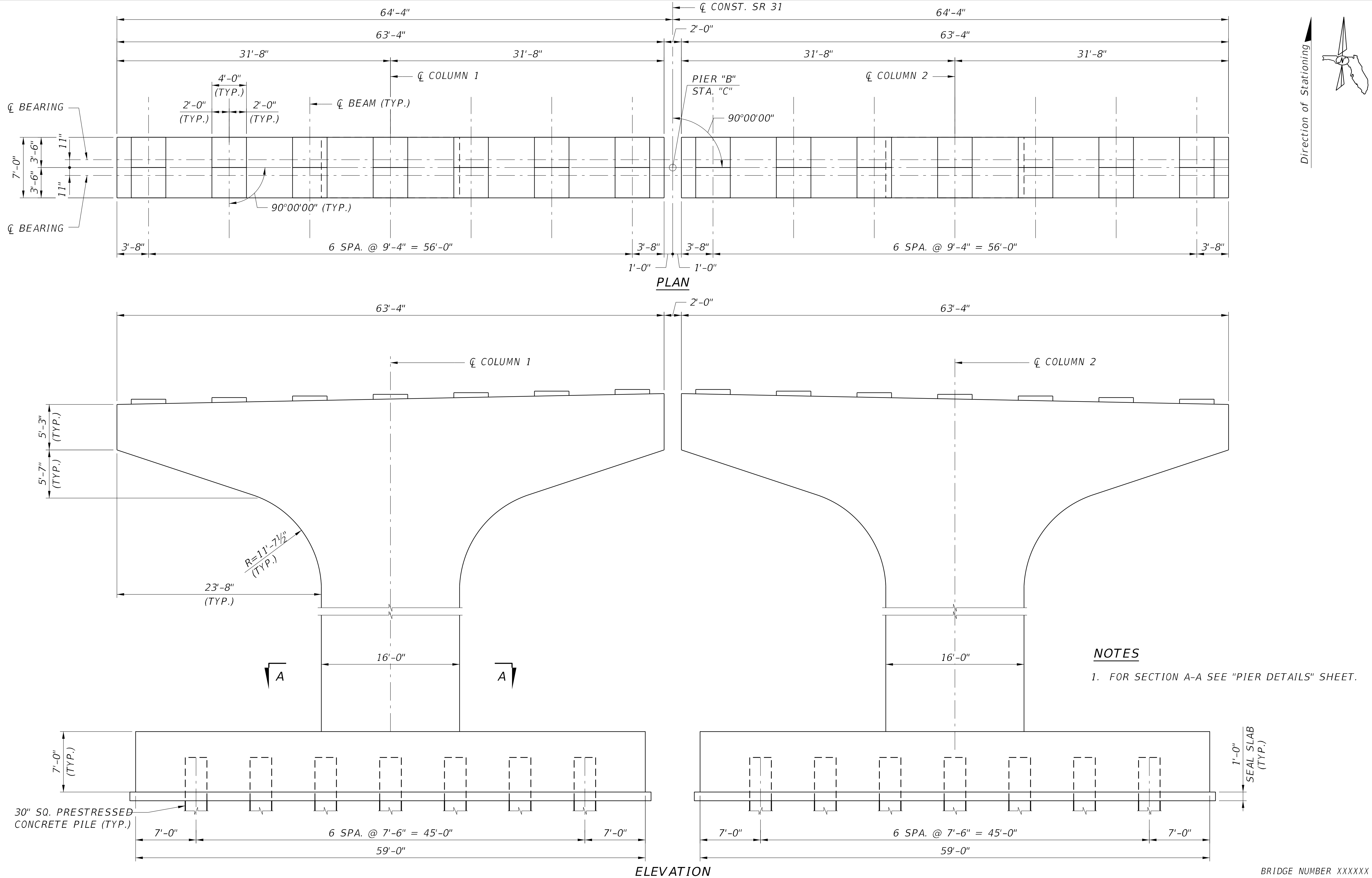
ROAD NO.	COUNTY	FINANCIAL PROJECT ID
SR 31	LEE	44194-22-01

SHEET TITLE: PIERS 2, 3, 4, 10 AND 12

PROJECT NAME: SR 31 FROM SR 80 (PALM BEACH BOULEVARD) TO SR 78 (BAYSHORE ROAD)

REF. DWG. NO.

SHEET NO. B1-18



NOTES

1. FOR SECTION A–A SEE "PIER DETAILS" SHEET.

BRIDGE NUMBER XXXXXX

REVISIONS					
DATE	BY	DESCRIPTION	DATE	BY	DESCRIPTION
					30% PLANS NOT FOR CONSTRUCTION

LEO E. RODRIGUEZ
License Number: 78493
DRMP, INC.
1531 AMBERLY DRIVE, SUITE 200
TAMPA, FL 33647

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CHECKED BY: EG 09-22

STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION

ROAD NO.	COUNTY	FINANCIAL PROJECT ID
SR 31	LEE	44194-22-01

SHEET TITLE: PIERS 5 THROUGH 10

PROJECT NAME: SR 31 FROM SR 80 (PALM BEACH BOULEVARD) TO SR 78 (BAYSHORE ROAD)

REF. DWG. NO.

SHEET NO. B1-19

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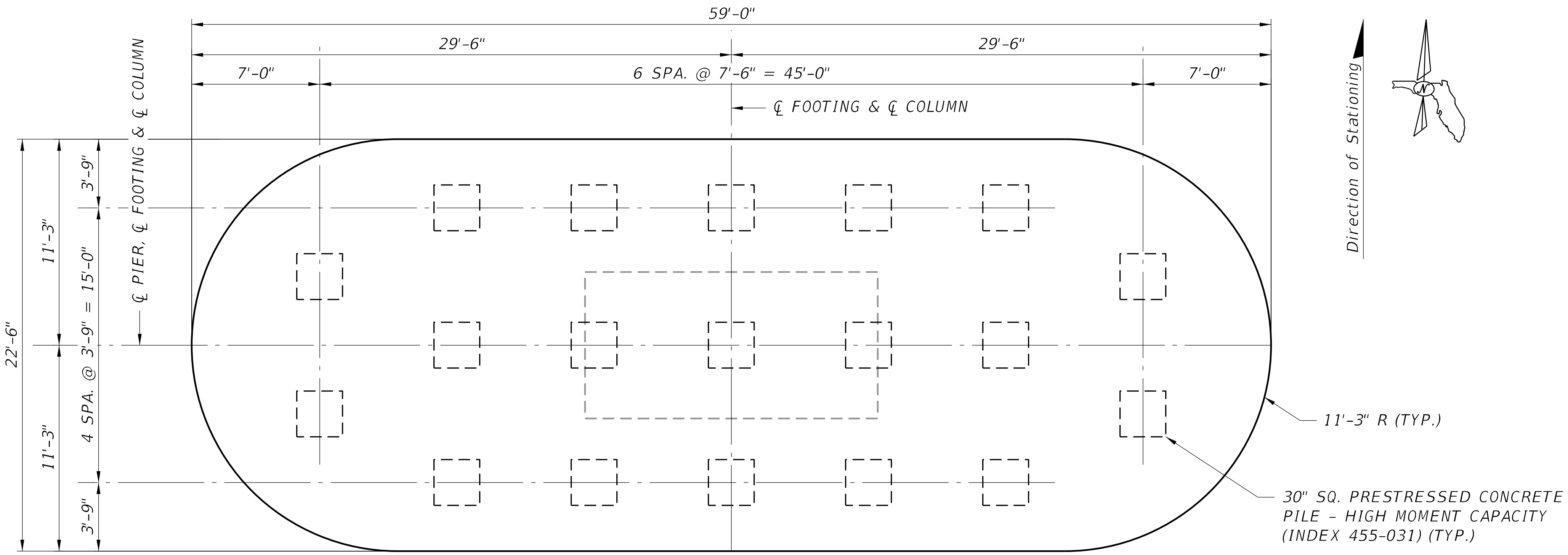

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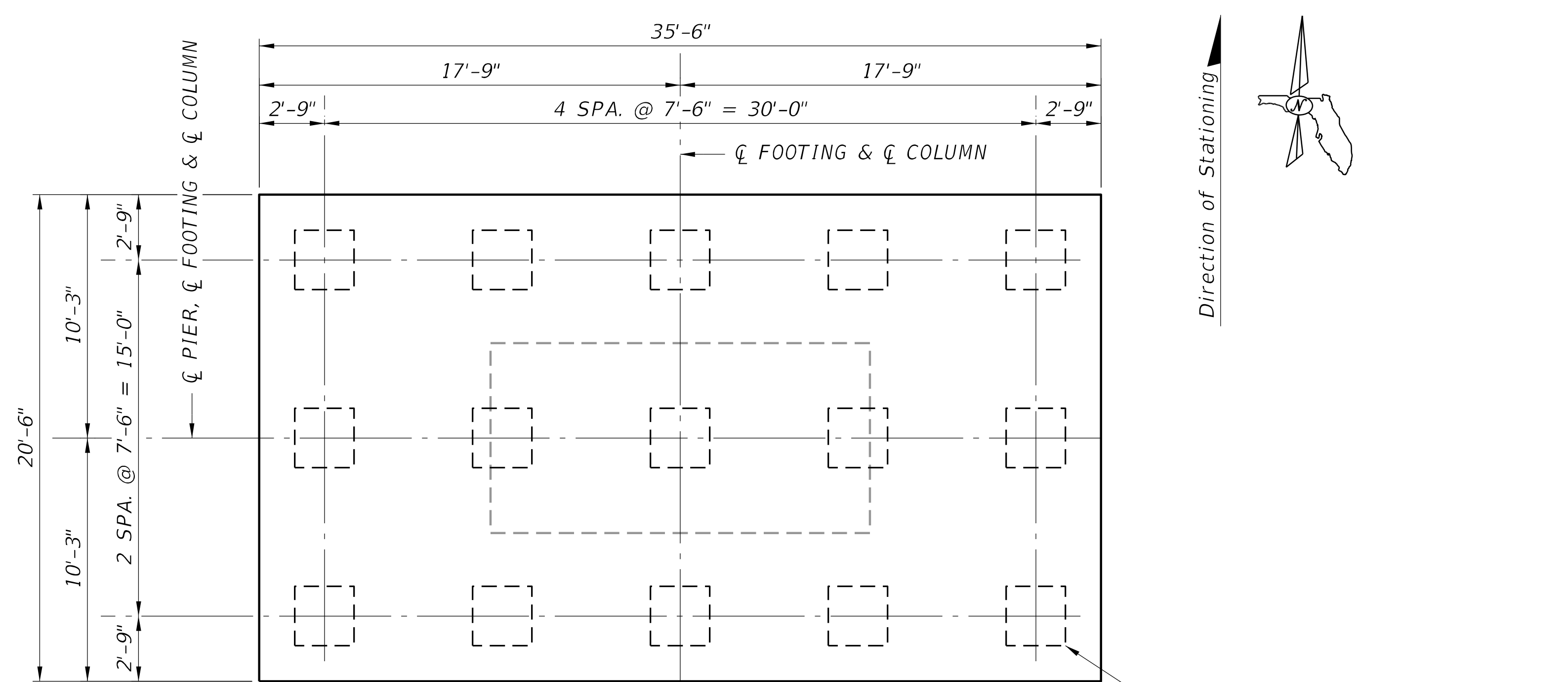

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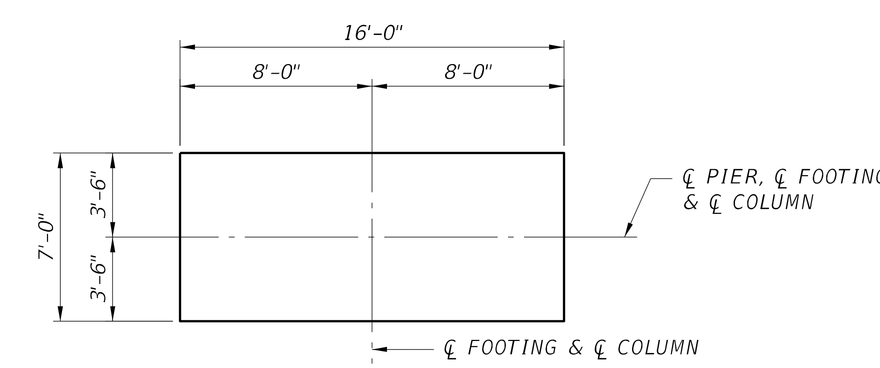

SECTION A-A

BRIDGE NUMBER XXXXXX

REVISIONS					
DATE	BY	DESCRIPTION	DATE	BY	DESCRIPTION
					30% PLANS NOT FOR CONSTRUCTION

LEO E. RODRIGUEZ
License Number: 78493
DRMP, INC.
1531 AMBERLY DRIVE, SUITE 200
TAMPA, FL 33647

DRAWN BY:	JLA 09-22
CHECKED BY:	EG 09-22
DESIGNED BY:	LCY 09-22
CHECKED BY:	EG 09-22

STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION

ROAD NO.	COUNTY	FINANCIAL PROJECT ID
SR 31	LEE	44194-22-01

SHEET TITLE: PIER DETAILS

PROJECT NAME: SR 31 FROM SR 80 (PALM BEACH BOULEVARD) TO SR 78 (BAYSHORE ROAD)

REF. DWG. NO.

SHEET NO. B1-20

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Appendix C Local Scour Calculations

FDOT Complex Pier Local Scour Calculator Version 6.2

Bridge Number:	TBD	Route:	SR 31
Pier Number:	2	Waterway:	Caloosahatchee River
Return Period:	100		
Calculated by:	MSG	Date:	10/21/2022
Notes:			

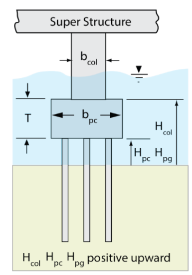
Input Data

Flow and Sediment Data

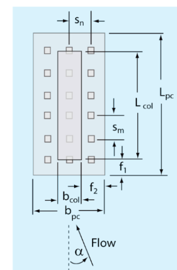
D50 (mm)	0.33
Angle of Attack, α (^{o})	5.00
y_0 (ft)	1.26
V (ft/s)	5.95

Column Data

b_{col} (ft)	7.00
L_{col} (ft)	16.00
H_{col} (ft)	-2.00
Shape	Rectangular



Front View



Top View

Pile Cap Data

b_{pc} (ft)	20.50
L_{pc} (ft)	35.50
T (ft)	8.00
H_{pc} (ft)	-10.00
Shape	Rectangular

Pile Group Data

n	No Pile Group
m	
b (ft)	
s_n (ft)	
s_m (ft)	
Shape	

Output Data

Column Data

K_{cols}	1.20
K_{colp} (ft)	8.37
K_{colh}	0.70
f_{ratio}	3.76
K_{colf}	0.00
K_{LOBcol}	1.00
D^*_{col} (ft)	0.00

Pile Cap Data

K_{pcs}	1.18
K_{pcp} (ft)	23.52
K_{pch}	0.15
K_{LOBpc}	1.00
D^*_{pc} (ft)	4.16

Pile Group Data

K_{pgs}	No Pile Group
K_{pgp} (ft)	
K_{pgpe} (ft)	
K_{pgh}	
D^*_{pg} (ft)	

Effective Diameter of Complex Pier

D^*_{cs} = 4.2 ft

Local Scour at Complex Pier

y_{scs} = 5.9 ft

FDOT Complex Pier Local Scour Calculator Version 6.2

Bridge Number:	TBD	Route:	SR 31
Pier Number:	2	Waterway:	Caloosahatchee River
Return Period:	500		
Calculated by:	MSG	Date:	10/21/2022
Notes:			

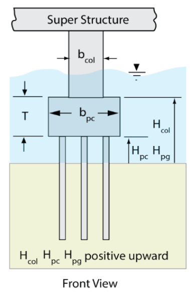
Input Data

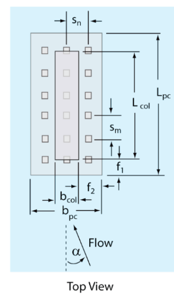
Flow and Sediment Data

D50 (mm)	0.33
Angle of Attack, α (^{o})	5.00
y_0 (ft)	1.62
V (ft/s)	8.72

Column Data

b_{col} (ft)	7.00
L_{col} (ft)	16.00
H_{col} (ft)	-2.00
Shape	Rectangular





Pile Cap Data

b_{pc} (ft)	20.50
L_{pc} (ft)	35.50
T (ft)	8.00
H_{pc} (ft)	-10.00
Shape	Rectangular

Pile Group Data

n	No Pile Group
m	
b (ft)	
s_n (ft)	
s_m (ft)	
Shape	

Output Data

Column Data

K_{cols}	1.20
K_{colp} (ft)	8.37
K_{colh}	0.69
f_{ratio}	3.76
K_{colf}	0.00
K_{LOBcol}	1.00
D^*_{col} (ft)	0.00

Pile Cap Data

K_{pcs}	1.18
K_{pcp} (ft)	23.52
K_{pch}	0.14
K_{LOBpc}	1.00
D^*_{pc} (ft)	3.86

Pile Group Data

K_{pgs}	No Pile Group
K_{pgp} (ft)	
K_{pgpe} (ft)	
K_{pgh}	
D^*_{pg} (ft)	

Effective Diameter of Complex Pier

D^*_{cs} = 3.9 ft

Local Scour at Complex Pier

y_{scs} = 6.0 ft

FDOT Complex Pier Local Scour Calculator Version 6.2

Bridge Number:	TBD	Route:	SR 31
Pier Number:	3	Waterway:	Caloosahatchee River
Return Period:	100		
Calculated by:	MSG	Date:	10/21/2022
Notes:			

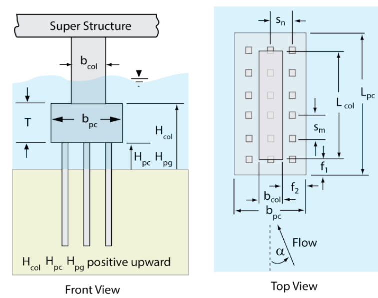
Input Data

Flow and Sediment Data

D50 (mm)	0.33
Angle of Attack, α (^{o})	5.00
y_0 (ft)	1.26
V (ft/s)	5.95

Column Data

b_{col} (ft)	7.00
L_{col} (ft)	16.00
H_{col} (ft)	-2.00
Shape	Rectangular



Pile Cap Data

b_{pc} (ft)	20.50
L_{pc} (ft)	35.50
T (ft)	8.00
H_{pc} (ft)	-10.00
Shape	Rectangular

Pile Group Data

n	No Pile Group
m	
b (ft)	
s_n (ft)	
s_m (ft)	
Shape	

Output Data

Column Data

K_{cols}	1.20
K_{colp} (ft)	8.37
K_{colh}	0.70
f_{ratio}	3.76
K_{colf}	0.00
K_{LOBcol}	1.00
D^*_{col} (ft)	0.00

Pile Cap Data

K_{pcs}	1.18
K_{pcp} (ft)	23.52
K_{pch}	0.15
K_{LOBpc}	1.00
D^*_{pc} (ft)	4.16

Pile Group Data

K_{pgs}	No Pile Group
K_{pgp} (ft)	
K_{pgpe} (ft)	
K_{pgh}	
D^*_{pg} (ft)	

Effective Diameter of Complex Pier

D^*_{cs} = 4.2 ft

Local Scour at Complex Pier

y_{scs} = 5.9 ft

FDOT Complex Pier Local Scour Calculator Version 6.2

Bridge Number:	TBD	Route:	SR 31
Pier Number:	3	Waterway:	Caloosahatchee River
Return Period:	500		
Calculated by:	MSG	Date:	10/21/2022
Notes:			

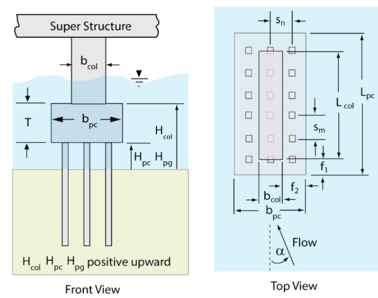
Input Data

Flow and Sediment Data

D50 (mm)	0.33
Angle of Attack, α (^{o})	5.00
y_0 (ft)	1.62
V (ft/s)	8.72

Column Data

b_{col} (ft)	7.00
L_{col} (ft)	16.00
H_{col} (ft)	-2.00
Shape	Rectangular



Pile Cap Data

b_{pc} (ft)	20.50
L_{pc} (ft)	35.50
T (ft)	8.00
H_{pc} (ft)	-10.00
Shape	Rectangular

Pile Group Data

n	No Pile Group
m	
b (ft)	
s_n (ft)	
s_m (ft)	
Shape	

Output Data

Column Data

K_{cols}	1.20
K_{colp} (ft)	8.37
K_{colh}	0.69
f_{ratio}	3.76
K_{colf}	0.00
K_{LOBcol}	1.00
D^*_{col} (ft)	0.00

Pile Cap Data

K_{pcs}	1.18
K_{pcp} (ft)	23.52
K_{pch}	0.14
K_{LOBpc}	1.00
D^*_{pc} (ft)	3.86

Pile Group Data

K_{pgs}	No Pile Group
K_{pgp} (ft)	
K_{pgpe} (ft)	
K_{pgh}	
D^*_{pg} (ft)	

Effective Diameter of Complex Pier

D^*_{cs} = 3.9 ft

Local Scour at Complex Pier

y_{scs} = 6.0 ft

FDOT Complex Pier Local Scour Calculator Version 6.2

Bridge Number:	TBD	Route:	SR 31
Pier Number:	4	Waterway:	Caloosahatchee River
Return Period:	100		
Calculated by:	MSG	Date:	10/21/2022
Notes:			

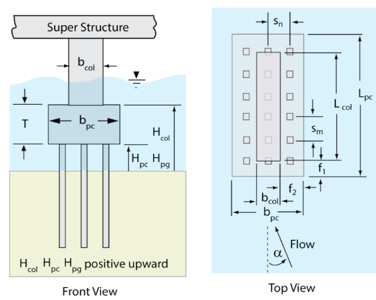
Input Data

Flow and Sediment Data

D50 (mm)	0.33
Angle of Attack, α (^{o})	5.00
y_0 (ft)	1.26
V (ft/s)	5.95

Column Data

b_{col} (ft)	7.00
L_{col} (ft)	16.00
H_{col} (ft)	-2.00
Shape	Rectangular



Pile Cap Data

b_{pc} (ft)	20.50
L_{pc} (ft)	35.50
T (ft)	8.00
H_{pc} (ft)	-10.00
Shape	Rectangular

Pile Group Data

n	No Pile Group
m	
b (ft)	
s_n (ft)	
s_m (ft)	
Shape	

Output Data

Column Data

K_{cols}	1.20
K_{colp} (ft)	8.37
K_{colh}	0.70
f_{ratio}	3.76
K_{colf}	0.00
K_{LOBcol}	1.00
D^*_{col} (ft)	0.00

Pile Cap Data

K_{pcs}	1.18
K_{pcp} (ft)	23.52
K_{pch}	0.15
K_{LOBpc}	1.00
D^*_{pc} (ft)	4.16

Pile Group Data

K_{pgs}	No Pile Group
K_{pgp} (ft)	
K_{pgpe} (ft)	
K_{pgh}	
D^*_{pg} (ft)	

Effective Diameter of Complex Pier

D^*_{cs} = 4.2 ft

Local Scour at Complex Pier

y_{scs} = 5.9 ft

FDOT Complex Pier Local Scour Calculator Version 6.2

Bridge Number:	TBD	Route:	SR 31
Pier Number:	4	Waterway:	Caloosahatchee River
Return Period:	500		
Calculated by:	MSG	Date:	10/21/2022
Notes:			

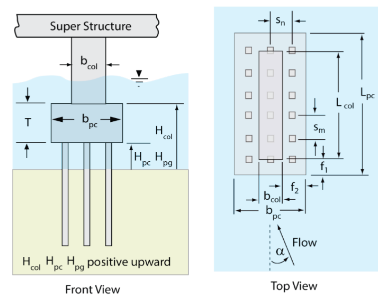
Input Data

Flow and Sediment Data

D50 (mm)	0.33
Angle of Attack, α (°)	5.00
y_0 (ft)	1.62
V (ft/s)	8.72

Column Data

b_{col} (ft)	7.00
L_{col} (ft)	16.00
H_{col} (ft)	-2.00
Shape	Rectangular



Pile Cap Data

b_{pc} (ft)	20.50
L_{pc} (ft)	35.50
T (ft)	8.00
H_{pc} (ft)	-10.00
Shape	Rectangular

Pile Group Data

n	No Pile Group
m	
b (ft)	
s_n (ft)	
s_m (ft)	
Shape	

Output Data

Column Data

K_{cols}	1.20
K_{colp} (ft)	8.37
K_{colh}	0.69
f_{ratio}	3.76
K_{colf}	0.00
K_{LOBcol}	1.00
D^*_{col} (ft)	0.00

Pile Cap Data

K_{pcs}	1.18
K_{pcp} (ft)	23.52
K_{pch}	0.14
K_{LOBpc}	1.00
D^*_{pc} (ft)	3.86

Pile Group Data

K_{pgs}	No Pile Group
K_{pgp} (ft)	
K_{pgpe} (ft)	
K_{pgh}	
D^*_{pg} (ft)	

Effective Diameter of Complex Pier

D^*_{cs} = 3.9 ft

Local Scour at Complex Pier

y_{scs} = 6.0 ft

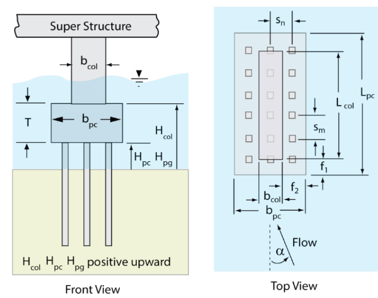
FDOT Complex Pier Local Scour Calculator Version 6.2

Bridge Number:	TBD	Route:	SR 31
Pier Number:	5	Waterway:	Caloosahatchee River
Return Period:	100		
Calculated by:	MSG	Date:	10/21/2022
Notes:			

Input Data

Flow and Sediment Data

D50 (mm)	0.33
Angle of Attack, α (^{o})	5.00
y_0 (ft)	16.26
V (ft/s)	5.95



Column Data

b_{col} (ft)	7.00
L_{col} (ft)	16.00
H_{col} (ft)	19.23
Shape	Rectangular

Pile Cap Data

b_{pc} (ft)	22.50
L_{pc} (ft)	118.00
T (ft)	8.00
H_{pc} (ft)	11.23
Shape	Rounded

Pile Group Data

n	3
m	14
b (ft)	2.5
s_n (ft)	7.5
s_m (ft)	7.5
Shape	Rectangular

Output Data

Column Data

K_{cols}	
K_{colp} (ft)	0.00
K_{colh}	
f_{ratio}	
K_{colf}	
K_{LOBcol}	
D^*_{col} (ft)	0.00

Pile Cap Data

K_{pcs}	1.02
K_{pcp} (ft)	30.82
K_{pch}	0.06
K_{LOBpc}	1.00
D^*_{pc} (ft)	1.96

Pile Group Data

K_{pgs}	1.40
K_{pgp} (ft)	16.62
K_{pgpe} (ft)	7.40
K_{pgh}	0.94
D^*_{pg} (ft)	9.71

Effective Diameter of Complex Pier

D^*_{cs} = 11.7 ft

Local Scour at Complex Pier

y_{scs} = 16.1 ft

FDOT Complex Pier Local Scour Calculator Version 6.2

Bridge Number:	TBD	Route:	SR 31
Pier Number:	5	Waterway:	Caloosahatchee River
Return Period:	100		
Calculated by:	MSG	Date:	10/21/2022
Notes:			

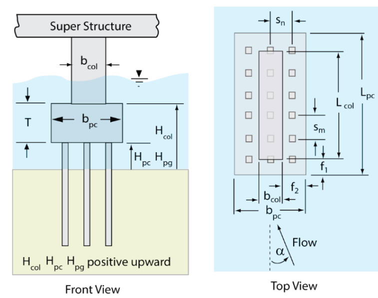
Input Data

Flow and Sediment Data

D50 (mm)	0.33
Angle of Attack, α (^{o})	5.00
y_0 (ft)	16.60
V (ft/s)	8.72

Column Data

b_{col} (ft)	7.00
L_{col} (ft)	16.00
H_{col} (ft)	19.23
Shape	Rectangular



Pile Cap Data

b_{pc} (ft)	22.50
L_{pc} (ft)	118.00
T (ft)	8.00
H_{pc} (ft)	11.23
Shape	Rounded

Pile Group Data

n	3
m	14
b (ft)	2.5
s_n (ft)	7.5
s_m (ft)	7.5
Shape	Rectangular

Output Data

Column Data

K_{cols}	
K_{colp} (ft)	0.00
K_{colh}	
f_{ratio}	
K_{colf}	
K_{LOBcol}	
D^*_{col} (ft)	0.00

Pile Cap Data

K_{pcs}	1.02
K_{pcp} (ft)	30.82
K_{pch}	0.07
K_{LOBpc}	1.00
D^*_{pc} (ft)	2.14

Pile Group Data

K_{pgs}	1.40
K_{pgp} (ft)	16.62
K_{pgpe} (ft)	7.40
K_{pgh}	0.93
D^*_{pg} (ft)	9.65

Effective Diameter of Complex Pier

D^*_{cs} = 11.8 ft

Local Scour at Complex Pier

y_{scs} = 19.4 ft

FDOT Complex Pier Local Scour Calculator Version 6.2

Bridge Number:	TBD	Route:	SR 31
Pier Number:	6	Waterway:	Caloosahatchee River
Return Period:	100		
Calculated by:	MSG	Date:	10/21/2022
Notes:			

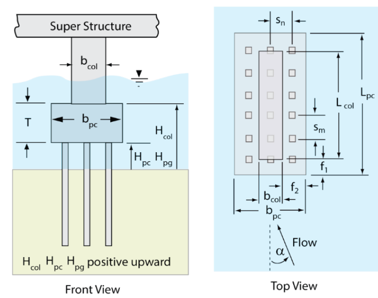
Input Data

Flow and Sediment Data

D50 (mm)	0.33
Angle of Attack, α (^{o})	5.00
y_0 (ft)	24.26
V (ft/s)	5.95

Column Data

b_{col} (ft)	7.00
L_{col} (ft)	16.00
H_{col} (ft)	27.23
Shape	Rectangular



Pile Cap Data

b_{pc} (ft)	22.50
L_{pc} (ft)	118.00
T (ft)	8.00
H_{pc} (ft)	19.23
Shape	Rounded

Pile Group Data

n	3
m	14
b (ft)	2.5
s_n (ft)	7.5
s_m (ft)	7.5
Shape	Rectangular

Output Data

Column Data

K_{cols}	
K_{colp} (ft)	0.00
K_{colh}	
f_{ratio}	
K_{colf}	
K_{LOBcol}	
D^*_{col} (ft)	0.00

Pile Cap Data

K_{pcs}	1.02
K_{pcp} (ft)	30.82
K_{pch}	0.03
K_{LOBpc}	1.00
D^*_{pc} (ft)	0.88

Pile Group Data

K_{pgs}	1.40
K_{pgp} (ft)	16.62
K_{pgpe} (ft)	7.40
K_{pgh}	0.97
D^*_{pg} (ft)	10.07

Effective Diameter of Complex Pier

D^*_{cs} = 10.9 ft

Local Scour at Complex Pier

y_{scs} = 15.4 ft

FDOT Complex Pier Local Scour Calculator Version 6.2

Bridge Number:	TBD	Route:	SR 31
Pier Number:	6	Waterway:	Caloosahatchee River
Return Period:	500		
Calculated by:	MSG	Date:	10/21/2022
Notes:			

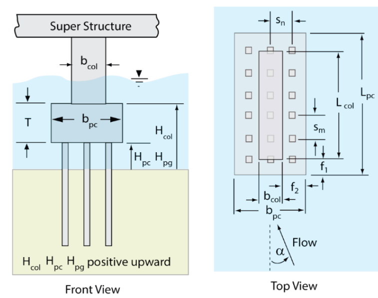
Input Data

Flow and Sediment Data

D50 (mm)	0.33
Angle of Attack, α (^{o})	5.00
y_0 (ft)	24.62
V (ft/s)	8.72

Column Data

b_{col} (ft)	7.00
L_{col} (ft)	16.00
H_{col} (ft)	27.23
Shape	Rectangular



Pile Cap Data

b_{pc} (ft)	22.50
L_{pc} (ft)	118.00
T (ft)	8.00
H_{pc} (ft)	19.23
Shape	Rounded

Pile Group Data

n	3
m	14
b (ft)	2.5
s_n (ft)	7.5
s_m (ft)	7.5
Shape	Rectangular

Output Data

Column Data

K_{cols}	
K_{colp} (ft)	0.00
K_{colh}	
f_{ratio}	
K_{colf}	
K_{LOBcol}	
D^*_{col} (ft)	0.00

Pile Cap Data

K_{pcs}	1.02
K_{pcp} (ft)	30.82
K_{pch}	0.03
K_{LOBpc}	1.00
D^*_{pc} (ft)	0.98

Pile Group Data

K_{pgs}	1.40
K_{pgp} (ft)	16.62
K_{pgpe} (ft)	7.40
K_{pgh}	0.97
D^*_{pg} (ft)	10.03

Effective Diameter of Complex Pier

D^*_{cs} = 11.0 ft

Local Scour at Complex Pier

y_{scs} = 18.1 ft

FDOT Complex Pier Local Scour Calculator Version 6.2

Bridge Number:	TBD	Route:	SR 31
Pier Number:	7	Waterway:	Caloosahatchee River
Return Period:	100		
Calculated by:	MSG	Date:	10/21/2022
Notes:			

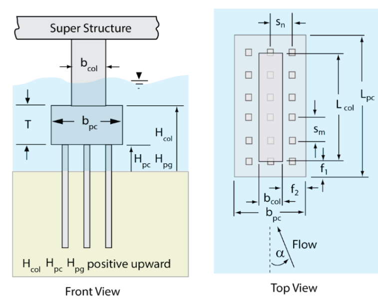
Input Data

Flow and Sediment Data

D50 (mm)	0.33
Angle of Attack, α (^{o})	5.00
y_0 (ft)	26.26
V (ft/s)	5.95

Column Data

b_{col} (ft)	7.00
L_{col} (ft)	16.00
H_{col} (ft)	29.23
Shape	Rectangular



Pile Cap Data

b_{pc} (ft)	22.50
L_{pc} (ft)	118.00
T (ft)	8.00
H_{pc} (ft)	21.23
Shape	Rounded

Pile Group Data

n	3
m	14
b (ft)	2.5
s_n (ft)	7.5
s_m (ft)	7.5
Shape	Rectangular

Output Data

Column Data

K_{cols}	
K_{colp} (ft)	0.00
K_{colh}	
f_{ratio}	
K_{colf}	
K_{LOBcol}	
D^*_{col} (ft)	0.00

Pile Cap Data

K_{pcs}	1.02
K_{pcp} (ft)	30.82
K_{pch}	0.02
K_{LOBpc}	1.00
D^*_{pc} (ft)	0.75

Pile Group Data

K_{pgs}	1.40
K_{pgp} (ft)	16.62
K_{pgpe} (ft)	7.40
K_{pgh}	0.98
D^*_{pg} (ft)	10.11

Effective Diameter of Complex Pier

D^*_{cs} = 10.9 ft

Local Scour at Complex Pier

y_{scs} = 15.3 ft

FDOT Complex Pier Local Scour Calculator Version 6.2

Bridge Number:	TBD	Route:	SR 31
Pier Number:	7	Waterway:	Caloosahatchee River
Return Period:	500		
Calculated by:	MSG	Date:	10/21/2022
Notes:			

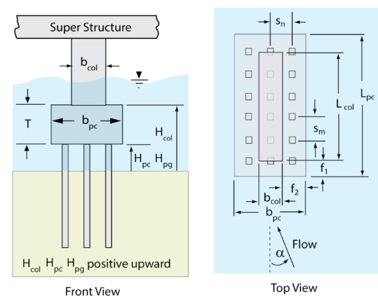
Input Data

Flow and Sediment Data

D50 (mm)	0.33
Angle of Attack, α (^{o})	5.00
y_0 (ft)	26.62
V (ft/s)	8.72

Column Data

b_{col} (ft)	7.00
L_{col} (ft)	16.00
H_{col} (ft)	29.23
Shape	Rectangular



Pile Cap Data

b_{pc} (ft)	22.50
L_{pc} (ft)	118.00
T (ft)	8.00
H_{pc} (ft)	21.23
Shape	Rounded

Pile Group Data

n	3
m	14
b (ft)	2.5
s_n (ft)	7.5
s_m (ft)	7.5
Shape	Rectangular

Output Data

Column Data

K_{cols}	
K_{colp} (ft)	0.00
K_{colh}	
f_{ratio}	
K_{colf}	
K_{LOBcol}	
D^*_{col} (ft)	0.00

Pile Cap Data

K_{pcs}	1.02
K_{pcp} (ft)	30.82
K_{pch}	0.03
K_{LOBpc}	1.00
D^*_{pc} (ft)	0.84

Pile Group Data

K_{pgs}	1.40
K_{pgp} (ft)	16.62
K_{pgpe} (ft)	7.40
K_{pgh}	0.97
D^*_{pg} (ft)	10.08

Effective Diameter of Complex Pier

D^*_{cs} = 10.9 ft

Local Scour at Complex Pier

y_{scs} = 17.9 ft

FDOT Complex Pier Local Scour Calculator Version 6.2

Bridge Number:	TBD	Route:	SR 31
Pier Number:	8	Waterway:	Caloosahatchee River
Return Period:	100		
Calculated by:	MSG	Date:	10/21/2022
Notes:			

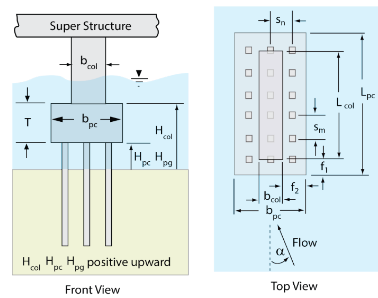
Input Data

Flow and Sediment Data

D50 (mm)	0.33
Angle of Attack, α (^{o})	5.00
y_0 (ft)	11.26
V (ft/s)	5.95

Column Data

b_{col} (ft)	7.00
L_{col} (ft)	16.00
H_{col} (ft)	14.23
Shape	Rectangular



Pile Cap Data

b_{pc} (ft)	22.50
L_{pc} (ft)	118.00
T (ft)	8.00
H_{pc} (ft)	6.23
Shape	Rounded

Pile Group Data

n	3
m	14
b (ft)	2.5
s_n (ft)	7.5
s_m (ft)	7.5
Shape	Rectangular

Output Data

Column Data

K_{cols}	
K_{colp} (ft)	0.00
K_{colh}	
f_{ratio}	
K_{colf}	
K_{LOBcol}	
D^*_{col} (ft)	0.00

Pile Cap Data

K_{pcs}	1.02
K_{pcp} (ft)	30.82
K_{pch}	0.13
K_{LOBpc}	1.00
D^*_{pc} (ft)	4.08

Pile Group Data

K_{pgs}	1.40
K_{pgp} (ft)	16.62
K_{pgpe} (ft)	7.40
K_{pgh}	0.87
D^*_{pg} (ft)	9.01

Effective Diameter of Complex Pier

D^*_{cs} = 13.1 ft

Local Scour at Complex Pier

y_{scs} = 17.3 ft

FDOT Complex Pier Local Scour Calculator Version 6.2

Bridge Number:	TBD	Route:	SR 31
Pier Number:	8	Waterway:	Caloosahatchee River
Return Period:	500		
Calculated by:	MSG	Date:	10/21/2022
Notes:			

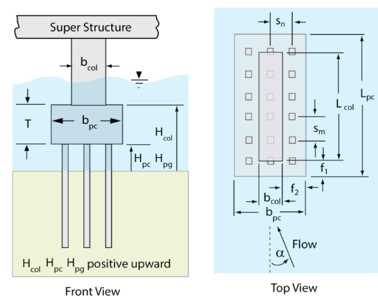
Input Data

Flow and Sediment Data

D50 (mm)	0.33
Angle of Attack, α (^{o})	5.00
y_0 (ft)	11.62
V (ft/s)	8.72

Column Data

b_{col} (ft)	7.00
L_{col} (ft)	16.00
H_{col} (ft)	14.23
Shape	Rectangular



Pile Cap Data

b_{pc} (ft)	22.50
L_{pc} (ft)	118.00
T (ft)	8.00
H_{pc} (ft)	6.23
Shape	Rounded

Pile Group Data

n	3
m	14
b (ft)	2.5
s_n (ft)	7.5
s_m (ft)	7.5
Shape	Rectangular

Output Data

Column Data

K_{cols}	
K_{colp} (ft)	0.00
K_{colh}	
f_{ratio}	
K_{colf}	
K_{LOBcol}	
D^*_{col} (ft)	0.00

Pile Cap Data

K_{pcs}	1.02
K_{pcp} (ft)	30.82
K_{pch}	0.14
K_{LOBpc}	1.00
D^*_{pc} (ft)	4.40

Pile Group Data

K_{pgs}	1.40
K_{pgp} (ft)	16.62
K_{pgpe} (ft)	7.40
K_{pgh}	0.86
D^*_{pg} (ft)	8.91

Effective Diameter of Complex Pier

D^*_{cs} = 13.3 ft

Local Scour at Complex Pier

y_{scs} = 21.5 ft

FDOT Complex Pier Local Scour Calculator Version 6.2

Bridge Number:	TBD	Route:	SR 31
Pier Number:	9	Waterway:	Caloosahatchee River
Return Period:	100		
Calculated by:	MSG	Date:	10/21/2022
Notes:			

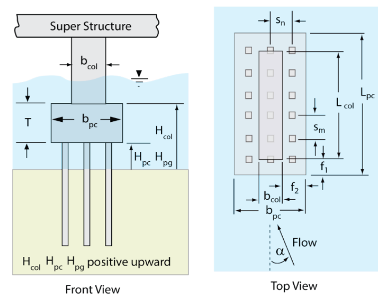
Input Data

Flow and Sediment Data

D50 (mm)	0.33
Angle of Attack, α (^{o})	5.00
y_0 (ft)	11.26
V (ft/s)	5.95

Column Data

b_{col} (ft)	7.00
L_{col} (ft)	16.00
H_{col} (ft)	14.23
Shape	Rectangular



Pile Cap Data

b_{pc} (ft)	22.50
L_{pc} (ft)	118.00
T (ft)	8.00
H_{pc} (ft)	6.23
Shape	Rounded

Pile Group Data

n	3
m	14
b (ft)	2.5
s_n (ft)	7.5
s_m (ft)	7.5
Shape	Rectangular

Output Data

Column Data

K_{cols}	
K_{colp} (ft)	0.00
K_{colh}	
f_{ratio}	
K_{colf}	
K_{LOBcol}	
D^*_{col} (ft)	0.00

Pile Cap Data

K_{pcs}	1.02
K_{pcp} (ft)	30.82
K_{pch}	0.13
K_{LOBpc}	1.00
D^*_{pc} (ft)	4.08

Pile Group Data

K_{pgs}	1.40
K_{pgp} (ft)	16.62
K_{pgpe} (ft)	7.40
K_{pgh}	0.87
D^*_{pg} (ft)	9.01

Effective Diameter of Complex Pier

D^*_{cs} = 13.1 ft

Local Scour at Complex Pier

y_{scs} = 17.3 ft

FDOT Complex Pier Local Scour Calculator Version 6.2

Bridge Number:	TBD	Route:	SR 31
Pier Number:	9	Waterway:	Caloosahatchee River
Return Period:	500		
Calculated by:	MSG	Date:	10/21/2022
Notes:			

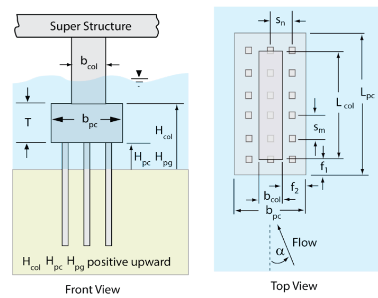
Input Data

Flow and Sediment Data

D50 (mm)	0.33
Angle of Attack, α (^{o})	5.00
y_0 (ft)	11.62
V (ft/s)	8.72

Column Data

b_{col} (ft)	7.00
L_{col} (ft)	16.00
H_{col} (ft)	14.23
Shape	Rectangular



Pile Cap Data

b_{pc} (ft)	22.50
L_{pc} (ft)	118.00
T (ft)	8.00
H_{pc} (ft)	6.23
Shape	Rounded

Pile Group Data

n	3
m	14
b (ft)	2.5
s_n (ft)	7.5
s_m (ft)	7.5
Shape	Rectangular

Output Data

Column Data

K_{cols}	
K_{colp} (ft)	0.00
K_{colh}	
f_{ratio}	
K_{colf}	
K_{LOBcol}	
D^*_{col} (ft)	0.00

Pile Cap Data

K_{pcs}	1.02
K_{pcp} (ft)	30.82
K_{pch}	0.14
K_{LOBpc}	1.00
D^*_{pc} (ft)	4.40

Pile Group Data

K_{pgs}	1.40
K_{pgp} (ft)	16.62
K_{pgpe} (ft)	7.40
K_{pgh}	0.86
D^*_{pg} (ft)	8.91

Effective Diameter of Complex Pier

D^*_{cs} = 13.3 ft

Local Scour at Complex Pier

y_{scs} = 21.5 ft

FDOT Complex Pier Local Scour Calculator Version 6.2

Bridge Number:	TBD	Route:	SR 31
Pier Number:	10	Waterway:	Caloosahatchee River
Return Period:	100		
Calculated by:	MSG	Date:	10/21/2022
Notes:			

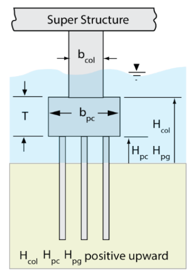
Input Data

Flow and Sediment Data

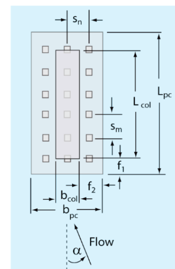
D50 (mm)	0.33
Angle of Attack, α (^{o})	5.00
y_0 (ft)	5.26
V (ft/s)	5.95

Column Data

b_{col} (ft)	7.00
L_{col} (ft)	16.00
H_{col} (ft)	8.23
Shape	Rectangular



Front View



Top View

Pile Cap Data

b_{pc} (ft)	22.50
L_{pc} (ft)	118.00
T (ft)	8.00
H_{pc} (ft)	0.23
Shape	Rounded

Pile Group Data

n	3
m	14
b (ft)	2.5
s_n (ft)	7.5
s_m (ft)	7.5
Shape	Rectangular

Output Data

Column Data

K_{cols}	
K_{colp} (ft)	0.00
K_{colh}	
f_{ratio}	
K_{colf}	
K_{LOBcol}	
D^*_{col} (ft)	0.00

Pile Cap Data

K_{pcs}	1.02
K_{pcp} (ft)	30.82
K_{pch}	0.59
K_{LOBpc}	1.00
D^*_{pc} (ft)	18.72

Pile Group Data

K_{pgs}	1.40
K_{pgp} (ft)	16.62
K_{pgpe} (ft)	7.40
K_{pgh}	0.41
D^*_{pg} (ft)	4.20

Effective Diameter of Complex Pier

D^*_{cs} = 22.9 ft

Local Scour at Complex Pier

y_{scs} = 24.4 ft

FDOT Complex Pier Local Scour Calculator Version 6.2

Bridge Number:	TBD	Route:	SR 31
Pier Number:	10	Waterway:	Caloosahatchee River
Return Period:	500		
Calculated by:	MSG	Date:	10/21/2022
Notes:			

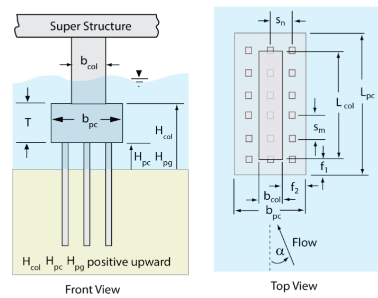
Input Data

Flow and Sediment Data

D50 (mm)	0.33
Angle of Attack, α (^{o})	5.00
y_0 (ft)	5.62
V (ft/s)	8.72

Column Data

b_{col} (ft)	7.00
L_{col} (ft)	16.00
H_{col} (ft)	8.23
Shape	Rectangular



Pile Cap Data

b_{pc} (ft)	22.50
$_{Loc}$ (ft)	118.00
T (ft)	8.00
H_{pc} (ft)	0.23
Shape	Rounded

Pile Group Data

n	3
m	14
b (ft)	2.5
s_n (ft)	7.5
s_m (ft)	7.5
Shape	Rectangular

Output Data

Column Data

K_{cols}	
K_{colp} (ft)	0.00
K_{colh}	
f_{ratio}	
K_{colf}	
K_{LOBcol}	
D^*_{col} (ft)	0.00

Pile Cap Data

K_{pcs}	1.02
K_{pcp} (ft)	30.82
K_{pch}	0.60
K_{LOBpc}	1.00
D^*_{pc} (ft)	18.83

Pile Group Data

K_{pgs}	1.40
K_{pgp} (ft)	16.62
K_{pgpe} (ft)	7.40
K_{pgh}	0.40
D^*_{pg} (ft)	4.16

Effective Diameter of Complex Pier

D^*_{cs} = 23.0 ft

Local Scour at Complex Pier

y_{scs} = 30.2 ft

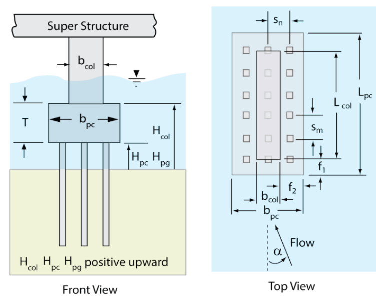
FDOT Complex Pier Local Scour Calculator Version 6.2

Bridge Number:	TBD	Route:	SR 31
Pier Number:	11	Waterway:	Caloosahatchee River
Return Period:	100		
Calculated by:	MSG	Date:	10/21/2022
Notes:			

Input Data

Flow and Sediment Data

D50 (mm)	0.33
Angle of Attack, α (^{o})	5.00
y_0 (ft)	5.26
V (ft/s)	5.95



Column Data

b_{col} (ft)	7.00
L_{col} (ft)	16.00
H_{col} (ft)	8.23
Shape	Rectangular

Pile Cap Data

b_{pc} (ft)	22.50
$_{Loc}$ (ft)	118.00
T (ft)	8.00
H_{pc} (ft)	0.23
Shape	Rounded

Pile Group Data

n	3
m	14
b (ft)	2.5
s_n (ft)	7.5
s_m (ft)	7.5
Shape	Rectangular

Output Data

Column Data

K_{cols}	
K_{colp} (ft)	0.00
K_{colh}	
f_{ratio}	
K_{colf}	
K_{LOBcol}	
D^*_{col} (ft)	0.00

Pile Cap Data

K_{pcs}	1.02
K_{pcp} (ft)	30.82
K_{pch}	0.59
K_{LOBpc}	1.00
D^*_{pc} (ft)	18.72

Pile Group Data

K_{pgs}	1.40
K_{pgp} (ft)	16.62
K_{pgpe} (ft)	7.40
K_{pgh}	0.41
D^*_{pg} (ft)	4.20

Effective Diameter of Complex Pier

D^*_{cs} = 22.9 ft

Local Scour at Complex Pier

y_{scs} = 24.4 ft

FDOT Complex Pier Local Scour Calculator Version 6.2

Bridge Number:	TBD	Route:	SR 31
Pier Number:	11	Waterway:	Caloosahatchee River
Return Period:	500		
Calculated by:	MSG	Date:	10/21/2022
Notes:			

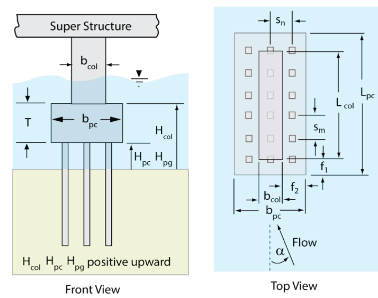
Input Data

Flow and Sediment Data

D50 (mm)	0.33
Angle of Attack, α (^{o})	5.00
y_0 (ft)	5.62
V (ft/s)	8.72

Column Data

b_{col} (ft)	7.00
L_{col} (ft)	16.00
H_{col} (ft)	8.23
Shape	Rectangular



Pile Cap Data

b_{pc} (ft)	22.50
L_{pc} (ft)	118.00
T (ft)	8.00
H_{pc} (ft)	0.23
Shape	Rounded

Pile Group Data

n	3
m	14
b (ft)	2.5
s_n (ft)	7.5
s_m (ft)	7.5
Shape	Rectangular

Output Data

Column Data

K_{cols}	
K_{colp} (ft)	0.00
K_{colh}	
f_{ratio}	
K_{colf}	
K_{LOBcol}	
D^*_{col} (ft)	0.00

Pile Cap Data

K_{pcs}	1.02
K_{pcp} (ft)	30.82
K_{pch}	0.60
K_{LOBpc}	1.00
D^*_{pc} (ft)	18.83

Pile Group Data

K_{pgs}	1.40
K_{pgp} (ft)	16.62
K_{pgpe} (ft)	7.40
K_{pgh}	0.40
D^*_{pg} (ft)	4.16

Effective Diameter of Complex Pier

D^*_{cs} = 23.0 ft

Local Scour at Complex Pier

y_{scs} = 30.2 ft

FDOT Complex Pier Local Scour Calculator Version 6.2

Bridge Number:	TBD	Route:	SR 31
Pier Number:	12	Waterway:	Caloosahatchee River
Return Period:	100		
Calculated by:	MSG	Date:	10/21/2022
Notes:			

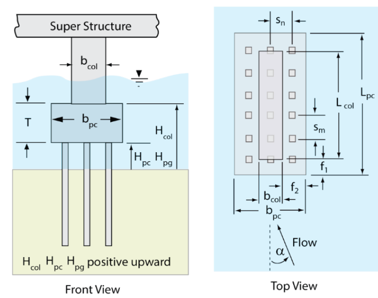
Input Data

Flow and Sediment Data

D50 (mm)	0.33
Angle of Attack, α (^{o})	5.00
y_0 (ft)	1.26
V (ft/s)	5.95

Column Data

b_{col} (ft)	7.00
L_{col} (ft)	16.00
H_{col} (ft)	-2.00
Shape	Rectangular



Pile Cap Data

b_{pc} (ft)	20.50
L_{pc} (ft)	35.50
T (ft)	8.00
H_{pc} (ft)	-10.00
Shape	Rectangular

Pile Group Data

n	No Pile Group
m	
b (ft)	
s_n (ft)	
s_m (ft)	
Shape	

Output Data

Column Data

K_{cols}	1.20
K_{colp} (ft)	8.37
K_{colh}	0.70
f_{ratio}	3.76
K_{colf}	0.00
K_{LOBcol}	1.00
D^*_{col} (ft)	0.00

Pile Cap Data

K_{pcs}	1.18
K_{pcp} (ft)	23.52
K_{pch}	0.15
K_{LOBpc}	1.00
D^*_{pc} (ft)	4.16

Pile Group Data

K_{pgs}	No Pile Group
K_{pgp} (ft)	
K_{pgpe} (ft)	
K_{pgh}	
D^*_{pg} (ft)	

Effective Diameter of Complex Pier

D^*_{cs} = 4.2 ft

Local Scour at Complex Pier

y_{scs} = 5.9 ft

FDOT Complex Pier Local Scour Calculator Version 6.2

Bridge Number:	TBD	Route:	SR 31
Pier Number:	12	Waterway:	Caloosahatchee River
Return Period:	500		
Calculated by:	MSG	Date:	10/21/2022
Notes:			

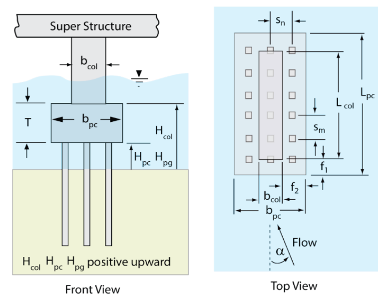
Input Data

Flow and Sediment Data

D50 (mm)	0.33
Angle of Attack, α (°)	5.00
y_0 (ft)	1.62
V (ft/s)	8.72

Column Data

b_{col} (ft)	7.00
L_{col} (ft)	16.00
H_{col} (ft)	-2.00
Shape	Rectangular



Pile Cap Data

b_{pc} (ft)	20.50
L_{pc} (ft)	35.50
T (ft)	8.00
H_{pc} (ft)	-10.00
Shape	Rectangular

Pile Group Data

n	No Pile Group
m	
b (ft)	
s_n (ft)	
s_m (ft)	
Shape	

Output Data

Column Data

K_{cols}	1.20
K_{colp} (ft)	8.37
K_{colh}	0.69
f_{ratio}	3.76
K_{colf}	0.00
K_{LOBcol}	1.00
D^*_{col} (ft)	0.00

Pile Cap Data

K_{pcs}	1.18
K_{pcp} (ft)	23.52
K_{pch}	0.14
K_{LOBpc}	1.00
D^*_{pc} (ft)	3.86

Pile Group Data

K_{pgs}	No Pile Group
K_{pgp} (ft)	
K_{pgpe} (ft)	
K_{pgh}	
D^*_{pg} (ft)	

Effective Diameter of Complex Pier

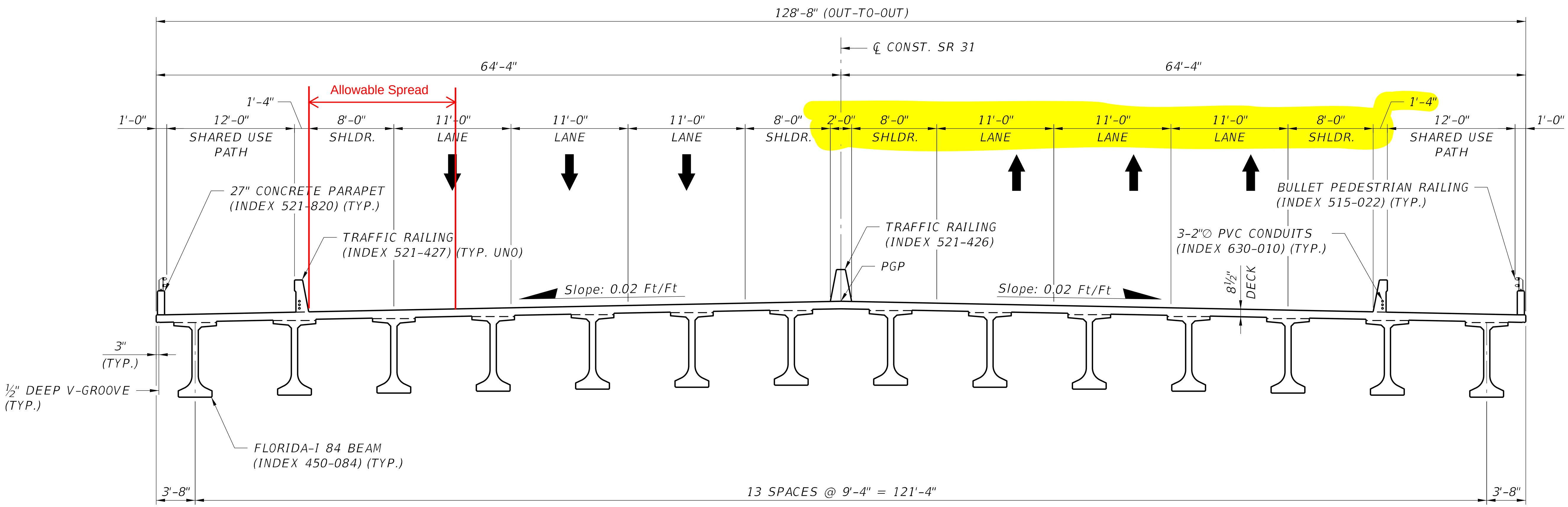
D^*_{cs} = 3.9 ft

Local Scour at Complex Pier

y_{scs} = 6.0 ft

Appendix D Deck Drainage Calculations

DRAFT BDR SUBMITTAL



SECTION THROUGH BRIDGE

3.9.1 Spread Criteria

The spread criteria listed is for permanent design and temporary construction conditions. Limit the spread resulting from a rainfall intensity of 4.0 inches per hour as follows.

Table 3.5: Spread Criteria

Typical Section Condition	Design Speed (mph)	Spread Criteria*
Parking Lane or Full Width Shoulders	All	No encroachment into the lane
Left Turn Lanes	Design Speed > 45	Keep 8' of lane clear
Right Turn Lanes	All	Keep ½ of lane clear
All Other	Design speed ≤ 45	Keep ½ of lane clear
	45 < Design Speed ≤ 55	Keep 8' of lane clear
	Design Speed > 55	No encroachment into the lane

* The criteria in this column apply to travel, turn, or auxiliary lanes adjacent to barrier wall or curb, in normal or super-elevated sections.

Allowable Spread is based on a 45 mph design speed:
Allowable Spread = the shoulder plus 1/2 the adjacent travel lane = 8 + (11/2) = 13.5 feet

LEGEND

DIRECTION OF TRAVEL

BRIDGE NUMBER XXXXXX

REVISIONS					
DATE	BY	DESCRIPTION	DATE	BY	DESCRIPTION
					30% PLANS NOT FOR CONSTRUCTION

LEO E. RODRIGUEZ, P.E.
License Number: P.E. 78493
DRMP, INC.
15310 AMBERLY DRIVE, SUITE 200
TAMPA, FL 33647

DRAWN BY: JMA 09-22
CHECKED BY: EG 09-22
DESIGNED BY: LCY 09-22
CHECKED BY: EG 09-22

STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION

ROAD NO.	COUNTY	FINANCIAL PROJECT ID
SR 31	LEE	441942-1-22-1

SHEET TITLE: TYPICAL SECTION

PROJECT NAME: SR 31 FROM SR 80 (PALM BEACH BOULEVARD) TO SR 78 (BAYSHORE ROAD)

REF. DWG. NO.

SHEET NO. B1-04

THE OFFICIAL RECORD OF THIS SHEET IS THE ELECTRONIC FILE DIGITALLY SIGNED AND SEALED UNDER RULE 61G15-23.004, F.A.C.

10/14/2022 3:07:14 PM wschreiner
c:\pw_working\drmp01\dms23297\B1TypicalSection01.dgn

DRMP

Project Name:	SR 31	Designer:	VAH
FPID:	441942-1-22-1	Checked by:	MJ
County:	Lee	Date:	10/21/2022

BRIDGE SPREAD CALCULATIONS

Reference: Section 6.3.2.4, Chapter 6, FDOT Drainage Design Guide, 2017

STRUCTURE NUMBER	STATION FROM (ft.)	STATION TO (ft.)	SIDE	LONG. SLOPE %	CROSS SLOPE Sx (ft/ft)	WIDTH (ft.)	AREA A (Ac.)	Intensity i (in/hr)	Runoff Coeff. C	FLOW Q (cfs)	BYPASS Upstream Qb (cfs)	TOTAL FLOW Qt (cfs)	SPREAD WIDTH T (ft.)	BYPASS Qb (cfs)	Allowable Spread (ft)	REMARKS
SR 31 ML	104+12.82	96+67.00	LT/RT	4.00%	0.0200	51.3	0.88	4.00	0.95	3.34	0.00	3.34	8.78	0.00	13.50	OK
SR 31 ML	104+12.82	101+54.24	LT/RT	2.64%	0.0200	51.3	0.30	4.00	0.95	1.16	0.00	1.16	6.38	0.00	13.50	OK
SR 31 ML	104+12.82	101+74.07	LT/RT	2.44%	0.0200	51.3	0.28	4.00	0.95	1.07	0.00	1.07	6.29	0.00	13.50	OK
SR 31 ML	104+12.82	101+93.90	LT/RT	2.23%	0.0200	51.3	0.26	4.00	0.95	0.98	0.00	0.98	6.18	0.00	13.50	OK
SR 31 ML	104+12.82	102+13.73	LT/RT	2.03%	0.0200	51.3	0.23	4.00	0.95	0.89	0.00	0.89	6.07	0.00	13.50	OK
SR 31 ML	104+12.82	102+33.56	LT/RT	1.83%	0.0200	51.3	0.21	4.00	0.95	0.80	0.00	0.80	5.96	0.00	13.50	OK
SR 31 ML	104+12.82	102+53.39	LT/RT	1.63%	0.0200	51.3	0.19	4.00	0.95	0.71	0.00	0.71	5.83	0.00	13.50	OK
SR 31 ML	104+12.82	102+73.22	LT/RT	1.42%	0.0200	51.3	0.16	4.00	0.95	0.63	0.00	0.63	5.68	0.00	13.50	OK
SR 31 ML	104+12.82	102+93.05	LT/RT	1.22%	0.0200	51.3	0.14	4.00	0.95	0.54	0.00	0.54	5.52	0.00	13.50	OK
SR 31 ML	104+12.82	103+12.88	LT/RT	1.02%	0.0200	51.3	0.12	4.00	0.95	0.45	0.00	0.45	5.34	0.00	13.50	OK
SR 31 ML	104+12.82	103+32.71	LT/RT	0.82%	0.0200	51.3	0.09	4.00	0.95	0.36	0.00	0.36	5.12	0.00	13.50	OK
SR 31 ML	104+12.82	103+52.54	LT/RT	0.62%	0.0200	51.3	0.07	4.00	0.95	0.27	0.00	0.27	4.86	0.00	13.50	OK
SR 31 ML	104+12.82	103+72.37	LT/RT	0.41%	0.0200	51.3	0.05	4.00	0.95	0.18	0.00	0.18	4.51	0.00	13.50	OK
SR 31 ML	104+12.82	103+92.20	LT/RT	0.21%	0.0200	51.3	0.02	4.00	0.95	0.09	0.00	0.09	3.97	0.00	13.50	OK
SR 31 ML	104+12.82	104+12.03	LT/RT	0.01%	0.0200	51.3	0.00	4.00	0.95	0.00	0.00	0.00	2.15	0.00	13.50	OK High Point = 104+12.82
SR 31 ML	104+12.82	104+31.86	LT/RT	-0.19%	0.0200	51.3	0.02	4.00	0.95	0.09	0.00	0.09	3.91	0.00	13.50	OK
SR 31 ML	104+12.82	104+51.69	LT/RT	-0.40%	0.0200	51.3	0.05	4.00	0.95	0.17	0.00	0.17	4.47	0.00	13.50	OK
SR 31 ML	104+12.82	104+71.52	LT/RT	-0.60%	0.0200	51.3	0.07	4.00	0.95	0.26	0.00	0.26	4.83	0.00	13.50	OK
SR 31 ML	104+12.82	104+91.35	LT/RT	-0.80%	0.0200	51.3	0.09	4.00	0.95	0.35	0.00	0.35	5.10	0.00	13.50	OK
SR 31 ML	104+12.82	105+11.18	LT/RT	-1.00%	0.0200	51.3	0.12	4.00	0.95	0.44	0.00	0.44	5.32	0.00	13.50	OK
SR 31 ML	104+12.82	105+31.01	LT/RT	-1.21%	0.0200	51.3	0.14	4.00	0.95	0.53	0.00	0.53	5.51	0.00	13.50	OK
SR 31 ML	104+12.82	105+50.84	LT/RT	-1.41%	0.0200	51.3	0.16	4.00	0.95	0.62	0.00	0.62	5.67	0.00	13.50	OK
SR 31 ML	104+12.82	105+70.67	LT/RT	-1.61%	0.0200	51.3	0.19	4.00	0.95	0.71	0.00	0.71	5.82	0.00	13.50	OK
SR 31 ML	104+12.82	105+90.50	LT/RT	-1.81%	0.0200	51.3	0.21	4.00	0.95	0.80	0.00	0.80	5.95	0.00	13.50	OK
SR 31 ML	104+12.82	106+10.33	LT/RT	-2.02%	0.0200	51.3	0.23	4.00	0.95	0.88	0.00	0.88	6.07	0.00	13.50	OK
SR 31 ML	104+12.82	106+30.16	LT/RT	-2.22%	0.0200	51.3	0.26	4.00	0.95	0.97	0.00	0.97	6.18	0.00	13.50	OK
SR 31 ML	104+12.82	106+49.99	LT/RT	-2.42%	0.0200	51.3	0.28	4.00	0.95	1.06	0.00	1.06	6.28	0.00	13.50	OK
SR 31 ML	104+12.82	106+69.82	LT/RT	-2.62%	0.0200	51.3	0.30	4.00	0.95	1.15	0.00	1.15	6.37	0.00	13.50	OK
SR 31 ML	104+12.82	106+89.65	LT/RT	-2.82%	0.0200	51.3	0.33	4.00	0.95	1.24	0.00	1.24	6.46	0.00	13.50	OK
SR 31 ML	104+12.82	107+09.48	LT/RT	-3.03%	0.0200	51.3	0.35	4.00	0.95	1.33	0.00	1.33	6.55	0.00	13.50	OK
SR 31 ML	104+12.82	107+29.31	LT/RT	-3.23%	0.0200	51.3	0.37	4.00	0.95	1.42	0.00	1.42	6.63	0.00	13.50	OK

DRMP

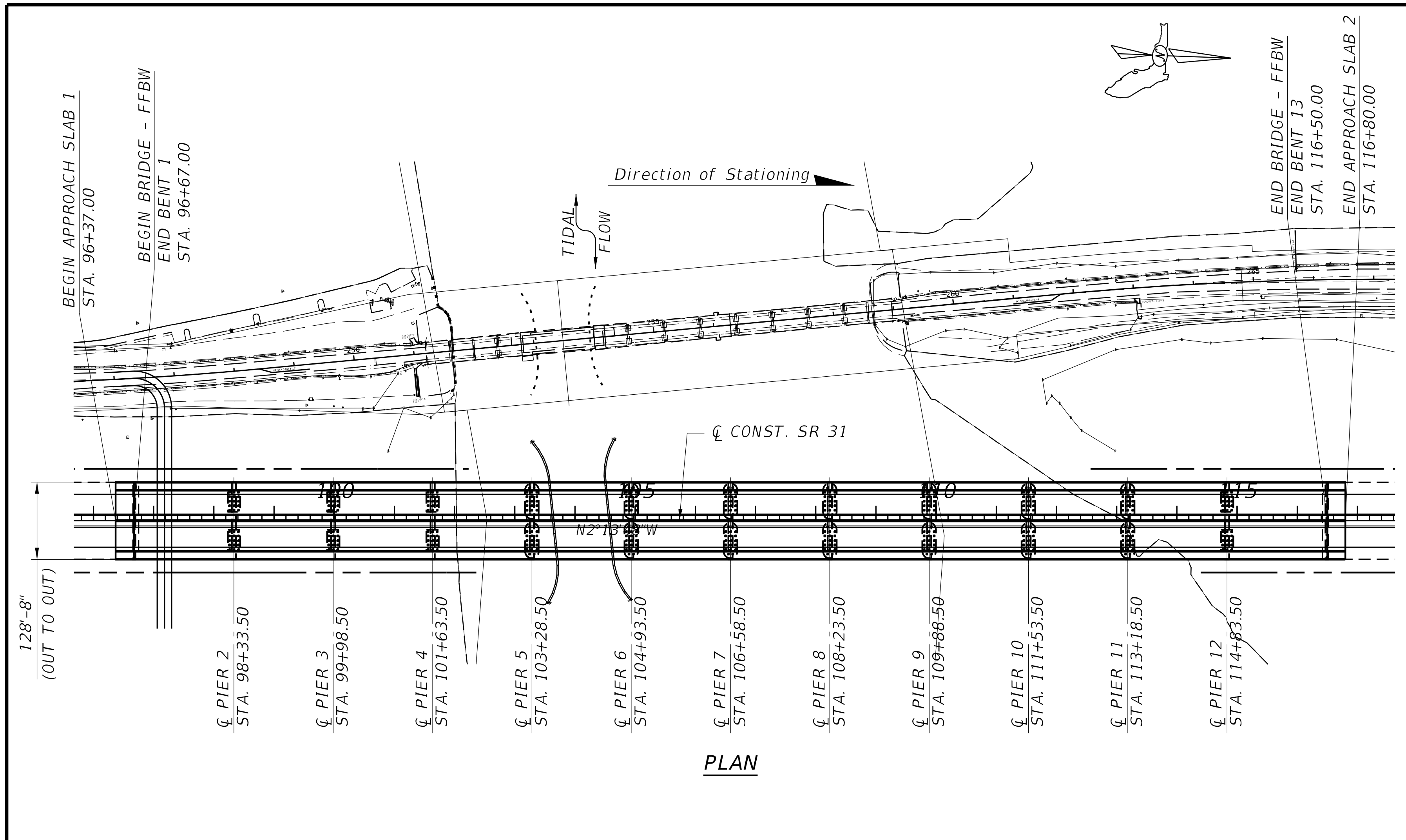
Project Name:	SR 31	Designer:	VAH
FPID:	441942-1-22-1	Checked by:	MJ
County:	Lee	Date:	10/21/2022

BRIDGE SPREAD CALCULATIONS

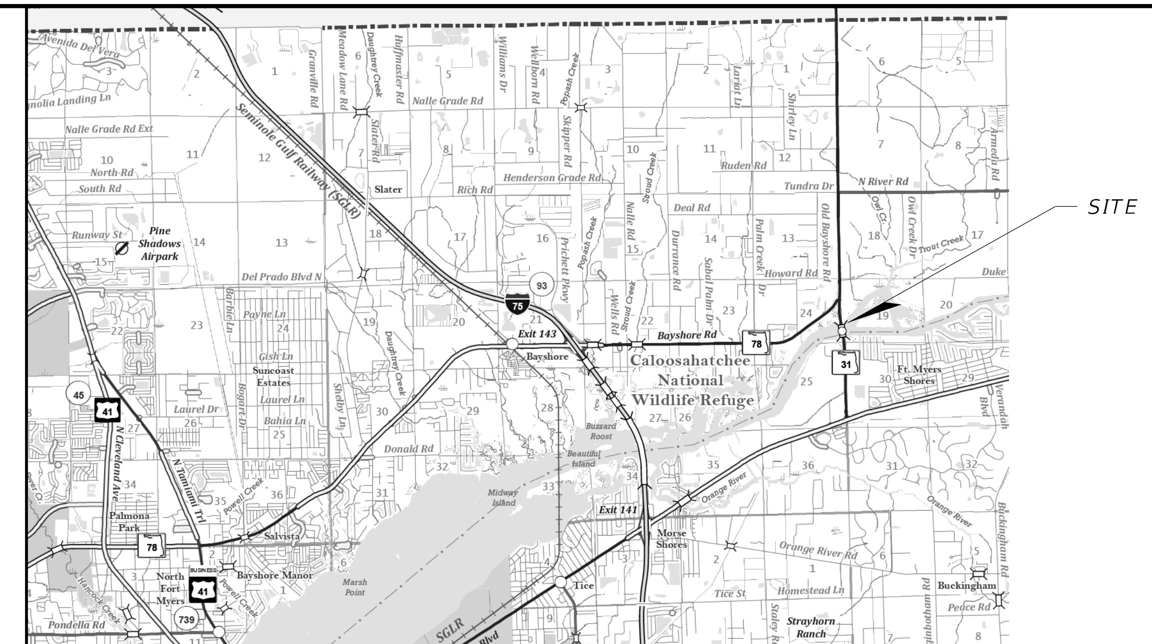
Reference: Section 6.3.2.4, Chapter 6, FDOT Drainage Design Guide, 2017

STRUCTURE NUMBER	STATION FROM (ft.)	STATION TO (ft.)	SIDE	LONG. SLOPE %	CROSS SLOPE Sx (ft/ft)	WIDTH (ft.)	AREA A (Ac.)	Intensity i (in/hr)	Runoff Coeff. C	FLOW Q (cfs)	BYPASS Upstream Qb (cfs)	TOTAL FLOW Qt (cfs)	SPREAD WIDTH T (ft.)	BYPASS Qb (cfs)	Allowable Spread (ft)	REMARKS
SR 31 ML	104+12.82	107+49.14	LT/RT	-3.43%	0.0200	51.3	0.40	4.00	0.95	1.51	0.00	1.51	6.70	0.00	13.50	OK
SR 31 ML	104+12.82	107+68.97	LT/RT	-3.63%	0.0200	51.3	0.42	4.00	0.95	1.59	0.00	1.59	6.77	0.00	13.50	OK
SR 31 ML	104+12.82	107+88.80	LT/RT	-3.84%	0.0200	51.3	0.44	4.00	0.95	1.68	0.00	1.68	6.84	0.00	13.50	OK
SR 31 ML	108+04.82	108+08.63	LT/RT	-4.00%	0.0200	51.3	0.00	4.00	0.95	0.02	0.00	0.02	1.21	0.00	13.50	OK
SR 31 ML	108+04.82	108+28.46	LT/RT	-4.00%	0.0200	51.3	0.03	4.00	0.95	0.11	0.00	0.11	2.41	0.00	13.50	OK
SR 31 ML	108+04.82	108+48.29	LT/RT	-4.00%	0.0200	51.3	0.05	4.00	0.95	0.19	0.00	0.19	3.02	0.00	13.50	OK
SR 31 ML	108+04.82	108+68.12	LT/RT	-4.00%	0.0200	51.3	0.07	4.00	0.95	0.28	0.00	0.28	3.48	0.00	13.50	OK
SR 31 ML	108+04.82	108+87.95	LT/RT	-4.00%	0.0200	51.3	0.10	4.00	0.95	0.37	0.00	0.37	3.86	0.00	13.50	OK
SR 31 ML	108+04.82	109+07.78	LT/RT	-4.00%	0.0200	51.3	0.12	4.00	0.95	0.46	0.00	0.46	4.18	0.00	13.50	OK
SR 31 ML	108+04.82	109+27.61	LT/RT	-4.00%	0.0200	51.3	0.14	4.00	0.95	0.55	0.00	0.55	4.46	0.00	13.50	OK
SR 31 ML	108+04.82	109+47.44	LT/RT	-4.00%	0.0200	51.3	0.17	4.00	0.95	0.64	0.00	0.64	4.72	0.00	13.50	OK
SR 31 ML	108+04.82	109+67.27	LT/RT	-4.00%	0.0200	51.3	0.19	4.00	0.95	0.73	0.00	0.73	4.96	0.00	13.50	OK
SR 31 ML	108+04.82	109+87.10	LT/RT	-4.00%	0.0200	51.3	0.21	4.00	0.95	0.82	0.00	0.82	5.18	0.00	13.50	OK
SR 31 ML	108+04.82	110+06.93	LT/RT	-4.00%	0.0200	51.3	0.24	4.00	0.95	0.91	0.00	0.91	5.38	0.00	13.50	OK
SR 31 ML	108+04.82	110+26.76	LT/RT	-4.00%	0.0200	51.3	0.26	4.00	0.95	0.99	0.00	0.99	5.57	0.00	13.50	OK
SR 31 ML	108+04.82	110+46.59	LT/RT	-4.00%	0.0200	51.3	0.28	4.00	0.95	1.08	0.00	1.08	5.75	0.00	13.50	OK
SR 31 ML	108+04.82	110+66.42	LT/RT	-4.00%	0.0200	51.3	0.31	4.00	0.95	1.17	0.00	1.17	5.93	0.00	13.50	OK
SR 31 ML	108+04.82	110+86.25	LT/RT	-4.00%	0.0200	51.3	0.33	4.00	0.95	1.26	0.00	1.26	6.09	0.00	13.50	OK
SR 31 ML	108+04.82	111+06.08	LT/RT	-4.00%	0.0200	51.3	0.36	4.00	0.95	1.35	0.00	1.35	6.25	0.00	13.50	OK
SR 31 ML	108+04.82	111+25.91	LT/RT	-4.00%	0.0200	51.3	0.38	4.00	0.95	1.44	0.00	1.44	6.40	0.00	13.50	OK
SR 31 ML	108+04.82	111+45.74	LT/RT	-4.00%	0.0200	51.3	0.40	4.00	0.95	1.53	0.00	1.53	6.55	0.00	13.50	OK
SR 31 ML	108+04.82	111+65.57	LT/RT	-4.00%	0.0200	51.3	0.43	4.00	0.95	1.62	0.00	1.62	6.69	0.00	13.50	OK
SR 31 ML	108+04.82	111+85.40	LT/RT	-4.00%	0.0200	51.3	0.45	4.00	0.95	1.70	0.00	1.70	6.82	0.00	13.50	OK
SR 31 ML	108+04.82	112+05.23	LT/RT	-4.00%	0.0200	51.3	0.47	4.00	0.95	1.79	0.00	1.79	6.95	0.00	13.50	OK
SR 31 ML	108+04.82	112+25.06	LT/RT	-4.00%	0.0200	51.3	0.50	4.00	0.95	1.88	0.00	1.88	7.08	0.00	13.50	OK
SR 31 ML	108+04.82	112+44.89	LT/RT	-4.00%	0.0200	51.3	0.52	4.00	0.95	1.97	0.00	1.97	7.20	0.00	13.50	OK
SR 31 ML	108+04.82	112+64.72	LT/RT	-4.00%	0.0200	51.3	0.54	4.00	0.95	2.06	0.00	2.06	7.32	0.00	13.50	OK
SR 31 ML	108+04.82	112+84.55	LT/RT	-4.00%	0.0200	51.3	0.57	4.00	0.95	2.15	0.00	2.15	7.44	0.00	13.50	OK
SR 31 ML	108+04.82	116+50.00	LT/RT	-3.00%	0.0200	51.3	1.00	4.00	0.95	3.78	0.00	3.78	9.71	0.00	13.50	OK

Appendix E Bridge Hydraulics Recommendation Sheet Information (BHRS to be included in next submittal)



PLAN



(REFERENCE)	EXISTING STRUCTURES (1)	(2)	(3)	(4)	PROPOSED STRUCTURE
FOUNDATION	STEEL H-PILES				CONCRETE PILES
OVERALL LENGTH	777'-9"				1983'-0"
SPAN LENGTH	VARIES				166'-6" & 165'-0"
TYPE CONSTRUCTION	CONC./STEEL				CONCRETE
AREA OF OPENING@D.F.	N/A				N/A
BRIDGE WIDTH	37'-2"				128'-8"
ELEV. LOW MEMBER	N/A				13.82'

HYDRAULIC DESIGN DATA

NOTE:
The hydraulic data is shown for informational purposes only to indicate the flood discharges and water surface elevations which may be anticipated in any given year. This data was generated using highly variable factors determined by a study of the watershed. Many judgements and assumptions are required to establish these factors. The resultant hydraulic data is sensitive to changes, particularly antecedent conditions, urbanization, channelization and land use. Users of this data are cautioned against the assumption of precision which cannot be obtained.

TERMS:
Design Flood: Utilized to assure a desired level of hydraulic performance.
Base Flood: Has a 1% chance of being exceeded in any given year (100 year frequency)
Overtopping Flood: Causes flow over the highway, over a watershed divide, or thru emergency relief structures.
Greatest Flood: The most severe that can be predicted where overtopping is not practicable.

WATER SURFACE ELEVATIONS: N.H.W. (Non-Tidal) N/A; M.H.W. (Tidal) +0.23'
CONTROL (Non-Tidal) N/A; M.L.W. (Tidal) -0.78'

FLOOD DATA:	MAX. EVENT OF RECORD	DESIGN FLOOD	BASE FLOOD	☐ OVERTOPPING or ■ GREATEST FLOOD
STAGE ELEV. NAVD (ft)		+8.1 (+9.1)	+9.7 (+10.7)	+13.4 (+14.4)
DISCHARGE (cfs)		50,231	62,754	106,257
AVERAGE VELOCITY (f/s)		4.9	6.0	8.7
EXCEEDANCE PROB. (%)		2	1	0.2
FREQUENCY (yr.)		50	100	500

SCOUR PREDICTIONS FOR PROPOSED STRUCTURE DESCRIBED ABOVE:

PIER INFORMATION NUMBERS	SIZE AND TYPE	LONG TERM SCOUR ELEV.	TOTAL SCOUR ELEVATION WORST CASE < 100 yr. FREQ. (yr.) 100	WORST CASE < 500 yr. FREQ. (yr.) 500
2, 3, 4, 11	3x5 30" SQ. CONC. PILES	-3.9'	-3.9'	-4.0'
5, 8, 9, 10	3x7 30" SQ. CONC. PILES	-30.1'	-30.1'	-33.4'
6, 7	3x7 30" SQ. CONC. PILES	-39.3'	-39.3'	-41.9'

HYDRAULIC RECOMMENDATIONS

1. BEGIN BRIDGE STATION 96+67.00 END BRIDGE STATION 116+50.00 SKEW ANGLE 0°
2. CLEARANCE PROVIDED: NAV: HORIZ. 90' VERT. 55' ABOVE EL. +0.23' DRIFT: HORIZ. 90' VERT. 5.7' ABOVE EL. +8.1'
3. MINIMUM CLEARANCE: NAV: HORIZ. ____ VERT. 6' ABOVE EL. +0.23' DRIFT: HORIZ. N/A VERT. 2' ABOVE EL. +8.1'
4. ABUTMENTS:

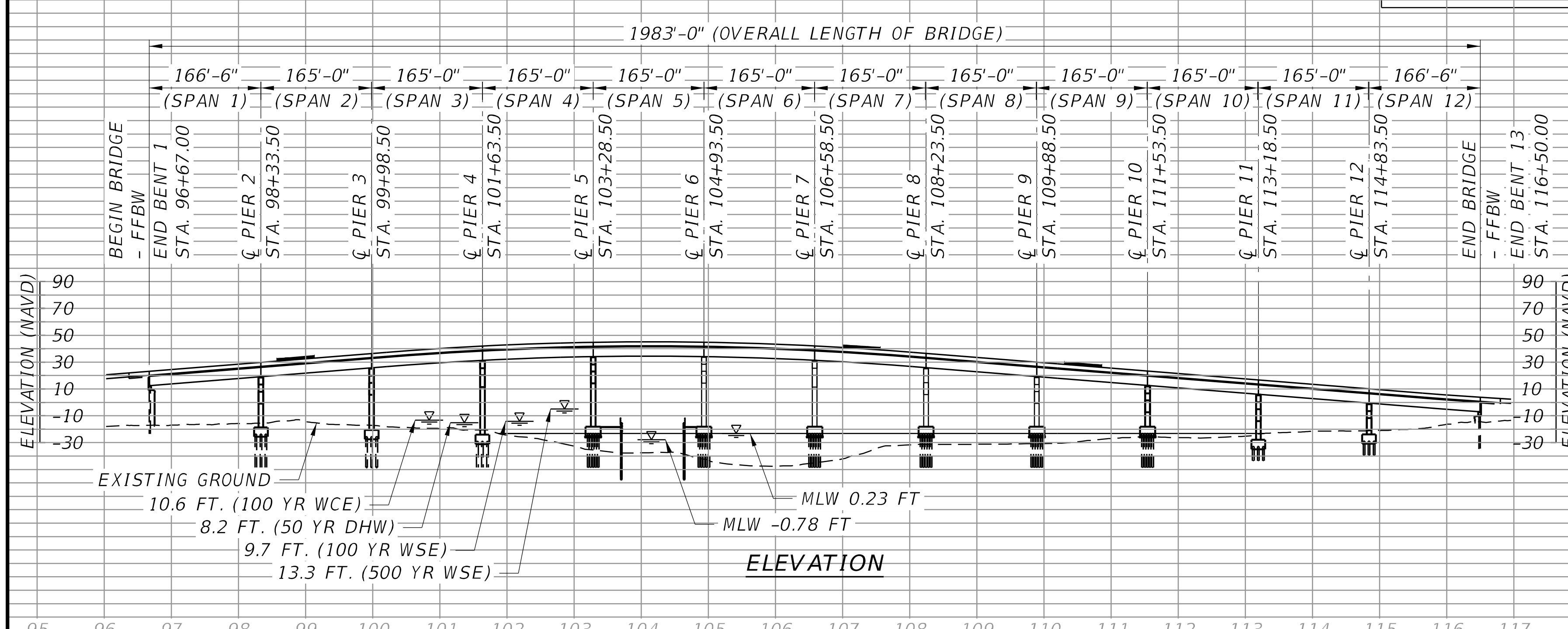
	BEGIN BRIDGE	END BRIDGE
RUBBLE GRADE:	BANK AND SHORE RUBBLE RIPRAP	BANK AND SHORE RUBBLE RIPRAP
SLOPE:	2H:1V	2H:1V
BURIED OR NON-BURIED HORIZ. TOE:	BURIED	BURIED
TOE HORIZ. DISTANCE:	10'	10'
LIMIT OF PROTECTION:	15'	15'

5. DECK DRAINAGE: COLLECTED AT BEGIN AND END BRIDGE

REMARKS: *NUMBERS IN PARENTHESES INCLUDE SEA LEVEL RISE.

BRIDGE NUMBER XXXXXX

BRIDGE NO.



ELEVATION

REVISIONS DATE	BY	DESCRIPTION	DATE	BY	DESCRIPTION

MARK GOSSELIN, PHD, P.E.
License Number: P.E. 54594
INTERA INCORPORATED
2114 NW 40TH TERRACE, SUITE A1
GAINESVILLE, FL 32605

DRAWN BY: JLA 10-22
CHECKED BY: XXX MM-YY
DESIGNED BY: XXX MM-YY
CHECKED BY: XXX MM-YY

STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION

ROAD NO.	COUNTY	FINANCIAL PROJECT ID
SR 31	LEE	441942-1-22-1

SHEET TITLE: BRIDGE HYDRAULIC RECOMMENDATIONS

PROJECT NAME: SR 31 FROM SR 80 (PALM BEACH BOULEVARD) TO SR 78 (BAYSHORE ROAD)

REF. DWG. NO.

SHEET NO. B1-05

10/28/2022 9:38:24 AM JArnemann
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